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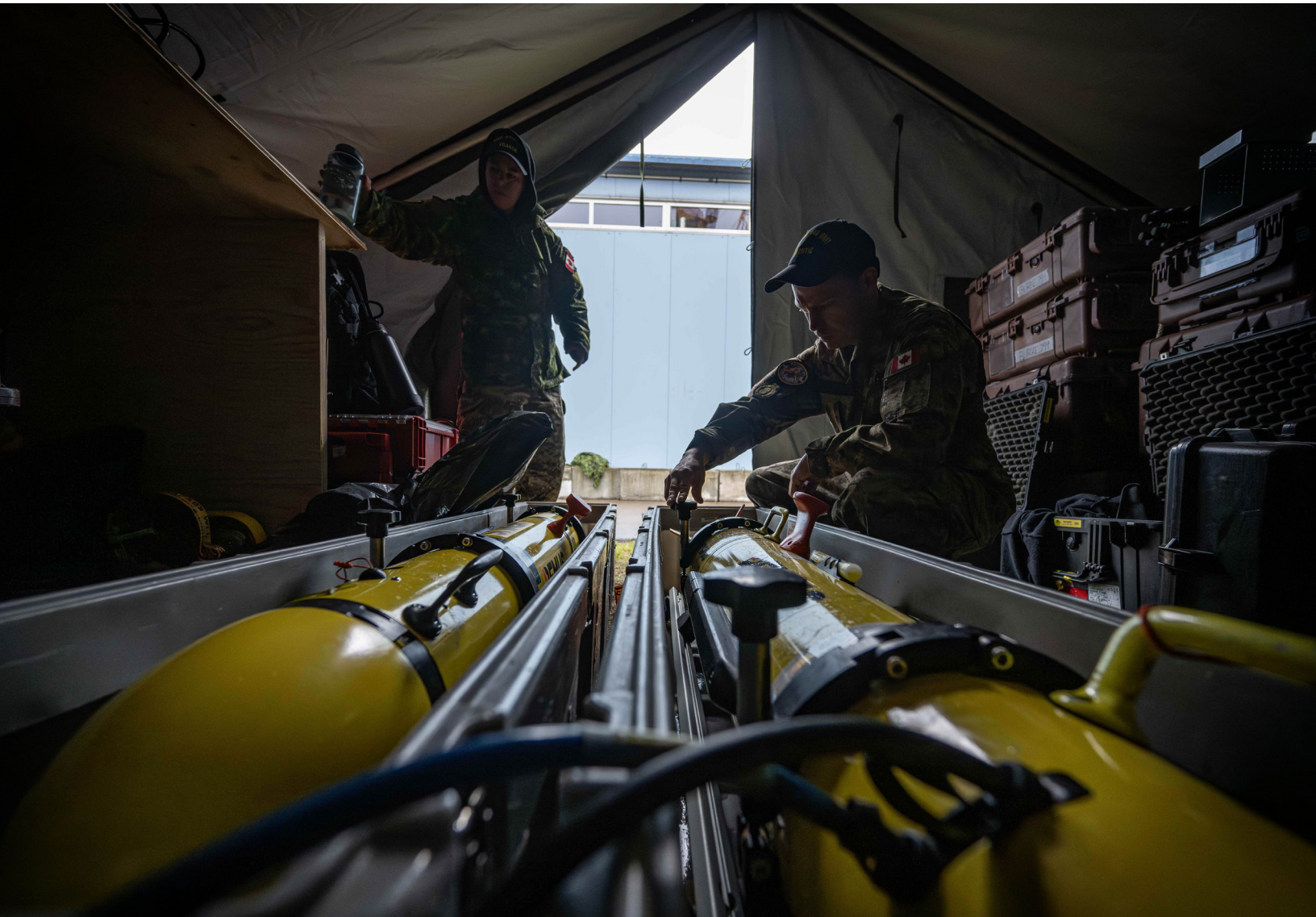
FORCE DEVELOPMENT

