



SCIENCE ^{AND} TECHNOLOGY IN ACTION:

DELIVERING RESULTS FOR CANADA'S
DEFENCE AND SECURITY

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FOREWORD

The Department of National Defence (DND) and the Canadian Armed Forces (CAF) are continuing to evolve in response to complex and ever-changing national and global realities. Clear priorities and approaches for protecting Canadians and defending Canadian interests at home and abroad are vital in the context of this dynamic defence and security environment.

Science and technology (S&T) plays a critical role in contributing to Canada's defence and national security, providing the technological and knowledge advantage necessary to develop the right military capabilities and prepare for an uncertain and potentially dangerous future. This Defence and Security S&T Strategy presents a comprehensive, long-term blueprint to help ensure DND and the CAF have the tools and capabilities to defend Canada and carry out their core missions and activities.

This Strategy is provided at a pivotal time in the context of defence renewal and the transformation of the defence enterprise. The Strategy describes how defence and security S&T will align with governmental and departmental priorities to deliver value through an integrated approach. At its core, it is based on getting the most from our S&T investment through maximizing the capacity resident in our own workforce and laboratories, and building partnerships with other departments and agencies, industry and academia, as well as our international allies. In doing so, we enable the transfer and application of scientific knowledge from the broader innovation community to the end users of defence and security S&T at all levels. This yields concrete benefits in the form of operational success, greater efficiency and effectiveness, and evidence-based decisions and solutions across DND and the CAF.

It is our pleasure to approve this Strategy and we look forward to its implementation. The departmental investment in S&T is an essential capability, and we are confident that the direction outlined here will ensure it provides the best possible support to Canada's defence and security priorities in the years to come.

Richard B. Fadden
Deputy Minister of National Defence

General Thomas J. Lawson
Chief of Defence Staff

“This Strategy demonstrates how S&T capabilities will be fully employed for the benefit of Canada’s defence and security requirements, and highlights DRDC’s unique role in harnessing S&T capacity. The Strategy articulates the future direction of defence and security S&T investments which will contribute to and align with the priorities of DND, the CAF and security organizations.”

Dr. Marc Fortin
Assistant Deputy Minister (Science & Technology)
Chief Executive Officer, Defence Research and Development Canada

CONTENTS

Foreword	3
Executive Summary	7
Introduction.....	11
Setting the Context	13
Meeting Client Requirements	15
Delivering S&T Solutions	19
A Purpose-Built S&T Program	21
Key S&T Program Enablers.....	23
The Way Forward	29



Hercules Observer Trainer or HOT version 2, installed at CFB Trenton, is used to train Load Masters to detect threats to aircraft. The HOT can be configured in the future to train observers in air to air refueling or search and rescue.

EXECUTIVE SUMMARY

S&T is essential for ensuring the defence of Canada, and represents a critical element of national security. The Department of National Defence (DND), the Canadian Armed Forces (CAF) and their safety and security partners depend on S&T to deliver on their respective mandates and adapt to ever-changing demands. S&T's importance is particularly true today, given the transformed technological and geostrategic landscape, and the complex challenges facing Canada's defence and security community. In an era of continuing global instability, resource constraints and the diffusion of advanced technologies, S&T and the broader innovation system are indispensable capabilities that support operational excellence and effective, evidence-based decision-making. It is this context which both shapes and defines Canada's new Defence and Security S&T Strategy.

S&T and the broader innovation system are indispensable capabilities that support operational excellence and effective, evidence-based decision-making.

The needs of DND, the CAF and their safety and security partners are wide-ranging and spread across an extended timeframe. If it is to contribute in a meaningful way, the departmental S&T investment must be aligned with and responsive to multiple demands. Such requirements are expressed in the Strategy as six principal objectives, each of which depends on S&T as a critical input in overcoming a diverse array of related defence and security challenges. These objectives are:

- 1 Build agile and adaptable forces to carry out missions across a wide spectrum of operations;**
- 2 Assist and support CAF and civilian personnel before, during and after operations;**
- 3 Enable the acquisition, sharing and use of critical information in support of situational awareness and decision-making;**
- 4 Develop and implement solutions to maximize the affordability and sustainability of DND and the CAF;**
- 5 Support public safety and security practitioners in their mission to protect Canadians; and**
- 6 Anticipate, prepare for and counter the emergence of future threats.**

Defence Research and Development Canada (DRDC) is the primary delivery agent for the departmental S&T investment. It operates at the centre of an innovation community whose members provide ideas, technology and know-how in support of the objectives outlined above. The key challenge before this community is to integrate these efforts in a way that effectively leverages capacity, draws on the strengths of all who collaborate, and is best suited to the client's requirements.

Success further requires S&T capability supported by effective project management and delivery, personnel with expert knowledge of client needs and the ability to tap productive relationships, and tools and infrastructure which enable innovation partners to collaboratively deliver solutions. These may take the form of evidence-based advice, prototype systems, field demonstrations, new protocols, concepts or doctrine, new training methodologies, test, evaluation and engineering, or in-theatre support. In turn, S&T providers expect clients to work with them to identify priorities, invest their own resources where applicable, assess results, and ultimately exploit S&T outputs.

Accordingly, DRDC will engage members of the national and global innovation communities along a continuum marked by three principal modes of interaction.

BUILD

DRDC will build and maintain critical mass of capability in areas of strategic national importance, as a result of legislative or regulatory imperatives, for access to neutral, evidence-based advice, or for reasons of sovereignty or security. The opportunities for collaboration here are limited.

