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BEYOND LEGACY RADAR: THE CASE FOR MODERNIZING THE RCAF WITH AN AIRBORNE EARLY WARNING AND CONTROL CAPABILITY

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AIM

1. This paper outlines the advantages of procuring an Airborne Early Warning & Control (AEW&C) capability for the Royal Canadian Air Force (RCAF). This acquisition would contribute to the modernization of NORAD, improve Canada's involvement in continental defence, and help achieve the policy objectives of the Government of Canada (GoC) in multiple areas.

INTRODUCTION

2. The RCAF research list for 2022/2023 is divided into six themes that align with the RCAF campaign plan lines of operation.[1] The fourth theme broadly aims to explore air and space force development, and the specific topic this paper will explore is:

> What capabilities will the RCAF need in order to respond to the changing environment in any of the following categories: the domestic region, the Arctic region, expeditionary operations, the maritime domain or space? Explore the new equipment or roles that the RCAF can reasonably be required to develop over the next 20 years.[2]

3. The following paper will explore the AEW&C capability and its potential to significantly benefit the GoC, the Canadian Armed Forces (CAF), and the RCAF. The paper will provide an overview of Canada's past involvement in AEW&C, examine relevant policies, describe capabilities, address key challenges, and offer a recommendation for moving forward.

DISCUSSION

AEW&C HISTORY

4. In 1943, a significant advancement in aerial warfare was introduced with the development of the first AEW&C systems.[3] These systems involved the integration of a search radar onto an aircraft, which allowed for early detection and tracking of potential airborne threats. A Very High Frequency (VHF) radio data transmitter was installed, enabling communication between the aircraft and a ground-based command center.[4] Modern AEW&C systems have become much more sophisticated and incorporate many advanced technologies. These systems are designed to provide real-time surveillance and intelligence-gathering

[1] 'RCAF Air and Space Power Research List 2022/2023' (RCAF Air Warfare Center, 5 September 2022), 2.
[2] Ibid, 8.
[3] Maurice W. Long, ed., *Airborne Early Warning System Concepts*, The SciTech Radar and Defense Series (Raleigh, NC: SciTech Pub, 2004), 2.
[4] Ibid, 2.

capabilities, and their data is fed into elaborate cloud-based command, control, and communication (C3) systems.[5]

5. The AEW&C capability has played a crucial role in the operations of NATO, NORAD, US Combatant Commanders, and single nation-states since its acquisition in the late 1970s. AEW&C provides a vital capability for commanding and controlling air, ground, and naval forces in areas that do not have existing C3 infrastructure, such as austere, remote, and hostile environments. AEW&C can also provide a radar gap-filling capability when existing surveillance infrastructure is not serviceable. Without this technology, the ability to effectively direct and coordinate military air operations would be limited to existing ground-based radar and radio systems. Therefore, the continued use and development of future AEW&C capabilities remains a top priority for military organizations worldwide.

6. Although the CAF has yet to acquire an AEW&C capability, its service members have long worked alongside their allied counterparts. As early as 1979, 14 Canadians were embedded in the United States Air Force (USAF) E-3 Airborne Warning and Control System (AWACS) detachment.[6] Since then, Canada has remained a fully integrated member of the USAF AWACS program and has also been involved with the NATO AEW and Control Force (NAEW&CF) since its establishment in 1980.[7]

7. Canada's contribution to AEW&C extends beyond just the RCAF. The Canadian Army (CA) has filled various technician roles on the aircraft, and the Royal Canadian Navy (RCN) has also supported the AEW&C program through various foreign Canadian Detachment positions. This demonstrates Canada's joint and combined involvement in AEW&C programs, creating a community of knowledgeable professionals who recognize the potential benefits of this capability for Canada.

CANADIAN POLICY

8. Canada has several policies that could greatly benefit from a future AEW&C capability. First, the Canadian government released the Strong, Secure, Engaged (SSE) national defence policy in 2017. Three categories comprise the SSE policy vision: Strong at home, Secure in North America, and Engaged in the World.[8] Several years after the release of SSE, the Minister of National Defence (MND) announced the NORAD Modernization initiative, which builds on the existing policy direction from SSE.[9] The language in both SSE and the NORAD Modernization announcement articulates Canada's intent to continue evolving capabilities to gain operational advantage over future adversaries. Specifically, SSE seeks to "anticipate, adapt, and act" and highlights the importance of improved situational awareness by prioritizing "Joint

[5] Bettina Mears, 'E-7A Wedgetail Controlling the Air, Land and Sea', Australian Government Defence, Aircraft, 30 July 2021, https://www.defence.gov.au/news-events/news/2021-07-30/e-7a-wedgetail-controlling-air-land-and-sea.
[6] Eric Emanuele, 'Canadian Detachment History: Parts 1,2,3&4', News, 552nd Air Control Wing, 1 May 2019, https://www.552acw.acc.af.mil/News/Article-Display/Article/1833215/canadian-detachment-history-part-3-of-4/.
[7] Chris Thatcher, 'Welcome Back, Canada: Flying the NATO E-3A AWACS Aircraft', Feature, Skies, 4 March 2022, https://skiesmag.com/features/welcome-back-canada-flying-nato-e-3a-awacs-aircraft/.
[8] *Strong Secure Engaged: Canada's Defence Policy* (Ottawa, ON, CA: National Defence, 2017).
[9] 'Minister of National Defence Announces Canada's NORAD Modernization Plan', Speech, Government of Canada, 20 June 2022.

