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Border Integrity Capability: Enhancements of Multi-jurisdictional Situation Awareness on Lake Ontario during the G20

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Canada

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In conducting the research described in this report, the investigators adhered to the policies and procedures set out in the Tri-Council Policy Statement: Ethical conduct for research involving humans, National Council on Ethics in Human Research, Ottawa, 1998 as issued jointly by the Canadian Institutes of Health Research, the Natural Sciences and Engineering Research Council of Canada and the Social Sciences and Humanities Research Council of Canada.

Abstract

While improvements have been made on Border Integrity Capabilities over time, significant gaps remain, particularly along the Great Lakes and St Lawrence Seaway. This study reports that, for the first time in Canada, law enforcement authorities on the Great Lakes and St-Lawrence Seaway were able to demonstrate the capability of wide-area surveillance and maritime domain awareness through the use of networked radar technology. While a recent study (PSTP-08-103BTS) demonstrated the technology's ability to detect and track small vessels and low-flying aircraft, the G20 Summit in Toronto, a major complex national event, offered the opportutnity to extend the above study and test the contribution of the technology to border integrity under multi-jurisdictional operational conditions. This major event included a large number of users and stakeholders (RCMP, Great Lakes Marine Security Operations Centre, Toronto Police Services, and Department of National Defence) and provided a unique opportunity to test the value of the system in an international operational setting. While it was not possible to collect quantitative data during G20 Summit, it was agreed that qualitatitve data would be collected as part of the study. The results indicated that the networked radar technology increased the operational effectiveness as well as cost-effectiveness of the marine security efforts. Because the technology enabled: 1) maritime domain awareness 2) common operating picture ("common language" in multi agency operations) and 3) seamless web-enabled sharing of radar tracks overlayed on Google Earth™, users reported the ability to interdict vessels during the G20 Summit that may otherwise not have been. The technology was successful in detecting and tracking vessels of interest with respect to International cross border activity. Due to their continued engagement in the technology, users have suggested a number of improvements, which are documented in this report.

Résumé

Bien qu'avec le temps des améliorations aient été apportées aux capacités de l'intégrité des frontières, il reste encore d'importantes lacunes, en particulier le long des Grands Lacs et de la Voie maritime du St-Laurent. La présente étude montre que, pour la première fois au Canada, les autorités chargées de l'application de la loi sur les Grands Lacs et sur la Voie maritime du St-Laurent ont été en mesure de mettre à l'épreuve une capacité de surveillance élargie et de connaissance de la situation maritime fondée sur la technologie radar en réseau. Alors qu'une récente étude (PSTP-08-103BTS) montrait la capacité de cette technologie à détecter et à suivre de petits navires et des avions qui volent à basse altitude, le G20 à Toronto, un événement national hautement complexe, permettait de prolonger l'étude en question et de tester l'apport de la technologie à l'intégrité des frontières dans des conditions opérationnelles plurigouvernementales. Cet important événement, qui impliquait un grand nombre d'utilisateurs et d'intervenants (la GRC, le Centre des opérations de sûreté maritime des Grands Lacs, les Services de police de Toronto et le ministère de la Défense nationale), a offert une occasion unique de tester la valeur du système dans le cadre d'une mission opérationnelle internationale. Même s'il a été impossible de recueillir des données quantitatives pendant le G20, on a convenu que les données qualitatives feraient partie de l'étude. Les résultats ont indiqué que la technologie radar en réseau a permis d'améliorer l'efficacité opérationnelle et la rentabilité des efforts de sûreté maritime. Étant donné que la technologie a permis : 1) d'avoir une connaissance de la situation maritime 2) d'avoir une image commune de la situation opérationnelle (« langage commun » lors d'opérations impliquant plusieurs organisations) et 3) le partage Web continu de pistes radar superposées sur Google Earth™, les utilisateurs ont signalé qu'il leur a été possible d'interdire des navires pendant le Sommet du G20 ce qui, autrement, aurait pu ne pas se faire. Grâce à la technologie, il a été possible de détecter et de suivre des navires d'intérêt en rapport avec les activités transfrontalières internationales. En raison de leur engagement soutenu à l'égard de la technologie, les utilisateurs ont proposé un certain nombre d'améliorations précisées dans le présent rapport.

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Executive summary

Border Integrity Capability: Enhancements of Multi-jurisdictional Situation Awareness on Lake Ontario during the G20: [Subtitle]

Pierre Meunier; Andrew Vallerand; DRDC CSS TM 2011-12; Defence R&D Canada – CSS; June 2011.

Introduction:

In 2007, a report by the Senate Committee on National Security and Defense concluded that "Canadian authorities on the Great Lakes still do not have a real time common operating picture of what vessels are operating on the Great Lakes. Nor do they have anywhere near the policing capacity that would deter threats to Canadian society from activities on the Great Lakes." With this in mind, the Public Security Technical Program (PSTP) called for study proposals that would address this deficiency. The result of this call for proposals was study PSTP-08-103BTS, which proposed to explore the performance of a low-cost networked radar technology at detecting and tracking small vessels and low-flying aircraft. The pilot study turned into much more than that as a result of the decision by the Government of Canada to hold the G20 Summit in Toronto. This major event caused the scope of the study to expand to a larger audience of users and stakeholders than originally intended, but at the same time provided a unique opportunity to test the value of the system under true operational conditions. The purpose of this report was to collect qualitative data from those who took part in the study - and from those who were subsequently brought into the study as a result of the G20 Summit - while still fresh from the experience. The hypothesis was that this unique technology would enhance Border Integrity capability operationally over the Border on Lake Ontario.

Results: The results indicated that the networked radar technology increased the operational effectiveness as well as cost-effectiveness of the marine security efforts. Because of the maritime domain awareness and common operating picture provided, the users reported that vessel interdictions occurred during the Summit that may otherwise not have occurred. The technology was successful in detecting and tracking vessels of interest with respect to cross border activity. Some of these included:

- Ability to distinguishing vessel types.
- Greater area coverage.
- Raw radar signal availability
- Electro-optic sensor integration.
- Integration of AIS (Automatic Identification System) data along with identification and elimination of AIS vessels.
- Enhanced Google background and additional information.
- Common communications and blue force tracking
- Resolution of interagency and international information sharing issues.
- Determination of admissibility of radar data as evidence in criminal prosecution.
- Clarification of operational responsibilities.

- Better use of interdiction capacity.

Significance: For the first time in Canada, law enforcement authorities on the Great Lakes and St-Lawrence Seaway were provided with a novel wide-area surveillance and maritime domain awareness tool through the use of networked radar technology. Because of the maritime domain awareness and common operating picture provided, the users reported that vessel interdictions occurred during the Summit that may otherwise not have occurred. The technology was successful in detecting and tracking vessels of interest with respect to cross border activity and thus greatly contributed to border Integrity capability. Of significance is that federal, provincial and Municipal Governments have expressed the common desire to continue to co-invest in that technology.

