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A Comprehensive Aerospace Surveillance System For the Canadian Arctic

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Introduction

The Canadian Arctic covers approximately 3.5 million square kilometers with less than 150,000 inhabitants.[1] As a result, much of this territory goes unmonitored, prompting the Standing Senate Committee on National Security and Defence to write, regarding the Arctic coastlines, "they are vast, they are vulnerable, and, unfortunately, they are largely unattended."[2] Several government departments are vested with some responsibility requiring their presence in the Arctic but most lack the resources and mandate to develop a comprehensive surveillance system. For example, the Canadian Coast Guard operates 6 icebreakers, amongst other activities, which are only capable of monitoring activities within visual or radar range of those vessels.[3] As well, their slow travel speed dictates that only small areas can be monitored. The RCMP presence includes 380 people who watch activities in and around their detachments, but the sparse distribution of stations limits the observable area.[4]

Numerous agencies such as Transport Canada, the Canadian Security and Intelligence Service and Natural Resources Canada are all involved in some Arctic endeavor, although; none contribute substantially to the regions surveillance needs. According to Rob Heubert an Arctic expert, the Canadian Government must respond to

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[1] Natural Resources Canada, "Polar Continental Shelf Project: Canada's Arctic," http://polar.nrcan.gc.ca/arctic/index_e.php; Internet; accessed 10 February 2007.

[2]Dalhousie Center for Foreign Policy Studies, "2004 Foreign and Defence Policy Review – Maritime Security Policy References," [report on-line]; available from http://centreforforeignpolicystudies.dal.ca/pdf/2004policyreview_maritime.pdf; internet; accessed 10 August 2004, 3.

[3]Department of National Defence, 1948-3-CC4C (DGSP) *Arctic Capabilities Study*, June 2000, 5.

[4]Department of National Defence, 1948-3-CC4C (DGSP) *Arctic Capabilities Study*, June 2000, 5.

this impending surveillance challenge; a capability that currently only the Department of Defence (DND) can provide.[5]

The need for DND to meet this surveillance challenge is becoming more critical and immediate as international and national interest in the Canadian Arctic increases. The quest for natural resources has further heightened interest in Canada's North. As an example, in only two of the explored natural gas reserves discovered it is estimated that they possess over 9 trillion cubic feet of exploitable reserve; plus the region has an abundance of gas hydrates which will soon be extractable. [6] The discovery of Arctic diamond fields has further focused attention on the economic potential of the Arctic. Additionally, the effects of Global Warming has also generated greater interest and activity in the Arctic as "the effects of climate change are expected to open up [Canadian] Arctic waters to commercial traffic by as early as 2015… reinforcing the need for Canada to monitor…events in its sovereign territory."[7]

Canada, as a sovereign nation, has an obligation to monitor the Arctic and as stated in the 1994 Defence White Paper, "the provision of surveillance…is an integral part of the Forces' activities in Canada"[8] thus placing the Canadian Forces (CF) in a leading role with regard to the conduct of surveillance activities.[9] Surveillance activities

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[5]Rob Huebert, "Renaissance in Canadian Arctic Security," *Canadian Military Journal*, (Winter 2005-2006): 25.

[6]Canadian Energy Research Institute, *The Economics of High Arctic Gas Development: Expanded Sensitivity Analysis*, January 2005 [report online] available from; http://www.ceri.ca/documents/HighArcticGasReport.PDF; internet; accessed 12 February 2007.

[7]Foreign Affairs and International Trade Canada, *Canada's International Policy Statement: A Role of Pride and Influence in the World Overview* (Ottawa: 2005),7.

[8]Department of National Defence, *1994 Defence White Paper* (Ottawa: Canada Communications Group), Chapter 4, 1.

[9]Department of National Defence, 1948-3-CC4C (DGSP) *Arctic Capabilities Study*, June 2000, 9.

include not only observation of an area, but also activity detection and identification and determination of the nature of that activity. Monitoring the Arctic to this level is extremely difficult due to its size, weather conditions and rugged terrain, to name just a few of the factors. Consequently, the CF must coordinate the activities of a variety of platforms and sensors to achieve the synergistic benefits of a system to effectively develop an understanding of activities occurring in the north.