Intelligence, Surveillance, and Reconnaissance capabilities."[10] The NORAD Modernization initiative highlights the importance of modernizing surveillance systems and investing more in technology-enabled decision-making.[11] It is clear from these two defence-focused policies that an AEW&C capability would support the GoC's intent.

9. The Canadian Arctic is a complicated region with several implicated policies where AEW&C would also play a role. The Arctic and Northern Policy Framework aims to "strengthen Canada's domain awareness, surveillance and control capabilities in the Arctic and North."[12] The policy highlights the growing importance of "vessel traffic in various waterways" and the "strategic, military, and economic significance" of that traffic.[13] The framework also sets three priorities in the Arctic that could implicate an AEW&C Capability: "Strengthen the rules-based international order in the Arctic; more clearly define Canada's Arctic boundaries; and broaden Canada's international engagement to contribute to the priorities of Canada's Arctic and North."[14] An AEW&C capability would greatly benefit the Arctic region, given the Arctic-specific policy direction.

10. Canada's foreign policy is another area where an AEW&C capability would help achieve Canada's strategic intent. Earlier this year, during a speech about diplomacy, the Canadian Minister of Foreign Affairs announced a new foreign policy that follows two main principles.[15] The first principle prioritizes safeguarding Canada's sovereignty. This principle recognizes that the global security situation is changing, and Canada cannot rely on its geographic location to guarantee sovereignty any longer.[16] The second principle of Canada's foreign policy describes the necessity for pragmatic diplomacy in order to prevent conflict. This principle favours diplomacy that promotes a predictable global system in which the rules-based international order is practiced by all.[17] Towards the first pillar, an AEW&C capability would undoubtedly bolster Canada's ability to safeguard its sovereignty unilaterally as well as collaboratively with allies. Towards the second pillar, an AEW&C capability would allow Canada to contribute in new ways to global alliances and coalitions in order to preserve the international rules-based order. These points will be discussed in more depth in another section of this paper.

AEW&C CAPABILITIES

11. AEW&C refers to a sophisticated airborne system capable of detecting and tracking airborne and surface objects such as aircraft, missiles, drones, remotely piloted air systems (RPAS), ground vehicles, and surface vessels. However, AEW&C is more than just this function

[10] *Strong Secure Engaged*, 63.
[11] 'NORAD Modernization Project Timelines', Fact Sheet, Government of Canada, 24 March 2023, https://www.canada.ca/en/department-national-defence/services/operations/allies-partners/norad/norad-modernization-project-timelines.html.
[12] *Canada's Arctic and Northern Policy Framework* (Ottawa: Government of Canada, 2019), 51.
[13] Ibid, 50.
[14] Ibid, 60.
[15] Mélanie Joly, 'Address by Minister Joly on Canadian Diplomacy Amidst Geopolitical Uncertainty', Global Affairs Canada, 30 October 2023, https://www.canada.ca/en/global-affairs/news/2023/11/address-by-minister-joly-on-canadian-diplomacy-amidst-geopolitical-uncertainty.html.
[16] Ibid.
[17] Ibid.

alone. It also incorporates advanced communication, navigation, and electronic warfare capabilities, making it an essential asset for military operations. With its ability to provide a comprehensive situational awareness of the airspace, AEW&C plays a crucial role in surveillance, reconnaissance, and C3 operations, enhancing military missions' effectiveness and safety.

12. Several platforms offer an AEW&C capability. These platforms can be grouped into categories: aerostats, blimps, rotary wing, fixed-wing, and recently remotely piloted systems.[18] Aerostats, or tethered balloons, operate most effectively at 5,000 to 10,000 feet and can maintain long periods in the air. Given their relatively low operating altitude, their detection ranges are approximately 100 nautical miles (nm) and are ideally suited for low and slow targets. This limited detection range is not ideal for Canadian-specific requirements, and the platform can be easily affected by high winds, which are a reality in Canada's high north.[19] Similarly, blimps can maintain long periods in the air (up to 96 hours airborne). However, they have limited detection ranges and travel very slowly compared to their fixed and rotary wing alternatives.[20] Blimps also operate at relatively low altitudes and have a limited radar detection limit, which is not ideal for the Canadian mission. Rotary wing AEW&C have similar limitations as they operate at relatively low altitudes and are further restricted by their short on-station time. Given the limitations of aerostats, blimps, and rotary wings, they will not be discussed further in this paper.

