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JUSTAS NOW: AN ARGUMENT AGAINST THE PREVAILING "WAIT AND SEE" APPROACH

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Exercise *Solo Flight*

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INTRODUCTION

The evolution of Canadian domestic and international operations over the last several decades has highlighted some deficiencies in the provision of accurate and timely intelligence, surveillance and reconnaissance (ISR) information to Canadian Armed Forces (CAF) commanders. Notwithstanding the existence and employment of the venerable CP-140 Aurora as a maritime ISR platform and its somewhat recent migration into an overland role in support of the Canadian Army, many believe that Canada should pursue additional technologies to complement and enhance the nation's already existing and evolving capabilities in the Sense domain function to support routine domestic operations, major international events in Canada, and assist Canadian civilian authorities during natural disasters as mandated by the 2008 Canada First Defence Strategy (CFDS).[1] The CFDS envisioned a Canadian surveillance system that would include aircraft, sensors, satellites, and Unmanned Aerial Vehicles (UAVs) to "keep Canada's maritime approaches safe and secure, including the Arctic", but a suitable UAV platform has not yet been purchased for this role despite much talk around the subject.[2] Adding to the dialogue, the CAF experience during the war in Afghanistan provided an opportunity to assess the utility of UAVs in a hostile and dangerous deployed environment. And, while they did not represent a long-term solution for domestic or international military operations, the employment of the CU-161 Sperwer and the CU-170 Heron further proved the ability of UAVs to significantly increase the overall operational and tactical awareness of CAF personnel thus reinvigorating the Joint Unmanned Surveillance and Target Acquisition System (JUSTAS)

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[1] Government of Canada, "Canada First Defence Strategy," http://www.forces.gc.ca/en/about/canada-first-defence-strategy.page (accessed May/7, 2015).

[2] *Ibid.*

project within the Department of National Defence (DND) that had begun in 2000.[3] Despite a continued interest in a UAV capability for Canada, the acquisition of a "flexible, effective and efficient" UAV system for domestic and international ISR employment remains in the planning stage.[4] The scope of JUSTAS continues to expand and the estimated costs continue to increase while the project timelines continue to slip. As late as May 2015 JUSTAS is still not a DND priority, a preferred platform or combination of platforms is yet to be determined and full project funding has not yet been approved by government.[5]

JUSTAS planners are acutely aware that there are currently no domestic or international regulations allowing for routine military or civilian UAV operations within un-segregated airspace. The specifications and system technical requirements that will be needed to ensure the safety of a "file and fly" UAV operation as envisioned by the project is delaying a procurement decision. Certainly, the questions surrounding the airworthiness of unmanned air vehicles and their airspace integration worldwide continue to represent serious risks to the project that, if completely ignored, could result in significant operational restrictions and additional cost to Canadian taxpayers, but they do not diminish a need for Canada to pursue this capability. This paper will examine the JUSTAS project and the regulatory hurdles yet to be overcome in the development of a comprehensive national domestic UAV policy in Canada. It will consider the significant gaps between stated JUSTAS project requirements and available technology and argue that rather than delaying the project further, the CAF should accept the relative immaturity of existing UA systems and press ahead with an acquisition.

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[3] Canadian American Strategic Review, "JUSTAS Project – Joint Uninhabited Surveillance and Target Acquisition System UAVs," http://www.casr.ca/bg-uav-justas-project.htm (accessed May/9, 2015).

[4] *Ibid.*

[5] Joint Unmanned Surveillance and Target Acquisition (JUSTAS) Project. 9th Annual Senior Review Board (SRB), 8 May 2015, MicroSoft PowerPoint Presentation, available on DWAN.

CONFUSING TERMINOLOGY

Before any comprehensive UAV legislation can be developed or even a coherent discussion about the JUSTAS program can be undertaken, the question of terminology must be addressed. There is, as of yet, no consensus on what to call unpiloted remotely operated air vehicles. Drones, Unmanned Aircraft (UA), Remotely Piloted Vehicles (RPV), Remotely Piloted Aircraft Systems (RPAS), Unmanned / Uninhabited Aircraft / Aerial / Air Systems (UAS), Uninhabited Combat Air Vehicles (UCAV), pilotless aircraft, remote controlled aircraft, autonomous air vehicles, flying torpedoes, and flying bombs are just some of the terminology used to refer to these air platforms in the existing literature. While the actual term used herein is unimportant to this discussion; it should be acknowledged that reference to any "unmanned" aircraft or system in this paper does not infer a fully autonomous machine that may routinely navigate the sky without human intervention. Rather, it refers to those platforms and systems that are tele-operated from a distance but still have a human "in the loop" making real-time decisions and able to respond to instructions issued by Air Traffic Control (ATC). A similar distinction must be made by all stakeholders to avoid possible confusion when referring to an autonomous robot versus a UA that is "remotely piloted".

