USS Chung Hoon (DDG-93) fires a missile at a practice target off the coast of the Hawaiian Islands during the biannual Exercise Rim of the Pacific (RIMPAC) on board HMCS WINNIPEG on 23 August 2020.

Image by: Sailor First Class Valerie LeClair

# Ground Based Air Defence: Canada, Potential Threats and Allied Responses


**BY RICHARD SHIMOOKA**

*Richard Shimooka is a Senior Fellow at the Macdonald Laurier Institute. He previously held fellowship positions at the Conference Defence Associations Institute, and Queen's University's Center for International Relations and the Defence Management Studies Program.*


**The past several decades, one of the most visible and publicized aspects of modern warfare has been the application of airpower on the battlefield. To be sure, there's nothing new with this trend – one can recall how the employment of precision-guided munitions in the Gulf War was frequently publicized by coalition planners in media briefings. Airpower has the ability to be decisive in conflict, though perhaps not alone, as illustrated by the debates over the outcome of the 1999 Kosovo conflict,[1] but certainly in-concert with capabilities from other environments.**

The development of an effective counter-capability is a critical part of contemporary land warfare. Yet, as we will see, the nature of airpower has changed dramatically, as has the technology environment that enable these capabilities. To adapt to the battle space, the Canadian Armed Forces (CAF) must not only have the weapon systems to deal with these threats, but also the procurement system that can continually incorporate new innovations. This study will identify this changing threat and technological environment, the requirements outlined by Canadian defence policy on this matter, and how allied countries are addressing the same challenges.

## The emerging threat and technological environment

As western militaries have enjoyed unfettered air superiority since the end of the Cold War, investments in new systems have stagnated significantly. The Canadian Army, for instance, divested itself of its primary surface-to-air missile system – the Air Defence Anti-Tank System (ADATS) – in 2012. Today, it is completely unprepared to combat aerial threats on the modern battlefield.

There are several factors behind this renewed threat. First the cost and accessibility of air-based capability has dramatically declined with the introduction of unmanned aerial vehicles (UAVs) in a military capacity. Several conflicts have highlighted this emerging threat; for example, Ukraine, Nagorno-Karabakh, and the war against ISIS in Syria and Iraq all featured extensive use of UAVs by both state and non-state actors.[2] In particular, the proliferation of affordable and easily employed small unmanned aerial vehicles (SUAVs), defined as Group 1 or 2,[3] represents a major threat to all combatants, including the CAF.

Second, the threat presented by these UAVs are different from the aerial threat from manned aircraft during the Cold War. At that time, the threats faced were either helicopters or fixed-wing combat aircraft, both of which generally weigh at least 10,000 lbs and present a large visual, radio and infrared profile. The introduction of UAVs, particularly the SUAV variety, has altered the threat dynamic dramatically. SUAVs tend to have extremely small radar cross-sectional profiles – as small as 30 centimetres across for some commercially available versions. SUAVs can also apply swarming tactics, which involve multiple units operating at low height that are able to avoid direct fire as well as have the redundancy to lose significant numbers and still complete their missions.

"Other new aerial threats have come arisen since the end of the Cold War: low observability, cyber, and electronic warfare technologies are becoming more broadly available and capable, as are stand-off munitions, ranging from short range air-launched missiles to long range air, sea, subsurface or ground launched cruise missiles."

A further complication has been the proliferation of loitering munitions, which are able to traverse the battlefield and attack targets of opportunity. While these systems remain largely "man-in-the loop" systems (i.e., ultimately controlled by a human), a few are semi- or fully autonomous, and several more autonomous systems are emerging on the market.[4] This allows for operations untethered from ground links, further reducing these munitions already small signature at very low flight profiles and thus making them more difficult to intercept and less susceptible to electronic attack.

Other new aerial threats have come arisen since the end of the Cold War: low observability, cyber, and electronic warfare technologies are becoming more broadly available and capable, as are stand-off munitions, ranging from short range air-launched missiles to long range air, sea, subsurface or ground launched cruise missiles. Finally, there's the growing proliferation of theatre ballistic missiles, which have become increasingly accurate and effective over the past decade. In short, the threat environment has become more acute and diversified in the past 20 years.

"...many capabilities, if not most, are software-enabled in some way, which undergo upgrades much more rapidly and regularly than physical systems."