COLLABORATE

Other areas of S&T lend themselves to active collaboration, characterized by reciprocal access between DRDC and partners to specialized facilities or sensitive information, personnel exchanges, joint initiatives and coordinated investment. In this case, the aim is to maintain sufficient internal capacity and specialization to offer equitable, valued contributions.

ACCESS

In areas where DRDC cannot or should not be the source of supply, the required S&T will be accessed from partners. In certain cases, this will mean maintaining only that internal capacity needed to direct research funding to external parties, and to value and understand their work as solutions are developed.

Satisfying the requirements of DND, the CAF and their safety and security partners can best be achieved through high-level, close consultation with clients on an ongoing basis. Top-down direction, supplemented by bottom-up expert input, will generate a set of agreed priorities that in turn drives S&T activities, focused on strategic outcomes of critical importance. To ensure maximum impact, the departmental S&T investment will support a smaller number of priorities while increasing



Defence scientists and industry partners, using Canadian commercial aircraft and technology, produced an autonomous aircraft system customized for military needs. Flight testing is underway for CAF reconnaissance and re-supply missions.

effort in strategic areas. The intent is to formulate a purpose-built S&T program that allocates funding in a balanced and integrated manner, and which establishes a clear path to exploitation and impact.

Defence and security S&T investment in Canada is a fraction of total R&D expenditures worldwide. Accessing the expertise and resources of this dispersed innovation community is critical, not only to meet client needs, but to avoid duplication of effort, draw on best practices, and benefit from investments already undertaken.

Collaboration with key S&T partners will be pursued in a strategic fashion, focusing on areas of greatest impact and alignment with departmental and government priorities. DRDC will continue to cooperate with science-based departments and agencies on projects and initiatives of interest, including those related to improving performance measurement and overcoming institutional barriers to collaboration. Allied S&T organizations contribute significantly to common defence and security objectives. Robust international collaboration is vital to achieving success, promoting lower costs, interoperability and common standards, encouraging risk and burden sharing, informing DND and Canadian industry of emerging issues and opportunities, and supporting broader diplomatic and policy goals.

For its part, industry is a major source of ideas and helps translate S&T into equipment, systems and operational solutions. DRDC will pursue collaboration with companies to bring the best of these ideas forward for exploitation, and work with DND's Materiel and Information Management Groups in reducing the technical and financial risks inherent in the acquisition process. Finally, universities generate knowledge, provide access to resources and develop expertise in support of the departmental S&T investment. Going forward, strategic interaction and strong oversight of government-funded research are needed to fully exploit the capacity the academic sector can offer.

Delivery of S&T solutions in whatever form must be objective, timely and user-friendly. Effective processes and tools will be implemented to convey integrated advice and provide coherent, objective evidence to inform defence and security activities, as well as learn from best practices. It is therefore essential that S&T outputs are designed for maximum impact: that is, highly relevant, directed to the right people at the appropriate level, in an accessible format, and delivered at the optimal point in the decision cycle.

Business process renewal is a leading objective for all federal departments and agencies, and DRDC is doing its part to optimize how it employs the funding it has been allocated. Operating as a single, fully integrated organization, and benefitting from the dedication and expertise of its workforce, DRDC will continue to promote a culture of excellence, results and responsiveness among all stakeholders across the innovation system.

The direction outlined in this Strategy presents a new way forward for providers and users of S&T alike, and carves out a central role for DRDC as a catalyst of change. Once implemented, the Strategy will enable key S&T stakeholders to effectively meet the challenges posed by new and emerging threats, rapid technological advances, budgetary constraints, and the need to ensure investment is focused on the highest priority outcomes. Building on a foundation of success, DND, the CAF and their partners are well positioned to meet Canada's critical defence and security requirements, now and in the future.



Scientists conduct post-incident analysis of personal protective equipment returned from Afghanistan.



A gantry system raises an Autonomous Underwater Vehicle out of the Arctic ice as part of the survey of Canada's extended continental shelf in support of Canada's submission to the United Nations Convention on the Law of the Sea.

INTRODUCTION

S&T is essential for ensuring the defence of Canada, and represents a critical element of national security. It provides an advantage on the battlefield, reduces risks to the safety and well-being of Canadians, and supports policies and decisions with timely, evidence-based advice. DND, the CAF and their safety and security partners depend on S&T to deliver on their respective mandates and adapt to ever-changing demands.

The importance of S&T is particularly true today, given the transformed geostrategic landscape and complex challenges facing Canada's defence and security community. Since 2011, the CAF have reduced the overall pace of operations after several years of high profile, intense engagements at home and abroad. At the same time, DND and the Forces continue to implement the [Canada First Defence Strategy](#) (CFDS), pursue structural and business process reforms, and lay the groundwork for potential changes to defence policy and future capabilities.

Canada must prepare for a future characterized by the persistence of conflict and advanced military capabilities in the hands of potential adversaries. Protecting Canadians also requires contributing to more secure borders, enhancing the resiliency of cyber and other critical infrastructure, and responding to natural disasters, humanitarian crises and health emergencies, both nationally and in coordination with the United States. In an era of significant resource pressures, Canada and its allies are focused on achieving internal efficiencies and increased mutual reliance. Meanwhile, these developments are occurring against a backdrop of S&T that is more globalized and available to state and non-state actors alike.

S&T provides an advantage on the battlefield, reduces risks to the safety and well-being of Canadians, and supports policies and decisions with timely, evidence-based advice.

