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Scientific Brief

Maritime Domain Awareness in the Canadian Safety and Security Program

Purpose of this Scientific Brief

To inform and make recommendations to DG CSS and other senior decision-makers regarding S&T investment in Maritime Domain Awareness to maximize probability of impact on public safety outcomes.

Summary

Given the parallel program formulation activities for the DND/CF-focused DRDC program (through a set of draft outcomes[1] and program briefs) and the safety and security outcomes[2] for the CSSP, there is an opportunity for the investment in Science and Technology to improve maritime domain awareness for *national defence* and *public safety*. However, in the context of the CSSP, we make the following recommendations with respect investment in MDA:

1. Avoid incremental investment in S&T programs that already receive significant funding from other government departments and instead leverage the outputs of these programs for Public Safety stakeholders;
2. Fund S&T projects that transition essential and affordable components of existing defence technology to the public safety domain;
3. Fund S&T projects that produce practical, lightweight, industry-supported, high TRL solutions that link awareness to response[3];
4. Fund S&T projects in horizontal initiatives that enable departments to work together;
5. Fund S&T projects that identify operational gaps and pilot programs that provide hard data to drive future investment.

Introduction

The Canadian Safety and Security Program (CSSP) outcome that relates to Maritime Domain Awareness (MDA) is Intermediate Outcome 5, which states *"Canada's border-related economic vitality and sovereign integrity is enabled."* One of the Immediate Outcomes under this reads *"Domain Awareness in the air, land and maritime border environments, including the North, is enhanced through S&T investment".* Our goal in this document is to provide guiding principles for investment in MDA, which has complex, multi-department national requirements. To do this, we need clarity over the "swimming lanes" vis-à-vis other programs, as well as terminology, both at the broad government level and specifically for MDA. **Public Security** is used informally to capture "the function of governments which ensures the protection of citizens, organizations, and institutions against threats to their well-being – and to the prosperity of their communities."[4] As public security overlaps with Public Safety it is used to mean law enforcement. As it overlaps with National Defence it is used to mean counter-terrorism. The confusion

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[1] Defence R&D Canada Draft Client Intermediate Outcomes for FY 14/15, Version 4.5 25 June 2013

[2] Articulated in A Framework for Public Safety and Security Science and Technology 2012/2013, draft for approval 2012.

[3] See Alberts, D. S. and Hayes, R.E. Power to the Edge: Command and Control in the Information Age, CCRP, 2003.

[4] http://en.wikipedia.org/wiki/Public_security

occurs when *security* is also used in the term *National Security* to be much more holistic and inclusive of geo-politics and expeditionary forces. For clarity, we will avoid *public security*, and rely on the terms formally within the names of existing government departments in Canada, i.e. **Public Safety** Canada and the *Department of* **National Defence**.[5]

In its broadest definition, MDA is "*The understanding of anything associated with the maritime domain that could impact domestic or international security, safety, economy or environment.* "[6]

No single department or agency is responsible for maintaining domain awareness in Canada's maritime approaches, inland waterways and Arctic region. Recognizing the need for a multi-agency approach, Transport Canada formed the Interdepartmental Marine Security Working Group (IMSWG) in 2001. The purpose of this working group, which includes representatives from 17 federal departments and agencies[7] with mandates for different aspects of marine security, is "to serve as a forum where members can identify and coordinate federal initiatives to enhance Canada's marine security".[8]

The IMSWG recently produced two reference documents, namely Canada's Maritime Security Strategic Framework and Canada's Maritime Domain Awareness Strategy. These documents define the **Maritime Domain** as:

> "*all areas and things of, on, under, relating to, adjacent to, or bordering on a sea, ocean, or other navigable waterway, including the maritime related activities, infrastructure, people, cargo, and vessels and other conveyances. Therefore, maritime activities are those things that are connected to the maritime domain;*"

and **Maritime Domain Awareness** as:

> "the effective understanding of anything associated with the maritime domain that could impact the security, safety, economy or environment of Canada."

The Strategic Framework states that effective MDA is achieved when the information necessary to enable informed decisions is available to national decisions-makers, and a coordinated whole-of-government response to marine security threats can be facilitated. It also categorizes the threats in the maritime environment as: Organized Crime, Terrorism, Migrant Vessels, Piracy and Armed Robbery, Threats in the Arctic Region, WMD proliferation and Espionage.

