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FUTURE OF FIGHTERS: THE RCAF FIGHTER CAPABILITY REQUIREMENT OF TODAY AND TOMORROW

Major Benjamn N. Switzer

JCSP 47

Service Paper

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JCSP 47 - PCEMI 47
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1. This paper will discuss the Royal Canadian Air Force's (RCAF) requirement for fighter aircraft in the context of current and future commitments and threats. It will examine the driving factors of these requirements and state the implications these factors have on future missions for fighter aircraft. A recommendation will be presented for one key fighter capability increase to ensure RCAF fighter relevance in the future battlespace.

INTRODUCTION

2. The Canadian Armed Forces (CAF) recognizes the future of warfare will exist both within and beyond the historical domains of land, sea, and air. It also understands that the activities of adversaries are not appropriately represented by a one dimensional linear spectrum of conflict. A more robust *matrix of competition* better represents the reality of the security environment.[1] Militaries are examining the implications this new view of the security environment will have on the future battlespace. The CAF recently published the *Pan Domain Force Employment Concept* (PFEC) recognizing that future operations will need coordinated action across multiple, and/or all domains, in order to maximize desired military effects. While the Pan Domain concept highlights the requirement to include non-traditional domains, such as Cyber, Space, and Information, the traditional air, land, and sea domains remain integral to military capability.[2] A shift towards a Pan Domain operational approach requires the RCAF to re-evaluate its current

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capabilities to determine whether or not these capabilities should be expanded to suit these changing domains. This paper will not directly analyse where fighter aircraft capabilities fall on the competitive matrix, nor recommend appropriate areas of fighter use within this matrix. Military leaders must recommend the use fighter aircraft and governments must ultimately decide when to commit these aircraft. This paper focuses on fighter aircraft in this context of commitments and threats. The focus is on the capabilities fighters can provide to the security environment, and what the future implications of fighter aircraft will be with a shift to a Pan Domain approach to security.

3. Militaries use combat aircraft because their elevation provides commanders with an advantage. Currently, attaining some form of advantage along the "Control of the Air Continuum" is seen as an early requirement for success in military conflict.[3] The Pan Domain recognizes that air domain relevance remains, but the question becomes are fighter aircraft still relevant, will they remain relevant, and are there any foreseeable changes in their capabilities, roles, or employment? This paper will discuss the relevance of fighters to the RCAF from the perspective of NATO commitments, foreseeable present and future threats, and some expected technology of future conflict. To ensure broad capability of deterrence, defensive, and offensive operation, this paper will conclude with a recommendation to increase the Suppression of Enemy Air Defence capability of RCAF fighters as part of the pan-domain force of the future.

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DISCUSSION

4. To understand why the RCAF will continue to require fighter aircraft, it is importance to first highlight the Canadian defence commitments. Canada's participation in the North Atlantic Treaty Organization (NATO) is one key commitment that influences defence obligations. The primary two articles of the Washington Treaty which are most applicable to a Fighter Aircraft requirement are Article 3 and Article 5.

5. Article 3 of the Washington Treaty states: "In order more effectively to achieve the objectives of this Treaty, the Parties, separately and jointly, by means of continuous and effective self-help and mutual aid, will maintain and develop their individual and collective capacity to resist armed attack."[4] Due to Canada's vast and varied geography, air access is the only rapid, year-round method to access and defend all Canadian territory. The RCAF fulfills Canada's commitment of self-help to resist armed attack in a rapid and territory-wide manner by maintaining fighter aircraft on Quick Reaction Alert. No other platform can match the reach and speed of fighter aircraft in providing physical armed response over Canadian territory.

6. Treaty Article 5 outlines the commitment Canada, and all NATO allies have made to assist in each other's collective defence if any member is attacked. This commitment can include armed force. While no further detail or restriction is included in the article on what contributions can entail, the speed and reach characteristics of airpower, as well as the agile kinetic capabilities of fighter aircraft, lend themselves to a rapid and powerful contribution to any Article 5 response. This rapid kinetic response

[4] North Atlantic Treaty Organization, "The North Atlantic Treaty," last modified 10 April 2019, https://www.nato.int/cps/en/natolive/official_texts_17120.htm.

was demonstrated when the RCAF deployed the CF-18 in support of the NATO led United Nations Security Council Resolution (UNSCR) No-Fly Zone over Libya, when the CF-18 was able to deploy within 24 hours and contribute to operations within 2 days of arrival.[5]

7. The annexation of Crimea demonstrates that Russia is willing to use military force to expand its territory and attain its political objectives. A strong and capable NATO alliance is one method to deter further offensive military projection by Russia that threatens Canada, its allies, and the international rules based order. The RCAF's demonstrated rapid and effective response with armed fighter aircraft is an important capability Canada contributes to provide deterrence to any aggressors against NATO. Doctrinally, *Air Attack* and *Control of the Air* are two core capabilities Canada could contribute to assist in a NATO Article 5 response.[6] The RCAF's fighter force is currently the only fleet that is specifically trained across many of the broad roles covered by these core capabilities. Thus, the CF18 is currently the most expeditious and capable means for Canada and the RCAF to best fulfill Canada's NATO commitment in a meaningful way.

