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Key Points

The Arctic is the preeminent staging ground for adversary missile attacks because it is the most direct route from Moscow or Beijing to Washington DC, and both Russia and China are subsequently taking steps to increase their foothold in the Arctic.

The size of the Arctic, and the potential for large, unpredictable missile raids, creates a need for new "left-of-launch" capabilities, such as increased domain awareness, to give U.S. leaders more options in a crisis.

The Department of Defense (DOD) should launch a joint capability technology demonstration to identify promising Arctic missile defeat efforts.

DOD and Congress should establish a North American Defense Initiative to fund Arctic domain awareness and infrastructure upgrades.

The Air Force should exploit existing weapon systems including Air National Guard MQ-9 Reapers and accelerate procurement of new systems to bolster Arctic domain awareness.

DOD should continue collaboration with the commercial space sector to enhance Arctic communications and reconnaissance.

The United States should encourage allies and partners to develop more missile defeat capabilities by offering incentives such as partnerships and intelligence exchanges.

Bolstering Arctic Domain Awareness to Deter Air & Missile Threats to the Homeland

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Abstract

The North American Aerospace Defense Command (NORAD), as a combined U.S.-Canada command charged with aerospace warning, aerospace control, and maritime warning in the defense of North America, identifies cruise missile attacks as a serious threat to the U.S. homeland.[1] Russia and China continue to diversify their arsenals of guided missiles, which can fly at low altitudes, have unpredictable flight paths, may reach hypersonic speeds, and be launched from air, sea, or subsurface platforms.

The Arctic has remained an attractive attack vector for both U.S. and Russian long-range aviation and missiles since the earliest days of the Cold War. The growing Arctic presence of China, a self-proclaimed "near-Arctic state" possessing an increasingly robust long-range aviation and missile inventory, reinforces the region's significance as a staging ground for air and cruise missile attacks.

The U.S. Department of Defense continues to invest billions to defend against limited ballistic missile attacks, but the U.S. military's ability to detect, track, and defeat a cruise missile strike emanating from the Arctic has degraded significantly over the past 30 years. China or Russia could exploit this shortfall using conventional cruise missile attacks to deal a quick blow that keeps U.S. military forces at distance and avoid a nuclear response.

Bolstering deterrence against conventional air and cruise missile threats in the Arctic starts by improving U.S., ally, and partner domain awareness and information dominance capabilities. Adversaries will be disinclined to launch strikes on the U.S. homeland if they know the United States is anticipating the attack and creating options to dissuade it. Achieving better domain awareness involves efforts to provide indications and warning of attacks through the detection, tracking, characterization, warning, and attribution of modern threats.[2] Establishing information dominance enables U.S. leaders to access decision-quality information more quickly than adversaries. Domain awareness and information dominance can underwrite a comprehensive "missile defeat" strategy, left and right of launch, that gives U.S. leaders more options to deter an attack on the U.S. homeland.

Introduction

In keeping with his penchant for making bold predictions about the future of airpower, Army Air Corps Brigadier General William "Billy" Mitchell told a U.S. Senate Committee in 1935 that Alaska would become "the most important strategic place in the world."[3] In the mind of Mitchell, widely considered the father of the U.S. Air Force, the reason for the strategic significance of Alaska, and the Arctic more broadly, came down to its accessibility by air. By Mitchell's calculations, U.S. Army aircraft of the time could reach any capital in the Northern Hemisphere within nine hours.[4] He also warned that the dawn of aviation would allow adversaries to capitalize on new attack vectors through the Arctic because of the short, direct aviation routes between the United States and Eurasia, particularly between Alaska and Siberia. In his 1930 book, *Skyways*, Mitchell warned, "It is along these lines that future invasions will come because they are the shortest lines and aircraft will fly directly along them."[5]

Today, Mitchell's predictions regarding the strategic significance of the northern approaches seem even more prescient. The shortest path by air to North America for Russian or Chinese missiles, fighters, and bombers is still over the polar region. Both have diversified their cruise missile arsenals and expanded their ability to launch cruise missile strikes on the continental United States from the air, sea, and land (see Figure 2).

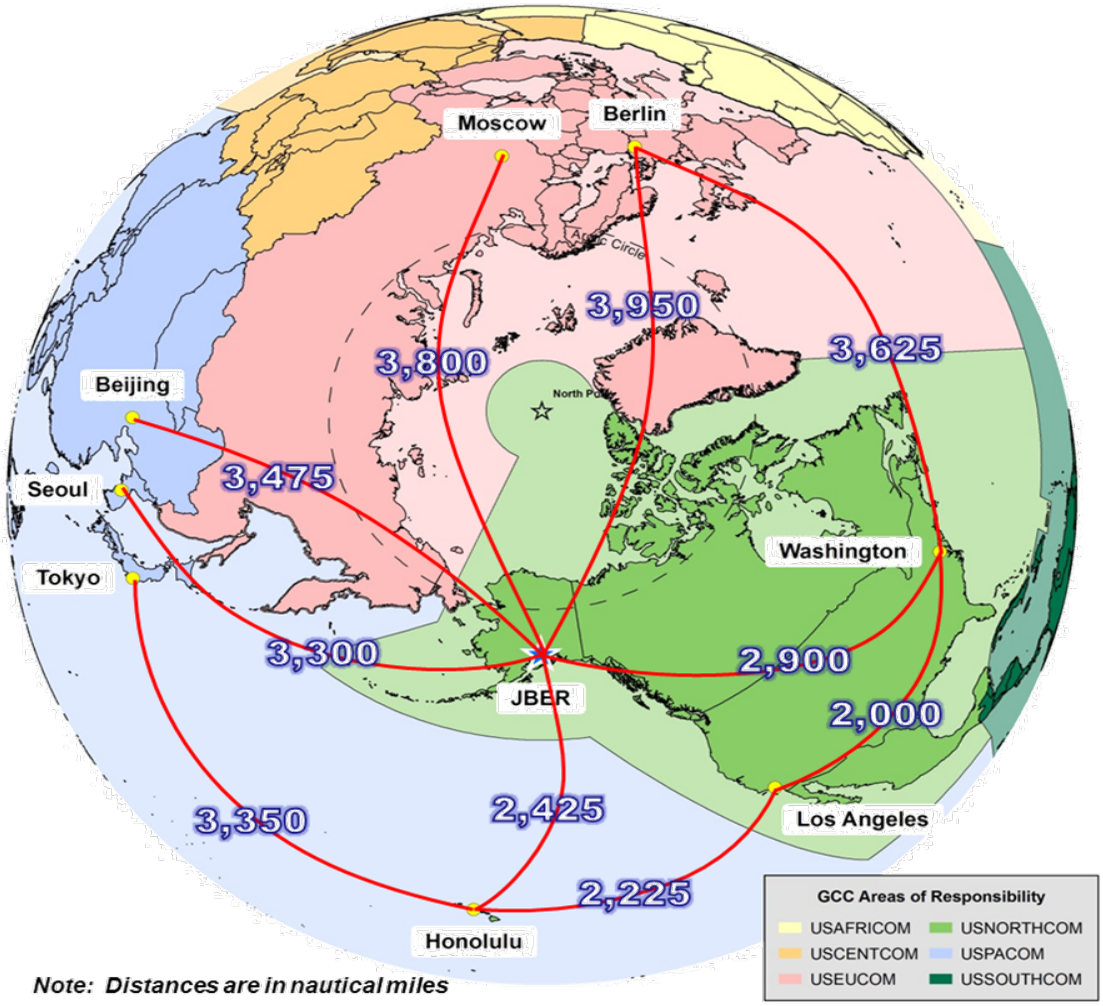

Figure 1: Distances between Alaska and major global capital cities, illustrating its accessibility by air.

Source: Graphic courtesy of North American Aerospace Defense Command [NORAD]; available in "The Department of the Air Force Arctic Strategy," U.S. Air Force, July 21, 2020, p. 9.

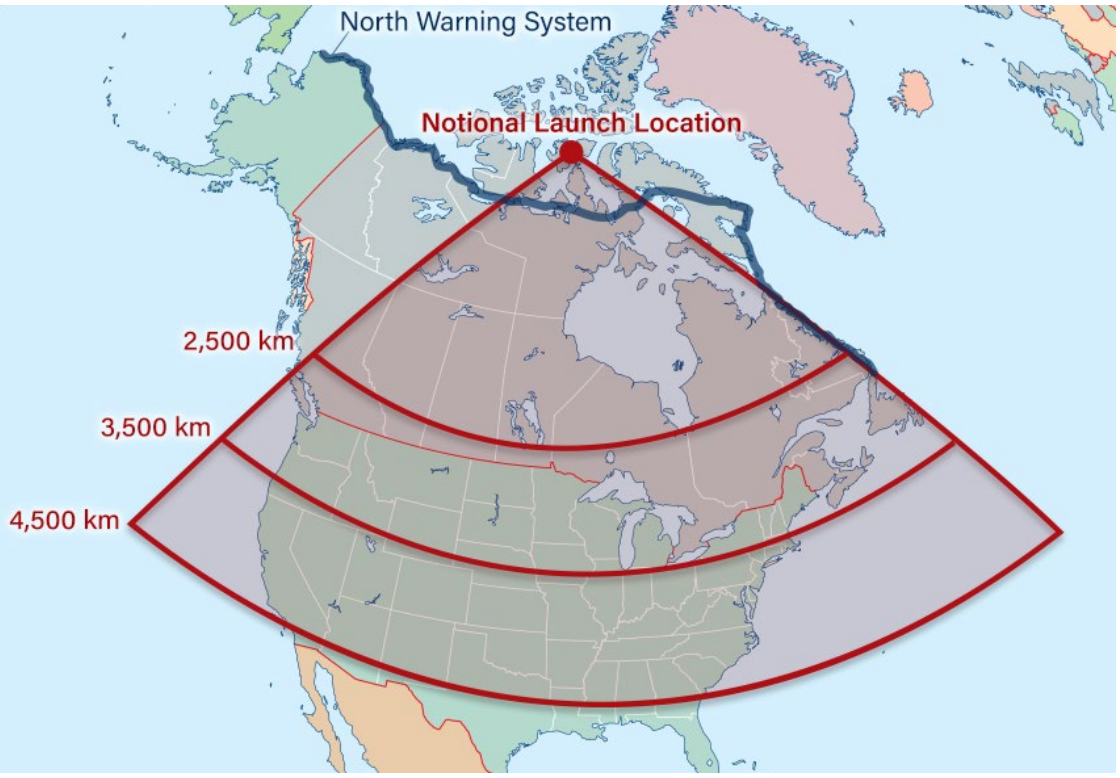

Figure 2: Overlay of Arctic missile launch ranges on U.S. and Canadian territory. This graphic depicts one example of how a cruise missile launched from a notional location in the Arctic might range a wide swath of US territory.

Source: Mitchell Institute based on Tom Karako et al., *North America Is a Region, Too* (Washington, DC: Center for Strategic and International Studies [CSIS], July 14, 2022), p. 5.

