Part 1, Attachment 1 – S&T Challenges

1) Understanding and addressing Post-Traumatic Stress Disorder (PTSD)

Challenge Statement

The Department of National Defence (DND) requires novel tools and methods to assess, address and treat PTSD resulting from defence and security operations. This includes the integrated dimensions of diagnosis, prevention, training, education, resilience, and moral injury treatment.

Background and Context

The Government of Canada (GoC) is committed to supporting ill and injured Canadian Armed Forces (CAF) members. In that context, mental health and PTSD remain primary concerns for the Chief of Defence Staff and the Surgeon General. Although advances have been made in understanding PTSD on a number of research fronts, the CAF requires comprehensive and multidisciplinary approaches to enable significant advances in the near and long term.

Outcomes and Considerations

Examples of significant outcomes of this comprehensive approach include but are not limited to:

- the development of new tools and methods for the diagnosis of PTSD,
- advances in brain scanning/imaging,
- new programs to educate and inform CAF members and their family from the early recruits to senior officers,
- building training and resiliency programs to prevent operational stress injuries before they occur, and,
- novel and efficient methods and programs to treat CAF members and public safety personnel who develop stress injuries or suffer from other brain injuries or trauma.

2) Recruit, retain, and reach 25% female representation by 2026

Challenge Statement

The Department of National Defence (DND) needs to develop recommendations on how the Canadian Armed Forces (CAF) can increase the recruitment and retention of women, including in non-traditional occupations in which women are under-represented.

Background and Context

The CAF have made a commitment to recruit and retain women in order to achieve 25% female representation by 2026. However, the level of interest among Canadian women in military employment makes this a significant challenge. Extensive CAF research on the recruitment and employment of women has identified a number of real and perceived barriers for women to serve in the military. These barriers include, but are not limited to, concerns about work-life balance,

separation from friends and family, potential marginalization in a male-dominated work environment, and the perception that it is not possible to pursue a preferred career field in the military.

Currently, 50% of women in the CAF Regular Force are found in eight occupations (i.e. Human Resources Administrator, Supply Technician, Logistics, Financial Services Administrator, Medical Technician, Cook, Nursing, and Mobile Support Equipment Operator). However, these eight occupations make up only 18% of the CAF population. Increasing growth in the representation of women in the CAF will require attracting more women to a wider range of occupations. How can the CAF achieve this? In the Canadian society, occupations are gender-related with clear patterns of male and female representation, as noted in the 2017 Statistics Canada report "Women and Paid Work". Thus, this challenge is not unique to the CAF, but it is certainly exacerbated by the nature of military service.

Outcomes and Considerations

The desired outcome is an innovative approach for recruiting and retaining women into non-traditional CAF occupations, as well as recommend approaches best suited to the unique context of the CAF. These recommendations must build upon research across a broad range of organizational types (i.e. private, public, non-profit, other). Novel methodologies and tools for the interest, recruitment, and retention of women are also sought, as are recommendations on how the CAF can address and change real and perceived barriers to female recruitment and retention.

3) Cognitive Performance Enhancement

Challenge Statement

Canadian Armed Forces (CAF) personnel need to process huge volume of information presented by complex information environments, often under stressful conditions. Therefore, the Department of National Defence (DND) requires the means to support CAF personnel in their use of at least one of the following: augmented reality environments, advanced interactive visualization, or enhanced vision (including extensions of the visible spectrum).

Background and Context

Every individual has a limited capacity to understand their environment. CAF personnel are expected on a routine basis to deal with information environments which are extraordinarily complex, or which exceed human sensory capabilities.

DND seeks ways to enhance cognitive capabilities to help CAF personnel in the completion of complex tasks requiring extended cognitive abilities. The approach need not be tied to specific means. Rather it must focus on the goal of improvement of human cognitive capabilities, and the measurement of those improvements in terms of task performance, dynamic workload, and memory in a real-world setting. The approach may employ technological adjuncts, including the smart use of compact computational devices, ubiquitous pervasive computing (ubicomp), or portable schemes for augmented reality, applications to the problems of enhanced wayfinding for the individual, and

enhanced vision (including extension of the perceivable spectrum). The human factors of large database visualization are especially important.