This paper will propose an Arctic surveillance system, using aerospace assets, that when efficiently employed will provide an effective surveillance capability to support security and sovereignty over Canada's Arctic. The challenges of the Arctic and capability requirements will be presented to develop the components of the Arctic surveillance system. The components of the surveillance system will then be discussed starting with the wide-area component, then the reconnaissance component, and finally the command, control, communications and intelligence component.

Arctic Challenges and Surveillance Requirements

This section will first discuss the challenges imposed on a surveillance system by the Arctic to establish the types of assets needed. A requirements analysis will follow explaining the CF's tasks and the effects on sensors and platforms. Once the requirements are understood the components of the surveillance system can then be established by gathering together related requirements.

The Arctic presents numerous challenges concerning the development of a surveillance system. The weather and terrain are perhaps the most formidable of these

challenges inhibiting even basic modes of transportation. The ability to travel by land or ice-bridge is limited to those few with very specific skill sets to withstand the cold or understand the ice flows. Shipping is restricted, due to ice, to only a few weeks annually or to icebreakers which also have limitations.

> The Canadian Arctic as officially claimed by Canada in 1925 is the sector between 60 degrees west longitude and 141 degrees west longitude… and …from 60 degrees north latitude to the geographic north pole[10]

a distance of 1800 nautical miles from north to south and even longer east to west. This distance necessitates that surveillance assets must be able to either monitor large areas while stationary or travel at high speeds in order to cover the long distance. Aerospace assets can do both, and are least affected by weather or terrain, making them ideal for the Arctic surveillance system.

With Arctic challenges imposing aerospace systems as key to the surveillance system, the components of the system must now be considered. To do this, a requirement analyses must be undertaken. The 1994 Defence White Paper provides a foundation from which the core requirements can be extracted. Even though the document is dated, Prime Minister Harper reaffirmed the Governments' commitment to the North by stating;

> the protection of Canadian Sovereignty in the Arctic would rely on expanded military presence north of the 60th parallel, as well as greater underwater and aerial surveillance.[11]

Specifically, the 1994 Defence White Paper states;

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[10]Natural Resources Canada, "Discover Canada through Maps and Facts," http://atlas.nrcan.gc.ca/site/english/maps/historical/territorialevolution/1927/1; Internet; accessed 2 February 2007.

[11]Norma Greenaway, "Tories vow to protect Arctic: $2B plan to expand military presence," *National Post*, 23 December 2005, A1.

> that the CF will be capable of mounting effective responses to emerging situations in our maritime areas of jurisdiction, our airspace, or within our territory, including the North. Specifically, the Canadian Forces will:
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> > a. demonstrate, on a regular basis, the capability to monitor and control activity within Canada's territory, airspace, and maritime areas of jurisdiction;
> >
> > b. assist, on a routine basis, other government departments in achieving various other national goals in such areas as fisheries protection, drug interdiction, and environmental protection;
> >
> > c. be prepared to contribute to humanitarian assistance and disaster relief within 24 hours, and sustain this effort for as long as necessary;
> >
> > d. maintain a national search and rescue capability;
> >
> > e. maintain a capability to assist in mounting, at all times, an immediate and effective response to terrorist incidents; and,
> >
> > f. respond to requests for Aid of the Civil Power and sustain this response for as long as necessary.[12]

From an Arctic surveillance perspective, these assigned functions provide a guide from which capability requirements can be drawn.

The White Paper states that surveillance must occur on a regular or routine basis. This implies that there must be resources dedicated to the Arctic on a full time basis, not just the infrequent CP-140 patrols or annual Ranger exercises.[13] Hence, the assigned sensor suites must provide persistent coverage and be capable of monitoring large areas at any given time if the government's expectations are to be realized. Sensors must also be capable of extracting detailed information to support activities such as fisheries

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[12]Department of National Defence, *1994 Defence White Paper* (Ottawa: Canada Communications Group), Chapter 4, 1.