In this environment, investment in defence and security S&T is indispensable for responding to the challenges of the coming decade and beyond. This Strategy charts the course for how such investment will contribute to and align with the priorities of DND, the CAF and security organizations. It explains how S&T capabilities will be fully exploited for the benefit of Canada's defence and security requirements, and highlights Defence Research and Development Canada's (DRDC) unique role in harnessing S&T capacity wherever it may exist. Finally, the Strategy outlines what will be needed to implement a successful defence and security S&T program focused on key partnerships, effective approaches to knowledge access and capability development, scientific, analytical and management excellence, improved business practices, and a dynamic workforce.

In formulating a new defence and security S&T Strategy, DND and the CAF do not begin with a blank slate. There are significant accomplishments, a wide range of expertise, valued relationships and skilled personnel, among other capabilities, that serve as a solid foundation on which to build going forward. A continuing challenge is to ensure the departmental S&T investment is providing maximum value to Canada, and is responding as effectively and efficiently as possible to current and emerging threats. The direction provided in this Strategy is a crucial step towards achieving these objectives.



An unmanned surface vehicle performs experiments in Gascoyne Inlet near Barrow Strait, Devon Island, Nunavut. Such autonomous unmanned systems are deployed to improve situational awareness at sea and to monitor evolving threats and events.

SETTING THE CONTEXT

Canada confronts a global security environment characterized by a complex set of challenges. Terrorist and insurgent groups continue to threaten Canadian and allied interests. Violence persists within and between states, creating instability and placing civilian populations at risk. The proliferation of highly destructive weapons and advanced delivery systems remains particularly worrisome, raising the spectre of aggressive regimes threatening their neighbours in volatile areas of the world. For their part, space and cyberspace are vulnerable to threats that could damage or degrade critical infrastructure as well as military assets. Additional challenges within Canada and North America include natural disasters, search and rescue, narcotics and human smuggling, security at major events, the spread of infectious disease, as well as the requirement to monitor and protect Canada's maritime and air approaches, and improve situational awareness and response capabilities in the North.

The relentless pace of scientific discovery, coupled with increased access of a larger number of actors to new technologies, is likely to have a significant impact on the security of Canada and its allies. For example, advances in the biological and chemical sciences, while potentially leading to life-saving treatments, may also generate new hazards if exploited for the purpose of inflicting damage. More generally, technologies developed for civilian use and available at relatively low cost may be misused and subsequently directed against the CAF or other security personnel.

The relentless pace of scientific discovery... is likely to have a significant impact on the security of Canada and its allies.

Advanced technology, however, should not be seen solely from the perspective of current and future vulnerability. Innovation through S&T has an essential role to play in safeguarding national interests. Canada's military and its safety and security partners rely on S&T to neutralize threats and retain an edge over potential adversaries. For example, automation and robotics are helping to minimize risks to personnel and enabling rapid analysis of large data streams. Likewise, increasingly capable guidance systems have enhanced the accuracy of weapons, lessening the potential for civilian casualties and collateral damage. Such advances are possible when defence and security organizations are sufficiently aware of new technological developments and maintain the agility to exploit breakthroughs, wherever they occur.

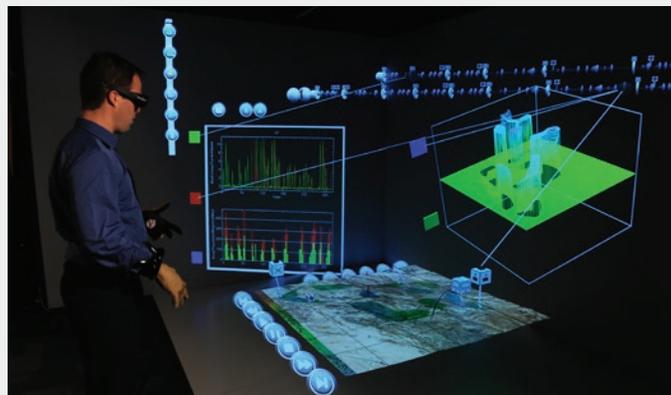
The Government of Canada is increasingly focused on establishing the necessary conditions to foster innovation and ensure that science performed in federal labs is connected to broader domestic and international efforts. Responding to recommendations arising from the 2011 [Review of Federal Support to Research and Development](#) (the Jenkins Report), the Government has increased funding to industrial assistance programs that have a direct impact on business innovation. The role of military procurement in encouraging innovation and strengthening the domestic economy is also being explored. Going forward, there is a growing consensus that all members of the innovation community within government, industry and academia have a stake in finding better ways of harnessing new technologies for the purposes of both operational success and economic gain, and that these objectives can best be achieved through close, ongoing collaboration.

Increasingly, much of the innovation applicable to defence and security can now be found outside government laboratories, driven by industry and universities. Indeed, the share of research performed in federal labs is steadily declining, continuing a trend begun in the 1970s. Likewise, a greater proportion of R&D activities is being undertaken by non-Western nations, as scientific expertise is developed and nurtured in Asia and Latin America, among other regions, fuelled by expanding economies and national policy. The rising influence of regional powers is being mirrored by a similar trajectory in the global distribution of scientific capacity. This shift will need to be taken into account as Canada and its allies seek to maintain the edge in defence and security capabilities in the years to come.