Outcomes and considerations

The desired outcome is a demonstration of the support of cognitive capabilities in human comprehension of unique information environments. Such support will be based on approaches such as the appreciation of realistic augmented reality environments, the interactive visualization of massive databases, perception of the results of broad-spectrum image fusion, or enhanced wayfinding ability with sharpened situational awareness. Engineering development of such environments is not the purpose of this effort. Still, the information environment for the demonstration should be as realistic and operationally relevant as possible. Outcomes will be as follows:

1) The cognitive abilities to be enhanced (i.e., short-term visual memory, span of logical reasoning) will be made specific, and their relevance to environmental tasks will be described in detail.
2) The improvement of these specific cognitive tasks will be demonstrated in realistic (near-real-world) scenarios.
3) The correlation between cognitive measures and task performance will be assessed.
4) The persistence and retention of these changes will be assessed after treatment, in terms of weeks and months. The use of effects which produce a savings in capacity over time is preferred to manipulations which require prolonged or continuous treatment.

The improvement of these specific cognitive tasks must be demonstrated in realistic (near-real-world) tasks that capture some of the conditions which prevail in military operations. These conditions include high workload, short deadlines, austere physical environments, and the need to ensure information security. The realism of the environment, whether a physical environment or an information environment, is of prime importance.

This proposal is agnostic to the technology to be applied. The research must follow Tri-Council standards of ethics.

4) Predicting and Optimizing Personnel Performance

Challenge Statement

The Department of National Defence (DND) is looking for novel concepts and technologies to facilitate prediction of individuals' ability in the areas of athletics, physical strength, mental strength and resilience, as well as cognitive skills. DND is also looking for means of achieving the predicted peak performance in individuals.

Background and Context

As the physical, mental, and cognitive demands on the Canadian Armed Forces (CAF) and security services personnel increase, there is a need to ensure that they are best equipped both mentally and physically to handle any situations that may arise. This includes maintaining readiness, and improving

agility of CAF and security personnel, facilitating their ability to respond and adapt quickly to ever-changing situations under less-than-ideal conditions.

Outcomes and Considerations

The desired outcomes are threefold:

1) demonstrate the capability to assess and understand the current state of an individual's athletic, physical, mental (psychological), and cognitive skills or abilities against established benchmarks;
2) develop a capability to predict the peak potential of those traits for an individual;
3) develop concepts or technologies that would be used to optimize the individual's skills and abilities to reach their peak potentials without the use of external augmentation/aids (e.g., exoskeletons).

These capabilities, concepts, and technologies must be safe and ethical, without any adverse effects on the individual. Concepts and technologies may include, but are not limited to:

1) Mental and cognitive training,
2) Psychometric testing,
3) Therapeutic techniques,
4) Nutrition,
5) Physical fitness assessments, and
6) Physical training.

Relevant gender based analysis (GBA+) factors must also be addressed.

5) Human Performance in Extreme Climatic Environments

Challenge Statement

The Department of National Defence (DND) seeks the means to enable human operators to perform tasks in extreme conditions including cold or hot and humid /dry environments, for extended periods interspersed by intense activity and inactivity. Manual dexterity issues in cold environments and mitigating thermal strain in hot/humid environments should be addressed. DND seeks innovative solutions in both physical and psychological conditioning aspects.

Background and Context

The Canadian Armed Forces (CAF) are developing concepts and strategies for future ground combat operations in the 2025-2040 timeframe that will require highly capable and dispersed units to achieve a common objective. Advancements in domains such as textiles, portable power sources, mobile computing, and data fusion technologies may converge to allow enhanced protection for soldiers operating in long-duration isolated and autonomous units in very austere environments. The ability for military units to operate without re-supply opportunities will require high calorie rations for physically demanding operations to ensure adequate muscular fuel and restoration after intense physical activity.

