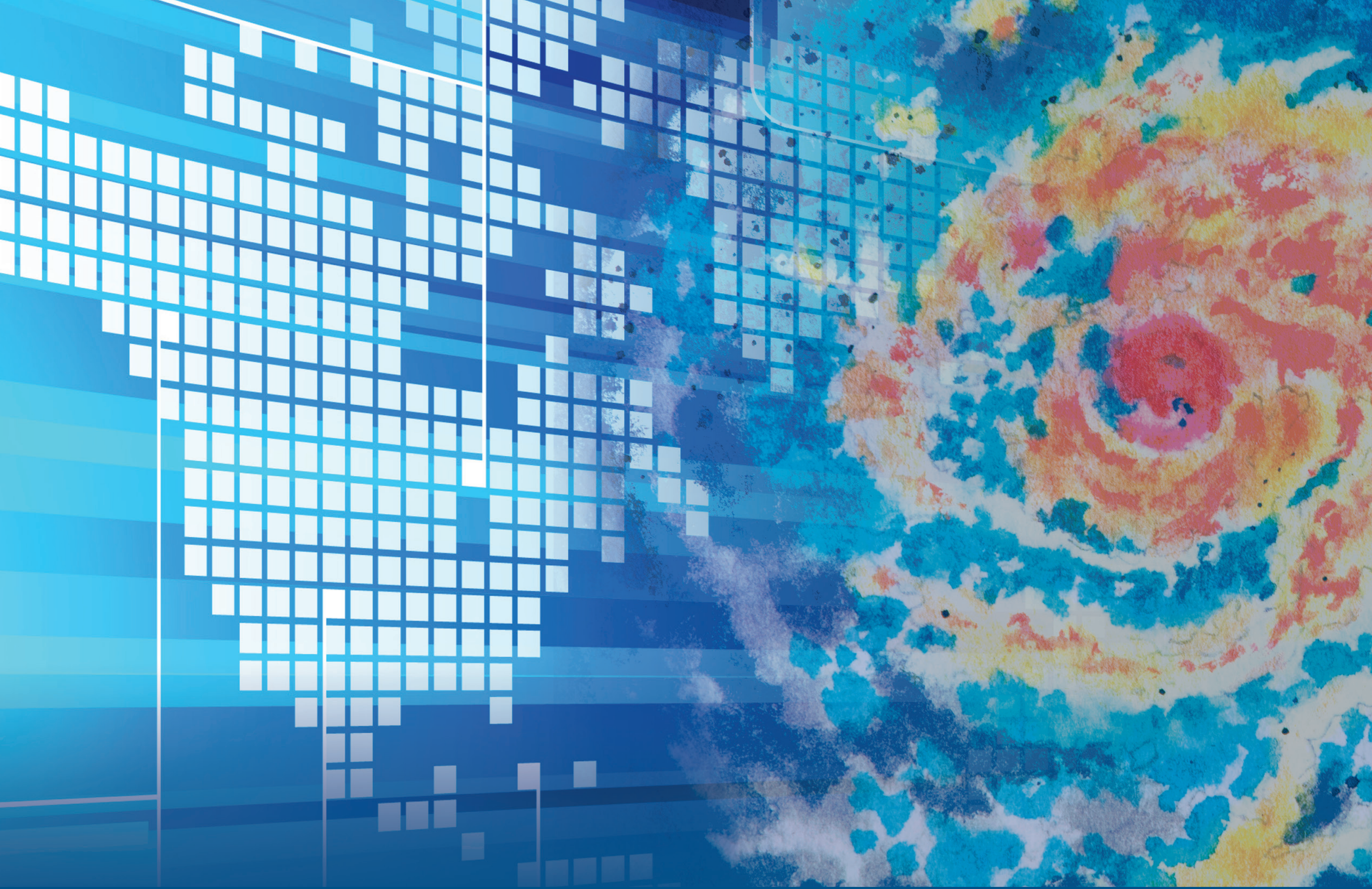

Canada-U.S. Enhanced Resiliency Experiment (CAUSE III)

Northeastern Scenario After-action Report

June 2015

Homeland Security

Science and Technology

Canada

Department of Homeland Security (DHS) Science and Technology Directorate (S&T)
First Responders Group

CANADA–US ENHANCED RESILIENCY EXPERIMENT SERIES "CAUSE III": NORTHEASTERN EXPERIMENT AFTER ACTION REPORT

Dan Cotter, Denis Gusty, Marc Caplan and Jeffrey Booth
Joel Thomas, Sara Estes Cohen, Erik Endrulat and Michael Amoabeng
DHS S&T

Defence Research and Development Canada – Centre for Security Science (DRDC CSS)

Philip Dawe, Kate Kaminska and Jack Pagotto
DRDC CSS

Kelly Forbes
International Safety Research

Darrell O'Donnell
Continuum Loop

DHS S&T Report Number [Will be inserted by DHS Publication Officer]

June 2015

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Abstract

On December 7, 2011, President Obama and Prime Minister Harper released the Beyond the Border (BTB) Action Plan. Specifically, the BTB Action Plan states that Canada and the United States (U.S.) will: "*promote the harmonization of the Canadian Multi-Agency Situational Awareness System with the U.S. Integrated Public Alert and Warning System to enable sharing of alert, warning and incident information to improve response coordination during binational disasters*."

To this end, the third Canada–U.S. Enhanced Resiliency III Experiment (CAUSE III) addressed this common goal in addition to several other initiatives. It was jointly sponsored by the U.S. Department of Homeland Security (DHS) Science and Technology Directorate (S&T) First Responders Group, Defence Research and Development Canada (DRDC)'s Centre for Security Science (CSS), and Public Safety Canada (PS). This cross-border initiative consisted of experiments held over the course of November 2014. This document reports the design, execution and findings from the experiment concerned with the Northeastern scenario that occurred during CAUSE III. Emergency management agencies in Nova Scotia and New Hampshire, supported by digital volunteers, tested the capability of officials to leverage social media. The experiment investigated the capabilities of the Canadian Multi-Agency Situational Awareness System (MASAS), the American Integrated Public Alert and Warning System (IPAWS), the Mutual Aid Support System (MASS) and Virtual USA (vUSA)[1] to improve the efficiency of creating, sending and receiving emergency alerts; processing requests for mutual aid; and contributing to enhanced situational awareness (SA) across borders. The results demonstrated improvements to shared SA and interoperable communications, which had a positive impact on enhancing community resilience.

Significance for Defence and Homeland Security

A simulated environment was created for the Northeastern CAUSE III experiment, which was designed around a large hurricane scenario. Social media and SA tools support the exchange of alerts, warnings and notifications and the coordination of mutual aid between Canada and the United States. The results demonstrated that the cooperation and collaboration between the traditional Emergency Management (EM) organizations and digital volunteers, including Virtual Operation Support Teams (VOSTs) and humanitarian organizations, have the potential to improve recovery operations measurably by using interoperable SA tools and social media tools. These findings will inform Canadian and U.S. emergency management agencies with respect to their efforts

[1] The National Information Sharing Consortium managed Virtual USA community is powered by ArcGIS Online. Note that the previous version of Virtual USA library used in CAUSE II was transitioned on September 30, 2014.

to address the BTB initiative and improve the coordination of mutual aid responses during cross-border events through shared SA and interoperable communications.

Acknowledgements

An experiment of this magnitude is carried out with the help, dedication and enthusiasm of a great number of people and organizations. The authors wish to thank all of the following participating organizations that have helped to advance Canadian and U.S. interoperability:

1 Introduction

The third experiment in the Canada-U.S. Enhanced Resiliency series, CAUSE III, represents the continuation of a collaborative effort between Defence Research and Development Canada's – Centre for Security Science (DRDC CSS), Public Safety Canada (PS), and the U.S. Department of Homeland Security (DHS) Science and Technology (S&T) Directorate First Responders Group. CAUSE III used a scenario-based approach to simulate the use of interoperable technology during two cross- border emergencies. These large-scale emergencies required a coordinated response and recovery from partnering emergency management (EM) organizations. The locations of the border regions that were involved in these experiments are depicted in Figure 1 below. The first scenario involved a hurricane affecting the Northeastern United States that subsequently made landfall in Halifax, Nova Scotia, Canada.[1] The second scenario involved a rangeland bush fire in the border region of Montana, Saskatchewan and Alberta.[2] Both scenarios required a cross-border response from Canadian and U.S. agencies. This report is concerned with the Northeastern scenario and a separate report will document the Western scenario.

Figure 1: Cross-border regions involved in CAUSE III.

1.1 Emergency Management

The construct of EM in Canada, as in the United States, recognizes that local and regional entities work at the critical operational level of responses to any crisis or emergency.[3][4] National or federal support is delivered upon request and is dependent upon the nature of the emergency and the need for augmentation or a specialized response capability.[5][6] On December 7, 2011, President Obama and Prime Minister Harper released the Beyond the Border (BTB) Action Plan (Action Plan), which set joint priorities and specific initiatives for cross-border collaboration.[7][8]

The goal of the BTB Action Plan is to build upon the existing perimeter approach to security and economic competitiveness, thereby leading to security enhancements and an accelerated flow of people, goods and services.[7] Further, this partnership helps to ensure that binational coordination is not geographically limited to the border crossing, but is extended to public safety issues that simultaneously affect both nations, regardless of where incidents occur. Indeed, the design of the simulated events during CAUSE III confirmed that an event near the border requires cooperation between officials in both countries. The shared goal within this partnership centers on enhancing the coordination of emergency responses during binational disasters.