Future plans: In an effort to continue the enhancement of that technology, users have recommended that the following objectives be pursued:

1) Integration of blue force tracking into the common operating picture and the development of standard operating procedures to optimize resource allocation;

2) Development of on-board display capability for law enforcement vessels at sea that can provide the real-time common operating picture;

3) Investigation of a means of augmenting the area of coverage through the use of mobile platforms, such as the marine radars on board vessels;

4) Perform data mining on the historical data collected over the summer to extract unusual patterns of behaviour with a view towards the development of automated alerts;

5) Investigate the potential integration of the system within the existing multi-agency search and rescue context;

6) Explore, with the appropriate US agencies, the technology's potential as an integrated tool for cross-border security applications;

7) Perform an operations analysis to develop novel ways of performing marine security duties by using the radar system capabilities to the fullest extent possible;

8) Investigate the potential of combining electro-optics with radar data as a means of augmenting the virtual on-water presence and make more effective use of the vessels;

9) Investigate inter-agency authorization, information-sharing and evidentiary policy issues relevant to the information generated by the radar technology;

10) Assess the performance of the newly developed vessel size detection capability and explore the operational uses and benefits;

11) Integrate and improve low-flying aircraft detection and identification capability into the common operating picture.

Sommaire

Border Integrity Capability: Enhancements of Multi-jurisdictional Situation Awareness on Lake Ontario during the G20: [Subtitle]

Pierre Meunier; Andrew Vallerand ; DRDC CSS TM 2011-12 ; R & D pour la défense Canada – CSS; juin 2011.

Introduction :

En 2007, un rapport du Comité sénatorial permanent de la sécurité nationale et de la défense concluait que « les autorités canadiennes sur les Grands Lacs n'ont toujours pas une image commune de la situation opérationnelle en temps réel des navires qui sillonnent les Grands Lacs. Elles n'ont pas non plus la moindre capacité de contrôle qui leur permettrait de contrer les menaces pour le Canada provenant des activités sur les Grands Lacs ». Tenant compte de cet aspect, les responsables du Programme technique de sécurité nationale (PTSN) ont effectué un appel de propositions d'étude sur cette lacune et retenu l'étude PSTP-08-103BTS, laquelle proposait d'examiner le rendement d'une technologie radar en réseau à faibles coûts pour la détection et le suivi de petits navires et d'avions volant à basse altitude. L'étude pilote s'est avérée beaucoup plus exhaustive après que le gouvernement canadien eut décidé de tenir le Sommet du G20 à Toronto. Non seulement cet événement d'envergure a-t-il fait en sorte d'étendre la portée de l'étude à un auditoire d'utilisateurs et d'intervenants plus grand que prévu, mais aussi de fournir une occasion unique de vérifier la valeur du système dans des conditions opérationnelles réelles. L'objectif du présent rapport consistait à recueillir des données qualitatives auprès de ceux qui ont participé à l'étude et de ceux qui ont vécu le G20, afin de vérifier l'hypothèse voulant que la technologie améliore la capacité opérationnelle de l'intégrité des frontières sur le lac Ontario.

Résultats : Les résultats indiquent que la technologie du radar en réseau améliore l'efficacité opérationnelle et la rentabilité des efforts de sûreté maritime. Grâce à la connaissance de la situation maritime et à l'image commune de la situation opérationnelle, les utilisateurs ont signalé qu'il leur a été possible d'interdire des navires pendant le Sommet ce qui, autrement, aurait pu ne pas pouvoir se faire. Grâce à la technologie, il a été possible de détecter et de suivre des navires d'intérêt en rapport avec les activités transfrontalières, notamment :

- Distinction des types de navire.
- Couverture de secteur élargie.
- Disponibilité de signaux de radar bruts.
- Intégration de capteurs électro-optiques.
- Intégration de données du Système d'identification automatique (SIA) de concert avec l'identification et l'élimination de navires munis d'un SIA.
- Amélioration de l'environnement Google et renseignements supplémentaires.
- Communications communes et suivi de la force bleue.
- Résolution des questions de partage de l'information internationale et interorganismes.

- Reconnaissance de l'admissibilité de données de radar comme preuve lors de poursuites criminelles.
- Précision des responsabilités opérationnelles.
- Utilisation améliorée de la capacité d'interdiction.

Portée : Pour la première fois au Canada, les autorités chargées de l'application de la loi sur les Grands Lacs et sur la Voie maritime du St-Laurent disposaient d'un nouvel outil de surveillance élargie et de connaissance de la situation maritime fondé sur la technologie radar en réseau. Grâce à la connaissance de la situation maritime et à l'image commune de la situation opérationnelle, les utilisateurs ont signalé qu'il leur a été possible d'interdire des navires pendant le Sommet ce qui, autrement, aurait pu ne pas pouvoir se faire. Grâce à la technologie, il a été possible de détecter et de suivre des navires d'intérêt en rapport avec les activités transfrontalières et ainsi, de contribuer encore davantage à la capacité de l'intégrité des frontières. Notons que les gouvernements municipaux, provinciaux et fédéral ont exprimé, d'une seule voix, qu'ils souhaitaient continuer à investir dans cette technologie.

Travaux futurs : Afin de continuer d'améliorer cette technologie, les utilisateurs ont recommandé de poursuivre les objectifs suivants :

12) Intégration du suivi de la force bleue à l'image commune de la situation opérationnelle et élaboration de procédures opérationnelles normalisées afin d'optimiser l'attribution des ressources;

13) Mise au point d'une capacité d'affichage à bord des navires chargés de l'application de la loi en mer, capable de fournir une image commune de la situation opérationnelle en temps réel;

14) Recherche d'une façon d'élargir le secteur de couverture grâce à des plateformes mobiles, comme les radars maritimes à bord des navires;

15) Analyse des données recueillies pendant l'été de manière à en extraire les modèles de comportement inhabituels tout en ayant à l'esprit la mise au point d'alertes automatiques;

16) Analyse de l'intégration éventuelle du système dans le contexte multi-organisme actuel de recherche et de sauvetage;

17) De concert avec les organismes américains appropriés, analyse du potentiel de la technologie comme outil intégré des applications liées à la sûreté transfrontalière;

18) Analyse d'opérations dans le but d'élaborer de nouvelles façons d'exécuter les tâches liées à la sûreté maritime en utilisant les capacités du système radar sous tous les angles;

19) Analyse de l'association des capteurs électro-optiques aux données de radar comme moyen d'améliorer la présence virtuelle sur l'eau et d'utiliser les navires plus efficacement;

20) Analyse des questions d'autorisation interorganismes, de partage de l'information et de politique de la preuve en rapport avec l'information produite par la technologie radar;

21) Évaluation du rendement de la nouvelle capacité de détection de la taille des navires et analyse des usages et avantages opérationnels;

22) Intégration à l'image commune de la situation opérationnelle et amélioration de la capacité de détection et d'identification d'avions volant à basse altitude.