DND and the CAF are themselves changing in response to an evolving threat environment, lessons learned from recent operations, the increased importance of new domains of defence and security activity, the acquisition of new equipment mandated by CFDS, implementation of Strategic Review and the Deficit Reduction Action Plan, as well as numerous initiatives related to defence transformation and business process renewal. Taken together, these efforts seek to ensure the success of the Forces' core missions while reducing duplication and unnecessary overhead, creating the efficiencies needed to protect existing operational capacity, and allowing for future defence investment and policy development. As this work is carried out, it is essential the S&T program supports and remains closely aligned with the changes underway at National Defence and in the Government as a whole.



Two subjects shooting as part of a simulated mission in DRDC's Small Arms Trainer. This type of training better prepares soldiers for real-life events on the battlefield.



An immersive virtual environment is used to augment individual and collective comprehension of a complex situation. The system combines simulation, visualization and rich user interactions to generate, explore, organize and process information.

MEETING CLIENT REQUIREMENTS

The needs of DND, the CAF and their safety and security partners are wide-ranging and spread across an extended timeframe. They include the immediate requirements of operators in the field responding to real-time threats, scientific, technical and analytical support to decision-making in such areas as readiness, capability development and acquisition, and the task of anticipating and developing effective responses to emerging threats. The defence and security community also relies on S&T to identify potential requirements not currently apparent to operators and decision-makers, focused on the very early stages of scientific work that could eventually have game-changing implications for the defence of Canada and the security of its citizens. To be effective, the departmental S&T investment must be aligned with and responsive to multiple demands.

Consistent with the Government's priorities, policies and direction, the following six principal objectives have been identified as a means of framing defence and security requirements going forward. For each objective, S&T is critical in overcoming a diverse array of operational and management challenges. Inevitably, these objectives and challenges will evolve over time. It will be important for the defence and security S&T program to remain flexible and able to respond to new requirements as they arise.

1 BUILD AGILE AND ADAPTABLE FORCES TO CARRY OUT MISSIONS ACROSS A WIDE SPECTRUM OF OPERATIONS

Achieving this objective requires the capacity to prevail in the presence of evolving non-conventional or novel threats, such as improvised explosive devices (IEDs), next generation chemical and biological agents, and possible future capabilities such as directed energy weapons. Maximizing the operational effectiveness and safety of CAF personnel, weapons and platforms is essential, particularly in light of evolving technologies and sophisticated capabilities in the hands of potential adversaries. The CAF also require additional time and space to react to threats, for example by extending sensor coverage as far away as possible from our forces, and leveraging automation and stand-off capacity of CAF weapon systems.

The ability of the CAF to operate in the Arctic as well as other extreme or hostile environments is a priority, as is mission effectiveness in the space and cyber domains. For their part, Special Operations Forces have unique requirements that highlight the imperative of maintaining advantage in the face of rapidly evolving threats, demands and technologies. Finally, to succeed operationally, the CAF need to be prepared to work in organizationally diverse environments as well as address new tactics and systems in the future, such as ubiquitous micro-sensors or the cyber-enabled infiltration of key systems.

2 ASSIST AND SUPPORT CAF AND CIVILIAN PERSONNEL BEFORE, DURING AND AFTER OPERATIONS

Realizing this objective requires effective programs and policies to strengthen the Defence Team as part of the recruitment, training and management of CAF and civilian personnel throughout their careers. It means providing leaders at all levels with the best possible advice and tools to make the right decisions for personnel. The [Public Service Renewal](#) Action Plan will offer opportunities to maximize military and civilian potential by continuing to strengthen leadership planning, continuous learning and professional development. The human aspects of military capability are a critical factor in achieving success, whether by creating the conditions for organizational and operational effectiveness, improving situational awareness and decision-making, understanding and forecasting hostile intent, or enabling personnel to make optimal use of military equipment and systems.

A key responsibility of DND and the CAF is to provide military personnel and their families with programs and services that enhance well-being and to prepare them for the eventual transition to civilian life. An essential component of this obligation is the provision of care for ill and injured personnel, as well as the prevention or reduction of the immediate medical and long-term health effects arising from operations. Looking to the future, engineering methodologies applied to biology are expected to continue transforming the life sciences, potentially offering new ways of augmenting human performance, preventing disease and caring for the injured.



Photonic devices enhance vision capabilities for surveillance and reconnaissance operations. A thin film deposition instrument is shown here.

3 ENABLE THE ACQUISITION, SHARING AND USE OF CRITICAL INFORMATION IN SUPPORT OF SITUATIONAL AWARENESS AND DECISION-MAKING

Attaining this objective requires better ways to find, integrate, analyze and understand multiple sources of data, whether from allies in the context of coalition operations, or the threats, intentions and capabilities of potential adversaries. Command, control, communications, computers, intelligence, surveillance and reconnaissance (C4ISR) systems must be secure, resilient and deployable. On one hand, these systems must manage a pervasive network of headquarters, platforms and personnel. On the other hand, they need to have the capacity for sharing information in a timely, seamless fashion with operational partners, including civilians within DND, other government departments, international allies and non-governmental organizations. Ultimately, these systems should facilitate timely and accurate decision-making.

A particular challenge involves protecting C4ISR assets against cyber threats across the continuum of missions and activities undertaken by the Forces. The CAF must also fully exploit the opportunities afforded by space and cyber to support operations. Space is the definitive high ground for wide area surveillance, and improves the CAF's ability to monitor Canada's maritime approaches, territory and airspace. This objective is set within a dynamic landscape, characterized by future advances in such areas as smart phone-enabled social networking, micro-satellites, emerging surface-based sensors for persistent wide-area surveillance, and data mining.