The BTB Action Plan led to the establishment of a Communications Interoperability Working Group (CIWG) that will:

- Coordinate national-level emergency communications plans and strategies;
- Identify future trends and technologies related to communications interoperability;
- Promote the use of standards in emergency communications;
- Promote governance models and structures; and
- Share best practices and lessons learned.

The BTB Action Plan is focused on developing and facilitating multi-jurisdictional and cross-border interoperability to harmonize binational emergency communications efforts. More specifically, it calls for the interoperability between the Canadian Multi-Agency Situation Awareness System (MASAS) and the U.S. Integrated Public Alert and Warning System (IPAWS) to enhance situation awareness (SA) by enabling the sharing of alert, warning and incident information.[7][8] These enhancements will lead to improved response coordination by EM authorities during binational disasters.

The ability of authorized federal agencies and first responder entities to share information about threats and emergency incidents with stakeholders (e.g., public safety officials, intelligence and law enforcement communities and the public) is an ongoing challenge.[9][10][11][12][13] First responders at the federal, state, provincial and local levels who are responsible for coordinating disaster planning and response do not always have the opportunity to adequately share information. Data sources and formats, and the way information is accessed, transferred, viewed and forwarded, differ across the first responder landscape. First responders assess the relevancy, timeliness and reliability of available information for preparedness, mitigation, response and recovery purposes. The tools and technology that are used to share information between agencies is an ongoing effort between Canada and the United States.[2][9][10]

There is information sharing happening at various governmental levels that is based on existing agreements and ongoing discussions related to developing future agreements.[14][15][16] [17][18] These agreements provide guidance that facilitates information sharing between Canadian and U.S. national-level operations centers. These ongoing discussions also consider how public safety officials should share SA and send cross-border alerts.[9][10]

1.2 Social Media for Emergency Management

Historically, the emergency response community has leveraged multiple tools and technologies to acquire critical data. Common tools and technologies are varied, and include:

- Land mobile radios,
- Paper maps,
- Landlines,
- Email,
- Cellular phone,
- Satellite phone,
- Mobile data (e.g., low-speed wireless data),
- Computer-aided dispatch for incident and unit status,
- Crisis management systems (e.g., E-Team, WebEOC, etc.),
- Traffic cameras,
- Amateur HAM radio,
- Enhanced 911,
- Reverse 911,
- Mobile text alerts,
- Global positioning services (GPS) for the location of response vehicles and resources,
- Geographic information systems (GIS) for visualization of information,
- Windshield assessments,
- Traditional media (television, radio, etc.).

These tools have been used to collect and exchange information needed for operational decisions.[9][10][11]

Recently, large scale disasters in Canada, the United States and internationally have led to the increased use of mobile devices, social media, photos, videos and other sensor data as viable information sources.[19][20][21] This information can be helpful in planning for, responding to and recovering from disasters and emergencies. The sheer amount and speed with which social media information is shared, combined with the slow adoption by traditional emergency management organizations to validate and summarize this information, often leaves data unused and, as a result, un-actionable. Challenges that have been identified by the emergency management and Virtual Operation Support Teams (VOSTs) communities include:

- Limitations to existing communications and information management policies, processes, training, and education;
- Familiarity with technology; access to, and capabilities of technology; and
- A lack of data standards to support interoperability and the full integration of non-traditional data (e.g., social media and sensor data) within traditional emergency management processes.[22][23]

Research conducted by DRDC CSS and DHS S&T also revealed that both Canadian and U.S. government agencies active in the disaster management domain, including local emergency management organizations (EMOs), are not currently fully exploiting social, mobile and networked technologies.[21][23] The reasons for this are many, but one of the primary barriers identified was the lack of consideration of how such technologies can be considered within the policy realm. While some EMOs are working on developing, or have already adopted, guidelines and policies for the inclusion of social media in their communications strategies, the potential for social technologies to support operations is rarely considered.[20] [21][23]

With the explosion of social media, responders can now leverage real-time, dynamic information from a variety of non-traditional sources, both for communications and to gather and share information to support decision-making more quickly.[24][25] There remain, however, several challenges to unfettered access to information shared through social media and the adoption of Information Application and Data and Open Standards.[21] These include the following:

- **Information Application:** The ability to access, share, search, verify, contextualize and manage available information. This concept also includes the identification of essential elements of information in social media as they relate to traditional public safety information requirements.
- **Privacy, Legal and Security Challenges:** There are several challenges associated with the use of social media for SA, especially with regard to: user privacy and the use of personally identifiable information; the need to remove details when sharing information across multiple platforms; and the security of networks, tools and data.
- **Data and Open Standards:** To truly enhance SA, social media must be integrated, both technically and contextually, within the larger information-sharing environment and into the public safety operational workflow. Additional considerations include the ability to detect events, data formats and use of

unstructured data, ontologies and taxonomies, semantic and linked data, automation and algorithms, and artificial intelligence and prediction.

- **Technology Development:** Challenges associated with the use of third-party platforms, analytics tools, the development of operational requirements, the ability to geo-locate information published to social media, spatial-temporal characteristics (e.g., disparate and virtual communities, age of information, etc.), and the integration of NextGen911 (text to 911) will require further research.

1.3 Mutual Aid

Social media use during emergencies can be enhanced by integrating digital volunteers into the structured processes and procedures that are consistent with traditional emergency management.[1] An Emergency Manager's ability to request and acquire mutual aid resources in response to large-scale disasters is often critical to ensuring effective response and recovery operations. In many cases, the nearest first responders to an incident may be across a state, provincial or international border, which necessitates that policies, agreements and workflows are established to provide mutual aid.[9][10] Today, the mutual aid process followed depends on the location and scale of the emergency. Mutual aid is generally handled informally between neighboring jurisdictions in small-scale emergencies; however, when an emergency exhausts local resources, the responding jurisdiction or state may request assistance from other intrastate, military or private sector sources. In larger U.S.-based disasters involving interstate or federal aid, a State's Governor will issue a state of emergency declaration, after which an authorized Emergency Management Assistance Compact (EMAC) representative will utilize the EMAC Operating System (EOS) to coordinate mutual aid between requesting and assisting states.[26][27] In Canada, assistance is provided by the provinces/territories or federal government, in accordance with the appropriate emergency response plans and policies, when requested or clearly within the mandates of these governments.[3][4][5] In these situations, the Government Operations Centre manages the request for assistance process through its logistics function and ensures that there is interaction with Public Safety's regional offices and the EMOs.

Three primary mutual aid frameworks have established agreements between border provinces and states to provide support during large emergencies, including the Northern Emergency Management Assistance Compact (NEMAC)[14], the Pacific Northwest Emergency Management Arrangement (PNEMA)[15][16] and, most relevant to CAUSE III, the International Emergency Management Assistance Compact (IEMAC).[17][18] The IEMAC was established between the northeastern states and eastern provinces. This agreement is also known as the International Emergency Management Assistance Memorandum of Understanding. The purpose of this Compact is to enable mutual assistance among the participating jurisdictions for resource and equipment shortages encountered while responding to natural disasters (e.g., blizzards), technological hazards, hazardous materials (Hazmat), man-made disasters or civil emergencies. CAUSE III was concerned with the request for mutual aid from Canada to the United States in response to a Hazmat incident that was an impact from the hurricane scenario.

This Compact also provides for the process of planning mechanisms among the agencies responsible, and for mutual cooperation. This can include, if need be, emergency-related exercises, testing or other training activities. Equipment and personnel can be used to simulate the performance of any aspect of mutual aid. Specifically, this includes the giving and receiving of aid by party jurisdictions or subdivisions of party jurisdictions during emergencies, with such actions occurring outside actual declared emergency periods. Mutual assistance in this Compact may include the use of emergency forces by mutual agreement among party jurisdictions.[18]

The agreement outlines protocols for establishing personnel and equipment through a general "Operations Plan" during a major emergency.[18] The agreements are governed by the International Emergency Management Group (IEMG), which meets bi-annually to review protocols and improve coordination. Currently, parties to these plans have created, through the assistance of the Canadian Safety and Security Program, a risk specific appendix to the IEMG Operations Plan that would examine addressing Hazmat responses beyond international boundaries.[27]

1.4 Integrated Situational Awareness

Both nations have been working for several years to develop the capability to enhance SA between EM organizations through the application of interoperable technology.[1][2] The use of integrated awareness tools and technology to enhance SA during emergencies was investigated during CAUSE I[9] and CAUSE II.[10] These experiments highlighted the benefits of enhancing SA along the CANUS border regions. CAUSE III took this approach to information exchange a step further by using these tools to direct cross-border alerts that targeted information exchange between specific emergency management authorities. CAUSE III addressed the intent of the BTB Action Plan and demonstrated the CANUS commitment to jointly improve cross-border coordination of emergency responses during binational disasters by using integrated SA tools and, where possible, sharing best practices. These SA systems enabled the transmission and receipt of geospatial information from the initial notification of the event through the execution of the entire response. This information is relevant to multi-agency emergencies and is exchanged between partnering EM organizations in near real-time.

