Canadian Ballistic Missile Defence From the Sea
Interoperability and Sea-Based BMD

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Western military dominance has remained relatively consistent for the past 200 years. Since the Gulf War, a growing number of states and non-state actors have attempted to acquire advanced weapon systems or discover the means to circumvent western technological superiority. One disturbing trend is the increasing number of asymmetrical threats that Canada and its allies will face in future operations: a trend made evident by the 11 September 2001 terrorist attacks and the appalling loss of homeland sanctuary. For an increasing number of states, ballistic missiles are viewed as the preferred means of political intimidation and coercion, including the delivery of weapons of mass destruction (WMD). Ballistic missiles, in fact, have been used in six regional conflicts since 1980 and the threat continues to develop steadily as sophisticated missile technology is becoming increasingly accessible.[1] The ability of Canada and other like-minded states to deploy to a theatre of operation could be considerably constrained.

An escalating number of states, especially the United States, are beginning to envision a future role for maritime forces in the defence of military as well as civilian assets and infrastructure from ballistic missiles.[2] While many navies continue to place emphasis on the traditional functions of sea control, the US Navy and others are shifting their focus towards the littorals, in order to influence continental events directly.[3] For maritime forces, this means that achieving military superiority in the littorals not only requires the ability to project power ashore through amphibious landings and fire support, but the protection of vital resources from air-breathing (includes aircraft and cruise missiles) and ballistic missile threats. These vital resources might include military personnel, military instillations, and civilian population centres. What role should Canadian maritime forces contribute to Ballistic Missile Defence (BMD) along side its American allies and what level of capability, if any, should it acquire for independent action?

The answer lies in an exploration of the threat posed by these weapons, their technological feasibility, and their strategic utility. This study examines whether the pursuit of a BMD capability to support Canadian and US expeditionary forces in foreign theatres is consistent with the nation's overall national security policy. While acquisition of a sea-based BMD capability is in part a technological problem it is more importantly a political and strategic dilemma. Underlining the entire debate is the need for interoperability with the US Navy towards fielding an integrated defence against these politically charged weapons. Since Canada does not possess the resources to contemplate the inclusion of the full range of maritime missions and functions, crucial choices must be made over what strategic options best match national security policy with available resources.

With the removal of Cold War restraints, the international community has witnessed an alarming increase in the proliferation of ballistic missiles. A controversial July 1998 bipartisan US congressional commission reported that any state with an advanced Scud infrastructure could deploy long-range ballistic missiles in about five years without extensive warning.[4] The survivability and political intimidation value of these weapons demonstrated by Iraq in the Gulf War will likely encourage others to acquire them.[5] While the West has concluded that ballistic missiles, unless armed with weapons of mass destruction, are not an overly effective military tool, states seeking to acquire these weapons note that the political influence and power are disproportionate to military utility. Charles Swicker indicated that these, "weapons confer national prestige upon a regime and its leader," and allow, "formidable international intimidation of regional foes."[6] Merely possessing these weapons might not ensure militarily victory against a more powerful adversary; however, they do confer potential political leverage by the threat they pose.

Adversaries will likely use these asymmetrical weapons to bypass superior frontline conventional forces to strike the more vulnerable rear areas, containing relatively unprotected logistics, administration and civilian population centres. By threatening to shift the centre of gravity to the unprotected rear, regional adversaries will possibly gain an unprecedented opportunity to coerce and deter the US and its allies, including Canada. If this is the case, the political will of the US to intervene in regional conflicts and humanitarian missions could possibly be undermined, impacting negatively on its capacity for deterrence. BMD is designed to counter the problem by negating ballistic missiles and devaluing them as strategic assets. The deployment of a defence against this threat would go along way in mitigating this strategic leverage and make possible instigators re-evaluate the utility of these weapons.

The Technological Feasibility of Sea-Based BMD

The deployment of a functional BMD must overcome a number of technological hurdles. Not surprisingly, it is the US Navy that is at the forefront of research into the development of a technologically feasible and cost-effective approach to sea-based BMD. Existing programs are structured on the billions of dollars that has already been allocated in the procurement of the composite and self-contained Aegis AAW platform, a system capable of tracking and engaging air-breathing targets.[7] An envisioned sea-based BMD is based on an evolutionary approach of upgrades to the existing Aegis architecture, in particular the Aegis/SPY-1 passive phased-array radar, the versatile Vertical Launch System, and the Standard missile.

