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# Is the UCAV the answer to Canada's Northern Sovereignty?

By / par Colonel Yvan Choinière

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**ABSTRACT**

The Arctic region is becoming more accessible to human activity as a result of global warming. If this trend persists, and most indications suggest it will, the Arctic will become a crucial trans-national trading route and a vast resource trove. Prime Minister Stephen Harper has been unequivocal in making Arctic sovereignty a lead Canadian policy issue. The Canadian Forces (CF) plays a major role in securing Canada's Arctic interests by performing various functions, chief among them, surveillance.

This paper argues that the Unmanned Combat Aerial Vehicle (UCAV) is the most cost and militarily effective solution for protecting Canada's sovereignty in the North. The context within which this claim is made is the timeframe 2025 when UCAV technologies will be sufficiently mature to be operationally viable, in large quantity. Chapter 2 outlines the significance of the Arctic as a resource and trade route and Chapter 3 explores the myriad of sensors that can be counted upon to form a surveillance web: from space-based assets through maritime and aerial vehicles to CF troops on the ground. Chapters 4 and 5 explore the UCAV as a military capability and highlight its comparative advantages over manned aircraft; less overall risk, more persistence in removing the human factor and cheaper cost overall. The UCAV demonstrates ample "upside" to the surveillance problem albeit as one tool among many others. Chapter 6 warns that Canadian defence budgets will always be constrained so it behoves institutional leaders to carefully balance capability with affordability across the

full spectrum of defence commitments. Lastly, Chapter 7 treats emerging procedural issues associated with UCAV operations but identifies none as show stoppers moving ahead.

This paper values the notion of balance in considering the Arctic sovereignty issue. Balanced capabilities that can service the Arctic but that are equally capable of expeditionary operations abroad enhance the case for their acquisition. Moreover, the UCAV is not a panacea solution to the complex issue of Canada's Arctic sovereignty. It is merely one component contributing substantially to being able to see, recognize and attend to incursions into sovereign territory. In the final analysis, the UCAV represents a viable, central component to the CF's Arctic sovereignty portfolio in the future and senior military leaders would do well to factor this into the force development narrative as a result.

## INTRODUCTION

Canada's North has not always been at the forefront of discussion in government policies. Throughout the years, it has transitioned from having high visibility within the government to almost being forgotten. The 1971 White Paper on defence acknowledged the importance of implementing "special measures to ensure the environmental preservation", "strict regulation governing land use" and, "exercise control jurisdiction of the Canadian Arctic."[1] The government's 1987 White Paper on Defence, *Challenge and Commitment*, discussed the need for capabilities in Canada's "Three Oceans." It called for boosting our presence in the Arctic by planning to acquire more Maritime Patrol aircraft and nuclear submarines which would have been complemented by the Sea-King replacement.[2] Most of these new projects either never came to fruition or were reduced to insignificance as a consequence of massive political pressures on budgets, imposed by a government trying to get its expenses and revenues under control so it could tackle the deficit.[3] In the White Paper for defence of 1994, the topic was brought up so sporadically that it would have been easy to miss.[4] By 2005, the Liberal government released the Defence Policy Statement (DPS) which emphasized the importance of the North. Indeed, it stated:

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[1] Department of National Defence, *1971 Defence White Paper* (Ottawa: Information Canada, 1971), 8.

[2] Department of National Defence, *1987 Defence White Paper* (Ottawa: Canada Communication Group, 1987), 53, 57.

[3] Bill Robinson and Peter Ibbott, "Canadian Military Spending: How does the current level compare to historical Level? To Allied Spending? To potential threats?" Project Ploughshares (March 2003) available from http://www.ploughshares.ca/libraries/WorkingPapers/wp031.pdf; Internet; accessed 8 March 2010.

[4] Department of National Defence, *1984 Defence White Paper* (Ottawa: Canada Communication Group, 1994), 8, 17, 21, 34.

> The effect of this new approach –a new command structure, with the emphasis on being able to bring an integrated military response to a given area to maximum effect will also be seen in the North. …Government will be able to more strongly assert Canada's interest in this vital region of the country.[5]

This paper argues that the Unmanned Combat Aerial Vehicle (UCAV)[6] is the most economical and effective solution for protecting Canada's sovereignty in the North. The paper will look at the importance of "future policy discussions that will need to consider the most effective and efficient means of protecting Canadian sovereignty in the Arctic,"[7] and provide an overview and describe the actual capabilities and gaps for the North. In addition, it will explain what a UCAV is, compare it with manned aerial vehicles, and look at the impact of the Department of National Defence (DND) budget on the acquisition of these new capabilities. Finally, it will examine the procedural aspect of prosecuting targets, a thousand miles away with precision weapons.

To provide more context with regard to the proposed thesis, global warming and climate change are affecting the North at a much greater rate than expected. The question now is not whether the Northwest Passage will open, but when will it do so? A navigable Northwest Passage will allow commercial shipping to reduce the length of

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[5] Department of National Defence. *Canada International Policy Statement.* (Ottawa: Information Canada, 2005), 18.

[6] The terms UAV and UCAV have many connotations that must be defined. The UAV is an aviation system that has its centerpiece an uninhabited, reusable aircraft that sustains flight using onboard propulsion and aerodynamic lift. This definition excludes lighter-than-aircraft, ballistic missiles, and cruise missiles, but leaves open the issue of flight control and autonomy. The UCAV is a small subset of UAV that carries and delivers both lethal and nonlethal weapons. For the purpose of this paper, the term UCAV will be used when referring to a UAV.

[7] Library of Parliament, Canadian Arctic Sovereignty, available from http//www.parl.qc.ca/information/library/PRBpubs/prb0561-e.htm; Internet; accessed 26 March 2010.

their trip by approximately 7000 kilometres on a route from Europe to Asia.[8] However, even before the opening of the Northwest Passage, the Arctic has gained the attention of the world due to its vast repertoire of natural resources. For Canada, this awareness translates into thriving economic opportunities such as the exploration for fossil fuels,[9] diamonds,[10] fresh water and, fish. Given the rise of emerging world powers, and the advancement of technological innovation, northern resources that were too costly to exploit suddenly have become economically viable. Consequently, Canada's government has articulated an Arctic policy, which it must implement in order to provide the ability to control access to the North. Canada needs to guarantee its sovereignty and security in the Arctic. It has developed a National Surveillance policy, but now needs the proper tools to implement it effectively. These ideas are evident in the following newspaper article:

> We should applaud any government that treats the Canadian Arctic seriously and aims to build a country from sea-to-sea-to-sea. With the moves sparked by the current controversies over global warming, oil and gas reserves and uncertain Arctic boundaries, the current government appears to be moving quickly and purposefully to draw the North into Confederation.[11]

In December 2005, the Harper government announced its "Canada First Defence Strategy" which would significantly enhance the presence of the Canadian Forces (CF)

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[8] Franklyn Griffiths, "The Shipping News: Canada's Arctic Sovereignty Not on Thinning Ice," *International Journal* 58/2 (Spring 2003): 263.

[9] Library of Parliament, Canadian Arctic Sovereignty, available from http//www.parl.qc.ca/information/library/PRBpubs/prb0561-e.htm; Internet; accessed 26 March 2010.

[10] George Werniuk, "Canada Now Ranks Third in Diamond Production," *Investor's Digest of Canada* 38, no.5 (3 March 2006), 131.

[11] Greg Poelzer and Ken Coates, "Two Arctic Scholars Support Harper's Northern Policy," *Saskatoon Star Phoenix,* 3 September 2008 available from http://www.canada.com/topics/news/national/story.html?id=448fc6e1-ace1-4f60-868d-c4f4e1775727; Internet; accessed 8 March 2010.

in the North. The CF was asked to improve its surveillance in the North by constructing six to eight Polar Class patrol ships that would be able to sustain operations in ice conditions up to one metre thick. This is intended to extend the CF maritime surveillance season of the Northwest Passage. Furthermore, these new ships would be supported by a deepwater port that would be located in Nanisivik, Nunavut (NU). Moreover, the underwater sonar surveillance first proposed in the 1987 White Paper, cancelled in 1996 due to fiscal constraint, has been re-activated. Along with this announcement, the government decided to build a Canadian Forces Arctic Training Centre in Resolute Bay. The Centre would be used to support emergency operations in the Arctic conducted by military and civilian personnel, with the intent to increase sovereign capabilities and shorten response times. Additionally, under the control of Joint Task Force-North (JTF-N), three annual exercises are to be conducted to improve the ability of the CF to operate and deploy year-round while having to deal with extreme weather conditions, and various exigencies, with an emphasis on protecting the Arctic. The CF intends to recruit an additional 500 Canadian Rangers and increase their level of training, activity and equipment. Finally, enhanced surveillance from radars, UCAVs, satellites and aircraft will emphasize our military presence and improves our capabilities to provide surveillance for the North.[12]

As demonstrated in the previous paragraph, government policies with respect to Northern sovereignty will entail that the role of the CF to protect Canadian citizens and their interests and values at home will remain one of its highest priorities. Indeed, with

[12] Department of National Defence, *Canada First Defence Strategy* (Ottawa: Information Canada, 2008), 4, 6, 7.

globalization of threats, this attendant and heavy burden will only increase the load on our military, both domestically and internationally. Canada must be equipped with an affordable military; however, at the same time; it must be a flexible, balanced, multi-role and combat-capable force able to counter the threats of today and tomorrow.[13]

Although the Canadian economy might permit Canada to have a highly capable military and allows it to participate as a partner in such projects as the Joint Strike Fighter (JSF), the government is not prepared to accept high risk, high cost defence projects. As such, it limits Canada's ability to apply massive infrastructure to solve space and time issues such as those posed by the North. Consequently, by extension, the defence procurement philosophies practiced by the United States (US) are simply not comparable to those practiced in Canada. With respect to technology, the last century has seen significant advances in the complexity of the tools and weapons developed for use in both the Canadian and US military. To that end, advanced technology requires advanced funding, consequently a high technology military force is more expensive than one that is less so. Such an assumption goes a long way to explain why the US is capable of fielding technological marvels like the new generation of fighters (NGF), while Canada continues to lead its Air Forces with the aging CF-18. However, it is also true that hi-tech products can be cheaper than low tech-tech ones. If this were not so, industry would not be so apt to introduce advanced technologies into the workplace to maintain a competitive advantage and adapt to the changing marketplace. As discussed earlier, the Arctic and international competition have changed the security environment

[13] Department of National Defence. *Canada International Policy Statement.* (Ottawa: Information Canada, 2005), 14.

and Canada must pursue a viable solution for the future. If the government must invest in northern sovereignty, the key will be to know exactly what technology to acquire.

It is a bold but verifiable assertion that technologies such as UCAVs are changing the face of warfare. They offer both opportunities to fight wars more cost effectively and also with significantly lower risk to friendly forces and subsequent loss of life. In that context, Canada must embrace UCAV technology immediately and significantly. This technology offers an effective solution for northern aerial surveillance, and the experience gained from such patrols will provide Canada the requisite knowledge needed to make sound future decisions on how to adapt this technology to protect her sovereignty in the Arctic. Most certainly, the CF will have to procure sophisticated and expensive capabilities within a very limited budget, and Canada cannot afford to buy all of the equipment it requires. Moreover, for the same reason companies often invest in automation to increase productivity. The most economical and effective solution to this problem may require the purchase of expensive high-technical solutions that would act as a force multiplier for the military in the huge expanse of the North.

For Canada, this technology has never been more important. The current War on Terror has forced a renewed interest in our armed forces, and the increased funding that has resulted from this has netted the CF some much needed support in terms of equipment replacements. However, this increased funding has not come without criticism and with the current global economic crisis it would be foolish for strategic

planners to expect any funding increases. Hence, the military is caught in a difficult situation, since it has to meet the intent of the government's northern strategy in a neutral or even declining fiscal climate. This poses a difficult but not unsolvable dilemma. Northern sovereignty is perhaps the most expensive issue on Canada's defence horizon. That horizon is already at full capacity with the CF fighter replacement project, recapitalization of the Navy, the aforementioned icebreaking cruisers, the UCAVs, the inevitable reconstitution of the Army's vehicle fleet after Afghanistan and many other initiatives.