4 DEVELOP AND IMPLEMENT SOLUTIONS TO MAXIMIZE THE AFFORDABILITY AND SUSTAINABILITY OF DND AND THE CAF

Meeting this objective requires DND and the CAF to link personnel, training, equipment and financial information in order to obtain a comprehensive force posture and readiness picture both today and in the future. The Department and the Forces are also seeking to enhance their capacity to systematically integrate capabilities, risks and science-based evidence into strategic planning, force development and procurement-related decision-making if they are to successfully implement transformation and renewal initiatives currently underway. An ongoing challenge for the CAF, as is the case with Canada's allies, is to effectively manage sustainment costs associated with both legacy fleets and new acquisitions.

Regarding acquisitions, DND and the CAF seek to reduce the technical risks associated with the definition and implementation phases of the process, while increasing their ability to account for through-life personnel, operational, financial and infrastructure considerations in procurement. Once new equipment is acquired, another important objective is training personnel in its use at a reasonable cost and with minimal adverse impact on the platforms themselves. In future years, there may be opportunities for more economical acquisition and effective use of defence equipment made possible by advances in digital product engineering, agile manufacturing, procurement modeling, human-systems integration and operational simulation, among other innovations.



DRDC personnel demonstrate source detection and mitigation as part of the advanced radiological response training they provide to the CAF.



A wide range of S&T activities support maritime defence and security, including anti-submarine warfare, torpedo defence, and maritime information and knowledge management.

5 SUPPORT PUBLIC SAFETY AND SECURITY PRACTITIONERS IN THEIR MISSION TO PROTECT CANADIANS

Achieving this objective requires DND, the CAF and their partners across all levels of government to work collaboratively to ensure a greater level of resilience against safety and security challenges, both domestically and on the international scene. Whole of government and multinational initiatives, built on a common understanding of risk, vulnerabilities, capability gaps and situational awareness, are essential in this regard.

Armed with this information, stakeholders need to focus on mitigating threats to critical infrastructure; enabling the efficient flow of goods, services and security cooperation across Canada's borders; and enhancing the disaster and emergency preparedness, interoperability, safety, and response and recovery capabilities of practitioners, first responders and communities. To pursue an all-hazards approach, innovative solutions to address challenges in each of these three broad areas need to be developed and operationalized. These may take the form of new equipment and technologies, strategy, doctrine and tactics, exercises and training, and improved sharing of information, including between civilian and military organizations.

6 ANTICIPATE, PREPARE FOR AND COUNTER THE EMERGENCE OF FUTURE THREATS

History is replete with the development of new capabilities that have changed the character of warfare, or posed unforeseen challenges to those responsible for safeguarding national security. The advent of such transformations is often rooted in scientific or technological breakthroughs, as occurred with the introduction of radar, stealth and unmanned vehicles, or with the unique application of existing tools, for example during the conflict in Afghanistan, where radio controlled triggers were used to detonate improvised explosive devices against the CAF and its allies. Responding effectively to emerging threats requires close, ongoing collaboration between the S&T, intelligence, force development and allied communities, which in turn should enable early warning of advances that might otherwise provide potential adversaries with a decisive advantage. It will also be essential to monitor new capabilities and technologies, including those described above, which may ultimately transform the defence and security arena in ways difficult to envision.

DELIVERING S&T SOLUTIONS

As the primary delivery agent for the departmental S&T investment, DRDC is at the centre of an innovation community whose members, wherever they are located, provide ideas, technology and know-how in support of defence and security objectives. Given that specialized S&T knowledge is increasingly dispersed beyond any single department or agency, university laboratory, private sector company or nation, the primary challenge facing this community is to integrate this knowledge in a way that effectively leverages capacity, draws on the strengths of all who collaborate, and is best suited to the requirements of DND, the CAF and their safety and security partners. Building these networks will require enhanced agility, and new collaborative approaches and instruments. Most important, all members of the innovation community, including DRDC, must champion an approach that begins with the defence or security problem which needs to be addressed, and shapes an integrated, holistic response without undue regard for turf, sector or geography.

Specifically, DND, the CAF and security organizations require S&T capability comprised of the following elements:

- **effective project management and delivery capacity;**
- **personnel with expert knowledge of client needs and the ability to tap rich innovation networks;**
- **productive relationships with both existing and new sources of S&T expertise; and**
- **tools and infrastructure which encourage innovation partners to collaboratively deliver S&T solutions.**

This capability must be sufficiently flexible to address challenges in a form suitable to the client, including evidence-based advice, prototype systems, field demonstrations, new protocols, concepts or doctrine, new training methodologies, test and evaluation, and engineering and in-theatre support. For their part, clients need to work in partnership with sources of supply to identify key priorities, invest their own resources where applicable, assess results, and ultimately exploit successful S&T outputs.

As a trusted partner, possessing a wide range of expertise, and with unique insights into the needs of Canada's defence and security organizations, DRDC is well positioned to bring to bear the full scope of S&T capabilities in support of client requirements.

Accordingly, DRDC will engage members of the national and global innovation communities along a continuum marked by three principal modes of interaction.

BUILD

DRDC requires robust in-house S&T capability in areas of strategic national importance, as a result of legislative or regulatory imperatives, for access to neutral, evidence-based advice, or for reasons of sovereignty or security. In such cases, opportunities may arise for sharing between close allies and partners. However, guaranteed access to foreign capabilities is often limited by Canada's interests in receiving independent counsel and safeguarding sensitive details regarding domestic capabilities. DRDC will therefore build and maintain critical mass of expertise and capacity in these areas.

