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THE COMBAT CLOUD: VISION OR DELUSION FOR THE RCAF

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Exercise *Solo Flight*

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INTRODUCTION

There is perhaps another buzzword in the air right now, and it is called the Combat Cloud. As part of higher U.S. defence objectives, the *Combat Cloud* is the United States Air Force (USAF) resolution to achieve decision superiority in multi-domain operations. So, perhaps allied nations and their respective air forces should take note. The Dean of the Mitchell Institute of Aerospace Power Studies, Lt Gen David Deptula, USAF (Ret.), argues that military effects in the years to come will be "generated by the interaction of systems that share information and empower one another."[1] Therefore, to generate desired effects, it will generally be expected that U.S. led coalitions will rely on interoperable allies capable of interacting with all systems regardless of individual technology, specific service, domain, or task.[2] Those effects will have to be generated in potentially fast-changing circumstances through a broader range of tasks amongst different levels of interfaces.[3] Based on Canada's defence policy – *Strong, Secure, Engaged* – the Royal Canadian Air Force (RCAF) envisions a systems-of-systems approach capable of integrating itself with core allies to meet Canada's future defence objectives.[4] Hence, the analysis of the Combat Cloud concept is particularly interesting for the RCAF. Considering the multi-domain operating environment of tomorrow and the inherent challenges of smaller air forces, is the Combat Cloud

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[1] David A. Deptula, *Evolving Technologies and Warfare in the 21st Century: Introducing the "Combat Cloud"*, (Arlington: The Mitchell Institute for Aerospace Power, 2016), 1. http://docs.wixstatic.com/ugd/a2dd91_73faf7274e9c4e4ca605004dc6628a88.pdf

[2] *Ibid, 3.*

[3] H., Myron et al, *Interoperability: A Continuing Challenge in Coalition Air Operations*, (Santa Monica, CA: RAND Corporation, 2000), 24. https://www.rand.org/pubs/monograph_reports/MR1235.html.

[4] Canada, Department of National Defence, Strong, Secure, Engaged: Canada's Defence Policy, (Ottawa: DND Canada, 2017), 39. http://dgpaapp.forces.gc.ca/en/canada-defence-policy/index.asp

conceivable for the RCAF? This essay will demonstrate that information, connectivity and command and control (C2) are essential to the RCAF's survival in the context of multi-domain operations, which requires the synchronization and convergence of effects across all domains. In particular, it will argue that to remain relevant in its evolution and obtain desired effects, the RCAF will have to adopt the Combat Cloud concept to meet the realities of multi-domain operations.

This paper is divided into three sections to evaluate how the RCAF could integrate a Combat Cloud in the future. First, regarding the concept itself, the triad of information, connectivity, and C2 will be presented. Second, looking into the horizon for smaller air forces, specific challenges of multi-domain operations will be explored. Finally, critical RCAF operations, expertise and technology implications will be demonstrated.

THE COMBAT CLOUD

In the early 2000s, models such as Network Centric Warfare (U.S.) and Network Enabled Capability (NATO) emerged and recognized the importance of a networked approach to planning and warfighting operations to enable decision-makers.[5] In 2016, the natural evolution of the network approach led to the publication of U.S. Air Combat Command's (ACC) vision of a future network of data distribution and information sharing, known as the Combat Cloud concept.[6] In other allied air forces, the Royal Australian Air Force (RAAF) for instance, the concept is also referred to as the Combat

[5] The Netherlands, Command and Control Centre for Excellence, *Catalyzing the art of C2*, (Utrecht: C2CoE The Netherlands, 2009), 10.

[6] Kiser, J. et al, "The Combat Cloud: Enabling multi-domain command and control across the range of military operations," *Wright Flying Paper*, no. 65 (2019): 1. https://www.airuniversity.af.edu/Portals/10/AUPress/Papers/wf_0065_hess_combat_cloud.pdf

Cloud, in what the RAAF considers the network portion of fifth generation warfare. In the RCAF, there is no distinct or specific terminology being used to discuss the Combat Cloud. Throughout this essay, the term Combat Cloud will be used as an all-encompassing term to explain the network approach, primarily based on the U.S. vision, but also supported by important elements of allied concepts. Originally developed commercially, a cloud computing environment is where "users can exchange information with a virtual cloud, pulling down data and applications as necessary, and adding information others may find useful."[7] In its military application, the Combat Cloud can be defined as an overarching network composed of authorized platforms and nodes in which data and information are shared seamlessly amongst users to conduct highly interconnected and distributed operations.[8] The concept provides several advantages. It shares situational awareness amongst all players, facilitates long-range engagements and reduces reliance on single platforms through extended connectivity and redundancy, and lastly, maximizes the effective use of all capabilities offered by different platforms in different domains.[9] Here, traditional military capabilities are no longer seen as separate entities (platform-centric), but rather a system that interacts (network-centric). It refers to the "notion of dynamic interaction, meaning that the system as a whole is more than the sum of its parts."[10] To be effective, the Combat Cloud relies on the intertwined pillars of information, connectivity, and C2. Accordingly, those three pillars are discussed below in detail.

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[7] Peter, Layton, "Fifth-generation air warfare," *Australia Defence Force* Journal, No.204. (2018): 25. http://www.defence.gov.au/ADC/ADFJ/Documents/issue_204/ADFJournal204_web.pdf

[8] Kiser, J. et al, "The Combat Cloud . . ., 1.; David A. Deptula, *Evolving Technologies and Warfare in the 21st Century* . . ., 3.

[9] Peter, Layton, "Fifth-generation air warfare," . . ., 25.