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Acknowledgements

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1. Introduction

1.1. Border Integrity Capability Gaps

In 2007, a report by the Senate Committee on National Security and Defense (Kenny, 2007) concluded that:

> "Canadian authorities on the Great Lakes still do not have a real time common operating picture of what vessels are operating on the Great Lakes. Nor do they have anywhere near the policing capacity that would deter threats to Canadian society from activities on the Great Lakes."
>
> "Responsibility for security is confused and security is almost non-existent along Canada's maritime approaches and major inland waterways. Consider the fact that the RCMP patrols the Great Lakes and St. Lawrence Seaway with 14 officers aboard 3 vessels. There are local police force marine units – typically with less than a handful of officers – but they have their hands full dealing with pleasure boaters and can't be counted on to address national security threats." (p.38)

The need for marine and low flying aircraft situation awareness was evident in the RCMP Integrated Border Enforcement Team (IBET) 2009 Annual Report (RCMP, 2009), which contained a number of directly relevant conclusions, such as:

> "The marine environment is particularly susceptible to smuggling activity. Recreational vessels, large vessels, rubber rafts and jet-skis appear to be preferred means of conveyance…. "Information that suspicious low-flying aircraft are being used to transport narcotics continues to be reported in various IBET regions." (p.14)
>
> "Human smuggling and un-facilitated illegal migration continues to be a primary concern between the ports of entry at the Canada/U.S. border… As was the trend in 2007, in 2008 more individuals were detained illegally entering Canada from the U.S. between the ports of entry - 952 Canada-bound and 819 U.S.- bound. In 2008, there were overall 1771 apprehensions, compared to 996 in 2007." (p.9)
>
> "Factors that may have contributed to the overall increase in IBET apprehensions in 2008 were:
>
> - more joint IBET marine operations;
> - enhanced information sharing and better analysis amongst regional IBET partners on interdictions;" (p.9)
>
> "They (smugglers) utilize the ports of entry, remote roads, unguarded roads, train tracks, trails and waterways. In some marine environments the rivers in winter are solid enough to support snowmobile and some vehicular crossings." (p.14)
>
> "As criminals continue to exploit the border using increasingly sophisticated concealment methods, technological aids, counter surveillance, and in some cases carrying firearms, the coordination and continued sharing of criminal information and intelligence by IBET

partners is essential, as well as joint operations such as the Integrated Maritime Security Operation (IMSO) – better known as "Shiprider"" (p.15)

In a meeting of the Commons Security Committee on February 6, 2008, M.P. Gord Brown asked, *"How would you describe the marine border surveillance capacity currently on the Great Lakes and along the St. Lawrence River?* RCMP Commissioner William Elliott responded, *"My forthright response is one word, and that is, it's inadequate"* (House_of_Commons, 2008). There is at present, virtually no persistent or deployable wide-area surveillance capability in the Great Lakes/St. Lawrence Seaway border region capable of providing real-time or historical situational awareness of vessel or aircraft movements related to border crime.

1.2. The Public Security Technical Program

The Public Security Technical Program (PSTP) was set up to extend the CRTI[1] program and to advance Canada's security capabilities to prevent and prepare for short- and long-term safety and security threats, whether caused by terrorist or criminal activity, accident, or natural disaster, beyond the usual threats of CBRNE. One of the mission areas of the program is Border and Transportation Security, where the aim is to perform S&T activities focused on emerging technologies that could significantly improve the ability to screen passengers and goods, and using new technologies to assist low-risk travellers and interrupt the flow of higher-risk travellers.

Persistent wide-area surveillance over the Great Lakes and St-Lawrence Seaway was one of the topics of a recent PSTP call for proposals. The purpose was to "evaluate a variety of potential technologies and techniques that could be employed to enhance the vulnerable Great Lakes and St. Lawrence Seaway border consistent with the Government of Canada's priorities on prosperity and security, and in synchrony with United States-Canada border security agreementsAn earlier study (PSTP-08-103BTS) focusing on *Evaluation of Wide-Area, Covert, Radar Networks for Improved Surveillance, Intelligence and Interdiction against Watercraft and Low-Flying Aircraft,* focused on the following goals:

- To improve our understanding of radar network performance against vessels and low-flying aircraft in the context of the operational requirements of border enforcement;
- To determine the best radar site selection strategies and spacings for persistent and covert surveillance over waterways;
- To collect law enforcement user feedback on the utility of both real-time and intelligence-based information products to better understand what improvements/developments are needed;
- Exploiting the knowledge gained during this study and the complementary expertise of the partners in radar technology and border enforcement, a roadmap for full-scale deployment will be developed.

The maritime picture was provided to operators over the course of the summer. The purpose of this report is to document the qualitative data collected.

[1] Chemical, Biological, Radiological-Nuclear, and Explosives (CBRNE) Research and Technology Initiative (CRTI), http://www.css.drdc-rddc.gc.ca/crti/index-eng.asp

2. Methods of the Case Study

2.1. Marine radar technology

It is important to define the term “marine radar technology” in the context of the study. The system developped by Accipiter Radar Technologies Inc., according to its patent application (Nohara et al., 2006), is composed of a land-based non-coherent radar sensor adapted for the detection of targets of small or low radar cross-section, a digitizer, and a computer that is programmed to process the digitized radar signal and store target data. One of the defining features of the technology is its use of low-cost recreational marine radars that would not normally be capable of detecting small targets but whose performance is greatly enhanced through the addition of appropriate hardware and software. The radar signals are fed to a central monitoring site (CMS) through encrypted wireless communication and are combined into a single common operational picture (COP) through specialized processing and displaying software. A conceptual view of the arrangement is shown in Figure 1Pictogram of Accipiter Radar Network Technology on Lake Ontario (Nohara et al., 2008)Figure 1, where fixed-location or mobile radars (depicted as RN, or radar nodes on the figure) are strategically positioned around the lake shore to provide overlapping coverage of the area of interest. Figure 1 illustrates the transmission of the common operating picture to a law enforcement vessel via wireless means. The tracks can be viewed via computer or hand-held electronic devices to provide situation awareness and guide the law enforcement vessel towards the interception of a vessel of interest.