According to the Canadian Forces Air Warfare Centre (CFAWC), discussing unmanned aircraft in terms of a flying platform only "…does not paint a realistic image of the equipment and personnel costs associated with the capability."[6] Certainly, the Royal Canadian Air Force (RCAF) is used to describing capabilities in terms of "the platform", but this does not account for the payload that a UA carries, the data-link system which enables its piloting by remote control, or the information processing, exploitation, and dissemination network needed to deliver

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[6] Canadian Forces Air Warfare Centre, "UAV Brief to the Air Board Executive Commitee" (MS Power Point Presentation, Available on DWAN, 2009).

actionable intelligence to end users. Because of this, one may even argue that the phrase "unmanned aerial vehicle" is no longer appropriate and a nomenclature that incorporates the "system" aspect should be utilized.[7] Transport Canada still refers to "UAVs", but recognized in 2014 the International Civil Aviation Organization's (ICAO) adoption of "RPAS" and is now beginning to change appropriate references within Canadian Air Regulations (CARs) to harmonize with this international body.[8] The term "RPAS" is quickly becoming the most widely used descriptor for this technology, but this may change yet again. Certainly, aviation regulators like the Federal Aviation Administration (FAA) in the United States and Transport Canada will have to consolidate the lexicon and standardize a set of terminology to unquestionably distinguish remotely piloted from autonomous drones when drafting possible future regulations for unmanned integration into the National Airspace System (NAS) of Canada and other countries. Additionally, they must develop agreed upon classification terms to differentiate between the larger military long endurance RPAS, for example, and recreational civilian-pattern "model aircraft" and the like. A failure to clearly define what a UAV, UAS, or RPAS is, for example, will undoubtedly result in confusion over the applicability of regulations for differing platforms. Similarly, the nomenclature of unmanned vehicles and systems will continue to be problematic for militaries until they too align their terminologies with each other and with industry. In the U.S. military alone, each of Army, Navy, Air Force, and Marine services has adopted differing terms which may lead to confusion; and the CAF has recently recognized that its "UAS classification table" is not in line with the accepted North Atlantic Treaty Organization

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[7] CFAWC cites LGen Deptula (HQ USAF A2 and Deputy Chief of Staff for ISR) and Colonel Gersten, Commander 432nd Air Expeditionary Wing Creech AFB from their opening address at a UAV conference.

[8] Second High Level Safety Conference, "Planning for Global Aviation Safety Improvement: *Canada's Approach to Managing the Risks of Remotely Piloted Aircraft Systems (RPAS)*" (Montreal, International Civil Aviation Organization, 2-5 Feb 2015, 2015).

(NATO) classifications based on take-off weight, operating altitude, and the level of operation they influence (tactical, operational, strategic). Interestingly, University of Canberra's George Cho believes that "a more accurate classification schema is to calculate the kinetic energy impact levels of the UAV" suggesting that ability of a UA to cause damage or injury upon crashing is of primary importance to domestic operations classifications.[9] An April 2015 CANFORGEN announced that DND has now adopted the NATO classification table "to ensure consistency when working with our allies and referring to current NATO STANAGS", but there is much more room for consistency in this area.[10]

The author, of course, recognizes that the naming convention of any weapons systems capability to be procured through JUSTAS will, in the absence of regulation, not influence a decision to acquire or not acquire it. Standardization of terms, however, is a first step toward the standardization of the industry as a whole and an important step in developing comprehensive regulations that delineate the specifications required for certain operations. This paper is concerned primarily with the combined technical characteristics of the actual UA and its command and control (C2) data-link system which may (or may not) aid a particular platform in meeting the requirements of routine and unrestricted operations within Canadian domestic and other airspace. The variety of terms and phrases used herein to this point and hitherto should be interpreted to mean both the platform and its control system.

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[9] George Cho, "Unmanned Aerial Vehicles: Emerging Policy and Regulatory Issues," *Journal of Law, Information and Science* 10 (2013), no. 22 (2013), 20 April, 2015., 5.

[10] National Defence - VCDS Executive, *CANFORGEN 080/15 C AIR FORCE 13/15 231956Z APR 15Implementation of NATO UAS Classification Table*, 2015).

JUSTAS PROJECT

With lengthy coasts on three oceans and vast uninhabited areas in the Arctic, carrying out surveillance and control of its territory and maritime approaches is a huge undertaking for Canada, the bulk of which to date has been accomplished by crews flying the CP-140 Aurora. With the surveillance successes enjoyed by the United States employing unmanned systems in the 1990's and in the post-9/11 era, it is not surprising that the RCAF sees an opportunity to use long-endurance unmanned aerial vehicles as a means of making this its own surveillance task more manageable. Although a future purchase of additional manned aircraft could augment; a "balanced mix" of manned and unmanned surveillance offers Canada the greatest payback in terms of "capability for dollars and personnel invested".[11]

The JUSTAS project was initially endorsed by the DND Senior Review Board (SRB) in 2000 with trials of leased unmanned platforms being conducted between 2002 and 2004.[12] It was in 2005 that the RCAF first began work on procuring a platform and, as part of its election campaign that year, the Progressive Conservative Party promised that, if elected, it would "station new long-range UAV squadrons at CFB Goose Bay and CFB Comox for eastern and western Arctic air surveillance."[13]

By 2006, with Canada involved in a war in Afghanistan, the RCAF decided that this "joint" project should be implemented in two phases. "Phase 1" would cover an overland capability and "Phase 2" would cover domestic maritime surveillance and northern patrols.[14]

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[11] Canadian Forces Air Warfare Centre, *UAV Brief to the Air Board Executive Commitee*

[12] Elinor Sloan, "Canadian Defence Commitments: Overview and Status of Selected Acquisitions and Initiatives," *SPP Research Paper* 6, no. 36 (2013). 16.