Outcomes & Considerations

The expected outcomes may include, but not be limited to, solutions that:

- aid soldiers in maintaining physical performance and/or fortify energy reserves in hot and cold, and/or for autonomous long-duration missions;
- enhance adaptive physiological responses to physical training and/or to mitigate negative physiological responses to harsh environment exposure;
- allow continuous and unobtrusive physiological monitoring;
- include pre-deployment acclimation strategies and techniques for austere environments; and/or
- respect all ethical standards.

Solutions must also consider relevant gender based analysis (GBA+) factors.

6) <u>**Detection and Classification of Objects of Interest**</u>

Challenge Statement

The Department of National Defence (DND) is looking for novel concepts, approaches, techniques and technologies to enable and augment the ability of the Canadian Armed Forces (CAF) and security personnel to:

- detect, recognize, and identify persons or objects of interest in a physical environment, and/or
- track identified persons and objects of interest using seamless information sharing across a decision network.

Of particular interest are methods supporting the soldier or emergency responder to:

- minimize or manage cognitive load;
- support real-time identification and tracking of objects for timely decision making;
- leverage and fuse multiple sensor and data sources;
- enable operations in complex environments including urban settings with the presence of cooperative and non-cooperative targets (i.e. disguised, camouflaged, or concealed); and
- differentiate between combatants and non-combatants.

Background and Context

CAF and security personnel must operate in complex and dynamic environments, and in the presence of physical threats while maintaining decision advantage. This challenge and capability solution must be geared toward the preservation of soldier safety in operations, the achievement of threat identification and possible avoidance, the minimization of collateral damages, and the achievement of improved speed, accuracy, confidence, assurance, and precision of impact as part of the operations decision-action cycle. It is also intended to improve individual and common situational awareness and understanding for mission success in both domestic and expeditionary operations.

Outcomes and Considerations

Desired outcomes of this effort will improve situational awareness and understanding, and support decision making by:

1) identification and tracking of objects/person of interest in real time;
2) successful cross-cueing of information from multiple sensors;
3) the ability to coordinate and hand-off to partners who are conducting follow-on actions;
4) efficient use of resources, and low error rates (i.e. false positives, false negatives); and
5) seamless interoperability among operators and link to higher command levels.

This challenge applies to day and night situations, as well as in the presence of adverse weather conditions and noise.

Proposals should address privacy and ethical concerns.

For this challenge, DND is not interested in the broader challenges of social media analytics or full motion video (FMV) analysis and associated automation algorithms. These matters are covered by separate challenges. However, exploitation of the output of such related methods and sources is relevant.

DND is interested not only in novel capabilities and concepts, but also in practical solutions which could be fielded and implemented quickly in the next few years.

7) Persistent Maritime Surveillance

Challenge Statement

The Department of National Defence (DND) requires the capability to monitor off-shore waters with emphasis on the detection of underwater threats by way of rapidly deployed, persistent, autonomous, yet affordable solutions.

Background and Context

The Canadian Armed Forces (CAF) require enhanced capabilities to perform surveillance of the maritime approaches to Canada. Recent advances in autonomy, robotics, energy and intelligent signal processing suggest that new concepts could be developed to provide better and less expensive surveillance solutions than those that are currently available.

The emphasis of this call for proposals is for surveillance of underwater threats which are defined as submarines and unmanned underwater vehicles (UUV). However, the ability to detect both underwater threats and above water objects may provide additional information to improve interpretation of underwater sensor signals and reduce false alarm rates.

The areas of employment include maritime regions from shore to the continental shelf break or the Exclusive Economic Zone of Canada, whichever is furthest. The technology should be able to provide

surveillance in waters up to 200 meters in depth as well as in a relatively shallow harbour environment.

The technology has to be highly autonomous. However, it must also be able to interact with a human operator/analyst in real time.

Outcomes and Considerations

The desired outcome is a rapidly deployable, persistent, autonomous, yet affordable technology to provide surveillance of off-shore waters with emphasis on detecting underwater threats. The technology should be deployable as multiple units to extend coverage. Highly autonomous on-board signal analysis should be demonstrated to provide good probability of detection with low false alarm rate. Sensors are expected to be predominately passive for covertness and for energy efficiency although an active sensor capability is acceptable. High speed, high capacity communications with the platform are required to transmit detection incident reports, sensor data for remote human analysis, status reports and to receive re-tasking commands.