[10] *Ibid*, 24.

The first pillar of the Combat Cloud is information and consists of "communications paths, computational nodes, operating systems and information management applications which enable computing and communications across the battlespace."[11] It goes without saying that information will be the dominant factor in modern warfare, by giving a military force the ability to lift the fog of war in challenged areas. The ability to dominate military operations through information is generally referred to information supremacy, or as explained by Lt Gen Deptula (Ret.), the prerequisite of superior data fighting as opposed to dog fighting. Information starts with data that is placed in context through processing and exploitation that provides end-users meaning and that reduces uncertainty. Once information is placed within a known framework of observation, it raises the degree of certainty and then becomes knowledge. Only once information enables decision-makers to understand a given situation does it become actionable knowledge, as the integration of multiple information sources result in shared situational awareness.[12] Other factors that influence the superiority of actionable knowledge are information quality, obtained through currency, accuracy, reliability, utility, and information adequacy, obtained through relevance, completeness, degree of synthesizes, and accessibility.[13] Here, the core air power function of Intelligence, Surveillance and Reconnaissance (ISR) must integrate its system holistically in order to generate advanced knowledge. Those systems include "intelligence collection and assessment systems, space-based intelligence and surveillance systems, cyber warfare capabilities, electronic warfare, strategic communications and battlespace

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[11] *Ibid*.

[12] Richard S. Deakin, *Batllepsace Technologies: Network-Enabled information dominance*, (Norwood: Artech House, 2010), 196.

[13] *Ibid*, 199.

management."[14] In the end, however, without a way to share and decide on critical nuggets of information and knowledge, information superiority is rendered useless. Hence, in what can be labelled as a symbiotic relationship, information as part of a Combat Cloud must also be supported by superior connectivity and C2.[15]

The second pillar of the Combat Cloud is connectivity and refers to the information management architecture that connects sensors, shooters, and decision-makers.[16] Here, sensor nodes detect, track, and identify targets, and then distribute the collected information to shooters who can deliver a range of kinetic and non-kinetic effects. At the same time, either in proximity or removed from the battlespace, decision-makers can direct forces based on near-real-time information.[17] The interaction between sensors, shooters, and decision-makers is based on the traditional targeting cycle, in which targets are selected, prioritized, and then matched with the appropriate means for engagement.[18] In the Combat Cloud, however, there are essential features that make the cloud a distinct weapon of choice. To begin with, the connection between networked platforms abandons the evaluation of specific conventional capabilities and their potential outputs. Rather, the overall output is calculated using a system-of-systems approach through mission-agnostic linkages. The cloud approach diminishes the strain on specific assets, maximizes potential effects, and minimizes threat exposure as all connected

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[14] Sanu, Kainikara, *Air power in the information age: The deciding factor*, Greenway: RAAF Air Power Development Centre, 2015, 8. http://airpower.airforce.gov.au/APDC/media/PDF-Files/Working%20Papers/WP41-Air-Power-in-the-Information-Age-The-Deciding-Factor.pdf

[15] *Ibid*.

[16] Peter, Layton, "Fifth-generation air warfare . . ., 24.

[17] *Ibid*.

[18] United States, Joint Chiefs of Staff, *Joint Targeting*, (Joint Publication 3-60. Washington, DC: JCS United States, 2013), II-4.

elements can take advantage or compensate for the capabilities of all participants.[19] Next, the targeting cycle is reduced from hours to a few minutes, if not less, due to modern telecommunications that enhance the velocity of information.[20] In other words, data derived from multiple sources across a multi-domain construct is quickly exchanged between sensors and shooters.[21] At last, layers of information across multiple networks and data servers are integrated into one network template that allows for seamless integration amongst platforms, services, allies, and domains. In most cases of warfare, the secure, jam-proof, and intrusion-proof connected environment of the Combat Cloud will provide an edge to its elements as they work together on common objectives against potential adversaries.[22] For instance, ISR data collected by an Unmanned Aircraft System (UAS) on a given target can be pushed to fighter aircraft, which then provide sensor and terminal guidance information to surface-to-surface missiles launched by ships. In that example, the target is destroyed within minutes, and connected elements of the Combat Cloud were able to share capabilities and actionable knowledge to defeat the enemy. That being said, without efficient C2, most of the advantages offered by the cloud are rendered ineffective.

The third pillar of the Combat Cloud is C2 and includes "the province of human decision-makers in involving their perceptions and problem-solving skills."[23] The backbone C2 idea is a "distributed, self-forming, all-domain Combat Cloud that is self-

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[19] Peter, Layton, "Fifth-generation air warfare . . ., 25.; David A. Deptula, *Evolving Technologies and Warfare in the 21st Century* . . ., 1.

[20] David A. Deptula, "A new era for Command and Control of aerospace operations," *Air and Space Power Journal* vol.28 no.4 (2014): 8 https://www.airuniversity.af.edu/Portals/10/ASPJ/journals/Volume-28_Issue-4/SLP-Deptula.pdf

[21] *Ibid*, 11.

[22] David A. Deptula, *Evolving Technologies and Warfare in the 21st Century* . . ., 6.