[13] *Ibid*., 16.

[14] Canadian American Strategic Review, *JUSTAS Project – Joint Uninhabited Surveillance and Target Acquisition System UAVs*

That same year there was reference to the acquisition of a fleet of 18 drones.[15] Perhaps recognizing the slow pace of the JUSTAS procurement, in 2007 DND attempted to acquire the General Atomics *Predator B* under a Joint Airborne ISR Capability (JAIC) advocating a sole-source foreign military sales (FMS) approach to field an interim version of JUSTAS Phase 1.[16] "That approach proved a political gaffe and it was promptly rejected by the Government which had recently been stung with criticism over other single-source deals."[17] Little more than planning has occurred since then on JUSTAS as the project has faced delay after delay. Whereas they were once anticipated to be operational by 2010, at the current pace the revised date for tentative RPAS service entry is now 2023.[18]

In an examination of Canadian Defence acquisitions, former Canadian defence analyst Elinor Sloan, states that "with advanced military technology, especially joint technology relevant to two or more services, it can be difficult to draw neat lines between platforms and the capability that they address."[19] JUSTAS for example is closely linked to the Canadian Multi-Mission Aircraft project because some of the surveillance missions carried out by long-range patrol aircraft (LRPA) could, in the future, be conducted by long-endurance MALE or HALE RPAS. Similarly, a drone capable of delivering weapons on target in support of the Army may also drop survival kits and be associated with the fixed-wing search and rescue project. With the proliferation of unmanned systems and advances in their technology, the possible uses of RPAS are bounded only by the imagination. This fact seems to be plaguing the project. Today, a clear-cut requirements solution for JUSTAS is not as readily apparent to planners as it was in

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15 Sloan, *Canadian Defence Commitments: Overview and Status of Selected Acquisitions and Initiatives*, 16.

16 Canadian American Strategic Review, *JUSTAS Project – Joint Uninhabited Surveillance and Target Acquisition System UAVs*

17 *Ibid.*

18 *Ibid.*

19 Sloan, *Canadian Defence Commitments: Overview and Status of Selected Acquisitions and Initiatives*, 6.

2007 because perceived uses and the scope of the project continues to expand. Some industry specialists argue that it is at the requirements phase of a project that "unreality sets in", or that "requirement definitions turn into more of a 'wish list' [of capabilities] than an operational requirement."[20] A project planner's failure to recognize that they are asking for a technology that is still in development will undoubtedly create procurement delays and increase costs significantly. The JUSTAS project, which had an original cost estimate of $500 million, is currently estimated to be in excess of $1.5 billion.

Currently under JUSTAS, DND and the RCAF are proposing to procure up to twelve unmanned aircraft (UA) systems that will complement (not replace) existing ISR and target acquisition capabilities such as the Aurora in an effort to increase domestic maritime and arctic domain awareness as suggested by the CFDS. The JUSTAS systems are to include medium and high altitude, long-endurance, long dwell, multi-sensor UA capable of operating anywhere in the Canadian domestic area of responsibility (AOR) under typical Canadian environmental conditions.[21] The RPAS will be operated using bi-directional command and control data-links comprised of an uplink to transmit UA and payload control commands and a downlink to transmit aircraft performance, navigation information and payload data. The exact specifications of these links are yet to be established, but may occur in the C, Ku, Ka, or X band "depending on the UAS communications configuration and availability of frequency spectrum and satellite communication services in the operating area."[22] A 2013 draft Statement of Operating Intent (SOI) claims the platforms will support a broad range of defence requirements, including Special

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[20] *Ibid*., 6.

[21] Canadian American Strategic Review, *JUSTAS Project – Joint Uninhabited Surveillance and Target Acquisition System UAVs*

[22] Royal Canadian Air Force, "Draft Statement of Operating Intent (SOI): Joint Unmanned Surveillance and Target Acquisition System" 30 June 2013)., 23.