[13]House of Commons, Standing Senate Committee on National Security and Defence. *Minutes of Proceedings and Evidence*. Monday, May 12,2003, 1:4.

protection, drug interdiction, and environmental protection, dictating the need for a variety of sensor types. The White Paper explicitly states surveillance must occur on any given occasion and at any time of the day. Accordingly, an all weather and complete day and night surveillance capability is required. Additionally, the surveillance system must monitor activities on land, in the air and on the sea, again highlighting the requirement for diverse capabilities within the system. Some support missions, such as counter narcotic, illegal fishing or even military operations, calls for a covert mission profile which necessitate a long-range standoff sensor capability be included. These sensors must also provide sufficient resolution to identify, by name, vessels and accurately assess the nature of their activity. Lastly, all the activities of the surveillance system will need to be coordinated and analyzed to obtain the synergy associated with an effective system.

Based on the requirements described above, it is now possible to begin to develop the components of an Arctic surveillance system by grouping similar requirements. The key requirements of persistence and the ability to monitor the vast areas, require similar types of systems. As such, a wide-area component can form the heart of the Arctic system; providing the necessary persistence to make initial detections and monitor movements. Typically, wide-area sensor systems will have gaps in their coverage in space or time and need augmentation from other wide-area systems. As well, when operating in a wide-area mode, sensors typically do not possess the ability to obtain detailed information such as a ship's name. For example, they may detect activity in the Arctic but are unable to resolve the nature of that activity.

In order to resolve these short comings, stand-off and high resolution assets can be grouped to meet the requirements of the reconnaissance component. The assets which form the reconnaissance components can be used to fully investigate an occurrence. Importantly, the wide-area surveillance component will be used to cue and direct reconnaissance assets to a point or area of interest. Aircraft-based sensors are ideal for this role and can provide sufficient flexibility to match sensor requirements to the on-going situations and, if manned the aircraft crew can also provide on scene command and control. Thus, the wide-area surveillance component can provide the necessary persistence to detect activity but must be supplemented with a reconnaissance component to identify that activity and to provide sufficient detail to allow the command and control element to make interdiction decisions. The requirement to coordinate all activities and to analyze the surveillance data forms the last component. This component consists of command, control, communications and intelligence functions needed to develop the synergistic benefits of a coordinated system.

The Artic surveillance system will be made up of three components. The wide-area surveillance component is designed for persistent coverage over a large area. The reconnaissance component can respond to surveillance or other intelligence information. The command, control, communication, and intelligence component will ensure activities are coordinated and that gathered information is effectively assessed and used. The following section will discuss these components in more detail.

Wide-Area Surveillance Component

The wide-area surveillance component, as explained above, must provide persistent coverage over the vast Arctic region. The shear size makes this a formidable goal as this component must reliably detect incursions and provide sufficient positional data such that the reconnaissance component can further investigate. As this involves air, land and sea monitoring, several sensor systems will be presented to fulfill these requirements.

Gaining and holding the high ground has always been a military advantage. As altitude allows a greater view of the surrounding territory, this is particularly true when referring to surveillance. When considering aerospace assets, satellites are the ultimate higher ground, allowing sensors to view and collect data over a vast region. Another key benefit of a space-based system is that it provides persistence, meeting the other key criteria for an Arctic surveillance system. [14] Space-based systems can be equipped with a variety of sensors but in this case, the selected system must be able to work day or night and penetrate the not infrequent cloud cover. As Canada is obscured by clouds, or in darkness, 60 to 70 percent of the time, optical sensors are precluded from forming the capstone of the Arctic wide-area component.[15]

> Space based radar, with the potential to provide wide-area, near continuous, surveillance of moving targets …promises to be the capstone element in a complementary mix of ISR assts necessary to fully satisfy the needs of the CF.[16]

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[14] United States. Department of Defence, *AFDD 1 Basic Doctrine,* (November 17 2003); available from http://afpubs.hq.af.mil; Internet; accessed 10 March 2007. 31.

[15] David Pugliese, *Canada to use Radarsat-2 to track ships in the Arctic*, Space News, 29 Aug 2005, 1.

[16] Peter B. Teets, "*Inaccurate Assertions*." Space News, 20 December 2004, 26.

The use of synthetic aperture radar (SAR) allows for the penetration of cloud cover and is effective regardless of the time of day.

