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REPLACEMENT OF THE NORTH WARNING SYSTEM RADARS

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AIM

1. In order to fulfil the North American Aerospace Defense Command (NORAD) missions of aerospace warning and control, it is imperative that there is continuous coverage of the air and maritime approaches to and within North America. The NWS radars are nearing the end of the life cycle and options for replacement need to be investigated. The aim of this paper is to suggest a potential area of further study and investigation prior to the required replacement of the North Warning System in 2025.

INTRODUCTION

2. In order to fulfil the North American Aerospace Defence Command (NORAD) mission mandate, the controllers in the Canadian Air Defence Sector (CADS) in North Bay and the decision makers at the Air Operations Center in Winnipeg need to have a Common Operating Picture (COP), which is currently being provided by radar feeds from the North Warning System (NWS) as well as various Air Traffic Control (ATC) radars. The NWS is a chain of 47 radar sites that are an essential capability in maintaining Canada's sovereignty. The radar sites were installed between 1986 and 1992 to replace the Distant Early Warning radars that had been built in the 1950s.[1] The NWS is approaching its Extended Life Expectancy in 2025, at which point a decision needs to be made as to what sensor will replace it. Preliminary estimates of replacement are $1.5 billion, with the options analysis not to begin until 2020.[2] As cited in the Canada First Defence Strategy (CFDS), defence of Canada is the number one priority of the Canadian Armed

[1] National Defence and the Canadian Armed Forces, "North Warning System," last modified 24 July 2013, http://www.forces.gc.ca/en/news/article.page?doc=north-warning-system/hgq87x9w

[2] National Defence and the Canadian Armed Forces, "North Warning System Replacement," last modified 12 March 2015, http://www.forces.gc.ca/en/business-defence-acquisition-guide-2015/aerospace-systems-960.page

Forces (CAF); finding an appropriate solution to the NWS replacement is critical to ensuring this priority and meeting the commitment to NORAD[3].

3. In order to determine the best replacement for the NWS, it is important to outline the requirements of the sensor in order to achieve the required effects. The NORAD partnership has been established since 1957, and a maritime surveillance mission was added to the mandate in 2006.[4] When the NWS was installed in the 1980s the threat was clearly defined, to protect Canada and North America from a Soviet Union Cold War attack from. The modern day threat and the potential threats in 2025 are much larger and varied in scope than when the radars were installed. Additionally, the Arctic continues to grow in terms of geopolitical importance to the Canadian government, with its waters being traversable for longer periods of time during the summer months. This compounds the problem of finding a NWS replacement that provides more benefit than simply aerospace surveillance. And while the replacement of the NWS is seemingly solely a Royal Canadian Air Force (RCAF) problem, the realities of dwindling defence and other governmental agency budgets force us to consider a solution that fulfils multiple mandates of the Canadian government, as duplication of effort is far too costly. As such, the replacement for the NWS should have the ability to provide coverage of all of Canada's coastal and interior regions including the Canadian Arctic, to include air, maritime and space approaches. The current NWS radars do not provide coverage for the most Northerly portion of the Arctic, and there are gaps in coverage in the interior of the country. The current NWS has limited Electronic Protect (EP) capability and is subject to physical attack. Therefore, the replacement should also have the ability to provide cyber security for transmitted information and enough redundancy in the

[3] National Defence and the Canadian Armed Forces, "Canada First Defence Strategy," last modified 27 March 2013, http://www.forces.gc.ca/en/about/canada-first-defence-strategy.page

[4] Joseph T. Jockel and Queen's University (Kingston, Ont.). Centre for International Relations, *Canada in NORAD, 1957-2007: A History* (Kingston, Ont: Queen's Centre for International Relations and the Queen's Defence Management Program, McGill-Queen's University Press, 2007), 2.

architecture that communication blackouts are unlikely to occur. This paper will examine a technology trend the United States is moving toward in order to assess if this could be a feasible option for the CAF.

DISCUSSION

4. The current radars in the North Warning System are FPS-117 radars that are capable of hopping randomly between 18 channels in the L-Band. The Canadian Coastal Radars are FPS-124, which have the same frequency hopping capabilities. These radars are all unmanned sites, and have no other EP capability besides frequency hopping. These radars have recently been approved a Service Life Extension to be completed by Raytheon which will extend the life of the radars until 2025. When the NWS radars were installed, 60% of the budget was paid by the United States, although the radars were to be maintained and operated by Canadians.[5] At the time of the installation of the NWS, it was a "peacetime surveillance system designed to give reasonable assurance that a precursor or surprise attack is ruled out."[6] The NWS itself is vulnerable to attack and the efficacy of its ability to detect and track low flying cruise missiles is questionable depending on several factors. Some of the NWS radars are located outside of anticipated release points for Soviet air-launched cruise missiles (ALCMs). That is, a Soviet bomber could release a cruise missile outside the range of the NWS and due to the distance that the ALCM travels, it is possible that neither the launch platform nor the missile would be detected.[7] If you cannot detect the missile itself, you need to be able to detect the platform at a minimum. The NWS has limitations in its detection capabilities of cruise missiles, and it certainly is unable to detect ballistic missiles.