[23] Peter, Layton, "Fifth-generation air warfare . . ., 24.

healing and difficult to attack effectively [that] significantly complicates an enemy's planning, and [that] will compel them to dedicate more resources toward defence and offence.[24] From an air power lens, the idea of distributed, self-forming and self-healing C2 is hard to grasp or imagine, especially since allied air forces have relied on the tenet of Centralized Control, Decentralized Execution in a relatively uncontested environment since Operation Desert Storm. However, C2 in a Combat Cloud is built around the notion of a contested environment, commonly referred to as Anti-Area/Area Denial (A2/AD). Accordingly, air power thinking must evolve to be successful in the future. During his tenure as ACC Commander in 2014, Gen Gilmary Michael Hostage III, USAF (Ret.) argued for resilient C2 through distributed control. Essentially, in order to achieve a continued orchestration of combat air power in an A2/AD environment, air forces will require Centralized Command, Distributed Control, and Decentralized Execution.[25] If the traditional Combined Forces Air Component Commander (CFACC) became isolated, distributed control would empower "subordinate commanders, organizations, operations centres, and battle management command and control platforms to amalgamate otherwise disconnected units into teams of synchronized combat airpower."[26] Stated explicitly, distributed control joins disconnected units and ensures the process of transitioning authority from one to another, from minutes to hours and days to months depending on the situation.[27] As such, units disconnected from the Combat Cloud can self-form using distributed control into self-organizations and therefore continue to execute the CFACC's

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[24] David A. Deptula, *Evolving Technologies and Warfare in the 21st Century . . .*, 4.

[25] Gilmary Michael Hostage III and Larry R. Broadwell Jr, "Resilient command and control: The need for distributed control," *Joint Force Quarterly* Vol. 74 3rd Quarter (2014): 38. https://ndupress.ndu.edu/Portals/68/Documents/jfq/jfq-74/jfq-74_38-43_Hostage.pdf

[26] *Ibid*, 39.

[27] *Ibid*.

intent until a connection is re-established. As it is expected that future adversaries will be able to, at worst, destroy friendly networks, those C2 networks will also have to be self-healing as part of the Combat Cloud. The ability to self-heal means that networks will have the ability to bypass or automatically preserve capabilities to ensure the continuity of Command.[28] Arguably, today's technology is already capable of self-forming and self-healing actions. For instance, in civilian applications, artificial intelligence and machine learning in network monitoring currently offer robust data processing, automatic problem solving, and customizable responses.[29] With that being said, C2 as part of a Combat Cloud is going to require an overarching and integrating vision to guide the development of individual military technologies and ultimately to ensure interoperability amongst elements.

Admittedly, the Combat Cloud concept will require significant investments in fifth generation warfare capabilities. Those capabilities are, for instance, stealth UAS designed for deep strikes and controlled by fifth-generation fighters, ISR platforms with extensive sensor suites, but also technologies that are not yet mainstream, such as swarms and hypersonic weapons.[30] However, the biggest challenge of the Combat Cloud is not the development or the acquisition of capability sets, but the realization that communications systems can no longer be seen as supporting capabilities that enhance

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[28] Canada, Department of National Defence, *Projecting power: Canada's air force 2035*, (Trenton: DND Canada, 2009), 40. http://publications.gc.ca/collections/collection_2010/forces/D2-247-2009-eng.pdf

[29] Network Monitoring Solutions Review, "The benefits of AI and machine learning in network monitoring," Last accessed 30 Apr 2019. https://solutionsreview.com/network-monitoring/the-benefits-of-ai-and-machine-learning-in-network-monitoring/

[30] The National Interests. "The U.S. Air Force of the future: Hypersonic weapons, swarm strikes and stealth fighters." Last accessed 30 Apr 2019. https://nationalinterest.org/blog/buzz/us-air-force-future-hypersonic-weapons-swarm-strikes-and-stealth-fighters-37482

primary combat tasks.[31] Instead, they need to be seen as a unifying force that holds everything together, that enables synchronized efforts and reconciles gaps or redundancies. As such, it will only be possible to build a path towards a fully integrated battle network once communications start to be developed dependably of each other, and with the multi-domain environment of tomorrow, mission effects will rely on an integrated battle network.

HORIZONS

In 2016, as the Chief of Staff of the USAF, Gen David Goldfein posited that the multi-domain battle is "more than the ability to work in multiple domains . . . [and] more than operations in one domain supporting or complementing operations in another domain."[32] In essence, future multi-domain operations will integrate all joint and coalition capabilities across all military operations to support high velocity and agile responses.[33] Those responses, paired with possible near-peer conflict, will become especially critical when faced with an A2/AD threat, in which the enemy uses "a series of interrelated missile, sensor, guidance, and other technologies designed to deny freedom of movement [in a pre-determined area]."[34] Also, battlefield effects generated by the advent of new domains, such as cyber and space, for instance, will continue shaping the way wars are fought in the future. That said, as seen in the previous section, the Combat Cloud will provide the required architecture to support a range of effects in a multi-domain

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[31] David A. Deptula, *Evolving Technologies and Warfare in the 21st Century . . .*, 8.

[32] USAF, "CSAF letter to airmen," Last accessed 30 Apr 2019. *https://www.af.mil/News/Article-Display/Article/1108931/csaf-letter-to-airmen/*

[33] *Ibid*.

[34] Charles Koch Institute. "What is A2/AD and why does it matter to the United States?" Last accessed 30 Apr 2019. https://www.charleskochinstitute.org/blog/what-is-a2ad-and-why-does-it-matter-to-the-united-states/

environment. However, within that same environment, smaller air forces will face inherent challenges in the near-future. In other words, within a coalition or alliance, it will be a daunting task to continue being a relevant weapon of choice against adversary targets. Consequently, there are some pressing challenges on the horizon for smaller air forces, and the RCAF is not exempt. This section explores the characteristics of smaller air forces and two sets of challenges as they relate to the future multi-domain environment.