Fortuitously, Canada is a world-leader in space-based radars owing to the success

Despite, these positive attributes, Radarsat-2 will not fully meet the requirements of the wide-area surveillance component in that its revisit time[21] is in the order of one day, allowing for the possibility that potential intruders could evade detection. [22]

Radarsat-2 must be augmented by other wide-area surveillance sensors. Perhaps the most cost effective system to do this is a High Altitude Long Endurance (HALE) UAV. A HALE, due to its endurance could provide surveillance of Arctic surface and maritime surface tracks for up to 24 hours at a time.[23] Currently, the only HALE UAV is the Global Hawk, which carries multiple sensors such as a surveillance radar for ground-based targets, an electro-optic system for visual identification and a system to intercept transmissions.[24] Such a UAV could easily cover large areas filling temporal gaps in Radarsat-2 coverage. Additionally, the CF operates a fleet of 18 CP-140 Aurora Long Range Patrol aircraft which have a similar sensor package to the Global Hawk, but are more responsive should the mission change during flight. Although very well suited to wide-area monitoring, Aurora missions are limited to about 12 hours in duration. The CP-140 is currently used to conduct wide-area surveillance in the Arctic but due to maintenance issues and other higher priorities the number of annual patrols have been

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[21]Revisit time is the length of time, or period, between successive passes of a sensor system.

[22]Canadian Space Agency, "Radarsat-2 Components and Specifications," http://www.space.gc.ca/asc/eng/satellites/radarsat2/inf_tech.asp#orbit; Internet; accessed 20 February 2007.

[23] House of Commons, Standing Senate Committee on National Defence, *Proceedings of the Standing Senate Committee on National Security and Defence*, Issue 17 – Evidence, 12 May 2003.

[24] United States, United States Air Force, "Global Hawk Fact Sheet" http://www.af.mil/factsheets/factsheet.asp?fsID=175; Internet; accessed 3 April 2007.

virtually been non existent.[25] Recently, the Auroras have been scheduled for only 2 patrols annually, although their midlife upgrade should alleviate the maintenance problem. [26] Once upgraded, they must be included as an element of the wide-area component.

Unfortunately, the elements of the wide-area surveillance component presented thus far are only effective at detecting land and maritime surface targets, but not airborne targets. The Standing Committee on National Defence and Veterans Affairs stated:

> a country's ability to monitor all aircraft within its national airspace is an important element in the assertion of sovereignty. Without the capability to intercept and identify intruding and suspicious aircraft, a country's claim that it controls activities within its airspace is questionable.[27]

Accordingly, the wide-area component must include a comprehensive air surveillance element. A legacy of the Cold War is the North American Aerospace Defence Command (NORAD), "a bi-national United States and Canadian organization charged with the missions of aerospace warning and aerospace control for North America." [28] As a result of its mission to monitor the northern airspace, NORAD has developed perhaps the most sophisticated air warning system in the world. Canada already has access to this airspace surveillance data and NORAD's comprehensive plans to deal with incursions into

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[25] House of Commons, Standing Committee on National Security and Defence, *Canada's Coastline: The longest Under-Defended Border in the World*, 10 Aug 2004, 5.

[26]Political and Social Affairs Division, "Canadian Arctic Sovereignty," http://www.parl.gc.ca/information/library/PRBpubs/prb0561-e.pdf; Internet; accessed 30 January 2007.

[27] House of Commons, Standing Committee on National Defence and Veterans Affairs, *Fourth Report*, May 2002, 4.

[28] North American Aerospace Defence Command, "NORAD Fact Sheet," http://www.norad.mil/about_us.htm; Internet; accessed 30 March 2007.

Canadian Arctic airspace. The North Warning System (NWS), NORAD's northern surveillance system, is a chain of 47 radar sites stretching across Alaska, the Yukon, the Northwest Territories, Nunavut, and down the Labrador coast.[29] It collects airborne information within its coverage area and forwards the information to the appropriate operation center for fusion into the wide-area surveillance picture.[30]

The NWS acts as a trip line detecting anything entering the airspace; however, it provides poor coverage of the northern extremities of Canadian territory and need to be augmented.[31] A recently fielded technology that could effectively augment the NWS is the High Frequency Surface Wave (HFSW) radar.