In a document entitled *Canada's Maritime Domain Awareness Strategy,* IMSWG recently identified three challenges and five strategic objectives:

Maritime Domain Awareness Gaps
• Lack of persistent wide area surveillance of Canada's Exclusive Economic Zone and approaches, acknowledging the particular challenges of the Arctic and the Great Lakes/St Lawrence Seaway;   • Inadequate awareness of small vessels in waters under Canada's jurisdiction and approaches; and   • Impediments to the sharing of routine information that enables MDA with particular note to legal, policy and cultural challenges.
Maritime Domain Awareness Objectives
• Track, Monitor and Identify vessels;   • Access and Maintain data;   • Collect, Analyze, Disseminate and Share Information   • Facilitate Awareness of MDA Activities; and   • Monitor and Review MDA Performance."

Table 1 Canada's Maritime Domain Awareness Strategy, from IMSWG

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[5] Additional discussion in Annex, with illustration.
[6] http://terminology.mil.ca/term-eng.asp
[7] Membership includes CBSA, CFIA, CSIS, CSA, DRDC, DFO/CCG, DOJ, DND, EC , FIN, DFAIT, GOC, PCO, PS, RCMP, TC, and TBS
[8] http://www.tc.gc.ca/eng/marinesecurity/partnerships-285.htm

The interdepartmental Coastal Marine Security Operations Centres (MSOC) Project Office, led by the Department of National Defence, was established on November 1, 2005.[9]   The two Coastal Marine Security Operations Centres (MSOCs) have been operating since September 2004 in Halifax, Nova Scotia, and Esquimalt (Victoria), British Columbia. They are situated in two existing Navy buildings at Joint Task Force Atlantic, Canadian Forces Base Halifax and Joint Task Force Pacific, Canadian Forces Base Esquimalt.   A third Centre, the Great Lakes-St Lawrence Seaway Marine Security Operations Centres has been operating since July 2005, in Niagara Falls, Ontario. The Centre is situated in facilities owned and managed by Royal Canadian Mounted Police.   The MSOCs provide comprehensive marine domain awareness along Canada's coasts enabling detection, assessment, and response to threats that could adversely affect the safety, security, environment or economy of Canada. Threats include foreign trans-national organized crime - drug trafficking, piracy, migrant smuggling - emerging terrorist activity, over-fishing, and polluters. The Centres enable marine intelligence and operations information and data that are collected by the partner agencies/departments to be transformed into integrated maritime situational awareness and contingency planning products.[10]

The Canada First Defence Strategy (CFDS) also highlights the needs and challenges related to MDA for the Canadian Armed Forces. Specifically, under the heading "Defending Canada", the CFDS states:

> *"…The Forces must also work closely with federal government partners to ensure the constant monitoring of Canada's territory and air and maritime approaches, including in the Arctic, in order to detect threats to Canadian security as early as possible.*
>
> *Excellence at home requires the Forces not only to identify threats, but also to possess the capacity to address them quickly and effectively. While, **under most circumstances, other government departments and agencies will have leadership responsibilities**, the Canadian Forces will also play a vital role in many situations. …*
>
> *…Delivering excellence at home requires the Forces to be aware of anything going on in or approaching our territory, deter threats to our security before they reach our shores, and respond to contingencies anywhere in the country. Specifically, it means that the military will maintain the capacity to:*

> - *Provide surveillance of Canadian territory and air and maritime approaches;*
> - *Maintain search and rescue response capabilities that are able to reach those in distress anywhere in Canada on a 24/7 basis;*
> - *Assist civil authorities in responding to a wide range of threats - from natural disasters to terrorist attacks. "[11]*

> *The Forces must also be available to assist other government departments in addressing such security concerns as over-fishing, organized crime, drug- and people-smuggling and environmental degradation. As well, the Forces will be prepared to effectively assist other government departments in providing security for major events at home, such as the 2010 Vancouver Olympic Games and the G8 Summit to be held in Canada that same year.*
>
> *Finally, the Canadian Forces must have the capacity to exercise control over and defend Canada's sovereignty in the Arctic…and [help] other government agencies such as the Coast Guard respond to any threats that may arise.*

The CFDS recognizes that other government departments have the lead at home but remains ready to provide assistance when required. With respect to MDA, the Forces must maintain a capacity to provide surveillance of the maritime approaches to Canada.