8. As part of the NATO enhanced Air Policing (NeAP) mission in Romania, RCAF fighter aircraft recently intercepted Russian fighter aircraft.[7] This is a NATO mission that is expected to continue. Further, Russian long range bomber aircraft occasionally enter the Canadian Air Identification Zone. Canadian fighters intercept these aircraft to identify

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and deter any entry into Canadian Sovereign Airspace.[8] Fighter aircraft are currently the only aircraft with the performance, maneuverability, armament, and sensors required to successfully accomplish these intercepts and promote deterrence. Russia is investing in new, more advanced fighter aircraft such as the Generation 4+ Su-35, and the fifth generation Su-57 Felon. This investment demonstrates Russia's continued intent and capability to employ these types of airframes. Thus, the RCAF must ensure it remains able to provide a credible deterrence and capable defence against these threats.

9. Seldom discussed is the human interaction and observation capability that a manned fighter can provide during intercepts. This provides feedback to command and control that would be otherwise unattainable. Human observation, interaction, and interpretation combined with the capabilities of fighter aircraft are not duplicated in any other airframe. This human element is a critical factor that needs to be considered in future requirements for fighter aircraft and the capabilities they are expected to fulfill. At this time, Unmanned Aerial Vehicles (UAV) are not designed with capabilities to replace the manned fighter in this way. Thus, the manned fighter platform is still required, relevant, and unmatched in these attributes.

10. Ground Based Air Defence (GBAD) could provide kinetic defence against threat aircraft. However, it does not provide an offensive option and relies on a target being positively identified as a hostile aircraft warranting engagement. In military operations other than war, and without eyes on, it may be challenging for commanders to determine if a suspect aircraft requires kinetic defensive engagement, or if simple investigation or

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deterrence would suffice. Further, adversaries are likely to use means such as Electronic Warfare (EW) to degrade allied forces situational awareness. Thus, engagement with GBAD may not always be warranted, and GBAD is unable to provide deterrence via visible presence. The physical presence of a fighter aircraft sends a strong message when intercepting another aircraft, and provides commanders with eyes on information, and unique perspective, critical for decision making.

11. Russian Surface-to-Air Missile (SAM) systems, such as the S-400, are mobile and can target aircraft or inbound weapons at a range of 400 kilometers.[9] These SAMs will be used in coordination with fighter aircraft as part of an Integrated Air Defence (IAD) to contribute to creating Anti-Area/Area Denial (A2/AD) regions. The PFEC recognizes that these future threats will require coordinated effort across all domains, including the conventional air domain, as part of the integrated approach to gain advantage in combat.[10] Kinetic effects will remain an important contribution to a successful Pan Domain approach for deterrence, defence, and destruction. An airborne, maneuverable, stealthy platform with kinetic and non-kinetic capabilities, such as a fighter aircraft, will be required. A gap in this area would leave bomber aircraft vulnerable to an adversary's defensive fighters. This was evident in World War II when long range bombers would undertake strike missions out of range of fighter defensive cover. The bombers were very vulnerable. Fighter range was subsequently extended with drop tanks to defend the bombers. This same concept will need to be maintained in the future to ensure broad

[9] Missile Defense Project, "S-400 Triumf," *Missile Threat*, Center for Strategic and International Studies, last modified 15 June 2018, https://missilethreat.csis.org/defsys/s-400-triumf/.

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effects can be brought to bear in an A2/AD environment. Thus, to avoid capability gaps or become vulnerable, current fighter capability will have to be maintained.

12. In high threat environments, maneuverable fighter aircraft stand the best chance of survival. Fighters with stealth and advanced EW will be the most survivable assets to operate in close proximity to some threats. Mobile targets, EW, camouflage, concealment, decoys, and other survival techniques used by adversaries may will challenge stand-off weapons to successfully engage all targets. A broad approach including fighter aircraft capable of operating and surviving closer to threats may be required to accomplish the desired effects. Non-kinetic effects will support aircraft but ultimately the destruction of defensive systems through kinetic effects will be required. Without inflicting physical damage, defensive systems can be brought back online.