Operations Forces (SOF) and support to other government departments (OGDs). Internationally, it will support CAF and Allied elements across the full operational spectrum, from peacetime engagement to full-scale war. The platforms will be equipped with a stores carrying and delivery capability that can support domestic search and rescue (SAR) efforts with air droppable survival kits and Land forces with precision kinetic effects. Operational flexibility, operator training, and transits to operations areas or existing air-to-ground ranges in Canada and elsewhere (the U.S. for example) will require relatively unfettered access to un-segregated, air traffic managed, national airspace systems alongside non-military aircraft. To facilitate this, the project's high level mandatory requirements (HLMRs) dictate, among other things, the need for an air vehicle "certified for flight in all classes of airspace".[23]

The JUSTAS project intends to deliver a RPAS capability for Canada but has now been in various stages of planning for fifteen years with nothing concrete to show for it. The nation undoubtedly has a need to complement its existing domestic and deployed ISR capabilities with a flexible and responsive platform that RPAS seem best suited to deliver, however, planners now seem to want the systems procured under the project to address an unpredictable range of scenarios the CAF may be faced with in the future. Before industry can deliver on the expanding requirements definition of JUSTAS, there are several technical and regulatory issues that will first need to be addressed. There are currently no all-weather RPAS systems available or suitable for year-round operations in Canada's north, frequency spectrum allocations and their protection from unintentional or unlawful interference has not been addressed, and a regulatory framework defining how RPAS may be integrated into airspace with manned aircraft is yet to be established. Although all the technology, regulations, and processes exist for manned aircraft,

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[23] *Ibid.*

there are currently no RPAS that possess the navigation performance, system redundancy/reliability or fault and error detection required for IFR certification. They are limited to Global Positioning System (GPS) navigation and are not capable of using legacy radio aids for navigation or approaches which is currently a requirement for many airspace operations. Recognizing some of these shortcomings, Major S.G. Sarty argued in 2011 that a delay in the project was prudent in order to establish what role unmanned aircraft would play in Canada's "ISR network". He advocated "waiting for the right UAV" to avoid "disappointment" and suggested that further study would avoid purchasing only the "best at the time".[24] The swift pace of unmanned technology and the work being conducted by regulatory bodies, however, is beginning to address these gaps. But, whether regulations accommodate the limits of technology or technology rises to meet regulations remains to be seen. What is for certain is that new technology will be developed and new possibilities for RPAS employment will emerge. Canada does not need to wait to see what the future will be, nor should it wait for the 100% solution to its JUSTAS employment vision.

AIRSPACE INTEGRATION

The integration of unmanned and manned platforms in the same airspace has been proven to be an important enabler to domestic and international military operations and there is now mounting pressure from civilian industry to "unlock the broad benefits of unmanned systems technology" and support its growth and development by "loosening the rules" around unmanned

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[24] S. G. Sarty and Canadian Forces College, *The CF MALEHALE UAV: Not an Immediate Panacea* (Toronto, Ont.: Canadian Forces College, 2008), 23., 2.

operations in the NAS.[25] The proliferation of RPAS and the envisioned military and commercial applications of the technology have undoubtedly highlighted a requirement to for new legislation and standardization to support its use. In fact, under the FAA Modernization and Reform Act of 2012, P.L. 112-95, the U.S. Congress has tasked the Federal Aviation Administration (FAA) with integrating RPAS into the national airspace system by September 2015.[26] Before this can happen, however, the hazard risk that unmanned aircraft may present to the civilian public has to be acceptably low. This risk is believed to be primarily associated with the possibility of midair collision between a RPAS and a manned aircraft, or the possibility of loss of control and impact with the ground in a populated area.[27] [28] There are no immediate solutions and ICAO acknowledges that the full and safe integration of RPAS into un-segregated airspace throughout the world will be a long-term activity involving inputs from many stakeholders.[29]

Operational Constraints

The successful operation of UAVs by Canada and her allies in support of ground operations in Afghanistan was accomplished through integration into a *combat airspace* where the risks were mitigated through the strict use of airspace control measures (ACMs) as well as by having RPAS operators emulate the safety procedures in use by manned aircraft. Residual risk of midair collision was accepted because of the excellent benefits that RPAS brought to the fight, but there were still some potentially disastrous flight safety incidents involving unmanned platforms that would not be acceptable in domestic or international airspace where airliners

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[25] Bart Jansen and Mike Snider, "Amazon Wants FAA to Loosen Up," *USA Today*, sec. B Money, Tuesday, April 28, 2015, 2015.

[26] U.S. Government 112th Congress, "Public Law 112-95," http://www.gpo.gov/fdsys/pkg/PLAW-112publ95/pdf/PLAW-112publ95.pdf (accessed 7 May 2015,

[27] Armand Awad, "An Analysis of the Risk from UAS Missions in the National Airspace" (Master's, University of Washington).

[28] Cho, *Unmanned Aerial Vehicles: Emerging Policy and Regulatory Issues*, 20 April, 2015

[29] International Civil Aviation Organization, *ICAO Circular 328 AN/190 Unmanned Aircraft Systems (UAS)* (Montreal: ICAO,[2011]).

carrying hundreds of civilian passengers could be put in harm's way.[30] Because of this, it is understandable that RPAS operations over most countries are currently only permitted in segregated areas unless approved through an elaborate and time consuming review process by its national airspace regulatory authority. Approved access to un-segregated airspace in North America currently involves "significant operational constraints that reduce flexibility and thus also [RPAS] mission utility."[31] Operators have only been permitted access to NAS on a case-by-case basis. FAA policy currently authorizes Certificate of Authorization or Waiver (COA) and Transport Canada issues Special Flight Operation Certificates (SFOC) to RPAS applicants upon thorough review of formal applications.[32] [33] Operations have been restricted to 'reserved airspace' blocked to all other traffic, or to very low altitudes within visual line of sight (VLOS) of its human operator and always away from populated areas.