The current government's priority is to place a greater emphasis on the defence of Canada and North America. However, considering the evolution of the modern threat, special attention must be devoted to the North. Current threats require that the government raises the level of interest for the safety and security of Canadians, the fundamental duty of a responsible government.[14]

## IMPORTANCE OF SOVEREIGNTY

> Sovereignty is a question of exercising, actively, your responsibilities in an area.[15]

In order to understand why Canada needs a strong presence in the North, a common understanding of what sovereignty means is required. Although the legal

[14] Department of National Defence, *Canada First Defence Strategy* (Ottawa: Information Canada, 2008), 3.

[15] Mathew Carnaghan and Allison Goody, "Canadian Arctic Sovereignty," Speech by Minister of National Defence Bill Graham, Library of Parliament, PRB 05-61E (Ottawa: Information Canada, 2006), 2.

definition of sovereignty is perhaps deliberately vague, it does in fact emphasize different aspects such as elements of control, authority and perception. The notion of "state sovereignty" is entrenched within international law and is basically a State's right to have jurisdictional control and non-interference by other states.[16] "Sovereignty is the supreme legitimate authority within a territory. … Supreme authority within a territory implies both undisputed supremacy over the land's inhabitants and independence from unwanted intervention by an outside authority."[17] In researching the question of Canada' rights in the North, there appears to be little dispute of Canada's claim to the territorial lands in the Arctic via the *Island of Palms Arbitral Award 1928.*[18][19]

However, the major dilemma occurs when the discussion shifts to Canada's claim of the Northwest Passage and the issue of climate change. "Canada claims that the Northwest Passage is part of the historic internal waters and therefore it falls under Canadian jurisdiction and control."[20] Nonetheless, this claim has been historically disputed by the European Union (EU) and particularly by the US. In their views, due to the distance between shores along the route, the Northwest Passage must be considered international waters and therefore every nation has the right of free transit through it. In order for the Northwest Passage, to be considered an international strait, it must to meet

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[16] Mathew Carnaghan and Allison Goody, "Canadian Arctic Sovereignty," Library of Parliament, PRB 05-61E (Ottawa: Information Canada, 2006), 4.

[17] Daniel Philpott, "Sovereignty: An introduction and Brief History," *Journal of International Affairs*, Vol. 48, no. 2, Winter 1995, 357.

[18] Guy Killaby, "Great Game in a Cold Climate: Canada's Arctic Sovereignty in Question", *Canadian Military Journal*, Vol. 6, no. 4, Winter 2005-2006, 5.

[19] Award of the tribunal of arbitration tendered in conformity with the special agreement concluded an January 23, 1925, between the United States of America and the Netherlands relating to the arbitration of differences respecting sovereignty over the Island off Palmas [or Miangas).—The Hague. April 4, 1928.

[20] Library of Parliament, Canadian Arctic Sovereignty, available from http//www.parl.qc.ca/information/library/PRBpubs/prb0561-e.htm; Internet; accessed 26 March 2010.

two criteria, geography and functionality.[21] Although the Northwest Passage connects two oceans which justifies the geographic criterion, the volume of traffic fails to meet the functionality criterion of having sufficient number of transits to qualify it as a useful route for international maritime traffic.[22] As a result, to ensure effective control, the Government of Canada needs to monitor the passage and establish a strong presence in the North. In addition, to ensure compliance with Canadian sovereignty claims, it is essential to establish a common understanding concerning Arctic sovereignty with the US.

The US recognizes the Northwest Passage as a strait and it has challenged Canadian sovereignty in this area on two different occasions. In 1969, the U.S. tanker *S.S. Manhattan* transited through the North which initiated the sovereignty debate. In 1970, the Canadian government legislated the Arctic Waters Pollution Prevention Act which provides authority for the government to enforce control over a 100-mile coastal zone. The response of the US emphasized that "we cannot accept the assertion of a Canadian claim that the Arctic waters are internal waters of Canada. … Such acceptance would jeopardize the freedom of navigation essential for US naval activities worldwide."[23] In 1985 the US icebreaker *CGS Polar Sea* transited the Northwest Passage which challenged our sovereignty again; however, the US did provide Canada with a notification of the voyage. Moving forward to 1988, an agreement was reached

[21] Donat Pharand, "Canada's Arctic Water in International Law," *Cambridge University Press*, Cambridge, 1988, p.221-225.

[22] Donat Pharand, "Canada's Arctic Water in International Law,"…, 224-225.

[23] United States, Department of State, *Foreign Relations*, 1969-1976, Vol. E-1, (Washington, DC: U.S. Government Printing Office, September 30, 1977), 34.

between the two nations to allow US icebreakers to navigate the Northwest Passage with Canada's approval.

However, since 11 September 2001 given the concerns with continental security, the US may back down its insistence that the Northwest Passage is an international strait. Therefore, Canada's approach should be one of controlling the passage "as a way of securing the North American perimeter."[24]

Another example where Canadian Arctic sovereignty has been disputed is the case of Hans Island where Denmark disagreed with Canada's claim that "It is located between Canada's Ellesmere Island and Greenland, a territory of Denmark. Both countries claim the Island as sovereign territory. These competing claims have never been conclusively settled in international law."[25] Although there was an attempt to solve the sovereignty dispute in 1973, the two countries were never able to resolve the issue. With National Defence Minister Bill Graham visiting the island in 2005, it demonstrated Canada's sovereignty over this Arctic island. This event was observed by the international community. Finally, in September 2005, both countries released a joint declaration stating "we will continue our efforts to reach a long-term solution to the Hans Island dispute."[26]

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[24] Andrea Charron. "The Northwest Passage: Is Canada's Sovereignty Floating Away?" *International Journal,* Summer 2005, 847.

[25] Library of Parliament, Canadian Arctic Sovereignty, available from http//www.parl.qc.ca/information/library/PRBpubs/prb0561-e.htm; Internet; accessed 26 March 2010.

[26] Department of Foreign Affairs and International Trade, "*Canada and Denmark Issue a Statement on Hans Island*," (Ottawa: Canada Communication Group, 2005), 6.

Another contributing factor for Canada to exert its sovereignty in the North is the abundance of natural resources available. Canada's Arctic and territorial waters have gathered increasing attention due to the natural resources of the region such as oil, gas, fish, and minerals. The U.S. Geological Survey affirmed that "the Arctic contains an estimated one-quarter of the world's undiscovered energy resources."[27] Also, it has been estimated that "up to 50 per cent of the earth's remaining undiscovered reserves of hydrocarbons are located north of 60°N latitude."[28] As many as ten years ago, it was unthinkable to extract and transport these resources, yet today, given advancements in technology; this process has become both feasible and affordable. In accordance with the United Nations Convention on the Law of the Sea (UNCLOS), Canada has committed $51M to survey the boundary of its continental shelf in the Arctic.[29] This survey, estimated for completion in 2013, will help Canada determine its sovereign rights in terms of resource exploration and economic control.[30]

Accordingly, "future policy discussions will need to consider the most effective and efficient means of protecting Canadian sovereignty in the Arctic, including what could be potentially costly programs."[31] In April 2005, the Government of Canada released its *International Policy Statement – A Role of Pride and Influence in the World*

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[27] Library of Parliament, Canadian Arctic Sovereignty, available from http//www.parl.qc.ca/information/library/PRBpubs/prb0561-e.htm; Internet; accessed 26 March 2010.

[28] Oran R. Young, "Arctic Shipping: An American Perspective," *Politics of the Northwest Passage*, (Kingston: McGill-Queen's University Press, 1987), 116.

[29] Department of Foreign Affairs and International Trade, Speech by Pierre Pettigrew, Minister of Foreign Affairs. "Canada's Leadership in the Circumpolar World." Ottawa, 22 March 2005.

[30] The UNCLOS was ratified in 2003. From that date, Canada has ten years to map its continental shelf. Canada is currently collecting and analysing scientific, technical and legal information in preparation of making a submission to the commission.

[31] Library of Parliament, Canadian Arctic Sovereignty, available from http//www.parl.qc.ca/information/library/PRBpubs/prb0561-e.htm; Internet; accessed 26 March 2010.

(IPS). The document places greater emphasis on the Arctic region and sovereignty concerns.

Given that the government now has a common understanding of Canadian sovereignty and the major issues related to the Arctic, the following section will examine the inherent requirements for surveillance of Canada's Arctic. So far, the paper has highlighted that Canadian sovereignty is one of the top priorities for the government and that the CF plays a critical role in maintaining Canada sovereignty. When considering Canadian sovereignty, attention has been primarily focused on Canada's arctic due to a myriad of factors which will be examined in the next section.

## SURVEILLANCE OF THE ARCTIC

> One of the most critical issues now facing the government is its ability to conduct surveillance of our vast territory, airspace and maritime approaches, and to respond to asymmetric threats. …The demands of sovereignty and security for the government could become even more pressing as activity in the North continues to rise. …Air traffic over the high arctic is increasing, and climate change could lead to more commercial vessel traffic in our northern waters. …Although the primary responsibility for dealing with issues such as sovereignty and environmental protection, organized crime, and people and drug smuggling rests with other departments, the Canadian Forces will be affected in a number of ways. Adversaries could be tempted to take advantage of new opportunities unless we are prepared to deal with asymmetric threats that are staged through the North.[32]

In this section, this paper will address the National Surveillance requirements of DND. It will not attempt to cover the requirements of other Government Departments or

[32] Department of National Defence, *Canada International Policy Statement, (*Ottawa: Information Canada, 2005), 16.

agencies, except to the extent that they are directly involved with DND. Several other departments and agencies have reasons and interests to gather information in the application of their mandate through surveillance. One of the main challenges faced with National Surveillance is that no specific department or agencies have been designated with the overall responsibility. Each department or agency has their own area of interest and jurisdiction and prior to 2004, synergy between departments was not promoted, which further complicated the issue. The National Security Policy published in 2004 resolved that problem by mandating the establishment of an Integrated Assessment Centre that would gather all threat-related information and process it to whomever needed it in a timely and effective manner. Within this "system of systems", DND is one provider that supports the government's mandate to defend Canada. However, on a regular basis, it plays a secondary role in supporting other departments such as Canadian Security Intelligence Service (CSIS), Solicitor General, Canadian Border Security Agency (CBSA), Public Safety and Emergency Preparedness Canada, Transport Canada (TC), Department of Fisheries and Oceans (DFO) and Department of Foreign Affairs and International Trade (DFAIT) when it comes to dealing with asymmetric threats of the 21st Century.

In establishing set guidelines, "The Government of Canada released in 2000 "*The Northern Dimension of Canada's Foreign Policy"* (NDFP). The policy listed four key objectives:

- to enhance the security and prosperity of Canadians, especially northerners and Aboriginal peoples;

- to assert and ensure the preservation of Canada's sovereignty in the North;
- to establish the Circumpolar region as a vibrant geopolitical entity integrated into a rules based international system; and,
- to promote the human security of northerners and the sustainable development of the Arctic." [33]

Canada's Arctic has always been at the centre of debate concerning Canadian sovereignty. However, recently there has been an increase in attention based on the fact that the affects of climate change in the arctic region are melting the polar ice cap.

> At the same time, there are continuing strategic issues relating to potential incursions into Canadian arctic territory at various levels – airspace, surface (terrestrial and maritime), and sub-surface (by nuclear submarines). Canada's ability to detect and monitor such territorial incursions and to enforce sovereignty claims over its arctic territory in such cases have been questioned by the international community. In addition to increased interest in potential natural resources hidden beneath the ice, the Northwest Passage also represents a potentially attractive and valuable commercial shipping route, if it were to become more accessible to navigation and for longer portions of the year.[34]

These two critical factors highlighted above have made Canada's Arctic much more attractive for other nations and consequently, the resulting probability of international challenge to Canadian sovereignty in the Arctic has also significantly increased, making northern security a top priority for the future.

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[33] Department of Foreign Affairs and International Trade, "*The Northern Dimension of Canada's Foreign Policy*." (Ottawa: Information Canada, 2000), 6.

[34] Library of Parliament, Canadian Arctic Sovereignty, available from http//www.parl.qc.ca/information/library/PRBpubs/prb0561-e.htm; Internet; accessed 26 March 2010.

It should be noted that the Canadian Arctic is a vast area. It comprises 40% of the Canadian landmass (3.8 million square km, or 1 million square nm.) and 75% of Canada's coastline. It is sparsely populated (approximately 104,000 personnel in 2004) and is largely without roads or rail.[35] The climate can be extremely hostile, with 24 hours of darkness for a portion of the year, and transportation and communications being both problematic. These factors combine to make it very difficult for the CF to conduct the required surveillance necessary to maintain situational awareness[36] throughout the Arctic area.