The accurate measure of an air force is made through an analysis of its air power output and capability spread, as opposed to merely looking at sheer numbers.[35] The air power output capability is calculated by evaluating the relationship between self-sufficiency and operational capacity within an air force. Here, it should be acknowledged that, with the amount of air power that it can project globally, the USAF is in a category of its own. Between large and niche air forces, smaller air forces "have the systems, processes and the inherent capacity to deliver all air power functions, roles and missions and are, as such, balanced forces."[36] The biggest differentiators, however, are the limited amount of effects that can be produced at any given time, the limited duration of operations, and the restricted national support infrastructure that is available.[37] Accordingly, air forces such as the RCAF and the RAAF, for instance, can be designated as smaller air forces. Up to now, those air forces have proven to be capable allies and partners that have brought considerable effects within U.S. coalitions. Historical challenges of smaller air forces have been to maintain the same level of professional

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[35] Kainikara, Sanu Kainikara, *The future relevance of smaller air forces*, (Greenway: RAAF Air Power Development Centre, 2008), 3. http://airpower.airforce.gov.au/APDC/media/PDF-Files/Working%20Papers/WP29-The-Future-Relevance-of-Smaller-Air-Forces.pdf

[36] *Ibid*, 4.

[37] *Ibid*.

competency and interoperability as larger air forces and doing so while being faced with typically strong resource competition with other national services and government departments.[38] If we assume that the western economic outlook will remain fairly stable in the future, then we could assume that the traditional challenges of smaller air forces will remain the same. Resources, for instance, will remain constrained. Further, the security environment is changing, as it is characterized by "the role of influencing the information space, networked approaches, the incorporation of indirect and covert actions, and the special quality of new technologies."[39] A vital consideration for this paper is that near-peer adversaries have studied how the U.S. and its allies conduct military operations and are quickly improving their capabilities to challenge the usual all-domain dominance that the West has come to enjoy.[40] As such, to avoid a slide towards irrelevancy in a multi-domain environment, especially against an A2/AD threat, smaller air forces will have to adapt.

The first set of challenges refers to capabilities and is identified with the example of two approaches that could be used to target an enemy that relies on A2/AD systems to protect its interests. First, the inside-out approach, using technology as an advantage, aims at hitting an enemy's centre of gravity in a surprise high-intensity and short duration conflict. In this approach, the challenge for smaller air forces is the requirement to invest in new standoff strike technologies that can successfully penetrate an A2/AD zone, such

[38] *Ibid*, 3.

[39] Hans-Georg Ehrhart, "Postmodern warfare and the blurred boundaries between war and peace," *Defense & Security Analysis*. Vol.33, no.3. (2017): 263. https://doi.org/10.1080/14751798.2017.1351156

[40] Air Force Magazine. "Goldfein's multi-domain vision." Last accessed 30 Apr 2019. http://www.airforcemag.com/MagazineArchive/Pages/2018/October%202018/Goldfeins-Multi-Domain-Vision.aspx

as hypersonic glide missiles and stealth bombers for instance.[41] Second, on the other end of the spectrum, the outside-in approach aims at destroying an enemy's capabilities, layer by layer, through a lengthy conflict that would likely generate higher attrition and mission fatigue.[42] In this approach, the challenge for smaller air forces is the realization that future operations might see an increase of risk, which could transform itself into mission failure without proper capabilities. As such, using the A2\AD example, the first set of challenges for smaller air forces is centred on building advanced capabilities that can help reduce the risk of the operating environment and therefore elevate the chances of mission success.

The second set of challenges refers to interoperability and sovereignty. Here, interoperability can be taken in its basic form, meaning the ability of different military organizations, regardless of nationality and element, to conduct seamless multi-domain operations. So, organizations that are interoperable do not warrant the same capabilities, but ones that will be able to share information and depend on each other.[43] However, defence cooperation through interoperability is also an important factor that supports objectives in other government departments. For instance, for U.S. allies, "part of the price for maintaining the positive economic benefits of a close relationship with the U.S. is a requirement to develop and maintain capabilities, doctrine, and operational methods

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[41] Andreas Schimidt, "Countering Anti Access / Area Denial: Future capability requirements in NATO," *The Journal of the Joint Air Power Competence Centre* Vol. 23 Autumn/Winter (2016): 74. https://www.japcc.org/wp-content/uploads/JAPCC_Journal_Ed-23.pdf

[42] *Ibid*.

[43] NATO, Public Diplomacy Division, BGR2-INTEROP-ENG-0706, *Backgrounder: Interoperability for joint operations*, (Brussels: NATO, 2006), 1. https://www.nato.int/nato_static_fl2014/assets/pdf/pdf_publications/20120116_interoperability-en.pdf

that are seamlessly interoperable with the U.S. armed forces."[44] As such, smaller air forces wishing to keep pace with the U.S. will require "a serious and continual commitment of resources, something made more difficult with defence technologies which have always evolved quickly."[45] There are ways to ensure that capabilities withstand the test of time in terms of interoperability, such as system upgrades and flexible concept developments for instance. Still, due to a finite amount of resources available, the level of interoperability of smaller air forces will remain a choice between fulfilling an important role within the greater apparatus of U.S. operations and between maintaining an acceptable level of capabilities that are geared towards domestic defence.[46] The choice between relevancy and domestic defence also highlights another challenge, which is sovereignty. Here, contemporary sovereignty refers to what is known in the modern polity as "the state, and the fundamental characteristic of authority within it . . . [and] the defence of [national] values.[47] The challenge for smaller air forces, as part of greater national defence objectives, is that they must balance the perception of cooperating too closely with the U.S. on defence issues with the requirement to maintain trade partnerships with potential adversaries in a globalized world.[48] Although this challenge should be considered due to its potential long-term damaging effects, it should not drive capability and interoperability decisions for smaller air forces. Indeed, research based on Canadian operations in South West Asia since the early 2000s demonstrated

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[44] Canada, Defence Research and Development Canada, DRDC-RDDC-2015-R212, *The future of allied air power: The Royal Australian Air Force*, (Trenton: Canadian Forces Aerospace Warfare Centre, 2015), 12.http://cradpdf.drdc-rddc.gc.ca/PDFS/unc203/p802709_A1b.pdf

[45] *Ibid*.