"The heart of the system," Stan Weeks has argued, "is an advanced, automatic detect and track, multi-function phased array radar, the AN/SPY-1."[8] Leveraging the inherent capabilities of the Aegis system has involved incremental upgrades to the multi-function radar.[9] The intent is to give this existing system a better capability to track high-speed targets like ballistic missiles and receive cueing from external sensors. The second pillar of an active sea-based BMD is the flexible Vertical Launch System (VLS). This missile launching structure allows for an assortment of missile types to be fitted within the missile cells. Its versatility provides for new weapons to be added to ships' magazines, just as new aircraft have been added to carrier decks.[10] BMD capable missiles can be loaded into the already standard VLS tubes, reducing the amount of structural changes to the platform in order to accommodate the capability.[11]

Third among the pillars of the successful Aegis weapon system is an evolution of the Standard Missile (SM) air defence interceptor. These missiles represent the primary workhorse of the Extended Air Defence (EAD) mission for the Canadian and US navies. Sea-based BMD requires refinements and upgrades to the SM to improve its guidance systems and additional boost stages for extended distance and increased velocity. The proven reliability of the Aegis system has proven that it is capable of engaging ballistic missile targets if armed with the appropriate interceptor.[12] It seems clear that sea-based BMD possesses the capacity to engage and nullify ballistic missiles through an evolutionary adaptation of the existing Aegis and air defence systems.

A Maritime Shield for Expeditionary Forces: Sea-Based Terminal Phase Defence

Sea-Based Terminal defence is intended to protect early entry forces in underdeveloped theatres of operation against missiles in their final stage of flight.[13] Sea-based BMD will be provided by an upgraded version of the current Standard Missile interceptor.[14] Known as SM2 Block IVA, the missile is a two stage boosted, solid-fuel interceptor armed with a proximity fused blast-fragmentation warhead. Able only to intercept endo-atmospheric targets, the interceptor is limited to engaging hostile missiles as they re-enter the atmosphere in its terminal phase.[15] Effective external cueing can increase the size of the defended area while increases in the ballistic missiles velocity, associated with the missile's range, decreases the area covered by sea-based terminal BMD. The physical separation of the vessel from the defended site requires that sea-based system have a larger intercept radius than ground-based systems. What is arguably its greatest advantage is that the SM2 Block IVA maintains the capacity to intercept air-breathing targets, most notably aircraft and cruise missiles, in addition to ballistic missiles.

Acquisition of a sea-based potential allows maritime forces to extend their EAD at sea to the protection of land-based vital targets. Due to the higher velocity of the sea-based terminal defence interceptor, it has the potential to defend a significantly larger engagement envelope than the Patriot ground-based systems. A single Aegis equipped warship, in fact, will be capable of defending an area many times that of a Patriot battalion.[16] As noted earlier, this provides an initial protection of ports, other vessels, airfields, coastal cities, troop concentrations and disembarkment points at the beginning of conflicts when forces and assets are most vulnerable and ground defences have not yet arrived. As state and non-state actors attempt to circumvent western military superiority, the ability for Canada, the US and their allies to enter a hostile theatre of operation requires a sea-based terminal defence capability.

A Maritime Shield for Theatre Wide Defence: Sea-Based Mid-Course Defence

Instead of protecting a specific area by patrolling offshore, Sea-Based Mid-Course Defence System (SMS), the successor to the Navy Theatre Wide (NTW) program, protects an area of negation by stationing itself between the launch point and target. The closer the vessel is to the launch point the greater its protective umbrella. Charles Swicker states that the size and shape of the defended area depends "more on the location of the defensive platform than on the location of the defended target."[17] Swicker continues by noting that this logically leads to the holy grail of sea-based BMD, the ability for *ascent* phase intercept.[18] By positioning itself close to the launch point and intercepting the missile over the territory of the hostile state, a SMD equipped vessel can protect several vital targets without specifically being physically located in close proximity to any. Theoretically a single vessel, if stationed properly, could protect all of Taiwan or Japan from medium- or intermediate-ballistic missiles launched from China and North Korea. SMS contributes to the larger tiered approach to BMD by allowing intercepts at any point along a missile trajectory while it remains outside the atmosphere. Permitting a 'shoot-look-shoot' intercept and tracking capability allows multiple interceptors to be launched at the hostile missile and thereby decrease the likelihood of leakage.[19]

According to Lieutenant General Lester Lyles, Former Director of the Ballistic Missile Defense Organization, the SMS program "continues to build upon the modifications we are making for the Navy Area Defense system [Sea-Based Terminal System] to Aegis ships and to the modified Standard missile."[20] Besides the necessary upgrades to the Aegis sensors, to track and receive external cueing, the SMS program comprises the further evolution of the Standard Missile. Known as the SM3 LEAP, this high-speed interceptor possesses a three-stage boost concept armed with a Hit-to-Kill (HTK) kinetic warhead. Consequently, this light exo-atmospheric projectile (LEAP) encompasses the means, "to detect and discriminate among moving objects above the atmosphere, and manoeuvre into direct collision with a target warhead."[21] The missiles ability to intercept targets only outside the atmosphere and its lack of a high explosive warhead confers no capability against air-breathing targets. As a result, the SM3 represents a single function missile and lacks the flexibility of the SM2 Block IVA missile. Overall, the SMS represents the most mature naval BMD system and the capability of a single vessel to provide an enclave-like defence for many different targets.