COLLABORATE

Other areas of S&T lend themselves to active collaboration with partners, characterized by reciprocal access to specialized facilities or sensitive information, personnel exchanges, joint initiatives and coordinated investment. In these cases, the aim is for DRDC to maintain sufficient internal capacity and specialization to offer equitable, valued contributions, thereby retaining a seat at the table and gaining access to a larger capability pool in support of client requirements.

ACCESS

In areas where DRDC cannot or should not be the source of supply and where legal, security or sovereignty issues are not impediments, the required S&T will be accessed directly from industry and academic institutions. In certain cases, knowledge and technology integration challenges will warrant DRDC maintaining only that internal capacity needed to direct research funding to these external parties, and to value and understand their work as they develop solutions for DND, the CAF and security organizations.

A one-size-fits-all strategy for satisfying client requirements does not exist. S&T areas of activity call for different approaches regarding capability development, investment, partnerships and delivery. At the same time, each mode of interaction poses unique challenges. When DRDC is not the leading generator of S&T capacity, it can nevertheless serve as a catalyst for solutions within the broader innovation community. Within such networks, the parties may need to reconcile differing national strategies, investment plans, legal systems and operational requirements to support collaboration. As for developing in-house capacity and expertise, resource constraints will demand difficult decisions about where and how much to invest.



Large scale exercises facilitated at DRDC's Counter Terrorism and Technology Centre prepare chemical, biological, radiological, nuclear, and explosive specialists to respond, resolve, and mitigate risks from terrorist incidents and natural disasters.

A PURPOSE-BUILT S&T PROGRAM

The departmental S&T investment directly supports the objectives of DND, the CAF and their safety and security partners, whose requirements define the priorities and parameters of the defence and security S&T program. Developing a comprehensive understanding of and then effectively satisfying these requirements can best be achieved through high-level, close consultation with clients on an ongoing basis. Top-down direction, supplemented by bottom-up expert input, will generate a set of agreed priorities that in turn drives S&T activities, focused on strategic outcomes of critical importance to the Department, the Forces and the broader safety and security community. To ensure maximum impact on outcomes, the departmental S&T investment will support a smaller number of priorities while increasing effort in strategic areas.

As the critical link between the client and potential sources of supply, DRDC is charged with translating the operational and management challenges articulated by senior officials into a coherent, integrated S&T program. To carry out this role effectively, DRDC will be intimately aware of defence and security requirements through continuous, high-level engagement with clients, and will nurture and maintain diverse S&T innovation networks. Ideally positioned between end-user and supplier, DRDC will call on the most appropriate capabilities and expertise to support client priorities, and act where needed as a catalyst for the development of external S&T capacity.

The intent is to formulate a purpose-built S&T program that allocates funding in a balanced and integrated manner, so as to achieve the right mix of investment, whether between portfolios, involving different risk and maturity levels, across time horizons, or among categories of work consisting of, for example, operational, technical and engineering support, force development and procurement-related advice, technology demonstration, or enabling research. Given the need to promote coherence while establishing a clear path to exploitation and impact, all current DRDC programs will be administered holistically and with direct 'line of sight' to client outcomes.



A Canadian soldier participates in the Canadian Load Effects Assessment Program, which is a set of trials to help evaluate the equipment burden placed on soldiers while undergoing physical testing.

“The intent is to formulate a purpose-built S&T program that allocates funding in a balanced and integrated manner ... and with direct ‘line of sight’ to client outcomes.”

Outcomes and related program proposals for each client portfolio area will be evaluated against a consistent set of criteria to ensure they have the best chance to deliver the results expected. The assessment of individual project proposals will be rigorous and independent, based on published criteria and with emphasis on ensuring the effectiveness, impact, alignment, scientific quality and integrated nature of the

overall S&T program. For its part, successful project management demands the close monitoring of progress throughout implementation. Resources may need to be reassigned to more productive or higher priority areas if certain S&T activities are failing to support client outcomes as anticipated.

Once an integrated program is approved that is aligned with this Strategy and consistent with the annual priorities of the department and government, resources will be allocated to program areas to enable execution. Funding will cover all categories of expenditures, including personnel, to ensure managers have the flexibility and means at their disposal to meet project commitments. In addition, the management of all S&T capability components will support the

integrated program on an ongoing basis. Overall, stewardship of the departmental investment in S&T will continue to meet the highest standards of probity and efficiency. Independent assessment of how funds have been spent as well as the results achieved will occur annually. Such assessment will be thoroughly documented and conducted separately from the program formulation process to ensure a robust challenge function.

“S&T capability components will support the integrated program on an ongoing basis. Overall, stewardship of the departmental investment in S&T will continue to meet the highest standards of probity and efficiency.”

Program Formulation and Delivery Cycle



KEY S&T PROGRAM ENABLERS

PARTNER ENGAGEMENT

Defence and security S&T investment in Canada is a fraction of total R&D expenditures worldwide. Accessing the expertise and resources of this dispersed innovation community is critical to meeting client requirements. Collaboration is also necessary to avoid duplication of effort, draw on best practices, and benefit from investments already undertaken.