> Unlike traditional shore-based microwave radar, this radar uses high frequency (HF) electromagnetic signals that are not limited by the horizon. This unique capability allows the HFSWR to be the only shore-based radar system capable of detecting small surface craft and low flying targets.[32]

Ottawa defence scientists believe that the system could be effectively employed in the Arctic and would be ideal in high risk surveillance gaps or key areas like the entrance to the North West Passage.[33]

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[29] National Defence and the Canadian Forces, "North Warning System," http://www.mdn.ca/site/newsroom/view_news_e.asp?id=411; Internet; accessed 15 April 2007.

[30]National Defence and the Canadian Forces, "North Warning System," http://www.mdn.ca/site/newsroom/view_news_e.asp?id=411; Internet; accessed 15 April 2007.

[31] Davis Cox, *Satellite and Airborne Surveillance for Arms Control Verification*, Peacekeeping, Crisis Monitoring and Sovereignty Workshop, [report on-line] available from http://www.rmc.ca/academic/gradrech/dorn25_e.html; Internet; accessed 8 Feb 2007.

[32]Defence research and Development Canada, "DRDC-sponsored radar successfully demonstrated" http://www.ottawa.drdc-rddc.gc.ca/html/feature2_e.html; Internet; accessed 12 January 2007.

[33] David Pugliese, *Radar can track Arctic intruders: Surface Wave systems spot ships, aircraft at greater distances*, The Ottawa Citizen, 6 February 2001, A3.

The wide-area surveillance component as presented is capable of effectively monitoring from the surface up but the CF must still monitor activities below the surface of the Artic waters. There are currently no aerospace wide-area systems for monitoring underwater activity. However, airborne assets are very capable of responding in a reconnaissance capacity so it must be noted that a well positioned underwater listening system would greatly enhance Canada's Arctic underwater wide-area surveillance.[34] Although not operated by the Air Force, such a system could easily be integrated into the wide-area surveillance component and provide cueing to aerospace reconnaissance systems.

In summary, the Arctic wide-area surveillance system will be anchored by Radarsat-2 and the NWS. These systems could be augmented by HFSW radar that can provide airborne and surface coverage. Finally, airborne systems such as Global Hawk and the CP-140, which are less persistent, can provide coverage in temporal gaps in Radarsat-2 coverage. This wide-area surveillance as described will be capable of providing cueing to reconnaissance elements designed to gather detailed information of a specific area or event.

Reconnaissance Component

The reconnaissance component is needed to investigate contacts or events in response to intelligence information of cueing from the wide-area component. Reconnaissance assets must be able to determine the identity of a vessel and accurately determine the nature of activities occurring in the Arctic. Some circumstances may

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[34]Department of National Defence, 1948-3-CC4C (DGSP) *Arctic Capabilities Study*, June 2000, 4.

require a standoff capability to ensure covertness while others may be investigated overtly. As reconnaissance assets are responsive in nature, they must be able to respond quickly to surveillance cueing. This section will detail the sensor and platform capabilities and specific assets required to be able to fill the Arctic reconnaissance role.

Whilst radar-based sensor systems are ideal for cueing other assets, they have limited ability to classify, identify or determine the nature of the detected activity. Radarsat-2, for example, is capable of positioning a contact within 10s of meters of it actual location, as well as determining its course and speed.[35] This type of information is critical, however it does not provide military commanders, or for that matter, government department managers, information concerning the type of activities that are actually occurring and who is conducting those activities. Higher resolution sensors are needed to fill this intelligence gap.

Modern electro-optic (EO) systems can provide very detailed imagery across several spectrums, allowing for day or night reconnaissance activities and standoff capability. As EO devises can not see through cloud cover it is important that the platform be able to maneuver as required, or if overcast, operate below the cloud cover. If covertness is not critical, visual surveillance a flight crew is an effective reconnaissance tool for platforms without sophisticated sensors. Other sensor systems, such as the spotlight synthetic aperture radar,[36] provide additional data in the event the

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[35] MacDonald, Dettwiler and Associates, "Radarsat-2, A New Era in Synthetic Aperture Radar" http://www.radarsat2.info/about/v2-6pager_marketing_6pg-web.pdf; Internet; accessed 4 April 2007.