Ballistic Missile Defence BMC4I Architecture

Undisputedly the core of a successful BMD architecture is the technology for real-time information sharing. What is inevitably the key to accurate targeting and weapon guidance is the availability of better and faster access to information.[22] Countering the high-speed threat of ballistic missiles requires the ability to speed up reaction time to engage such high velocity targets. The incapacity for real-time coordination of sensor data and external cueing severely limits the effectiveness of any BMD system. Sensor netting is the core of the Battle Management, Command, Control, Communication, Computers, and Intelligence (BMC4I) architecture that envisions the ability to share accurate, real-time information between sensors. This differs substantially from "the current practice of transmitting highly processed track information between units."[23] A number of joint networks have been proposed for future navy BMD systems that range from non-real time communication to the passing of precise raw sensor data in real-time.

Network-centric warfare revolves on the sharing of a common operational picture and the decentralization of engagement.[24] For the US Navy, network-centric operations will be conducted over the Cooperative Engagement Capability network (CEC), allowing for a combined air picture to enhance the ability to detect, track, and engage ballistic missiles.[25] Raw sensor information passed from one unit will nearly simultaneously cue other units within the network and allow the unit in the best position to engage the target. It is this system in particular, according to Jeremy Stocker, which permits the exploitation of individual unit capabilities and position by allowing the separation of sensors and shooters.[26] All sensors in a network will pass their raw sensor information to the weapon system in the best situation to engage the threat.

Successful defence against ballistic missiles denotes a theatre-wide composite tracking and command and control that include all available BMD systems. During the Roving Sands 95 exercise, the lack of real-time BMD coordination resulted in the firing of seven navy and army interceptors at a single ballistic missile. While maintaining excellent kill rates, there was an excessively high expenditure of interceptors. Further attempts to solve the problem of multiple engagements by the appointment of geographical zones allowed a number of ballistic missiles to leak through the defences.[27] Countering the higher *speed of battle* imposed by ballistic missiles designates a joint approach to the coordinating of real-time sensor information. Maritime forces need the capability to work jointly with its national partners and with other like-minded states.

Is There a Canadian Requirement for BMD?

Development of an autonomous Canadian BMD capability must be measured against the national security policy and avoid the pitfalls of allowing strategy to fall subordinate to the marvel of technology. Occasionally, new technologies run the risk of dominating thought on the employment of navies, especially since they draw their strategic utility from an environment that relies heavily on technology. Much of the academic debate, "tends to concern itself with the rise and fall of the potency of a particular weapon against its antidote," rather than ascertaining the feasibility of a specific strategy.[28] The evolutionary way in which technological military modernization has impacted upon the utility of naval forces has been to direct strategy imperceptibly in certain directions before Canadian strategists are able to establish innovative strategy based upon a logical comprehension of national purpose. What may be operationally or technologically attractive may likely be politically and strategically objectionable.

The evolutionary direction of Canadian national security and defence policy indicate a required shift in strategy that would include some level of BMD capability. Canadian security interests have never depended solely upon protecting Canada from invasion.[29] The national interest is embodied principally in the prosperity and betterment of its citizens vis-à-vis the maintenance of a stable international system. Canada's military strategy document, *Shaping the Future of the Canadian Forces: A Strategy for 2020*, outlined that the defence mission, "is to defend Canada and Canadian interests and values while contributing to international peace and security."[30] At its core, the strategy document advocates the requirement for armed forces capable of being globally deployed. The military establishment has repeatedly stated the growing necessity for Canadian forces to be able to be deployed quickly and efficiently to support humanitarian and peace support operations to trouble spots globally.[31] Isolation from the rest of the world, except from the United States, by three oceans makes Canadian strategy expeditionary by nature.[32]

Owing to the inherent global reach of Canadian maritime forces it is unsurprising that the navy is the most vocal advocate for an essentially expeditionary strategy.[33] Few states have embraced the expeditionary strategy as enthusiastically as the US Navy and Marines, yet an increasing number of states are recognizing the importance of global deployability and are beginning to improve or expand their expeditionary capabilities.[34] Conducting expeditionary operations is undeniably at the core of the current Canadian defence strategy. In the past ten years, the military has experienced an escalating demand for interventionist and peacekeeping operations beyond Canada's borders. In 2001, Canada had approximately 3000 military personnel serving overseas in nineteen missions. September 2001 saw a slight reduction in deployed personnel, but the Canadian Forces quickly found themselves with roughly 5000 personnel deployed after the terrorist attacks of 11 September.[35]

For maritime forces, a mere transitory sea control is inefficient for the successful conduct of littoral operations aimed at influencing inland events. Confronted by the challenges of sealift and littoral operations, Dr. Boutilier, Special Advisor to the Commander Maritime Forces Pacific, questions the degree to which East Timor-style operations might require mid-sized navies to procure amphibious capabilities to undertake, "operations across a beach rather than across a jetty."[36] Canadian forces will unlikely obtain the resources to attain the specialized capability to carry out amphibious operations against a hostile state prepared to deny access. What Canadian Forces advocate is the capacity to conduct so-called administrative landings in regions with inadequate infrastructure.[37] The disruptive quality of ballistic missiles makes these vulnerable areas the preferred targets to bypass the strengths of the US and Canadian conventional forces.[38] With the expanding threat posed by the proliferation of ballistic missiles there is a rapidly emerging need for the Canadian forces to consider some solution to this threat to deployed troops, citizens and allies. Without the assurance of some degree of protection, Canadian and US forces are confronted with the choice of exposing forces and civilian populations to possible attack by weapons of mass destruction or limiting overseas deployments. Both alternatives should be rejected as strategically and politically unacceptable.

