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Broad Area Maritime Surveillance

An Unmanned Solution for the Royal Canadian Air Force

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Unmanned aircraft systems (UAS) have experienced extraordinary growth in the past three decades, particularly in the defence and security sectors.[2] The overarching mission sets that have driven contemporary innovation into defence UAS include those that are predominantly "dull, dirty and dangerous"[3] and pose untenable risk to manned platforms. Today the military UAS continuum ranges from specialized tactical micro-UAS platforms to semi-autonomous, high-altitude long-endurance (HALE) vehicles that are fitted with sophisticated sensor and communications suites and are capable of projecting air power globally.

While Canada led the industry in early UAS research and development activities in the 1960s and demonstrated modest engagement in operational UAS applications during the war in Afghanistan, the Canadian Armed Forces (CAF) and more specifically the Royal Canadian Air Force (RCAF) have since fallen significantly behind alliance partners in practical UAS skills and experience.[4] This paper will identify several operational areas in which the RCAF could, in conjunction with existing CAF frameworks, leverage a single emerging UAS concept to achieve synergistic effects in the joint operating environment. In the interests of clarity, the following examination will be delivered through the lens of the United States Navy's (USN) Broad Area Maritime Surveillance (BAMS) initiative and how it could be employed to great effect in support of a variety of RCAF missions. Despite the perspective from which it is examined here, it is crucial that BAMS be viewed not as something to be conducted by a specific platform but rather as a conceptual UAS capability, and that any future or derivative analysis remain impartial and informed only by legitimate CAF operational requirements.

The aim of this paper is to examine and recommend a practical option for the use of unmanned aircraft systems in support of RCAF missions. The paper will highlight several RCAF defence and non-defence mission sets that could be conducted more effectively or efficiently by a UAS in comparison to a conventional platform.

Broad Area Maritime Surveillance

In 2017, the government published a Defence White Paper entitled *Strong, Secure, Engaged*.[5] In this policy paper, the overarching defence priority established by the government and CAF

strategic leadership is *strong at home*, which includes the detection, deterrence and defence against threats to or attacks on Canada.[6] Having the longest coastline in the world, the defence of Canada's maritime approaches, including the Arctic, is of utmost importance in the future operating environment. Arctic sovereignty is particularly challenging given the harsh climate, vast geography, sparse population and limited infrastructure. In spite of the factors that serve to restrict CAF presence in the Arctic, the effects of climate change and economic globalization are converging to make the Arctic increasingly accessible and thus potentially a source of security threats.[7] If it is to fulfill its core mandate, the CAF must develop innovative means of conducting persistent intelligence, surveillance and reconnaissance operations across the continuum of domestic maritime operating environments, including the Arctic.

The current CAF initiative to field an RCAF-operated UAS is the Remotely Piloted Aircraft Systems (RPAS) project, a derivative of its predecessor, the Joint Unmanned Surveillance Target Acquisition System (JUSTAS). As a major capital procurement project, the objectives of RPAS are intrinsically linked to the strategic objectives and investment initiatives outlined in *Strong, Secure, Engaged*.[8] Characterized as a medium-altitude long-endurance (MALE) UAS, the ultimate aim of the RPAS project is to deliver:

> … an integrated persistent long-range, intelligence, surveillance, target acquisition and reconnaissance capability … capable of providing near-real-time information to tactical, operational and strategic commanders to support both domestic and deployed operations, and when required, provide a precision strike capability to support operations.[9]

It is envisioned that RPAS will act as a force multiplier and not a replacement of any existing capability. Still in the Review and Refine Requirements phase, the forecast completion of RPAS is 2030 and the current maximum budget allocation is $4.99B (CAD).[10]

Intelligence, surveillance and reconnaissance (ISR) is a framework by which integrated activities of collection, exploitation and processing of information are planned and executed in a synchronized manner and the resulting intelligence products are disseminated in direct support of operations.[11] In practical terms, the aim of ISR is to build situational awareness and facilitate superior decisions, essential elements of any effective military operation. Although ISR is an inherently joint activity, the core attributes of speed, reach, precision and elevation inherent in air power make the RCAF a principal stakeholder in the ISR enterprise. Furthermore, UAS platforms are "ideally suited for collection missions that are long and tedious (dull), hazardous to humans (dangerous) or are carried out in undesirable conditions (dirty),"[12] attributes that are the epitome of maritime and Arctic ISR operations.

