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Strengthening Canada's Air Defence:

A Cost-Effective Approach to Combat Modern Air Threats

If it flies, it dies.

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Introduction

Since the end of the Cold War, Western militaries have operated with a near absolute confidence in their ability to control the skies. As a result, many NATO members, including Canada, diminished their investment in ground-based Air Defence, leaving many without the capabilities needed to address modern air threats (Kieley, 2021). In 2012, the Canadian Army divested its last dedicated Air Defence platform, the Air Defence Anti-Tank System (ADATS), creating a substantial capability gap. Recent events in Ukraine and the Nagorno-Karabakh region have highlighted the necessity for affordable, adaptive, and multi-layered Air Defence systems in modern warfare (Shomooka, 2023). These conflicts show how massed salvos of uncrewed aerial vehicles (UAVs), cruise missiles, loitering munitions and one way attack(OWA) drones can overwhelm or circumvent defences that rely heavily on expensive systems or single layer defence (Goffus, 2024).

Although Canada has recently accelerated procurement of limited Air Defence systems for its troops deployed with NATO's Enhanced Forward Presence (eFP) in Latvia, these measures fail to address the entire range of current threats. This essay argues that Canada must improve its short and medium range Air Defence capability and develop cost effective kinetic solutions if it intends to meet its obligations at home and abroad. While acquisition of long-range interceptors or directed energy weapons (DEW) may remain out of reach for fiscal reasons, Canada must invest in cheaper, layered systems. Integrating short and medium range interceptors, self-propelled anti-aircraft guns (SPAAG), and multi sensor detection can substantially bolster Canada's credibility as a force and therefore its domestic security and its contribution to NATO's deterrence objectives in the Baltic region.

This essay begins with an overview of the evolving air threat environment, particularly emphasizing lessons learned from recent conflicts. It then examines Canada's commitments in Latvia under NATO's eFP framework and the implications of the current situation in the region to show the need for urgent action. Next, it discusses the current state of Canadian procurement, highlighting technical and doctrinal shortcomings. Finally, it presents recommendations for near-term, cost-effective solutions backed by insights from the ongoing war in Ukraine that prioritize affordability, interoperability, and survivability without exceeding Canada's budget constraints.

The Evolving Air Threats

1. Rapid Proliferation of UAVs and Loitering Munitions

The widespread availability of drone technologies has transformed the modern threat landscape (Molloy, 2024). In Ukraine, for instance, both sides have deployed large numbers of inexpensive, commercially adapted UAVs to conduct intelligence, surveillance, target acquisition, and reconnaissance (ISTAR), and to execute precision strikes, resulting in over 75% of casualties in the conflict. The challenge for defenders is that these small drones can be difficult to detect using radars and engaging them with expensive missiles skews the cost exchange ratio in favor of the attacker (Kunertova, 2023).

Loitering munitions and OWA drones push this challenge further. They can reach very long distances, fly at different altitudes and hover over a target area, only striking when a high value asset is identified. Operators can deliberately coordinate swarm attacks, launching multiple UAVs simultaneously from different axis to overwhelm defences that lack sufficient coverage or multi target engagement capabilities. Moreover, modern UAVs increasingly feature autonomous guidance or anti-jamming technologies (Buric & De Cubber, 2017), further tipping the advantage toward the attacker if defences rely on single layered, high-cost solutions.

2. Conventional Threats

Despite UAV proliferation, more traditional air and missile-based attacks remain a critical concern. A peer-on-peer conflict would see large salvos of ballistic and cruise missiles combined with UAV strikes in order to mass effectors in a short time to overwhelm Air Defences. In

Ukraine, Russia uses loitering munitions or small drones to exhaust Air Defence personnel and munitions. Over time, they learn the locations or vulnerabilities of defensive systems, then mount large scale attacks from multiple angles to saturate them (Boyarski, 2024).

Another notable development is the growing use of standoff munitions by both fixed wing and rotary wing platforms, allowing enemy aircraft to launch precision weapons from beyond the reach of Air Defence (Watling & Reynolds, 2023). While the likelihood of directly engaging the attacking aircraft is reduced, this tactic highlights the value of longer-range Air Defence systems as a deterrent preventing the platforms from entering contested airspace, and the need for low-cost interceptors against the munitions themselves.