Yet, the U.S. ability to detect, track, attribute, and counter these attacks has significantly diminished since the end of the Cold War. This reality was laid bare to the American public in January 2023, when a Chinese spy balloon entered U.S. airspace north of Alaska and drifted across the entire country before NORAD shot it down. General Glen VanHerck, Commander of U.S. Northern Command and NORAD, later testified to Congress that four Chinese surveillance balloons had previously transited U.S. airspace undetected: "That's a domain awareness gap we'll have to figure out," he told lawmakers.[6]

This paper examines the strategic implications of growing air and cruise missile threats emanating from the high north, as well as potential near-term approaches to address those threats. Mitchell Institute met with over a dozen NORAD/NORTHCOM personnel in Colorado Springs, CO in March 2023, interviewed experts from industry and academia, conducted a review of government budget and strategy documents, and digested contemporary academic and policy papers to address three core questions:

- To what extent do Russian and Chinese interests and missile capabilities in the Arctic pose a threat to the U.S. homeland?
- How and why is the U.S. approach to deterring air and cruise missile threats in the Arctic changing, and what are the risks and benefits of that approach?
- What steps can the United States take to bolster deterrence in the Arctic region, and what are some specific capabilities needed to do so?

Importantly, analysis revealed that Arctic domain awareness and information dominance should be a top DOD priority now, not in a decade or more, to shore up cruise missile defense of the homeland. The United

Figure 3: View from a U-2 of the Chinese balloon intercepted and shot down by NORAD in January 2023.

Credit: Photo courtesy of the Department of Defense.

States and Canada have tentative plans to field additional over-the-horizon radars (OTHR) that can detect a broad swath of threats like bombers flying at medium altitudes, low-flying cruise missiles, and even surface ships in the next five to ten years.[7] But the risk that adversaries could turn regional conflicts into global ones already exists today—whether it is through kinetic cruise missile attacks, non-kinetic cyberattacks, or even provocative ISR overflights of the U.S. homeland that lead to inadvertent escalation or miscalculation.

Russia and, increasingly, China are building up capabilities to deal the United States a quick, painful blow specifically designed to coerce the U.S. Government to abstain from further involvement without provoking a nuclear response. China and Russia's development of longer-range weapons, combined with new capabilities to strike through cyberspace and space, is specifically aimed to help them achieve this goal. The DOD must find new ways to deter and defeat these threats that may be conventional in character but can have long-lasting, even existential, strategic effects on the United States, its allies, and its partners.

Unfortunately, completing kill chains against cruise missiles that can maneuver and fly at low altitudes is notoriously difficult. Cruise missiles can be difficult to detect from a distance, which reduces time and options to counter them. Even if they are detected and attributed in time to act, it is resource-intensive to shoot them down using DOD's current kinetic defenses, which tend to be expensive and create an unfavorable cost-exchange ratio. As subsonic garden-variety cruise missiles continue to evolve and proliferate globally, other air and missile threats, including hypersonic and ballistic missiles, uninhabited aircraft, and even China's fractional orbital bombardment system (FOBs), are posing increasingly complex challenges to U.S. homeland defense.

To deal with these threats, U.S. defense leaders have gradually adopted a new emphasis over the last decade on a holistic concept called "missile defeat."[8] Rather than narrowly focusing on kinetic kill options to deny adversary attacks, missile defeat involves using the entire spectrum of options to prevent and defeat missile threats, from countering proliferation to early indications and warning

and, of course, detection, tracking, and intercepting cruise missiles. It also seeks to integrate defensive, offensive, passive, kinetic, and non-kinetic capabilities, the latter of which could include cyber warfare, directed energy, and electronic attacks (see Figure 4).[9]

NORAD, which has more than half its area of responsibility focused on the Arctic, mainly channels its missile defeat efforts into detecting threats as early and proactively as possible. To this end, NORAD/U.S. Northern Command, have made "all domain awareness" a top priority. As applied to air and missile threats, the term describes all efforts to enable "indications and warnings through detection, tracking, identification, characterization, warning and attribution."[10] The goal of this "left-of-launch" approach is to expand decision space for senior U.S. leaders so they are not left with only highly escalatory response options, such as preemptive or retaliatory strikes.[11] Gen VanHerck describes the ability to give U.S. decisionmakers the information needed to expand their options as "information dominance" and argues that increased domain awareness, when combined with information dominance, will lead to enhanced deterrence.[12]

Over, Through, & Under: Russian & Chinese Threats from the Northern Approaches

To what extent do Russian and Chinese interests and missile capabilities in the Arctic pose a threat to the U.S. homeland? Homeland defense, defined as "the protection of U.S. sovereignty, territory, domestic population, and critical defense infrastructure against external threats and aggression, or other threats as directed by the President," is the responsibility of the U.S. Department of Defense.[13] Adversaries that pose the most credible and stressing threats to U.S. national security generally meet three criteria: 1) their objectives are adversarial to U.S. interests; 2) their actions threaten important U.S. interests; and 3) they possess the significant military capabilities necessary to follow through on those hostile intentions.[14] In the Arctic region, both Russia and, increasingly, China fit these criteria and therefore pose a serious challenge for U.S. homeland defense strategy and force planning.

Missile Defeat vs. Missile Defense

Comprehensive missile defeat, as defined by Assistant Secretary of Defense for Space and Missile Defense Policy John Plumb, encompasses the "full spectrum—how do you prevent and defeat adversary missiles in all domains along all timelines with both kinetic and non-kinetic capabilities."

Missile defense is an important component of missile defeat. It encompasses the mechanical process of finding, fixing, tracking, targeting, and, if required, destroying a hostile missile after it has launched. Missile defense capabilities thus include everything from missile warning and tracking satellites and ground-based sensors to electronic warfare, cyber capabilities, and kinetic interceptors. They do not, however, encompass the tracking of enemy ground, ship, subsurface, or air launchers.

Source: CSIS, "The 2022 Missile Defense Review: A conversation with John Plumb," November 14, 2022.

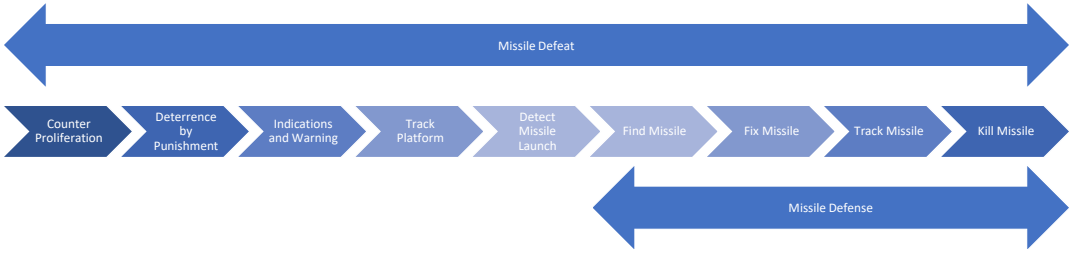

Figure 4: Comparing missile defense and missile defeat.

Credit: Mitchell Institute

Figure 5: Force planning is conducted against threats that overlap in three key areas.

Source: Adapted from David Ochmanek and Stephen Hosmer, "The Context of Defense Planning: The Environment, Strategy and Missions," in David Ochmanek and Zalmay Khalilzad, eds., *Strategic Appraisal 1997: Strategy and Defense Planning for the 21st Century* (Santa Monica, CA: RAND Corporation, 1997), p. 53, "A Framework for Classifying Threats."

Russian & Chinese Arctic Activities Threaten the U.S. Homeland

The Arctic consists of the Arctic Ocean, adjacent seas, and parts of eight nations: Canada, the Kingdom of Denmark (including Greenland), Finland, Iceland, Norway, Russia, Sweden and the United States.[15] Yet, despite the Arctic's geographic size, proximity to U.S. territory, and role as a staging ground for offensive missile strikes, the 2022 National Defense Strategy warns that "U.S. activities and posture in the Arctic should be calibrated, as the Department preserves its focus on the Indo-Pacific region."[16]

A central goal of U.S. efforts to bolster deterrence is focused on dissuading China or Russia from attempting to rapidly seize the territory of a U.S. ally or partner like Taiwan or one or more of the Baltic states.[17] So it is a natural and appropriate result that, today, the center of gravity for great power competition and conflict is in these adversaries' near peripheries in the Indo-Pacific and Europe.[18] But China and Russia and other adversaries also recognize America's power projection advantages and are developing strategies and doctrine around cruise missiles and other long-range capabilities to prevent the U.S. forces from deploying abroad in the first place.

The high north is becoming an increasingly attractive vector for Russian and Chinese missile strikes on the U.S. homeland. More than half the Arctic coastline is sovereign Russian territory.[19] Russia is modernizing its military bases and airfields, deploying new coastal air defenses and submarines, and increasing its military exercises and training within its 5th Military District, Moscow's Arctic combatant command.[20] China now self identifies as a "near-Arctic state," has expanded Arctic scientific research activities that have military applications, invested more than $90 billion in Arctic infrastructure projects, and stated its intent to build a "polar silk road."[21]

Moscow and Beijing can exploit their Arctic footholds to launch air and cruise missile strikes that can reach targets in nearly every U.S. state. Growing U.S. Government concern about cruise missile threats emanating from northern approaches is reflected in DOD's 2022 Missile Defense Strategy, which identifies the U.S.-Canada partnership through NORAD as the backbone of efforts to improve early warning surveillance of "increasingly sophisticated conventional missile capabilities that are able to target critical infrastructure in North America."[22]

Over the last three decades, conventional missiles of all types have become weapons of choice for U.S. adversaries. Since the 1990s, China and Russia have explored options to employ long-range, conventional weapons to deter U.S. leaders without provoking a nuclear response. Chinese doctrine describes precision strikes as a means of "war control" to manage escalation and frames power-projection nodes, such as Air Force and Navy bases in Guam that are in the range of China's DF-26 ballistic missiles, as sources of U.S. vulnerability in warfare.[23] In 2017, China deployed its DF-17 ballistic missile,