"Persistence" is defined as multiple months on-station. The technology should be deployable from military ships without the need for engineering changes to the vessel. Deployment from shore would also be useful.

Proposals should address privacy and ethical concerns.

8) Lightweight Ballistic Protection

Challenge Statement

From the perspective of Canadian Armed Forces (CAF) personnel, current ballistic protection systems are heavy, bulky, limit mobility, contribute to overheating and discomfort and alter natural movement biomechanics which may increase the risk of injury. In addition, current ballistic protection does not offer much modularity or scalability that might enable adoption of less burdensome solution and improve integrated survivability. The Department of National Defence is looking for means to significantly improve any of these characteristics in order to increase survivability, personnel performance, and unit effectiveness.

Background and Context

The CAF will continue to deploy to areas of operation where ballistic and blast are the main threats to the survivability. CAF personnel must wear protection to counter these threats while performing very physically demanding tasks, often under very harsh environmental conditions. The most challenging situation, in which lightweight ballistic protection is required, involves infantry, combat engineers, medics, and combat support who may not have vehicle transportation nearby for support. Soldiers routinely carry loads comprising weapons, ammunition and other combat supplies, protection (including ballistic), communications and sensing equipment, portable power, water, and other sustainment items. Even for short duration missions, soldiers carry in excess of 40 kilograms, depending on their role and mission.

The concept of integrated survivability is defined by the consideration of all factors influencing CAF personnel survivability, including the efficiency of protective equipment as well as its effects on personnel performance and its interaction with the environment. For example, while a protective system may reduce the probabilities of sustaining an injury following a ballistic impact, the same system may increase the probabilities of being detected, engaged and hit, which ultimately leads to an overall decrease in survivability.

Outcomes and Considerations

The desired outcome of this research effort is the enhancement of efficient soldier ballistic protection, thereby allowing the right balance of protection, mobility, weight, and ergonomics while maintaining high soldier survivability.

Some considerations are, as follows:

- Lighter weight, reduced bulk, more flexible, and/or more breathable materials and system designs to achieve the same levels and coverage of protection or to improve the outcome and quality of life of those who survive ballistic injuries.

- Ballistic protection materials and system designs that mitigate health and soldier performance impacts of wearing ballistic protection over extended periods in challenging operational environments, while ensuring an adequate level of protection.

9) **Chemical, Biological and Radiological (CBR) Hazard Detection and Planning**

Challenge Statement

The Department of National Defence (DND) is looking for innovative solutions and technologies for the persistent surveillance of CBR threats that allows rapid detection, early warning, and effective monitoring of CBR releases.

Background and Context

The CBR detection challenge may include surface or airborne contamination in theatres of operation or complex urban environments, and may involve fixed-site detectors and/or detectors on mobile platforms. A capability made of people, sensors and data (both existing and acquired) that enables timely and accurate decision-making is desirable to address this problem. This could be achieved through the combination of people, technology (i.e. sensors) and data realized by way of the: optimal positioning of sensors in what may be complex and hostile environments; managing, in real-time, alternative potential courses of action from the moment an alarm is triggered to the moment a CBR threat is confirmed or denied; and real-time integrating of sensing outputs to generate a consolidated threat representation.

Outcomes and Considerations

The desired outcome of this research effort is to identify, assess and enable technologies and solutions for the detection and mitigation of CBR threats. Advanced, rapid detection capabilities that are deployable, reliable and improve the management of information for decision making are desired. In addition, user friendliness, ability to address real-time airborne release, and proximal detection of contaminated surfaces at sensitivity levels below those which would cause adverse physiological effects should be considered. To enable rapid and efficient use of data being collected from complex environments the use of a learning capability for the analysis and threat assessment needs to be considered.