3. Asymmetric UAV Employment

Just as state actors, so too can non-state actors or individuals leverage small, commercially available drones to disrupt both military and civilian operations (Miasnikov, 2005). Reports of UAVs disrupting civilian infrastructure like the Gatwick Airport incident demonstrate how cheap drones can impose disproportional operational and logistical costs (Pyrgies, 2019). In a military context, the mere presence of small, low flying drones can temporarily halt air traffic at Aerial Ports of Debarkation (APODs), limiting the arrival of personnel and materiel. In the Baltics, the eFP itself constitutes a trip-wire force to ensure NATO commits to Article 5 commitments should Russia invade, which means it depends heavily on follow-on reinforcements. Disruption of APODs and Sea Ports of Debarkation (SPODs) by drones or missiles could delay Allied forces, undermining the region's defence. Furthermore, even a modest UAV incursion can degrade overall air superiority if high value aircraft are unable to take off or land.

On Canadian soil, these same tactics could threaten Critical National Infrastructure (CNI), airports, or major public events. At present, Canada lacks the capacity to defend high-profile summits or sporting venues against malicious drone use, relying primarily on law enforcement who are ill-suited to counter swarms or sophisticated UAVs (Aksu et al., 2024).

Lessons from Ukraine

The ongoing war in Ukraine offers powerful lessons on staying ahead of the "cost curve" in Air Defence. High-end surface-to-air missiles like the Patriot system are vital for intercepting ballistic missiles and engaging ABT from afar, but they are too expensive to have everywhere. They also require protection by lower cost defences to handle smaller UAV and swarming threats (Boyarski, 2024). Ukraine's experience illustrates the necessity of adopting less expensive, more agile means of defeating large numbers of threats. These include:

1. **Multi-Sensor Detection:** Ukraine has adopted "Sky Fortress", an array of over 14000 acoustic sensors over their territory fused to provide real-time targeting information (Boyarski, 2024). These inexpensive, passive sensors can locate and classify threats based on their acoustic signature, being able to differentiate between target types and even between decoys and live threats. For 400-500$, these passive sensors can be used to cue active radars to increase Air Defences' survivability. (Carberry, 2024)

2. **Mobile Kill Teams:** Ukrainians are deploying light vehicles armed with heavy machine guns and searchlights to patrol areas vulnerable to drone incursions or cued by Sky Fortress through an IPAD app. This tactic, requiring minimal equipment cost and training, has proven effective against slow moving UAVs, even at night, forcing OWA drones to fly higher into radar and missile range. (Boyarski, 2024)

3. **Rapid adaptation:** According to Boyarski, the Chief Technology Adviser for the Air Defence office of Ukraine's Land Forces Command, Western militaries rely too heavily on costly, slow to adapt high-tech solutions, an approach he deems unsustainable in a peer-on-peer conflict. In contrast, Ukraine survives by constantly innovating and remaining operational despite high material losses. Boyarski describes warfare as a perpetual cycle of innovation and counter-innovation. For example, after Russia began flying drones at higher altitudes, Ukraine countered with helicopter-based kill teams, driving drones to vary their flight altitude again.

4. **Mass and Scale:** "In the industrial scale warfare, any war between large combatants that is not decided in its early campaigns will devolve into an industrial war of attrition." (Hecker, 2024). Winning a peer-on-peer conflict will depend on economic strength and resiliency. High intensity warfare will generate losses; we must ensure that we can sustain them.

5. **Camouflage, Concealment, and Dispersion:** The conflict demonstrates the important role of decoys to trick the opponent in engaging. Furthermore, Air Defences must be concealed, to avoid being easily targeted, and regularly move to avoid coordinated attacks (Goffus, 2024).

While advanced interception technologies such as high-power microwave or laser based directed energy weapons (DEW) are possible future solutions, they currently carry high procurement and maintenance costs (Tianfeng, 2023) and their effectiveness deteriorates in inclement weather. Ukraine's defence suggests that higher-end interceptors should be complemented by cheaper but effective gun based or man portable solutions. For Canada, the lesson is clear: a small number of advanced interceptors must be layered with cheaper man portable or gun-based solutions that can handle UAVs in mass, preventing adversaries from winning the cost exchange battle.