Nation of Origin	Missile Name	Launch Mode	Warhead	Range	Targets
Russia	3M-14 Kalibr (SS-N-30A)	Ship and submarine	Conventional and reported nuclear	1,500 - 2,500 km	Ground
Russia	3M-54 Kalibr/Club (SS-N-27 "Sizzler")	Submarine	Conventional	220 - 300 km	Ships
Russia	9M729 (SSC-8)	Ground	Conventional or low yield nuclear	2,500 km	Ground
Russia	Kh-101 / Kh-102	Air	Conventional or low yield nuclear	2,500 - 2,800 km	Ground
Russia	Kh-55 (AS-15 "Kent")	Air	Conventional or low yield nuclear	2,500 km	Ground
Russia	Kh-555	Air	Conventional	3,500 km	Ground
Russia	P-800 Oniks/Yakhont/Bastion (SS-N-26 "Strobile")/3M-55	Air, ship, submarine, and ground	Conventional	300 km	Ship and Ground
Russia	RK-55 Granat (SS-N-21 "Sampson")	Submarine	Conventional	2, 400 km	Ground
Russia	P-15 Termit (SS-N-2 Styx)	Ships	Conventional	30-80 km	Ships
Russia	P-120 Malakhit (SS-N-9 Siren)	Ships	Conventional or low yield nuclear	110 km	Ships
Russia	P-270 Moskit (SS-N-22 Sunburn)	Air, sea, and ground	Conventional or low yield nuclear	120 km	Ships
Russia	P-500 Bazalt (SS-N-12 Sandbox)	Ships and submarine	Conventional or low yield nuclear	550 km	Ships
Russia	P-700 Granit (SS-N-19 Shipwreck)	Ship and submarine	Conventional or low yield nuclear	625 km	Ships
Russia	KH-35 (SS-N-25 Switchblade)	Air, sea, and ground	Conventional	300 km	Ships
Russia	P-1000 Vulkan	Submarine	Conventional	550-700 km	Ships
Russia	*Burevestinik Nuclear Powered Cruise Missile*	Ground	Unknown	Unknown	Ground
Russia	*Tsirkon (Ziricon) Hypersonic Cruise Missile*	Air, submarine, and ground	Unknown	1,000 km	Ships
Russia	9M727	Ground	Conventional	500 km	Ground
Russia	9M728	Ground	Conventional or low yield nuclear	50-2,500 km	Ground
Russia	9M729 (SSC-8)	Ground	Conventional	50-2,500 km	Ground
Russia	Kh-22 (AS-4 Kitchen)	Air	Conventional	460-500 km	Ships and Ground
China	HN 1	Air and ground	Conventional or nuclear	600-650 km	Ground
China	HN 2	Ship, submarine, and ground	Conventional or nuclear	1,400-1,800 km	Ground
China	HN 3	Ship , submarine, and ground	Conventional or nuclear	1,800-3,000 km	Ground
China	CJ-20	Air	Conventional and possibly nuclear	1,500-2,000 km missile + 3,500 H6K combat radius	Ground
China	CJ-10	Ground	Conventional or low yield nuclear	2,000 km	Ground
China	YJ-63	Air	Conventional or low yield nuclear	200 km missile + 3,500 km H6K combat radius	Ground
China	YJ-12	Air	Conventional or low yield nuclear	460 km missle + 3,500 km H6K combat radius	Ship
China	YJ-18 A	Ship	Conventional	540 km	Ship
China	YJ-18 B	Submarine	Conventional	540 km	Ground
China	YJ-18 C	Shipping containers	Conventional	540 km	Ground

Table 1: Inventory of Russian and Chinese cruise missiles. Red text indicates cruise missiles that Russia is employing against Ukraine, and red italicized text indicates cruise missiles that have successfully penetrated Ukrainian air defenses according to press reports.

Source: Mitchell Institute analysis of sources including "Missiles of the World," CSIS Missile Defense Project; and "Today's Missile Threat," Missile Defense Advocacy Alliance.

reportedly with approval from Moscow, along its border with Russia where it could reach the U.S. homeland via the polar region while remaining outside the range of Navy Aegis anti-ballistic missile ships in the Pacific.[24] Missile warfare is becoming a premier means for Russia to project power; in Ukraine, Russia has launched hundreds of ballistic and cruise missiles, as well as suicide drones, targeting power grids and other critical infrastructure in an attempt to force Kyiv into a settlement.[25]

Given adversaries' growing interest in employing missiles for a quick, low-cost advantage, it's perhaps not surprising that missile-related threats to the U.S. homeland have, as the *2022 Missile Defense Review* noted, "rapidly expanded in quantity, diversity, and sophistication."[26] Modern conventional cruise missiles are the most rapidly growing threat in terms of numbers and employment because they are harder to detect, track, target, and intercept compared to ballistic missiles.[27]

The operational advantages of cruise missiles can best be understood by comparing them to ballistic missiles. Cruise missiles generally cost less than ballistic missiles.[28] They are also highly maneuverable, in contrast to ballistic missiles, which fly a predictable ballistic trajectory that can be detected from thousands of miles away. Cruise missiles are also harder to detect because they can fly at low altitudes below the scans of surface radars and take advantage of ground clutter to obscure their signatures. Finally, subsonic cruise missiles, which constitute the great majority of current cruise missile inventories, are harder to detect because they do not produce significant infrared signatures. Cruise missile rocket boosters are small and burn for only a few seconds, and air-launched subsonic cruise missiles would not even need a rocket booster.[29] This means cruise missiles may not be detectable by existing space-based missile detection and warning systems, which were designed to detect ballistic missiles with a bigger heat signature during the Cold War era.[30]

Because cruise missiles greatly complicate detection and early warning, adversaries have begun to favor their development over continued ballistic missile development. The trend is part of a broader one that favors increasingly maneuverable designs, to include not just conventional cruise missiles, but other types as well. These include hypersonic cruise missiles, which fly above Mach 5 and trade a larger heat signature and less maneuverability for higher speed. And then there is China's fractional orbital bombardment system, or (FOBS), which launches a highly maneuverable hypersonic glide missile into orbit and then de-orbits it into the earth's atmosphere on an unpredictable trajectory. Overall, these trends suggest that adversaries are developing missiles with a spectrum of attributes specifically designed to impose increasingly tough operational problems on U.S., allied, and partner missile defenses.[31]

The attributes of cruise missiles make them particularly attractive options for long-range strikes, and their relatively low cost means adversaries can access them at scale and may be more willing to expend them to deter U.S. leadership below the nuclear threshold. On the higher end of the missile spectrum, to include ballistic missiles, more sophisticated hypersonic cruise missiles, and FOBs, weapon costs increase with their capability. Adversaries will have fewer of these assets and may prefer to hold them for actions that are higher on the escalation ladder, to include offensive and retaliatory nuclear strikes.

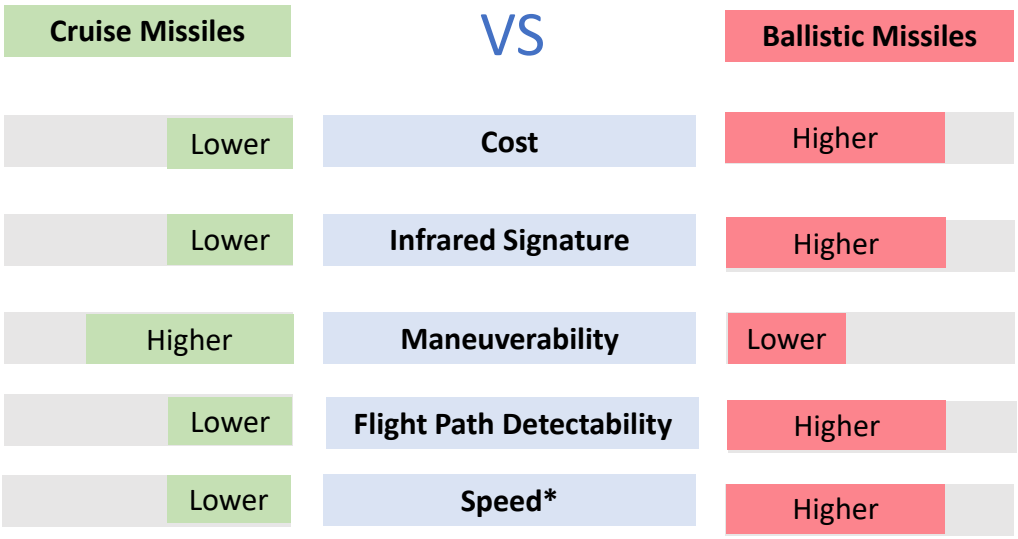

Figure 6: Comparing the basic attributes of cruise missiles and ballistic missiles. *Hypersonic cruise missiles are faster than garden-variety cruise missiles and can be faster than some ballistic missiles.

Credit: Mitchell Institute

On the lower end of the threat spectrum, drones are joining cruise missiles in becoming a weapon of choice against high-value targets. The alleged Ukrainian drone attack on the Kremlin in May 2023 is just one example of this.[32] The maneuverability and range limitations of the great majority of drones worldwide may make them less attractive weapons for very long-range attacks on the U.S. homeland, but those limitations are starting to diminish as militaries pursue increasingly capable drone technologies.[33] Furthermore, other launch platforms can be employed to mitigate these range constraints. China, in particular, has shown an interest in using so-called drone "mother ships" to launch swarms of drones closer to U.S. military assets.[34]

The mother ship example highlights another key operational advantage of cruise missiles and drones: militaries can extend their range by launching them from the air and sea using assets closer to the U.S. homeland. Compatibility with multiple launch platforms not only effectively provides additional options to extend their range but also increases the uncertainty about attack vectors across domains. The expanding menu of launch platforms also makes attribution of cruise missile attacks more difficult. Imagine a foreign-flagged container ship launching cruise missiles right off the East Coast of the United States on behalf of China or Russia: the possibility of launching cruise missiles and their cousins from multiple platforms creates a 360-degree surveillance problem for NORAD and dramatically complicates decision-making for American leaders during a crisis. As a result, both China and Russia are aggressively pursuing new launch platforms and alternatives to hold the U.S. homeland at risk from multiple vectors, including its northern approaches.

Cruise Missile Employment Options in the High North

In the air domain, Air Force intercepts of Russian aircraft entering the Alaska Air Defense Identification Zone (ADIZ), which extends 200 nm from Alaska into international airspace, increased sixfold from 10 intercepts in 2015 to 60 in 2020.[35] Moscow is now also fielding a new AS-23A cruise missile with an extended range that will allow Russian bombers flying well outside NORAD radar coverage to threaten targets in North America.[36] Furthermore, a Russian Arctic military exercise in 2022 included live-fire cruise missile launches designed to test Moscow's readiness for conflict in the high north.[37] China, meanwhile, is developing an aerial refueling capability for its H-6 bombers that could theoretically extend their range far enough to launch cruise missile attacks on U.S. territory.[38]

From the maritime approaches, the waters between Greenland, Iceland, and the UK—known as the G-I-UK gap—are currently the only way for Russia's northern-based ships and submarines to reach the Atlantic. In the next two years, Russia could have operational *Severodvinsk* class conventional and nuclear-capable cruise missile submarines that can transit that gap and persistently patrol the east and west coastlines of the United States.[39] The Bering Strait is a second, and often overlooked, maritime approach that offers China its most direct access to the Arctic. In 2021, Chinese warships were spotted operating in off the coast of Kiska, the United States' westernmost Aleutian Island.[40] In recent years, Beijing has focused heavily on the development of air-launched and sea-launched anti-ship cruise missiles for the purpose of striking U.S. carriers and other surface ships in a war with the United States over Taiwan.[41] China is also developing the ability to extend the reach of its sea-launched cruise missiles well beyond the Pacific's second island chain. According to Gen VanHerck, China will have Russia-

Figure 7: Polar map of Russia's Arctic military bases as of June 2022.