In June 2014, a formal agreement was established between the U.S. Federal Emergency Management Agency (FEMA) and Canadian DRDC CSS, resulting in the completion and implementation of the interface between the FEMA's IPAWS and Canada's MASAS, and legitimizing sharing of operational incident alert information over the border. It helps to distinguish between public alerts and alerting between officials, and to note that the IPAWS system serves both purposes in the United States, whereas in Canada two separate systems are used to alert these two distinct communities. The National Alert

Aggregation and Dissemination (NAAD)[2] System and MASAS both distribute alerts to all system users equally, whereas IPAWS alerts are addressed to specific Collaborative Operating Groups (COG), which may be limited to a group of officials or include public distribution.[3] Within the NAAD System and MASAS, the onus for being informed and redistributing alerts is put on the organization with the 'need to know' and share; they must filter the system content for what is applicable and of interest.

The tools that were used in these experiments were at various stages of maturity and development. The DHS Interoperability Continuum [28] shown in Figure 2 below depicts a framework of core elements and key attributes of a mature interoperable capability. Canada uses a similar framework, the Canadian Communications Interoperability Continuum Model, which includes these five pillars and attributes for its Interoperability Continuum. These conceptual models identify governance, standard operating procedures (SOPs), technology, training and exercises, and usage as the core elements that are required to achieve cross-border interoperability. CAUSE III focused primarily on technology integration, while recognizing the importance of the human element in building a binational capability and making these systems truly interoperable.

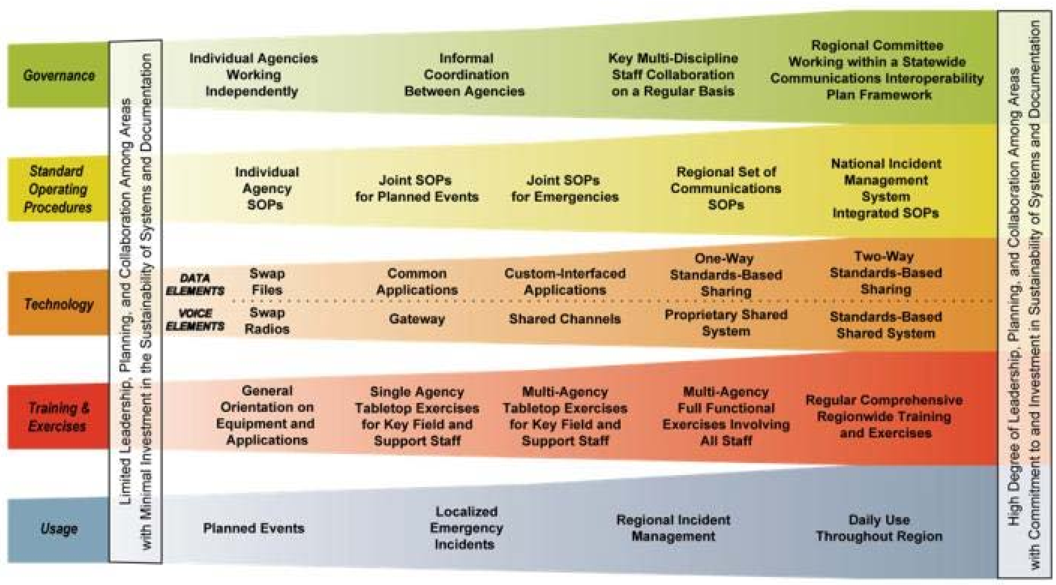

Figure 2: The DHS SAFECOM Interoperability Continuum.

[2] Further information on NAADS can be found here: https://alerts.pelmorex.com.

[3] Further information on IPAWS can be found here https://www.fema.gov/integrated-public-alert-warning-system.

1.5 Objectives

The goal of the CAUSE Resiliency experiment series was to perform a scenario-based, multi-agency cross-border experiment involving Canadian and U.S. emergency response organizations. It was hypothesized that improvements to shared SA and interoperable communications during multi-agency emergency events would lead to enhanced community resilience. The Northeastern experiment was focused on the use of social media technology by digital volunteer organizations as a means to support traditional emergency response organizations, enhanced awareness of cross-border emergencies through the application of interoperable SA tools, and the testing of cross-border mutual aid processes during the response and early recovery operations following a large hurricane.

The following were the experiment objectives:

- **Connect, test and demonstrate emerging operational technologies** that enhance resilience and reduce regional and national risks through enhanced multi-jurisdictional and cross-border interoperability, particularly with respect to sharing SA information that supports prevention, mitigation, response and recovery from major cross border incidents.
- **Advance emergency management and responder SA capabilities** along the border for all stakeholders, including municipal, regional, provincial/state, federal, non-governmental organizations and key critical infrastructure owners.
- **Demonstrate the value of federal Science and Technology investments** with and for the responder community.
- Test, evaluate and validate various operational and technical workflows and **develop recommendations for a binational Concept of Operations (ConOps).**
- **Identify and catalyze action on policy, regulatory and operational challenges and gaps**, as well as emerging technological trends.
- **Provide an assessment of the impact of the experiments on resiliency** as a result of the enhanced capability to share SA.

2 Experiment Design and Methodology

This section describes the participants, scenario design, cross-border and digital volunteer-related vignettes, interoperable systems, information products, and the evaluation process that was used to assess the findings from the Northeastern experiment for CAUSE III.[29]

2.1 Participating organizations

The principal Canadian organizations that participated in the Northeastern experiment included: Nova Scotia Emergency Management Office, City of Halifax, City of Calgary, Canadian Red Cross (CRC), Public Safety Canada, Crisis Commons, and Canadian Virtual Operations Support Team (CanVost). This Canadian-based team was comprised of approximately 25 people representing mostly emergency management and humanitarian personnel, as well as virtual volunteers.

The principal U.S. organizations that participated in the experiment included: City of Nashua New Hampshire Office of Emergency Management, New Hampshire National Guard, New Hampshire Department of Public Safety Homeland Security and Emergency Management, Maine Emergency Management Agency, New York City Office of Emergency Management, and FEMA Region I. In addition to the primary U.S. organizations, the following agencies, working groups and companies provided support to the experiment: the National Information Sharing Consortium (NISC), DHS Virtual Social Media Working Group (VSMWG), VOST, Kentucky Division of Emergency Management, SeeClickFix, Hootsuite Labs, Humanity Road, and the National Emergency Management Agency (NEMA). This U.S.-based team was comprised mostly of volunteers and had approximately 76 people.

Representatives from the participating organizations were associated with one of four participant groups: players, controllers, observers and CAUSE III champions. A brief description of each group is provided below.

- Players: The players consisted of the operational personnel from the EM and digital volunteer organizations represented during the experiment.
- Observers: The observers were invited to attend the experiment by the exercise controllers and represented stakeholder organizations at the local, provincial/state and federal levels.
- Controllers/Experiment Design Team: The controllers designed the scenarios, facilitated the pace of the experiment and managed the interoperable toolsets in each of the three physical locations.
- CAUSE III Champions: The CAUSE III Champions were responsible for leading and facilitating the experiment, which their respective organizations funded. The

Champions were Jack Pagotto (Canada) and Dan Cotter (United States), who observed the experiment either in person or via webinar.

2.2 Northeastern Scenario Design

The objective of the Northeastern scenario was to evaluate enhanced information sharing and SA between emergency management and humanitarian organizations in Canada and the United States who have mandates during the response and early recovery phases of a large-scale, multi-agency emergency.[1]

A tropical depression formed over the Atlantic Ocean and slowly moved over the Caribbean Sea, building to a point where it was classified as a Tropical Storm. It quickly gained strength until it was a Category III storm by August 28. (Figure 3)

Figure 3: Fictional category III storm.

The hurricane moved northward following the Gulf Stream, making landfall in southern New England on August 29 with sustained winds of 140km/h. The storm caused significant damage, including flooding, downed trees and power outages throughout the Northeast and especially New Hampshire before moving north along the coastline and into the Bay of Fundy. The storm made a second landfall in Nova Scotia. By the time it made its way up from southern Nova Scotia, the storm had continued to be a Category III storm. Hurricane Kelly struck Halifax, causing extensive damage to the Halifax Region, especially around Bedford Basin area. The hurricane struck with winds over 160km/h, and led to storm surges that flooded many low-lying areas in the region. During the scenario, the storm moved out to sea and the long recovery process started. Workers around the region had to contend with a variety of issues.

The Northeastern scenario was comprised of a series of seven vignettes. Each vignette focused on a particular aspect of using social media and SA tools to support emergency response and early recovery operations (refer to the schedule in Annex A). Injects were delivered primarily through a closed web portal, which provided mock applications similar to popular social media platforms (e.g., Facebook, Twitter), as well as through simulations of traditional news media and blogs.

As the experiment progressed, the participants were expected to perform their roles in the capacity of emergency management and humanitarian organizations. The digital volunteer community, with social media, provided support to the emergency operations. Tasks included coordinating actions and resources, addressing rumors and misinformation, providing updates to the public concerning shelter status and availability, and providing health and safety information. These simulated tasks were completed during each vignette and in response to the evolving conditions that were driven by the experimental injects. The following sub-sections outline the main themes of the vignettes. Two vignettes with CANUS information exchanges between EMOs are discussed in detail in the sub-sections below. Finally, the role of the digital volunteers that was observed across the other five vignettes is discussed within the final sub-section.