The technology environment also cuts both ways, providing potentially new opportunities to improve air defence systems, including with directed energy weapons, improvements in sensor capabilities and data networking systems, among others. Furthermore, many capabilities, if not most, are software-enabled in some way, which undergo upgrades much more rapidly and regularly than physical systems. This makes capabilities more adaptable to changing operational circumstances but require new approaches to effectively manage.

The CAF currently faces this threat environment with little in the way of capabilities, a problem that its procurement process is particularly ill-equipped to deal with. As noted above, it divested the ADATS system in the early 2010, in part due to the lack of threat and budgetary pressures, but also because of the system's obsolescence. While an excellent system at its development, ADATS's human steered guidance system would have struggled against these new air threats. While Canada is reportedly in the process of re-acquiring stocks of man-portable, shoulder-launched systems (likely the FIM-82 Stinger missile), they are often mis-matched to the threat. In other words, they are comparatively expensive to use against low-cost drones, and the small signatures of these threats – especially compared to legacy Cold War-era platforms – may lead to higher numbers of shots being taken to achieve a mission kill.

To partially address the changing nature of aerial threats, the Department of National Defence in 2015 launched the Ground Based Air Defence (GBAD) project. It has undergone several revisions, and, while officially stated to have a funding range between approximately $250 and $500 million, reports suggest the budget ceiling may have doubled to $1 billion.[5] According to its stated aim:

> *The GBAD system will provide tactical air defence protection to friendly forces and vital installations during expeditionary and domestic operations against the increasingly diverse air threat... The target threats are rocket, artillery and mortar (RAM) munitions, air to surface missiles (ASM) and bombs, and Remotely Piloted Aircraft Systems (RPAS).*[6]

The statement is consistent with the three broad missions of the CAF, as outlined in various defence while papers: 1) the defence of Canada, 2) North America, 3) and allies or international security. The first two missions tend to be covered through the continental defence mission, specifically the North American Aerospace Defence Command (NORAD). The third entails an expeditionary capability to provide forces to the North Atlantic Treaty Organization (NATO), or other multinational coalitions. These three missions normally focus on very different threats, and thus require different systems.[7]

For domestic operations, the CAF has occasionally deployed short-range air defence systems temporarily for major national events, such as *Operation Grizzly* in 2002 Kanaskis Summit, *Operation Cadence* for the G8 and G20 summits in Ontario in 2008, and *Operation Podium* for the 2010 Winter Olympics. The increased commercial affordability and availability of SUAVs will make these kinds of domestic counter-terror event protection deployments more frequent.

NORAD's mission considerations have become a major priority for government, focusing on very large technical solutions for surveillance and detection of threats, including two new over-the-horizon radars and possibly a polar satellite radar system.[8] While GBAD is not primarily focused on strategic threats to, NORAD modernization could draw draw some resources away from the program by forcing it to integrate with them.

Expeditionary operations are clearly the primary focus of GBAD – the development of an air defence capability for foreign operations, usually within a multinational framework. This will likely be the primary focus of GBAD's use; this would include operating in support of other CAF elements in the field, primarily (but not exclusively) Army units. The broad swath of scenarios and threats that it is intended to defend against, alongside its mention of "tactical air defence," imply a fairly

**Canadian Armed Forces soldiers from 3rd Battalion, Princess Patricia's Canadian Light Infantry, supplemented with reservists of The Calgary Highlanders and The Loyal Edmonton Regiment, conduct an 81mm mortar range during Exercise APOLLO VALIDATION, March 9 2022.**

**Image by: Corporal Djalma Vuong-De Ramos**

broad array of capabilities. At present, counter rocket, artillery and mortar (C-RAM) missions as well protection against air-to-ground ordnance tend to be the domain of semi-fixed site systems, such as Israel's Iron Dome. The high levels of radar-track accuracy needed to hit high-speed moving targets, and large munitions magazines required to successfully defeat an incoming barrage of multiple projectiles, limit the mobility of these systems. Protecting army units manoeuvring in the field from SUAVs and other aerial threats will require a second mobile air defence system.

Foreign militaries have understood the inherent difference between these two mission sets (fixed systems versus mobile) and have separated these roles into different programs, thus increasing the robustness of their air defence network. In the next section, we will examine the US and Germany's respective approaches to this emerging threat environment.

## Allied responses

Due to the emerging and acute aerial threat environment, many NATO members have jumpstarted materiel responses tailored to their specific needs. The United States, in particular, is undertaking a major modernization effort across the entire spectrum of air defence capabilities.