Source: Mitchell Institute based on "The Department of the Air Force Arctic Strategy," U.S. Air Force, July 21, 2020, p. 5, and "Russian Military Moves in the Arctic Worry the U.S. and NATO," *Yahoo! News*, June 10, 2022.

equivalent subsurface capabilities in five to ten years, including the 093 *Shang* class nuclear-powered attack submarine, which is reportedly quiet and can launch cruise missiles from its torpedo tubes.[42]

From a ground warfare perspective, Russia has re-opened several Arctic bases in the last decade. These bases could provide it with additional air and missile attack vectors, as well as staging areas for Russian integrated air and missile defense (IADs) systems that can keep U.S. forces out of the high north (see Figure 7). Defending Russian territory in the Arctic through a layered defense system is a priority for Russia, which seeks to protect its access to oil and gas resources in the region, defend the second-strike capability resident in its nuclear submarine fleet located close to the Kola Peninsula, and harness the Arctic as a source of strategic depth—this last item being an enduring worry for Russia because of the proximity of NATO countries on its Eastern front.[43]

The Erosion of U.S. Air & Cruise Missile Defeat Capability in the Arctic

The revival of great power military and civilian scientific activity in the Arctic over the last 15 years, combined with the proliferation of conventional cruise missiles and drones, suggests that Billy Mitchell's predictions about the relevance of the High North to aerospace power remain as true as ever. Yet America's missile defeat capability—which should be thought of in terms of the entire detect, track, attribute, and counter kill chain—has declined significantly in the Arctic since the early Cold War for technical, geostrategic, and budgetary reasons.

During the Cold War, DOD's original raison d'etre for developing homeland missile defenses was to shoot Soviet nuclear bombers out of the sky before they could range targets in the United States. A centerpiece of the U.S. air defense system that emerged in the mid-1950s was the Distant Early Warning (DEW) line, fielded in the Arctic region in 1955 to detect Soviet bombers. By 1962, U.S. strategic missile and air defenses included "42 primary radar stations and 96 gap-filler radar sites" serving as sensors and "forty-one interceptor squadrons numbering 800 aircraft, seven BOMARC missile squadrons, and scores of Army Nike missile battalions" as shooters.[44]

But once the Soviet Union developed intercontinental ballistic missiles (ICBMs), which could reach the continental United States within 30 minutes or less, U.S. policymakers stopped investing in homeland air defense capabilities. The Soviet Union's shift toward using ICBMs instead of long-range bombers for nuclear strikes reduced the need to maintain the massive air defense force the U.S. Air Force fielded through the mid-1950s and early 1960s.[45] The problem was that surface-to-air missile defenses of the time could not credibly defeat Soviet ICBM strikes. Although bombers remained a component of both sides' nuclear forces, the strategy of deterrence through mutually assured destruction replaced air defenses as the primary means of "protecting" the United States from nuclear attack. By the end of the 1970s, most of NORAD's surface-to-air missile sites had been closed, its fighter forces significantly diminished, and its warning systems had shifted to ground radars and satellites equipped with infrared sensors designed to track ballistic missiles launched from the Soviet Union.[46]

This logic led the United States and Soviet Union to ratify the 1972 Anti-Ballistic Missile (ABM) Treaty, which limited their homeland missile defenses and helped reduce pressure to build larger ICBM forces.[47] President Ronald Reagan briefly revived initiatives to build national missile defenses in the 1980s, but systems capable of defeating even a few ICBMs were not fielded until the U.S. Ground-based Midcourse Defense System (GMD) became operational in 2004.[48]

In the post-Cold War period of the 1990s and early 2000s, Arctic defense planning took a backseat to other geopolitical concerns for both the United States and Russia. Following the collapse of the Soviet Union in 1991, the Russian economy imploded, and its Northern Fleet and air assets fell into disrepair. Post-Cold War arms reduction treaties, combined with a major shift in the U.S. military's focus towards operations in the Middle East after September 11, 2001, contributed to DOD reducing its Arctic focus. DOD closed or downsized almost all of its bases in Alaska and significantly shrank other capabilities for defending the northern approach to the United States.[49] Despite this shift, the high north nevertheless retains its geostrategic significance as a staging ground for U.S. and Russian nuclear forces. As such, both have maintained extensive surveillance systems to warn of adversary attacks. Today, NORAD still operates the aging North Warning System, a network of long-range and short-range radars fielded in the late 1980s to detect incoming Soviet bombers.

A Detection Gap

Defense of the homeland against a cruise missile attack requires early detection to allow time to take actions intended to deter the attacker. If deterrence fails, cruise missiles must be detected as early as possible to cue air interceptors and blunt the attack. Until the Northern Warning System is fully operational in the next decade, the homeland is at great risk from the Arctic approaches. A sensing solution is needed to fill an extended gap in Arctic sensing of air threats.

It did seem, at least for a time, that the main focus of the U.S.-Russia security relationship in the post-Cold War era had shifted from deterrence to diplomacy. For the Arctic region, this diplomacy included the formation of the Arctic Council, an eight-member organization consisting of the United States, Canada, Denmark, Finland, Iceland, Norway, Sweden, and the Russian Federation, that focused on the sustainable development and environmental protection of the Arctic. This was merely a strategic pause, however, as Russia increasingly viewed NATO expansion as a threat, culminating in 2007 when Russian President Vladmir Putin declared at the Munich Security Conference that the West was taking advantage of a weakened Russia to advance its own interests and that this behavior would no longer be tolerated. Russia subsequently resumed its Arctic military buildup and modernization, restarted long-range strategic bomber patrols over the Arctic, and began rebuilding its nuclear-powered submarine fleet in the Arctic.

Since Russia began using military force in 2014 to seize territory in Ukraine, its relations with the West have steadily deteriorated. Tensions in the Arctic region are rising, and Norway, Denmark, the Baltic states, the United Kingdom, Finland, and Sweden have all experienced increases in Russian maritime and aerial incursions close to their sovereign territory. While the United States has continued its military presence in the Arctic and has invested in improvements to its Arctic ballistic missile defenses, Russia is expanding its military capabilities at a rate that exceeds NORAD/NORTHCOM's ability to develop and field the capabilities that are needed to deter and, if necessary, defeat modern air and cruise missile threats posed by Russia in the near-term. In the not-so-distant future, these same capabilities will be necessary to deter or counter threats from China as well.

Missile Defeat in the Arctic: Breaking Old Paradigms

How and why is the U.S. approach to deterring air and cruise missile threats in the Arctic changing, and what are the risks and benefits of that approach? Protecting the U.S. homeland remains the number one strategic objective outlined in the *2022 National Defense Strategy* and requires bolstering deterrence against air and cruise missile threats in the Arctic. But in recent years, a consensus has emerged in the U.S. government that the legacy approach to missile defense is too reactive. What is needed is a more comprehensive missile defeat approach, focused on getting information to decisionmakers—ideally before a missile attack is launched—to expand options beyond kinetic missile kills. As part of this broader missile defeat strategy, NORAD/NORTHCOM has made "domain awareness" and "information dominance" top priorities. This shift must be matched by improvements in the command's capabilities, which are still very limited in both these areas.

U.S. Objectives in the High North

At the national level, the Biden administration's *2022 National Strategy for the Arctic Region* seeks a high north that is "peaceful, stable, prosperous, and cooperative," while recognizing the "increasing strategic competition" in the region and that the "highest priority" is to protect the American people and their sovereign territory and rights from threats that transit or originate in the Arctic.[50] For the U.S. military, these strategic objectives create significant operational demands for missile defeat capabilities.

The White House's Arctic guidance also calls on U.S. forces to pursue three specific goals: improve domain awareness, including the ability to detect and track Arctic airborne and maritime threats; maintain a military presence in the Arctic to support homeland defense, power projection, and deterrence goals;

and maximize "unity of effort" with allies and partners to deter aggression, "especially from Russia."[51] The U.S. Air Force has also published an Arctic strategy that reflects and expands on these goals, noting that the Air Force provides almost 80 percent of DOD's Arctic resources, including funding for bases, training complexes, satellite command and control (C2) stations, and the North Warning System's short-range and long-range radars.[52] The Air Force's strategy identifies four key lines of effort (LOEs) to bolster Arctic deterrence and defense, all of which support the need for missile defeat capabilities:

- Vigilance: This LOE is focused on "domain awareness, including threat detection, targeting and tracking, communications, and weather forecasting sufficient to build a reliable operational picture." The main goal of vigilance is to protect the U.S. homeland from emerging air and cruise missile threats that have "long range, better precision, and lower radar cross sections."[53]
- Power projection: This LOE emphasizes the need to maintain free and open access to the Arctic, citing Alaskan bases—especially Eielson AFB, which now hosts two F-35 Lightning II fighter squadrons—as key U.S. power projection nodes. The Air Force's Arctic strategy also notes the need for agile combat employment (ACE) in the Arctic, which requires operating from fixed military bases, airfields of opportunity, as well as taking advantage of portable capabilities like relocatable radar systems to disperse the service's forces to complicate an adversary's air and missile attacks. Like all military bases near and within contested forward areas, these bases and operating locations will need flexible, persistent defenses against air and cruise missile threats.
- Cooperation with allies and partners: The Air Force's strategy calls for improving interoperability between the militaries of friendly Arctic nations to help mitigate shortfalls in Arctic domain awareness assets.[54] The entry of Sweden and Finland into NATO is another opportunity to expand a shared domain awareness of air and cruise missile threats in the Arctic region.
- Preparation for Arctic operations: Perhaps the least directly connected to air and cruise missile defense, this LOE is nevertheless critical, particularly because it emphasizes the role of the Air National Guard (ANG), which possesses "a substantial portion" of the Air Force's Arctic expertise—with some of it still untapped. ANG forces provide combat search and rescue assets, F-22 fighters, and ski-equipped transport and contingency aircraft for Arctic missions. The ANG also operates about 30 MQ-9 Reaper aircraft, which are not currently involved in Arctic operations but could play a role in enhancing awareness of air and cruise missile threats in the region.

The first two LOEs in the Air Force's Arctic strategy, vigilance and power projection, suggest that building up domain awareness to detect and track air and cruise missile threats will support two of its top priorities: area defense of the U.S. homeland and point defense of Arctic bases. These priorities are further enabled by the next two LOEs, enhanced cooperation with allies and partners and routine Arctic training. The strategy also notes that it will be impossible for the Air Force to achieve its LOE objectives without upgrading the capabilities and infrastructure U.S. forces will need to defend America's northern approaches. This includes upgrades to DOD's Arctic air and cruise missile defenses.

Who Defends the Homeland?

Given total responsibility for air defense of the entire United States, the Air National Guard (ANG) is best postured to prototype the use of remotely piloted MQ-9A Reapers to bridge a long-term gap in detection, tracking, and engagement of cruise missiles from the Arctic approaches. The concept of operation involves the deployment of high-endurance MQ-9 remotely piloted aircraft (RPA) into the Arctic that are networked together and with other air defense elements under the control of NORAD. The ANG can also leverage insights from Air Force Special Operations Command's recent procurement of the MQ-9B Sky Guardian. This variant of the MQ-9 has improvements to include increased endurance and range, more expansive automation, reduced manpower requirements, and all-weather capability. The use of remotely piloted aircraft can eliminate the risk to airborne manpower while gaining significant endurance. Operating costs would be lower on a cost-per-flying-hour basis than manned aircraft that are already scheduled for retirement.