2.2.1 Alerts, Warnings and Notifications Vignette

The objective of the Alerts, Warnings and Notifications (AWNs) vignette was to determine how CANUS agencies could share basic situation reports and guidance regarding the preparations that should be taken in preparation for impact of the hurricane. Figure 4 below depicts how test alert messages were generated and disseminated during the experiment.

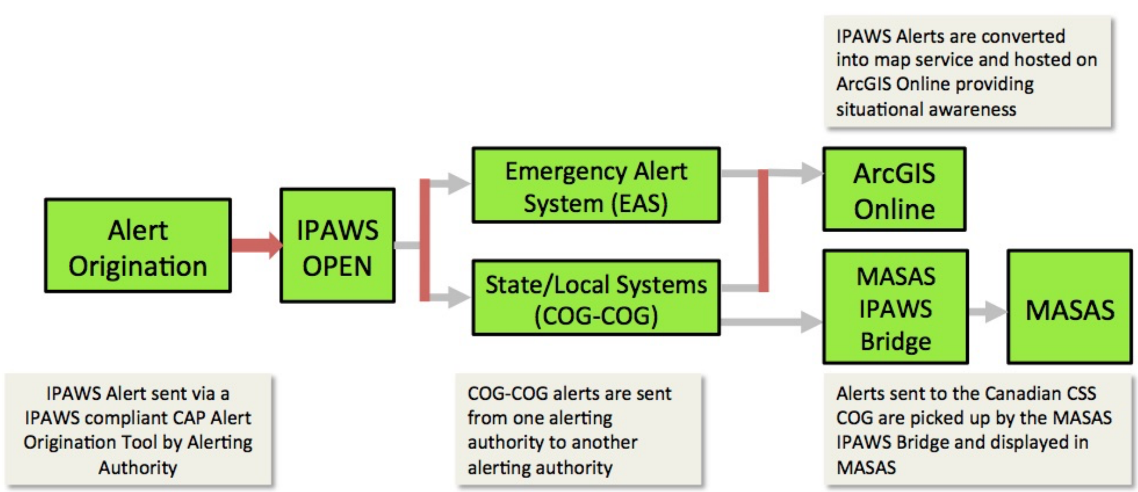

Figure 4: Alerts, Warnings and Notifications (AWNs) workflow.

2.2.2 Mutual Aid for Emergency Management Vignette

The objective of the U.S.-led Mutual Aid vignette was to test, evaluate and validate operational and technical "best practice" workflows that enable integrated planning, operations and technology to support a mutual aid assistance lifecycle. This vignette was led by the United States during CAUSE III and focused on U.S. capabilities that have been established for providing mutual aid support upon request from Canadian authorities. This workflow included:

- Threat, hazard and risk assessments along border communities;
- Response planning for cross-border operations;
- Pre-scripted mission assignments;
- Development of the Mission Ready Packages (MRPs) in the United States: National Incident Management System (NIMS)-typed response [30], recovery and mitigation capabilities that are organized, developed, trained and exercised prior to an emergency or disaster; request and acquisition of cross-border mutual aid; and tracking of mission assignments. Secondary objectives included testing the mutual aid inventory catalog tool (MASS[4]), and a machine-to-machine MRP information exchange process based on a draft National Information Exchange Model (NIEM) Information Exchange Package Documentation (IEPD) for mutual aid.

Prior to the experiment, an inventory of relevant assets, in this case MRPs, was conducted and these resources were registered in the MASS. A VOST MRP was developed and later validated by EMAC members in four states.

2.2.3 Digital Volunteers to Support Social Media for EM Vignettes

The remaining five vignettes involved interactions between the digital volunteers who participated in the experiment. The overall objective of these vignettes was to test the integration of the digital volunteers within the traditional EM processes. More specifically, the digital volunteers were activated by the EMO organizations as a supportive function. The Nashua Emergency Management Agency (EMA) defined the information requirements for the digital volunteers and provided guidance to any VOST organization that was activated in support of the EOC. Participants from the EMOs defined the essential elements of information, reporting, and technical/data format requirements based on traditional SA information requirements. These requirements were then translated into social media-driven guidance for the VOSTs and other digital volunteers, involved in finding and reporting information to the Incident Commander.

[4] MASS version 1.0 created by Kentucky Division of Emergency Management was tested throughout the CAUSE III experiment. MASS 2.0 is the version hosted by NEMA and was not tested during CAUSE III.

2.3 Interoperable Systems

Information exchange was enabled through the use of open standards, including: the Open GeoSpatial Consortium Standards (i.e., Web Map Service (WMS); Geographical Rich Site Summary (GeoRSS); Keyhole Markup Language (KML); Representational State Transfer (REST); the Organization for the Advancement of Structured Information Standards (OASIS) approved Emergency Data Exchange Language (EDXL) (the OASIS EDXL includes the Common Alerting Protocol (CAP)); and a draft version of the Mutual Aid / MRP NIEM IEPD. MASAS-X adopts known standards (e.g., Atom and CAP) and provides a RESTful Application Programming Interface (API) that is easily integrated into modern web applications. In addition, vUSA adopts open and well-established industry standards to create an environment where geospatial information and emergency incident information can be shared among systems.

CAUSE III followed a System-of-Systems (SoS) approach whereby existing systems were connected based on open standards. Table 1 identifies the systems that were used during the experiment.

Table 1: Canadian and U.S. systems used during CAUSE III.

Technology	Details
MASAS National Information Exchanges (MASAS-X)	
Owner:	DRDC/Centre for Security Science
Intended Use	The system enables creation, consumption and publication of official incident-specific data, alerts and warnings required to support shared SA at the local, provincial and national level. Information shared in MASAS-X is visible to all MASAS-X users, but not to the general public.
Sub-technology	MASAS-X at its core is a server-based, non-visible system that supports a graphical user interface. The CSS/MASAS team made available two components that enable users to consume and publish MASAS-X data from within the CAUSE III Viewer based on Flex and a mobile application that enables users to use MASAS-X from iOS™ or Android™ devices.
International Safety Research Inc. (ISR) Exercise Portal	
Owner:	International Safety Research Exercise Portal
Intended Use	Provides simulated social media tools Chatter (Twitter), Chatbook (Facebook), Chatlr (Tumblr), ChatDeck (TweetDeck/Hootsuite), Chattube (YouTube), etc.
Sub-technology	Proprietary.
Shelter Manager	
Owner	Open-Source by DRDC/Centre for Security Science

Technology		Details
Intended Use	The Shelter Manager is used by agencies that need to share information about the status of the shelters that they are managing. An agency can keep information current, update a sharable map (ArcGIS Online) and update social media (Chatter in CAUSE III and Twitter for real-world activity).	
Sub-technology	HTML5 + JavaScript, Python (for Twitter API access) and ArcGIS Online.	
Virtual USA (vUSA)– ArcGIS Online Platform		
Owner	DHS S&T (and the National Information Sharing Consortium [NISC])	
Intended Use	The vUSA CAUSE III participants, based on the ArcGIS Online platform, enables cross-jurisdictional information sharing and discovery of real-time, static or incident-specific information at any level of government and enables use of the data through ArcGIS Online or the user's current geospatial applications. Information shared in vUSA can be targeted to all users or only to specific private groups.	
Sub-technology	The vUSA ArcGIS Online Portal Widget was made available in both JavaScript and Flex by the National Information Sharing Consortium to enable consumption of data in the vUSA from within users' Flex Viewer (e.g., CAUSE III Viewer).	
CAUSE III Viewer		
Owner	Joint (DRDC/Centre for Security Science and DHS S&T)	
Intended Use	The tool enables any CAUSE III participant/observer to view and use experimental data on a situational awareness viewer, which is organized to highlight the main focus areas of the experiment.	
Sub-technology	Esri ArcGIS for JavaScript, based on an Esri Story Map Journal template.	
NH VIEWW (New Hampshire Visual Information and Emergency WatchWeb)		
Owner	NH Department of Public Safety Emergency Services Division	
Intended Use	The tool enables New Hampshire officials to consolidate various datasets into a virtual map that provides SA from sources at every level of government, the private sector and other key partners for New Hampshire officials. This tool includes key datasets provided from IPAWS TDL, vUSA, etc.	
Sub-technology	NH Granite View is based on the Esri ArcGIS Viewer for Flex framework. The Granite View application provides a common operating picture function by providing access to key map services to track emergency events, and tools to enter road closures and other incident-related data.	
MASAS-IPAWS Bridge		
Owner	DRDC/Centre for Security Science	
Intended Use	The MASAS-IPAWS Bridge provides the ability for bi-directional information sharing between MASAS and IPAWS. It provides relay capability for sharing Public Alerts (NOTE: MASAS is not a Public Alerting system – Public Alerts are used in MASAS for situational awareness purposes) and Private, official-to-official alerting.	
Sub-technology	Python, PostGIS, RabbitMQ, MASAS API, and IPAWS API.	
National Guard Northeast Geoplatform		