[36] Defence Research and Development Canada describes the Spotlight SAR system as a multi-mode imaging radar designed to provide a capable and flexible system for long range, day-night, all weather military surveillance over land and sea. It incorporates advanced signal processing techniques to generate a synthetic image of a target allowing the operator to determine a ships classification.

target is totally obscured by weather. This allows for contact classification down to ship type. Electronic intercept systems may also provide another source of information. Such systems are particularly useful in determining the nature of an activity.

Similar to the need for a variety of sensors, the types of aircraft used will also vary. Because a reconnaissance platform may be tasked to investigate everything from a subsurface contact to a high-speed aircraft, several types of aircraft are required. The first is an aircraft interceptor designed to work within the NORAD structure. The CF currently operates the CF-18 Hornet which already fulfills this function and is in the process of undergoing a modernization programme.[37] They are capable of operating from any of the four Forward Operating Locations (FOL) located in the Arctic: Inuvik, Iqaluit, Yellowknife and Rankin Inlet. [38] Unfortunately, CF-18s are rarely tasked to operate from the FOLs.[39] If Canada is to provide comprehensive coverage of the Arctic then the CF-18s must be regularly deployed. The CF-18's can also be tasked to investigate ground-based targets but lack the range and endurance to conduct a search should the target not be immediately detected by the aircraft.

The CP-140 Aurora is better equipped to investigate surface contacts and can also investigate maritime surface and subsurface targets. Even though the CP-140 is part of the surveillance component, its sensor packages also make it ideal as a reconnaissance platform in the Arctic. The CP-140 is also going through a modernization programme,

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[37]National Defence and the Canadian Forces, "CF-18 Modernization" http://www.mdn.ca/site/newsroom/view_news_e.asp?id=1601; Internet; accessed 20 April 2007.

[38]Rob Huebert, "Renaissance in Canadian Arctic Security" *Canadian Military Journal*, (Winter 2005-2006): 20.

[39]Rob Huebert, "Renaissance in Canadian Arctic Security" *Canadian Military Journal*, (Winter 2005-2006): 22.

including the installation of a very capable electro-optic sensor package which greatly enhances the aircraft's over-land capability.[40] The maritime radar and acoustic sensor system provide excellent surface and subsurface investigation capacity. The CP-140 offers ideal reconnaissance capabilities, but like the CF-18, is rarely utilized in the Arctic.[41] The Auroras are able to operate out of their main bases in the south and still reach most of the Arctic but have limited time on station to fully investigate or track a target in that circumstance. It is therefore necessary that an Aurora be forward deployed to Iqaluit or Yellowknife on a regular basis to meet the Arctic reconnaissance requirements.

Like the Aurora, the HALE UAV can also be used in the Arctic reconnaissance role. The Global Hawks radar and electro-optics system allow it to gather very high resolution imagery from stand-off ranges and the aircraft has sufficient persistence to monitor activities over time. The primary limitation of the HALE is that it is designed to operate at very high altitudes, making cloud cover a potential problem. It is possible to descend the Global Hawk below cloud cover but this will dramatically reduce its endurance.

The CF operates four CC-138 Twin Otters from Yellowknife. These aircraft can be used as a reconnaissance platform for missions requiring only visual observations. Similarly, the C-130 Hercules, which work in the Arctic conducting re-supply and search and rescue missions, can be used should a significant event occur.

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[40]Department of National Defence, "CP-140 Aurora," http://www.airforce.forces.gc.ca/equip/CP-140/future_e.asp; Internet; accessed 20 April 2007.

[41]Rob Huebert, "Renaissance in Canadian Arctic Security" *Canadian Military Journal*, (Winter 2005-2006): 20.

In summary, the CF already operates a number of platforms able to conduct Arctic reconnaissance but because of other higher priorities they are rarely used in the Arctic. The CF-18 should be tasked on a regular basis to the FOLs to fulfill the air intercept task. The modernized CP-140 is an ideal platform to investigate ground-base and maritime surface and subsurface targets and should also be regularly deployed to the North. A HALE such as Global Hawk can obtain imagery of ground-based and maritime surface targets and must be purchased to round out the Arctic reconnaissance component. The Twin Otter or any other aircraft operation in the Arctic can provide visual reconnaissance if tasked. While these platforms are all capable of conducting reconnaissance, they must first receive mission assignments and respond to updated cueing or intelligence information. This necessitates that there be a dedicated command, control, communications and intelligence component to the system.