An emergent UAS paradigm that is well positioned to address the specific challenges of Canada's maritime and Arctic security mandate is the Broad Area Maritime Surveillance (BAMS) concept. Developed and trialed by the US Navy (USN) beginning in 2012, BAMS was driven by the unique operational requirements of maritime ISR and the inherent challenges that otherwise limit or preclude the employment of existing UAS fleets in the maritime domain. BAMS commenced its first operational deployment in January 2020 and continues to undergo implementation.[13]

The BAMS platform, known as the RQ-4C Triton, is based on an enlarged version of the Northrup-Grumman RQ-4 Global Hawk with several distinct improvements that enable maritime and Arctic operations.[14] The BAMS UAS concept offers a persistent beyond-line-of-sight maritime ISR platform that embodies both the MALE and HALE concepts of operations. The inherent strengths of BAMS lie in its reach, endurance, ability to operate in austere conditions and

versatile suite of maritime-centric sensors. Although it does not fully replicate conventional maritime capabilities, BAMS augments them by providing a fused recognized maritime picture that allows conventional manned platforms to focus on localized kinetic activities (i.e., active (and primarily conventional) military engagements); a complementary capability closely aligned with the core tenets of RPAS.

The BAMS air vehicle is fitted with anti-ice capability, lightning protection and a reinforced fuselage for protection against hail, birds and wind gusts. These features allow BAMS to transition safely from a benign HALE operating envelope (50,000 ft and higher),[15] through cloud and volatile maritime weather, down to low levels. At the lower level it transitions from general wide-area surveillance to focusing the sensor suite and platform's overall field of view on one specific area/target. The robust features of BAMS facilitate this tactical agility with minimal risk to the vehicle, attributes that lend themselves well to operations in the harsh Canadian maritime domain.

BAMS features a 360-degree array of active and passive sensors that are task-tailored for maritime operations. With a greater than 400 nm sweep width, the multi-function active sensor (MFAS) maritime radar of BAMS is adept at scanning the wide swaths of ocean or shoreline of Canada's expansive maritime approaches. The MFAS is equally capable of individual target investigation to a very high degree of fidelity and generating a detailed radar image of a contact for the purposes of automated target recognition, a task that is the essence of maritime security operations.

BAMS is fitted with an auto-tracking, multi-spectral electro-optic/infra-red (EO/IR) targeting system sensor that produces and transmits high-fidelity imagery and full-motion video of targets or areas of interest. BAMS also features an absolutely essential element of any maritime ISR platform – an Automatic Identification System (AIS) receiver. AIS is an automatic maritime tracking system consisting of ship-based transponders which transmit vital information about ships such as name, type, position, size, registration, speed, track, ports of call, etc. When employed as a corroborative tool in conjunction with other sensors, AIS is vital in identifying suspect maritime vessels requiring further investigation or interdiction.[16]

Essential to persistent UAS maritime security operations, particularly in the vastness of Canada's northern maritime approaches, are the elements of coverage and endurance. BAMS is capable of remaining aloft for over 24 hours, has an operating range of over 8,000 nm and can cover more than 2.7 million square miles in a single mission.[17] In a Canadian context, BAMS can survey an area that equates to two-thirds the size of Canada's landmass or the entirety of Canada's Exclusive Economic Zone from Yarmouth, Nova Scotia, to the northern tip of Ellesmere Island to Vancouver Island in a single sortie.