Technology	Details
Owner	NH National Guard (NHNG)
Intended Use	Based on ArcGIS Online for Organizations, the Northeast National Guard Geoplatform enables information sharing among the northeast National Guard member states and a platform for building applications. The Geoplatform was used in conjunction with the NHNG Granite View.
Sub-technology	Implementation of an ArcGIS Online for Organizations site.
Integrated Public Alert and Warning System Test Development Lab (IPAWS TDL)	
Owner	U.S. FEMA
Intended Use	The tool enables authorized officials (including the President) to deliver alert messages to the public or other agencies with established COG identifications. (Note: the Canadian equivalent is the National Alert and Aggregation Dissemination System [NAADS]).
Sub-technology	IPAWS TDL alert aggregator is populated with AWNs generated by numerous CAP alert origination tools in use by officials at various levels of government. A PHP script was written to convert the IPAWS TDL CAP feed into a near real-time hosted map feature service on ArcGIS Online.
Mutual Aid Support System (MASS)	
Owner	Kentucky Emergency Management Agency
Intended Use	The tool enables officials to create, share and discover mutual aid resources (i.e., MRPs) to support local, state-to-state or international requests for assistance from an official government agency.
Sub-technology	MASS is built on a Microsoft® SQL (Structured Query Language) Server database and has made available a web application and widgets that enable the visualization of MRPs in an organization's ArcGIS Viewer for Flex (e.g., CAUSE III Viewer), via vUSA/ArcGIS Online, or through MASAS-X (i.e., using the draft MRP NIEM exchange tested during CAUSE III).
MASAS-NIEM Bridge	
Owner	DRDC/Centre for Security Science
Intended Use	An EM alert and warning origination application, which inter-operates with FEMA's Integrated Public Alert and Warning System (production and test versions) to allow authorized users to send AWNs to selected aggregations of the public and other collaborating EM organizations.
Sub-technology	Python, PostGIS, MASAS API, MASAS Watchers, CAD2CAD NIEM IEPD (DRAFT)
On-The-Go Alerting™	
Owner	Eye Street Solutions LLC

Technology	Details
Intended Use	An EM alert and warning origination application, which inter-operates with FEMA's Integrated Public Alert and Warning System (production and test versions) to allow authorized users to send AWNs to selected aggregations of the public and other collaborating EM organizations.
Sub-technology	iOS application, IPAWS TDL
VOST GeoForm	
Owner	DHS S&T, NISC
Intended Use	This tool entering spatially explicit "Social Media for Emergency Management" (SMEM) information into a form connected to a map feature service. The form is based on a data model that tracks information requirements established by emergency managers, data entered into the form is available in the NISC vUSA ArcGIS Online CAUSE III Group.
Sub-technology	Esri GeoForm template.
Google Docs	
Owner	N/A
Intended Use	Google Docs was used extensively by the U.S. VOST, Nashua VOST and Nashua EMA for general information management, collaboration and cataloguing SMEM content obtained from Chatter.
Sub-technology	N/A
Google Hangout	
Owner	N/A
Intended Use	Google Hangout was used extensively by CanVOST during the experiment for project management activities and for status updates provided by the volunteers.
Sub-technology	N/A
Skype	
Owner	N/A
Intended Use	Skype was used by the U.S. VOST, Nashua VOST, and Nashua EMA during CAUSE III for its conference calling and chat room functionality.
Sub-technology	N/A

2.3.1 Technology at Physical Sites

Each of the physical sites that participated in the experiment used a set of integrated SA tools to exchange information. The toolsets are represented in Table 2 below. Certain tools (e.g., MASAS-X, vUSA) were commonly used across all locations. Moreover, each location used additional tools that were already implemented within their respective EM organizations.

Table 2: Integrated SA tools across physical sites.

Physical Location	Technology
Halifax (NS)	MASAS-X, MASAS-X Flex widgets, MASAS-IPAWS Bridge, MASAS-NIEM Bridge, MASAS Mobile, ArcGIS Online, ArcGIS Story Maps, Shelter Manager (CSS), Google Docs, Google Hangout, Chatter, ChatDeck, ChatBook, vUSA
Nashua and Concord (NH)	vUSA (ArcGIS Online), NH Granite View, National Guard Geoportal, IPAWS TDL, MASS, WebEOC™, On-The-Go Alerting™.,Chatter, Skype, Google Docs
Augusta (ME)	vMaine, vUSA, IPAWS TDL, On-The-Go Alerting™.
San Antonio (TX)	ArcGIS Online, VOST GeoForm, SeeClickFix map widget, Chatter, Skype, Google Docs

2.4 Information Products

A combination of simulated 'inject material' data pre-populated before the experiment, and live or static data relevant to the scenario was used to provide SA during the experiment, as summarized in Table 3 below. The National Information Sharing Consortium (NISC) vUSA ArcGIS Online Organization was selected as the platform to support information input, visualization and sharing, and also enabled rapid application development for CAUSE III. Over 60 named users were granted access to the private CAUSE III group, and hundreds of map services, web maps and applications were shared over this group.

Table 3: Information product shared during CAUSE III.

Category	Title	Description/Source
General SA	Hurricane points, tracks, and cone of uncertainty [S]	Simulated, time-enabled storm track data based on experiment scenario.
	Real-Time Weather Alerts	Alerts from Canadian (Environment Canada) and United States (National Weather Service via IPAWS) weather authorities.
	FEMA Region I Hurricane Response Decision Guide	Decision guide based on pre-defined regions along the Atlantic coast with triggers based on storm strength and location.
	Emergency Declarations, National Response Framework (NRF) Phase Status [S]	Time-based data prepared for the experiment based on inject material indicating the likely declaration and NRF Phase status at different time points.
Alerts, Warnings, Incidents	IPAWS Alerts, Warnings and Notifications [S]	Test AWNs sent over FEMA's IPAWS shared on ArcGIS Online by the NISC.

Category	Title	Description/Source
	MASAS Incidents S	Incident data exercise data shared via the MASAS-x
EM Response, Mutual Aid	Damage Assessments S	Damage assessments collected using Esri Collector application.
	Requests for Assistance S	Requests for mutual aid assistance submitted by local jurisdictions in NH.
	Mission Ready Packages	MRP data created for the experiment from MASS.
	Mutual Aid Missions S	Mission tracking data used by the NH National Guard.
Social Media, Crowd Source, VOST	Chatter S	Geo-tagged Chatter data made exposed to ArcGIS Online via the Chatter API.
	SeeClickFix S	Data submitted by VOST members into the SeeClickFix reporting utility setup for the experiment, exposed to ArcGIS Online via the SeeClickFix API.
	VOST contributions S	Data submitted by VOST members into the VOST GeoForm.
Mass Care	Shelters S	Shelter data provided by emergency managers through the Shelter Management tool, as well as static data from the U.S. National Shelter System. City and Partner infrastructure (schools, community centres, churches, etc.), city depots in Halifax Regional Municipality (HRM) (Open Data via HRM).
Transportation	Gas Stations Status S	Status of fuel stations in Nashua, NH.
	Gas Stations*	Gas station data form GasBuddy shared via the NISC.
	Road Obstructions, Closures S	Simulated road obstruction and closure data from MASAS, the State of New Hampshire, and the City of Nashua, NH. Road Closures via HRM and MASAS-X.
	NISC-511*	Transportation status data from U.S. 511 system aggregated by the NISC.
	Waze*	Crowd-sourced traffic from Waze.
Utilities	Power Status S	Time-based data prepared for the experiment based on likely county-based power status in the northeastern part of the United States in the days and weeks following a large hurricane.

*Near real-time data
S Data developed or simulated for the experiment

During the course of the planning and execution of the event, there were tens of thousands of views of the CAUSE III data layers[5] that were created and shared by experiment participants at the local, state, provincial and federal levels in the vUSA CAUSE III Group in ArcGIS Online, including the Department of Transportation 511 data and power outage data. This capability was provided by the NISC to all CAUSE III participants, and was a critical success enabler for CAUSE III. The views associated with various reports are reported in Table 4 below.

[5] Metrics were gathered in the NISC vUSA ArcGIS Online portal for each of the data layers exchanged during CAUSE III.

Table 4: Information sharing metrics.

Title	Number of Views
New Hampshire 511/traffic	40,000 + views
SeeClickFix reports	12,000 + views
Google Waze reports	2,000 + views
National Guard reports	2,000 + views
VOST reports	1,250 + views
Hurricane Kelly Story Map	1,000 + views

2.5 Evaluation Process

A two-phased evaluation framework was generated to measure the effects of using social media during the experiment on emergency recovery operations.[29] This included a data collection plan involving pre- and post-experiment questionnaires and the development of two sets of tailored evidence-based metrics to support the development of qualitative findings.