Risks of the Legacy Approach to U.S. Missile Defense in the Arctic

The legacy air and missile defense paradigm is intuitive for U.S. military operators who have been trained to use kinetic capabilities to kill threats including drones and cruise missiles.[55] While these capabilities are important and need to be urgently modernized, an overreliance on kinetic kill platforms, delivery systems, and weapons alone could lead to a reactive strategy that limits warfighter options. Betting on successful missile intercepts alone is a particularly risky choice given the area defense requirements of the Arctic, which, much like the contiguous United States, is a vast expanse that requires a comprehensive missile defeat approach.

In the legacy missile defense paradigm, there are three essential elements to an air and cruise missile defense system: sensors, battle management systems, and shooters. The role of sensors is to detect, track, and identify inbound air and cruise missile threats; battle management systems coordinate defensive actions; and shooters, such as fighter aircraft, surface-to-air missiles, or non-kinetic capabilities like electromagnetic warfare and high-powered microwave weapons, destroy the incoming threats.[56]

Air defense for the contiguous United States is now provided by a network of ground-based radars—including those in the North Warning System—and a small number of fighters on air defense alert at several air bases around the country. These fighters are on alert status to rapidly respond to and intercept foreign military aircraft, such as Russian bomber patrols that routinely fly near and occasionally into U.S. airspace. Air Force fighters also intercept unidentified aircraft, aircraft that have strayed from planned flight paths, and aircraft that are not properly communicating with air traffic control.

In practice, the small numbers of fighters and the lack of a system of sensors that can detect low-flying targets over long ranges limits the system's effectiveness against modern cruise missiles and other threats. Air defense systems like the kinds being used in Ukraine also offer some defense against low-volume missile attacks—systems such as Patriot, Terminal High Altitude Area Defense (THAAD), or the National Advanced Surface-to-Air Missile System (NASAMS), which is used to defend the Washington DC national capital region. But these systems are low-density, high-demand assets, may cost more per shot than the missiles they defend against, and are not effective against many types of cruise missile and drone threats.[57]

Benefits & Risks of a New Missile Defeat Paradigm

Because of historically limited interest and investment in cruise missile defense concepts and technologies, the U.S. military now has very little capability to detect, track, identify or intercept cruise missiles and other aerial strikes on the U.S. homeland.[58] To overcome this inertia, NORAD/NORTHCOM has embraced a new paradigm that emphasizes domain awareness *and* information dominance as the foundation of its missile defeat approach.[59] The argument is that early detection of a potential threat can open up decision space for U.S. leaders so they can make moves left of launch or even left of conflict to reduce the risk of an attack in the first place. As Gen VanHerck has said, "If I'm shooting down cruise missiles and ballistic missiles, we've failed in deterrence and that's not where we want to be."[60]

Domain awareness and information dominance are also prerequisites for any actions to defeat missiles right of launch: after kinetic or non-kinetic attacks have occurred. Short-range point defenses surrounding a particular location and longer-range area defenses are important for selected homeland military and civilian infrastructure because they can further bolster deterrence and protect U.S. power projection capability. But an over-emphasis on the "counter" element in the detect-track-counter kill chain is not a recipe for success due to the escalatory risks relative to stopping or preventing attacks in the first place. Another consideration is the technical difficulty and expense associated with building a defense system that has the capacity to even handle the high volume of increasingly sophisticated cruise missiles that can be launched at the United States, much less launch counterattacks.

In a missile defeat architecture that favors domain awareness and information dominance, the Arctic plays a central role. In his March 2023 testimony to Congress, Gen VanHerck paraphrased Billy Mitchell's comments about Alaska being the most strategic location on the planet and reminded senators that the Arctic is the most direct route for missile attacks from Russia, China, and North Korea. Furthermore, with sea ice receding, China and Russia are increasingly able to deploy missile-carrying submarines into the region.[61] However, the new emphasis on domain awareness and information dominance is not without risks. Gen VanHerck noted in his testimony that the missile defeat approach, which favors detection over tracking and countering, is at risk because of a sheer lack of capabilities in the Arctic.

Domain Awareness Gaps in the Arctic

The January 2023 intrusion of a Chinese spy balloon into U.S. airspace by way of northwest Canada caught the nation off-guard and highlighted the severe lack of U.S. domain awareness in the Arctic. When asked by Senator Angus King during a March 2023 Senate hearing whether the lack of indications and warning in the Arctic presents an "Arctic gap" in U.S. national security, Gen VanHerck responded that "we are not organized, trained or equipped to respond in the Arctic."[62] Another Arctic expert described the region as "a dark area on the map" because it is so vast and so few civilian surveillance resources cover it.[63] The lack of domain awareness prevents the United States from obtaining the early warning and intelligence, surveillance, and reconnaissance (ISR) information necessary to anticipate and take actions to deter air and cruise missile attacks. This domain awareness gap would become acute in the event of an actual cruise missile launch. Without the ability to identify and track incoming threats,

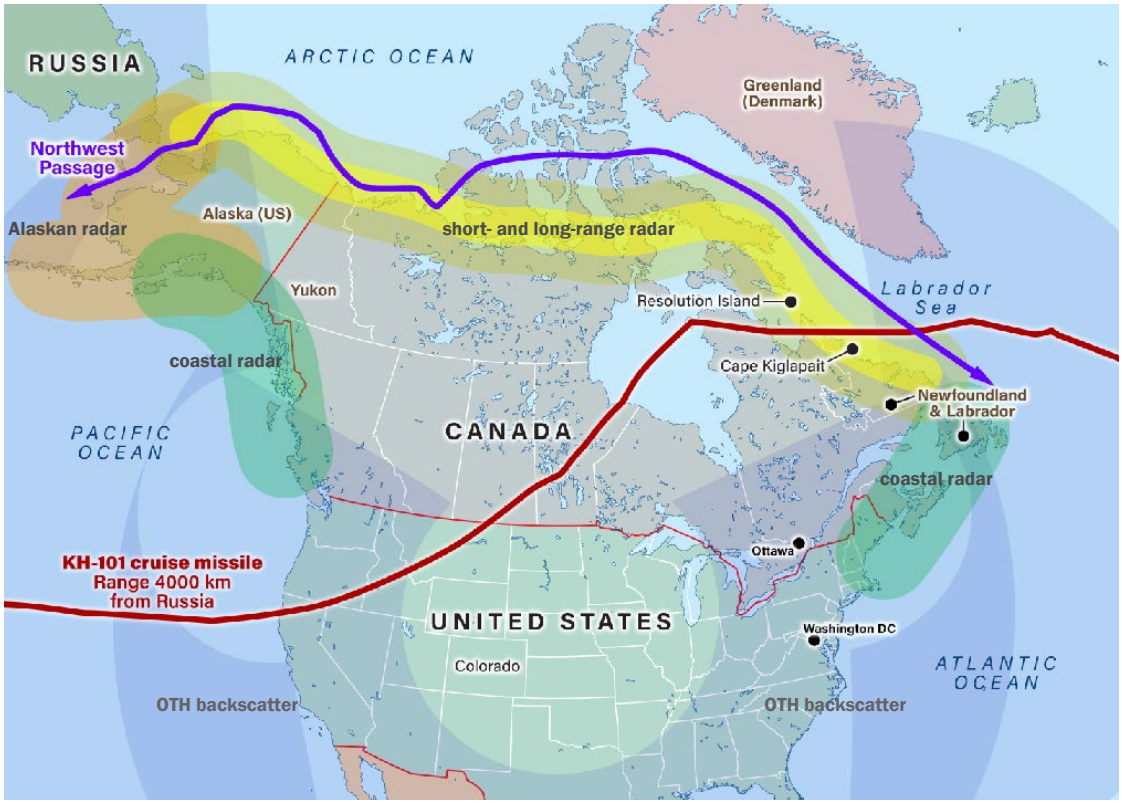

Figure 8: The "picket fence." Shaded areas depict different elements of the North Warning System's radar coverage.

Source: Mitchell Institute image based on "North America's Arctic Radar Shield Is Due for an Upgrade," *The Economist*, July 29, 2021.

U.S. forces would be poorly positioned to scramble fighters, activate air defenses, and execute other kinetic and non-kinetic defensive actions in response.

Risk: The North Warning System is a "picket fence." Today, the centerpiece of Arctic domain awareness for North American air and cruise missile defense is the aging North Warning System, a network of 47 radar stations that monitor the airspace over the Canadian Arctic and Alaska. The North Warning System was established in 1985 as a joint project between Canada and the United States, replacing the outdated Distant Early Warning (DEW) Line that was built in the 1950s. The North Warning System itself is increasingly outdated since it continues to rely on technology first developed in the 1970s.[64] This system is only designed to identify approaching Soviet or Russian bombers that have already launched and are flying within the range of its radar; it cannot provide early indications and warning of adversary force posture changes in the Arctic that could be a prelude to an attack.[65]

The NWS also lacks the ability to detect air and missile threats launched from inside Russia, and it cannot detect incoming bombers, cruise missiles, drones, and other threats that are simply flying too low to be detected or are operating too far beyond the range of its radar.[66] As Russia and China develop stealthier cruise missiles and diversify their cruise missile launch options, whether through different air approaches, land-based attacks, or surface and sub-surface attacks, the gaps in the North Warning System's effective radar coverage will continue to increase. "Imagine a solid fence shrinking to a picket fence," Gen VanHerck, explains. "And now you have cruise missiles that can get through your capability to detect."[67]

Risk: U.S. Arctic airborne surveillance assets are scarce. There are two general ways that airborne assets could improve Arctic

domain awareness. First, inhabited and uninhabited ISR aircraft routinely operating in the northern tier could provide early indications and warning of threat activity on the ground, in the air and above and below the water's surface. Second, airborne early warning and control aircraft—namely the Air Force's E-3B/G AWACS—can detect incoming hostile air and cruise missile threats, providing battle management capabilities to coordinate fighters or other defensive assets against missile targets. The problem is that these assets are scarce and are not assigned or routinely allocated to Northern Command or NORAD. The situation is particularly dire for the Air Force's E-3 AWACs: this small fleet of around 30 aging aircraft suffers from mission capable rates below 60 percent and is in constant demand in the Indo-Pacific and European theaters.[68] This gap will continue until E-7 Wedgetail replacement aircraft come online in the late 2020s. Even then, total inventory numbers will be limited.

Risk: U.S. space capabilities covering the Arctic are limited. Satellites can support regional domain awareness by providing additional sensing capability for threat indications and warning and to detect and track incoming air and cruise missile strikes. Satellites can also provide additional communications and navigation capabilities critical for the day-to-day Arctic operations of aircraft, ships, submarines, and land forces. That said, legacy U.S. space architectures that rely on exquisite geostationary satellites have limited utility in the Arctic for three main reasons.