[46] *Ibid.*

[47] Policy Options. "Canada in North America: From political sovereignty to economic integration." Last accessed 30 Apr 2019. http://policyoptions.irpp.org/magazines/the-dollar/canada-in-north-america-from-political-sovereignty-to-economic-integration/

[48] *Ibid.*

that Canada suffered modest external sovereignty costs, but that those were largely due to the inherent closeness of the Canada-U.S. relation and the dependency that goes with it, as opposed to military interoperability requirements.[49]

It is true that, if the minimalist approach to Canadian defence spending continues, the country could look to military force specialization as a way to stay relevant. Going away from a balanced force structure would entail a reduction in capability for the RCAF. A new force structure would ensure those remaining capabilities are interoperable with the U.S. and stand the test of time as the U.S. embarks on an extensive technological and doctrinal transformation of its forces.[50] However, at the benefit of international peace and stability contributions, force specialization would also put at risk critical domestic roles of the RCAF, such as Search and Rescue (SAR) for instance, as its responsibility is challenging to transfer to another organization given the amount risks it entails. Force specialization would also quite possibly reduce the sovereignty of Canada as it tries to deter aggression on its contested Arctic borders. Hence, considering the inherent challenges of smaller air forces and the most likely stable Canadian balanced force structure approach in which resources are limited, there are important implications for the RCAF if wishes to implement a Combat Cloud.

RCAF IMPLICATIONS

Going forward, the Combat Cloud will enable the processing of information into

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[49] Eric J. Lerhe, "Canada-U.S. military interoperability: at what cost sovereignty?" (Degree of Doctor of Philosophy paper, Dalhousie University, 2012), 387. https://dalspace.library.dal.ca/bitstream/handle/10222/15306/Lerhe%2C%20Eric%2C%20PhD%2C%20POLSCI%2C%20Oct%202012%20D.pdf?sequence=5&isAllowed=y

[50] Philippe Lagassé, "Specialization and the Canadian Forces," (The Norman Paterson School of International Affairs - Occasional Paper, Carleton University, 2003), 36. https://www3.carleton.ca/csds/docs/occasional_papers/npsia-40.pdf

actionable data, for all platforms through all domains.[51] As the U.S. continues to build advanced capabilities that rely on technology, it makes sense for the USAF, the world's greatest and biggest air force, to adopt the Combat Cloud as a mean to stay ahead of the competition in tomorrow's environment; an environment that will require multi-domain solutions in light of new threats. As such, as a smaller air force that routinely operates hand in hand with the USAF, at home and abroad, the RCAF must ask if the Combat Cloud makes sense for itself. Considering the future environment and the inherent challenges of smaller air forces, is an RCAF Combat Cloud a vision or a delusion? In building the way forward, the likely answer is that the RCAF should undeniably envision and adopt some elements of the Combat Cloud. This section argues that the RCAF should focus future efforts on operations, expertise and technology to establish its version of the Combat Cloud. More specifically, it offers possible avenues by building on RCAF *Air Force Vectors* and the RCAF *Future Concepts Directive* (FCD), as well as the RAAF *Plan Jericho*, which is currently guiding the development of a fifth-generation air force in Australia.

The RCAF vision is to be "an agile and integrated air force with the reach and power essential for Canadian Armed Forces (CAF) operations."[52] The RCAF vision, released in 2014, aims to provide the CAF "with relevant, responsive, and effective air power to meet the defence challenges of today and into the future."[53] Out of the four RCAF *Air Force Vectors* (agile, integrated, reach and power), the one that is most interesting for the Combat Cloud vision is - *integrated* - as it is intended to "maintain and

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[51] Kiser, J. et al, "The Combat Cloud . . ., 1.

[52] Canada, Department of National Defence, A-GA-007-000/AF-008, *Air Force Vectors: Agile, Integrated, Reach, Power*, (Ottawa : DND Canada, 2014), 34. http://publications.gc.ca/collections/collection_2017/mdn-dnd/D2-300-2014-1-eng.pdf

[53] *Ibid*.

advance interoperability and pursue full networked capability to ensure Canadian air power remains a key enabler to the success of CAF operations."[54] This Vector calls for a network of systems that can share information "with many different organizations, secure and non-secure communication systems, platforms, and people through datalinks, common or user-defined operating pictures, combat identification, and air traffic management systems."[55] In the RCAF capstone Force Development document, the FCD, which seeks to determine how the RCAF will orchestrate itself to achieve its objectives out to 2035, there are a few considerations that focus on a networked force and information dominance.[56] First, the document acknowledges that capacity (bandwidth) on networks that support decision-making must be improved. It also recognizes that organizational capacity and workforce requirements "should be developed for joint network design and management (communications, datalinks and logistics systems) as well as spectrum, information and bandwidth management resource requirements."[57] Lastly, the FCD supports the development of local and wide area networks to "enable better network integration across the battlespace."[58] Those considerations, however, are dependent on the CAF's ability to deliver on its Military Integrated Information Infrastructure (MI3) initiative as part of the implementation of a national joint information network. Overall, the examination of RCAF strategic documents indicates that there is an appetite for a networked force operating within a Combat Cloud.