Collaboration will be pursued in a strategic fashion. Partnering will focus on areas of greatest impact and alignment with departmental and government priorities, and be guided by a set of overarching principles and assessment criteria to evaluate new proposals before formal arrangements or projects are established. While Canada is well served by existing bilateral and multilateral instruments, these too will be evaluated to ensure they provide effective support to defence and security objectives. Another important goal is to build a holistic and coherent innovation system that translates good ideas into tangible support to defence and security priorities, while providing corollary benefits to Canadian industry and the broader economy.



S&T personnel train with public safety and security partners for an integrated emergency response approach.



Effective operations require the evaluation and protection of GPS and navigation systems embedded in equipment.

DEPARTMENTS AND AGENCIES

Addressing Canada's defence and security challenges can best be achieved through a shared approach to providing S&T solutions. DRDC will continue to cooperate with federal partners on projects and initiatives of interest to DND, the CAF and security organizations. Within the framework of the [Canadian Safety and Security Program](#), DRDC will work with all levels of government to coordinate and support S&T activities that respond to public safety and security priorities and address capability gaps. Through the Integration Board and other senior-level committees, science-based departments and agencies (SBDAs) collaborate on cross-cutting issues, such as improving performance measurement and overcoming institutional barriers to joint initiatives. SBDAs are also exploring new mechanisms to exchange information on priorities, plans and activities, and to expand the sharing of equipment and infrastructure. In this way, dual-use assets could potentially be applied in support of defence and security priorities.

INTERNATIONAL PARTNERS

Allied S&T organizations contribute significantly to common defence and security objectives. Collaboration occurs within The [Technical Cooperation Program](#) (Five Eyes), the [NATO S&T Organization](#), and through separate agreements with individual or small groups of states. Such mechanisms complement one another, providing good coverage and flexibility in terms of S&T capability areas, technology readiness and project duration. Nevertheless, allies recognize the need to continuously assess return on investment and the viability of projects, initiatives which Canada strongly supports. Allies are also reaching out to emerging centres of S&T expertise, acknowledging the increasingly global nature of innovation and the potential such engagement offers.

Overall, robust international S&T collaboration is vital to achieving success, promoting lower costs, interoperability and common standards, encouraging risk and burden sharing, informing DND and Canadian industry of emerging issues and opportunities, and supporting broader diplomatic and policy objectives. To fully benefit from these advantages, Canada will ensure it remains a credible and valued partner. It will explore ways to enhance collaboration with Allies consistent with the concept of enhanced mutual reliance, and seek to engage a broad range of like-minded countries.

INDUSTRY

As a key component of the Canadian innovation system, industry is an important partner for DND, the CAF and security organizations. Industry is a major source of ideas and has the capability to translate concepts into reality, providing equipment, systems and operational solutions to address leading defence and security problems. For its part, DRDC will continue to rely on a co-investment, co-development model as it seeks to bring the best ideas forward for exploitation. It will collaborate with and support DND's Materiel and Information Management Groups in reducing the technical and financial risks inherent in the acquisition process. It will work with [Public Works and Government Services Canada](#) to overcome longstanding obstacles in this area. Still another objective is to support sustained engagement on high priority projects and ultimately help move solutions through to commercialization. Finally, the departmental S&T investment provides opportunities for Canadian industry, which translate into economic benefits for Canada as a whole.



A transponder is used in this experiment to generate synthetic targets for satellite radar.

ACADEMIA

Universities can generate knowledge, provide access to resources and develop highly-qualified personnel in support of the departmental S&T investment in defence and security. Mechanisms are currently available for interacting with academic partners, including contracts linked to specific projects, the [DND/NSERC Research Partnership Program](#) (which supports collaborative, university-based research with dual-use applications), staff exchanges, and lab-based agreements with local or regional networks.

Going forward, strategic interaction and strong oversight of Government of Canada-funded research are needed to fully exploit the capacity and expertise the sector can offer. For example, building on the relationship recently established with the [Canadian Institutes of Health Research](#), DRDC will seek to leverage the national networks and administrative infrastructure of the granting councils to increase the return on investment. In addition, identifying priority lines of research at the outset will encourage academic work that directly supports client requirements.

KNOWLEDGE MANAGEMENT

This Strategy assigns a key role to DRDC on behalf of the Department to provide trusted access to S&T knowledge, expertise and know-how, wherever it exists, and to deliver these in a timely fashion for maximum impact. DRDC will work closely with clients to ensure the right questions are posed to the broader innovation community. For their part, all stakeholders should have a clear understanding of the problems to be addressed. To this end, new practices and mechanisms will be adopted to enable more effective transfer of knowledge between suppliers and end users of defence and security S&T.

“New practices and mechanisms will be adopted to enable more effective transfer of knowledge between suppliers and end users of defence and security S&T.”

S&T solutions must be objective, timely and user-friendly. Effective processes and tools will be implemented to convey integrated advice and provide coherent, objective evidence to inform defence and security activities, as well as learn from best practices. Accordingly, these outputs will be synthesized and translated into a form that resonates with clients, and communicated to officials at the highest levels. Moreover, following the lead of other science-based departments and agencies, DRDC will determine the feasibility of supporting clients through dedicated personnel with expertise in knowledge synthesis and application, who can provide and draw from evidence generated across the innovation community.