13. Weapons such as Advanced Anti-Radiation Guided Missiles (AARGM) will be required to kinetically counter surface to air threats, deplete enemy defensive systems, and progress a battlefield toward favorable conditions for the RCAF and its allies. This type of weapon with redundant methods of targeting will be required in order to overcome an adversary's increasingly advanced countermeasures. "AARGM's seeker includes three separate modules working together: passive radar, millimetre radar and INS/GPS. The above makes it possible to neutralize moving targets or objects that do not emit radar signals, in case of which the coordinates are known."[11] Many United States (US) fighter aircraft currently employ these weapons to fulfill the Suppression of Enemy Air Defence (SEAD) capability on designated platforms. However, with the increase

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number, proliferation, and defensive capabilities of SAM systems, such as would be present in an A2/AD environment, every capable aircraft will have to contribute to the SEAD mission for its own survivability, as well as that of the entire missions.

14. Fighter weapon payloads are relatively small when compared to dedicated bomber aircraft. Bombers, however, have limited performance and maneuverability making them vulnerable in a high threat environment. As networked integration becomes more prevalent, networked weapons will become normalized. Further, Artificial Intelligence (AI) will also become more prevalent on the battlefield. When appropriately combined, the strengths of each technology will create complimentary effects and dramatically increase offensive success. Consider the following conceptual example of combining these technologies. Fighters could operate forward in a threat area, and prioritize their limited weapons payload on those effects critical to their own survival, such as Air-to-Air and SEAD weapons. With increase fighter survivability, they can focus to find and fix targets providing real-time updated coordinates disseminated via network.[12] The increase range capability of stand-off weapons combined with networked updated target information, could be transported and employed from a variety of larger platforms outside of the threat region. AI, integrated on the network, could process data and distribute updated target information. Based on target priority and networked weapon capability, AI could then analyse and update which inbound weapon is designated to which target. Further, AI could re-allocate targets if weapons are intercepted by defences. AI used in this manner would not be the authority on target engagement, but rather it

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would simply assign, or re-assign, weapons against already approved targets based on the information it can rapidly process. By using AI in this fashion, it would mitigate any moral concerns over AI use in kinetic strike. In this type of scenario, space-based assets can also be incorporated on the network to assist and support the mission. Combining all these technologies creates a system of systems that uses the strengths of each, minimizes vulnerabilities and creates redundancies, all while complicating an adversary's capability to counter such an attack. In this system of systems, fighters can be seen as one of many advantageous elements that contribute to the overall effect leading to mission success.

CONCLUSION

15. Manned fighter aircraft will remain relevant for the RCAF for the foreseeable future. Currently, no other single platform will fulfill the RCAF doctrinal capabilities and roles held by fighters. These capabilities and roles are derived in part from the commitments Canada has made to NATO. The rapid response and visible deterrence to defend Canadian territory from armed attack is currently only provided by manned fighter aircraft. Russian fighter jets consistently test NATO's resolve, and require an armed, capable fighter response to provide a credible deterrent. The human observation, interaction, and information passage required of intercept missions highlight the need for a piloted cockpit until technology can provide a means to gather and disseminate comparable information. Canada and its allies are anticipating the need to employ Pan Domain operations in future conflicts to overcome advanced adversary threats such as A2/AD regions. A kinetic, fast, agile, maneuverable, networked, airborne capability will be an integral part of those scenarios.

RECOMMENDATION

16. The RCAF should pursue increasing fighter aircraft capabilities to provide kinetic SEAD effects for self-defence and extended self-defence. This will ensure the ability to operate in current and future threat environments. Ideally, these capabilities would have redundant guidance methods, such as AARGM's capabilities, and ideally be transferable to future fighter replacement aircraft to maximize cost effectiveness and ensure continued capability into the future. A lack of these capabilities will leave fighter aircraft vulnerable and a liability to coalition operations as they will require more protection from partner allied nations with these capabilities. As SAM systems become more proliferated and numerous, allies may not have the excess capacity to support their own needs and assist RCAF fighters. Thus, if the RCAF is unable to provide for its own protection, it may not be able to contribute in theaters with advanced threats. With A2/AD regions becoming a reality, it may mean allied forces cannot establish permanent air superiority. Advantageous windows of opportunity may be all that is available. If the RCAF cannot contribute to operations in A2/AD environments, then its fighter aircraft may not be a useful commitment to fulfil NATO Article 5 obligations.

BIBLIOGRAPHY

Canada. Department of National Defence. *Pan-Domain Force Employment Concept*. Ottawa: DND Canada, 2020.

Canada. Department of National Defence. B-GA-400-000/FP-001, *Royal Canadian Air Force Doctrine*. Trenton: RCAF Aerospace Warfare Centre, November 2016.

Defence24. "AARGM - Evolution of Anti-Radiation Capabilities." Last modified 16 April 2018. https://www.defence24.com/aargm-evolution-of-anti-radiation-capabilities.