In 2015, Australia launched *Plan Jericho* with the intent of transforming the

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[54] *Ibid*, 36.
[55] *Ibid*, 38.
[56] Canada, Department of National Defence, *Future concepts directive part 2: Future air operating concept*, (Ottawa: DND Canada, 2016), 25. http://www.rcaf-arc.forces.gc.ca/assets/AIRFORCE_Internet/docs/en/cf-aerospace-warfare-centre/elibrary/future-concepts-directive-part-2-future-air-operating-concept.pdf
[57] *Ibid*.
[58] *Ibid*.

RAAF into a fifth-generation air force, as it begins to employ advanced capabilities, such as the F-35A Joint Strike Fighter and the E-7A Wedgetail. Further, since technology alone appears to have its limits against near-peer adversaries, another primary objective of *Plan Jericho* is to enable the RAAF to explore and exploit the potential that lies at and beyond the edges of fifth-generation warfare.[59] The RAAF plans to take advantages of those edges by first exploiting the cumulative effects of many small and short-lived effects that arise from the synergy of Australia's defence force, and second, by moving away from a centralized infrastructure in order to leverage technologies that can process information at the edge of the battlespace through decentralization.[60] As such, supported by an augmented intelligence backbone, the RAAF Combat Cloud combined with advanced sensing and autonomous processing will play a significant role in exploiting the edges of fifth-generation warfare. Notably, the RAAF plans to achieve the objectives of *Plan Jericho* through partnerships inside and outside the air force, within the Australian Defence Force, the Australian industry, academia, and open society. For instance, *Jericho Labs* will provide "physical space and equipment that supports the rapid collaborative discovery, testing, and prototyping of opportunities, including ideas and technologies, with universities and industry across Australia."[61] Thus, the RAAF Combat Cloud concept appears to be ahead of the RCAF, both in terms of capabilities and measures taken thus far. An important lesson for the RCAF, however, is the collaborative aspect of national partnerships that the RAAF is prioritizing to ensure it can exploit the edges of fifth-generation warfare.

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[59] Australia, Royal Australian Air Force, *At the edge: Fifth-generation air force*, (Canberra: RAAF Australia, 2019), 6. http://view.publitas.com/jericho/at-the-edge/page/1

[60] *Ibid*, 7.

[61] *Ibid*, 17.

The RCAF version of the Combat Cloud should build on what is already known. It is known that the RCAF is subject to the dynamics of smaller air forces, that it will have to operate with a limited amount of resources, and that it will be required to operate in a new environment in which decision and information superiority will be determining factors. It is also known that the Combat Cloud concept provides the edge over potential adversaries. Here, given those facts, the RCAF should capitalize in areas where it has control, specifically on three lines of efforts, operations, expertise, and technology.

In terms of operations, the RCAF should first look at how it integrates air effects into joint, combined operations via the Joint Forces Air Component Commander (JFACC). In Canada, through the Combined Air Operations Centre (CAOC), the JFACC assumes three roles, JFACC to Canadian Joint Operations Centre Commander, JFACC to Regional and Joint Task Force Commanders (RJTF/JTF), and Commander of Canadian North American Aerospace Defence Command (NORAD) Region (CANR). Looking into to the future, the CAOC will be somewhat hampered by its size, as with only 100 personnel assigned to it, " it will find it increasingly difficult to meet the growing demands upon air power by JTF commanders."[62] As such, the challenge will be "the ability of the CAOC to effectively plan, execute and monitor multiple, protracted operations across the country and around the globe, all in different time zones."[63] That being said, the CAOC, which supports three crucial JFACC roles, should be the primary focus of an RCAF Combat Cloud. Based on the Australian experience, a Combat Cloud reinforced by augmented intelligence would ensure that RCAF personnel supporting

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[62] Pux Barnes, "The JFACC and the CAOC-centric RCAF: Considerations for the employment of air power in joint operations," *RCAF Journal* vol.3 no.3 (2014): 18. http://www.rcaf-arc.forces.gc.ca/assets/AIRFORCE_Internet/docs/en/cf-aerospace-warfare-centre/elibrary/journal/2014-vol3-iss3-04-the-jfacc-and-the-caoc-centric-rcaf.pdf

[63] *Ibid*.

operations at the tactical and operational level have the tools and cognitive capacity to deliver air effects at the highest standard.

With regards to the expertise of its personnel, the RCAF should capitalize on the CAF's goal of becoming a networked force by stimulating capability development, reconfiguring command structures where it makes sense to do so, and ultimately, shaping the transition towards a fifth-generation force.[64] As the Combat Cloud fundamentally involves a joint mindset, the RCAF should seek to influence the greater CAF through calculated personnel assignments within the organization. Similarly, it should build on its role as the CAF Joint Space functional authority.[65] In that role, RCAF expertise delivers daily effects that enable Joint operations at home and abroad. Arguably, the Joint Space function is a proven model on which the RCAF could build its Combat Cloud.