The Baltic Region and Canada's NATO Commitment

Within NATO's enhanced Forward Presence, Canada leads a multinational Brigade stationed in Latvia to deter Russian aggression. This mission places Canada's troops in close proximity to Russia's Western Military District and Kaliningrad, where Russia's A2AD systems create a layered defence bubble that extends into the Baltic states (Harper et al., 2018). In a crisis, Russia could open hostilities with a large-scale air campaign encompassing ballistic missiles, cruise missiles, glide bombs, and UAVs. Since Canadian forces in Latvia operate from known, unhardened garrisons, they could be primary targets in the early hours of a conflict. However, Harper et al. (2018) identifies Air Defence as the most critical gap in the Baltic region's capabilities.

The region's critical infrastructure also remains vulnerable. Reinforcement of Baltic states depends significantly on rapid deployment of air and naval assets from Western Europe. If Russia's salvos manage to disrupt or destroy APODs and Sea Ports of Debarkation (SPODs), NATO forces could be delayed or even prevented from marshaling the firepower necessary to defend the Baltics effectively (Harper et al., 2018). Without layered Air Defence assets pre-positioned in theater, an aggressor's surprise offensive could deal devastating blows to key nodes before Allied air power or additional ground forces can respond.

The Baltic Air Policing (BAP) mission has been operational since 2004, rotating allied fighter jets through Estonia and Lithuania. Its purpose is primarily to patrol airspace and respond to peacetime violations rather than to provide integrated Air Defence (Harper et al., 2018). In a full-scale conflict, the small number of BAP fighters would face overwhelming odds against the number of threats to intercept in a short time, especially through Russia's layered surface-to-air missile (SAM) systems and own fighter jets. Even if indicators and warning of a conflict could lead to a more robust posture in the region, we cannot rely on air power alone to defend against the onslaught. Furthermore, as mentioned by Poland's IAMD Division Chief Colonel Jaworski:" one week is not enough to integrate all Air Defence systems that would deploy in the theatre. We will only have minutes to respond to an initial Russian aggression" (Jaworski, 2024).

In effect, for deterrence to be credible and for a forward deployed force to survive the initial air attack, layered ground-based systems (short, medium, and inevitably long range) must already be in theatre.

Canada's Current Air Defence Posture and Procurement Gaps

The retirement of ADATS left the Canadian Army without a viable platform to counter UAVs, low flying aircraft, and helicopters (Shimooka, 2023). Recognizing the threat highlighted by recent conflicts, Canada has made purchases under Urgent Operational Requirements (UOR) specifically for its troops in Latvia. These include three different radio frequency (RF) and GPS jamming systems to intercept or disrupt basic commercial drones: the Orion H9, CACI BEAM3, and Falcon Shield (Government of Canada, 2023).

However, as UAVs become more autonomous, employing inertial navigation or advanced anti-jamming features, jamming alone becomes inadequate (Molloy, 2023). The war in Ukraine has shown that adversaries can outfit drones with fiber optic links, hardened guidance modules, or pre-programmed flight paths that circumvent RF or GPS interference. Furthermore, regulations restrict jamming outside deployed environments, as employing strong jamming domestically risks compromising civilian communications and navigation signals, making it a less flexible solution for protecting airports, infrastructure, or high-profile public events in Canada.

The Canadian Armed Forces is also procuring a limited number of RBS-70 systems, a Very Short-Range Air Defence (VSHORAD) missile system, for point defence. While the RBS-70 can be highly effective against low altitude threats, it can only engage a single target in line-of -sight which limits its utility in scenarios involving multiple inbound drones or munitions. With only one Troop in service, adversaries can bypass its limited engagement envelope by flying above its ceiling or saturating it with multiple UAVs unless it is paired with other systems.

According to Harper et al. (2018), "Air Defence is the biggest and most critical gap in military capabilities in the Baltic region". At present, Canada's RBS-70 Troop in Latvia is insufficient as it cannot be a credible deterrent by itself.