In comparison to its conventional manned maritime ISR counterparts, namely the CP140 Aurora, BAMS is far superior at conducting long-range detection, deterrence and defence in the Canadian maritime domain. BAMS is operated with less than half the crew of the Aurora (four versus 10), has twice the endurance, twice the range and a superior ISR sensor payload.[18] And, as noted, BAMS is also the platform of choice to conduct the dirty, dull and dangerous mission sets. Maritime surveillance missions, particularly in Canada's northern reaches often face adverse meteorological and environmental conditions (dirty), protracted and risky periods of tedium (dull) and few viable alternates should an emergency occur (dangerous). Executing these missions using an unmanned platform, with no corresponding degradation in capability, diminishes the effects of external mission stressors, increases the tolerance for risk, and affords the RCAF greater operational flexibility.

While BAMS is specifically designed to fulfill a maritime surveillance role, it could readily be employed in an expeditionary ISR capacity to support another element of *Strong, Secure,*

Engaged – i.e., engagement abroad in mandates such as the operation in Libya in 2011.[19] In addition to the payload specifications discussed above which are compatible with virtually any expeditionary mission, BAMS possesses a sophisticated electronic support measures (ESM) suite that acts as a force multiplier in the delivery of theatre-wide operational effect. On-board or built-in ESM allows BAMS to detect, classify and localize electromagnetic radiation in the battlespace, using RF emissions detected to determine what platforms and/or potential threats are present in the battlespace, and enhance operational decisions.

BAMS is also a capable network relay and data-fusion centre, a synergistic joint effect delivered by the CP140 in Libya during *Operation Mobile*.[20] Not only can BAMS act as a theatre communications relay platform facilitating communications among elements that are not within line-of-sight of one another, it can also fuse sensor inputs from deployed friendly forces and rebroadcast the common operating picture via data link. This capability would allow the RCAF to "drastically increase interoperability, situational awareness, targeting efficiency and sensor picture clarity of the total force while also providing a resilient alternative to vulnerable satellite communications systems."[21] While the CP140 has proven itself capable in these domains, unlike the CP140, BAMS can maintain station much closer to the battlefield, above the engagement zones of hand-held ('man-portable') weapons systems.

BAMS also possesses significant potential in the non-defence role of national search and rescue (SAR). Canada's SAR regions extend from the mid-Atlantic Ocean, to the geographic North Pole, to approximately 600 miles west of Vancouver Island. SAR events that occur at the outermost boundaries of these areas are extremely demanding for conventional SAR assets, particularly when a protracted search is required and on-station time is severely limited by extended transit requirements. The extraordinary agility, reach and endurance of BAMS combined with a sensor payload that closely rivals modern fixed-wing SAR platforms such as Canada's Airbus CC-295, make it a perfect complement to the national SAR enterprise.

One of the many possible SAR scenarios invoking the engagement of BAMS involves a vast search area in the mid-Atlantic resulting from a missing aircraft or sailing vessel. In this instance, BAMS could be deployed to the scene in advance of the manned SAR assets, operating in a MALE/HALE configuration to quickly cover the search area using the full suite of on-board sensors. Upon detecting and classifying possible SAR targets from the aloft position, it could then descend through cloud into an identification configuration so as to ascertain each targets' identity and relevance via EO/IR. Whether the outcome of this process is the positive location of the SAR target or simply the elimination of hundreds of irrelevant targets, BAMS could substantially reduce search-phase pressure on conventional manned SAR assets. While RPAS systems are great for the often tedious 'search, locate and identify' aspects of SAR, however, the complexities of the 'rescue' part of the situation necessitate conventional human engagement on scene.

The RCAF is also routinely engaged in humanitarian response and disaster relief (HADR) missions in the wake of catastrophes such as earthquakes, hurricanes, fires and floods. Often the first task of any HADR response is area reconnaissance. A deliberate and detailed survey of the affected area provides a clear operational picture to enable the effective allocation of HADR resources. With its ability to provide sustained, real-time multi-spectral imagery over a wide area of operations, conceivably in advance of the deployed force's arrival, BAMS constitutes a highly effective post-disaster reconnaissance platform that would enhance Canada's whole-of-government commitment to HADR missions both domestically and abroad.