Why a sea-based BMD capability?

The United States has envisioned an entire 'family of systems' to counter the threat posed by ballistic missiles. No particular system is the holy grail of BMD, each contributing their unique characteristics to a network approach. Independent from the technological features of a sea-based defence capability are several strategic and operational issues that make it a logical choice for a Canadian response to this asymmetrical threat. Equally important, such a capability would be a logical contribution to cooperative efforts with the United States. The Canadian Navy builds upon the framework of inherent qualities of the current force structure and expertise and offers the most cost-effective and flexible approach to BMD.

It is a misunderstanding of the ballistic missile threat to presume that such a defence is unnecessary if one is not in the business of conducting forced amphibious landings. The Gulf War demonstrated that any large-scale conventional coalition is logistically tied to its strategic sealift tail. Stan Weeks argues that despite the accomplishments of airlift, it only brought in roughly four per cent of the cargo.[39] A coalition's successful military build-up, therefore, depends upon the access to port facilities and coast cities. These crucial centres of gravity are the ideal targets for adversaries to acquire strategic and political leverage from use of their ballistic missile arsenal. Sea-based systems represent an effective means of negating the threat and use of ballistic missiles, contributed to by the nature of warships, the extending of existing area air defence, and the limited reliance on airlift.

Sea-based BMD systems benefit from the same characteristics that warships bring to their other functions, notably their flexibility, versatility, and strategic mobility. Only the sea-based systems are relatively free from the restrictions of host-nations and can operate close to theatre without the permission of the littoral state.[40] Even those advocating a cautioned approach to the acquisition of any type of BMD capability acknowledge a noncommittal sea-based system "is likely to be less controversial than a land-based system deployed on foreign territory."[41] Yet, a BMD capable platform is more than a mobile defence system. Multi-purpose platforms can contribute to an entire spectrum of missions. Unlike ground-based systems, maritime vessels are capable of being tasked with other responsibilities once the threat has been neutralized.

Another benefit of sea-based BMD is that through incremental technological upgrades the area air defence already enjoyed at sea can be extended inland. These improvements build upon a foundation of air defence expertise from an institution that has gained a high-level of experience countering air-breathing threats. Compared to other proposed US programs, the US and Canadian navies already contain a pool of trained personnel that provide for the least amount of force structural change and capital investment. The multi-purpose Sea-based Terminal system allows for the defence against not only ballistic missile but also aircraft and cruise missiles. A modern AAW vessel with a BMD capability, for instance, can be tasked with the escort duty or a Task Group's area air defence and 'plug in' to the network as it flows into theatre. A flexibility level that is unachievable by single-purpose ground-based programs. Considerable advantages are intrinsic to a concept based upon the evolution and innovation of existing infrastructure and programs.

Perhaps equally advantageous is the self-contained nature of these platforms. Warships operate relatively independent of limitations imposed by reliance upon airlift or sealift. Jeremy Stocker's analysis of airlift demands of ground-based BMD systems raises an interesting observation. He notes that a Patriot Battalion requires 128 dedicated C-5 Galaxy or 301 C-141 Starlifter sorties.[42] These requirements would undoubtedly place a substantial burden on an all too scarce airlift capability. While constituting a major strain on US resources, it would be a shear impossibility for Canada. Once ground-based systems arrive in theatre they require set-up that may be denied by hostile states. Only a sea-based capability retains the capability to enter a theatre and "provide immediate coverage," with no additional deployed support.[43] Prior to deployment a vessel would be given a mixed load of missiles allowing for the capability to undertake a spectrum of missions, depending on operational requirements.

Implications and Limitations of Sea-Based BMD

An informed debate on sea-based BMD must consider the restrictions and disadvantages that the capability implies for the Canadian Navy. Maritime vessels are restricted to the environment they inhabit and can reach inland only as far as sea-based aircraft and weapons can be projected. In the case of terminal BMD, defended targets may lay outside the reach of its effective range. Although SMS does not endure the same difficulties, ballistic missile trajectories must cross or travel close to the water patrolled by the BMD capable vessel. The innate characteristics of maritime forces are ineffectual if they are unable to defend vital interests against ballistic missile attack. Furthermore, the political unintrusiveness may hinder the achievement of the state's political objective. In some cases, an allied reassurance of US or coalition support favours the presence of land-based commitments. The commitment required for deploying ground troops, due to their relatively limited visibility and flexibility, signals a higher degree of threat or reassurance than expressed by the ambiguity that often surrounds the deployment of maritime forces.[44]

Despite the extensive miniaturization, which is making warships truly multi-purpose, there still is a finite amount of space from which to hang weapon systems. "You cannot have everything. If you attempt it, you will lose everything."[45] Alfred Mahan so insightfully stated, "On a given tonnage . . . there cannot be the highest speed *and* the thickest armour, *and* the heaviest battery, *and* the longest coal endurance."[46] Competing for the limited space on a BMD capable AAW vessel will be the SM2 Block IVA, SM3, Evolved Sea Sparrow Missile (ESSM), and possibly Tomahawk and SM4 land attack missiles. Any VLS load-out is a zero-sum game. Every missile loaded for one mission reduces the vessel's capacity to fulfill another.[47] Canada must consult closely with the United States and other like-minded states prior to any cooperative operation to ensure its vessels come prepared to contribute most effectively to coalition requirements.