2.5.1 Data Collection Plan – Phase 1

Phase 1 of the data collection plan was designed to gather feedback directly from the study participants at each physical site (i.e., Halifax, Nova Scotia; Nashua and Concord, New Hampshire; and San Antonio, Texas). A set of instruments was administered to the participants during the experiment. All identifiers were removed from the data that were compiled upon conclusion of the experiment. Each instrument is briefly described below:

- **Pre-Experiment Questionnaire**: This questionnaire gathered feedback related to the participants' knowledge and experience on the use of social media and EM tools and techniques. This information was used to support the conduct of the experiment and was compared to participant feedback that was gathered using the Post-Experiment Questionnaire at the end of the experiment. The Pre-Experiment Questionnaire was administered as an online survey.
- **Post-Experiment Questionnaire**: This questionnaire gathered feedback related to the participants' experience with the experimental vignettes. The questionnaire was designed to develop an understanding of how the technology can be deployed in support of early recovery and response operations, respectively, and how the participant's opinions may have changed as a result of the experiment. This questionnaire also gathered feedback related to the participant's workload, and the design and execution of the experiment. This questionnaire was also an online survey and was administered at the end of the second (i.e., final) day of the experiment.

2.5.2 Data Collection Plan – Phase 2

Phase 2 of the data collection plan was designed to gather observational data related to the information exchange that occurred between the participants. The observational data were used to perform a qualitative evaluation using two sets of metrics that were developed from earlier research studies. Each set of metrics had a unique focus and is described below.

- **SMEM Maturity Model Metrics**: This set of metrics was focused on the impact of using social media during recovery operations. The metrics were tailored to the four categories identified in the SMEM Maturity Model (i.e., People, Governance, Technology and Implementation) as shown in Figure 5 below.[22] This model summarizes the main elements and characteristics along four dimensions: people, governance, technology and implementation that are essential for maturing this capability. Each dimension is associated with several essential elements with characteristics that evolve as an organization implements and optimizes its use of social media.

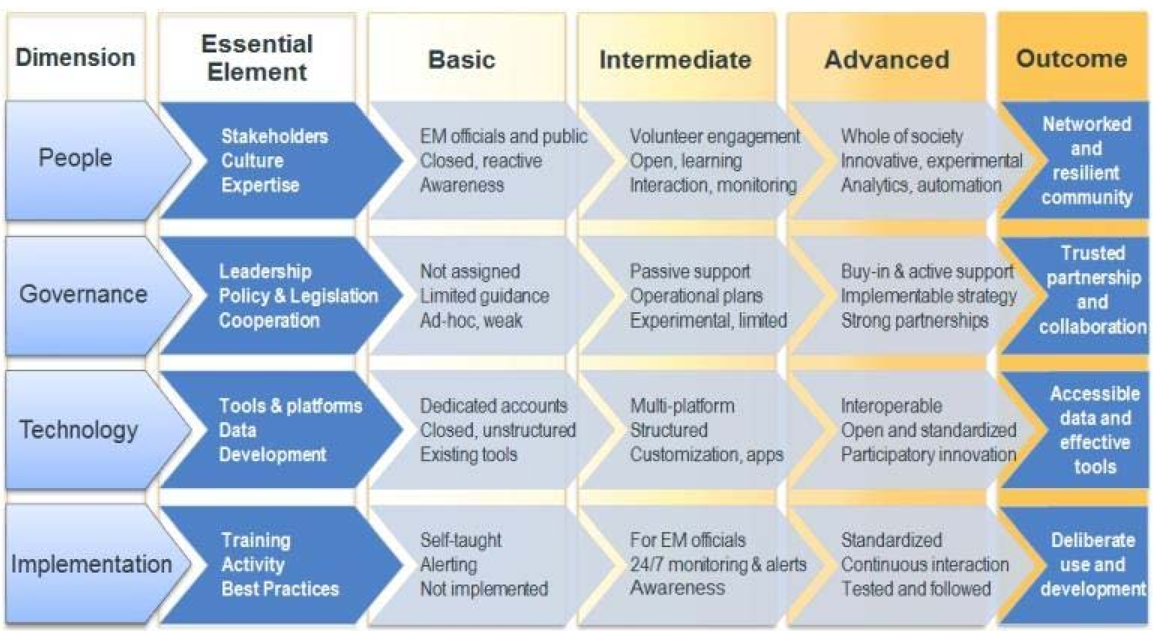

Figure 5: The SMEM maturity model.

Observations mapped to each of the metrics were scored on a 5-point scale. The scale reflected the extent to which information exchange, facilitated through the use of social media, supported the development of SA potentially leading to a more coordinated organizational response.

A score of ‘1’ reflected that there was little demonstration of information exchange or how situation awareness was generated or enhanced within any organizations. In contrast, a score of ‘5’ reflected that the extensive information exchange allowed multiple organizations to plan a coordinated response. A moderate score of ‘3’ reflected that information was gathered from other organizations and used to determine an organization’s own actions. The evaluation was performed based on observations by the study team.

- **Canadian Communications Interoperability Continuum (CCIC) Model Metrics**: This set of metrics was focused on the impact of interoperable technology on the cross-border information exchange during the cross-border vignettes that were included in the experiment. The overall impact of interoperable technology on the resiliency within the affected community was assessed with these metrics. The metrics were tailored to the five categories identified in the CCIC Model categories as depicted in Figure 14 below (i.e., Governance; SOPs; Technology, Training and Exercises; and Usage).[28][31] Observations were mapped to each of the metrics and scored on a 5-point scale. The scale reflected the extent to which cross-border information exchange led to enhanced situation awareness and the development of coordinated goals.

A score of ‘1’ indicated that there was little cross-border information exchange. In contrast, a score of ‘5’ indicated that the technology use supported the coordination of cross-border responses that work toward a common goal. A moderate score of ‘3’ indicated that cross-border organizations were able to develop shared SA during an operation.

3 Results and Discussion

The survey data gathered from players and observers (N=52) were analyzed using descriptive statistics. The participants who identified their location were primarily distributed across multiple physical sites as follows: Halifax (n=24), Nashua and Concord (n=4), San Antonio (n=6), other U.S. locations (n=13) and Christchurch, New Zealand (n=1). The other U.S. locations included New Haven (CT), Washington (DC), Berkshires (MA), New Orleans (LA), Sacramento (CA), Denver (CO), Santa Fe (NM), Boydton (VA) and Mount Arlington (NJ).

Perceived differences observed among the groups are not intended to reflect statistical significance. Rather, differences are intended to provide guidance related to the impact of technology used during early recovery operations. Qualitative comments gathered during the experiment are presented in Section 3.1.

3.1 Qualitative findings

The Northeastern experiment was the first cross-border event that investigated the use of social media to support the response and early recovery phase following a large hurricane that affected both sides of the CANUS border. Qualitative observations were gathered during the experiment and were evaluated in accordance with two sets of metrics. The results of the survey findings and these metrics evaluations are presented in the subsections below.

3.1.1 Survey Findings

Most of the participants represented government and non-governmental organizations responsible for responding to cross-border emergency events. These organizations tend to use social media to monitor public information, to inform the public and to gather information that supports decision-making.

At the beginning of the experiment, U.S. respondents rated their own level of knowledge concerning the use of social media during recovery operations higher than the ratings that were provided by Canadian respondents. Upon conclusion of the experiment, the understanding of how digital volunteers can be engaged and how social media can be used to support emergency operations was improved to comparable levels for Halifax and U.S. respondents. This finding indicated that the experiment effectively simulated the social media environment and provided an opportunity, especially for the Halifax participants, to improve their knowledge regarding the use of social media.

The following impacts of social media were noted in the survey findings:

- Social media allowed information to be shared with a wider community during the recovery phase.
- Social media enhanced information sharing within my team.
- Social media enhanced SA and decision-making processes *within* my organization.
- Social media enhanced SA and decision-making processes *between* my organization and other organizations.
- Social media improved cooperation between digital volunteer and disaster recovery organizations.
- Social media encouraged the public to share information.
- Social media enhanced my understanding of the initial efforts to recover from the disaster.
- Social media enhanced my understanding of the on-going efforts to recover over time.
- Social media improved coordination of recovery operations between organizations.

The primary barriers to using social media, as indicated by the CAUSE III participants, are related to the proper use of social media, lack of awareness and acceptance of social media by traditional emergency management organizations, and lack of training for EM officials regarding the integration of social media and digital volunteers. While there is ongoing work in different EM communities regarding social media usage for EM purposes, there is a need to continue the discussions.[1][7][8][12][13][32][33]

3.1.2 Social Media in Emergency Management (SMEM) Maturity Model Metrics

Seven Canadian-led vignettes investigated unique aspects of social media use that can provide support to traditional EMOs. Observations that were gathered during these vignettes were subjected to a qualitative evaluation.[29] This evaluation rated the impact of social media on information exchange using a 5-point scale. The scale reflected the extent to which the information enhanced SA and was used to support coordinated responses. The main findings derived from this analysis are identified below.

- The evaluation indicated that social media use facilitated information exchange and lead to enhanced SA, cooperation between volunteer and traditional organizations, and the determination of appropriate actions during the recovery phase.
- Social media was used in an inclusive manner between digital volunteers and EMOs, which encouraged the sharing of information and collaboration between multiple stakeholder organizations.

- Digital volunteers were meaningfully engaged in a manner that was consistent with existing organizational policies and procedures within traditional EMOs.
- The use of social media with respect to the People and Governance dimensions reflected an Intermediate-Advanced level of maturity based on the willingness to explore the involvement of trusted digital volunteers and the open environment that encouraged learning and transfer of skills and knowledge.
- The use and implementation of the social media tools and technologies was effective and allowed organizations to summarize and exchange information effectively. The information obtained from digital volunteers could be shared with other EMOs as part of the regular status updates or as issues that required urgent attention.
- The outcome of the experiment demonstrated that the engagement of the digital volunteers expanded the EMOs information exchange capabilities. This lead to increased SA by operations staff, which enhanced their ability to determine when appropriate actions could be taken during the recovery phase.