The lowest tier of capability is the Mobile SHORAD (Short Range Air Defence) or M-SHORAD capabilities, increment one, two and three. Currently mounted on the Stryker armoured fighting vehicle (a derivative of the Canadian LAV III), increment 1 uses a mix of an auto cannon and short-ranged surface-to-air missiles (currently the FIM-82 Stinger missile), while increment 2 (also known as Directed Energy SHORAD) will mount a high-powered laser.[9] A brigade-level asset, platoons will be apportioned out to protect manoeuvre companies and battalions as necessary.

The next tier is three fixed-site defence programs under the Indirect Fire Protection Capability (IFPC), designed for the Counter Unmanned Aircraft Systems (C-UAS) mission, as well as C-RAM: Kinetic (Increment 2), High Energy Laser (HEL), and High-Powered Microwave (HPM).[10] These programs are intended to provide fixed-site cruise missile defence, as well as eventually replacing the existing base defence protection system, like the Iron Dome and C-RAM systems.

For brigade level and above, the US will continue to utilize the MIM-104 Patriot missile system, but it will see further improvements – both in the types of missiles available and the launcher vehicles employed, in order to increase the mobility and flexibility of the overall system.

In addition to these kinetic and direct energy systems, the US is pursuing several radar and sensor projects. One is the Sentinel A4, which is optimized to detect and track C-RAM and Remotely Piloted Aircraft System (RPAS) threats.[11] It will be complemented with AN/TPQ-53, which overlaps in its capabilities but is larger and more capable in its performance.[12] Another major program is the Lower Tier Air and Missile Defense Sensor, which

"...allowing different sensor and weapon systems to be "plug and played" as available and/or required."

is intended to provide long-range sensor coverage and tracking for larger threats, which support Patriot and IFPC operations.[13] Collectively, these systems will provide a flexible approach to detection across a spectrum of threats and environments.

Finally, tying all of these systems together is the US Army's Integrated Air and Missile Defense program, more commonly known by its contractor name, Integrated Command Battle System (IBCS). The prime contractor for this system is Northrop Grumman, with the system intended to enable a "transformation to a network-centric SoS (shoot on sight) capability that integrates AMD sensors and weapons with the IBCS EOC (Engagement Operations Center)."[14] At its core, it is a transformational approach to air defence – allowing different sensor and weapon systems to be "plug and played" as available and/or required. This should allow for an approach known as "any sensor, best shooter" – essentially using networking to create a fused sensor picture of the battlefield, then allocating air defence assets to strike targets.[15]

The development of IBCS, as well as other similar systems, reflects a broader move towards modular and open source architectures (MOSA) due in part to the "pace of technology maturation in some sectors" and how traditional acquisition approaches were challenged by them.[16]

> *Implementing MOSA architectures will accelerate and simplify the delivery of advanced capability into systems without replacing entire systems. Incorporating modularity principles should result in systems with highly cohesive, loosely coupled, and severable modules that can be openly competed. This approach would enable both pre-planned and opportunistic technology based upgrades in the areas of technology that are most subject to change. It enables the independent acquisition of systems, subsystems, and components, to include software.*[17]

Through effective battlefield networking, each platform does not necessarily require sensors, weapons and decision-making systems onboard. Instead, they can be disaggregated into interconnected, single-purpose platforms, which can increase a unit's overall flexibility, redundancy and lethality.

Procurement has started to reflect this system-of-systems reality. In the past, the US would acquire the capabilities as a single completed system, with radar, command and missiles collectively developed as a single program. In light of the systems-of-systems' approach, the US has split the program management of these capabilities into individual projects. For example, 20 years ago, the Patriot missile system was managed as a single capability – its missiles, radars and command, control and communications (C3) systems were self-contained within the project. However, with the growing transformation centered around networking and system-of-systems, the constituent parts (PAC3, AIAMD and LTAMDS) are acquired and managed separately.

Similarly, European efforts have focused on multiple systems designed to address different threats to different organizational levels. For example, the Bundeswehr has nearly completed fielding a multi-tiered approach for air defence.[18] This includes the Boxer NNBS, an interim, vehicle-based, very short-ranged air defence (VSHORAD) capability against small UAVs.[19] This will likely be supplemented in the coming years by a more capable brigade-level SHORAD platform – possibly the Sky Ranger 30 auto-cannon mounted on a Boxer armoured fighting vehicle chassis.[20]

The divisional level is the most developed force structure, including three platoons of mixed air defence systems – a medium-ranged system using the IRIS-T missile, and two platoons of SHORAD systems. Above this level is the long-ranged air defence provided by the US-developed Patriot, and an emerging theatre anti-ballistic missile (ABM) system (likely to be the Israeli Arrow 3 system) with attendant radars.