10) <u>Proactive Deterrence</u>

Challenge Statement

The Department of National Defence (DND) is looking to identify novel and innovative strategies, mechanisms and enabling technologies to anticipate and deter potential international crises and war in the 21st Century.

Background and Context

The resurgence of major power competition, emerging threats from non-state actors, and challenges in the space and cyber domains have returned deterrence to the centre of defence thinking. Canada benefits from the deterrent effect provided by its core alliances (NORAD and NATO) and, through Strong, Secure, Engaged, has communicated how it takes seriously its responsibility to contribute to collective efforts to deter aggression by potential adversaries in all domains. At its core, deterrence is about discouraging a potential adversary from doing something harmful before they do it. Deterrence requires influencing an adversary's risk calculus on both sides of the cost-benefit equation, and closely linking military means and activities with political and diplomatic efforts. Deterrence is context-based, and therefore it is necessary to continue to evolve Canada's deterrence strategies to keep pace with the changing global environment. In the context of re-examining how to deter a wide spectrum of challenges to the international order, including those related to "hybrid warfare", DND has recognized that there may exist as-yet unidentified possibilities for advancing deterrence concepts and practice.

Existing deterrence concepts and theory were largely developed during the Cold War, with a focus on the prevention of nuclear war. Since the end of that era, the world has seen much sociological and technological change, resulting in challenges to some of the underpinning principles of deterrence. What used to be a relatively simplistic peer-to-peer calculation in a limited number of areas is now a many-on-many situation where all players have a variety of tools at their disposal.

Due to this increase in complexity, there lies renewed opportunity to look at various aspects of deterrence. This could include areas such as cognitive distortion / deception in the decision-making process, the understanding of adversaries (both state and non-state actors) and their associated motivations, risk-tolerances, and susceptibility to coercion. Understanding of individual and group psychology and behaviours as well as sociological and ideological concepts all play a strong role in the effectiveness of deterrence strategies. Thanks to globalization and advances in technology, these

fields are also being exploited by corporations and individuals in an attempt to control and influence behaviours of customers and competitors alike.

The complexity of developing understanding in these areas is compounded by the expanded use of non-traditional warfighting domains such as cyber and space, where concepts such as protection and attribution may be more challenging.

Outcomes and Considerations

The desired outcome of this research effort is a set of tools, techniques, and concepts for the purpose of proactive deterrence from a comprehensive perspective. As such, this type of research could include, but is not limited to, a broad range of deliverables, such as the development of a forecasting capability, game theory concepts for assessing emerging instability or conflict, and novel strategies for defence diplomacy.

Researchers should look to exploit both traditional and non-traditional areas of deterrence. Specifically, it is recognized that the concepts of deterrence are also developed and applied outside of the defence context. Deterrence and the influencing of behaviour through anticipated consequences can be seen in the activities of corporations, political bodies, and individuals as well as nations and terrorist groups. Sociology, individual and group psychology, cognitive theory, and data analytics are playing a large role in the shaping of individual and corporation behaviors.

It is the combination of traditional and contemporary thinking that is being sought to advance deterrence practice as it applies to the physical, cognitive and cyber domains.

11) Collaboration of Robotic Systems

Challenge Statement

The Department of National Defence (DND) is looking for solutions to allow for a single human operator to control and coordinate multiple robotic systems (e.g. uninhabited vehicles, across ground, air, and sea or combinations of each) and perform tasks in an environment with many obstacles where vehicle localization is difficult.

Background and Context

Robotic system usage can reduce the human exposure to dirty, dangerous, or dull tasks as well as assist in accomplishing tasks that are beyond the capacity of a single person. Robots can evolve from singular function tools to function as team members capable of contributing to the solution of larger scale issues. This may involve the self-organization of a large number of robots into a group to augment the collective capability and capacity in executing objectives, assigned with high levels commands and/or actioned due to evolving degrees of autonomous behaviour. Human must remain in the loop for supervision and the provision of high-level commands.