Concerning technology, the RCAF should exploit the potential of the Combat Cloud in future investments. One of the most critical comes from NORAD, one of the RCAF's main line of operations. Indeed, amid NORAD's modernization, the North Warning System (NWS) is set to require the integration of multiple sensors from current and future weapon platforms across multiple domains.[66] From a connection standpoint, the remoteness of the Arctic region poses a significant problem to the Combat Cloud. That challenge, however, could also be solved through a Combat Cloud that would enable distributed operations in the region. Another challenge comes from its C2 construct, as it relies on a sole CAOC to perform numerous Air Component Commander

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[64] Canada, Department of National Defence, *FCD part 2 . . ., 6.*

[65] RCAF, "RCAF leads CAF space initiatives," Last accessed 30 Apr 2019. http://www.rcaf-arc.forces.gc.ca/en/article-template-standard.page?doc=rcaf-leads-canadian-armed-forces-space-initiatives/jtk96x80

[66] Andrea Charon and James Fergusson*, NORAD: Beyond modernization*, (Winnipeg: Centre for Defence and Security Studies, 2019), 14. https://umanitoba.ca/centres/cdss/media/NORAD_beyond_modernization_2019.pdf

functions. Here, cloud-enabled technologies could be the answer, such as Lockheed's multi-domain Air Operations Centre that "is built on an open mission architecture with plug and play technology designed to help planners formulate a plan and then quickly adjust when the environment changes."[67] In the end, synchronizing RCAF operations, expertise and technologies should enable the organization to develop its version of the Combat Cloud.

CONCLUSION

In summary, the Combat Cloud relies on the pillars of information, connectivity, and C2 to enable decision and information superiority. That superiority becomes critical for any military force that wishes to be dominant and competitive in the multi-domain environment of tomorrow. With the advent of new threats, blurred lines between peace and war, and the likely return of great power competition, smaller air forces such as the RCAF will have to become cloud-enabled if they wish to stay relevant in that arena. The future for smaller air forces is not without challenges, as the mounting resource pressures put capabilities, interoperability, and sovereignty at risk. As always, careful planning and prioritization of resources will be vital. Fortunately, smaller air forces such as the RAAF have already proven how a vision, with *Plan* Jericho, can be translated into tangible air power effects enabled by a Combat Cloud and a fifth-generation mindset. At home, the RCAF has aligned its vision with the Combat Cloud, by looking into the future and stating that it wishes to become a networked force within the greater CAF. That was the first step, but there are many steps ahead that are filled with opportunities and challenges.

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[67] Air Force Magazine, "Lockheed conducts multi-domain C2 experiments," Last accessed 30 Apr 2019. http://www.airforcemag.com/Features/Pages/2018/February%202018/Lockheed-Conducts-Multi-Domain-Command-and-Control-Experiments.aspx

It should, therefore, be imperative that the Combat Cloud concept becomes a major part of the discussion in the years to come.

BIBLIOGRAPHY

Air Force Magazine. “Goldfein’s multi-domain vision.” Last accessed 30 Apr 2019. http://www.airforcemag.com/MagazineArchive/Pages/2018/October%202018/Goldfeins-Multi-Domain-Vision.aspx

Air Force Magazine. “Lockheed conducts multi-domain C2 experiments.” Last accessed 30 Apr 2019. http://www.airforcemag.com/Features/Pages/2018/February%202018/Lockheed-Conducts-Multi-Domain-Command-and-Control-Experiments.aspx

Australia. Royal Australian Air Force. *At the edge: Fifth-generation air force*. Canberra: RAAF Australia, 2019. http://view.publitas.com/jericho/at-the-edge/page/1

Barnes, Pux. “The JFACC and the CAOC-centric RCAF: Considerations for the employment of air power in joint operations.” *RCAF Journal* vol.3 no.3 (2014): 12-20. http://www.rcaf-arc.forces.gc.ca/assets/AIRFORCE_Internet/docs/en/cf-aerospace-warfare-centre/elibrary/journal/2014-vol3-iss3-04-the-jfacc-and-the-caoc-centric-rcaf.pdf

Canada. Department of National Defence, A-GA-007-000/AF-008, *Air Force Vectors: Agile, Integrated, Reach, Power*. Ottawa: DND Canada, 2014. http://publications.gc.ca/collections/collection_2017/mdn-dnd/D2-300-2014-1-eng.pdf

Canada. Department of National Defence. *Future concepts directive part 2: Future air operating concept*. Ottawa: DND Canada, 2016. http://www.rcaf-arc.forces.gc.ca/assets/AIRFORCE_Internet/docs/en/cf-aerospace-warfare-centre/elibrary/future-concepts-directive-part-2-future-air-operating-concept.pdf

Canada. Department of National Defence. *Projecting power: Canada’s air force 2035*. Trenton: DND Canada, 2009. http://publications.gc.ca/collections/collection_2010/forces/D2-247-2009-eng.pdf

Canada. Department of National Defence. *Strong, Secure, Engaged: Canada’s Defence Policy*. Ottawa: DND Canada, 2017. http://dgpaapp.forces.gc.ca/en/canada-defence-policy/index.asp

Canada. Defence Research and Development Canada. DRDC-RDDC-2015-R212. *The future of allied air power: The Royal Australian Air Force.* Trenton: Canadian Forces Aerospace Warfare Centre, 2015. http://cradpdf.drdc-rddc.gc.ca/PDFS/unc203/p802709_A1b.pdf

Charles Koch Institute. “What is A2/AD and why does it matter to the United States?” Last accessed 30 Apr 2019. https://www.charleskochinstitute.org/blog/what-is-a2ad-and-why-does-it-matter-to-the-united-states/

Charon, Andrea and Fergusson, James. *Beyond NORAD and modernization to North American defence evolution*. Winnipeg: Centre for Defence and Security Studies for the Canadian Global Affairs Institute, 2017. https://www.cgai.ca/beyond_norad_and_modernization_to_north_american_defence_evolution

Deakin, Richard S. *Batllepsace Technologies: Network-Enabled information dominance*. Norwood: Artech House, 2010.