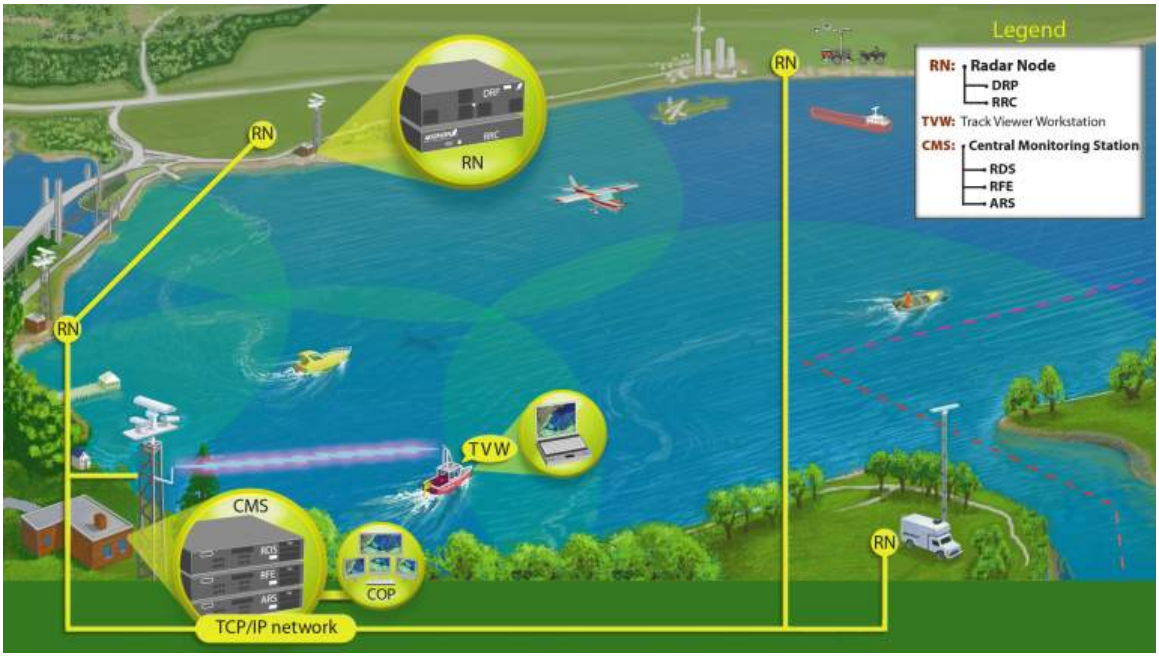

Figure 1Pictogram of Accipiter Radar Network Technology on Lake Ontario (Nohara et al., 2008)

The radar information gathered by the radar sensors and subsequent processing is then displayed as an overlay on Googel Earth. An example of what the common operating picture might look like is shown in Figure 2. This is the type of information that was made available to the IBET

team and the Toronto Police Services over the summer months, including the period of the G20 Summit.

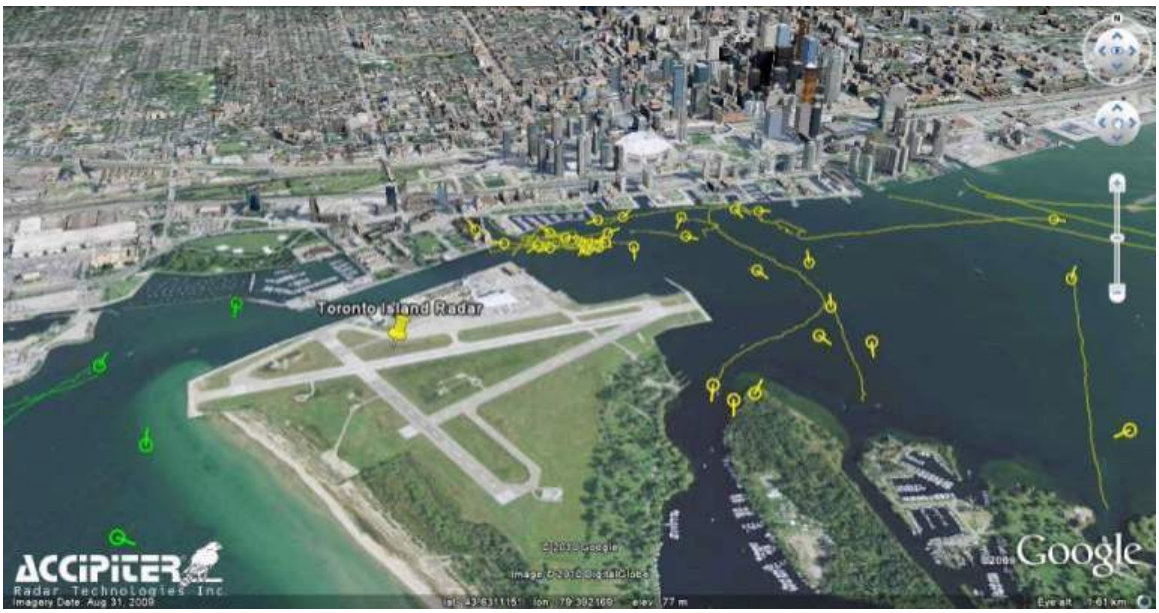

Figure 2 Google Earth and vessel track overlays from two radar nodes in toronto (yellow and green icons)

Operational Scenario

Coverage for the pilot study was provided for the western end of Lake Ontario as well as the marine area adjacent to the city of Toronto, including Toronto Harbour. The project featured data feed from both fixed and mobile radar nodes at four locations including:

- Saint Catharines (fixed)
- Fonthill (fixed)
- Niagara on the Lake (mobile)
- Toronto Island Airport (2-fixed)

The common operating picture (COP), which comprised a Google Earth™ map display of the relevant areas with live vessel tracking data, was shared among the Marine Security Operations Center (MSOC) participants (RCMP, CBSA, and DND) as well as with the Toronto Police Services (TPS) Emergency Operations Center. The tracking refresh rate was 2.5 seconds, which permitted detailed and complete tracking vessels. The TPS Emergency Operations Center also received direct radar feed from the Toronto Island airport nodes as well as Closed-Circuit TV (CCTV) coverage from that location.

Alerting capability

In addition to the live tracking of vessels, the software has the ability to generate alerts automatically based on user-defined criteria, such as vessels crossing into restricted areas. These

alerts were transmitted securely to operators' blackberries, which allowed for constant situation awareness and rapid response. This feature was used during the Summits.

Identified pre set automated alerts that were programmed by users included:

- vessel headings to designated areas
- vessel lingering in designated areas
- defined vessel activity (meeting)

The TPS users were only able to be operationally involved in the final planning stages of the project and thus were able to benefit from customized alerts or receive offsite communications, although they reported being satisfied with the alerts that were used.