The Strategic and Operational Role of Autonomous Systems

Report - January 2026



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On the Cover

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Op OPEN SPIRIT
L-R Sailor First Class Kendra Martin and Sailor First Class Charles MacDonald, prepare a REMUS autonomous underwater vehicle for operation while taking part in Operation OPEN SPIRIT 2025 in Lithuania, on May 19, 2025.
Photo by Master Corporal Mark Wanzel
https://flic.kr/p/2r6vFLM

Introduction

In recognition of the incredible complexity of sustaining defence capabilities, including the timely adoption and integration of rapidly evolving technologies, the CDA Institute has initiated the Force Development Series, comprised of events involving a diverse range of subject matter experts and reports as a contribution to the national discussion on defence policy. With the generous support of the Department of National Defence (DND), this workshop event of the series was held in December 2025 on the topic of The Strategic and Operational Role of Autonomous Systems.

The objective of the event was to address, at a high level, the challenges ahead in sustaining Canada's autonomous systems capabilities, including the potential risks and consequences of a capability gap, and fostering open conversations amongst experts to generate creative, multi-stakeholder solutions-focused dialogues. Topics covered during the event included the operational and strategic value of autonomous systems to the Canadian Armed Forces (CAF) in a changing security environment, structural barriers to progress in the CAF's procurement process, ethical concerns surrounding lethal force without human intervention, and opportunities for greater collaboration between the CAF, government, industry, and academia.

This report summarizes the discussions held during the event, providing a comprehensive overview of the key points made by the invited experts. In alignment with the CDA Institute's mandate to educate the broader Canadian public on defence and security issues, the report aims to promote better understanding and informed debate about the importance of and challenges associated with autonomous systems capabilities. Complying with the Chatham House rule, the report does not attribute any comments to individuals.

A special thank you to our Rapporteur, Kurt Karul,
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Executive Summary

This report provides a detailed analysis of the event's discussions around the strategic and operational role of autonomous systems for the CAF, and underscores their growing importance in the shifting international security landscape. The rapid evolution of conflict, exemplified by the war in Ukraine, demonstrates that the widespread integration of uncrewed and autonomous systems is an immediate, strategic imperative. Future military competence hinges on achieving affordable massing and shifting procurement to a pace measured in months, not years.

The core operational advantages of autonomous systems are the mitigation of risk to personnel and achievement of affordable mass. By removing human lives from the immediate line of fire, these systems allow for high-attrition maneuvers and persistent coverage across vast areas—capabilities that are prohibitively dangerous or expensive for crewed platforms. This provides the massing capability required to defend Canadian sovereignty, particularly in the vast and remote Arctic, where autonomous assets can operate in a 'system-of-systems' alongside crewed and uncrewed assets. By reducing risk to the force while increasing operational reach, leveraging autonomous systems is crucial to credibly deter, detect, deny, and defeat adversaries while preserving Canadian lives.

Though the advantages of autonomous systems are clear, their deployment and integration face systemic challenges. Discussions centered critically around the existing CAF procurement model, which is fundamentally risk-averse and has proven unable to keep pace with the hyper-accelerated development cycle of modern autonomous technology. The model's reliance on lengthy, low-risk acquisitions and the prioritization of 'lowest price' procurements have created a critical capability gap that will widen without decisive, immediate action.

The path forward calls for a fundamental cultural shift across the defence establishment. This shift moves away from slow, legacy procurement processes and toward a holistic strategy that prioritizes four key elements.

First, Canada should leverage best-in-class technology to bring its autonomous capabilities up to speed. Second, the CAF should deepen collaboration with the Canadian government, industry, and academia to ensure that it is involved in the entire life cycle of autonomous systems, not just buying off-the-shelf. Third, Canada needs to ensure that existing lines of ethical and legal accountability for commanders, decision-makers, and the government are adapted to the complexities of autonomous systems. Fourth, focusing investment in technologies that have both military and civilian applications (dual-use/multi-use capabilities) would accelerate development, attract capital, and ensure the commercial viability of Canadian innovation, both at home and abroad.

Without these concurrent efforts, the discussions concluded that Canada risks falling critically behind its peers and adversaries, limiting its capacity for self-defence and effective cooperation on the international stage. Crucially, the discussions underscored the need not only to recognize these challenges, but to take immediate and meaningful action to address them.

Points of Consensus

- Autonomous systems are crucial for achieving the affordable massing and deterrence required to defend Canada's vast territory, particularly the Arctic.