Aside from the physical limitations of space, albeit more severe for smaller warships, differing operational requirements mean that vessels cannot be in the position to carryout all functions. Choices are required between varying missions although technologically capable of undertaking multiple missions. To be sure, the terminal and mid-course mission require separate positional requirements in comparison to the locations of ballistic missile launch areas and their targets. A vessel forward deployed to intercept a missile in its mid-course phase will likely be unable to participate in terminal defence. Increasing demand for maritime assets makes it improbable that states will possess the necessary resources to accommodate all missions and necessitate cooperative efforts between allies.

US/Canadian Naval Interoperability and Ballistic Missile Defence

Listed in *Strategy 2020* as a major objective of the Canadian defence strategy is the ability for Canadian forces to operate seamlessly with the US and other allies.[48] Commander Barry Coombs (USN), in examining potential areas of future collaboration between the two navies, argued that shrinking maritime assets necessitate enhancing cooperation as one key to success in pursuit of the common focus on regional crisis. Although it remains in the interest of the USN to maintain interoperability with Canada and other allies, Captain (N) A. J. Goode makes an important observation that imbalance in the two fleets designates that the imperative for standardization falls on Canada.[49] US research and acquisition of advanced BMC4I technologies will likely widen the capability gap with its allies. Canada's geographical proximity and cooperative efforts with the US in North American security denotes a necessity that Canada's navy remains interoperable.

A Canadian vessel must do more than simply "show up and defend itself," it must contribute directly to combined and joint operations.[50] Countering the threat posed by ballistic missiles will require the Canadian Navy to share extremely accurate information with the USN. A failure to acquire a CEC capability could substantially hinder any attempt at seamless cooperation. Without the ability to 'plug in' to the sensor net, the tasks undertaken by Canadian maritime forces will be limited and position them outside the information loop. Moreover, maintaining this high level of interoperability will enhance that same vessel's ability to contribute to littoral operations and multiply the capability of its offensive systems.

Still constrained by the geography of the maritime environment, operational limitations of sea-based BMD are partially solved by the presence of additional vessels. The procedure of determining force structure must appreciate that *mass* still matters. The introduction of Canadian vessels into a BMD sensor network allows a US vessel to fulfill another function or *visa versa*. In cases where land attack and air defence missions require different positioning, for instance, a Canadian warship could allow a US Aegis cruiser to shift from a defensive to offensive role. The theoretical ability of a single vessel to conduct BMD has been highlighted. Yet, strain on both the crew and systems stipulate a teamwork approach to BMD missions. Increasing demands across the entire spectrum of mission requirements will continue to place a strain on limited resources, this when most western maritime forces have reduced their force levels. The Canadian Navy's ability to integrate into the US BMC4I network will extend its protective air defence 'umbrella' over embarked Canadian and allied forces.

Canada has two choices in its approach towards fielding sea-based BMD dependent upon the degree to which the Canadian navy can act independently and contribute to allied BMD. Both options necessitate the acquisition of a CEC capability and a high-level of interoperability with US forces. First, the capability permitting shooter-sensor separation offers the Canadian Navy the alternative to acquire the weapon systems mandatory for the BMD role without the expensive Aegis sensor array. BMD capable missiles aboard Canadian vessels would be launched and controlled by Aegis capable US vessels. The Canadian navy has recognized that an inability to plug into a CEC network may affect integration into joint Task Groups and the capacity to improve AAW reaction times without the need for the procurement of expensive sensors.[51] Such a restriction imposed by a partial BMD capability would be inappropriate for Canada. Second, a more advantageous choice is the acquisition of a limited capability to conduct BMD operations without the US. This requires the ability to track and intercept missiles. Undoubtedly a more expensive option, a complete BMD capacity provides a more meaningful and uniquely Canadian contribution to allied operations.[52]

Conclusion

Strategists, naval thinkers among them, face the difficult task of predicting the future of conflict and required force structure. Two trends in the use of maritime forces described earlier include a shift towards the conducting of operations within the confines of the littorals and the proliferation of ballistic missiles as the preferred means of circumventing western military dominance. Both signify need for the US and Canada to deploy in support of their national security interests that requires a capacity to protect their forces from asymmetrical weapons. Given that the majority of armed conflicts or humanitarian interventions will take place within the 300 miles of the coast, a warship's versatility and flexibility makes them the ideal platforms for defence against ballistic missiles.