In its second role, i.e. that of defending North America, the CFDS states:

> *"The Canadian Forces will continue to collaborate with their US counterparts as a partner in the North American Aerospace Defence Command (NORAD). This binational command has been an important element of the Canada-US defence relationship since its creation in 1958, and its primary mission of defending North American aerospace*

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[9] http://www.msoc-cosm.gc.ca/en/description.page?
[10] http://www.msoc-cosm.gc.ca/en/questions-answers.page?
[11] http://www.forces.gc.ca/en/about/canada-first-defence-strategy.page

remains important today. NORAD is also evolving to meet future threats and, as part of the May 2006 renewal of the Agreement, the Command was assigned the new responsibility of maritime warning."

Guidance from DND applied to S&T programs[12] includes defence-specific aspects related to MDA. The Royal Canadian Navy's key objectives in the focus area of *maritime information warfare* include MDA and development of a recognized maritime picture, but also maritime targeting and acquisition, safeguarding of forces and supporting forces ashore through joint fires. Objectives include integration of local surveillance information with external MDA networks, and leverage of MDA information sources to ensure information dominance for littoral operations.

The RADARSAT Constellation Mission (RCM) at the Canadian Space Agency is important for the future of maritime domain awareness, identifying three main uses for the RCM:

- Maritime surveillance (ice, wind, oil pollution and ship monitoring);
- Disaster management (mitigation, warning, response and recovery); and
- Ecosystem monitoring (forestry, agriculture, wetlands and coastal change monitoring). [13]

With respect to MDA, the CF are integral part of NORAD, which has maritime warning and monitoring of maritime approaches within its mission.[14]

Efforts in the United States have paralleled Canadian efforts, as described in the National Plan to Achieve Maritime Domain Awareness[15] issued by the Department of Homeland Defence that provides priorities and strategic guidance for MDA.   Similar issues with overlapping mandates, information sharing and complexities appear in Canada and the US.[16] In the defence communities and the public safety communities that MDA is a continental priority and shared responsibility, as indicated in the need for domain awareness in the Beyond the Border Agreement.[17]

Maritime Domain Awareness S&T Landscape

The CSSP at DRDC's CSS has targeted the MDA gaps identified by IMSWG[18] in its last two calls for proposals and has received several proposals worthy of consideration. CSS has previously funded work on maritime radar feasibility on the Great Lakes[19], Canada/US sensor sharing on shared waterways, and MDA support to major events[20]. It is currently funding work on acoustic sensors, historical vessel traffic analysis and providing operational capability directly to enforcement initiatives such as Integrated Border Enforcement Team (IBET) and Shiprider.

With increasing pressure on government funding, CSSP resources should be dedicated to nurturing capabilities that have the highest probability of impact without duplicating the efforts of other programs or activities, recognizing that they will be employed in a multi-agency effort.

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[12] The *Maritime Science and Technology Programme Guidance – 2012, signed by Commodore D. Sing, Director General Maritime Force Development for Commander Royal Canadian Navy.*

[13] http://www.asc-csa.gc.ca/eng/satellites/radarsat/default.asp

[14] http://www.norad.mil/AboutNORAD/Vision.aspx

[15] http://www.dhs.gov/xlibrary/assets/HSPD_MDAPlan.pdf

[16]Example:http://www.marad.dot.gov/environment_safety_landing_page/Office_of_Security/OS_global_supply_chain_security/global_supply_chain_security.htm

[17] http://actionplan.gc.ca/grfx/psec-scep/pdfs/bap_report-paf_rapport-eng-dec2011.pdf

[18] From *Canada's Maritime Domain Awareness Strategy, IMSWG,* quoted in Table 1.

[19] Nohara, T. et al, Evaluation of Wide-Area, Covert, Radar Networks for Improved Surveillance, Intelligence and Interdiction against Watercraft and Low-Flying Aircraft, Accipiter Radar Inc. Contractor Report DRDC CSS CR 2011-30, December 2011.