The first and principal challenge is the high latitude of the region. Geostationary satellites orbit the Earth at the same speed as its rotation, so they appear to be fixed over a certain point on the equator. However, geostationary satellites have a maximum outer coverage limit of 81.3 degrees north and south latitude. This results in a distinct gap in geostationary communication and navigation services near the Earth's poles.[69] These dynamics can affect availability of signals intelligence and reconnaissance satellites that operate in geostationary orbit.[70]

Second, satellites operating over the Arctic are plagued by a unique electro-magnetic phenomenon that occurs in the northern tier. Ionospheric scintillation, the flickering and distortion of radio waves, is more prominent at the poles. While this phenomenon does not damage satellites, it does interfere with the transmission and reception of their signals, which include signals received from position, navigation, and timing satellites such as the Global Positioning System.[71] In addition, the Earth's magnetic poles trap charged particles that can create electro-magnetic anomalies that hamper space-based sensor collection operations.[72]

Third, it may be difficult to detect cruise missile launches with legacy U.S. satellite architectures. The problem with these space-based infrared detection systems is that they were designed to detect the hot exhaust plumes of ballistic missiles when they launch and ascend into their trajectories, not cruise missiles with much lower infrared signatures than their ballistic or hypersonic missile counterparts.

Risk: U.S. Arctic infrastructure is poorly suited for Missile Defeat. Operating both ground and air-based assets in the Arctic is logistically challenging. The lack of airbases with sufficient runways, weapons, and fuel storage are significant problems for aircraft operations in the region.[73] The remote and harsh nature of the high north poses unique challenges to personnel, machinery, and infrastructure—temperatures frequently reach below -40 Celsius. Shifting permafrost makes both the construction and maintenance of buildings a difficult and constant battle against the elements. Even maintaining the existing North Warning System's remotely operated

ground-based radar stations is challenging and requires dedicated support and transportation infrastructure given the vast distances and remoteness involved.[74]

Information Dominance Gaps in the Arctic

Risk: Difficulty identifying threats. A fundamental challenge for achieving information dominance—the ability of U.S. leaders to access decision-quality information more quickly than adversaries—is that it is difficult to determine if airborne objects detected by long-range sensors are actual threats or benign civilian or commercial aircraft. Many cruise missiles fly at speeds and altitudes similar to civilian aircraft, or they could be programmed to do so.[75] American and Canadian fighters now average 100 intercepts of unidentified aircraft each year, mostly involving small general aviation aircraft that accidentally encroach on restricted airspace.[76] Scrambling fighters to identify these aircraft wastes precious time and resources that could be better used for other purposes. Alternative, lower-cost means are needed to sense these aircraft and distinguish actual threats from routine air traffic.

Risk: Inefficient information-sharing. Once NORAD/NORTHCOM sensors detect potential threats, its current process for communicating that information to C2 authorities is analog, consisting of a series of phone calls to increasingly higher headquarters. Gen VanHerck explained the chain of command for a response to a missile launch: "It will get to my headquarters through a phone call, which would take minutes to do that…That is not good enough in my mind."[77] Moreover, many NORAD/NORTHCOM radar systems involved in air and cruise missile defense are literally analog, so they can't feed into digital systems that provide a common operating picture to warfighters. This can cause critical delays in determining appropriate actions to counter missile attacks.

Taken together, these capability gaps make it difficult for NORAD/NORTHCOM to provide decision space for senior leaders left of launch, much less timely and accurate information for effectors to counter missile attacks right of launch. Often, the only option is to scramble a fighter to interrogate a potential threat, which exposes valuable inhabited aircraft assets, takes up valuable resources, and may not be sufficient to counter the threat depending on the size of the missile raid. Developing the means to detect air and cruise missile threats from northern approaches as they are developing—rather than once they are inbound to the United States—is the central challenge facing NORAD/NORTHCOM as it seeks to shore up homeland defense in the northern tier.

Implementing an Improved Missile Defeat Approach in the Arctic

What steps can the United States take to bolster deterrence in the Arctic region, and what are some specific capabilities needed to take those steps? To build NORAD/NORTHCOM's focus on improving domain awareness and information dominance, the United States should develop a layered, overlapping set of missile defeat capabilities for the Arctic region. Although the United States Government now recognizes air and cruise missile defense in the Arctic as a serious problem, strategy and resources are not yet fully aligned to reflect the magnitude of the threat, and the timeline for resources that are allocated to address the challenge is too drawn out. There are several capabilities that are already available or could be rapidly fielded to contribute to a more effective Arctic missile defeat strategy in the short term. These capabilities can be part of a missile defeat strategy that supports NORAD/NORTHCOM's focus on providing decision-quality information to U.S. leaders that will help expand options available to deter missile attacks before they occur.

A Layered Approach to Missile Defeat

Gen VanHerck has called for a layered air and cruise missile defense approach, which involves working with other U.S. combatant commands as well as allies and partners. This approach is focused on sensing emerging missile threats as far left of launch as possible, rapidly communicating necessary information about threats, and determining resources available to deal with it as quickly as possible.[78] The key to achieving these operational objectives will be to mitigate existing domain awareness and information gaps with networks of integrated sensors, including airborne platforms such as autonomous uninhabited aircraft, ground radars, and surface and undersea sensing capabilities. In terms of right of launch capabilities, Gen VanHerck envisions creating more non-kinetic options to counter air and cruise missiles such as electromagnetic spectrum systems and cyber tools.[79] Overall, Gen VanHerck has said NORAD/NORTHCOM's missile defeat architecture, known as Homeland Defense Design 2035, will be "vastly different from the way we do it today with fighters, tankers, AWACS and those kinds of things."[80]

DOD is already investing in certain components of air and missile defense that will improve NORAD/NORTHCOM's ability to detect, track, attribute, and counter hostile air threats in the Arctic and across its full area of responsibility. But funding for the effort is not coordinated under one portfolio or a strategy for air and cruise missile defense of the homeland. Furthermore, timelines for fielding new systems are too drawn out to address threats in the Arctic today. For instance, NORAD/NORTHCOM's first new over-the-horizon radars, which can achieve very long-range detection of threats by bouncing long-range radar beams off the atmosphere and over the curvature of the earth, will not become fully operational until 2031. As DOD's cruise missile defense acquisition authority, the Air Force is responsible for funding four OTHRs for NORAD/NORTHCOM. Meanwhile, Canada plans to invest billions in Arctic OTHR, Polar OTHR, and Crossbow, a classified sensing program.[81] And while DOD is mulling plans to modernize the North Warning System ground-based radars, no final decision has been made.[82] The point is, none of these efforts will be completed until 2030 or later.[83]

The DOD needs to speed up these efforts, but it cannot do so without developing a common vision that is shared by the full range of stakeholders in Arctic air and cruise missile defense. DOD, NORAD/NORTHCOM, the Department of the Air Force, the Missile Defense Agency, and the other military services all have a role to play in air and cruise missile defense in the Arctic. Canada and the other Arctic nations are also critical to an effective approach. In a region where threats are growing but U.S. military resources remain limited, these actors need to be united around a vision that ties together existing and planned capabilities across these organizations and employs them in new and innovative ways.

Implementing a Missile Defeat Strategy in the Arctic

Based on discussions with NORAD/NORTHCOM and industry experts and an open-source literature review, Mitchell Institute developed a notional framework for a layered missile defeat approach that applies specifically to the Arctic (see Figure 9). The framework emphasizes left-of-launch detection and tracking of potential missile launch threats. Of course, tactical battle management and intercept capabilities are still needed for point defenses of key nodes such as Arctic airfields or exquisite radars that are potential targets for missile attacks. But the framework places a premium on

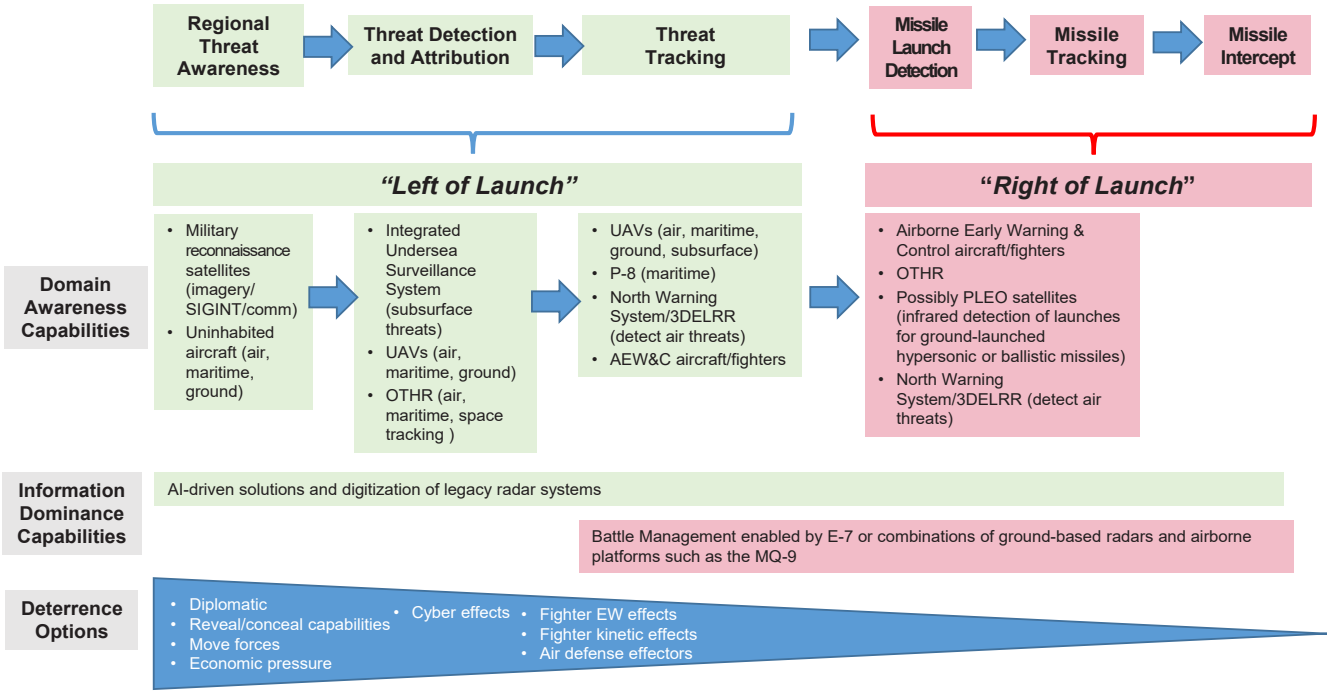

Figure 9: A layered missile defeat approach in the Arctic.

Credit: Mitchell Institute

early detection of changes in adversary behavior that allow the U.S. Government to better anticipate missile strikes on the continental United States.

Domain awareness and information dominance are the keys to this missile defeat framework. The United States can improve both capabilities in the Arctic, which will help create more options for responding to cruise missile threats left of launch *and* right of launch. As the blue triangle at the bottom of Figure 9 depicts, being able to identify threats early opens up new options to counter them, which in turn bolsters deterrence.

DOD could draw on many capabilities that are either available today or already programmed and could be accelerated to implement this missile defeat approach. Figure 9 also shows some examples of how these capabilities could be applied across the six overlapping layers of this approach: regional threat awareness, threat detection and attribution, threat tracking, missile launch detection, missile tracking, and missile intercept.