If Canada maintains its shift towards expeditionary forces and a defence policy of preserving international stability alongside its allies, the government must be willing to deploy its forces to theatres threatened by ballistic missiles, cruise missiles and weapons of mass destruction. Canada needs to move beyond technological feasibility or acquisition arguments and examining how the capability fits within the overall national security strategy. No national treasury is infinite and there will never be the available resources to require the capabilities to undertake missions across the entire spectrum. Structuring maritime forces for BMD is a much more cost-effective alternative to the fielding and manning of a ground-based system. There are also significant advantages inherent in developing future BMD capabilities on proven US systems, including increases in the potential level of interoperability. While there is no silver bullet in missile defence, a sea-based BMD capability for Canada's navy will enable the deployment of Canadian and US forces with increased protection from this growing asymmetrical threat.

NOTES

[1] House Committee on National Security. *Statement of Lieutenant General Llester L. Lyes, USAF Director, Ballistic Missile Defense Organization before the Subcommittee on Research & Development*, 6 March 1997, 2.

[2] For sample of the countries examining the possible acquisition of sea-based BMD, see Japan Defense Agency, *On the Mid-Term Defense Build-up Plan (FY1996-FY2000)*, 28 November 1995, Chp. 15; "Japan Joins U.S. Effort to Counter Missiles," *Defense News*, 23 August 1999; Steven A Hildreth & Jason D. Ellis, "Allied Support for Theatre Missile Defense," *Orbis* 40, no. 1 (Winter 1996), 110; Jeremy Stocker, *Sea-Based Ballistic Missile Defence*, (Lancaster: Centre for Defence and International Security Studies, 1999), 79-97; Jeremy Stocker, "Missile Defence From the Sea," in Theatre Missile Defence, eds. Robin Ranger, (Lancaster: Centre for Defence and International Security Studies, 1998), 94-98; Department of National Defence, *Leadmark: The Navy's Strategy for 2020*, (Ottawa: Directorate of Maritime Strategy, 2001), 151-152. For information on US programs, see Department of Defense, *Ballistic Missile Defense Approach*, Missile Defense Agency Fact Sheet, October 2002, and *Sea-Based Midcourse*, Missile Defense Agency Fact Sheet, Janurary 2003.

[3] The Canadian Navy describe the littorals as: "The coastal sea areas and that portion of the land which is susceptible to influence or support from the sea, generally recognized as the region which horizontally encompasses the land-water mass interface from 100 kilometres (km) ashore to 200 nautical miles (nm) at sea, and extending vertically into space from the bottom of the ocean and from the land surface." Department of National Defence, *Leadmark: The Navy's Strategy for 2020*, GL12.

[4] U.S. Congress, *Report of the Commission to Assess the Ballistic Missile Threat to the United States*, 104th Cong., 15 July 1998.

[5] David B.H. Denoon, *Ballistic Missile Defense in the Post-Cold War Era* (Boulder: Westview Press, 1991), 62.

[6] Charles C. Swicker, *Theatre Ballistic Missile Defense from the Sea: Issues for the Maritime Component Commander* (Newport: Naval War College, 1998), 6.

[7] Air-breathing targets refer to those weapon systems and platforms that operate within the earth's atmosphere; this includes aircraft and cruise missiles.

[8] Stanley B. Weeks and Charles A. Meconis, *The Armed Forces of the USA in the Asia-Pacific Region* (St. Leonards: Allen & Unwin, 1999), 148.

[9] Ibid., 148. The authors claim that "The heart of the system is an advanced, automatic detect and track, multi-function phased array radar, the AN/SPY-1."

[10] Daniel J. Murphy, "Like Thunder and Lightning," *USNI Proceedings* 123, no. 6 (June 1997), 58. Japanese Aegis equipped warships again highlighted the radars capability of tracking ballistic missiles when it monitored the launch of a missile over the Japanese northern islands by North Korea.

[11] Presently, the US Navy's Arleigh Burke-class destroyers contain ninety missile cells and the Ticonderoga-class cruiser contains 122 cells. The Mark-41 VLS is also found on non-Aegis equipped platforms, albeit in smaller numbers, like the US Navy's Spruance-class destroyers. See, Rodney W. Jones, *Taking National Missile Defense to Sea: a Critique of Sea-Based and Boost-Phase Proposals* (Washington, D.C.: Council for a Livable World Education Fund, 2000), 7. The ageing Canadian IROQUOIS class destroyers responsible for the Canadian Task Groups AAW capability is equipped with a smaller array of 32 cell Mark-41 VLS. See, DND DOC 8.

[12] John D. Gresham, "Navy Area Ballistic Missile Defense Coming On Fast," *USNI Proceedings* 125, no. 1 (January 1999), 60.