13. Fixed-wing aircraft have been the AEW&C platform of choice since the early 1980s. Fixed-wing platforms offer more options for airframes that provide improved range, speed, size, payload, and altitude. The USAF, Royal Air Force, French Air Force, Saudi Air Force, and NATO have employed several versions of the Boeing E-3 AWACS for decades. The E-3 AWACS is a competent AEW&C platform, but given its age, it would not make sense to consider it as it is currently being phased out of service by most users. Alternatively, the US Navy operates the Northrop Grumman E-2 Hawkeye, an aircraft carrier-capable airframe offering AEW&C capabilities. However, this aircraft has been in service since the early 1960s and will likely be replaced soon. A more recent fixed-wing option is the Boeing E-7A Wedgetail, currently operated by the Royal Australian Air Force, which other countries have committed to purchasing as their next-generation AEW&C platform.[21]

14. Fixed-wing AEW&C platforms offer a long radar detection range, operating at 30,000 feet or higher altitudes if needed. Their ability to detect air and surface tracks at long ranges enables them to contribute to a robust common operating picture. AEW&C platforms can act as C3 nodes or pure surveillance platforms or provide air battle management to a complex battlespace. These platforms have various communications capabilities, including HF, VHF, UHF, Link-11, Link-16, SATCOM, active and passive radar, and electronic warfare. However, these aircraft do have some downsides. Fixed-wing AEW&C platforms carry a heavy payload and are usually large airframes requiring long paved runways. These platforms are typically

[18] Long, *Airborne Early Warning System Concepts*, 56.
[19] Ibid, 48.
[20] Ibid, 53.
[21] Stephen Losey, 'US Air Force Awards Boeing First Contract for Fleet of 26 E-7 Aircraft', Defense News, Air Warfare, 1 March 2023, https://www.defensenews.com/air/2023/03/01/us-air-force-awards-boeing-first-contract-for-fleet-of-26-e-7-aircraft/.

costly to purchase and maintain and are sensitive to adverse weather conditions such as extreme cold or heat.

NORAD MODERNIZATION & CONTINENTAL DEFENCE CHALLENGES

15. The Canadian government has prioritized NORAD Modernization and improved continental defence. This holds significant importance for several reasons. Firstly, during the previous US administration under President Trump, Canada faced mounting pressure to increase its defence spending to match NATO burden-sharing commitments.[22] The current US administration, or a future one, may direct similar criticism toward Canada's involvement in the NORAD alliance. As per the NORAD agreement, the US and Canada share the costs of running the North Warning System (NWS), with the US contributing 60% of the budget and Canada contributing 40%.[23] Additionally, the RCAF relies solely on the USAF for air-to-air refuelling (AAR) during Op NOBLE EAGLE, NORAD's air-terrorism response. These examples highlight Canada's disproportionate reliance on the US for continental defence. Although Canada has taken steps to improve its AAR capabilities by acquiring the new Multi-Role-Tanker-Transport (MRTT) aircraft, more action is necessary.[24] Joining the AEW&C program would likely be viewed favourably by the US government and demonstrate Canada's commitment to fair burden-sharing toward continental defence. An AEW&C capability would enable Canada to contribute in several ways to NORAD Modernization and continental defence. First, the capacity would directly contribute to the NWS replacement by plugging into the system of systems, providing increased domain awareness, which is a crucial component of NORAD Modernization. It would allow Canada to provide a more robust surveillance and control capability during significant events such as the Olympics or G8/G20 summits. Additionally, it would increase Canada's ability to provide RCAF force generation, enabling for more fighter aircraft training and ultimately contributing to a more robust continental defence posture. Perhaps most importantly, an AEW&C capability would enhance Canada’s ability to demonstrate sovereignty during increased Russian long-range aviation penetrating the Canadian Air Defence Identification Zone.

CANADA’S ARCTIC CHALLENGE

16. The feasibility of an AEW&C capability holds significant potential to contribute to the GoC’s priorities in the Arctic region. With the opening of the Northwest Passage, the need to increase Arctic domain awareness has become crucial. Canada's limited options to track vessels of interest in the high north necessitate exploring future technologies to enable this function. Moreover, the Arctic region poses significant challenges to emergency management, such as responding during emergencies requiring air power's speed and reach. As highlighted in the Arctic policy, Canada aims to define its Arctic boundaries more clearly and increase

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[22] Joseph T. Jockel and Joel J. Sokolsky, *Canada in NATO, 1949-2019*, McGill-Queen’s Transatlantic Studies 5 (Montreal ; Kingston ; London ; Chicago: McGill-Queen’s University Press, 2021), 228.