Regional Threat Awareness

This outermost layer of a future Arctic missile defeat architecture could consist of network sensors operating in multiple domains to provide early indications and warning of potential threats. In the days, weeks, and even months prior to a missile attack, adversaries may show signs of their intent by making force posture changes and logistical preparations to support a strike. For instance, Russia is building up a number of military bases not far from Alaska (see Figure 10). Tracking activities that could be a prelude to a hostile act at these bases could help U.S. leaders to manage escalation and possibly increase options for the United States to deter or prevent an attack. This requires enhanced Arctic domain awareness provided by the aforementioned network of multi-domain sensors.

Reconnaissance satellites. ISR satellite assets that can be used to map out activity in the Arctic and detect changes in adversary behavior are one obvious and attractive solution to improve indications

Figure 10: Exemplar Russian military bases in the Arctic region and approximate ranges from Eielson AFB, AK.

Credit: Mitchell Institute.

and warning in the Arctic. In the event U.S. Government satellites are not in the right orbit or are allocated to fulfill higher priority requests from other combatant commands, commercial companies and U.S. partners and allies operating satellites with Arctic coverage could help fill the void. Candidates could include satellite imaging and sensing companies like Maxar and Spire Global, which are now engaged in providing remoting sensing services for both commercial and scientific purposes.[84] In 2019, Canada launched its RARSTAT Constellation Mission, which uses three radar imaging satellites to conduct maritime and Arctic surveillance. Canada intends to further improve its space-based ISR capabilities through its Defense Enhanced Surveillance from Space program, which will harness space-based synthetic aperture radar and automatic maritime identification to improve domain awareness in the Arctic region.[85] However, this program will not become operational until 2035.

Uninhabited aircraft. UAVs already operational today—such as the MQ-9 Reaper and RQ-4 Global Hawk—can also play a critical role in regional threat awareness. The MQ-9 Reaper, for example, can carry a variety of sensors, including maritime surveillance radar and a signals intelligence payload. The high altitude, long duration RQ-4 carries a synthetic aperture radar that can map an adversary's Arctic infrastructure and activities on a persistent basis. Flying these aircraft close to adversary locations in the Arctic could put them at greater risk of attacks, but such behavior in and of itself can be an indication of an emerging threat. UAVs—including mature systems operating today—can also be equipped with a variety of sensors and defensive payloads like electronic countermeasures or heat-seeking air-to-air or air-to-surface missiles that could help dissuade or prevent adversaries from targeting them.

Left-of-Launch Threat Detection & Attribution

Maritime, ground, surface, and subsurface surveillance systems. Once there are indications and warning that an adversary is posturing for missile strikes based on its force movements, signals intelligence, logistical developments, or other indications, NORAD/NORTHCOM will need the means to track suspected specific strike platforms. Perhaps the threat is a Russian bomber taking off from an Arctic base where a ship full of cruise missiles unloaded the week before or a submarine that left its pen and is thought to be headed toward Canadian waters. A variety of different sensors covering large areas of the Arctic and environs close to the Arctic would be needed to detect and confirm the origins of these threats.

For instance, routine patrols of MQ-9s equipped with maritime surveillance, signals intelligence, and electro-optical/infrared sensors could help to identify the number and type of potential aircraft or surface vessel threats. To the extent they are available, P-8 aircraft could augment MQ-9 maritime surface tracking operations. Modernizing and expanding underwater sensing systems in the Arctic—at least to cover maritime chokepoints and areas with deep water where submarines might be likely to hide—could also improve the detection and tracking of adversary submarines that could have vertical launch systems.[86] Gen VanHerck has repeatedly called for the United States and Canada to modernize and expand the Integrated Undersea Surveillance System, which includes mobile, deployable, and fixed acoustic arrays capable of detecting undersea vessels, to cover more of the Arctic region.[87]

Left-of-Launch Threat Tracking

Once a specific threat is detected, whether it's a submarine, aircraft, surface ship, or land-based missile launch system, it becomes necessary to maintain tracking custody of it. At this point, strikes are expected based on prior indications and warning. The goal at this stage is to track the threat to provide target-quality data to kinetic and non-kinetic effectors that could take action to deter, prevent, or respond to a missile launch.

Over the horizon radar. Initial air, surface, and subsurface threat detection and attribution information could be passed to an OTHR, which bounces radar energy off the ionosphere to track targets over very long ranges—up to 4,000 nm.[88] An OTHR could pass target location information on to other inhabited and uninhabited aircraft and land-based radars in the North Warning System that can reconfirm the type and number of threats.

Inhabited aircraft. If they are available, airborne early warning and control aircraft, such as the E-3 AWACs or its replacement, the Air Force's future E-7 Wedgetail, could use cues from other sensors to establish a track on airborne threat aircraft and direct fighters or other effectors to the right place at the right time to counter those threats if necessary. If available, fighter aircraft, including 5th generation F-35s with their integrated suite of sensors, can play a valuable role in tracking and intercepting missile launch platforms before they can launch their missiles.

Combining capabilities. In the absence of available inhabited aircraft, another option to maintain custody of incoming threats is to use UAVs with sensors to augment OTHR and the North Warning System. Current generation UAVs lack the same radar systems and the high speeds needed to keep pace with enemy strike aircraft. However, if UAVs deployed to provide overwatch of likely launch vectors, they could accept cueing data on a possible threat from OTHR and then use their EO/IR sensors to verify and characterize threat aircraft. Long-duration UAVs could also employ maritime surveillance radar to locate and track potential hostile missile-carrying ships. They might even be equipped with sonobuoys to help monitor adversary submarine movements.

Right of Launch: Detect & Track Missile Launches

Should left-of-launch actions fail to prevent an adversary from launching a missile strike, the next layer of missile defeat is right of launch actions, which include detecting and tracking the launch and missile post-launch maneuvers. SDA has begun deploying missile tracking satellites into low-earth orbit (LEO). As the LEO constellation proliferates, it will be able to provide missile launch detection and tracking of hypersonic and ballistic missiles with engines that burn hot enough to be detected. However, space-based missile tracking would likely not be the best apparatus for detecting surface or airborne cruise missile launches.

Once a cruise missile is launched, inhabited aircraft, including AEW&C and fighters that host powerful air moving target radars would be able to track them and vector effectors with kinetic kill or electronic warfare capabilities to counter the threat. This is the last opportunity to defeat the missile before handing off target custody to terminal area defenses that offer the last line of defense. These defenses currently consist of a small number of fighter combat air patrols and, for the U.S. National Capital Region, a handful of short-range surface-to-air interceptor launchers.

The Role of Information Dominance

Overlapping Arctic domain awareness and information dominance is the essential ability to get timely information to decisionmakers. This requires providing decisionmakers with a broad understanding of the operational environment left of launch and the tactical information they need for an intercept right of launch. To enable information dominance, several capabilities are required.

Communications satellites. Satellite communications are essential for early threat indications and warning because they provide a means to share intelligence with remotely piloted UAVs flying in the farthest regions of the Arctic, control their operations, and pipe their feeds back to decisionmakers. Today, satellite communications coverage is sparse in the Arctic, but both OneWeb and SpaceX's Starlink are expanding their network of commercial proliferated LEO communication satellites to improve coverage in the high north.[89] The SDA's ongoing fielding of a satellite communications transport layer in LEO will also provide high-speed data connectivity for U.S. warfighters operating in remote regions worldwide, including in the Arctic.

The United States can also bolster its deterrent posture by increasing the overall resilience of hybrid communications. Adding UAVs with communications payloads in the Arctic region would diversify networks of nodes and allow for multiple alternative communication pathways, decreasing the consequence of losing any single node. Connectivity between UAVs and any other aircraft to the space-based transport layer requires the benefits of optical communications technology.

"Laser comms" enable the optimum use of the highly resilient, satellite proliferated transport layer being fielded by the SDA, resulting in high-speed, flexible communication links across the air defense network that are substantially more secure against adversary interception and jamming than existing methods. Furthermore, laser comms can also facilitate the transfer of far larger quantities of data that exceed the standard radio frequency (RF) transmission capabilities used by many current SATCOM systems. Laser communication will be important to ensure all domain sensors are rapidly linked to analysis, adding decision time to act. Optical communications are an enabler of military capability across the globe and critical to homeland defense, and therefore should be a high priority for U.S. Space Force efforts and resourcing by the Congress.[90]

Finally, allies and partners can contribute. Norway's Arctic Satellite Broadband Mission (ASBM), for example, will launch two satellites into highly elliptical orbit by 2024, and these will provide improved broadband satellite communications within the Arctic region.[91]

Artificial intelligence. AI can play a critical role in making sure the right information gets to the right decision makers at the right time. NORAD/NORTHCOM has conducted "global information dominance" or "GIDE" experiments that allow the command to fuse sensor data from a variety of platforms and dramatically cut down on the time required to get emerging threat information to decisionmakers. Once one sensor picks up a potential threat, artificial intelligence cross-cues that data with other sensor's information to confirm, identify, and attribute the threat. "What we've seen is the ability to get way further, what I call, left: left of being reactive to actually being proactive, and I'm not talking minutes and hours. I'm talking days," Gen VanHerck explained in 2022.[92]

Battle management platforms. Finally, battle management platforms, including AEW&C aircraft, are important for providing another layer of tactical information dominance once a threat is incoming.

Environmental intelligence. Increased focus on the Arctic approaches in the defense of the homeland must assert the importance of environmental sensing from space. The Arctic environment and its weather are still not well understood and forecasted. While sensing deep into the Arctic can be facilitated by an all-weather UAV like the MQ-9B, there is a need for a multi-faceted approach to sensing weather that affects air, sea, and land operations in the Arctic.

However, the Defense Meteorological Satellite Program (DMSP) is well past its lifetime as a defense-dedicated weather sensor that covers the Arctic in a polar orbit. Fortunately, the U.S. Space Force is moving ahead with the Electro-optical Infra-red Weather Satellite program (EWS) that will ultimately need to be disaggregated as a constellation of numerous satellites that provide both higher performance and resilience against attack by an adversary. While Space Force is handling the program well, Congress needs to ensure adequate resourcing is available to keep the program on track.

Combining Domain Awareness & Information Dominance to Bolster Deterrence

An overlapping, layered approach to missile defeat in the Arctic can give U.S. leaders more time to proactively shape adversary behavior and manage escalation. Referring back to the horizontal blue triangle in Figure 9, early threat detection creates time to bring non-kinetic options to bear, including diplomatic and economic actions or strategic signaling actions, such as revealing capabilities or moving U.S. forces. As the threat of a missile launch becomes more acute, cyber options might be effective, but only if time is available to generate the desired effect on the target. As a final measure, leaders can turn to kinetic countermeasures for missile defeat. Applying this overlapping, layered strategy is critical in the Arctic, where the early detection of an enemy's intent to launch cruise missile strikes is so critical for homeland defense. The importance of a layered missile defeat strategy will only grow as China brings more forces to bear in the Arctic region. The United States needs to maintain the Arctic as a critical U.S. and Canadian strategic buffer for managing great power competition and conflict.