"In the October 2004 Speech from the Throne, the Prime Minister announced a northern strategy that would, among other things, protect the northern environment and Canada's sovereignty and security."[37] "In April 2005, the Government of Canada released its *International Policy Statement (IPS) – A Role of Pride and Influence in the World* (IPS). The document places greater emphasis on the Arctic region and sovereignty concerns than the 1995 *Canada in the World: Canadian Foreign Policy Review*. Arctic sovereignty is discussed in the Overview, Diplomacy, and Defence sections of the IPS."[38] The 2005 Defence Policy Statement (DPS) provided a blueprint for action in many areas, including marine security intelligence. The 2005 DPS identified the critical national surveillance issue: the ability to conduct surveillance of Canada's vast territory, airspace and maritime approaches, and to detect, recognize, and

[35] Department of National Defence, *The Canadian Forces in the North,* 17 August 2009 available from http://www.canadacom.forces.gc.ca/nr-sp/bg-do/09-002a-eng.asp;Internet;accessed 21 April 2010.

[36] It involves being aware of what is happening around you to understand how information events and your own actions will impact your goals and objectives, both now and in the future.

[37] Government of Canada, Speech from the Throne, 5 October 2004.

[38] Department of National Defence, *Canada International Policy Statement,* (Ottawa: Information Canada, 2005), 16.

identify asymmetric threats. It further called on DND to perform more Arctic surveillance, and share information and intelligence with other government agencies and civil authorities.

**Space Surveillance**. Situational awareness regarding the Arctic is incomplete because of a lack of wide-area surveillance[39] assets. The recent launch of RADARSAT II is definitely a positive step, however this will only provide one component of a potential all encompassing solution. Of particular note, RADARSAT II only provides irregular glimpses of various sectors of the Arctic. With the announcement of the RADARSAT Constellation by the Canadian Space Agency in November 2008, the evolution of the RADARSAT Program, which includes three satellites, will provide uninterrupted daily coverage of Canada's land and oceans.

> The Constellation is designed to function day and night in all weather conditions. It will fully support the priorities of the government and enhance Canada's ability to ensure its sovereignty and security through space-borne surveillance, including oversight of the Northwest Passage. The mission design focuses on maritime and land security requirements, particularly in the Arctic region, and will be dramatically enhanced in comparison to previously fielded systems. The system offers up to four comprehensive passes per day in Canada's far north, and several passes per day over the Northwest Passage as shown in Figure 1.[40]

[39] A platform that can conduct surveillance within a surface area of dimension in the order of 1000 nm across.

[40]Canadian Space Agency, "Announcement of RADARSAT Constellation", available from http://www.asc-csa.gc.ca/eng/media/news_releases/2008/1114.asp; Internet; accessed 10 March 2010.

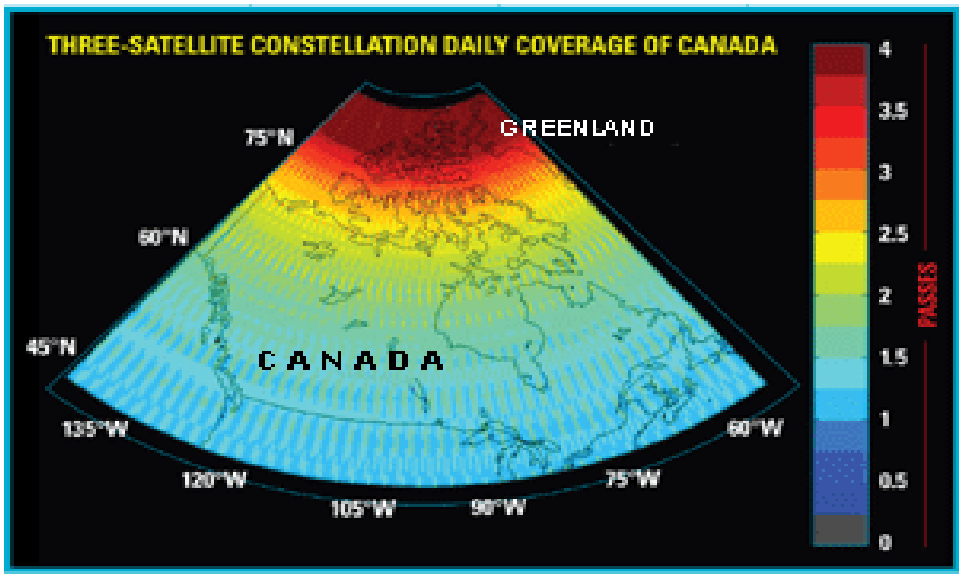


Figure 1.Coverage provided by 3 satellites constellation, CSA

On the issue of surveillance, Steve MacLean, President of the Canadian Space Agency, stated that: "The development of this constellation will support government in its efforts to assure sustainable development, manage natural resources, and exercise security and sovereignty, especially in the Arctic."[41] Depending on how many individual platforms are launched, the constellation may offer an acceptable persistence for detection of maritime traffic within Canada and beyond all three oceanic coastlines out to 1000 nautical miles (nm).

However, one of the main deficiencies within Space Surveillance is not having capabilities that allow continuous surveillance of targets. There is no single platform that "can provide persistent, wide area, all weather and automated surveillance coverage

[41] Canadian Space Agency, "Announcement of RADARSAT Constellation", available from http://www.asc-csa.gc.ca/eng/media/news_releases/2008/1114.asp; Internet; accessed 10 March 2010.

over Canada's oceans."[42] While RADARSAT provides regular wide-area coverage of the maritime approaches, it is not continuous, therefore other complementary solutions are necessary to provide persistence and target identification although both manned and unmanned vehicles could provide persistent coverage, the cost; however, of operation could make this option unaffordable. A potential solution to address the lack of surveillance is the employment of UCAVs in the Arctic.

**Airspace Surveillance**. Given that the deficiencies of Space Surveillance have been highlighted, it is important to examine the Airspace Surveillance dimension. North American Aerospace Defense Command (NORAD) has the mandate for surveillance and control of North American airspace. NORAD deals with threats in three different phases including detection, identification and prosecution. NORAD is divided into three operational regions which include Alaskan NORAD Region (ANR), Canadian NORAD Region (CANR) and Continental NORAD Region (CONR). The North Warning System (NWS) and Canadian Coastal Radars (CCR) represent Canada's first line of defense for potential external attack from the North. The network is composed of 13 long-range radars and 39 short-range radars located along the northern edge of Canada and Alaska. All the data received from the NWS and the CCR are compiled and analyzed at 22 Wing/Canadian Forces Base North Bay before it is released to 1 Canadian Air Division and the NORAD command and control centre in Colorado Springs. The coverage provided by these radars is shown in Figure 2. To compliment this capability, all CF airfields and NAV Canada radars feed into the Canadian Air Defense Sector (CADS) Battle Management system to provide situational awareness for

[42] Department of National Defence, National Surveillance Study 2008, (Ottawa: Information Canada, 2008), 17.

CANR on the assessment of threats within the interior of Canada. If required, airspace surveillance systems such as the E-3 Airborne Warning and Control System[43] (AWACS) from NORAD or NATO can be provided to augment situational awareness. The AWACS extends the capability of the ground-based radar stations, and the perimeter of the airborne radar system to provide a decrease in alert and response time. Once a potential threat has been detected and identified as a viable concern to Canadian territory, it may be prosecuted by CF-18 Hornet aircraft, normally based out of 3 Wing Bagotville and 4 Wing Cold Lake. In situations where alert levels have been elevated to a higher security level, the aircraft may be forward based out of Inuvik, Yellowknife, Rankin Inlet and Iqaluit.[44] As indicated earlier, this airspace surveillance system deals with threats in three different phases including detection, identification and prosecution; however, it does not address day-to-day surveillance.

[43] An airborne early warning and control (AEW&C) system is an airborne radar system designed to detect aircraft. Used at a high altitude, the radars allow the operators to distinguish between friendly and hostile aircraft hundreds of miles away. AEW&C aircraft are used for defensive and offensive air operations.

[44] John Granatstein, "NORAD North American Air Defence Agreement", I*n the Canadian Encyclopedia*, 2010 Historica, 24.

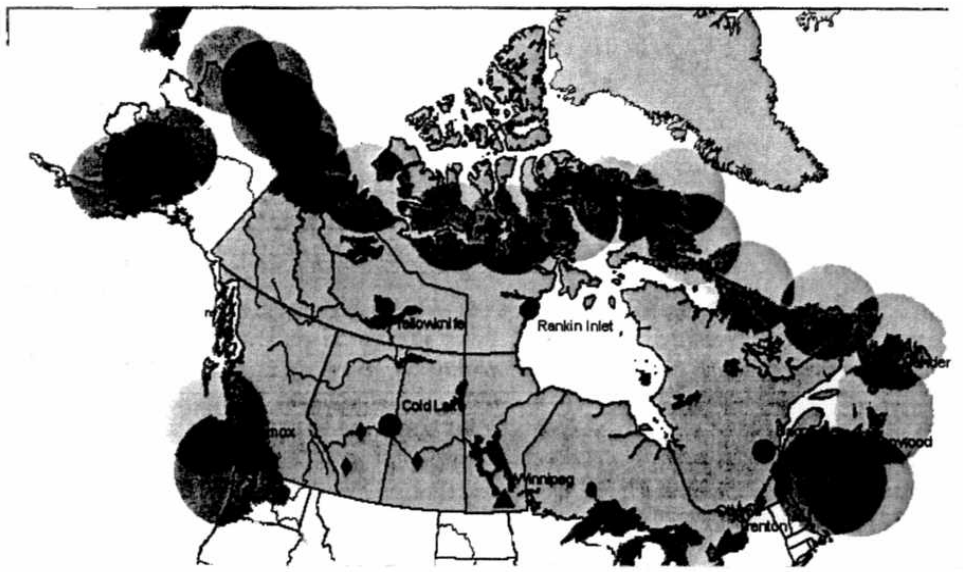


Figure 2.Perimeter Long and Short Range Coverage for Canadian NORAD, National Surveillance Study 2008

Canada has a variety of systems and capabilities for Airspace Surveillance, yet there are several gaps that need to be addressed. Historically, the NORAD mandate was to look for threats outside of the continental perimeter. However, it has become apparent that significant gaps have appeared in the high and low altitude perimeter coverage for the Arctic. Threats such as cruise missiles could potentially easily penetrate Canada's air defence system. The events of 9/11 have also demonstrated that looking within the North American continent for threats continues to be of critical concern. The interior surveillance over Canada certainly poses significant challenges and limitations that must be addressed. The utilization of US Air Force platforms such as E3-AWACS can improve surveillance requirements over limited special airspace zones for specific events such as the 2010 Olympics or the G8 Summit, but Canada does not control these assets. However, there are issues with transmitting the quantity of

data to the CADS to provide the adequate situational awareness required for supporting the decision-making process. It is very difficult for the CF to plan the employment of assets such as the AWACS for a long term operation due to the fact that it is constrained by the limited availability and mission prioritization. In effect, it is a high demand low density asset.[45] A sovereign UCAV capability could easily address many of the gaps identified in the Airspace Surveillance by providing persistent surveillance as well as utilization during times of threat.

**Present CF Capabilities**. There are a number of combinations of sensor platforms that currently provide an incremental improvement to the quality of Canada's Arctic situational awareness. Since the 1st Canadian Ranger Patrol is the primary CF unit that can provide presence on the ground, it represents part of a potential solution, but due to the vast area to be covered, it is obvious that it alone cannot provide what would constitute 'real presence'. Considering this, the next step in enhancing surveillance of the Arctic would be to improve reconnaissance and reaction capabilities. Wide-area surveillance at times discovers a contact that requires further investigation, usually for a limited, finite period of time. Further investigation may reveal that the contact needs to be engaged with a reactive asset. A potential solution to such standard military scenarios could be dedicated aircraft under JTF-N control. Unfortunately Canada does not have assets able to simultaneously provide persistent surveillance and react to a threat if required. Upon further analysis of persistent surveillance and reacting to a threat in the Arctic, there are two problem areas, distance and time. Currently, there

[45] Department of National Defence, "National Surveillance Study 2008", (Ottawa: Information Canada, 2008), 10.

is no specific asset in the CF inventory with the capability to observe more than just a small percentage of the North's landmass and coastlines. The one platform that currently provides the most enhanced capability is the CP-140 Aurora; however, from a cost effective perspective, it utilizes over $7000 per hour in fuel and has maintenance costs that far exceed these figures. The second element of concern is the length of time to respond to an event. If the Aurora surveillance aircraft determines that suspicious activity was in fact threatening Canadian sovereignty, that being primarily a shipping or anti-submarine weapons platform, the Aurora is ill equipped to effectively deal with serious sovereignty threats on land or under the ice surface. Upon notice of a threat and the delayed transit time of a CF-18 arriving on location, it is likely that the threat would have safely departed the area of concern. Ideally, Canada requires a capability that is affordable within the limits of the capital procurement budget, an ability to stay airborne and on station for long periods of time, is able to respond immediately to land or sea threats and has the ability to be operated cost effectively. This clearly represents a tall order and something likely beyond budget limits.