[20] Meunier, P. and Vallerand, A. Border Integrity Capability: Enhancements of Multi-jurisdictional Situation Awareness on Lake Ontario during the G20, DRDC CSS TM 2011-12, June 2011.

S&T related to MDA at other DRDC Centres

Within the *DRDC Draft Client Intermediate Outcomes for FY 14/15*[21], and *DRDC Science and Technology Program Briefs*[22], MDA is divided among several portfolios (Director Generals S&T Program), including the Joint Force Development, Navy, Air and Force Employment programs. A full excerpt of relevant passages is provided in the Annex.

The Joint Force Development S&T program on ISR are the most likely place to seek out exploitation of results developed for the Canadian Armed Forces (CAF) in the public safety context. The key area is the exploitation of space-based sensors for persistent awareness of Canada's maritime approaches.

The Navy S&T Maritime Information Warfare program provides support to MARLANT/N6 for the generation of a recognized maritime picture that may be passed to stakeholders such as the MSOCs and may have exploitable data fusion technology.

Other programs for the navy are primarily on protection of naval platforms. Collaborations that enhance sharing of situational awareness between CAF platforms and other government systems may have dual outcomes to enhance MDA for public safety and provide earlier detection of missile and torpedo threats.

The Force Employment S&T program for the Canadian Joint Operations Command is focused on the Arctic, and may have leverage opportunities with respect to methodologies and technologies to improve maritime situational awareness in the Arctic.

S&T related to MDA at the Canadian Space Agency

One of the mandates of the Canadian space strategy is to "integrate space fully and completely in Government of Canada departments and agencies as an invaluable tool to help fulfill their mandates …".[23] CSA's mandate in the area of MDA is to:

- *Support the surveillance of Canada's territorial land and coastal sovereignty and related national security issues;*
- *Support disaster management and emergency response in Canada and abroad, including the protection of critical infrastructures;*
- *Support Canada's effort to play an active, visible and key role in initiatives stemming from its foreign policy, particularly in peacekeeping operations, humanitarian assistance and transborder issues (pollution, fisheries, etc.).*[24]

The Earth Observation Application Development Program (EOADP)[25] at CSS funds R&D program to "transpose results from R&D projects to operational use" in the area of environmental monitoring, resource & land use management, security & sovereignty and technology & innovation. Of particular relevance is CSA's sponsorship of the development of MDA applications using Radarsat 2 and the future Radarsat Constellation Mission (RCM).

CSA is active in the field of Synthetic Aperture Radar (SAR) and holds bi-annual workshops to share information in this area. One of the 2013 workshop tracks on "maritime applications"[26] included the following papers:

1. Suspicious Vessel Monitoring using RADARSAT-2,
2. Ship Detection and Observations of Ship Wakes by simultaneous TerraSAR-X and Marine Radar Measurements,
3. Ship Detection Performance Assessment Using Simulated Radarsat Constellation Mission Data,
4. On the use of Radarsat-2 data for ship monitoring: advanced methodologies with medium resolution images,
5. Vessel Tracking and Anomaly Detection using Level 0/1 and High-Level Information Fusion Techniques,
6. Ship Detection in K-Distributed Clutter using Polarimetric Data,
7. Space based vessel detection – the role of Earth Observation for maritime surveillance,
8. Oil spill aging and polluter identification from SAR imagery: toward an integrated system with AIS and drift modeling,
9. Semi-Automated Classification of Oil slicks at sea using RADAR and Optical imagery (SACORO).

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[21] Defence R&D Canada Draft Client Intermediate Outcomes for FY 14/15, Version 4.5 25 June 2013.
[22] DRDC Science and Technology Program Briefs, Nov 2013, https://partners1.drdc-rddc.gc.ca/admstsec/comms/default.aspx
[23] http://www.asc-csa.gc.ca/eng/publications/strategy.asp
[24] Ibid.
[25] http://www4.asc-csa.gc.ca/auot-eoau/eng/eoadp/projects/type/rd.aspx
[26] http://www.asc-csa.gc.ca/eng/events/2013/20131015-asar.asp