Command, Control, Communications and Intelligence Component

Having the surveillance and reconnaissance capability and capacity is absolutely necessary for effective Arctic surveillance but without an effective command, control, communication and intelligence capability these resources cannot be properly employed. It is in fact these functions, when properly executed, will tie the wide-area and reconnaissance components together to form a comprehensive system. Specifically, effective surveillance requires detailed planning and integration of intelligence factors into the surveillance plan. Effective reconnaissance requires human interpretation to determine the need and priority of the reconnaissance mission. Most importantly of all, a

clearly defined chain of command provides the control from which the whole system can function.

Until recently, the Commander CF Northern Area (CFNA) was tasked "to coordinate and facilitate military activities in the North and to coordinate surveillance in the North."[42] In military terms, coordinate and facilitate do not provide the commander with sufficient authority to control or prioritize missions or even obtain the necessary resources to carry out the mission. Fortunately, CF command transformation resulted in the development of a single chain of command for domestic operations.

> Reporting directly to the CDS, the Commander of Canada Command (CanCom) will be responsible for the conduct of all domestic operations – routine and contingency -- and will be the national operational authority for the defence of Canada and North America.[43]

Commander CanCom has divided Canada into functional regions and appointed regional Commanders. As a result, CFNA is now Joint Task Force North (JTFN) and has command of Arctic region operations, with the exception of NORAD missions. The new mission of JTFN is "to assert Canadian sovereignty, providing a presence through routine and contingency operations in the [area of responsibility] AOR."[44] Accordingly Commander JTFN has the authority and responsibility to exercise command and control of activities within the northern region. To properly execute this mission, Commander JTFN must have complete awareness and a clear understanding of the activities occurring within the region. Therefore commander JTFN must have access to the surveillance

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[42]Department of National Defence, 1948-3-CC4C (DGSP) *Arctic Capabilities Study*, June 2000, 10.

[43]National Defence and the Canadian Force, "Canada Command," http://www.dnd.ca/site/newsroom/view_news_e.asp?id=1692; Internet; accessed 10 April 2007.

[44] National Defence, "Joint task Force North's Mission," http://www.cfna.forces.gc.ca/aboutus/mission_e.asp; Internet; accessed 2 March 2007.

information from assigned and supporting assets in order to develop a Common Operating Picture (COP) for the Arctic region.

Currently, JTFN HQ does not have the ability to receive data from surveillance platforms. For example, Radarsat-2 data will be sent in near real time to Atlantic and Pacific region operation centers. No such arrangement has been established for the Northern region, a situation that must be rectified as Radarsat-2 is an important element of the wide-area surveillance component. When operating in the Arctic, CP-140 crews rarely communicate directly with JTFN, but instead do so with either the Pacific or Atlantic operation centers. This must change to see communication links and management systems established at JTFN HQ if the commander is to fully execute the assigned mission. The surveillance and reconnaissance platforms proposed herein must all be able to communicate directly with the tasking authority for mission updates and provision of sensor information to JTFN for inclusion in a COP. Without this type of two-way communications the Commander is blind and forced to make decisions on limited information and the effectiveness of the tasked sensor platform is dramatically reduced because it is not achieving the aim; to contribute to the establishment and maintenance of a COP within the JTFN area of responsibility.

Beyond the communication links that allow JTFN to receive data, it is necessary that the collected surveillance be analyzed, assessed and fused with all other information to further develop the COP. JTFN must include a robust intelligence capability able to operate on a 24 hour, 7 days a week basis. Analyzed information can then be submitted to the commander, who can then decide if reconnaissance is needed or if some control measures are required. Further, the commander is far more able to coordinate activities

with other government departments, as mandated by the government, if an accurate COP is achieved.

Functionally, it is critical that the COP, and sensor data such as streaming video available from EO equipped platforms, be displayed to the commander in a way to achieve maximum impact and situational awareness. Thus it is critical that the command, control, communications and intelligence functions be collocated. Typically, these functions are located in an operations centre with sufficient staff for continuous operations. Therefore, JTFN must be equipped with a state of the art command center to maximize effect of the assigned sensor platforms and sharing of information with other commands and government agencies. In the end, it is this component that makes a group of sensor platforms a system, and is therefore the most critical component of an Arctic surveillance system.