- The core operational advantage of autonomous systems is their mitigation of risk to personnel. By removing human lives from the line of fire, the CAF can maintain a persistent presence in environments where crewed assets would be too vulnerable.

- The current CAF procurement model is risk-averse and reliant on long-term acquisitions. This is creating a critical capability gap where Canada is unable to keep pace with rapid generational leaps in autonomous capabilities seen in active arenas like Ukraine.

- Canada must leverage best-in-class global innovations to avoid falling further behind in autonomous capabilities. This should be balanced with an effort to solidify the domestic industrial base and bolster technological sovereignty.

- Canada should be involved in the entire autonomous systems life cycle (R&D, deployment, retraining) instead of just buying off-the-shelf. Deeper collaboration between the CAF, industry, government, and academia will be crucial.

- Effective use requires reinforcing existing lines of accountability. Autonomous systems should be transparent, explainable, and interpretable and governed by a socially accountable policy framework.

Points of Contention

- To what extent should autonomous systems make lethal decisions without human intervention? At the same time, with existential threats like intercontinental ballistic missiles (ICBMs), would human input pose too much of a national security risk?

- Who should be held accountable for an autonomous system malfunction that results in unintended civilian casualties? Would this fall on the government who procured the system or the commander who 'pushed the button'?

- How can Canada balance the risks of accelerating procurement with the need to match the pace of adversarial development? Ukraine's risk-heavy model has been massively successful, but Canada's geopolitical context and needs may be fundamentally different.

- How can Canada incentivize investment in critical capabilities that may lack immediate commercial viability? To what extent should a focus on dual-use capabilities with military and civilian applications be used to bridge this gap?

Background

The Canadian Armed Forces (CAF) currently faces a critical deficit in persistent domain awareness and mass, particularly within Arctic and maritime approaches. As adversarial technologies in these regions advance, traditional crewed platforms are increasingly challenged by prohibitive costs, vast geography, and operational risk.

Leveraging autonomous systems is essential to bridging this gap. By deploying high numbers of low-cost assets, Canada can effectively contest environments where human-crewed platforms would be too vulnerable or expensive to operate. This scale is especially critical given the size of Canada's territory.

While the terms 'autonomous' and 'uncrewed' describe different characteristics, they represent a unified strategic priority in this context. Most modern uncrewed platforms incorporate varying levels of autonomy, ranging from basic flight stabilization to total 'fire-and-forget' capabilities. Regardless of the specific level of human intervention, these systems provide the same fundamental advantage of removing personnel from the immediate line of fire, thereby reducing operational risk to the force.

Global Geopolitical Landscape

Since Russia's illegal invasion of Ukraine in February 2022, the international order has taken on a markedly realist lens. As multilateral institutions and soft power dynamics alone have proven unable to deter adversaries from military aggression, traditional hard power metrics and great power competition have returned to the forefront.

Workshop discussions centered on the vulnerability of Canadian territory across a wide spectrum of conflict. At the strategic level, the most significant threat remains ICBMs, with potential launch points now ranging from traditional silos to container ships transiting the Northwest Passage. At the tactical level, the war in Ukraine has demonstrated a fundamental shift in battlefield lethality, characterized by the proliferation of uncrewed systems and a requirement for cost-effective, large-scale, and risk-tolerant capabilities.

Participants agreed that the CAF's current force structure is insufficient to meet the scale of these threats. The military's traditional, crewed platforms are increasingly strained and lack the foundational mass required to persistently cover Canada's vast territory and maritime approaches.

Strategic Necessity and Operational Imperatives

Operational Mass and Risk Advantages: Affordable massing is the only feasible solution to the infinite costs of fully and effectively covering Canada's massive territory. Autonomous platforms, particularly Uncrewed Ground Vehicles (UGVs) and Uncrewed Aerial Systems (UAS), offer persistent, ubiquitous coverage that is cost-effective and scalable. Working in a 'system-of-systems' alongside crewed assets like the P-8 Poseidon and space-based sensors, autonomous platforms would provide the mass required to deter, detect, deny, and defeat adversarial threats. For example, these systems could identify and engage enemy submarines before they launch missiles—a task that a limited crewed fleet may not adequately address.