Ensuring the sovereignty of its nation is a primordial role for the military. There are a number of equipment replacement projects forecasted for the Air Force such as the Next Generation Fighter (NGF), the northern utility aircraft, and the Aurora replacement. The CF has been actively engaged for several years in determining its next generation of fighter capabilities. Given the limited budget, the number of aircraft to be procured has been gradually diminishing to the current forecast of 65 NGF aircraft. From the current number of CF-18 fighter assets, the major effect of this reduction is

the end state fighter capability and the potential requirement of fewer mission set types. Difficult decisions will be necessary in future as roles such as air defence, ground attack or international deployments must be prioritized and potentially eliminated or reduced. The procurement of the NGF aircraft is beyond the scope of this paper. A key deduction, however, is that a small fighter fleet will not have the ability to respond to a threat on its own. The next chapter analyses the UCAV technology as a new northern platform which may augment the role of the NGF or potentially carry the same role on its own.

How does one prove that the procurement of a UCAV capability would help solve the gap issue that is present in protecting Canadian sovereignty in the North? The UCAVs would be permanently deployed on the Forward Operating Location (FOL) that is currently used by the CF-18 in the Arctic. The ground control station would be located in North Bay which is the facility that compiles and analyzes all data before it is released to 1 Canadian Air Division, and NORAD command and control centre in Colorado, consequently solving the logistical issue of establishing large bases in the far north. Furthermore, in working out its strategy for the year 2020, the CF indicated that Canada's allies "want it to be a competent partner capable of playing a significant role in inter-allied operations."[46] This interoperability is primarily tied to the similarity of equipment used by allied partners. Since the UCAV and the NGF are being produced by defence contractors in the US, it may be expected that they will be interoperable with one another, and by extension will be interoperable with their respective suites of equipment. The concept of augmenting the NGF capability would be enhanced by using

[46] Department of National Defence, "National Surveillance Study 2008"…, 14.

UCAVs as a strike package under the command of an operator on a manned aircraft in theatre, and potentially, they could deploy in formation with new generation fighters before being released onto their targets.[47] Finally, UCAVs will be able to be air-refuelled, thereby providing further loiter time and combat range which manned platforms are limited in doing due to the fatigue of the aircrew.

"In summary, Canada's ability to detect and monitor territorial incursions and to enforce sovereignty claims over its Arctic territory in such cases has been questioned."[48] With the increased level of activity in the Arctic, Canada needs to select the proper capability to fill gaps and provide a better solution to wide-area surveillance to demonstrate a genuine presence.[49] Presently only vessels and aircraft provide limited surveillance for the Arctic; however, the cost for providing these assets is enormously expensive and marginally effective in providing a degree of surveillance. Given that this section has provided a better understanding of the deficiencies in the surveillance of the Arctic and the potential solutions for enforcement of Canadian sovereignty in the Arctic, the following section will go onto describe the utilities and savings of employing UCAVs.

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[47] James, R. Asker, "Who needs stealth?" *Aviation Week & Space Technology*, September 21, 1998. Vol. 149, Iss 12; 25.

[48] Department of National Defence, "National Surveillance Study 2008", (Ottawa: Information Canada, 2008), 10.

[49] Donald, McRae, "Behind the Headlines: Arctic Sovereignty? What is at Stake*"? Canadian Institute of International Affairs*, 8th Vol. 64 no. 1, 2007, 14.

## WHAT IS AN UNMANNED COMBAT AERIAL VEHICLE (UCAV)?

The option, beyond NGF, that could provide persistent surveillance to ensure Arctic sovereignty, is the UCAV. The concept that an aircraft could fly without a pilot on board has existed almost since the dawn of manned flight. The original strategists contemplating UCAV's sought to remove the pilot from operations that were considered to be too dull, or too dangerous.[50] The first attempts at this occurred in WWII when drones were used to take pictures of enemy positions before infantry troops advanced.[51] Over time our technology, combined with a decreasing tolerance for our own bloodshed, has generated increased interest in the possibilities offered by UCAVs. Far from the clumsy flying cameras of WWII, today's UCAVs offer high tech abilities that rival, or outperform the latest generation of manned aircraft.

> ENSIGN Nolo (short for no live operator) was a master at tank plinking. Twenty enemy tanks destroyed in half as many days. In fact, Nolo's entire squadron was filled with eagle-eyed tank killers that had flown through enemy defences, dropped their bombs with unheard-of accuracy, and made it back to the aircraft carrier without a scratch. But as Nolo touched down on the carrier deck, no celebrations were being planned. No medal would be awarded. Even beer call in the Officer's club and a pat on the back for a job well done was out of the question. Instead, Nolo was crated and returned to storage.[52]

This is what the future of fighter pilots may look like. They would become operators of unmanned platforms that conduct combat missions thousands of miles away from where they are located. After their work day is completed, they would go

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[50] Peter Pae, "Pentagon Flies High on Drones". *The Los Angeles Times.* January 19, 2002.

[51] Eugene Emme, "Aeronautics and Astronautics: An American Chronology of Science and Technology in the Exploration of Space". Washington, D.C. 1961.

[52] Steve Douglass, "No Pilot Required", *Popular Science*, June 2001, Vol. 258, no. 6, 84.

home to their families. This could be the life of a fighter pilot in 2025. Today, the United States Air Force (USAF) uses UAVs such as the MQ-9 Reaper[53] to prosecute targets with weapons. In December 2002, for the first time in history, a dogfight was recorded between an Iraqi MiG-25 and a US MQ-9 Reaper.[54] In October 2007, another critical milestone in the evolution of UCAVs occurred when a MQ-9 Reaper had its first combat kill by firing a Hellfire missile against Afghanistan insurgents. This was the beginning of combat aircraft without pilots. A new generation of UAV was born, it would be called UCAV.

In 2000, the USAF in collaboration with Defence Advanced Research Projects Agency (DARPA) started a UCAV Advanced Technology Demonstration (ATD) program. Boeing and Northrup Grumman were tasked by the USAF to develop the new generation of UCAVs. Boeing developed the X-45[55] for the USAF while Northrup Grumman developed the X-47[56] for the US Navy.[57] These represent a newer generation of UCAVs that are capable of carrying a bigger payload and operate at faster speeds. The production started in 2003, with an initial capability in 2006 to reach final

[53] The General Atomics MQ-9 Reaper (originally the Predator B) is an Unmanned Aerial Vehicle (UAV) developed by General Atomics Aeronautical Systems (GA-ASI) for use by the United States Air Force and other Air Force in the world. The MQ-9 is the first hunter-killer that carries weapons such as the Paveway II laser-guided bomb, the Hellfire II air-to-ground missile, the Sidewinder and, the JDAM (Joint Direct Attack Munition).

[54] Unmanned Combat Aerial Vehicle, available from http://en.wikipedia.org; Internet; accessed 31 March 2010.

[55] The Boeing joint unmanned combat air system X-45 is an unmanned combat air vehicle being developed for strike mission such as Suppression of Enemy Air Defence (SEAD), Electronic Warfare (EW), and Air Interception.

[56] The Northrop Grumman joint unmanned combat air system X-47 that provided a proof of concept for the Defence Advanced Research Projects Agency (DARPA) and the US Navy requirements. It is an unmanned combat air vehicle being developed for strike mission such as Suppression of Enemy Air Defence (SEAD), Electronic Warfare (EW), and Air Interception.

[57] Michael Leahy, "Unmanned Combat Aerial…47.

operational capability in 2010.[58] The Pentagon is forecasting that by 2025, those robotic warriors will replace and save pilot lives by performing manoeuvres that exceed the human capacity, which, in turn will provide an edge for UCAVs in a combat scenario. LCol Mike Leahy, Director of DARPA's X-45 Project, stated that "UCAVs will take on some of the dangerous and demanding kinds of missions during a combat situation. This aircraft will help to take care of some of the air-to-ground threats that exist now and allow manned assets to do their jobs more efficiently and safely."[59] Given the advantages that the UCAV technology will provide, it is in Canada's best interest to consider UCAVs as a key capability to protect our Arctic Sovereignty.

UAVs are used to loiter above targets and guide manned aircraft to the target. UCAVs however, have the advantage of locating targets and engaging the target immediately. Although there is some reservation and concern from the public concerning collateral damage, UCAVs, overall, are well accepted given the relative acceptance of the loss of software and hardware as opposed to human lives and as a result of the use of precision weapons, collateral damage is reduced. Furthermore, the use of UCAVs is much cheaper to operate based on the fact that, minimal training is required and one simply needs to program the platform, not to train a pilot. This assertion regarding training is based on the fact that 95% of the hours flown on a JSF will be devoted towards training, whereas only 50% of the hours flown on a UCAV will

[58] In October 2001, the US Air Force signed a contract with General Atomics to purchase an initial pair of Predator B-003s for evaluation, with follow-up orders for production machines. The first test MQ-9s were delivered to the Air Force in 2002. The name Altair did not follow the aircraft into testing, with the Air Force continuing to refer to the system as Predator B until it was renamed Reaper.

[59] Michael Leahy, "Unmanned Combat Aerial…, 47.

be towards training.[60] Also, operation without a pilot, allows for the removal of human physiological and life support equipment thus reducing significantly the price of the platform while enhancing performance.[61]

UCAVs represent an evolution in the capability of precision weapons. For example, every platform can receive tasks or send information to another unmanned aircraft, a manned aircraft or to the ground controller via line of sight or satellite communication. If one communication link fails, redundant links allow the platform to continue to fly, or if those communication paths fail, the UCAV is pre-programmed to fly to a pre-determined area to re-establish communication. If unable, the asset would then return to base. For example, the Predator UCAV is a reconnaissance platform that can cruise at 240 knots and stay airborne for over 24 hours at an altitude of 20 000 feet. The Global Hawk on the other hand, can cruise at over 400 knots and stay airborne for more than 40 hours at an altitude of 65,000 feet.[62] "During a typical reconnaissance mission, the Global Hawk[63] can fly 3,000 miles to an area of interest, remain on station for 24 hours, and survey an area the size of the state of Illinois 40,000 square nm, and then return 3,000 miles to its operating base"[64] Such capabilities would enable the broad surveillance of the North from existing bases in the Canadian south and offer a significant increase in capability and flexibility.

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[60] Carl Doyon (LCol), "Replacing the CF-18 Hornet: Unmanned Combat Aerial Vehicle or Joint Strike Fighter", *Canadian Military Journal*, Vol.6, no. 1, Spring 2005, 37.

[61] Steve Douglass, "No Pilot Required"….84.

[62] William Scott, "UAV's / UCAV's Finally Joint Air Combat Teams", *Aviation Week & Space Technology,* 8 July 2002, Vol. 157, Issue 3, 35.

[63] The Global Hawk is a high-altitude, long-endurance unmanned aerial reconnaissance system which provides military field commanders with high resolution, near real-time imagery of large geographic area.

[64] Global Hawk, from http://www.globalsecurity.org; Internet; accessed 31 March 2010.

The major difference between UAVs and UCAVs is that the UCAV represents a small subset of UAV that carries and delivers both lethal and nonlethal weapons. The development of the UCAV has stemmed from the desire for increased combat efficiency. Even if a UCAV spots an enemy force, there is a possibility that during the time that the information is passed, processed and tasked by the ground controller, the enemy may be lost. If a UCAV could be capable of destroying that enemy force, then the efficiency of the strategy would be remarkably increased. Currently, all UCAVs are experimental, but to prove the viability of the research, the "Central Intelligence Agency jury-rigged a Predator with missiles and then used it to take out a Taliban target in Afghanistan."[65] The significance of this act was not immediately apparent, but one could argue that it is the first chink in the armour of a modern icon, the fighter pilot.