**A CF-18 Hornet aircraft from 3 Wing Bagotville arrives at Thule Air Base, Greenland to take part in Exercise AMALGAM DART, North American Aerospace Defense Command's Arctic air defense exercise, March 20, 2021.**

**Image by: Master Corporal Gary Calvé**

As with the US Army, the Bundeswehr approach has been to develop new sensor platforms as well as a connected battle management C4I (command, control, communications, computers and intelligence) system with plug-and-play capabilities. The existing Airbus SAMOC system[21] will be supplanted by a newer system, the Integrated Battle Management System (IBMS), which will have greater modularity and flexibility to incorporate data sources into a single fused battle map.[22] In addition, like the United States, the German military has also disaggregated its air defence acquisition programs into different levels of capabilities, sensors and battle management systems. This achieves the flexibility required to deal with the challenging threat environment.

## Lessons and recommendations for Canada

As the previous sections make clear, the nature of the threat environment and the allied state responses means that multi-system approach is required. Doctrinal development over the past decade has been towards greater integration of all systems on the battlefield. The US Army's Integrated Air and Missile Defense and the Bundeswehr's Airbus IBMS are examples of the core role that the battle management system now plays in developing an effective air defence capability.

Yet Canada has been slow to absorb the emerging strategic threat and procurement reality. The focus on a single system acquisition is completely at odds with what major western military powers are doing. In its present state, GBAD will be much less flexible and effective at dealing with the new highly

"This is a conceptual shift that Canadian military procurements must adapt to, or else risk fielding much less capable capabilities, often at a much higher cost."

uncertain threat environment. By acquiring entire capability sets as a package, it is less likely that sub-systems will receive upgrades necessary to keep them modernized and flexible enough to use against new and emerging threats, while also being less easily integrated with other capabilities acquired against such threats.

Furthermore, GBAD's scoped range of threats may well be far too large for the project. GBAD calls for both the protection of friendly forces and installations – roles that both the Bundeswehr and US Army divide into two families of systems (M-SHORAD and IFPC in the latter's case). No single system exists that would be able to cover the mission set, and it is likely that none will ever exist. Thus, it is possible that the GBAD does not undertake the M-SHORAD mission at all, which leaves the CAF with a major capability gap.

While altering the GBAD project at this late stage to take advantage of these realizations is unlikely, there are some useful lessons to be gleaned from how allies are responding to the air defence threat. Their efforts have adapted to the emerging era of networked systems and rapid technological change. Capabilities have become separated into individual subsystem, which themselves have been segmented into different increments as technologies improved. What has enabled this approach is vastly improved levels of networking and computing, which has allowed for subsystems to be integrated into a broader cohesive capability. This is a conceptual shift that Canadian military procurements must adapt to, or else risk fielding much less capable capabilities, often at a much higher cost.

Based on this reality, Canada should always look towards developing the underlying networking backbone of their military capabilities, specifically concerning command and control system. Its progress should be guided by flexibility to remain upgradable and interoperable with allied systems. Ancillary programs should build upon this foundation and address specific categories of threats.

As noted earlier, iterations of this approach can be used successfully for other environments, such as maritime surveillance or battlefield reconnaissance. It will have particular relevance given the proliferation of UAVs, particularly ones of vastly different sizes, weights and capabilities. Through this approach, the CAF can ensure that it obtains the best value for money, while remaining relevant to the emerging battlefield at hand. CMJ Canadian Military Journal

## Notes

1 Daniel Byman and Matthew Waxman "Kosovo and the Great Air Power Debate" *International Security*, Vol. 24, No. 4, Spring 2000

2 For examples see: Jack Detcsh "Drones Have Come of Age in Russia-Ukraine War" *Foreign Policy* April 27, 2022 https://foreignpolicy.com/2022/04/27/drones-russia-ukraine-war-donbas/ and Jack Watling and Sidharth Kaushal "The Democratisation of Precision Strike in the Nagorno-Karabakh Conflict" *Royal United Services Institute* October 22 2020 https://rusi.org/explore-our-research/publications/commentary/democratisation-precision-strike-nagorno-karabakh-conflict