Koudelka, Benjamin F. Jr. "Network-enabled Precision Guided Munitions." Maxwell AFB AL: Center for Strategy and Technology, Air War College, Air University, November 2005.

Mayne, Richard O. "The Canadian Experience: Operation Mobile." In *Precision and Purpose Airpower in the Libyan Civil War,* edited by Karl P. Mueller, 239-266. Santa Monica, CA: RAND Corporation, 2015.

Missile Defense Project. "S-400 Triumf." *Missile Threat*. Center for Strategic and International Studies. Last modified 15 June 2018. https://missilethreat.csis.org/defsys/s-400-triumf/.

North Atlantic Treaty Organization. "The North Atlantic Treaty." Last modified 10 April 2019. https://www.nato.int/cps/en/natolive/official_texts_17120.htm.

Radio Canada International. "Canadian CF-18s intercept Russian fighter jet near Romanian airspace." Last modified 25 September 2020. https://www.rcinet.ca/en/2020/09/25/canadian-cf-18s-intercept-russian-fighter-jet-near-romanian-airspace/

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15. Manned fighter aircraft will remain relevant for the RCAF for the foreseeable future. Currently, no other single platform will fulfill the RCAF doctrinal capabilities and roles held by fighters. These capabilities and roles are derived in part from the commitments Canada has made to NATO. The rapid response and visible deterrence to defend Canadian territory from armed attack is currently only provided by manned fighter aircraft. Russian fighter jets consistently test NATO's resolve, and require an armed, capable fighter response to provide a credible deterrent. The human observation, interaction, and information passage required of intercept missions highlight the need for a piloted cockpit until technology can provide a means to gather and disseminate comparable information. Canada and its allies are anticipating the need to employ Pan Domain operations in future conflicts to overcome advanced adversary threats such as A2/AD regions. A kinetic, fast, agile, maneuverable, networked, airborne capability will be an integral part of those scenarios.

RECOMMENDATION

16. The RCAF should pursue increasing fighter aircraft capabilities to provide kinetic SEAD effects for self-defence and extended self-defence. This will ensure the ability to operate in current and future threat environments. Ideally, these capabilities would have redundant guidance methods, such as AARGM's capabilities, and ideally be transferable to future fighter replacement aircraft to maximize cost effectiveness and ensure continued capability into the future. A lack of these capabilities will leave fighter aircraft vulnerable and a liability to coalition operations as they will require more protection from partner allied nations with these capabilities. As SAM systems become more proliferated and numerous, allies may not have the excess capacity to support their own needs and assist RCAF fighters. Thus, if the RCAF is unable to provide for its own protection, it may not be able to contribute in theaters with advanced threats. With A2/AD regions becoming a reality, it may mean allied forces cannot establish permanent air superiority. Advantageous windows of opportunity may be all that is available. If the RCAF cannot contribute to operations in A2/AD environments, then its fighter aircraft may not be a useful commitment to fulfil NATO Article 5 obligations.

BIBLIOGRAPHY

Canada. Department of National Defence. *Pan-Domain Force Employment Concept*. Ottawa: DND Canada, 2020.

Canada. Department of National Defence. B-GA-400-000/FP-001, *Royal Canadian Air Force Doctrine*. Trenton: RCAF Aerospace Warfare Centre, November 2016.

Defence24. "AARGM - Evolution of Anti-Radiation Capabilities." Last modified 16 April 2018. https://www.defence24.com/aargm-evolution-of-anti-radiation-capabilities.

Koudelka, Benjamin F. Jr. "Network-enabled Precision Guided Munitions." Maxwell AFB AL: Center for Strategy and Technology, Air War College, Air University, November 2005.

Mayne, Richard O. "The Canadian Experience: Operation Mobile." In *Precision and Purpose Airpower in the Libyan Civil War,* edited by Karl P. Mueller, 239-266. Santa Monica, CA: RAND Corporation, 2015.

Missile Defense Project. "S-400 Triumf." *Missile Threat*. Center for Strategic and International Studies. Last modified 15 June 2018. https://missilethreat.csis.org/defsys/s-400-triumf/.

North Atlantic Treaty Organization. "The North Atlantic Treaty." Last modified 10 April 2019. https://www.nato.int/cps/en/natolive/official_texts_17120.htm.

Radio Canada International. "Canadian CF-18s intercept Russian fighter jet near Romanian airspace." Last modified 25 September 2020. https://www.rcinet.ca/en/2020/09/25/canadian-cf-18s-intercept-russian-fighter-jet-near-romanian-airspace/

United States. United States Air Force. *Basic Doctrine Annex 3-01 CounterAir Operations.* Maxwell AFB, AL: Lemay Center for Doctrine, 06 September 2019.