Today, technology allows commercial airplanes to fly on autopilot from take-off to landing, and land in visibility reduced to zero. Cruise missiles can circumnavigate the earth's surface thousands of kilometres away to hit their targets with incredible precision. Satellites can explore the solar system for years without the smallest glitch, yet the military continues to draft requirements for future aircraft acquisition with pilots on board. Of course this makes a certain amount of sense as the people who develop and research these requirements are pilots themselves that share a belief, based on experience, that manned aircraft "with pilots" are required to fly missions over enemy territory. Those pilots and operational specialists are unable to fathom the idea that an unmanned machine can perform to the same level of reliability and versatility. As far as

[65] Peter Pae, "Pentagon Flies High on Drones". *The Los Angeles Times*. January 19, 2002 available from http://www.globalsecurity.org/org/news/2002/020119-uav.htm; Internet; accessed 21 March 2010.

they are concerned, there is no technology such as sensors, computers and on-board guidance that can replace a human in the cockpit. However, it is fair to say that research from defence institutions has shifted thinking from the latter philosophy in favour of the former. Today's traditional fighter planes such as the F-16 Falcon, F-15 Eagle, A-10, AV-8B are all scheduled for retirement between 2015 and 2020.[66] Canada needs to explore the new generation of fighters options such as the Typhoon, F-22 and the JSF as a replacement for the CF-18. Another potential replacement for persistence surveillance would include the procurement of UCAV.

In movies such as "Top Gun", the life of the fighter pilot is personified as glamorous and is indeed the envy of many. But as the ever changing world shifts to more advanced technology, they too may become a thing of the past, as technology advances to the unmanned fighter aircraft. With today's modern fighter aircraft equipped with computers and advanced on-board systems, the training requirements have changed significantly as well. In addition, the physical forces that today's fighter pilot must endure while performing constant mental calculations is extraordinary. Hence, leading to the reflection and attitude of why the average 'fighter-jock' expresses such confidence and arrogance in their abilities to perform these tasks. How then can one begin to compete? A UCAV can be made smaller and lighter than the current manned aircraft used today. Take away all the equipment required to sustain the fighter pilot such as the ejection seat, canopy, instrument panel, oxygen bottles, etc, and you

[66] Stewart, Penney, "Autonomous Attacker," Flight International Magazine, December 15, 1999, 30.

can shrink the airplane to a small size such that enemy radar cannot see it."[67] The UCAV potential seems immense, but can it compete in a face-off between man and machine?

Today many ex-fighter pilot generals dominate the United States Air Force (USAF) and are advocates for the air power strategic doctrine. Among this group there is much controversy and debate over whether or not a UCAV should replace the fighter pilot. As quoted by one USAF general: "to date, no unmanned remotely piloted vehicle has shown the potential of attaining the potency of the marriage between a skilled pilot and a well designed fighter, and this is not expected to change in the near future."[68] "The main argument rests with the premise that a human brain with its mental ability is superior to that of a UCAV's computer that lacks reasoning ability."[69] Therefore, thus far, the idea of a UCAV replacing the fighter pilot has not found its way into the strategic development of USAF doctrine. While engineering development staffs promoter are continuing to develop the technology for UCAV, the majority of defence research and developmental spending is focused on projects such as the $100M per copy manned F-22 Raptor as opposed to $5M per copy X-45 UCAV.[70]

In Canada, given the expected retirement of the CF-18s in the 2017 timeframe, the CF is currently investigating the capabilities necessary to meet future requirements.

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[67] *Ibid,* 31.

[68] William Siuru, "Supermaneuverability", *Aerospace Power Journal,* available from http://www.airpower.maxwell.af.mil/airchronicles/apj/apj88/spr88/siuru.html l; Internet; accessed 21 March 2010.

[69] William Scott, "UAV's / UCAV's Finally Joint Air Combat Teams"…35.

[70] Roxana Tiron, "Unmanned Bomber Prepares for Crucial Tests", *National Defense Magazine*, May 2002 available from http://www.encyclopedia.com/doc/1G1-85918217.html; Internet; accessed 21 March 2010.

Participation in the JSF program has allowed the DND and Canadian industry to be part of a cutting edge international military program. Participation in the next phase of procurement is optional for the department; however, it could help the department in defining and evaluating future requirements to replace the CF-18 along with its capabilities of the NGF.[71] The CF-18 purchased by Canada more than 25 years ago, has been upgraded throughout the years, will reach the end of its life expectancy by the year 2020. To replace the CF-18, Canada could consider acquiring the UCAV. This is not a simple statement as it requires the review and research of several factors that include; life cycle cost, reliability, usefulness/interoperability, and capability.

Canada's limited financial resources for procurement of equipment perhaps may represent one of the key considerations when deciding between the UCAV and the JSF. Major William K. Lewis, a veteran fighter pilot, "estimates that the UCAV's operating and maintenance costs will clearly be lower than those of the JSF."[72] Based on relative operational versus training hours flown[73] the purchase price and maintenance costs are accounted for, the net effect of these differences results in a per operational hour cost of $130,000 for the JSF, compared with $7,200 for the UCAV.[74] To put that into perspective, the UCAV is estimated to be 18 times less expensive to operate than the JSF. Furthermore, this cost difference will be exaggerated during peacetime when the ratio of training missions to operational missions increases.

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[71] National Defence and the Canadian Forces, Canadian Participation in the Joint Strike Fighter Program, 2006.

[72] Carl Doyon (LCol), "Replacing the CF-18 Hornet: Unmanned Combat Aerial Vehicle or Joint Strike Fighter", *Canadian Military Journal*, Vol.6, no. 1, Spring 2005, 37.

[73] This estimate is based on the fact that 95% of the hours flown on a JSF will be devoted towards training, whereas only 50% of the hours flown on a UCAV will be towards training.

[74] Carl Doyon (LCol), "Replacing the CF-18 Hornet…37.

As anyone who owns a vintage classic car knows, reliability is also a crucial factor in determining the cost of equipment. The UCAV will have most of its training conducted in simulators, resulting in fewer flying hours overall, which translates into more serviceability, less maintenance, fewer spare parts necessary, and less personnel required to maintain it. However, although the NGF will be a complex system, it is fair to expect that the reliability will be as good as the UCAV.[75] This seems counter intuitive, but the UCAV is built with less stringent manufacturing standards (because it is unmanned) than the JSF, and this compensates for the reliability issues that would be expected with the increased complexity of the JSF.

Another area of exploration in determining the best option for persistent surveillance is the interoperability of the technology, particularly when comparing the UCAV with the JSF. "As the working group studying the repercussions that the Revolution in Military Affairs could have upon the defence of Canada after 2010 noted: the credibility of DND, the CF and, even more, of Canada is tied to the existence of forces which are truly useful and are seen as such."[76] Additionally, while mapping out their strategy for the future, the CF indicated that Canada's allies "want it to be a competent partner capable of playing a significant role in inter-allied operations."[77] This interoperability is tied to the similarity of equipment used by allied partners. Since both the UCAV and the JSF are being produced by defence contractors in the US, it is guaranteed that they will be interoperable with each other and by extension will be interoperable with related command and control and fire control systems. Consequently,

[75] *Ibid,* 37.
[76] *Ibid*, 38.
[77] *Ibid,* 38.

in terms of interoperability, there is no doubt that the UCAV and the JSF will be largely equivalent.

For clarity, a system's ability to fill the functions and missions of an air combat force is defined as operational capability. It is in this respect that the advantage must go to the JSF at this time. "This stems primarily from the fact that air-to-air capability for a UCAV has not yet been demonstrated."[78] However, "an air-superiority UCAV should be feasible by the year 2025 which could provide an effective and affordable alternative to manned air-superiority fighters."[79] Unfortunately, Canada will need to replace the current CF-18 by approximately 2017, leaving a very serious, eight year commitment-capability gap. On the other hand, these technological predictions are forecasted over a decade into the future and there is a possibility that an air-to-air operational capability for UCAVs may mature earlier.

CF long-term plans for the UCAV seem undeniable especially if the relative importance of the unmanned criteria is evaluated. Furthermore, when one considers the assertion by *Global Defence Review* that, "all future combat aircraft are almost inevitably going to be unmanned, then it seems even clearer that Canada should consider the UCAV over the JSF."[80] Nonetheless, despite the high operating and life cycle costs, the JSF indisputably remains a possible option that could meet the operational requirement for the Canadian Air Force as a combat aircraft, and seems to be the only option that will not result in a near decade of commitment-capability gap.

[78] *Ibid,* 38
[79] *Ibid,* 38
[80] *Ibid,* 38

Fortunately, this decision does not need to be made for approximately seven years. Northern surveillance, on the other hand, is an issue that needs to be addressed immediately.

Given that Canada has several gaps in its defence coverage of the North, the question must be asked as to what can be done. "Given the volume of airspace that needs to be monitored in Canada, aircraft that can remain on station for a long duration are particularly valuable."[81] As stated previously in this chapter, based on the Global Hawk performance, 25 Global Hawk UCAVs could provide continuous high resolution coverage of approximately 1,000,000 square nm.[82][83] Or a less ambitious approach, a single Global Hawk could provide high-resolution surveillance of the entire Arctic area every 25 days, which is still incomparably greater than what Canada is currently capable of.

Canada's northern sovereignty issues represent the potential of direct threats to our land mass and sovereignty because at this time Canada does not have persistent surveillance of this area. For this reason, the national response to this threat must be comprehensive and effective. Canada does not have the size of military budget of some of its potential adversaries in this dispute, but this does not mean that Canada is incapable of funding an effective capability. The UCAV such as the Global Hawk, X-45

[81] Paul T. Mitchell, "The Joint Strike Fighter: Solution or Wishful Thinking?" *Canadian Military Review,* Vol. 3, no. 2, Summer 2002, 33.

[82] Based on the Global Hawk performance, during a typical reconnaissance mission, it can fly 3,000 miles to an area of interest, remain on station for 24 hours, survey an area the size of the state of Illinois (40,000 square nm), and then return 3,000 miles to its operating base.

[83] Mark Day, "Global Hawk Completes First Flight", available from http://www.fas.org/irp/program/collect/docs/980302-News-Release.htm; Internet; accessed 21 March 2010.

or X-47 as example, represents an opportunity to deploy a technology that can provide real presence and highly accurate surveillance, at a very affordable price. What is more, the looming issue of replacing our current CF-18 fleet may also be solvable through UCAV technology. The fighter replacement issue is much more complicated however, and requires further study. But if Canada is to be capable of making the correct decision on the fighter replacement project, then it must draw upon meaningful experience with UCAV technology, and there is perhaps no better way of accomplishing this than by spending a decade protecting Canada's North with such assets. Without question, Canada should take immediate steps to embrace UCAV technology.

## ADVANTAGE OF UCAV VERSUS MANNED FIGHTER / GUIDED MISSILES

The most effective way to introduce the advantages of UCAVs, and how it can be best employed in a variety of circumstances, is to look at cost, technology and survivability.

**Cost.** "UCAV systems can provide all the capabilities of a manned system at a fraction of the cost. The most significant savings with UCAVs are expected to accrue from how they are used in training and operations."[84] The UCAV will provide increased surveillance and control of Canadian waters and territory in the Arctic. Given the technology available today, it will be persistent coverage with a significant savings

[84] Thomas P. Ehrhard, "Unmanned Aerial Vehicles in the United States Armed Services: A Comparative Study of Weapons System Innovation." (Washington, DC: Johns Hopkins University Dissertation, 2000), 20.

in cost. In a world of competing constraints, the military will need to be more selective in its procurement to achieve the right balance between cost and efficiency.

From Ehrhard's perspective, "effectiveness is defined as the capability that a UCAV can deliver on a specific mission while efficiency is the ability to perform the mission as a function of resources expended."[85] Cost efficiency is directly related to combat effectiveness per dollar spent. In the following comparison between manned and unmanned vehicles, the cost of operating the UCAV will include all segments such as the vehicle, weapon and the ground station.[86] Also, it is important in the comparison that all three segments of the weapon system's life are considered.[87] The UCAV does not need to duplicate the performance of the manned aircraft as long as it can functionally attain the same mission. The critical factor is whether the UCAV can achieve the desired effect at a lower cost.[88]

The research and development (R&D) costs of manned and unmanned systems are comparable to each other. As described by Thomas May, R&D represents costs associated with the development and research of a specific platform. Additionally, it

[85] Thomas P. Ehrhard, "Unmanned Aerial Vehicles in the United States Armed Services: A Comparative Study of Weapons System Innovation." (Washington, DC: Johns Hopkins University Dissertation, 2000), 20.