Outcomes and Considerations

The land, sea, and air environments each present unique challenges for a robot's mobility, perception, and navigation that must be overcome. Methods for real-time communication and processing may need to be developed to enable synchronization between systems.
The desired outcomes are:

- the definition of the limiting factors of human versus automated (e.g. artificial-intelligence) control as both a function of task and environment complexity (e.g. noise, clutter, GPS and communication denial);

- the development of designs that help a single operator to control multiple robots simultaneously, possibly over as many as 100 platforms of both current and emerging designs; and

- the development of the capability for robotic platforms to function individually as well as in partnerships in order to perform coordinated and collaborative functions, such as surveillance, that are not possible using singular systems.

Proposals should address privacy and ethical concerns.

12) Resilient Non-Global Positioning System (GPS) Based Positioning, Navigation and Timing

Challenge Statement

The Department of National Defence (DND) is looking for non-GPS solutions for positioning, navigation and timing (PNT). Specifically, DND seeks to provide military personnel with continuous and seamless 3D positioning and ad hoc environment mapping under degraded or denied GPS conditions. Military personnel should be able to transition from open environments to urban canyons, and operate from street level to inside buildings and underground without disruptions in their localization and navigation capabilities.

Concepts and systems that exploit recent rapid advances in relevant PNT technologies such as new or advanced sensors, algorithms, integration concepts, and tactical procedures that allow for extremely accurate PNT, are of interest.

This call to develop new, non-satellite based PNT capability for specific requirements and constraints is critical to the development of conventional and autonomous systems requiring robust PNT.

Background and Context

GPS has become ubiquitous on the modern battleground. However, operations often force military personnel into urban, indoor, subterranean or other difficult environments that are affecting the effectiveness of GPS equipment. To fulfil the requirement of providing precise locations in such GPS-denied environments, new systems and techniques are required. The cost, size, weight, and power reductions made possible by the rapid developments in modern technologies and algorithms in an integrated navigation system allow for significant opportunities for innovation.

Outcomes and Considerations

The desired outcome of this effort is to achieve a capability to allow operation without GPS (or any satellite navigation) for at least one hour with navigation error less than 30 meters and timing error less than one microsecond using equipment that can be easily carried by military personnel. The ultimate goal is to obtain "GPS-like" performance (10 meter accuracy) without GPS, indefinitely.

Constraints on proposed solutions include the size, weight, power, performance and cost objective thresholds. These constraints are driven by limitations on personnel weight bearing and power consumption. The system must operate globally, in all-weather, and under all-terrain conditions (i.e. from featureless to underground). There must be no reliance on pre-surveyed/pre-mapped locations or features except during system initialization at a trusted location. There must be seamless context handover (e.g. airborne to underground) without operator intervention. Any communication with external systems or sensors must be secure.

13) Identification and Characterization of Space Objects

Challenge Statement

In today's highly competitive space operations environment, there is a need to improve space situational awareness to ensure a safe and efficient environment for space operations.

The Department of National Defence (DND) is looking to develop a configurable Common Operating Picture (COP) of space assets that provides the required space situational awareness for informed, expedited decision-making in support of space system operations.

Background and Context

Canada's new Defence Policy, *Strong, Secure, Engaged*, characterizes space as increasingly congested, contested, and competitive. Space is congested due to the ever-increasing amount of space objects orbiting Earth; more than 20,000 objects larger than 10 centimeters are currently orbiting the Earth while it is estimated that more than 300,000 items between one and 10 centimeters are in orbit. Space is contested because of threats and hazards, such as actions by hostile entities or adverse space weather conditions that could affect space assets. The congested and contested aspects are of particular concern, since they could lead to the temporary or permanent disruption of space capabilities.

In addition, novel methods for increasing the understanding of objects in Low Earth Orbit (LEO) and Geostationary Equatorial **Orbit** (GEO) are being sought. The current approach for space object characterization is limited to non-resolved images and orbit determination. The world of congested/contested space will require methods of determining the shape, status, configuration, orientation and capabilities of space objects.