Autonomy's other core advantage is the reduction of risk to personnel. By removing human lives from the immediate line of fire, autonomous systems allow for the execution of more aggressive maneuvers that would be prohibitively dangerous for crewed assets. Therefore, leveraging autonomous systems can bolster operational lethality, which is crucial for operating alongside allies in contested Anti-Access/Area Denial (A2/AD)

environments abroad. Conversely, in the Arctic, these same advantages enable Canada to create its own A2/AD environment, effectively denying adversaries freedom of movement and securing Canadian sovereignty.

Deterrence: Autonomous systems enable deterrence by denial and punishment. By offering scalability and enhanced protection of personnel, these systems provide the persistent presence needed to deny adversarial objectives, while their increased lethality ensures a credible threat of punishment. Participants emphasized that defensive capabilities alone are insufficient; a credible threat of offensive action—including the ability to strike deep into adversary territory—is also required to achieve maximum deterrence.

The Procurement Crisis and Strategic Friction

Risk-Averse Procurement: Workshop discussions identified uncrewed and autonomous systems as a strategic necessity, but saw Canada's internal institutional framework and acquisition culture as the primary obstacles to integration. The CAF's current procurement model is designed to ensure fiscal oversight and eliminate political risk. While these elements are crucial, this focus results in procurement operating at a glacial pace that is wholly incompatible with the exponential speed of technological change.

Discussions centered around two main points. First, the CAF's 'lowest price' model inherently prioritizes immediate savings over long-term strategic value. This approach penalizes innovation and is systemically biased against emerging Canadian firms. By favouring established foreign incumbents, the current system threatens Canada's long-term economic sovereignty by leaving the CAF dependent on foreign technology that may be unavailable during a crisis. This discourages the growth of a resilient domestic defence industry, which is critical in an increasingly volatile international order. Second, Canada's multi-departmental approach—involving the DND, Public Services and Procurement Canada (PSPC), and others—creates bureaucratic bottlenecks, duplicative processes, and a lack of clear accountability.

If Canada wants to keep pace with the developments in autonomous systems seen by its partners and adversaries, the current culture of risk aversion needs to change. At the current pace, any newly acquired autonomous systems would already be obsolete by the time they became ready to deploy. However, participants disagreed regarding the extent to which traditional validation and safety standards should be streamlined for the sake of procurement speed.

The Ukrainian Model: The workshop highlighted the extreme contrast with the model in Ukraine, where existential threats to statehood have forced a cycle of rapid, continuous development and high tolerance for risk and operational loss. Consequently, Ukraine has seen generational leaps in uncrewed capabilities approximately every six months. Regular battlefield use and constant urgency have created an ecosystem where user feedback directly drives rapid hardware and software development.

Although the Ukrainian model demonstrates the required procurement speed, participants noted that the CAF faces a fundamentally different geopolitical reality and threat landscape. Canada is not under an active, existential invasion, and may not need a model with such high risk tolerance. At the same time, Canada must still address the existing systemic obstacles to progress in order to move to a development pace measured in months, not years.

Ethics and Accountability

Ethics of Lethal Autonomy: One of the discussion's key questions revolved around Lethal Autonomous Weapons Systems (LAWS): To what extent should autonomous systems be allowed to apply lethal force without human intervention?

Participants largely, though not unanimously, agreed that autonomous systems should have this capability. Increased lethality is one of their core operational advantages, and restricting their lethal autonomy would reduce battlefield effectiveness. Autonomous systems can make near-instant decisions, and any required human input would inherently slow them down. This time constraint may not only be theoretical, but existential. In a worst-case scenario where every millisecond counts, such as an ICBM intercept, human delays could have catastrophic consequences. This is especially critical given that launch points are no longer limited to traditional silos in adversary territory, but can now include bombers, submarines, or container ships transiting the Northwest Passage.