Communication, coordination and interaction

Users not only received radar data but also supplied personnel and vessels for interdiction purposes. These assets were deployed successfully during the Summits as a result of data generated by the radar system. In particular, interdiction efforts in the immediate vicinity of Toronto Harbour and at the Port itself were noted as being especially effective when aided by the radar data. TPS, for example, has the largest enforcement 'fleet' on Lake Ontario and the radar data greatly enhanced its deployment effectiveness and capacity to interact with other agencies. This too was noted as important for the Summit and for future law enforcement operations especially with a cross border context. Providing multiple agencies with a common operating picture was key to the successful interaction and coordination of effort; it provided a "common language" that operators used to coordinate their efforts.

Surveillance/patrol vessels deployed for the Summit as part of this pilot project had radio communication with the Operations Center to respond to the radar tracking data, although TPS vessels appeared to lack the necessary GPS tracking capacity to maximize interdiction effectiveness.

Because of the success of the PSTP-08-103BTS study, TPS requested and received continued use of the system for the Caribana Festival and Airs Show both of which followed the Summit. TPS reported that it was able to detect, track and interdict cross border vessel traffic of interest which it had previously not been able to do.

Data querying capability

One of the key features of the radar system is its retention of vessel positional data and its ability to query those data. With this feature, users are able to identify and tag individual vessels of interest and obtain a full history of its whereabouts; what time it left its port, where it came from, where it went, etc. This type of data management feature was recognized by the users as potentially having great intelligence value. Because of the pressing operational priorities attached to the Summits, although some of the playback feature was used, there wasn't enough time for the users to take full advantage of this capability for the conduct of a more in-depth analysis of the tracks. Both the RCMP and TPS are in the process of investigating this new capability in recognition of its potential value.

Automatic Identifcation System (AIS) signal integration

Some of the users of the radar system identified the need to integrate the AIS signals, emitted by various classes of vessels, to the radar picture and allow interactive querying of information. While not explicitly part of the study, this capability was added in short order and supplied to the study participants.

Hypothesis

The hypothesis of the study was that the Common Operating Picture produced by Accipiter's networked radar technology and features increased the operational effectiveness as well as cost-effectiveness of the marine security efforts.

3. Results of Operational Experiences in G20 Summit

3.1. General comments

The technology was verifed and validated elsewhere (Nohara, 2009, 2010; Nohara, et al., 2008) and the BTS-103 study was an opportunity to expose border integrity stakeholders to this type of capability in an operational setting. This report focuses less on the technology *per* se and more on the effect it had on operations through better situation awareness, communications, and information sharing. It was determined that the technology worked as advertised, accurately depicting the tracks of vessels of interest. Ease of use was verified, with Google Earth™ being used as the medium through which tracks could be accurately overlayed and properly and seamlessly shared with G20 Summit security partners of all stripes. This Federal/Provincial/Municipal Common Operating Picture was conducive to better coordination during complex Major National Events such as the G20 Summit last summer. The result of deploying this surveillance capability and its impact on a case-study of national significance was captured through end-user interviews.

Based on the RCMP and Toronto Police Service user interviews and post Summit reports, the following general comments were recorded:

- The system accepted relevant automated alerts and properly recognized incidents (defined zone intrusion and loitering) resulting in **alerts received at the Operations Center as well as messages relayed to remote locations** (e.g. via smart phones such as Blackberries).

- The system **detected vessels of interest** that couldn't be detected visually from vessels at sea or from their on-board radar. Several instances were reported where assets were advised to persist based on the radar data, and vessels were detected and intercepted that would have otherwise been missed.

- The **MSOC received an integrated picture** from data coming from all radar nodes. The common picture displayed on a Google Earth background was useful and was shared as appropriate.

- **MSOC was provided with 24/7 tracking data** and the system operated with full redundancy.

- The **mobile radar system integrated into the overall capability** flawlessly and used existing communications systems without problem.

- **Vessels of interest were identified and intercepted** during the Summit operations as a direct result of using the radar system.

- The radar system was especially **helpful in detecting and tracking and interdicting small vessels targets**, which were of greatest interest to the operators.

- The **radar system was capable of detecting low flying aircraft** with the same tracking and display features.

- The **stored data playback feature performed with positive effect** for a current operational purpose including immediately accessing tracking history of a detected vessel of interest.

- In **subsequent operational use (Caribana)**, the radar system detected pre-set relevant cross border and vessel meeting activity as required.

- The system provided **data that was identified as being specifically useful for security of the Port of Toronto**.

- The radar system **produced data which was successfully received and used by various agencies in operational circumstances**, which is critical to the marine environment. The technology facilitated inter-agency co-ordination and co-operation by providing a common operating picture.

- The data supplied **supports the various mandate areas of participating agencies** and enhances the joint investigative effectiveness of multi agency operations.

- The radar system showed an **ability to integrate AIS data** so as to eliminate targets that were not of interest and focus on those that were.

- The Summit experience provided valuable training for law enforcement personnel on making use of the **technology, which was viewed as being user friendly**.

- The radar **technology permitted improved efficiency and productivity** in deployment of assets and thus served as a cost effective force multiplier.

- The radar **technology supported intelligence led enforcement**, which is critical in a marine enforcement environment, and for cross border related issues.

- Although the interviewees' experiences relating to Summit operations did not involve US authorities, all participants have other enforcement relationships with US authorities and agreed that the **radar system (which is already being used by several US agencies) would be easily integratable with US partners**.

- The experience using the networked radar **technology demonstrated important ancillary issues critical to inter-agency marine enforcement** which require resolution including authorizations for necessary information sharing, evidentiary requirements for use of data, standardized communications, appropriate agency authorizations and sensor integration.