Space watch crews currently monitor well over a dozen separate information feeds. These feeds include space situational awareness, space weather, positioning navigation and timing (PNT), and system status information as provided by sources such as the Canadian Sapphire satellite or the U.S. Space Surveillance Network. This requires constant vigilance and running of checklists, as very few of

these feeds flag the crew in a prioritized fashion if something requires their attention. They have to interpret/analyze, validate, and re-transmit the information which requires checklists and transcribing/retransmitting of information. Additionally, operational analysis staff must conduct higher-level space event risk analysis requiring a cross-correlation of much of the information that the watch crews monitor and retransmit. Their analysis supports operational decisions related to the protection and/or the operation of Canadian and allied space assets/capabilities. Therefore, there is a need to integrate all the required information feeds to produce a space COP for rigorous and effective evidence-based decision-making.

Outcomes and Considerations

The desired outcome of this research effort is to collect, collate, integrate, analyze and display all the available data feeds that are essential to establish and maintain a complete and continuous situational awareness for effective management of space assets and the provision of space effects.

From a user perspective, the space COP system should:

1. provide 3D and 2D visualization capabilities of space assets, as well as background/raw data;
2. be configurable, based on the user needs;
3. provide succinct, prioritized, time-ordered prompts of significant events (including assessed threats);
4. leverage existing commercial or military-off-the-shelf solutions wherever possible; and
5. if possible, integrate Canadian space sensors (such as the Sapphire satellite while being open for future sensors) and allow for the command and control of these systems.

14) <u>What is in that Full Motion Video?</u>

Challenge Statement

The Department of National Defence (DND) is looking for solutions that will assist analysts in monitoring and interpreting the high volume of Full Motion Video (FMV) feeds. FMV analysis supports the detection, identification and tracking of events, people and objects of interest.

Background and Context

The Canadian Armed Forces (CAF) has acquired new airborne intelligence, surveillance and reconnaissance (ISR) platforms while preparing for the next generation multi-mission aircraft (CP-140 Aurora maritime patrol aircraft replacement). These platforms will enhance the capacity of CAF to provide critical, near real-time, surveillance and operational support to military organizations.

These airborne platforms will be equipped with state-of-the-art sensor suites to enable the collection of still images and FMV feeds. While the ability to operate these platforms has advanced to a high level of sophistication, the process of monitoring and interpreting video feeds continues to make a significant demand on the operational community. The CAF needs access to new tools to assist the analysts in monitoring multiple video feeds, identifying activities of interest, and alerting the operators.

With access to such tools, it will be possible for an operator to simultaneously monitor multiple feeds, thereby achieving enhanced efficiency and reduced workload. The task of monitoring video feeds is well-suited to emerging technologies in order to identify items of interest within the field of view against a moving background and in the presence of other activities. Beyond recognizing items of interest, a further challenge is to determine if the system is observing an activity which could be of interest to the operator. This includes basic counting of objects of interest, analysing patterns and, eventually, identifying indicators of anomalous activity.

Outcomes and Considerations

The desired outcome is the development of tools for automatic monitoring and interpretation of multiple live/near-real time image/video feeds or FMV feeds, collected with various camera technologies (e.g. high resolution, electro-optics, infra-red and Synthetic Aperture Radar). One should note that these sensors often image areas for which limited a-priori information is available.

The proposed solution should address one or more of the following:

1. Generate meta-data to assist in the rapid retrieval of images or video clips;

2. Automatically recognize and track specific objects within the field of view (for example, buildings, vehicles, people, etc.);

3. Track mobile objects as they travel through the field of view;

4. Automatically compare patterns from the same area at different times, potentially using data from different sensor platforms and develop a model of normal patterns of life in a region;

5. Detect anomalous behavior of objects (for example, vehicles travelling against normal traffic flow) with a reliable degree of confidence, thus alerting the operators to items of interest.

15) Making Sense of the Chatter

Challenge Statement

The Department of National Defence and security intelligence communities are challenged with making sense of ever increasing volume, variety, and velocity of social media data to produce actionable intelligence in support of decision making. We are looking for novel approaches, processes, technologies, and methods to assist intelligence analysts in the analysis of social media to extract relevant information for improved situational awareness and prediction of potential threats.