Recommendations for a Realistic Air Defence Posture

Modern air threats cannot be effectively countered by a single system (Nikolakakos, et al., 2021*)*. For Canada, whose defence budget cannot currently accommodate high altitude interceptors like the Patriot or THAAD, the optimal strategy is a layered, collaborative framework built around affordability and interoperability. The following recommendations are grounded in lessons from recent conflicts.

1. Acquire a Medium Range System

While long range interceptors may be out of reach, Canada can invest in existing Medium Range Air Defence (MRAD) platforms, like the NASAMS or IRIS-T. These platforms use proven interceptors that are less expensive than high altitude missile defence systems but still effective

against cruise missiles, air breathing threats (ABT) and higher-flying UAVs. An MRAD layer would complement VSHORAD systems like RBS-70, filling a gap that currently leaves Canada's forces vulnerable. While this option involves a significant upfront cost, Canada needs something that can engage threats beyond visual range and deny enemy aircraft the freedom to operate. This is the backbone of any credible deterrence.

Procuring an MRAD as soon as possible is also about rebuilding expertise, relearning how to operate in a modern air defence network, and regaining our credibility as a serious contributor to NATO operations. Acquiring the knowledge and training to effectively use and integrate these systems would take years. Deploying a limited number of MRAD batteries alongside NATO allies in Latvia would not only help deter aggression, but also help quickly learn from other nations while integrating within NATO's Integrated Air and Missile Defence System (NATINAMDS). Ballistic Missiles would remain a threat to critical national infrastructure (CNI) that Canada is unable to fully mitigate within its current budget, but mobile forces can reduce their vulnerability through dispersal and mobility. An MRAD system would make the Canadian Armed Forces (CAF) a credible force and a useful ally to have in any high intensity conflict.

2. Integrate Gun Based or Other Low-Cost Interceptors

Alongside MRAD systems, Canada can bolster its ability to address UAVs and low flying air threats through Self-Propelled Anti-Aircraft Guns (SPAAG). SPAAG platforms combine a rapid-fire cannon (or twin cannons) with onboard sensors, providing a quick and cost-effective mean of dealing with UAVs and low flying ABT threats (Watling & Bronk, 2024). For instance, mounting sensors paired with a 35 or 30mm cannon on a chassis such as the Light Armoured Vehicle (LAV) would allow the system to move with mechanized troops, protecting maneuver elements from air threats while being able to provide direct fire support in a fire base. Critically, the cost per engagement of a cannon-based system is typically much lower than using surface-to-air missiles. This emphasis on a "right effector for the right threat" philosophy helps us remain on the favorable side of the cost curve.

As already discussed, UAVs are a highly cost-effective effector, but they can also serve as interceptor platforms to neutralize incoming threats. Ukraine is currently operating interceptor-drones, using purpose-built UAVs to destroy enemy drones and missiles with notable success. While NATO allies have yet to field such systems at scale, Canada can carve a niche by focusing on the integration and large-scale deployment of interceptor drones within its armed forces, leveraging Ukrainian lessons to bolster allied air-defence capabilities. By doing so, we would establish ourselves as NATO's go-to experts in affordable, large-scale drone warfare, filling a critical niche at minimal cost.

3. Improve Detection with Multi-Sensor Networks

Effective interception depends on early and accurate detection. Canada's reliance on large, ground based radars raise survival concerns in high intensity conflict. Cost-effective ways to improve early warning include:

- **Acoustic Sensors:** Passive networks modeled on Ukraine's "sky fortress" concept, where thousands of inexpensive acoustic sensors provide enhanced situational awareness for less than the cost of a pair of Patriot missiles.
- **Tethered Aerostats:** Elevating a lightweight radar on an aerostat extends coverage above forest lines, acting as a more affordable analog to Airborne Warning and Control Systems (AWACS).
- **Electro-Optical/Infrared (EO/IR):** While standard in many direct fire systems, EO/IR sensors can also tie into a broader surveillance network to monitor low altitude UAVs or other incoming threats (Slyuasar, 2023).

Combining these sensors in a cohesive command and control (C2) system means Canada can conserve costly interceptors for the right threats. A mesh approach, incorporating multiple passive and active sensors, acts as a force multiplier and reduces the risk that a radar becomes an easily targeted emitter.