See-and-Avoid

Until now, the integration of unmanned and manned aircraft in the NAS has been anything but routine due to what some see as "ongoing and significant technical issues."[34] Of primary concern to regulators is the fact that RPAS have no way of adhering to the principle of "see and avoid" thus increasing the likelihood of collision with other aircraft. The ability to visually identify other air traffic and avoid a collision with the same is the responsibility of the

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30 This information is taken from the author's own experience with RPAS operations.

31 Andrew Lacher et al., "Airspace Integration Alternatives for Unmanned Aircraft," *CAASD, the MITRE Corporation* (2010),1.

32 Bart Elias, *Pilotless Drones: Background and Considerations for Congress regarding Unmanned Aircraft Operations in the National Airspace System*Congressional Research Service,[September 10, 2012])., 6.

33 Transport Canada, "Review and Processing of an Application for Special Flight Operations Certificate for the Operation of an Unmanned Air Vehicle (UAV) System," http://www.tc.gc.ca/media/documents/ca-standards/(SI)_No._623-001_2_en.pdf (accessed May/9, 2015).

34 J. S. F. Laplante and Canadian Forces College, *The use of UAS in Canada's Unsegregated Airspace: Foundations and Roadmap*, Vol. JCSP/PCEMI 39-42 (Toronto, Ont.: Canadian Forces College, 2013), 97., 22.

pilot in a manned aircraft and a significant contributor to flight safety in all types of airspace.[35] FAA Advisory Circular FAA AC90-48C outlines this traffic avoidance responsibility and is one of the principle documents restricting RPAS access to the NAS.[36] The nature of unmanned flight prohibits an operator from visually deconflicting with other airspace users. Technology developers are currently working to address this problem, but notwithstanding the reluctance of Transport Canada to allow un-segregated military RPAS operations due to collision risk, DND has determined that *it* alone "is the legal regulator for all military aircraft in Canada and, as such, does not require any approval to operate a UAV in Canadian domestic airspace" and that the current constraints under which it works "is entirely self-imposed".[37] The U.S. military too asserts that its unmanned operations in un-segregated airspace are merely "constrained, not prohibited".[38] If this is true, then the current lack of robust airspace regulations specifically allowing unmanned aircraft will not curtail the military operations of a JUSTAS platform. Public safety, of course, is of primary concern and DND sees a layered solution to increased access to airspace. This solution, it says, "starts with procedural flight requirements, then air traffic management, followed by traffic collision and avoidance systems (TCAS) and, finally, an autonomous 'sense and avoid' capability".[39]

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[35] FAA Advisory Circular, "Pilot's Role in Collision Avoidance," https://www.faa.gov/regulations_policies/advisory_circulars/index.cfm/go/document.information/documentID/23090 (accessed May/9, 2015).

[36] *Ibid.*

[37] M. Wuennenberg, "UAV Operations in Canadian Domestic Airspace" (Briefing Note, 2011).

[38] Steven Aftergood, "Army use of Drones in U.S. is Constrained, Not Prohibited," https://fas.org/blogs/secrecy/2013/02/usarmy_drones/ (accessed May/4, 2015).

[39] Wuennenberg, *UAV Operations in Canadian Domestic Airspace*

TECHNOLOGICAL GAPS

Obviously, the main difference between an unmanned and a manned aircraft is that there is no pilot on-board the former. Operational control of the RPAS is exercised from a Ground Control Station (GCS) that uses a data-link signal to control a flight control computer on the UA. The GCS for most systems is configured similar to the cockpit of an actual aircraft with minor architecture changes, but the fact that the operator is on the ground has major implications on how RPAS operate and their ability to interact with the operations of manned aircraft.

Sense-and-Avoid

Operating RPAS requires a skill set that approximates that of piloting a manned aircraft. However, the reliance on synthetic presentations of flight instruments to develop situational awareness coupled with the lack of proprioceptive performance indicators such as G-forces presents a unique challenge to RPAS operators. Sensors and cameras are the only direct source of information to build situational awareness for operators, and while these may be capable of taking a detailed look at a very small area, they do not provide awareness of anything outside the 'soda straw' view.[40] Other cameras mounted on the nose or tail of potential JUSTAS platforms may provide a broader view of the flight direction, but operators still would not receive the kind of visual cues that would allow them to exercise see-and-avoid. Some may question whether see-and-avoid is even absolutely necessary for airspace integration. In his *Analysis of the Risk from UAS Missions in the National Airspace*, for example, University of Washington researcher Armand Awad argues that "[RPAS] already achieve manned levels of safety with respect to midair collisions…because general aviation aircraft routinely operate in conditions where see-