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[5] *Ibid.*
[6] *Ibid., 123.*
[7] *Ibid., 123.*

5. During the height of the Cold War, in order to compensate for the gaps in what was meant to be simply peacetime radar coverage, multiple aircraft were to be forward deployed to five different Forward Operating Locations (FOLs) as required, in order to push the warning and engagement zones further North. American Airborne Warning And Control System (AWACS) aircraft and Canadian and American interceptor aircraft were to be deployed in the event of a potential crisis to in order to increase the amount of coverage and provide the potential to intercept a bomber or cruise missile inbound.[8] The hope at the time would be that with the aircraft forward deployed they could respond to a crisis further north of populated city centers, or ideally completely north of the NWS.[9] With today's threat being much different than when the NWS was installed in the 1980s, replacing the NWS with radars with comparable capabilities may be of limited value for the cost. The NWS was essentially designed to be a trip-wire system to warn of an incoming threat, and this is of limited value given today and tomorrow's probable threats.

6. A possible solution could be to look to satellite technology to monitor Canadian sovereign airspace instead of replacing the NWS with another type of radar. The United States is currently undergoing a replacement project of all their Air Traffic Control (ATC) radars to the Next Generation (NextGen) Satellite System. This system is expected to be fully operational across the United States by 2025, and the transition has already begun. The NextGen system will replace traditional ATC radars with a linked network of satellites, providing for a more comprehensive COP as well as more accurate ATC data than traditional radar can provide.[10] The satellite network system is called Automatic Dependent Surveillance-Broadcast (ADS-B), and is

[8] *Ibid., 126.*
[9] *Ibid.*
[10] Federal Aviation Administration, "ADS-B Broadcast Services," last modified June 2014 http://www.faa.gov/nextgen/library/media/getSmart_ADSB.pdf

mandated by the FAA by 2020 for aircraft flying in classes of airspace where transponders are required today.[11] ADS-B works by the aircraft sending its GPS position to other aircraft nearby, as well as to a host of ground stations in order to create the picture of all the aircraft in the air which is transmitted to air traffic controllers. The ground station is where information is collated from all orbiting satellites and sent to air traffic controllers as a COP.

7. The current ADS-B system is dependent on the aircraft having the ADS-B equipment installed. In the interim until a full system replacement has occurred, for those aircraft that do not have ADS-B equipment but still have a transponder, the non-compliant aircraft's information is transmitted via the use of Traffic Information Service Broadcast (TIS-B).[12] TIS-B takes information from existing primary and secondary surveillance radars and translates it into the ADS-B network to add to the COP. The United States will not be replacing ground radars and will move to a solely satellite based system for sensing and tracking of air traffic over the country, slowly phasing out ground radars. This is problematic for NORAD, as the majority of the radar feeds that make up the COP come from Federal Aviation Administration (FAA) radars.

8. The NextGen technology is dependent on the aircraft being equipped with ADS-B equipment. This is not useful in its current state when it comes to NORAD use, as aircraft without ADS-B equipment are undetectable by the NextGen system as it is currently published. The FAA has developed an ADS-B Out procedure and has successfully flight tested it on a high-altitude balloon that was not equipped with the ADS-B equipment.[13] Although details of this test are not public at this point, this is a potential way to use the ADS-B system to identify potential threat aircraft who are not ADS-B compliant.