3.2. Case-specific comments

Participants were hesitant to provide case specific examples of interdiction actions resulting from the radar system deployment and, as noted herein, evidentiary procedures concerning the generated data need to be established to make full use of this new capability. Notwithstanding these concerns, participants did advise that the following circumstances have occurred as a result

of the networked radar system deployment:

- The radar was used on multiple occasions for detecting vessels of interest because of defined activities and then guiding interdiction vessels to the targets where enforcement investigations followed. Police vessels had not been able to pick up target vessels on the ship's radar but the Accipiter radar was able to pick up small vessel targets at a greater distance, thus allowing interdiction;

- The radar was used on a “rules-based” setup to automatically detect vessels in a predefined area. Interdiction did take place on multiple occasions as a result of alarms, with interdiction and investigational follow-up;

- Cross border vessel activity of interest was detected on several occasions with resulting interdiction and enforcement investigation;

- The radar system was successfully used in a specific SAR instance involving a reported missing boater. The sytem’s historical data was used to "back track" the vessel to its originating port, establish a search grid based on this information, and subsequently monitor the established search grids;

- The radar system was used to track an already identified vessel of interest as it departed Canada and crossed into the US, leading to enforcement-related investigation;

- During the Economic Summit a report of a vessel having departed the Port of Montreal without authorization was received. The vessel entered Lake Ontario then proceeded toward the Port of Toronto on an unusual course of travel, far from the established shipping lanes. Heightening security concerns was the fact that the ship would not acknowledge two radio messages and appeared to have disabled its AIS midway through her voyage. Using radar system, Marine Radar security personnel were able to track the ship's movements across Lake Ontario until intercepted and investigated by the RCMP;

- The radar system was used to verify information provided relating to the characteristic vessel behaviour and *modus operandi* of persons suspected of drug trafficking;

- The radar system was used to monitor the waterside restricted zone of the Toronto International Air Show. Intrusions into the restricted area of the Air Show were averted due radar information provided by the networked radar system.

3.3. New capabilities

In summary, the networked radar technology was viewed as providing the following overall operational benefits when compared to current circumstances:

- Targeting of scarce resources by awareness in contrast to the past where knowledge was obtained mostly as a consequence of physical presence;
- More effective (cost + time) patrols which positively impacts on resource use and productivity;
- Proven enhanced situational awareness rather than patrols using onboard systems;
- Permits deployment of the right resources to the right locations;
- Assets can be directed to suspected targets-reduces the guesswork and enhances ability of officers to question operators more effectively (e.g. where are you coming from) which expands potential investigative authority;
- Being part of larger system saves scarce resources and permits maximized use of resources that might otherwise go unused;
- Earlier detection of targets of interest;
- Permits intelligence-based interception including on docking;
- Permits alerts to domestic and US agencies thus enhancing partner capacity;
- Permits historical data analysis for intelligence purposes which further increase productivity;
- Permits enhanced inter-agency effectiveness for Emergency Management and especially in Search and Rescue situations.

Users of the radar technology at the Summits individually and collectively provided overall positive reports of the system's performance and, as noted below, offered clear support for expanded law enforcement and border security deployment throughout the St Lawrence and Great Lakes.

3.4. Additional requirements

Because of the partners' intent to continue to co-invest in an enhanced capability with that technology, users identified a number of additional requirements based on their operational experiences of Summer 2010. Some of the issues identified included:

- **Ability to distinguishing vessel types -** The radar system, at the time the pilot study began, was not able to distinguish the size or type of vessel identified. Recent developments, which occurred during the project as a result of the comments made by some of the users, have prompted the company to develop radar cross-section algorithms that would meet that requirement. These are now available and published in the open literature (Nohara, 2010)
- **Greater area coverage –** Users noted that a greater area of coverage would be required in the longer term. This could be helped by the use of a military type of

radar sensor, e.g. by the Danish company Terma. This particular radar sensor integrates well with the Accipiter radar system and the company has integrated like systems to ensure that any particular radar location can be equipped with a sensor well matched in power and aperture to its line of sight performance requirements.

- **Raw radar data availability –** Some of the users deplored the fact that raw radar signals, while collected, were not directly available in the user tools for viewing, for example in the COP. As a result of this comment, the company decided to modify its software to supplement the current common operating picture with a dedicated layer that overlays the scan-converted PPI (Plan Position Indicator) signal onto the map. This capability now exists and is integrated in the COP. In fact, it has proven useful as a weather channel and for showing overlap in radar coverage by radars in the network.

- **Sensor integration -** Although the Summit marine operations did not report sensor integration, it was observed that this capacity would be of assistance for law enforcement and security activities. For instance, the addition of electro-optical assets would allow users to perform visual checks on alarms. The company has confirmed that its system is integratable with a variety of sensors, including CCTV, with several cameras already integrated.

- **Identification/elimination of AIS vessels -** With the exception of vessels which turn off their AIS signal, differentiation of these vessels from other targets of interest would narrow target focus and eliminate clutter. This appears to be feasible with the Accipiter radar system. AIS integration is now included in the Accipiter COP as a separate layer.

- **Enhanced Google background and additional information -** It was suggested that the Google Pro version of mapping might be more suitable for the additional data provided and that addition of available information relevant to search and rescue applications, such as water depth, would be helpful. Accipiter currently supports Google Enterprise Server and clients and in deployed systems where specialized maps are desired.

- **Common communications and blue force tracking –** The users noted that communications interoperability should be improved among security partners if the full value of the Common Operating Picture and resulting efficiencies are to be gained. The technology for communications and for blue force tracking exists and can be made to work.

- **Stability of network connection -** One of the users reported frequent disconnect from signal requiring re-logging to gain access. This was unfortunately not identified as a problem until after the Summit and was apparently caused by an improper network setup and not a systemic problem.

- **Interagency and international information sharing -** This issue has been raised previously and surfaced again during the Summit. Participants expressed frustration at unidentified ‘legal’ obstacles being cited to prevent law enforcement related information sharing, including radar tracking data, which all operational parties

acknowledged was desirable. Current efforts by the Department of Justice (and others) to clarify information sharing are underway that could resolve this issue in the near future. The common operating picture provided by the radar system could facilitate the sharing of information and enhance coordination.

- **Admissibility of radar data as evidence in criminal prosecution -** TPS participants noted uncertainty in this regard in their inquiries and advised they would welcome clarification to ensure that what is gathered is admissible in a subsequent prosecution. The Canada Evidence Act contains various sections which pertain to admissibility of expert, electronic and documentary evidence which would seem to permit the use of the tracking data obtained by the radar system. This issue should be clarified with the Department of Justice.

- **Clarification of operational responsibilities -** This policy issue was raised by TPS particularly with respect to any future law enforcement related deployment. TPS, for example, although eligible to be a partner in the Shiprider program has not yet been so designated. There are also temporary appointment authorities and designated responsibilities for various agencies and a full identification and resolution of these issues was recommended to maximize operational effectiveness.

- **Interdiction capacity -** The radar technology evaluated as part of this study created a hitherto unknown marine domain awareness and marine operational intelligence. The creation of this enhanced awareness and intelligence can have a profound impact on the current way of doing business. There is therefore a requirement to rethink strategies and operations to take full advantage of the new capabilities offered by such a powerful tool, including interdiction capacity.

3.5. Value added and additional opportunities going forward

The Summit marine operations were aided by the deployment of networked radar surveillance technology, which was used by the multiple participating agencies from different levels of government. This event provided an unparralled opportunity for an assessment of the technology's capabilities and performance under true operational conditions, as opposed to the study's more modest original goals. Accordingly, interviewees were asked to provide their insights and recommendations, positive or negative, with respect to any potential future deployments of the automated analytical radar system. Not surprisingly, there was a harmonization of requirements, there was a notable concurrence in identified marine sector vulnerabilities and the potential of networked radar technology to address it.