[13] The US Navy's terminal defence system was previously know as Navy Area Defence (NAD) and was perceived to be the most technologically feasible option and required the least amount of modifications to the existing AAW capability. The program was cancelled following poor performance and higher projected costs and a breach of the Nunn-McCurdy Selected Acquisition Report. A Nunn-McCurdy unit cost breach occurs when a major defence acquisition program exceeds the projected cost by at least 15 percent.[13] In cooperation with its allies, the US Navy and the MDA are still exploring the deployment of a modified sea-based terminal defence to guarantee rapid protection of deployed forces. The Naval Area Defence acquisition unit cost was roughly fifty-seven percent above initial estimates and, therefore, was in material breach of the Nunn-McCurly Selected Acquisition Report. The program was not re-certified as currently configured. See, Department of Defense, *Navy Area Missile Defense program Cancelled*, New Release (14 December 2001)

[14] Swicker, *Theatre Ballistic Missile Defense from the Sea: Issues for the Maritime Component Commander*, 22; and Charles C. Swicker, "Ballistic Missile Defense from the Sea: The Commander's Perspective," *Naval War College Review* 50, no. 2 (Spring 1997).

[15] The MDA divides a missiles trajectory into the boost, mid-course, and terminal phases. The Boost Defence Segment (BDS) is anticipated to engage the missile from post-launch through to the completion of its propulsion burn. This segment last less than 200 km, depending on its range capability, and space- or air-based systems offer the best defence. The Mid-Course Defence Segment (MDS) will provide the capability to destroy missiles above the atmosphere. This portion offers the best option for defence given the more predictable and longest flight path. Finally, the Terminal Defence Segment (TDS) intercepts the missile as it re-enters the atmosphere. The timeframe is very short and the interceptor must be deployed close to the missile's intended target. For further information, see Department of Defense, *Ballistic Missile Defense Approach*, Missile Defense Agency Fact Sheet, October 2002.

[16] Swicker, *Theatre Ballistic Missile Defense from the Sea: Issues for the Maritime Component Commander*, 62.

[17] Ibid., 24.

[18] *Ascent* segment refers to the beginning portion of the mid-course phase when the missile is still climbing to altitude.

[19] 'Leakage' represents missiles that are able to penetrate any BMD system. The increased number of intercept opportunities due to 'shoot-look-shoot' capabilities and tiered systems decreases the percentage of probability that a missile will fail to be intercepted.

[20] House Subcommittee on Research & Development, *Statement of Lieutenant General Lester L. Lyles, USAF, Director, Ballistic Missile Defense Organization*, 104th Cong., 6 March 1997, 6.

[21] Jones, *Taking National Missile Defense to Sea: a Critique of Sea-Based and Boost-Phase Proposals*, 9.

[22] For David Freyman, data relevant to warfare missions is the only lever that will ultimately move maritime forces from the industrial age to the 'trans-industrial' age. J. Paul Reason and David G. Freymann refer to the trans-industrial age to define the current age between the earlier transition age to something different. See, J. Paul Reason and David G. Freymann, *Sailing New Seas*, The Newport Papers (Newport: Naval War College, 1998), 5.

[23] Robert Kerno, "CEC and the Interoperability," *Sea Power* (March 1999), 45.

[24] Roger W. Barnett, "Naval Power For a New American Century," Naval War College Review 55, no. 1 (Winter 2002), 54.

[25] Ibid., 3.

[26] Stocker, *Sea-Based ballistic Missile* Defense, 78.

[27] Cited in Swicker, *Theatre Ballistic Missile Defense from the Sea: Issues for the Maritime Component Commander*, 15.

[28] Raja Menon, *Maritime Strategy and Continental* Wars, (London: Frank Cass, 1998), 141.

[29] Nearly thirty-eight percent of the Canadian GDP was generated by foreign exports in 2000, that is more than double the average among the other G-8 countries. Making roughly one in three Canadian jobs reliant on international trade according to the Conference of Defence Associations. See, Conference of defence Associations, *Caught in the Middle: An Assessment of the Operational Readiness of the Canadian Forces*, (Ottawa: The Conference of Defence Associations Institute, 2001), 3.

[30] Department of National Defence, *Shaping the Future of Canadian Defence: A Strategy for 2020*, (Ottawa: Department of National Defence, 1999), 2.

[31] Nearly all strategy and operational documentation from the Department of National Defence highlight the Canadian need for global deployability. For instance, see Canada, Department of National Defence, *Report on Plans and Priorities 2001-2002*, A-PP-015-000/AF-002 (Ottawa: Department of National Defence, 2002), 4; Department of National Defence, *At the Crossroads: Annual Report of the Chief of the Defence Staff 2001-2002*, A-JS-015-000/AF003 (Ottawa: Department of National Defence, 2002), 27; and *Shaping the Future of Canadian Defence: A Strategy for 2020*, 10.

[32] Richard H. Gimblett, "A Strategic Overview of the Canadian Security Environment," Canadian Foreign Policy 9, no. 3 (Spring 2002), 8.

[33] Department of National Defence, *Leadmark: The Navy's Strategy for 2020*, 88, 104-5.