[23] James Fergusson, ‘Missed Opportunities: Why Canada’s North Warning System Is Overdue for an Overhaul’, MacDonald Laurier Institute, January 2020, 4, https://macdonaldlaurier.ca/files/pdf/20191219_NORAD_Fergusson_COMMENTARY_FWeb.pdf.

[24] ‘Government of Canada Awards Contract for the Strategic Tanker Transport Capability Project’, National Defence, News Release, 25 July 2023, https://www.canada.ca/en/department-national-defence/news/2023/07/government-of-canada-awards-contract-for-the-strategic-tanker-transport-capability-project.html.

international engagement to contribute to the priorities of the North.[25] The deployment of an AEW&C capability can assist Canada in achieving the aforementioned Arctic goals. Deliberate and routine surveillance sorties by an AEW&C capability can significantly increase air and maritime domain awareness and define the Arctic's boundaries by tracking and prosecuting any challengers. The advanced technologies on next-generation AEW&C platforms can contribute to emergency management in the Arctic using space-enabled communications and onboard surveillance sensors to better direct search and rescue efforts. Although landing these platforms in much of the Arctic is not currently feasible given current airfield runway constraints, AAR can allow certain AEW&C platforms to stay airborne for up to 24 hours, thus overcoming this operational limitation.

EXPEDITIONARY OPERATIONS

17. The vision of being "engaged in the world," as outlined in SSE, is a necessity in today's complex geopolitical landscape.[26] The return of great power competition, persistent state-on-state conflict, the evolving nature of counter-insurgency operations, and the ever-present threat of foreign political interference all underscore the critical need for a capable, agile, and globally deployable CAF. Within this context, the RCAF stands as a vital service, often called upon as a first responder to global crises due to its unparalleled speed and reach. The RCAF has honed its expertise in providing strategic air mobility, rapidly deploying resources to all corners of the globe when called upon. However, additional capabilities are essential to maintain its relevance and effectiveness. The acquisition of an AEW&C capability would represent a crucial step forward in this regard. AEW&C would enhance Canada's ability to respond to global crises and also serve as a force multiplier, improving interoperability within alliances and coalitions. The acquisition of an AEW&C capability aligns with the SSE policy's vision of global engagement and reinforces Canada's role as a responsible global actor capable of meeting current and future security challenges.

CONCLUSION

18. The acquisition of an AEW&C capability represents a strategic imperative for the RCAF and aligns with the broader policy objectives of the GoC. This paper has demonstrated the historical significance of AEW&C in military operations and highlighted Canada's longstanding involvement in AEW&C programs through its partnerships with allied nations. Moreover, it has underscored the importance of AEW&C in supporting Canada's national defence policy, NORAD Modernization, and the Arctic and Northern Policy Framework. The discussion on AEW&C capabilities has described the various platforms available and emphasized the suitability of fixed-wing aircraft for Canada's needs. Furthermore, the paper has addressed Canada's challenges in continental defence, Arctic surveillance, and expeditionary capabilities. Overall, the acquisition of an AEW&C capability holds the promise of bolstering Canada's defence posture, improving continental defence cooperation with the United States, enhancing domain awareness in the Arctic region, and enabling more opportunities for expeditionary involvement. By investing in this critical capability, Canada can better anticipate and respond to

[25] *Canada's Arctic and Northern Policy Framework*.
[26] *Strong Secure Engaged*.

evolving security challenges, thereby safeguarding its national interests and contributing to international peace and stability.

RECOMMENDATION

19. Given the evolving security landscape and the strategic imperatives outlined in Canada's defence policy, it is crucial that the RCAF NORAD Modernization team undertakes a comprehensive exploration of the AEW&C capability and available platforms. This investigation should provide robust recommendations that will inform future defence policy and drive strategic force development initiatives.

20. The recent commitment by the Prime Minister to allocate a minimum of 2% of GDP to defence spending presents a unique opportunity for Canada to strategically invest in capabilities that offer significant returns in terms of national security and defence readiness.[27] The AEW&C capability stands out as a prime candidate for such investment, given its multifaceted benefits and strategic relevance in the current geopolitical landscape. An investment in AEW&C represents a prudent allocation of defence resources and a strategic commitment to enhancing Canada's sovereignty, security, and leadership in the international community. By leveraging the AEW&C capability, Canada can assert its position as a responsible global actor capable of addressing emerging security challenges.

[27] Murray Brewster, 'Canada Pledged to Spend 2% of GDP on Its Military. Would That Transform It? Is It Affordable?', CBC News Analysis, 24 July 2023, https://www.cbc.ca/news/canada/gdp-nato-military-spending-canada-1.6912028.

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