Interviewees supported the deployment of networked radar technology for law enforcement and border security, Search and Rescue operations and site specific Critical Infrastructure Protection. What was recommended overall was a common radar surveillance system with general capabilities augmented by user-specific applications that are adapted for each stakeholder's needs.

Law Enforcement - Border Security - The radar system features, such as user-determined automated alerts, vessel tracking, real time, secure, multi party communications and data retention were specifically viewed as being of great value for law enforcement and border security activities.

Need for an interdiction capacity to operationalize the networked radar data - It was agreed that this needs to be a nationally led, joint force capacity involving all of the RCMP, CBSA, OPP, SQ and local police jurisdictions. Participation should be crafted through written Memoranda of Understanding that detail roles and responsibilities. Appropriate legal authorizations and information sharing agreements, where required, should be put in place prior to the activation of the operational unit. This includes taking whatever steps are required to ensure that all participating agencies, including CBSA, are approved partners in the Shiprider program.

Cross border application - One of the interviewees was aware that the technology is being used by US authorities at both the national and state level. As noted above, by its nature, the system permits full data integration of multiple radar sensor nodes which means cross border data integration is currently possible. This was recommended both from an operational productivity perspective as well as from a cost effectiveness one. Such an approach is also fully consistent with the IBET program and its recommendations as well as the Shiprider Agreement.

It was further recommended that the nature of the St Lawrence-Great Lakes marine environment (and indeed inland lakes) is such that the networked radar system should be integrated with other sensors, such as CCTV, that can be activated automatically. The example of an automated detection of a cross border vessel entering a non designated port of entry marina triggering the activation of a CCTV to try and capture footage of the individuals involved was provided. The intelligence analysis made possible by the radar system's data retention should also assist in setting the automated alerts and integrated sensor activation. This feature was recognized as necessary due to the sheer volume of the environment and the impossibility of always having an interdiction unit available.

The capacity to detect and track low flying aircraft crossing the border was also identified as being a feature that needs to be incorporated into border related enforcement operations including automated remote alerts.

The ability to recognize and monitor vessels that deviate from shipping lanes and that turn off their AIS was identified as being desirable especially with the system's capacity to create and automate detection and alerts for small craft that make contact with such vessels.

Search and Rescue - One interviewee whose agency is extensively involved in search and rescue efforts described the technology as a 'Godsend' with respect to the activities inherently involved in search and rescue operations. Features such as data retention, vessel tracking, capacity to set exclusion zones and real time, multi party communications were all identified as being significantly able to enhance the effectiveness of search and rescue operations. The increased operational effectiveness is described by interviewees as resulting in significant cost effectiveness for search and rescue operations.

The technology used during the Summits demonstrated a multi party access that has particular application in search and rescue applications. A system that is deployed for law enforcement purposes can also be used for search and rescue activities involving non law enforcement agencies such as DND and the Coast Guard through restricted information access. The same inter agency authorizations and arrangements as noted above will need to be implemented.

Critical Infrastructure Protection Application - The features which were used for the Port of Toronto, such as intrusion zones and loitering, demonstrated a site-specific capacity which was

described as ideal for marine situated critical infrastructure facilities (such as ports or power plants). Infrastructure operators could be given restricted access to the data including through user designed automated alerts and this could be augmented through specified protocols with public authorities.

The ability of the technology to provide select data for specified users would permit infrastructure operators to be part of the larger marine surveillance system without receiving law enforcement sensitive information. It was also recognized that the use of private security at such facilities would create requirements for operators to ensure specialized personnel screening and expertise.

3.6. Operational Issues

If such a St Lawrence-Great Lakes system were to be launched, interviewees identified a number of operational issues that should be considered, such as:

>*Identify all existing radar nodes to assess ability to incorporate into new system*
As the Summit operations demonstrated, there are pre-existing radar nodes currently deployed throughout the entire region, on both sides of the border. It was recommended therefore that an inventory of existing radar nodes suitable for use in the contemplated system be identified so as to reduce costs and expedite deployment.

>*Ensure radar node site security*
While some radar node locations have inherent site security, others do not. This includes radar nodes in remote locations, including potentially on islands or private property. Discrete placement of the radar node in such circumstances is recommended to the greatest extent possible (consistent with line of sight). Further, consideration should be given to ensuring an ongoing mobile private security presence as part of overall systemic maintenance. The radar system has automated health monitoring and alerting in case of damage or system malfunction or failure which should also be included in overall planning to ensure timely corrections and back up coverage if possible.

4. Conclusions

For the first time in Canada, law enforcement authorities on the Great Lakes and St-Lawrence Seaway were provided with a unique wide-area surveillance and maritime domain awareness capability through the use of multiple networked radar nodes. The PSTP-08-103BTS study, originally intended to explore this technology's ability to detect and track small vessels and low-flying aircraft, turned into much more than that as a result of the G20 Summit taking place in Toronto. This major event caused the scope of the study to expand to a larger audience of users and stakeholders than originally intended, and provided a great opportunity to test the value of the system under operational conditions. The comments of those who took part in the study - and those who were brought into the study due to their marine security responsibilities during the G20 Summit - were collected while still fresh from the experience can be summed up as follows:

1. The networked radar technology increased the operational effectiveness of the marine security efforts through:
   - the availability of pre set, automated alerts of vessel activity or presence of interest
   - vessel detection, tracking and interdiction which would otherwise not have been possible
   - increased domain awareness through multiple radar node data integration
   - remote, multi party secure communications of received alerts
   - increased ability to identify and interdict targets of interest at a distance, rather than previous awareness based on physical presence
   - increased awareness of activity of interest in and around the Port of Toronto
   - increased capacity for coordinated inter agency action
   - increased generation of intelligence for operations

2. The networked radar technology increased the cost-effectiveness of the marine security efforts through:
   - increased ability to target resources, thus serving as a force multiplier
   - reduced need for routine patrol
   - increased inter-agency effectiveness
   - increased generation of intelligence for operations

3. As a result of the networked radar technology, vessel interdictions occurred during the Summits based on vessel activity of interest that may otherwise not have occurred

4. The networked radar technology was user-friendly and the Summit provided valuable learning experience for personnel assigned to marine security.

5. The networked radar technology was successful in detecting and tracking vessels of interest with respect to cross-border activity

6. The networked radar technology would be extremely helpful for law enforcement, border security, Search and Rescue, and marine Critical Infrastructure Protection applications throughout the St Lawrence and Great Lakes region. The nature of the system is such that it could be fully integrated on a Canada-US basis.