3.1.3 CCIC Model Metrics

Two U.S.-led vignettes investigated cross-border components of the Alerts, Warnings and Notifications, as well as Mutual Aid. Observations gathered during these vignettes were subjected to a qualitative evaluation focused on the extent to which cross-border information exchange led to enhanced SA and the development of coordinated goals.[29] A set of qualitative metrics, tailored to the CCIC Model categories (i.e., Governance, Standard Operating Procedures (SOPs), Technology, Training & Exercises and Usage) was scored on a 5-point scale. The scale reflected the extent to which cross-border information exchange led to enhanced SA and the development of coordinated goals. The main findings derived from this analysis are identified below.

- New internal SOPs or modification of existing internal SOPs will be needed to guide EM organizations with respect to activating digital volunteer organizations as a method for providing mutual aid. SOPs should also provide guidance related to how to specify the type of support, consistent with an emerging NIMS Typing model [30], that is needed and whether any special processes are needed to engage support from volunteers who are located internationally.
- An EM plan, based on a ConOps, which depicts the integration of qualified digital volunteer organizations, must be validated within the international community. The EMOs are not responsible for employing staff from the Digital Volunteer (DV) organizations and therefore do not incur additional employee related liabilities. However, the relationship needs to be defined.
- Mutual aid can be augmented by digital volunteer organizations. These organizations will determine which tools and processes, without authorization or approval from the activating organization(s), will be used to gather and analyze the social media data related to alerts, warnings and notifications. The EM

organizations must decide how informed they need to be about how the information is compiled and this should be reflected in the relevant policies.

- The delivery of mutual aid that is supported by digital volunteers can be provided from any country and time zone. The information derived from the use of social media technology is unclassified and therefore can be openly shared within the EM community. However, bi-national policies should address any public safety or security concerns regarding the information analyses that will be performed by international organizations.
- Non-governmental organizations (e.g., the Canadian Red Cross, American Red Cross) with a presence in both Canada and the United States will work cooperatively to ensure the needs of their local regions are met and to proactively coordinate the ways in which they can provide mutual aid while they are both recovering from the same major event. One of the ways these organizations can coordinate activities is to monitor the impacts of the disasters and the actions being taken across the various affected jurisdictions.
- Cross-border communities can improve their resilience during large-scale disasters by monitoring social media to predict their own needs and communicate with the other communities who will have similar information requirements.
- Digital volunteer organizations will need to support the leading authorities in the affected jurisdictions. Cross-border jurisdictions will have similar information requirements and therefore it is possible for digital volunteer organizations to coordinate their own efforts and support jurisdictions in both Canada and the United States. This approach will support the delivery of mutual aid between the nations.

3.2 System Interoperability Technology Findings

Observations related to the system interoperability and the participants' experience using the technology are presented in the sub-sections below. The two CANUS vignettes are discussed separately and the digital volunteers' overall experiences are identified in the sub-sections below.

3.2.1 Alerts, Warnings and Notifications Vignettes

The integration of messages propagated by IPAWS and MASAS was tested by Canadian participants in two systems: MASAS/IPAWS messages were visualized in ArcGIS Online and IPAWS messages from the United States were in visualized in MASAS. For Canadian alert generation, CAP messages were authored using MASAS tools and external systems via the MASAS Exercise Hub and sent to IPAWS COGs using the

MASAS-IPAWS Bridge.[6] The AWNs generated during the experiment were visualized using a variety of tools. Figure 6 illustrates an alert displayed in the CAUSE story map. GIS-enabled collaboration and SA tools such as the MASAS common toolset and Virtual USA (vUSA), which leveraged Esri's ArcGIS Online platform, were used to manage alerts and notifications to enhance SA in the scenarios.[7]

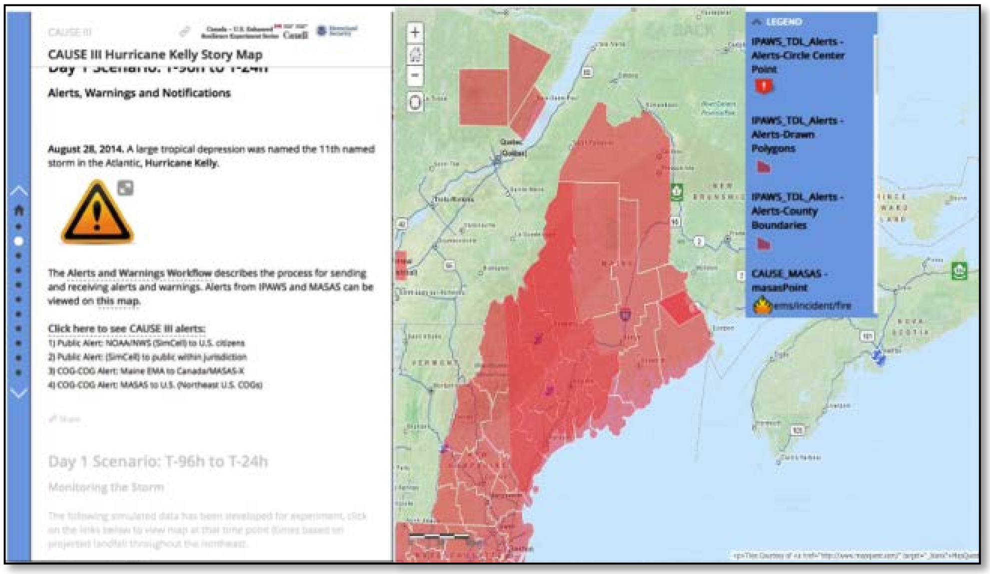

Figure 6: Example of IPAWS alert displayed in CAUSE story map.

In the United States, MASAS/IPAWS information was readily visible and accessible in ArcGIS Online and other common operating pictures capable of accessing map services. For U.S. alert generation, messages were authored using the On-The-Go Alerting iPad application, one of numerous alert and warning origination applications currently available, and sent through FEMA's IPAWS Test Development Lab (TDL) system.[8] The CAP messages were forwarded from IPAWS Open to an IPAWS COG that was bridged to MASAS. The IPAWS Alerts were also converted to a map service and made accessible in ArcGIS online.

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[6] Open standards include the Organization for the Advancement of Structured Information Standards (OASIS) Emergency Data Exchange Language (EDXL) Common Alerting Protocol (EDXL-CAP) and Distribution Element (EDXL-DE), national profiles of CAP (CAP-IPAWS and the Canadian Profile of CAP (CAP-CP)), Open Geospatial Consortium Standards (i.e., Web Map Service (WMS)), Geographical Rich Site Summary (GeoRSS), Keyhole Markup Language (KML), Representational State Transfer (REST)).

[7] Further information on vUSA can be found here: http://nisconsortium.org/vusa.

[8] Further information on On-The-Go Alerting can be found here: https://www.onthegoalerting.com; Full list of IPAWS Alert origination tools available here: https://www.fema.gov/alert-origination-service-providers.

CAUSE III successfully tested the following information flows:

- U.S. IPAWS Public messages were relayed from FEMA's Test and Development Laboratory (TDL) via the MASAS-IPAWS Bridge into MASAS.
- Canadian Public Alerts (e.g., Environment Canada Weather Alerts) were relayed into IPAWS using the COG-to-COG mechanism. These Alert messages were for official use only.
- U.S. Official-to-Official messages using the COG-to-COG mechanism were relayed via the MASAS-IPAWS Bridge into MASAS.
- Canadian Official-to-Official messages were relayed using the COG-to-COG mechanism to IPAWS for U.S. officials.

During the experiment, MASAS content was represented as point, line and polygon layers. The lack of symbology for line and polygon data made it difficult to understand the maps. In combination with real-world National Weather Service data that was also displayed, there was too much information for the operators to understand the context of the AWNs. Hence, to use ArcGIS Online with IPAWS and MASAS operationally will require substantial filtering and symbology work. Furthermore, the point-based symbology based on the Canadian EM Symbology 1.0 that was used during the experiment will require training and knowledge in order for this system to be used effectively by the operators.

The second system tested IPAWS alert information in MASAS. Both IPAWS and MASAS are based on the OASIS EDXL Common Alerting Protocol. The use of this international standard ensured that the information exchange and display for Alerts along with the other point, line and polygon data was successfully displayed. Filtering tools within MASAS are also provided for the display of information.

The key outcomes and impacts of the U.S.-led Alerts and Warning vignette are summarized in Table 5 below.

Table 5: Outcomes and impacts for alerts, warnings and notifications.