3 Group 1 and 2 SUAVs tend to operate under 1200 and 3500 feet above ground level, respectively, and have a maximum of 20 to 55 lbs maximum gross takeoff weight. See Page D-3 "Unmanned Aircraft System Airspace Integration Plan Ver. 2.0" *Department of Defense* March 2011 and TITLE 14, PART 107 - SMALL UNMANNED AIRCRAFT SYSTEMS *Code of Federal Regulations* https://www.ecfr.gov/current/title-14/chapter-I/subchapter-F/part-107

4 Zachary Williams "Loitering Munitions in the Future of Chinese Warfare" *The Diplomat* October 21, 2022: https://thediplomat.com/2022/10/loitering-munitions-in-the-future-of-chinese-warfare/

5 David Pugliese "Canadian military eyes new ground-based air defence system at a cost of $1 billion" *Ottawa Citizen*. May 2, 2022 https://ottawacitizen.com/news/national/defence-watch/canadian-military-eyes-new-ground-based-air-defence-system-at-a-cost-of-1-billion

6 Defence Capabilities Blueprint "Ground Based Air Defence" *Government of Canada* January 9, 2020 http://dgpaapp.forces.gc.ca/en/defence-capabilities-blueprint/project-details.asp?id=940

7 Generally speaking, Canada's continental security role has not possessed a continuous land-based air defence system since the retirement of the Bomarc anti-strategic bomber missile system in 1972.

8 Anita Anand "Minister of National Defence Announces Canada's NORAD Modernization Plan" Department of National Defence. June 20, 2022 https://www.canada.ca/en/department-national-defence/news/2022/06/minister-of-national-defence-announces-canadas-norad-modernization-plan.html

9 Page 9 "Department of Defense Directed Energy Weapons: Background and Issues for Congress" *Congressional Research Service* September 13, 2022. https://crsreports.congress.gov/product/pdf/R/R46925

10 Page 10 "Department of Defense Directed Energy Weapons: Background and Issues for Congress" *Congressional Research Service* September 13, 2022. https://crsreports.congress.gov/product/pdf/R/R46925

11 "Sentinel A4" *Lockheed Martin*. https://www.lockheedmartin.com/en-us/products/sentinel-a4.html

12 "AN/TPQ-53 Radar System" *Lockheed Martin* https://www.lockheedmartin.com/en-us/products/tpq-53.html

13 "GhostEye® Family of Radars: LTAMDS" Raytheon Missiles & Defense https://www.raytheonmissilesanddefense.com/what-we-do/missile-defense/air-and-missile-defense-systems/ghosteye

14 "R-1 Program Element: Army Integrated Air and Missile Defense" *United States Army*. March 2019 https://www.dacis.com/budget/budget_pdf/FY20/RDTE/A/0605457A_166.pdf

15 Tamir Eshel "US Army Missile Test Demonstrates 'Any Sensor, Best Shooter' Capability" *Defense Update*. April 20 2016. https://defense-update.com/20160420_ibcs.html

16 Page 14 "Better Buying Power 3.0" *Department of Defence* April 2015 https://www.acq.osd.mil/fo/docs/betterbuyingpower3.0(9apr15).pdf

17 ibid

18 "The Oerlikon Skyranger mobile air defence system" *Rheinmetall Group* June 11, 2018 https://rheinmetall-defence.com/media/editor_media/rm_defence/publicrelations/pressemitteilungen/2018/2018_06_11_rheinmetall_eurosatory/englisch_1/2018-06-11_Rheinmetall_Eurosatory_Oerlikon_Skyranger_Boxer_en.pdf

19 ibid

20 Paolo Valpolini "Countering RAM, drones and other flying objects with highly mobile assets, Rheinmetall's solutions" *European Defence Review*. July 1, 2022. https://www.edrmagazine.eu/countering-ram-drones-and-other-flying-objects-with-highly-mobile-assets-rheinmetalls-solutions

21 "Fortion-SAMOC" *Airbus Defence and Space* https://www.intelligence-airbusds.com/markets/defence/c2/air-c2/fortion-samoc/

22 "Fortion-IBMS" *Airbus Defence and Space* https://www.intelligence-airbusds.com/markets/defence/c2/air-c2/fortion-ibms/