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[40] Joint Air Power Competence Centre, "Remotely Piloted Aircraft Systems in Contested Environments - A Vulnerability Study," http://www.japcc.org/portfolio/remotely-piloted-aircraft-systems-in-contested-environments-a-vulnerability-analysis/ (accessed May/9, 2015).

and-avoid is used but is not effective."[41] While this may be proven through statistics, it is misleading and it is not an effective argument for allowing unrestricted access to NAS by RPAS even under Instrument Flight Rules (IFR). The inherently reduced need for interaction in unmanned operations can sometimes result in a lack of sustained attention and induced complacency actually increasing the collision risk even in a procedural deconfliction scenario. Increased automation "can lower an operators' task load to the point where vigilance is negatively affected and boredom may result."[42] As increased automation shifts RPAS operators into "system management positions", monotony, loss of vigilance and boredom are more likely to occur.[43] Even now, it is not uncommon for RPAS operators on ISR missions to spend the majority of the sortie "merely waiting for a system anomaly to occur and to only interact with the system occasionally."[44] To address this, RPAS developers are currently working on several "*sense*-and- avoid" technologies, but whether the accepted standard will be "radar based", or some other "multiple sensor approach" is still unclear.[4546] Delaying the pursuit of a procurement option under JUSTAS to await the maturation of sense-and-avoid technology would be pointless as "the complexity of domestic airspace and the multitude of platform sizes and types that operate within it mean no single approach to sense-and-avoid will be able to cover all aircraft and eventualities".[47]

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41 Awad, *An Analysis of the Risk from UAS Missions in the National Airspace*, 1.

42 Joint Air Power Competence Centre, *Remotely Piloted Aircraft Systems in Contested Environments - A Vulnerability Study*, 59.

43 *Ibid.*, 59.

44 *Ibid*., 59.

45 Pascal Cornic et al., "Sense and Avoid Radar using Data Fusion with Other Sensors" IEEE, 2011)., 13.

46 Julien F. Esposito, "Real-Time Obstacle and Collision Avoidance System for Fixed Wing Unmanned Aerial Systems" (Ph.D., University of Kansas), .

47 Huw Williams, "Sense and Avoid: In Search of a Solution," http://www.ihs.com (accessed April/25, 2015)., 9.

Data-link Vulnerability

Domestic C2 frequency spectrum allocation for JUSTAS will need to be coordinated with Industry Canada and be consistent with still to be determined safety requirements.[48] Where the draft JUSTAS SOI states that the system will "be operated in compliance with existing communications and electromagnetic spectrum policy and regulations" it fails to adequately acknowledge that high integrity C2 spectrum will be needed for both Line of Sight (LOS) communications and for Beyond Line of Sight (BLOS) communication and that there is currently a shortage of available and dedicated RPAS frequencies that can be protected against harmful interference. [49] A dependence on a constant control signal between a GCS and the UA naturally makes RPAS vulnerable to disruptions to it. In fact, military researcher Jaysen A. Yochim says that this signal dependence has contributed to "an accident rate [in RPAS] 100 times greater than manned aircraft".[50] This would be concerning for regulatory bodies when considering airspace integration, but also of great concern to the Canadian military which can ill-afford losing an asset that may fall victim to random interference or be targeted using low tech, easy to produce, jamming weapons. The availability of Electronic Warfare (EW) equipment to potential future adversaries and the susceptibility of RPAS data-links to electromagnetic interference have both been assessed as 'high' by some military analysts.[51] Reliance on pre-programmed "lost-link" procedures can contribute to predictability and safety of "uncontrolled" UA in un-segregated airspace, but without data streams protected by encryption, little can be

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[48] JUSTAS SOI states that frequency spectrum allocation abroad will be coordinated with allies and host nations through the responsible DND directorates. Assigned foreign frequency allocations will face the same vulnerability concerns as discussed.

[49] Royal Canadian Air Force, *Draft Statement of Operating Intent (SOI): Joint Unmanned Surveillance and Target Acquisition System*, 23.

[50] Jaysen A. Yochim, *The Vulnerabilities of Unmanned Aircraft System Common Data Links to Electronic Attack* (2010).

[51] Joint Air Power Competence Centre, *Remotely Piloted Aircraft Systems in Contested Environments - A Vulnerability Study*, 34.

done to ensure the absence of unlawful "highjack" events by would-be terrorists. While formidable data-link signal encryption technology is not yet available, it will undoubtedly be forthcoming. And technology is forever shrinking in size too. As it is with manned military aircraft, it is expected that a JUSTAS RPAS procured today could easily be retrofitted with whatever is required in the future for safe flight in un-segregated airspace.