7. Technology enhancements were identified that could greatly improve the effectiveness of the system and that are well within reach.

8. Interagency authorization, information-sharing and evidentiary policy issues were identified as factors that require resolution in order to maximize the system's usefulness.

9. Use of the technology over the summer months has generated data history of potential significance for future operations. Analysis of these data could provide insights into characteristic behaviours worthy of investigation.

10. Expansion of the Common Operating Picture to the appropriate US agencies would greatly enhance the ability to respond to cross-border situations of concern. Application of the technology, including radar data integration and information sharing supported by joint enforcement activity should be explored by appropriate Canadian and US agencies.

5. Recommendations

In view of the results of the PSTP-08-103BTS study as well as the qualitative data collected from the summer operations, it recommended that the following objectives be pursued:

1) Integration of blue force tracking into the common operating picture and the development of standard operating procedures to optimize resource allocation;

2) Development of on-board display capability for law enforcement vessels at sea that can provide the real-time common operating picture;

3) Investigation of a means of augmenting the area of coverage through the use of mobile platforms, such as the marine radars on board vessels, and through the identification of all existing radar nodes with a view to integrate into the network;

4) Perform data mining on the historical data collected over the summer to extract unusual patterns of behaviour with a view towards the development of automated alerts;

5) Investigate the potential integration of the system within the existing multi-agency search and rescue context;

6) Explore, with the appropriate US agencies, the technology's potential as an integrated tool for cross-border security applications;

7) Perform an operations analysis to develop novel ways of performing marine security duties by using the radar system capabilities to the fullest extent possible;

8) Investigate the potential of combining electro-optics with radar data as a means of augmenting the virtual on-water presence and make more effective use of the vessels;

9) Investigate inter-agency authorization, information-sharing and evidentiary policy issues relevant to the information generated by the radar technology;

10) Assess the performance of the newly developed vessel size detection capability and explore the operational uses and benefits;

11) Integrate and improve low-flying aircraft detection and identification capability into the common operating picture.

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List of symbols/abbreviations/acronyms/initialisms

AIS	Automatic Identification System
BTS	Border and Transportation Security
CBSA	Canada Border Services Agency
CCTV	Closed-circuit TV
CMS	Central Monitoring Site
COP	common operating picture
DND	Department of National Defence
DRDC	Defence Research & Development Canada
DRDKIM	Director Research and Development Knowledge and Information Management
IBET	Integrated Border Enforcement Team
M.P.	Member of Parliament
MSOC	Marine Security Operations Center
OPP	Ontario Provincial Police
PPI	Plan Position Indicator
PSTP	Public Security Technical Program
R&D	Research & Development
RCMP	Royal Canadian Mounted Police
RN	Radar Node
SQ	Sûreté du Québec
TPS	Toronto Police Service
DND	Department of National Defence
DRDC	Defence Research & Development Canada
DRDKIM	Director Research and Development Knowledge and Information Management
R&D	Research & Development

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While improvements have been made on Border Integrity Capabilities over time, significant gaps remain, particularly along the Great Lakes and St Lawrence Seaway. This study reports that, for the first time in Canada, law enforcement authorities on the Great Lakes and St-Lawrence Seaway were able to demonstrate the capability of wide-area surveillance and maritime domain awareness through the use of networked radar technology. While a recent study (PSTP-08-103BTS) demonstrated the technology's ability to detect and track small vessels and low-flying aircraft, the G20 Summit in Toronto, a major complex national event, offered the opportutnity to extend the above study and test the contribution of the technology to border integrity under multi-jurisdictional operational conditions. This major event included a large number of users and stakeholders (RCMP, Great Lakes Marine Security Operations Centre, Toronto Police Services, and Department of National Defence) and provided a unique opportunity to test the value of the system in an international operational setting. While it was not possible to collect quantitative data during G20 Summit, it was agreed that qualitatitve data would be collected as part of the study. The results indicated that the networked radar technology increased the operational effectiveness as well as cost-effectiveness of the marine security efforts. Because the technology enabled: 1) maritime domain awareness 2) common operating picture ("common language" in multi agency operations) and 3) seamless web-enabled sharing of radar tracks overlayed on Google Earth™, users reported the ability to interdict vessels during the G20 Summit that may otherwise not have been. The technology was successful in detecting and tracking vessels of interest with respect to International cross border activity. Due to their continued engagement in the technology, users have suggested a number of improvements, which are documented in this report.

Bien qu'avec le temps des améliorations aient été apportées aux capacités de l'intégrité des frontières, il reste encore d'importantes lacunes, en particulier le long des Grands Lacs et de la Voie maritime du St-Laurent. La présente étude montre que, pour la première fois au Canada, les autorités chargées de l'application de la loi sur les Grands Lacs et sur la Voie maritime du St-Laurent ont été en mesure de mettre à l'épreuve une capacité de surveillance élargie et de connaissance de la situation maritime fondée sur la technologie radar en réseau. Alors qu'une récente étude (PSTP-08-103BTS) montrait la capacité de cette technologie à détecter et à suivre de petits navires et des avions qui volent à basse altitude, le G20 à Toronto, un événement national hautement complexe, permettait de prolonger l'étude en question et de tester l'apport de la technologie à l'intégrité des frontières dans des conditions opérationnelles plurigouvernementales. Cet important événement, qui impliquait un grand nombre d'utilisateurs et d'intervenants (la GRC, le Centre des opérations de sûreté maritime des Grands Lacs, les Services de police de Toronto et le ministère de la Défense nationale), a offert une occasion unique de tester la valeur du système dans le cadre d'une mission opérationnelle internationale. Même s'il a été impossible de recueillir des données quantitatives pendant le G20, on a convenu que les données qualitatives feraient partie de l'étude. Les résultats ont indiqué que la technologie radar en réseau a permis d'améliorer l'efficacité opérationnelle et la rentabilité des efforts de sûreté maritime. Étant donné que la technologie a permis : 1) d'avoir une connaissance de la situation maritime 2) d'avoir une image commune de la situation opérationnelle (« langage commun » lors d'opérations impliquant plusieurs organisations) et 3) le partage Web continu de pistes radar superposées sur Google Earth™, les utilisateurs ont signalé qu'il leur a été possible d'interdire des navires pendant le Sommet du G20 ce qui,

autrement, aurait pu ne pas se faire. Grâce à la technologie, il a été possible de détecter et de suivre des navires d'intérêt en rapport avec les activités transfrontalières internationales. En raison de leur engagement soutenu à l'égard de la technologie, les utilisateurs ont proposé un certain nombre d'améliorations précisées dans le présent rapport.

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Radar; Marine Security; Marine Domain Awareness