Deptula, David A. "A new era for Command and Control of aerospace operations." *Air and Space Power Journal* vol.28 no.4 (2014): 5-16 https://www.airuniversity.af.edu/Portals/10/ASPJ/journals/Volume-28_Issue-4/SLP-Deptula.pdf

Deptula, David A. *Evolving Technologies and Warfare in the 21st Century: Introducing the "Combat Cloud"*. Arlington: The Mitchell Institute for Aerospace Power, 2016. http://docs.wixstatic.com/ugd/a2dd91_73faf7274e9c4e4ca605004dc6628a88.pdf

Ehrhart, Hans-Georg. "Postmodern warfare and the blurred boundaries between war and peace." *Defense & Security Analysis*. Vol.33, no.3. (2017): 263. https://doi.org/10.1080/14751798.2017.1351156

Hostage III, Gilmary Michael and Broadwell, Jr., Larry R. "Resilient command and control: The need for distributed control." *Joint Force Quarterly* Vol. 74 3rd Quarter (2014): 38-43. https://ndupress.ndu.edu/Portals/68/Documents/jfq/jfq-74/jfq-74_38-43_Hostage.pdf

Kainikara, Sanu. *Air power in the information age: The deciding factor*. Greenway: RAAF Air Power Development Centre, 2015. http://airpower.airforce.gov.au/APDC/media/PDF-Files/Working%20Papers/WP41-Air-Power-in-the-Information-Age-The-Deciding-Factor.pdf

Kainikara, Sanu. *The future relevance of smaller air forces*. Greenway: RAAF Air Power Development Centre, 2008. http://airpower.airforce.gov.au/APDC/media/PDF-Files/Working%20Papers/WP29-The-Future-Relevance-of-Smaller-Air-Forces.pdf

Kiser, J. Hess, E.M. Bouhafa, S. Williams. "The Combat Cloud: Enabling multi-domain command and control across the range of military operations." *Wright Flying Paper*. no. 65 (2019): 1-28. https://www.airuniversity.af.edu/Portals/10/AUPress/Papers/wf_0065_hess_combat_cloud.pdf

Layton, Peter. "Fifth-generation air warfare." *Australia Defence Force* Journal. No.204. (2018): 23:31. http://www.defence.gov.au/ADC/ADFJ/Documents/issue_204/ADFJournal204_web.pdf

Lerhe, Eric J. “Canada-U.S. military interoperability: at what cost sovereignty?” Degree of Doctor of Philosophy paper. Dalhousie University, 2012. https://dalspace.library.dal.ca/bitstream/handle/10222/15306/Lerhe%2C%20Eric%2C%20PhD%2C%20POLSCI%2C%20Oct%202012%20D.pdf?sequence=5&isAllowed=y

Lagassé, Philippe. “Specialization and the Canadian Forces.” The Norman Paterson School of International Affairs - Occasional Paper. Carleton University, 2003. https://www3.carleton.ca/csds/docs/occasional_papers/npsia-40.pdf

H., Myron, G.W. McLeod, E.V. Larson, J. Schneider, D. Gonzales, D M. Norton, J. Jacobs, K.M. O'Connell, W. Little, R. Mesic, and L. Jamison, *Interoperability: A Continuing Challenge in Coalition Air Operations*. Santa Monica, CA: RAND Corporation, 2000. https://www.rand.org/pubs/monograph_reports/MR1235.html.

NATO. Public Diplomacy Division. BGR2-INTEROP-ENG-0706. *Backgrounder: Interoperability for joint operations*. Brussels: NATO, 2006. https://www.nato.int/nato_static_fl2014/assets/pdf/pdf_publications/20120116_interoperability-en.pdf

Network Monitoring Solutions Review. “The benefits of AI and machine learning in network monitoring.” Last accessed 30 Apr 2019. https://solutionsreview.com/network-monitoring/the-benefits-of-ai-and-machine-learning-in-network-monitoring/

Policy Options. “Canada in North America: From political sovereignty to economic integration.” Last accessed 30 Apr 2019. http://policyoptions.irpp.org/magazines/the-dollar/canada-in-north-america-from-political-sovereignty-to-economic-integration/

RCAF. “RCAF leads CAF space initiatives.” Last accessed 30 Apr 2019. http://www.rcaf-arc.forces.gc.ca/en/article-template-standard.page?doc=rcaf-leads-canadian-armed-forces-space-initiatives/jtk96x80

Schmidt, Andreas. “Countering Anti Access / Area Denial: Future capability requirements in NATO.” *The Journal of the Joint Air Power Competence Centre* Vol. 23 Autumn/Winter (2016): 69-77. https://www.japcc.org/wp-content/uploads/JAPCC_Journal_Ed-23.pdf

The National Interests. “The U.S. Air Force of the future: Hypersonic weapons, swarm strikes and stealth fighters.” Last accessed 30 Apr 2019. https://nationalinterest.org/blog/buzz/us-air-force-future-hypersonic-weapons-swarm-strikes-and-stealth-fighters-37482

The Netherlands. Command and Control Centre for Excellence. *Catalyzing the art of C2*. Utrecht: C2CoE The Netherlands, 2009.

USAF, “CSAF letter to airmen,” Last accessed 30 Apr 2019. https://www.af.mil/News/Article-Display/Article/1108931/csaf-letter-to-airmen/

United States. Joint Chiefs of Staff. Joint Targeting. Joint Publication 3-60. Washington, DC: JCS United States, 2013.