International S&T related to MDA

Through the Technical Cooperation Program, the five eyes community collaborates on MDA in the maritime group, activity group TTCP MAR AG 8, exploring topics such as sensor and data fusion, sharing maritime situational awareness and maritime assessment of risk.[27]

The United States Department of Homeland Security Science and Technology Directorate (DHS S&T) maintains a division on border and maritime security. Through a memorandum of understanding, DRDC's CSS is able to have collaborative programs in MDA with this division.[28]   A recent presentation[29] by the division director listed projects with coastal surveillance systems, detection of people in water, and the ability to introduce technology through pilot programs to the Air and Marine Operations Centre - an international multi-domain federal law enforcement center[30] with similar mandate to the Canadian MSOCs.

Recommendations and Conclusions

Where possible, S&T investment should be placed to achieve both national defence and public safety *outcomes* when they overlap.   When S&T investment is decomposed by other means (e.g. by threat, enabling technology, or operational capability), it may also indicate an appropriate blend of investment. This area is not without ambiguity and uncertainty, as shown in Figure 2, which shows an estimate of relative importance for a variety of items on the spectrum from national security to public safety. Note these are subjectively arranged relative to one another, rather than scaled.
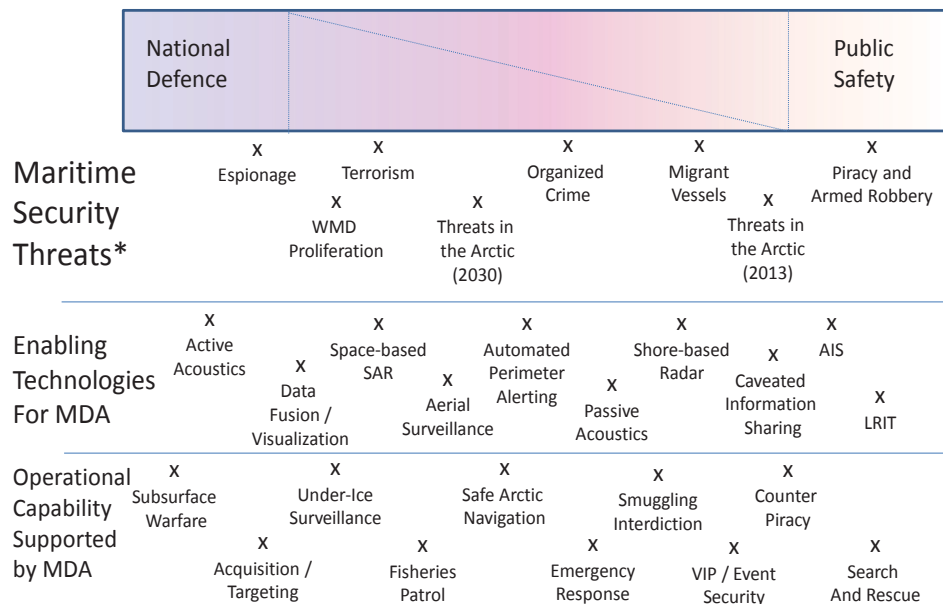
	National Defence → → → → → → → → → → → → → → → → → → → Public Safety
Maritime Security Threats*	x Espionage; x Terrorism; x Organized Crime; x Migrant Vessels; x Piracy and Armed Robbery; x WMD Proliferation; x Threats in the Arctic (2030); x Threats in the Arctic (2013)
Enabling Technologies For MDA	x Active Acoustics; x Data Fusion / Visualization; x Space-based SAR; x Aerial Surveillance; x Automated Perimeter Alerting; x Passive Acoustics; x Shore-based Radar; x Caveated Information Sharing; x AIS; x LRIT
Operational Capability Supported by MDA	x Subsurface Warfare; x Acquisition / Targeting; x Under-Ice Surveillance; x Fisheries Patrol; x Safe Arctic Navigation; x Emergency Response; x Smuggling Interdiction; x VIP / Event Security; x Counter Piracy; x Search And Rescue

Figure 1 An estimate of the relative importance on the Security Spectrum exposes the ambiguity and subjective understanding of MDA