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[11] *Ibid.*
[12] *Ibid.*
[13] Federal Aviation Administration, "Automatic Dependent Surveillance Broadcast," last modified 24 July 2015, https://www.faa.gov/nextgen/update/progress_and_plans/adsb/

9. The NextGen system also replaces traditional line of sight radio frequency voice communication with networked voice and data communication. The new National Airspace System Voice System (NVS) uses voice over IP (VoIP) technology on a secure network through the continental United States region.[14] This permits a controller in any part of the country to control any aircraft without the traditional need for radio frequency line of sight with the aircraft. Additionally, the use of data communications is coming with NextGen. Akin to sending Free Text Messages (FTM) via Link-16, the air traffic controllers can send digital messages using the satellite link to aircraft anywhere in the network.[15]

10. The use of satellites to provide monitoring of Canadian airspace and coastlines is not new. RADARSAT-2 was launched in 2007, and provides marine surveillance, ice mapping, and environmental monitoring in Canada.[16] And the Sapphire satellite system has been fully operational since 2014, monitoring space objects orbiting between 6,000 and 40,000 kilometers above the Earth's surface. In 2010, Navigation Canada (NAVCANADA) announced their participation in the Aireon project, as a partnership with Iridium Satellite Communications.[17] This was originally agreed upon by NAVCANADA as a means to provide coverage and communications for aircraft in areas of Canada where there is a lack of existing ATC radar coverage, and is currently operational providing surveillance over the Hudson Bay and portions of the Arctic. However, it has since expanded to have all of Canada covered by 66 Low Earth Orbit (LEO) Satellites that will track and detect air traffic. These LEO satellites act as a replacement to the ground station and assist in tracking aircraft that are not within line of sight of

[14] Federal Aviation Administration, "NAS Voice Services," last modified November 2014 http://www.faa.gov/nextgen/library/media/getSmart_NVS.pdf
[15] Federal Aviation Administration, "Data Communications," last accessed 02 February 2015, http://www.faa.gov/nextgen/library/media/getSmart_DVC.pdf
[16] Andrea Charron, "Canada, the Arctic, and NORAD: Status Quo or New Ball Game?" *International Journal* 70, no. 2 (2015), 228.
[17] Nav Canada, "Automatic Dependent Surveillance Broadcast," last accessed 4 February 2015, http://www.navcanada.ca/EN/products-and-services/Pages/on-board-operational-initiatives-ads-b.aspx

a ground station, making oceanic tracking possible. These LEO satellites are expected to be operational in 2018, providing for global air traffic coverage.[18]

CONCLUSION

11. While a satellite based aerospace detection and warning system for the purpose of aerospace defence is not currently readily available, it is the way of the future and should seriously be considered for the replacement of the NWS. In order for this to work for a NORAD function, it would be necessary to integrate multiple satellites orbiting the earth into a fused operating picture, linked to the controllers at CADS. This common operating picture would be monitored 24 hours a day and provide the ability to detect and track threats coming into Canadian airspace. In order to provide the engage piece, the fighter aircraft that is selected to replace the CF-188 Hornet will need to be equipped with ADS-B equipment that allows them to receive satellite communications from the controllers at CADS. As such, the CADS controllers will be able to communicate with the fighters no matter where they are in Canadian airspace and provide updated threat and target information as they travel to intercept. The system as it is currently published is also problematic as the signals are currently unencrypted and can be received by anyone who is equipped with the ADS-B equipment on their aircraft.[19] In order for this to be a viable option for NORAD, there needs to be means to secure the aircraft location, voice and data information relayed between NORAD assets and controllers, and not simply have all the available information broadcast for all on the network to access.

12. While this seems like a fairly simplistic way ahead for Canadian NORAD, there is still considerable study and work that needs to be done, as the current ADS-B system works well

[18] Nav Canada, "NR 28 2015," last accessed 4 February 2015, http://www.navcanada.ca/EN/media/Pages/NR-28-2015.aspx

[19] Federal Aviation Administration, "ADS-B Frequently Asked Questions (FAQs)," last modified 30 June 2015, https://www.faa.gov/nextgen/programs/adsb/faq/#5

only with compliant aircraft. Further testing and study needs to occur in order to ensure the satellite detection system will have the ability to detect aircraft and missiles that are not ADS-B equipped, as potential threats will most likely not be. Additionally, the ability for satellite based systems to detect ballistic missiles needs to be further researched. The current LEO satellites that NAVCANADA has agreed to certainly do not detect or track ballistic missiles, but finding the right combination of sensors for detection of air-breathing threats as well as missiles is imperative prior to the 2020 options analysis for replacement of the NWS.

13. Primary and secondary search radar technology is becoming phased out, replaced by GPS and Satellite position reporting. As aerospace technology is evolving, it is necessary for NORAD to evolve in technology in order to keep up with the current threats. As the United States is moving away from primary radar and transponders and towards the ADS-B system in conjunction with other ballistic missile defense detection systems, it would cause a host of problems for the continued NORAD relationship if Canada were not to follow suit. While it is outside of the scope of this paper to make assessments on national level strategic decisions, the use of satellite technology to provide aerospace surveillance and warning is a technology trend that must be further studied and assessed for viability.

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