[86] Peter R.Worch, UAV Technologies and Combat Operations (Washington, D.C.: United States Scientific Advisory Board, 1996), 4-6.

[87] David R. Oliver, Unmanned Aerial Vehicles Roadmap, 2000-2005 (Office of the Secretary of Defense, 2001), 51.

[88] Major William K Lewis, "UCAV - The Next Generation Air-Superiority Fighter?" June 2002, 75.

will include costs associated with the development of the hardware and software of a weapon system.[89]

Table 1. Manned vs. Unmanned Aircraft Development Costs

| Mission Aircraft | Program Start | First Flight | Type of Program Program Sponsor | Cost to First Flight ($FY00) |
|---|---|---|---|---|
| Reconnaissance | | | | |
| U-2 | Dec 54 | Aug 55 | SAP*/CIA | $243M |
| RQ-4 Global Hawk | Oct 94 | Feb 98 | ACTD/DARPA | $205M |
| Attack Strike | | | | |
| F-16 | Feb 72 | Jan 74 | DAB**/USAF | $103M |
| X-45 UCAV | Apr 98 | Mar 03 | ATD/DARPA | $102M |
| Recce | | | | |
| SR-71 | Aug 59 | Apr 62 | SAP/CIA | $915M |
| D-21 | Mar 63 | Feb 65 | SAP/USAF | $174M |
| Stealth | | | | |
| F-117 | Apr 76 | Dec 77 | SAP/USAF | $103M |
| RQ-3 Dark Star | Jun 94 | Mar 96 | ACTD/DARPA | $134M |

SAP* - Special Access Program DAB** - Defense Acquisition Board
Source: UCAV Roadmap, page 53.

Table 1 illustrates the costs of manned and unmanned platforms reaching their first flight. Historically, the costs of delivering a manned or unmanned platform are fundamentally the same. "This is reasonable given that the engineering required to get a new design airborne is driven more by aerodynamics and propulsion than by human factors and avionics."[90] There is no indication that the trend will change in the future consequently there is little potential of savings on UCAV R&D.

The costs of procuring manned or unmanned system are also comparable to each other. A procurement cost is usually the cost to introduce an aircraft into the inventory.

[89] Thomas E. May, "Operating and Support Cost Estimating: A primer" (Maxwell AFB, Ala.: Air Command and Staff College, 1982), 2-1.

[90] David R. Oliver, Unmanned Aerial Vehicles Roadmap…51.

Traditionally, the cost of procuring an aircraft is directly linked with its empty weight.[91] "This rule comes from a standard parametric model for estimating life cycle costs called the Burns Model. The model uses a judgement factor for computing airframe engineering hours for development and production to account for advanced technology features such as stealth, vectored thrust, and maximum speed."[92] If one removes the pilot and the supporting subsystems, one can reduce the weight of an F-22 by approximately 2000 pounds. Considering that the cost per pound of the F-22 is $3125, this would translate in savings of approximately $6M.[93] Additionally, by removing the pilot from the aircraft, it allows the engineers to reduce the size and weight of the aircraft by as much as 40% which translates into an increase in vehicle performance, range and payload.[94] All of these factors discussed in this paragraph demonstrate the potential savings that can be achieved in the procurement of UCAV. However, all of these savings are offset by the expense required for the ground equipment. The ground control station (GCS) is the brain of the UCAV system. Although it is a one-time expense, the initial cost is considerable. Additionally, the protective storage unit is also a large expense. The protective storage is to shield the GCS against weather and relative humidity and allows rapid deployment of the system. The end result is that the cost of the GCS and storage containers negates the saving from the procurement.[95] So in the end, manned or unmanned costs are roughly neutral.

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[91] Wayne J Burns, Aircraft Cost Estimation Methodology and Value of a Pound Derivation for Preliminary design Development Applications, SAWE Paper no. 2228, Long Beach, CA 23-25 May 1994.

[92] Major William K Lewis, "UCAV- The Next Generation Air-Superiority Fighter …77.

[93] Peter R.Worch, UAV Technologies and Combat Operations…4-8.

[94] Stacey Evers, "Unmanned Fighters: Flight without Limits," *Jane's Defence Weekly*, 10 April 1996, 29.

[95] Major William K Lewis, "UCAV- The Next Generation Air-Superiority Fighter…78.

The real potential savings come from the operations and support (O&S) costs. The O&S include variables such as petrol, oil, and lubricant (POL), training, and hangars space that are required to operate, maintain, and support the system. As discussed previously, the concept of operations considers that all training be conducted in a simulator. Once a conflict develops, the platforms would be loaded on strategic airlift and transported to the combat theatre. Considering that training will be conducted in simulator and the UCAV will be transported into theatre on strategic airlift, this would allow significant savings in O&S during wartime and peacetime.[96] Potentially, the UCAV, in hostile situations, could encounter a higher rate of combat loss than manned aircraft; however, it would still be more cost efficient because the UCAV is less expensive to operate. Considering that the cost to operate the Raptor is estimated at $162,500 per combat flying hour compared to the X-45 at $6000, it is fair to deduce that an organisation could lose as many as 27 UCAVs and still be cost efficient.[97] This is a significant saving for wartime O&S. Accordingly, O&S savings during peacetime are even greater. In addition, human error accounts for 70% of peacetime aircraft losses. By improving automation of the platform and introducing advanced simulators, the technology can direct the vehicle toward safer operations. Therefore, the operation of the unmanned vehicle during peacetime and wartime have the potential for significant reductions in O&S cost.

The utility of any system has to be considered along with its experience to determine cost effectiveness in equilibrium with their expense. Although the

[96] John A. Tirpak, "UCAV Move towards Fidelity," *Air Force Magazine*, March 1999, 34.
[97] David R. Oliver, Unmanned Aerial Vehicles Roadmap…54.

advancement in technological progress on unmanned vehicle has been slow due to the focus on the manned vehicle, some progress has been made in the last ten years. As learned, procurement and development costs are very comparable between the two, yet the O&S costs for unmanned vehicle are significantly lower than those for manned vehicles. However, poor reliability and supportability have decreased the savings in costs for the UCAV.

As much as the efficiency of a platform is tied to its combat effectiveness, factors such as theatre integration, cost of acquisition, and operation are extremely important when evaluating the effectiveness of a platform. Expensive acquisition programs such as the helicopter EH-101[98] are sometimes cancelled due to budgets being slashed, and complex and expensive weapons systems that have not been tested in training are not trusted by Battlefield Commanders during wartime scenarios, and complex and expensive systems are usually disregarded for a more inexpensive system that may be more reliable.[99] System costs are certainly a major concern for the Commander. A Tomahawk[100] cruise missile cost is comparable to the F-22 Raptor at a ratio of 245 to 1; therefore, since the Gulf War 1 Commanders have demonstrated a preference in using cruise missiles over the manned aircraft in combat situations. The cost of losing a high demand low density platform is certainly significant, however, no

[98] The Canadian government placed a $4.4 billion (CAD) order in 1987 for 48 (later 42) EH101s to replace the Canadian Forces' CH-124 Sea-King and CH-113 Labradors. The whole programme was cancelled after a change of government in 1993, leading to a payment of $500 Million in cancellation penalties.

[99] Walter Kross, "Military Reform: The High-tech Debate in Tactical Air Forces," National Defense University Press, Washington D.C. 1985, 11.

[100] The Tomahawk is a long-range, all-weather, subsonic missile. It was designed as a medium- to long-range, low-altitude missile that could be launched from a submerged submarine.

one can measure the cost of killed or captured aircrew in terms of dollar-value or public support and morale.[101]

Seventy years ago, fighters with propellers used to drop dumb bombs where today stealth bombers drop precision guided weapons. The most popular interdiction weapon is the cruise missile based on the fact that it is the most effective weapon based on cost and risk. Although the cost of a UCAV ($15M US) is approximately 20 to 1 in comparison to the cruise missile ($750K US), it delivers twice the amount of ammunition on target. Additionally, UCAVs are considerably more survivable than the cruise missiles, which of course are only used once each, or manned aircraft which make them cheaper per sortie as long as attrition remains below 5%.[102] The cruise missile does not carry the variety of sensors that UCAVs can carry so it does not have the benefit of providing situational awareness and a surveillance capability to the Commander. Finally, UCAVs provide more flexibility to strike targets sheltered in valleys or pop-up targets appearing during the mission.[103]

In December 2002, for the first time in history, a dogfight was recorded between an Iraqi MiG-25 and a US RQ-1 Predator. While the outcome ended in a loss for the UCAV, it confirmed that a UCAV could carry out an air interception mission.[104] In the early development of the UCAV, it was not expected to be able to penetrate enemy

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[101] Walter Kross, "Military Reform: The High-tech Debate in Tactical Air Forces…12.

[102] James, R. Asker, "Get Busy," *Aviation Week & Space Technology*, 29 June 1998, Vol.148, Iss 26, 21.

[103] Walter Kross, "Military Reform: The High-tech Debate in Tactical Air Forces." National Defense University Press, Washington D.C. 1985, 13.

[104] Boothie, Cosgrove-Mather, "Pilotless Warriors Soar to Success," CBS News, 25 April 2003, available from www.cbsnews.com; Internet; accessed 27 March 2010.

territory, avoid air defence systems, and destroy enemy aircraft while recovering to home base. Given that the cost ratio of UCAVs to NGF is 1 to 4; this would translate into an enemy needing to shoot down four UCAVs for every fighter it lost.[105] Therefore, these examples demonstrate UCAV utility for ground and air attack.

During peacetime, operating a manned aircraft will normally easily cost 10's of thousands of dollars per sortie and will require approximately 30 man-hours of maintenance.[106] It could be argued that the support costs incurred during the life of a manned aircraft can cover its acquisition cost.[107] Considering that UCAV operators could fly simulated missions in flight simulators at a much lower cost than the real thing, it would significantly reduce the requirement of flying actual mission in times of peace. This could be translated in savings of approximately 80% over manned systems.[108]

Upon analysis of all aspects related to costs of UCAVs versus manned vehicles, although procurement costs are comparable, UCAVs have a significant advantage over manned vehicles as it regards operational and support expenses. In addition, the cost of a UCAV ($15M US) is approximately 20 to 1 in comparison to cruise missiles ($750K US) and provides more flexibility to strike targets sheltered in valleys or pop-up targets appearing during missions. Now that cost advantages of the UCAV have been

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[105] Walter Kross, "Military Reform: The High-tech Debate in Tactical Air Forces."…13.
[106] *Ibid*, 60.
[107] David, A. Fulghum, "High-G Flying Wings Seen For Unmanned Combat", *Aviation Week & Space Technology,* 11 November 1996, Vol. 145, Iss 20, 58.
[108] David, A. Fulghum, "Unmanned Strike Next For Military", *Aviation Week & Space Technology*, 2 June 1997, Vol. 146, Iss 23, 47.

considered, the next section compares the technology between UCAVs and manned vehicles.

**Technology.** Based on the fact that a UCAV is comparable to a manned NGF without a pilot, by removing items such as the canopy, oxygen, pressurization, instrument displays and ejection seat, it reduces the weight of the vehicle by 40% and increases the payload by 2000lbs.[109] It also reduces the chances of equipment malfunction and improves the serviceability of the vehicle. If the human is removed from the equation, it improves the manoeuvrability of the vehicle due to the fact that the manned fighters are limited by the capability of G absorption by the pilot. The airframe is capable of sustaining more than 20Gs which would challenge its human opponent in a dogfight scenario.[110] A UCAV will be able to evade more effectively than manned aircraft and guided missiles because the airframe is capable of sustaining more Gs. A final consideration, after an extensive G session, the pilot will become exhausted quickly which is not a factor with the UCAV.

With the improved aerodynamics and reduction in weight, the UCAV vehicle is capable of range, speed and loitering that makes it a competitive platform for use in ground attack, intelligence, surveillance and reconnaissance (ISR), and air interdiction. Based on the fact that they do not carry pilots, UCAVs have no restriction on the number of sorties and the length of the crew day. UCAVs are expected to fly three

[109] United States, Department of Defense, Defence Science Board Task Force: Future DOD Airborne High-Frequency Radar needs/resources, U.S. Government Printing Office April 2001.