[34] The new US navy strategy was founded on the ability to project power across the shore, including amphibious landings and sealift. See, Department of the Navy, *. . . From the Sea: Preparing the Naval Service for the 21st Century*, (Washington, D.C.: Department of the Navy, 1992), *Forward. . . From the Sea*, (Washington, D.C.: Department of the Navy, 1994), and *From the Sea: The Naval Operational Concept*, (Washington, D.C.: Department of the Navy, 1997). For information on the US Marine Corps strategy, see Department of the Navy, *Marine Corps Strategy 21*, (Washington, D.C.: Department of the Navy, 2000), and *Expeditionary Maneuver Warfare: Marine Corps Capstone Concept*, (Washington, D.C.: Department of the Navy, 2001). The changes in British maritime strategy are more pronounced with a visible emphasis on expeditionary operations. The British believe that in the "future littoral operations and force projection, for which maritime forces are well suited, will be our primary focus. These tasks, which range from the evacuation of citizens from an overseas crisis to major warfighting operations as part of a joint force, will be highly demanding." United Kingdom, Ministry of Defence, *Strageic Defence Review*, (London:The Stationary Office, 1998). Maritime contribution to joint operations will steer British maritime strategy and these force will be "optimised for joint power projection . . .." Ministry of Defense, *Naval Strategic Policy: The Next Fifteen Years*, (London:The Stationary Office, 2001), and *The Fundamentals of British Maritime Doctrine* (BR 1806), (London: The Stationary Office, 1995).

[35] Department of National Defence, *At A Crossroads: Annual Report of the Chief of the Defence Staff, 2001-2002* (Ottawa: Government of Canada, 2002), 3.

[36] James Boutilier, "Mid-Sized Navies in the Asia-Pacific Region, 2000-2025: The case of the Canadian, South Korean, and Japanese Navies," *Royal Australian Navy: Maritime War 21 Conference*, 15.

[37] Department of National Defence, *Leadmark: The Navy's Strategy for 2020*, 105. The Canadian maritime forces state the need for the capacity to insert forces into a part of the world that lacks commercial-standard off-load but does not pose a significant threat to force disembarkation.

[38] It is misleading to conclude that such ports or disembarkment points continue to remain sheltered from a potential adversary's reach. The Iraqi Scud attack on the port of Al Jubayl, Saudi Arabia, narrowly missed hitting a pier complex at which the amphibious ship *Tarawa*, fully loaded with Marines, was moored. Additionally, the pier contained an ammunition storage area, petrol truck area and several other ships; including a hospital ship, army barge and two aviation support ships. If it had been struck the resulting damage and loss of life would have been incredible. The vulnerability of these large and stationary targets becomes clear when considering the largest single loss of life for the coalition forces was a similar missile strike on a billeting building at Dhahran. See, Greshan, 58

[39] Weeks, *The Armed Forces of the USA in the Asia-Pacific Region*, 182.

[40] Murphy, 59.

[41] David A. Adams, "Walking the Missile Defense Tightrope," *USNI Proceedings* 124, no. 9 (September 1998), 99.

[42] Jeremy Stocker, "Missile Defence From the Sea," in *Theatre Missile Defence*, Bailrigg Study 1 (Lancaster: Centre for Defence and International Security Studies, 1998), 49.

[43] Willard G. Fallon, "Combating the Ballistic Missile Threat," *USNI Proceedings* 121 no. 7 (July 1994), 33.

[44] For instance, the US garrison presence sends a different message to North Korea then the more ambiguous maritime presence and the defence of Taiwan.

[45] Alfred T. Mahan, *The Influence of Seapower Upon History, 1660-1783*, (1890; reprint, London: Methuen, 1965), xxxi.

[46] Ibid.

[47] Swicker, "Ballistic Missile Defense from the Sea: The Commander's Perspective," 34.

[48] Canada, Department of National Defence, *Shaping the Future of Canadian Defence: A Strategy for 2020*, (Ottawa: Government of Canada, 1999), 10.

[49] Goode, Captain (n) A. J., "Interoperability with the USN: Essential for the Canadian Navy?" *Maritime Security Working Papers*, no. 2 (June 1995), 2.

[50] Department of National Defence, *Leadmark: The Navy's Strategy for 2020*, 149.

[51] Ibid., 38.

[52] Presently the Canadian Navy's IROQUOIS class destroyers, Canada's primary AAW vessels, maintain no capability against ballistic missiles. Equipped for the Task Group area air defence role, the Department of National Defence has determined that the current destroyer fleet could be upgraded to carry the SM2 Block IVA and SM3 missiles, but technically difficult and expensive to modify the class of destroyers to carry the Aegis SPY-1 radar. Department of National Defence, *Employment of Canadian Ships in Theatre Missile Defence (TMD)* MARC: 3293-1 (CMS) 6 August 1999, 10. This holds true for the HALIFAX class frigates as well. A Maritime staff investigation found that ships of between 5000 to 6500 tons displacement will be capable of supporting such a capability in the next ten years, the current displacement tonnage of the IROQUOIS class or larger. In fact, any new Canadian AAW replacement vessel for the IROQUOIS class will likely be inherently BMD capable.