To improve the intelligence capability, we are particularly interested in developments (with varying levels of automation) related to:

- Content analysis and extraction;
- Data fusion;

- Social science approaches for inferring intent;
- Processing of multiple languages and cultural use of languages (e.g. particular semantics);
- Validation and assessment of credibility (source reliability and inference);
- Display of results (e.g. visual analytics, reporting);
- Data searching, filtering and alignment, and
- Alerting and notification (e.g. cross-cueing)

Background and Context

With the increasing complexity and fluctuating veracity of data in the open source domain, it is not possible to filter, identify and make sense of all information which could be relevant to defence and security. Data is often in multiple formats, multiple languages, unstructured and highly dynamic originating from hundreds of different social media platforms. Analysts are increasingly faced with cognitive overload and fatigue, while trying to make sense of this complex data. Growth in the number of analysts to manually process and interpret the data is not sustainable in the long term. In their aggregation with other similar topics, which are potentially based on different time periods or audiences, interpretation and contextual errors easily occur.

Increasing computing power has improved the ability to identify trends and relevant patterns in huge data sets, which would usually remain hidden, in part due to the recent advances in artificial intelligence with novel methods of text and data mining, including statistical and machine learning techniques.

Outcomes and Considerations

The expected outcome is the development of more effective and efficient processes for content analysis capable of understanding and predicting human behavior based on online activities and communications. Specific outcomes of this effort include:

- Achieving strategic and tactical advantage;
- Process efficiencies for analysts;
- Informing protection of assets, and
- Predictive analytical power.

Concepts and technologies proposed may include, but are not limited to the application of:

- Natural language processing;
- Artificial intelligence, text analytics and pattern recognition;
- Detecting deception;
- Behavioral modelling based on social sciences;
- Sentiment analysis;
- Smart data tagging, and
- Data aggregation and visualization

For this particular call for proposals, we are not interested in data warehousing, information technology associated with hardware for computation, compression techniques for bandwidth management, analysis and extraction of full motion video (FMV), other intelligence gathering mechanisms, or policy considerations which will be assessed at later stages of development.

We are interested in novel capabilities and concepts, but also practical solutions for operators which could be tested, fielded, and implemented quickly in the next few years.

16) Cyber Attribution for the Defence of Canada

Challenge Statement

The Department of National Defence (DND) is looking for innovative approaches to access, interpret, and compare all available evidence (e.g. technical, all-source intelligence) on how current cyberspace activities get attributed. This will assist in assessing the current cyberspace environment to improve methods on how to obtain secure cyberspace attribution in a timely manner.

Background and Context

Attribution is one of the most challenging problems in cyberspace. The internet was not designed with the goal of attribution in mind. The decentralized, dynamic, and open architecture of the internet enables a perpetrator to easily hide his or her tracks and operate with varying degrees of anonymity. Perpetrators may also operate on spatial scales ranging from local targets in close physical proximity to global targets connected by telecommunication technology over great distances. Consequently, perpetrators can be anywhere in the world and conduct their activities through compromised innocent third parties and obfuscate their origins.

Privacy rights are constantly being challenged, and government initiatives and legislation, such as those in the United Kingdom and Australia, increasingly request that application providers have mechanisms to attribute content and communications to users for lawful access. At the same time, application level encryption further complicates attribution as computing and micro segmentation are being used more frequently.

The ability to identify the source of a malicious cyber activity is the basis for taking action against a perpetrator. If one cannot convincingly show whether a perpetrator is a nation state or a criminal organization or a terrorist organization, one cannot establish the conflict's legal status or the internationally authorized response options. Legal and policy frameworks for responding to malicious cyber activities cannot work unless there is adequate attribution.

Outcomes and Considerations

The desired outcome of this research effort is to demonstrate methodological approaches and confidence metrics as well as identify challenges and issues (for e.g. technical, regulatory, etc.) with cyber activity attribution that would advance shared understanding of cyberspace and promote national cybersecurity. How these approaches can vary and be adapted for different levels of engagement (e.g. conflicts, aid to civil powers, response to national and continental threats) should be part of the solution.