[110] David, A. Fulghum, "Payload, Not Airframe, Drive UCAV Research," *Aviation Week & Space Technology*, 2 June 1997, Vol. 146, Iss 23, 51.

sorties per day with a surge capacity of five sorties. As of 5 December 2007, the USAF Research Laboratory and Boeing successfully demonstrated that UCAVs are capable of rendezvous with a tanker aircraft for refuelling. Finally, given their limited size and payload capacity compared to a larger aircraft, the development of UCAVs promises to significantly increase flight-times and range.[111]

UCAVs can also provide an advantage by engaging targets precisely with dumb bombs as they can carry the same payload as any NGF.[112] With sensors and guidance being an integral part of the platform, this allows the UCAV to carry a larger payload than a cruise missile. Another consideration for a Battlefield Commander is in having to deal with the loss or the capture of aircrew, not only in dollar-value but also in terms of public relations and morale. Therefore, it is a lot easier to send unmanned vehicles that can get close to its targets and hit them with the same precision as guided weapons. Also, one interesting concept developed is to use UCAVs as a strike package under the command of an operator on a manned aircraft in theatre.[113]

Recognizing several technological advantages associated with UCAVs, one of the biggest challenges for the Canadian military will be to operate UCAVs with substantial communications bandwidth.[114] One of the lessons learned in recent conflicts

[111] Boeing Demonstrated UAV automated Aerial Refuelling Capability available from http://www.spacewar.com/reports/Boeing_US_Air_Force_Demonstrate_UAV_Automated_Aerial_Refueling_Capability_999.html; Internet; accessed 27 March 2010.

[112] Colonel Bruce Carmichael et al. « Strikestar 2025, » a research paper presented to Air Force 2025, August 2006, available from www.au.af.mil/au/2025/volume3/chap13/v3c13-1.htm; Internet; accessed 28 March 2010.

[113] James, R. Asker, "Who needs stealth?"…25.

[114] One of the biggest challenges for the Canadian military to operate UCAVs will be to acquire substantial communications bandwidth. Significant amount of bandwidth will be required to transmit data

was that regardless of how much communications bandwidth is available, battlefield Commanders will always demand more. A significant amount of bandwidth will be required to transmit data on mission, threats, and navigation. Satellite communication will allow operators located thousands of miles from the theatre of operation to receive battlefield intelligence, and direct UCAVs to specific targets. Considering that the UCAVs may not be operational until year 2025, it allows Canada sufficient time to implement solutions to solve the deficiencies in communications bandwidth especially in the North. A potential solution may be offered via Canadian participation in the MILSTAR project[115] and involvement is the Canadian Space Agency through the "Polar Communication and Weather mission project to resolve this issue."[116] Another possible solution is through the use of civilian satellite communications to transmit mission data; however, there is a significant involved in tasking commercial satellites.

Without a pilot on board, the UCAV is capable of sustaining more Gs which would facilitate the evasion of adversary platforms in a dogfight scenario. Also, given the reduction in weight of the platform, UCAVs offer significantly longer flight times and range. Furthermore, without the risk of losing a pilot, it is a lot easier to send unmanned vehicles in close proximity to its targets. Finally, one of the biggest challenges will be to operate UCAVs with enough bandwidth. In the next section, the

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on mission, threats, and navigation. Considering that the UCAVs would not be operational until year 2025, it allows Canada to implement solutions to solve the deficiencies in communications bandwidth.

[115] Milstar Satellites System, available from http://www.af.mil/information/factsheets/factsheet.asp?id=118; Internet; accessed 28 March 2010.

[116] Polar Communication and Weather Mission, available from http://www.neossat.ca; Internet; accessed 28 March 2010.

final factor to consider when comparing UCAVs with manned vehicles, survivability, will be considered.

**Survivability.** One of the most important factors in the development of the UCAV is to increase its survivability. UCAVs will fly the same mission as manned aircraft and guided missiles into enemy territories while avoiding surface-to-air missiles, anti-aircraft artillery and enemy manned aircraft. The capability to effectively handle these threats will determine the attrition rate for UCAVs, which will make them more attractive than unmanned aircraft and guided missiles.[117] Another important factor to improve survivability is state-of-the-art navigation systems on board that provide exceptional navigational capabilities. Most of these systems are Global Positioning Systems (GPS) with Inertial Navigation Systems (INS) which enhance the navigational capability to fly at very low altitudes, making it difficult to be detected by enemy aircraft or surface-to-air missiles. Finally, like manned aircraft, there is no operational limitation preventing UCAVs flying at night, as the cover of darkness adds to the survivability of the platform.[118]

Although the advancement in technological progress on unmanned vehicle has been slow due to the focus on manned vehicle, some progress has been made in the last ten years and great cost savings have encouraged their development. The procurement costs for manned and unmanned systems are also comparable to each other; but, the

[117] United States, Department of Defense, U.S. Air Force Scientific Advisory Board. New world Vistas: Air and Space Power for the 21st Century. 1996, 35.

[118] United States, Department of Defense, Government Accounting Office, NSIAD-97-134. Operation Desert Storm Air Campaign, 1992.

O&S costs for unmanned vehicle are significantly lower than that for manned vehicles. Poor reliability and supportability have decreased the savings in costs for UCAVs. With the advancement of technology, the reliability and supportability will be improved to a level where the UCAVs will be both cost and operationally efficient, making UCAVs a viable option for Canada. In fact the latest figures seem to support significantly decreased costs of operating UCAVs when compared with manned fighters or even long range patrol aircraft like the Aurora. The key challenge is that combat UCAVs that can provide significant surveillance in the North and actively respond to engage targets of interest, simply do not exist as of yet. So while Canada does not have the military budget of some of its potential adversaries, this does not mean that Canada is incapable of funding an effective resistance to defend our sovereignty in the Arctic.

## CANADA'S DEFENCE BUDGET AND NEEDS

For a comprehensive understanding of the challenges of procuring equipment for the military, it is critical to be aware of the difficulties of forecasting the flow of money. Under the Chretien government, the military suffered many years of budget reductions while the government got their expenses and revenues under control to tackle the deficit.[119] Significant cuts in spending have affected the military's ability to operate with allies and have crippled the forces' ability to operate in an increasingly dangerous world. Between 1993 and 1998, the budget was reduced by 23% by closing bases,

[119] Bill Robinson and Peter Ibbott, "Canadian Military Spending: How does the current level compare to historical Level? To Allied Spending? To potential threats?" Project Ploughshares (March 2003) available from http://www.ploughshares.ca/libraries/WorkingPapers/wp031.pdf; Internet; accessed 8 March 2010.

delaying the purchase of new equipment, cutting back on military and civilian positions, and reducing international commitments within NATO. In the late 1990s, the funding slowly returned to the levels seen early 1990s; however, much of the new money - $3.9B - was assigned to improvements in the quality of life of the soldiers.[120] Defence supporters, such as Jack Granatstein, co-chair of the Council for Canadian Security in the 21st Century, called for significant cash infusion to allow the military to upgrade or replace old equipment in their military arsenal. Although the Liberals had cancelled the $4.4B project to replace the 40 years old Sea-King in 1993, it was not until 2000 that the Military Helicopter Project (MHP) released a Request for Proposals (RfP) for 28 new Maritime Helicopters at a total cost of $3.0B.[121]

With the decade-long bloodletting, the credibility of the CF was disputed by the defence supporters and Allies. Jack Granatstein argued that the state of readiness of the CF after decades of inappropriate funding had driven the military near the verge of collapse. Although the last formal defence review in 1994 promised a more modern and sophisticated force, the reality, says Granatstein, was that "Canada had to rely on its Allies to sustain its modest participation in international operations."[122] Aircraft and ships had to be parked to be cannibalized for parts while troops had to hitch a ride with Allies or rent a plane from questionable providers to get to destinations.

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[120] Jonathon Gatehouse, "Why the Canadian Military isn't ready for a war," Maclean's, 30 September 2002, Vol. 115, Iss 39, 16.

[121] http://CH-148 Cyclone, available from www.airforce.forces.gc.ca/v2/equip/ch148/bgd-doc-eng.asp; Internet; accessed 24 March 2010.

[122] Jack Granatstein, "NORAD North American Air Defence Agreement." I*n The Canadian Encyclopedia*, 2010 Historica, 22.

A study released by the Council for Canadian Security in the 21st Century acknowledged that "Canada is losing international credibility and influence, and called for at least $1.5B a year more in military spending. Military power still matters, says Granatstein. When people talk about powerful nations, they don't mean moral power."[123] Even our friends to the south were concerned about Canada's military competence. Paul Cellucci, the American ambassador to Canada from 2001 to 2005, recognized the valuable contribution that was provided by Canada during the war on terror; however, the present state of the force raised worries about their future. If there is anything that has been learned since 9/11, it is that distance and borders are not factors for terrorists, therefore a military is forced permanently to the highest readiness level.[124] A ready force should have the adequate number of troops with the right equipment to be deployed globally without depending on Allies. Americans felt that Canada was not spending enough on defence. "Based on the United Nations Human Development report, military spending in Canada is the equivalent of 1.3 per cent of its Gross Domestic Product (GDP) in 1999, which ranks Canada seventh of the G8 countries, and well behind NATO allies like Greece, Norway and Denmark. In 1990, prior to the budget cuts, Ottawa was spending two per cent of GDP on the CF."[125]

Starting in 1999, the Defence Department started to receive a significant increase in its budget; however, it was nowhere near the level required to sustain the operation, the people, and the acquisition program. As stated by the Minister of

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[123] Jonathon Gatehouse, "Why the Canadian Military isn't ready for a war,"…17.
[124] Jonathon Gatehouse, "Why the Canadian Military isn't ready for a war,"…16.
[125] United Nations Development Program, "Human Development Reports; Globalization with a Human Face," available from http://hdr.undp.org/en/reports/global/hdr1999/; Internet; accessed 21 March 2010.

Finance, Hon John McCallum, "We need a significant injection of resources to be sustainable in the long term, both on the people side and on the capital side. But we're certainly not going to get $4B. With no magic solution on the horizon, the challenge for Canada's soldiers, air crews and sailors will be the same as it has been for a decade - getting the job done, even if it means breaking out the chewing gum, string and duct tape."[126]

The arrival of the Prime Minister, RHon Paul Martin, and the Chief of Defence Staff, Gen Rick Hillier, started to change the focus on the Department. In June 2005, the CF announced the establishment of a new command structure for the operational headquarters. The aim was to respond more quickly to either domestic or international threats. In 2005, the government delivered on their electoral promises to provide funds to revamp Canada's military.[127] The Liberal government injected close to $13B in new money to rejuvenate the military over the next five years.[128] During the years that followed, the Conservatives' budget allocated an extra $1.1B to the CF. This was part of the $5.3B in funding promised over the next five years.[129] "Finally, Canada's military budget for 2008 was $18.2B. In the budget, the government pledged to increase military spending by two per cent a year for 20 years, starting in 2011, which would add an additional $12B. It is projected to reach $19B next year."[130]

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[126] Jonathon Gatehouse, "Why the Canadian Military isn't ready for a war,"…17.

[127] Adam Day, "Budget, Missile Defence Dominate Conference," *Defence Today*, 1 May 2005.

[128] CBC News, "Canadian Forces in the 21st Century," 21 April 2008, available from http://www.cbc.ca/news/background/cdnmilitary/;Internet; accessed 21 March 2010.

[129] Department of Finance, "The Budget in Brief 2006: Focusing on Priorities," available from http://www.fin.gc.ca/budget06/pdf/briefe.pdf;Internet;accessed 21 March 2010.

[130] Department of National Defence, "*Report on Plans and Priorities 2008-2009*," Part III Estimates, available from http://www.tbs-sct.gc.ca/rpp/2008-2009/inst/dnd/dnd01-eng.asp#sec1g_e;Internet; accessed 21 March 2010.

The new federal budget for 2010 has slightly changed the plan for the Harper Government. The plan will remain the same for fiscal year 2010-2011 and the following year; however, the Minister of Finance indicated that the size of the planned growth in military spending will be reduced for the next two years. The reduced growth will affect the 2012-2013 budget by $525M while the impact on the 2013-2014 budget will be $1B dollars.[131] The military budget will then return to a normal rate of increase as promised by the Harper government under the Canada First Defence Strategy.