4. Emphasize Passive Air Defence

Air defence is not only about intercepting projectiles or platforms in flight; it also involves minimizing the damage if an attack does succeed. Dispersing key assets, hardening critical infrastructure, and applying thorough camouflage can substantially reduce target vulnerability. In Latvia, Canadian forces are often stationed in known, unhardened locations, which makes them vulnerable to a first strike. Although intelligence indicators might provide some warning, Ukraine's recent incursion into Russia's Kursk region highlights that strategic and operational deception remains possible in modern warfare.

- **Dispersion and Mobility:** Instead of centralized depots on bases, critical assets should move frequently in order to defeat the enemy's targeting cycle.
- **Camouflage and Decoys:** Inflatable decoys and dummy radar emissions can mislead enemy intelligence, forcing them to expend munitions and unmask their effectors.
- **Hardening:** Reinforced bunkers and shelters protect personnel and equipment against near misses or smaller warheads.

Many of these passive measures are inexpensive compared to the procurement of new systems and can therefore offer immediate enhancements to survivability.

5. Procurement and Doctrine

Recent conflicts demonstrate that adaptation speed is as crucial as the technology itself. Canada's existing procurement processes, while designed to maintain transparency and accountability, often move too slowly to keep pace with emerging threats (Department of National Defence, 2024). A more agile approach could include:

- **Incremental Upgrades:** Purchasing a proven system to fill a capability gap, then upgrading hardware or software to match specific Canadian requirements, rather than starting a new acquisition from scratch.
- **International Industry Partnerships:** Collaborating with private industry for fast integration of commercial off-the-shelf (COTS) technologies, even if the companies are

outside of the country.

- **Doctrinal Alignment:** Updating Air Defence doctrine to incorporate lessons learned from Ukraine and ensuring interoperability with NATO's existing structures.

To enhance interoperability, any system Canada procures should be fully capable of linking into NATO's broader Integrated Air and Missile Defence (IAMD) System. Common data links, shared situational awareness software, and joint training exercises all help ensure that Canadian assets can operate effectively with allied forces.

Conclusion

For decades, Canada implicitly relied on allied air dominance to safeguard against air threats. This assumption has weakened in the face of rising threats ranging from massed cost-effective UAV attacks to advanced ballistic and cruise missiles.

Canada's role in the Enhanced Forward Presence in Latvia places its troops on NATO's eastern front, where they would be among the first to confront any overt Russian aggression. However, Canada's current Air Defence posture falls short against the broad spectrum of threats in modern warfare. While long range interceptors and DEW programs remain out of financial reach, Canada must think of cost-effective ways to bolster its Air Defence. This involves procuring an MRAD system, cheap kinetic interceptors and robust detection networks, but it also includes doctrinal reforms to better integrate with our allies and reemphasizing passive measures such as dispersion, camouflage, and hardening.

To facilitate these changes, Canada must streamline its procurement process. The ongoing war in Ukraine shows that threats evolve more quickly than Canada's procurement timelines allow. To catch up, the country must develop a better rapid acquisition model and leverage COTS technology. All new acquisitions would need to integrate with NATO's IAMD, ensuring the CAF adds value to the alliance while benefiting from shared expertise and resources.

Finally, while hardware solutions are critical, training, doctrine, and leadership cannot be overlooked. A robust Air Defence posture depends on well-trained operators and commanders capable of coordinating and adapting effectively. Canada must participate in joint Air Defence

exercises with allies to build shared understanding, standardize procedures, integrate in existing structures, and train at a scale beyond its own capacity. These exercises are especially valuable in bridging the knowledge gap left by decades of disinvestment.

In conclusion, Canada's must recognize that the era of unchallenged air superiority is likely over. If Canada aims to protect its forces, fulfill its commitments in NATO, and maintain credibility on the global stage, it must embrace a balanced and integrated Air Defence strategy; one that couples mid-range systems with low-cost kinetic interceptors, cutting-edge but practical sensors, and agile, survivable forces on the ground. Through such measures, Canada can significantly enhance its readiness to confront the emerging threats of modern warfare, safeguarding both its domestic interests and its commitments on NATO's eastern flank.

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