CONCLUSION

Over a decade ago Canada recognized the utility of unmanned systems as a complementary ISR capability for both domestic and deployed operations. Today, however, a RPAS system for the Canadian military is still in the planning stages. Problematic terms, lack of regulation allowing for full airspace integration, and technology gaps that may mitigate the risk associated with a "file and fly" operation are potentially delaying Canada's entry into the future of military aviation. Exacerbating the issue is the nascent and still evolving unmanned aircraft technology and imaginative new potential military uses for it. There seems to have been some difficulty defining what capability JUSTAS *can* fulfill in the *future* when the focus until now should have been primarily on what it *should* fulfill *now*. The expanded project scope and operating intent of JUSTAS since 2000 necessarily requires a platform that is to be certified to operate in all classes of airspace while the existing regulatory structures governing airspace operations do not yet account for its co-use by unmanned and manned aviation. Efforts are being made by regulatory bodies to accommodate unmanned operations, but we do not yet know what technology requirements will be necessary to satisfy non-existent regulation granting full RPAS integration into domestic and international airspace. There is understandably some concern that

if we do not buy the right platform today, future operations could experience significant restrictions and significant additional cost to achieve necessary airworthiness requirements.

ICAO has been adamant that there is "a need for a harmonization of terms, strategies and principles with respect to the [RPAS] regulatory framework".[52] The FAA expects that "incremental advances" in research and development, airworthiness standards, and the development of RPAS-related technologies will lead to "full operational approval".[53] The organization believes that "safe integration will lead us from today's need for accommodation of [RPAS] through individual approvals to a time when standardized/routine integration into domestic and international airspace environment is well defined".[54] To date there is no airworthiness standards, no proven sense-and-avoid technology, and no protection of C2 data-links from unintentional or unlawful interference which are limiting factors for JUSTAS. Technology, however, will develop and become standardized, mechanisms for dealing with vulnerabilities of RPAS command and control links will be established, and regulations will be solidified. In what order is anyone's guess, but Canada cannot take a "wait and see" approach.

The regulatory environment is still uncertain and this uncertainty may limit the use of a JUSTAS procured platform in the short-term, but the pressure on Transport Canada, the FAA and other organizations to develop airspace integration plans means that there is unlikely to be restrictions on the JUSTAS ambition to "file and fly" in the near future. The new and exciting technology that permits unmanned aviation promises many uses and benefits to the CAF, and the challenge to demonstrate an equivalent level of safety when compared to manned aircraft will

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[52] International Civil Aviation Organization, *ICAO Circular 328 AN/190 Unmanned Aircraft Systems (UAS)*, 1.

[53] FAA Joint Planning and Development Office, *Unmanned Aircraft Systems (UAS) Comprehensive PlanA Report on the Nation's UAS Path Forward*,[2013])., 3.

[54] *Ibid*., 3.

soon be addressed by the same. Rather than investing in “Model T’s”, as Vanguard magazine’s Chris Thatcher quipped in 2013 referring to first generation RPAS, “perhaps it's just as well that the Canadian Forces has been slow to move forward with the procurement”[55] But the time has passed for waiting for newer technology and comprehensive regulation. Already there has been a larger shift within Western militaries toward unmanned air operations. Certainly the United States, our biggest and closest ally, is heavily invested in the technology. Does Canada want to be left behind? Make a move.

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[55] Chris Thatcher, "JUSTAS: Seeking the Right Solution," Vanguard, http://vanguardcanada.com/justas-seeking-the-right-solution/ (accessed May/8, 2015).

Bibliography

Aftergood, Steven. "Army use of Drones in U.S. is Constrained, Not Prohibited.". Accessed May/4, 2015. https://fas.org/blogs/secrecy/2013/02/usarmy_drones/.

Awad, Armand. "An Analysis of the Risk from UAS Missions in the National Airspace." Master's, University of Washington, 2013.

Baille, Stewart, Keith Merideth, and Dave Roughley. *Canadian Civil UAS 2014*: National Research Council, 2014.

Byers, Michael and Kelsey Franks. "Unmanned and Unnecessary: Canada's Proposed Procurement of UAVs." *Canadian Foreign Policy Journal* 20, no. 3 (: 19 April 2015. doi:10.1080/11926422.2014.934866.

Canadian American Strategic Review. "JUSTAS Project – Joint Uninhabited Surveillance and Target Acquisition System UAVs." . Accessed May/9, 2015. http://www.casr.ca/bg-uav-justas-project.htm.

Canadian Forces Air Warfare Centre. "UAV Brief to the Air Board Executive Commitee." MS Power Point Presentation, Available on DWAN.

Cho, George. "Unmanned Aerial Vehicles: Emerging Policy and Regulatory Issues." *Journal of Law, Information and Science* 10 (2013), no. 22 (2013): 20 April, 2015.

Civil Air Navigation Services Organization. "ANSP Considerations for RPAS Operations." CANSO. Accessed May/4, 2015. https://www.canso.org/sites/default/files/ANSP%20Considerations%20for%20RPAS%20Operations.pdf.

Cornic, Pascal, Patrick Garrec, Stephane Kemkemian, and Laurent Ratton. "Sense and Avoid Radar using Data Fusion with Other Sensors."IEEE, 2011.