In recent years, the Harper Government has aggressively increased the military budget to provide the major investment necessary to acquire the military capabilities required to modernize the CF. The government long-term vision is well represented in the Canada First Defence Strategy. All of the investments in recent years have strengthened the military and produced concrete results in our capabilities confirmed by our deployment in Afghanistan, support to the major earthquake in Haiti, and the provision of the security at the 2010 Olympics. However, due to fiscal restraints, the government temporarily reduced military spending with the understanding that the budget will return to normal for budget 2014-2015. If you combine the fact that Canada's claim to sovereignty in the North is actively being challenged and the military is not currently capable of ensuring sovereignty along with the need to be fiscally responsible, the future acquisition of UCAVs for the protection of the Arctic makes both economic and operational sense. However, the question must be asked as to

[131] Department of Finance, "*The Government Expense Plan and the Main Estimates,"* (Ottawa: Information Canada, 2010), 22.

whether the Canadian population is ready to have their sovereignty in the North protected by robotic airplanes with the capability to drop lethal weapons on a target.

**PROCEDURAL ASPECT**

In order to validate the possibility of employing UCAVs in the North, it is critical to review the related legal implications. The Canadian government, in conjunction with the Department of National Defence (DND) must develop policies that will address domestic and international flight regulations, Rules of Engagement (RoE) and, the Laws of Armed Conflict. If Canada does not address these issues, UCAVs will never get airborne in support of Canadian Defence Policy. More importantly, is Canada ready ethically to let operators thousands of miles removed from the battlefield process and destroy targets that could end up in potential loss of life?

An area of concern for the government will be to address domestic and international flight operations. Considering that the initial intent is to use unmanned systems in the Arctic, the government will concentrate on national air regulations. The main concern for UCAV flight operations will be to implement Standard Operating Procedures (SOP) and the Concept of Operations (CONOPS) that have already been developed by the Commander 1 Canadian Air Division.[132] Further coordination will be required with Transport Canada (TC) prior to any flight. The SOP for processing any targets or intruders will be identical to the ones used presently with Canadian fighters.

[132] Commander 1 Canadian Air Division, Concept of Operations; Joint Unmanned Aerial Vehicles Surveillance Target and Acquisition System (JUSTAS), 27 February 2009.

The progress that has been made in commercial/civilian UCAVs have assisted DND to expedite the acceptance of the unmanned vehicles flying into domestic airspace.[133] By using the platform in international airspace, the regulation is that "flight operations into a nation's sovereign airspace require approval by the nation."[134] This means that a UCAV can fly in any country around the world as long as it has received permission. With the approval of the host nation, the unmanned platform will be able to overfly the country.

Another related challenge is to integrate Command and Control (C2) with the human-machine interface. There are three types of C2: autonomous, semi-autonomous and manual. Autonomous represents the mode where the ground controller is only involved in take-off and landing. Semi-autonomous is the mode where ground controller inputs are required for take-off, landing, weapons deployment and evasive actions. Finally, manual mode is where inputs from the ground controller are required continuously. Most of the new platforms today operate with autonomous and semi-autonomous mode. A more critical mode of the C2 is the safe mode.[135] Considering that the UCAVs will carry weapon systems, it is critical that a safe system be built between the platform and the ground controller. In the case of an emergency, the platform needs to be programmed with precise procedures and instructions to follow. The potential for

[133] Civilian registrations are assigned to the UAVs that belong to the CIA.

[134] Capt Robert A. Ramey, "Overflight under the Chicago Convention," *The JAG Warrior,* Vol. II, (June 1999), 5.

[135] Most of the time, a UCAV will carry some type of weapon. SOPs need to be developed and legal arrangements need to be in place regarding emergency operations of UCAVs. In the event of engine problems, loss of control and command system, or weapon malfunction, the UCAV must be programmed with precise instructions and procedures to follow. These instructions or procedures may include a pre-planned orbit point to regain control, a pre-planned self-destruct point, or an autonomous recovery and landing option.

a serious accident exists when one arms an aircraft and remove the pilot. This issue needs to be addressed by the government and DND.

The next challenge for the Canadian government/DND is to resolve the issue with the Laws of Armed Conflict (LOAC). The LOACs have two main sources: treaty law and customary international law, which potentially can impact UCAV operations with two LOAC principles such as Discrimination and Humanity.[136] "The Principle of Discrimination requires the parties of the conflict to: distinguish between civilians and combatants; between civilian objects and military objectives; and direct operations against military objectives only."[137] At the end of the day, the operator has to take all precautionary steps to reduce collateral damage to nothing if possible. Worldwide, there is a growing perception that the advancements in technology for precision weapons legitimize the use of it and criminalize collateral death and demolition.[138] This statement indicates that the law institutes restrictions on using weapons that can hit a target with lethal force. Therefore, ground control with autonomous or semi-autonomous controls demonstrates severe accountability issues. Each UCAV weapon system needs to demonstrate accuracy and reliability as a discriminating weapon before their employment in theatre.

[136] Col David G Ehrhard ed., "The Military Commander and the Law" (Alabama: AFJAGS Press, 2000), 596.

[137] Department of Defense, Defense Logistic Agency: "Air and Space Law", available from www.dla.mil/dg/html/practice/contingency/manual/chap06.htm; Internet; accessed 30 March 2010.

[138] "UCAV issues." Available from http://asme.me.utexas.edu/uer/ucav/issues.htm; Internet; accessed 30 March 2010.

The Principle of Humanity prevents the usage of any excessive force that is not required for the purpose of combat.[139] The problem is that the legal status of unmanned vehicles was challenged by the 1988 Intermediate-range Nuclear Force (INF) Treaty signed by the Soviet Union and the US. Critics argue that if UCAVs are not programmed to return to the point of departure, it could be considered that a cruise missile carrying a nuclear device which is specifically in contradiction with the intent of the INF. This issue has been raised with the INF and Strategic Arms Reduction Treaty (START) and both countries concluded that it was not prohibited under both treaties.

The final legal issue is the development of the release of the Rules of Engagement (RoE), prior to deployment. The clarity of the RoE will facilitate the work for the Commander in theatre. They will provide guidance for the effective use and application of the force required. The most important item of the RoE is the specificity of the release and usage of the weapon. As discussed previously, there are three modes of operation for the UCAVs; autonomous, semi-autonomous and manual mode. The autonomous mode is the most problematic and challenging because it does not legally provide the safety of a human-in-the-loop. As much as the advanced technology available in UCAVs allows them to evaluate the situation, apply the RoE and release the weapon automatically, it is critical not to remove the human presence in the process. By having a human involved in the final two processes, this will facilitate the process of acceptance by legal authorities as accountability will ultimately rest with the operator. There will be moral and legal issues only when there is a malfunction that creates collateral damage. At the end of the day, the public must have confidence that a robotic

[139] Col David G Ehrhard ed., "The Military Commander and the Law"…598-9.

airplane can drop lethal weapons at the right place with the same degree of conscious precision as a manned system.[140]

Canada must start to work now on the legal framework required for future employment of UCAVs. It must integrate the employment of UCAVs within domestic and international airspace. Also, DND has to make sure that UCAV operations meet all the requirements and principles of the LOAC and any treaties. Finally, specific RoE's need to be developed to support UCAVs operations and the accountability that rests with the operator. While the employment of UCAVs appears to be a technological and financial good decision, it has several challenges from a legal perspective.

## CONCLUSION

This paper has made the case that a UCAV program is the most economical and effective solution for protecting Canada's sovereignty in the North. The factors which led to this conclusion included a discussion of future policy and other considerations to ensure Canadian sovereignty in the Arctic, and an exploration of the actual capabilities and capability gaps as applicable for arctic missions. It followed with an in-depth explanation of what UCAVs are together with a comparison with manned aerial vehicles. The paper also explored the impact of the DND budget on the acquisition of such new capabilities, and concluded with a discussion of the legal implications of utilizing UCAVs.

[140] John A. Tirpak, "The Robotic Air Force," Air Force Magazine, September 1997 Vol. 80, no. 9, 24.

In exploring why Canada needs a strong presence in the North, it was essential to explore the concept of sovereignty. Although definitions of sovereignty can be ambiguous, what is apparent from this research is that elements of control, authority and perception are of the utmost importance. In the North, while there is no dispute of the territorial lands, Canada's claim of the Northwest Passage have been challenged. Given these challenges to Canada's sovereignty and with global warming and the opening of these waters, it is becoming more critical that Canada exercise its sovereignty in fact rather than in political rhetoric. This is a significant issue for Canada now, and will become increasingly so in the future: Canada needs to monitor the Northern passage, establish a strong presence in the North and ensure the compliance of foreign powers with Canada's sovereignty claims. In addition, Canada's Arctic and waters have gathered increasing attention due to the natural resources available such as oil, gas, fish, and minerals, given today's technology making it possible and affordable to extract and transport these resources easily. Hence, Canada has committed $51M to surveying the boundary of its continental shelf in the Arctic in order to assist in determining its sovereign rights in terms of resource exploration and economic control.

This paper also focused on the main deficiencies present within the current Northern Surveillance, as this does not have capabilities that allow continuous surveillance of targets, as there is no single platform that can provide persistent, wide area, all weather and automated surveillance coverage over the Canada's ocean. While RADARSAT provides regular wide-area coverage of the maritime approaches, it is not persistent, and therefore something else is needed to provide this persistency and target

identification. A combination of both manned and unmanned vehicles could provide this 24/7 persistence, however the cost of such an operation would make this option unaffordable at this time, making the employment of UCAVs in the Arctic a possible alternative solution.

Defending national sovereignty is a key military role. With this understanding, the CF will have to make a decision on procuring the next generation of fighter which could potentially be the last manned fighter aircraft. Due to the limited Canadian military budget, the number of manned fighter aircraft planned for procurement is constantly dwindling. This will directly impact the capacity and types of mission that may be performed with the CF-18 replacement. The NGF will be challenged to accomplish all potential domestic and expeditionary roles, and therefore it is important that Canada procure a new platform that will either augment the role of the NGF, be able to carry more roles, more economically on its own. Understanding the need to balance what is required with the inescapable fiscal restraints imposed by the government is a challenge. With the technological progress of recent years in unmanned systems, studies clearly show that they can be considered comparable with the much more expensive manned systems currently being considered. The O&S costs for unmanned vehicle are significantly lower than the manned vehicle especially given the recent advancements that address the reliability and supportability of these systems. The UCAV could be permanently deployed in the Forward Operating Locations (FOLs) that the military currently use for the CF-18 in the Arctic. In addition, another concept

which could be developed is to use the UCAV as a strike package under the command of an operator on a manned aircraft in theatre.

Under the former Chretien government, the defence budget was reduced significantly as priorities shifted to deficit reduction, which impacted DND's ability to operate. With the arrival of RHon Paul Martin as the new PM, and the new Chief of Defence Staff (CDS), Gen Rick Hillier, the focus reverted to a commitment towards revamping Canada's military. This continued under the Harper Government and thus there have been significant increases to the military budget, which provided the major funds necessary to acquire the military capabilities needed to modernize the CF. These investments have strengthened Canada's military and produced concrete results in our capabilities which were confirmed through Canadian deployments in Afghanistan, support to the major earthquake in Haiti and, our provision of the security at the 2010 Olympic. However, with the recent shift in the global economy, the government has opted for implementing fiscal restraint, which has translated into a temporary reduction of military spending, with the understanding that the budget will return to normal for the budget year 2014-2015. With this, it is essential that any new acquisition being considered by the military be economical and linked to Canada First Defence Strategy and aligned with the government's agenda of the day. However, as explored in this paper, there are legal hurdles that UCAVs will need to be addressed for the implementation of this technology in the future.

In summary, the evidence has shown that the UCAV program is the most economical and effective solution for protecting Canada's sovereignty in the North. This paper explored why Canada needs a strong presence in the North to guarantee the sovereignty of its nation. It is critical for a nation to defend its sovereignty which can only be achieved through strong defence policies. "The government future policy discussions will need to consider the most effective and efficient means of protecting Canadian sovereignty in the Arctic"[141] including what could be potentially costly programs. It needs to provide a better understanding of the deficiencies in the surveillance of the Arctic and propose potential solutions for the enforcement of Canadian sovereignty in the Arctic. Canada does not have the kind of military budget of some of its potential adversaries in this area, but this does not mean that Canada is incapable of funding an effective resistance. The military utility of any weapon must be cost effective. Although the advancement in technological progress on unmanned vehicle has been on hold due to the focus on the manned vehicle, significant progress has been made in the last ten years and great cost savings has encouraged their development. Finally, Canada must start to work now on the legal groundwork required for future employment of the UCAVs by integrating the employment of the UCAVs within domestic and international airspace.

[141] Library of Parliament, Canadian Arctic Sovereignty, available from http//www.parl.qc.ca/information/library/PRBpubs/prb0561-e.htm; Internet; accessed 26 March 2010

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