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[27] Newton, Robert, MDA/MSA From AG-8 to TP-14, presented to TTCP MAR AG 9 on 27 November 2013.
[28] http://www.dhs.gov/st-bmd
[29] Duong, Ahn, Borders and Maritime Security Division: An Overview, presented during visit by CSS to DHS S&T, November 5, 2013.
[30] http://www.cbp.gov/linkhandler/cgov/border_security/am/documents/oam_fact_sheets/oam_factsheet.ctt/oam_factsheet.pdf

Recommendations for selection of MDA topics for S&T investment include:

1. There are marginal returns in impact from additional investment in existing mature department-specific programs, due to the small scale of an additional investment in the context of a significant long-term program and the transitional filter to the public safety community. **We recommend avoiding additional investment in S&T programs that already receive significant funding from other government departments and instead leverage the outputs of these programs for Public Safety stakeholders.** An example of this is the area of space-based surveillance and the parallel exploitations activities at DRDC, which are funded by both CSA and DND; collaboration to leverage and exploit their output is valuable, but providing incremental funding to their existing S&T programs would likely not return significant results for public safety.

2. S&T Investment should bridge the gap from national defence to public safety. Acknowledging that the scale of DND's efforts and capability (and budgets for sustainment) in MDA are much greater than that of the Canadian Coast Guard, which are again greater than the RCMP or regional law enforcement, where possible **we recommend S&T investment to leverage prior defence investment by transitioning essential and affordable components of existing defence technology to the public safety domain.**

3. The sophistication and costs of the solution must match the capacity of the receiving organization to operationalize and sustain it. While coastal maritime security and the associated MDA and interdiction processes have been in operation for decades (and have their origins in war efforts), efforts by law enforcement agencies to manage the Great Lakes and shared border waterways are relatively primitive. Indeed, the Great Lakes MSOC would have little maritime awareness other than publicly available AIS, if it were not for previous CSSP investment to exploit existing maritime radars for small vessels and low-flying aircraft. Sophisticated solutions around data fusion and long range sensors that might be appropriate for national defence applications may not be manageable by law enforcement partners. **We recommend investment in practical, lightweight, industry-supported, high TRL solutions that link awareness to response.**

4. The main challenge in MDA for public safety may be to remove barriers to collaboration rather than a better sensor or analytical capability. **We recommend S&T investment in cross-cutting , horizontal initiatives that enable departments to work together.** A typical example of this is technology to enable information exchange between MSOC partners in the context of legal, cultural and privacy issues. Other examples include the linking of science communities in different departments with interdepartmental workshops.

5. There is great value in informing future investment with evidence-based options analysis. **We recommend finding activities that identify operational gaps and pilot programs that provide hard data to drive future investment.**

This document has tried to establish swimming lanes for the investment by CSSP in maritime domain awareness and should be considered a first effort in an evolving philosophy. The motivation is to use the considerations and recommendations herein during the selection of proposals and the generation of priorities for future CSSP calls for proposal.

Prepared by:
Paul Hubbard
DRDC Centre for Security Science paul.hubbard@drdc-rddc.gc.ca

Pierre Meunier
DRDC Centre for Security Science pierre.meunier@drdc-rddc.gc.ca

Annex A: Additional Information and Annotations

Reasoning on Terminology

National Security is *"the requirement to maintain the survival of the state through the use of economic power, diplomacy, power projection and political power... Security threats involve not only conventional foes such as other nation-states but also non-state actors such as violent non-state actors, narcotic cartels, multinational corporations and non-governmental organisations; some authorities include natural disasters and events causing severe environmental damage in this category. Measures taken to ensure national security include:*

- *using diplomacy to rally allies and isolate threats*
- *marshalling economic power to facilitate or compel cooperation*
- *maintaining effective armed forces*
- *implementing civil defense and emergency preparedness measures (including anti-terrorism legislation)*
- *ensuring the resilience and redundancy of critical infrastructure*
- *using intelligence services to detect and defeat or avoid threats and espionage, and to protect classified information*
- *using counterintelligence services or secret police to protect the nation from internal threats"*[31]

Within Canada, the Government of Canada (GoC) National Security Strategy focuses on protecting the nation and its citizens, ensuring Canada is not a base for threats to our allies, and contributing to international security[32] National Security elements are distributed across the Department of National Defence, Public Safety Canada and other departments.