From a cost perspective, a modest BAMS fleet capable of fulfilling core *Strong*, *Secure*, *Engaged* requirements is tenable under the current RPAS procurement framework. Based on existing foreign military sales data, the approximate per unit cost of BAMS including control,

support and training systems is estimated at $250-$850M (CAN),[22] making the BAMS concept a feasible option to satisfy the CAF's future UAS operational requirements.

Despite its versatility and robust design, BAMS does possess some inherent limitations. Perhaps foremost among these is the lack of precision strike capability, an attribute that makes BAMS non-compliant with the defined requirements of RPAS. However, public opposition to the concept of armed UAS operations is one of the factors that has been cited as a key impediment to recent UAS procurement initiatives in Canada.[23] If the public debate over the ethical and moral aspects of armed UAS operations continues in Canada, an analysis, justification and/or validation of the RPAS precision strike requirements may be in order, and any compromise in this area could serve to streamline the program.

Another noteworthy barrier to the CAF's implementation of a strategic UAS asset such as BAMS is the inevitable and costly requirement for reliable multi-band satellite communication (SATCOM) accessibility to support beyond-line-of-sight UAS operations.[24] Canada's limited access to existing SATCOM architecture is unlikely to improve and is a capability gap that it must bridge in close synchronization with any beyond-line-of-sight UAS procurement initiative. Several Canadian SATCOM projects have been initiated to enhance CAF's limited capabilities in this domain,[25] however significant investment effort will be required to ensure SATCOM accessibility and the full exploitation of MALE/HALE UAS capabilities, particularly in the Arctic.

Conclusion

This paper examined the strengths and weaknesses of the BAMS concept in the context of the CAF strategic vision, existing defence frameworks and various RCAF missions. While the analysis was conducted through the lens of the specific BAMS platform, it was intended to illustrate that a collection of sophisticated capabilities under one conceptual umbrella could be employed with synergistic effect across the joint operational domain.

Despite some limitations, BAMS is potentially an ideal candidate to fulfill the strategic objectives of the RPAS program from the perspective of both cost and operational effectiveness. Conceptually it offers the appropriate mix of specialized maritime-centric features while remaining versatile in its potential scope of operational employment activities both domestically and abroad. If decisively applied,[26] the BAMS concept would improve RCAF efficiency, effectiveness and interoperability while simultaneously allowing the CAF to re-establish its footing and credibility in a defence sector that will become increasingly prevalent in the modern battlespace.

In light of the analysis here, the following recommendations are provided for the consideration of the Chief of Force Development and engagement with CAF/Department of National Defence (DND) stakeholders as applicable. First, establish a CAF/Defence Research and Development Canada (DRDC) consortium to conduct a detailed study of the operational merits of the BAMS concept, in whole or in part, in the context of CAF doctrine, operational requirements and overarching government strategic direction. The analysis should also include requisite fleet size along with possible basing and mission control centre options. Second, expand the scope of RPAS to include consideration of a hybridized MALE/HALE UAS that is capable of global, all-weather operations. Third, validate and/or justify the RPAS precision strike requirement to ensure compatibility with government and international policy, public/societal expectations, CAF operational requirements and potential barriers it might impose on timely RPAS program implementation. If possible, consideration should be given to deferring the precision strike capability to a future MALE project. And, finally, analyse existing CAF SATCOM procurement

initiatives to ensure compatibility and synchronization with possible RPAS command and control (C2) support requirements.

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Notes

1. This paper was written in 2018 while the author was attending the Canadian Forces College. It was written in fulfillment of one of the requirements of the course of studies (CSP 45/PCEMI 45, 15 October 2018, DS545 Component Capabilities). The paper was updated in February 2020. The paper is a scholastic document, and thus contains facts and opinions which the author alone considered appropriate and correct for the subject. It does not necessarily reflect the policy or the opinion of any agency, including the government of Canada and the Canadian Department of National Defence.
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26. By this I mean that the capability and concepts are not watered down over time, perhaps due to fiscal restraints, political intervention or entrenched institutional resistance.