Dalamagkidis, Konstantinos, Kimon Valavanis, and Les A. Piegl. *On Integrating Unmanned Aircraft Systems into the National Airspace System: Issues, Challenges, Operational Restrictions, Certification, and Recommendations*. Vol. 54 Springer Science & Business Media, 2011.

Elias, Bart. *Pilotless Drones: Background and Considerations for Congress regarding Unmanned Aircraft Operations in the National Airspace System*: Congressional Research Service, September 10, 2012.

Esposito, Julien F. "Real-Time Obstacle and Collision Avoidance System for Fixed Wing Unmanned Aerial Systems." Ph.D., University of Kansas, 2013.

FAA Advisory Circular. "Pilot's Role in Collision Avoidance." . Accessed May/9, 2015. https://www.faa.gov/regulations_policies/advisory_circulars/index.cfm/go/document.information/documentID/23090.

FAA Joint Planning and Development Office. *Unmanned Aircraft Systems (UAS) Comprehensive PlanA Report on the Nation's UAS Path Forward*, 2013.

Government of Canada. "Canada First Defence Strategy." . Accessed May/7, 2015. http://www.forces.gc.ca/en/about/canada-first-defence-strategy.page.

International Civil Aviation Organization. *ICAO Circular 328 AN/190 Unmanned Aircraft Systems (UAS)*. Montreal: ICAO, 2011.

Jansen, Bart and Mike Snider. "Amazon Wants FAA to Loosen Up." *USA Today*, Tuesday, April 28, 2015, 2015, sec. B Money.

Joint Air Power Competence Centre. "Remotely Piloted Aircraft Systems in Contested Environments - A Vulnerability Study." . Accessed May/9, 2015. http://www.japcc.org/portfolio/remotely-piloted-aircraft-systems-in-contested-environments-a-vulnerability-analysis/.

Kenny, Caitlin A. "Unmanned Aircraft System (UAS) Delegation of Separation in NextGen Airspace." M.S., San Jose State University, 2013.

Lacher, Andrew, Andrew Zeitlin, David Maroney, Kelly Markin, Duane Ludwig, and Joe Boyd. "Airspace Integration Alternatives for Unmanned Aircraft." *CAASD, the MITRE Corporation* (2010).

Laplante, J. S. F. and Canadian Forces College. *The use of UAS in Canada's Unsegregated Airspace: Foundations and Roadmap*. Masters Thesis (Canadian Forces College). Vol. JCSP/PCEMI 39-42. Toronto, Ont.: Canadian Forces College, 2013.

National Defence - Chief Review Services. *Internal Audit of Joint Unmanned Surveillance and Target Acquisition System (JUSTAS)*, January 2014.

National Defence - VCDS Executive. *CANFORGEN 080/15 C AIR FORCE 13/15 231956Z APR 15Implementation of NATO UAS Classification Table* 2015.

Ott, Joseph T. "Well Clear: General Aviation and Commercial Pilots' Perception of Unmanned Aerial Vehicles in the National Airspace System." M.S., San Jose State University, 2014.

Pugliese, David. "DND Concludes it does Not Need Permission to Fly Drones in Domestic Airspace, Despite 'Greater Challenges'." *National Post*, August 17, 2013, 2013, sec. Politics.

Royal Canadian Air Force. "Draft Statement of Operating Intent (SOI): Joint Unmanned Surveillance and Target Acquisition System.".

Sarty, S. G. and Canadian Forces College. *The CF MALEHALE UAV: Not an Immediate Panacea*. Exercise New Horizons. Toronto, Ont.: Canadian Forces College, 2008.

Second High Level Safety Conference. "Planning for Global Aviation Safety Improvement: *Canada's Approach to Managing the Risks of Remotely Piloted Aircraft Systems (RPAS)*." Montreal, International Civil Aviation Organization, 2-5 Feb 2015, 2015.

Sloan, Elinor. "Canadian Defence Commitments: Overview and Status of Selected Acquisitions and Initiatives." *SPP Research Paper* 6, no. 36 (2013).

Thatcher, Chris. "JUSTAS: Seeking the Right Solution." Vanguard. Accessed May/8, 2015. http://vanguardcanada.com/justas-seeking-the-right-solution/.

Transport Canada. "Review and Processing of an Application for Special Flight Operations Certificate for the Operation of an Unmanned Air Vehicle (UAV) System." . Accessed May/9, 2015. http://www.tc.gc.ca/media/documents/ca-standards/(SI)_No._623-001_2_en.pdf.

U.S. Government 112th Congress. "Public Law 112-95." . Accessed 7 May 2015, . http://www.gpo.gov/fdsys/pkg/PLAW-112publ95/pdf/PLAW-112publ95.pdf.

Williams, Huw. "Sense and Avoid: In Search of a Solution." . Accessed April/25, 2015. http://www.ihs.com.

Wuennenberg, M. "UAV Operations in Canadian Domestic Airspace." Briefing Note, .

Yochim, Jaysen A. *The Vulnerabilities of Unmanned Aircraft System Common Data Links to Electronic Attack* (2010).