Participants noted that Canada has safely managed lethal autonomy for decades. Since their commissioning in 1992, Halifax-class frigates have had an auto-engage mode in their Combat Management Systems (CMS) to automatically detect, track, and engage hostile targets once pre-set criteria have been met.[1] By reacting to supersonic threats faster than any human operator, this capability exemplifies the fundamental value of autonomous systems. Discussions suggested that while the precedent for automated defence was well-established, there is hesitancy when extending this capability to proactive, offensive platforms. Officially, the CAF is committed to "maintaining appropriate human involvement in the use of military capabilities that can exert lethal force," enabling them to signal caution while retaining operational flexibility.[2]

Building on that discussion, another hypothetical question was raised: If adversaries were to deploy LAWS, should Canada match them or maintain a policy of human control, even if it means being at a military disadvantage? Though some argued that Canada should maintain a moral advantage over its adversaries by upholding a stricter policy of human oversight, most participants emphasized that operational effectiveness remains the primary determinant of national security. From this perspective, a system is engineered to achieve specific, predictable outcomes, and it is the fulfillment of that function which matters most. If Canada's deterrence is only as strong as its most capable systems, then restricting lethality may create a strategic vulnerability that far outweighs any perceived moral benefits of manual intervention.

Again, this debate is already familiar to Canadian defence policy. Since the 1980s, Canada has used 'fire-and-forget' Harpoon anti-ship missiles which use their own radar seeker to autonomously identify and strike targets once launched. Through rigorous testing, validation and the development of rules of engagement and release criteria, this level of lethal autonomy was deemed acceptable decades ago.

Accountability and Command Responsibility: In the event of a hypothetical system malfunction where a CAF autonomous system resulted in unintended civilian casualties, who should ultimately be held responsible? Though systems 'fail' or miss targets regularly, a malfunction in this context refers to unpredictable algorithmic behaviour that falls outside of established testing and validation parameters, rather than simple mechanical

[1] Department of National Defence, The Commissioning of HMCS Halifax (Ottawa: Government of Canada), 9, https://www.forposterity-sake.ca/RCN-DOCS/RCND0955.pdf.

[2] Department of National Defence, "A New Canadian Approach to Defence: Anticipate. Adapt. Act.," May 31, 2019, https://www.canada.ca/en/department-national-defence/corporate/reports-publications/canada-defence-policy/new-approach-defence.html.

issues.

From one perspective, this would be a government failure on account of their inability to create sufficient ethical, legal, and policy frameworks before deploying autonomous systems. Another perspective was that accountability should rest with the commander who authorized the mission or 'pushed the button' to activate the system. To that extent, what level of understanding should be required for commanders, especially as autonomous systems become increasingly complex and decisions are driven by internal algorithms?

Adding further complexity was the issue of proprietary technology. If the system was bought off-the-shelf and had a 'black box', external actors, including the commander and investigators, may never fully understand why the system made a specific decision. Without full transparency, some argued that assigning blame may be very difficult—liability might rest with the manufacturer, or ultimately with the government for procuring that system in the first place.

As before, this is not a new issue. The CAF's existing rules of engagement and release criteria are specifically designed to address these types of hypothetical situations and bridge any accountability gaps. Furthermore, as required by the Geneva Conventions, all new weapons undergo a rigorous Article 36 review, a legal audit to ensure a weapon can be used in compliance with international law. In relation to the 'black box' problem, the Harpoon missile's radar seeker contains proprietary technology whose lethal autonomy was deemed acceptable after rigorous testing. From this perspective, any hypothetical malfunction would be a question of negligence rather than a legal void. Did the commander follow the established doctrine and release criteria? If so, the failure is a technical mishap; if not, the responsibility is human.

Requirements for Domestic Competence

Digital Infrastructure and Data Sovereignty: A clear consensus emerged that Canada must strive for greater technological sovereignty in the autonomous systems domain. From a security perspective, reliance on foreign, off-the-shelf capabilities creates a technological dependence. In a worst-case scenario, this could leave Canada vulnerable to external actors withholding critical capabilities during a crisis.

Though it was recognized to be unrealistic, participants envisioned an ideal scenario similar to the American Joint All-Domain Command and Control (JADC2) with a sovereign software layer where autonomous battlefield assets could seamlessly share and act upon information in real-time.[3] Establishing Canadian-controlled infrastructure would better protect Canadian military data from adversarial interference and ensure that the underlying data architecture is secured to national standards. This would also bolster operational strength and resilience by facilitating integration across different capabilities, departments, and environments.