For Commander JTFN to be successful at developing a COP, the goal of a surveillance system, an operations center incorporating command, control, communications and intelligence elements are needed. The operations center staff can then receives surveillance data, manage and analyze the data, and fuse the analyzed information into a COP. Thus, such an install once properly manned will meet the requirements of the command, control, communications and intelligence component of the Arctic surveillance system.

Conclusion

The Canadian Arctic is an area covering in excess of 3.5 million square kilometers and is home to less than 150,000 permanent resident.[45] As a result much of the Arctic is left unmonitored by the Canadian government. Growing interest in the Canadian Arctic due to the abundance of natural resources such as gas and diamonds and the possible opening of the NWP as a result of global warming means Canada must take steps to better monitor the region. The CF, who are mandated to conduct surveillance in Canada and are best suited to perform that function in the Arctic, must overcome the challenges of the Arctic to develop and implement a comprehensive surveillance system.

The surveillance challenges in the Arctic are best overcome by aerospace assets that possess the speed and range needed to cover the large distances presented by the Arctic. A capability requirements analyses focusing on aerospace assets yields the high-level Arctic surveillance system requirements as extracted from the 1994 Defence White Paper. These requirements include the need for persistence and the ability to monitor a large region at any given time. The system must be able to detect activity during the day, night and in poor weather conditions. The ability to maintain a covert posture while identifying targets and determining the nature of activities is also fundamental t the system. By grouping similar requirements together it becomes apparent that the Arctic surveillance system consists of three distinct components: the wide-area surveillance component, the reconnaissance component and the command, control, communications and intelligence component.

The purpose of the wide-area component is to achieve persistence and provide large area coverage. The main element of this component is a radar-based satellite

[45]Natural Resources Canada, "Polar Continental Shelf Project: Canada's Arctic," http://polar.nrcan.gc.ca/arctic/index_e.php; Internet; accessed 10 Feb 2007.

known as Radarsat-2 which can detect surface and maritime surface contacts. The NORAD operated NWS can provide detection of aircraft entering Canadian airspace. HFSWR can be utilized to cover high risk gaps in these two systems as it has the capacity to detect aircraft, land and maritime surface targets. Finally, properly equipped aircraft such as Global Hawk and the CP 140 are needed to provide variance to the surveillance patterns and search any additional gaps in coverage by the more persistent systems.

The reconnaissance component is used to investigate targets detected by the wide-area component or other intelligence generated information. As time is often critical, it is paramount that the reconnaissance platform arrives quickly, a characteristic of aerospace platforms. The CF-18s operated by the CF are ideal air intercept platform and should be frequently deployed to forward operating locations in the Arctic. The CP-140s should also be forward deployed to Yellowknife or Iqualuit. As well, a UAV such as Global Hawk, is suitable for this type of work; providing a capable platform at a relatively low cost. Finally, any airborne platform can provide visual reconnaissance if covertness or standoff is unimportant.

A command, control, communications and intelligence component is crucial if the wide-area and reconnaissance components are to be efficiently utilized. The JTFN already has the necessary command and control authorities as a result of the CF command transformation, however, the commander requires an accurate COP to properly execute the assigned mission. JTFN must have two-way communications with all sensor platform operators. This will allow the commander to modify missions as, or if required, and to receive up-to-date sensor data in order to maintain full situational awareness. Further to this, an intelligence function must be available to analyze, interpret and fuse

the data to develop an accurate assessment of a developing situation. These functions are best done within a modern command centre, dictating that such a facility be included at JTFN.

In summary, the Canadian Government must invest in the CF to ensure that the Arctic is properly monitored. Many of the elements of the three components are already operated by the CF but are not assigned to the Arctic. This must change, as the priority to monitor the Arctic continues to increase. Most importantly the third component of command, control, communications and intelligence is the backbone of the proposed Arctic surveillance system and must be fully developed if Commander JTFN is develop the COP needed to fulfill the assigned mission. Together, these three components will provide an Arctic surveillance system capable of providing a comprehensive understanding of activities in the Arctic, which is key to the maintenance of sovereignty and security within the region.

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