Scientific publications are an important means of communicating knowledge and evidence-based advice to operators, decision-makers and other end-users within DND, the CAF and security agencies. It is therefore essential that these products are designed for maximum impact: that is, highly relevant, directed to the right people at the appropriate level, in an accessible format, and delivered at the optimal point in the decision cycle. Standards of excellence must also be maintained via quality control practices, applied to all publications, covering scientific process, organization of content, editorial quality, clarity and comprehension. Finally, there is a need for greater flexibility in responding to multiple client requirements, built on increased knowledge exchange, efficiencies through process reform, automation and digitization, and strengthened independent review to ensure the integrity and accuracy of the S&T advice provided.

CORPORATE SERVICES DELIVERY

As the primary delivery agent for the departmental S&T investment, DRDC must become more nimble and efficient in the way it operates administratively in order to provide focused, prioritized support to DND, the CAF and their security partners. Business process renewal is a leading objective for all federal departments and agencies, and DRDC is doing its part to optimize how it employs the funding it has been allocated. This is particularly important in corporate services, which serves a vital enabling function in support of S&T activities.

Specifically, DRDC will manage across its research centres as a single, fully integrated organization. Under this new approach, the delivery of corporate services, including finance, human resources, communications, information management, information technology services, security, infrastructure and procurement, will rely on shared resources and consistent, streamlined processes and tools. Service Delivery Centres will address repeatable, transaction-based requirements. Meanwhile, DRDC is working closely with DND and CAF partners to support similar efforts occurring at the departmental level while ensuring alignment with broader initiatives across the federal government. The overall aim is to improve service, measured through increased responsiveness to client needs and better access to corporate support.

AN EVOLVING WORKFORCE

The team supporting the departmental S&T investment is dedicated, highly capable and focused on meeting the needs of Canada's defence and security organizations.

It has been the driving force behind numerous achievements over the years, and is now an integral part of the transition to a leaner, more agile and aligned approach to addressing today's challenging operational and decision-making environment. To be successful, employees will be provided the means and support to implement the new approaches to program formulation, partner engagement and service delivery outlined in this Strategy. In turn, they will take advantage of opportunities to widen their expertise, acquire needed skills and collaborate across the broader innovation community. To this end, DRDC will build the right mix of skills and experience within the workforce, as well as optimal

approaches to talent management, professional development and merit review to support the outcomes required.

To derive maximum value from the departmental S&T investment, DRDC will continue to promote a culture of excellence, results and responsiveness among all stakeholders across the innovation community. Regardless of level, location, occupation or years of experience, DRDC managers and staff must act as one unified organization, with a balanced, integrated and coherent S&T program, embedded at the core of a larger network whose objective is to achieve maximum impact for defence and security. Equally important, in an environment of fiscal restraint and as stewards of public funds, DRDC personnel will continue to adhere to rigorous management and scientific standards, and ensure decisions are rooted in analysis, evidence and review.

“To derive maximum value from the departmental S&T investment, DRDC will continue to promote a culture of excellence, results and responsiveness.”



Numerous large scale explosive trials are conducted at DRDC's Experimental Proving Ground, evaluating various operational structures designed to resist the effects of blast and to protect CAF personnel. Many of these structures have been used in recent theatres of operation.



Long military deployments can have an impact on personnel, their families and CAF operations. DRDC conducts strategic and operational research in the area of personnel, family support and organizational dynamics.



S&T personnel help the CAF to advance knowledge and techniques in a variety of medical areas. Shown above, military staff execute medical training at Valcartier Garrison's Medical Simulation Centre.



A CC-177 drops decoy flares during a trial campaign aimed at validating protection coverage. The defence S&T community is deeply involved in validating and improving the protection of the various CAF fleets.

THE WAY FORWARD

The defence and security challenges facing Canada are profound and complex, demanding practical, effective solutions today and forward-looking strategies to address an uncertain and potentially dangerous future. Military technologies will continue to evolve, translating into new threats and opportunities for our forces. The task of ensuring the safety and security of Canadians is also ever-changing, given the inherent unpredictability of the risks and vulnerabilities prevalent in modern society. In this dynamic environment, it is imperative that DND, the CAF and the broader defence and security community can deliver on their mandates, supported by the best possible S&T advice and solutions.

To achieve success, Canada's military and security organizations must maintain a technological and knowledge advantage, built on investments in S&T that respond aggressively to the priorities of National Defence and its safety and security partners. Over the past decade, as a key member of the S&T innovation system, DRDC has worked hard to meet the wide-ranging needs of its DND and CAF clients, and has been recognized for life-saving, ground-breaking contributions to operations, planning and policy initiatives. Nevertheless, the context in which defence and security S&T is carried out in Canada and globally is continually changing. Expectations regarding alignment, impact, scientific excellence and accountability have been raised and traditional ways of doing business no longer suffice.

The direction outlined in this Strategy presents a new way forward for providers and users of S&T alike, and carves out a central role for DRDC as a catalyst of change. Once implemented, the comprehensive set of activities and initiatives described in these pages will enable key S&T stakeholders to meet the challenges posed by new and emerging threats, rapid technological advances, budgetary constraints, and the need to ensure investments are focused on the highest priority outcomes. Looking ahead, a leading measure of success will be whether DND, CAF and security clients are effectively supported by the departmental S&T program in the form of objectives achieved and outcomes realized. Empowered by clear guidance, improved processes and wide-ranging expertise, DND, the CAF and their partners are well positioned to meet Canada's critical defence and security requirements, now and in the future.



This advanced modular integrated helmet system is intended to improve soldier survivability against multiple battlefield threats.

“Empowered by clear guidance, improved processes and wide-ranging expertise, DND, the CAF and their partners are well positioned to meet Canada's critical defence and security requirements, now and in the future.”