Additionally, visibility into the data and algorithms powering autonomous systems is a matter of trust. Having the power to audit these systems' internal logic would mitigate any 'black box' concerns, clarify lines of legal and command responsibility, and enable the government to refine policy frameworks surrounding the use of autonomous lethal force.

Leveraging Global Innovation: While the ideal example of total technological sovereignty would

[3] John R. Hoehn, Joint All-Domain Command and Control (JADC2), CRS In Focus IF11493 (Washington, DC: Congressional Research Service, updated January 21, 2022), https://sgp.fas.org/crs/natsec/IF11493.pdf.

maximize national security, discussions recognized that it is not a feasible or realistic strategy at this time. For example, Canada cannot replicate the massive capital expenditures—totalling hundreds of billions of dollars annually—of cloud 'hyperscalers' like Amazon, Microsoft, and Google.

However, falling further behind is not an option. To stay competitive both among allies and adversaries, Canada must leverage the world's best technology, but should not rely purely on off-the-shelf capabilities. Even when using foreign-built cloud foundations, Canada must focus its domestic industry on keeping those systems secure and tailoring them to the CAF's specific needs. This approach would stimulate homegrown innovation and reinforce a competitive domestic military industrial base.

Industry Collaboration: Discussions emphasized that such a shift would require the relationship between the CAF and industry to evolve beyond a simple buyer-seller dynamic. To overcome existing procurement barriers, participants envisioned a broader strategic ecosystem that would also include government and academia.

Critically, Canada must adopt a 'builder's mindset' and shift its focus from exhaustive planning to immediate action. Through 'learning-by-doing', the military can test equipment and understand what actually works, rather than spending years on theoretical requirements. The government would therefore act as a 'market maker', providing the predictable demand and testing environments—leveraging programs like Innovation for Defence Excellence and Security (IDEaS)—necessary to bridge the gap between prototype and deployment. This kind of collaborative ecosystem would create a mutually-reinforcing dynamic where the CAF provides greater opportunities for the private sector, who then bolster operational capabilities with faster innovation, while increased involvement from academia further refines R&D as well as the ethical and legal frameworks underpinning lethal autonomy.

Dual-Use Technology Strategy: If increased collaboration between the CAF and industry is a prerequisite for technological catch-up, discussions emphasized that Canada should prioritize the development of dual-use technologies with commercial and military utility. This is necessitated by the fact that the Canadian defence sector is behind the commercial sector in autonomous systems advancements. An increased focus on dual-use applications would allow the CAF to harness the rapid innovation cycles of the private sector, integrating commercial breakthroughs more efficiently than through isolated military R&D.

The status quo shows that relying exclusively on military procurement has proven insufficient to sustain a robust domestic defence industrial base. A dual-use strategy would enable Canadian companies to scale in commercial and defence markets simultaneously, keeping them viable and innovative between major defence contracts. This approach would also bolster Canada's economic and operational resilience. A domestic industry already producing high volumes of commercial autonomous units could more easily pivot to support military demand during a crisis.

Conclusion

The integration of autonomous systems into Canada's defence architecture is not merely a technological upgrade, but a strategic necessity. These systems offer a decisive advantage in speed, precision, and endurance, and are being employed by Canada's allies and adversaries alike. The CAF must find a way to effectively leverage these technologies in order to maintain operational relevance and keep pace with an increasingly volatile international security environment.

However, the path to adoption is fraught with

systemic friction. The urgent need for innovation is currently stalled by structural obstacles in the procurement process and a risk-averse institutional culture. These challenges must be weighed against the critical requirements of trust, accountability, and ethical use—especially as autonomous systems become more complex and integrated into command decisions. The risk of institutional paralysis remains high. If Canada cannot resolve these tensions, it may find itself at a severe disadvantage, unable to field the very systems required for its own national defence.

By shifting focus from planning to action and prioritizing a dual-use industrial strategy, Canada can build a foundation that supports both rapid innovation and rigorous ethical oversight. Ultimately, securing Canada's place in an era of autonomous warfare demands not only the adoption of new capabilities, but a long-term strategic commitment to furthering collaboration between the CAF, industry, government, and academia.

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