National Defence typically refers to military forces used for power projection, peace-keeping and domestic (homeland) defence. Within Canada, The Canada First Defence Strategy (CFDS) states that *"the Government is giving the Canadian Forces clear direction concerning their three roles - defending Canada, defending North America and contributing to international peace and security - as well as the types and numbers of missions it expects our military to fulfill."*[33]
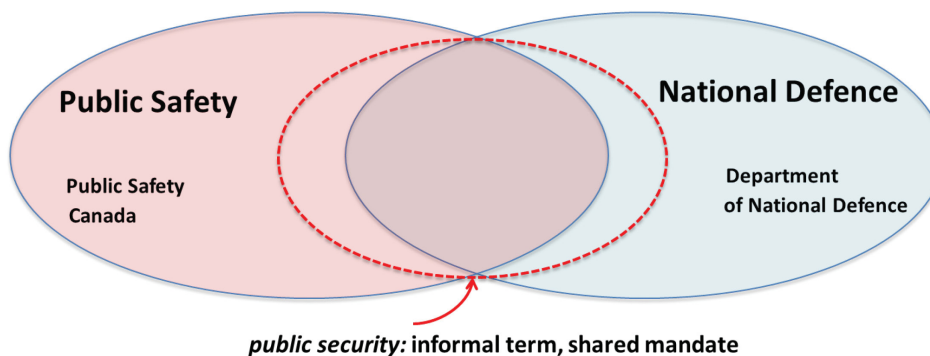

Figure 2 – Terminology for National Security and avoiding the informal use of public security

Public Safety *"involves the prevention of and protection from events that could endanger the safety of the general public from significant danger, injury/harm, or damage, such as crimes or disasters (natural or man-made)"* [34]. Within Canada, Public Safety Canada has the mandate *"to keep Canadians safe from a range of risks such as natural disasters, crime and*

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[31] http://en.wikipedia.org/wiki/National_security.
[32] http://publications.gc.ca/site/archivee-archived.html?url=http://publications.gc.ca/collections/Collection/CP22-77-2004E.pdf
[33] http://www.forces.gc.ca/en/about/canada-first-defence-strategy.page
[34] http://en.wikipedia.org/wiki/Public_safety

terrorism."[35] Notably, public safety coordinates an integrated approach to emergency management, law enforcement, corrections, crime prevention and border security and works with other partners in critical infrastructure protection (including transportation security), counter-terrorism and cyber security.

The term **Public Security** is used informally to capture "the function of governments which ensures the protection of citizens, organizations, and institutions against threats to their well-being – and to the prosperity of their communities."[36] A frequent source of confusion is the usage of the common word *security,* prepended with *public*, to include elements of both National Defence and Public Safety. As it overlaps with Public Safety it is used to mean law enforcement. As it overlaps with National Defence it is used to mean counter-terrorism. The confusion occurs when *security* is also used in the term *National Security* to be much more holistic and inclusive. For clarity, we will avoid *public safety*, and rely on the terms formally within the names of existing government departments in Canada, i.e. **Public Safety** *Canada* and the *Department of* **National Defence***,* as illustrated in Figure 1.

MDA components in the DRDC Science and Technology Program Briefs

The following are excerpts are from the Nov 22, 2013 DRDC S&T[37] program brief that relate to MDA, arranged by program: .

The Navy - Above Water Warfare Program:

- Immediate Outcome: *"Approaches and technologies for persistent off-board Anti-Ship Cruise Missile surveillance and jamming with a goal of defeating the threat prior to hard kill engagement range*", p. 26

The Navy - Underwater Warfare Program:

- Immediate Outcome: *"Increased detection capability against underwater targets using off board sensors"* and *"Improved understanding of future anti-submarine warfare capability requirements including Force ASW"* p. 33

The Navy - Maritime Information Warfare Program:

- Context: *"Reconfigurable, cross-domain capable networks must fuse and disseminate information rapidly using diverse, re-definable meshed communications bearers to maximize flexibility and minimize vulnerability. Maritime Domain Awareness, which contributes to the development of a Recognized Maritime Picture, remains an enduring requirement, both at home and abroad." P. 38*
- Immediate Outcome: *"Expanded persistent over-the-horizon and under-ice surveillance, target acquisition and reconnaissance capabilities",*
- Immediate Outcome: *"Enhanced data and information exchange between underwater platforms and sensors and task groups and shore-based headquarters", and*
- Immediate Outcome: *"Improved leveraging of MDA information sources and ensured Information Dominance for both operational and tactical maritime decision makers". P. 41*
- Sourcing strategy: *"Other Government Departments (OGDs) will be engaged for areas of common interest to DND. It is known that MARLANT N6 is currently compiling the initial Recognized Maritime Picture (RMP), which is then passed on to various DND/CAF stakeholders as well as other stakeholders such as those at the Maritime Security Operations Centers (MSOCs) for their own purposes. As such, the Maritime Information Warfare Program is an enabler for providing an in-depth understanding of the N6 processes/systems so that other programs can ensure streamlined integration of their products. In particular, early projects within the MIW area have provided advice on the integration of satellite-based products into the RMP. DRDC will provide advice as required to the coastal N6 on requests for integration of OGD information feeds into the RMP for subsequent use by non-DND stakeholders. This work will be coordinated with the Joint Force Development ISR program." P. 43*

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[35] http://www.publicsafety.gc.ca/cnt/bt/index-eng.aspx
[36] http://en.wikipedia.org/wiki/Public_security
[37] Defence R&D Canada Draft Client Intermediate Outcomes for FY 14/15, Version 4.5 25 June 2013.

The Air - Integrated Program:

- Immediate Outcome: *"The ability to integrate and exploit ISR sensor data and communication capabilities from multiple airborne platforms including networked, autonomous sensors and platforms to generate situational awareness which is greatly enhanced in comparison to that available from a single sensor, "*
- Immediate Outcome: *"The ability for operators to fuse ISR sensors outputs and tactical data to deal with the large volume of information produced by modern systems onboard an aircraft or distributed across multiple RCAF platforms."*
- Immediate Outcome: *"The ability to maintain surveillance and perform reconnaissance in Canada's littoral, maritime and Arctic regions in support of Canadian sovereignty and security".* P.105

The Air - Reach Program Outcome:

- Immediate Outcome: *"New ISR capabilities that are derived from the fusion of information from multiple sensor types, based on CD&E, algorithm and visualization studies (data-to-decision) and an analysis of ISR system optimization, human systems integration and manpower needs."* P. 118

The Joint Force Development - Space Operations Program:

- Context: *"In maritime and global domain awareness, DRDC has provided direct support to Polar Epsilon (to exploit RADARSAT 2), and contributed to Polar Epsilon 2 (to exploit RCM) by performing risk mitigation to integrate an AIS space payload on RCM."* P. 175
- Immediate Outcome: *"The CAF [Canadian Armed Force] will maintain and improve Space Situational Awareness (SSA)"* P. 178

The Joint Force Development Intelligence Surveillance and Reconnaissance:

- Program Outcome: *"The CAF have accurate, timely, and persistent Situational Awareness of Canada's territory, air and maritime approaches as well as other areas of interest around the world"* P. 188
- Immediate Outcome: *"The CAF will continue to operationally exploit national and allied space-based SAR;"* p 191
- Immediate Outcome: *"The CAF will continue to operationally exploit space-based EO/IR;"* p 191
- Immediate Outcome: *"The CAF will maintain and improve Maritime Domain Awareness (MDA) using space-based sensors when and where appropriate;"* p 191
- Immediate Outcome: *"The CAF will maintain and improve Arctic intelligence using space-based sensors when and where appropriate;"* p 191
- Immediate Outcome: *"The CAF will conduct IPB [Intelligence Preparation of the Battlefield] in support of deployed forces using space-based sensors when and where appropriate;"* p 191
- Immediate Outcome: *"The CAF will execute the Direction, Collection, Processing and Dissemination (DCPD) cycle using space-based sensors when and where appropriate;" p 191*

The Force Employment Support of the Canadian Joint Operations Command Program

- Immediate Outcome: *"DND is informed on the most effective system of systems to provide All Domain Situational Awareness in the Arctic, and improved situational awareness across the Canadian Arctic."* P. 229