Conclusion & Recommendations: Steps to Bolster Air & Cruise Missile Defeat in the High North

DOD's *2022 Missile Defense Review* identifies conventional missile strikes as a growing threat to the U.S. homeland.[93] As Russia's prolific use of cruise missiles in Ukraine highlights, these cheap and

accessible weapons can be used to hold sovereign territory at risk over increasingly longer ranges. For the United States, the Arctic approaches present the most proximate and direct means for China or Russia to launch long-range cruise missile attacks on targets located nearly anywhere in the continental United States.

In August 2022, Deputy Secretary of Defense Kathleen Hicks assigned the Air Force acquisition responsibility for homeland cruise missile defense.[94] In practice, dozens of defense agencies and all the military services have a part in missile defeat strategies, and the national strategic vision for air and missile defeat is still emerging. Over the longer term, new U.S. air and cruise systems may come online that greatly improve homeland missile defeat operations. This includes better space-based capabilities, high-powered microwave weapons, and new cyber tools that will give the United States more leverage to deter attacks both left and right of launch. While this is good news, the bad news is that air and cruise missile threats are acute *today*, and current gaps in Arctic domain awareness and information dominance represent a major and immediate void in U.S. missile defeat capabilities.

In the near term, there are steps the U.S. Government should take to create a layered, overlapping approach to missile defeat in the Arctic. Most importantly, U.S. national security leaders should explicitly link Arctic missile defeat strategies to resourcing decisions that will support their number one U.S. national defense priority—protecting the homeland. Elevating Arctic domain awareness as a homeland defense issue does not mean DOD should reduce its emphasis on U.S. power projection priorities to deter and defeat great power aggression in the Indo-Pacific and Europe—quite the contrary. Those priorities are essential to dissuading aggression as far from home as possible and keep conflict away from U.S. territory. But the fact is that adversaries increasingly recognize that attacks on the U.S. homeland could potentially be a viable way to create serious dilemmas for U.S. leaders and deter U.S. intervention in conflicts abroad. This means DOD, the Air Force, and the other services must find ways to address air and cruise missile defeat in the Arctic without losing focus on deterring and winning in the Indo-Pacific and Europe. To this end, the Mitchell Institute recommends a number of short-term steps that the U.S. Government should take to mitigate these missile defeat challenges.

For DOD & Congress: Establish a Joint Capability Technology Demonstration Focused on Cruise Missile Defense of the Homeland

Concepts for improving cruise missile defense of the homeland are still developing, but to date they have largely focused on improving point air and missile defenses for geographically discrete, high-value areas like the National Capital Region, Guam, and Hawaii. These efforts have intrinsic value for protecting critical U.S. infrastructure and power-projection nodes, but they are no substitute for addressing serious air and cruise missile defeat in the high north. Given the geopolitical importance of the Arctic as a staging ground for offensive missile attacks and the well-known domain awareness gaps that exist there, domain awareness and information dominance in this region should be a top priority for air and cruise missile defense of the homeland.

In some ways, Arctic missile defeat challenges are unique. The very cold conditions and geographic proximity to adversaries make it a complex operating environment. There are also some requirements for missile defeat in the Arctic that reflect the same challenges facing the contiguous United States: namely, the need to improve domain awareness across a very large area to protect against the potential

for adversaries to adopt multiple vectors of attack, severely degrading the U.S. ability to detect and track threats. Just as Guam and Hawaii serve as proving grounds for missile defense strategies for discrete areas, Alaska can serve as a testbed for missile defeat strategies that emphasize indications and warning over a broad swath of territory.

To operationalize a missile defeat strategy in the Arctic, the DOD and Congress should launch a joint capability technology demonstration (JCTD) to test different sensor network combinations and software tools aimed at increasing domain awareness and information dominance. After acquisition responsibility for cruise missile defense of the homeland moved from the Missile Defense Agency to the U.S. Air Force, a previous JCTD to examine a layered approach to cruise missile defense was scaled down to focus on the National Capital Region. Congress and DOD should fund a broader JCTD to experiment with air, space, surface, and subsurface capabilities that could provide an overlapping, layered cruise missile defense for the Arctic.

For DOD & Congress: Create a Dedicated Fund to Bolster Deterrence in the Arctic

The DOD and Congress should consider creating a North American Deterrence Initiative. The initiative would focus on increasing investments for cruise missile defeat and bolstering physical military presence in the Arctic. For missile defeat, investments would target left-of-launch capabilities. Investing in domain awareness and decision dominance would be central requirements; getting left of launch may help to reduce the overall costs of an approach focused solely or heavily on traditional missile defense. The Congressional Budget Office assessed that a comprehensive missile defense strategy for the contiguous United States would cost between $75 billion and $465 billion, while the Center for Strategic and International Studies proposed an architecture that would cost nearly $33 billion.[95] However, these architectures include relatively robust funding for right of launch defensive capabilities. A posture that emphasizes left-of-launch capabilities in the Arctic might ultimately bolster deterrence and result in cost savings.

The second focus of the new fund should be physical infrastructure improvements. These would include building pre-positioned, hardened shelters to store aircraft equipment, spares and other logistics needs, and the modernization of Pituffik Space Base, DOD's northernmost base, which is in need of significant investment and improvements to withstand harsh environmental conditions. Expanding the U.S. military's physical presence in the Arctic is key to bolstering deterrence in the region.

Decisions on where to invest in Arctic domain awareness would be based on two criteria: 1) DOD analysis to determine trades between enhancing Arctic domain awareness versus various right of launch cruise missile defense options for key infrastructure nodes in the contiguous United States, and 2) Lessons learned from the Arctic cruise missile defeat JCTD proposed above.

For the Air Force: Exploit Existing Weapon Systems & Accelerate Procurement of New Ones to Support a Missile Defeat Approach

As the lead acquisition authority for cruise missile defense of the homeland, the Air Force will need to spearhead its own efforts to enhance NORAD/NORTHCOM's emerging cruise missile defeat approach. Four of the most urgent areas the USAF should address include support for the fielding of a new radar capability in the Arctic; developing a plan for a rotational UAV presence in the Arctic; accelerating the E-7 Wedgetail; and preserve legacy fighter capacity.

Rapidly Field New Radar Capability

The USAF is responsible for funding four new OTHR to expand coverage in the Arctic, but those systems won't be fully operational until 2031. DOD should provide funds to allow the Air Force to invest the additional $55 million on NORAD's unfunded priority list to accelerate OTHR fielding to 2027 and amplify the capabilities of the North Warning System with an investment of about $211 million to acquire nine NORAD-dedicated advanced mobile Three Dimensional Expeditionary Long Range Radars (3DELRR).[96]

Establish a Rotational UAV Presence in the Arctic

With support from Canadian Forces through the NORAD/NORTHCOM chain of command, the Air Force should also bolster its UAV posture in the Arctic to support domain awareness. Acting alone or in concert with other radar platforms, the MQ-9 and other UAVs can provide ISR across the layers of a missile defeat strategy. In particular, the Air National Guard currently operates about 30 MQ-9A Reaper aircraft in a training capacity. UAV operators are no strangers to "training" missions that take place in operational venues, so ANG training could easily take place in the Arctic, where it could support ISR efforts. Canada may soon be joining the United States in operating the MQ-9B SkyGuardian, which would provide additional ISR capacity and further deepen the U.S.-Canadian NORAD partnership.[97] Finally, the United States and Canada should work together to establish a combined rotational presence of MQ-9s in the Arctic, where they can provide training to Airmen, increase day-to-day domain awareness, fill critical capability gaps, increase strategic architecture resiliency, and serve as "flying battle labs" that can be equipped with an array of sensors and payloads for experimentation as part of an Arctic domain awareness JCTD.[98]

The Broader Sensing Perspective

The Department of Defense should not limit the use of networked unmanned aircraft to the sensing of air threats approaching from the Arctic. The same concept is applicable to detecting and intercepting cruise missiles launched off the coasts of the continental United States and Canada. The unique virtue and value of an aircraft is that they can rapidly be repositioned throughout the continent or across the globe. This has significant value as threats evolve, allowing leaders to reposition forces in a dynamic fashion to best ensure tools align with the mission.

Accelerate E-7 Procurement & Preserve Legacy Fighter Capacity

When deterrent options fail and missiles are launched, it becomes critical to maintain information dominance at the tactical level as well as having multiple options to counter missile attacks kinetically or non-kinetically.

The Air Force is now confronting a major gap in its battle management capabilities as it retires the E-3 AWACS inventory and waits for the new E-7 Wedgetail to come online, with the first two arriving in 2027. The U.S. Congress should support an unfunded $633 million Air Force request to speed up procurement of the rest of the E-7 Wedgetail inventory. This funding would allow the Air Force to buy parts in advance to accelerate procurement of the rest of the inventory to four per year.[99]

The Air Force now plans to retire over 600 fighters over the next five years, while acquiring less than half of that number of new fighters.[100] The F-35 is the linchpin of USAF fighter modernization, and that buy should be accelerated to ensure the service has the capabilities required to defeat peer adversaries, deter threats to the U.S. homeland, and meet other operational requirements. For the homeland defense

mission, the Air Force should also rely on its fourth generation fighter inventory. This means the F-16 and F-15EX should not become targets for additional force cuts.[101]

For the Air Force & Space Force: Expand Collaboration with Commercial Sector

The Air Force and Space Force should continue their joint efforts to expand commercial satellite capabilities in the Arctic. While the SDA is working to rapidly field new satellite architectures for communications and missile tracking, commercial and scientific satellites may be able to fill in immediate gaps. NORAD/NORTHCOM should build on recent prototyping efforts to test commercial satellite capability in the Arctic to develop a plan to procure commercial satellite services in the Arctic that can fill gaps until SDA constellations are fully online.[102]

For the U.S. Government: Deepen Ally and Partner Ties to Support Arctic Missile Defeat

The U.S. Government should strengthen and deepen bilateral and multilateral relationships with Arctic nations to bolster deterrence against air and cruise missile threats in the region. It can become an important proving ground for the Biden administration's concept of integrated deterrence, which is centered on greater collaboration with allies and partners to offset existing shortfalls in warfighting capability and capacity. Allies themselves will have incentives to pursue increased capabilities in the Arctic. Denmark, for example, has already allocated $245 million to improve drone surveillance in the Arctic and is modernizing air surveillance in the Faroe Islands, while Canada is acquiring new drones that can be used for Arctic domain awareness.[103] Norway is already working with the United States to launch communications satellite payloads. But much more needs to be done. To accelerate Arctic nations' efforts, the United States can also offer incentives—similar to providing AUKUS partners with access to sensitive intelligence and sharing key technology—to Arctic countries that rapidly commit substantive investments to Arctic domain awareness.[104]

Conclusion

Bolstering deterrence against conventional air and cruise missile threats in the Arctic starts by improving U.S., ally, and partner domain awareness and information dominance capabilities. Adversaries will be disinclined to launch strikes on the U.S. homeland if they know the United States is anticipating the attack and creating options to dissuade it. Domain awareness and information dominance can underwrite a comprehensive "missile defeat" strategy, left and right of launch, that gives U.S. leaders more options to deter an attack on the U.S. homeland. ✪

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