OUTCOME	IMPACT
An operational model for the exchange of IPAWS TDL Alerts information between MASAS and IPAWS.	*Canadian MASAS of approximately 500 agencies have access to IPAWS alerting Information for enhanced situational awareness. A model workflow exists that could be scaled to operations with effective training across the entire CANUS border.*

OUTCOME	IMPACT
Successful integration of IPAWS TDL Alerts into vUSA / ArcGIS Online.	*Enhanced situational awareness to emergency managers on both sides of the border by enabling visualization of alert messages in their common operating pictures.*

3.2.2 Mutual Aid for EM Vignette

CAUSE III participants successfully tested various mutual aid workflows during the hurricane scenario. First, damage assessments at the local level were conducted to determine the level of need required to respond to the hurricane. Second, requests for assistance (RFAs) followed the damage assessments, which were submitted to the state emergency management agency using WebEOC, as well as a parallel system utilizing ArcGIS Online. Based on the RFAs, missions were assigned using available MRPs in MASS. A total of five MRPs were assigned and deployed to requesting jurisdictions during the experiment.

During the experiment, the mutual aid workflow generally followed the process shown in Figure 7 below. Much of the process was investigated during a 'table-top' exercise discussion. Following the simulated hurricane incident, needs were identified by local emergency managers and based on these needs, RFAs were logged into the state-level emergency management agency's incident management system. The state emergency management agency reviewed requests and identified available MRPs to respond using the MASS.

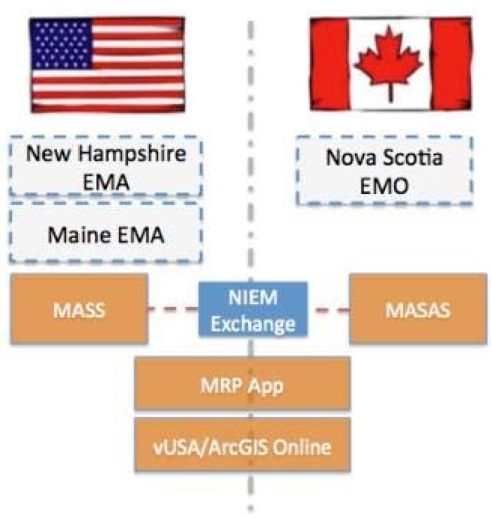

Figure 7: Canadian and U.S. mutual aid systems.

Participants used the MASS to assign MRPs to the requesting jurisdictions and the deployments were tracked using a variety of geospatial viewers. Participants gathered SA for MRPs either through the MASS, a map service in ArcGIS Online, or in their native common operating pictures. A 'machine-to-machine' MRP exchange was tested between MASS and Canadian's MASAS following a draft MRP NIEM IEPD exchange.[9]

The CAUSE III hurricane scenario that unfolded simulated a depletion of local resources required to act during the response and recovery period. This led to requests for assistance from Nashua EMA to the state, the VOST community and the National Guard. There were two main workflows tested during the Mutual Aid Vignette. The first focused on demonstrating how NIMS typed resources and MRPs can help in the discovery and deployment of VOST teams. Specifically the following U.S.-led component was tested for the mutual aid VOST workflow:

- Nashua EMA requests Type 1 VOST support;[10]
- Nashua EMA requests NIMS Typed Resources and MRPs from State of New Hampshire (request filled by New Hampshire National Guard);
- International mutual aid request for resources from CANVOST to Nashua VOST. The focus of this request was to provide additional support to the activating organization (Halifax Regional Municipality); and
- International mutual aid request from Halifax to Maine for Hazmat MRP. This request assumes that the appropriate workflows and Canadian capabilities have been considered and that mutual aid support is required from the state of Maine.

The Mutual Aid workflow depicted in Figure 8, including damage assessments, requests for assistance and MRP locations, were visualized in both Canadian and U.S. SA tools. The figure below depicts the location of Canadian and U.S. VOST Teams in the vUSA ArcGIS Online Story Map.

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[9] Further information on NIEM can be found here: https://www.niem.gov.

[10] As defined by the Type 1 VOST model (for evaluation purposes only), members of this VOST were required to have:

- General public information experience and understanding and general knowledge of emergency operations, objectives goals and requirements;
- Proficiency in several social media tools/platforms (e.g. Facebook, Twitter, Instagram, Pinterest, LinkedIn, YouTube, Skype, Google Hangout, etc.);
- Understanding of methods for validation, confirmation and verification of information found on social media channels, including imagery and videos; and
- Technical proficiencies may also include mapping, and general understanding/ability to develop tools with: RSS, geoRSS, (all API formats), CSV, Excel, Flex, etc.

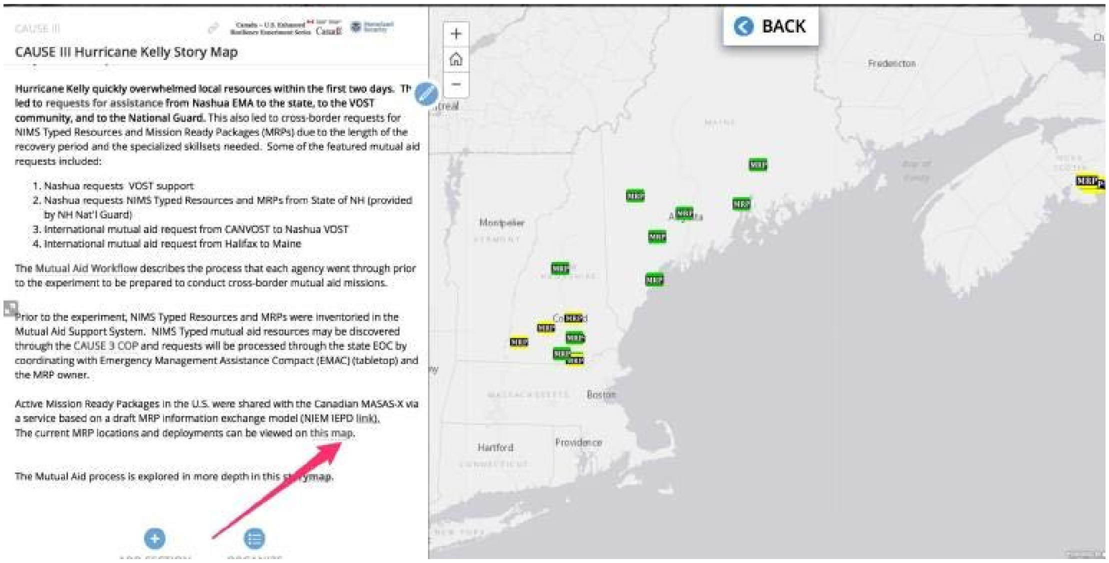

Figure 8: Mutual aid workflow for digital virtual volunteers.

CAUSE III participants prioritized the ability to identify available resources, their location, type (based on NIMS typing), and other important variables about the MRPs including cost per day and time to arrival. CAUSE III leveraged previous S&T investments in Kentucky, Central U.S. Earthquake Consortium (CUSEC) and NEMA related to the development of the MRP data exchange model and geospatial query tools.[13]

The second workflow tested during CAUSE III focused on a cross-border, IEMAC-based request for a Hazmat team as shown in Figure 9. During this mutual aid workflow, Maine offered a Hazmat Team to Canada. Prior to the experiment, Hazmat teams were entered as MRPs into the MASS. During the experiment, Canadian participants could visualize available resources in the United States using the CAUSE viewer. From the Canadian side, a request for a U.S. Hazmat team was made using information provided in the CAUSE Viewer.

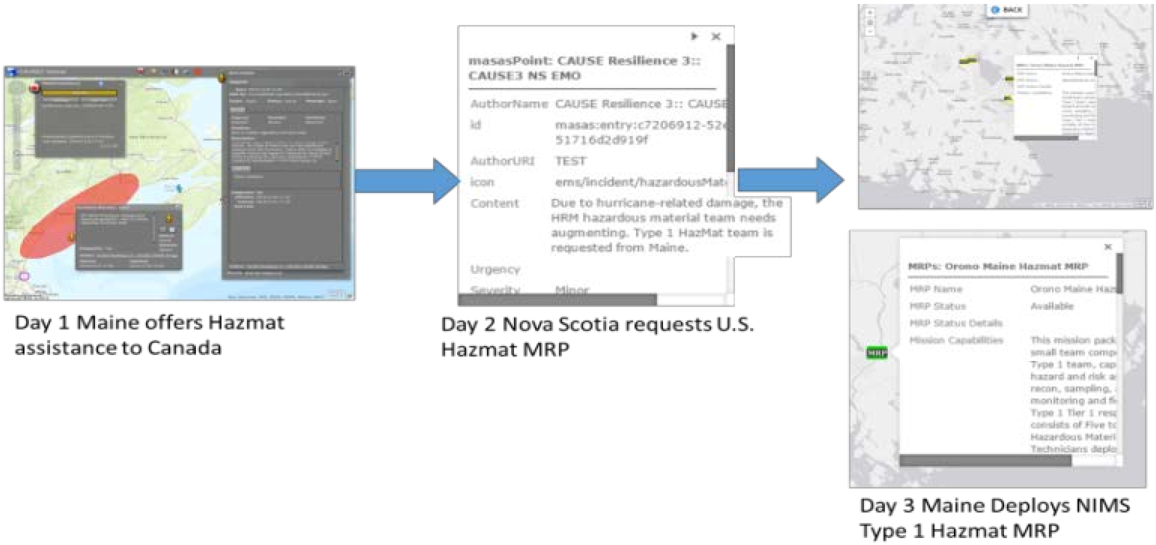

Figure 9: Mutual aid workflow.

A service based on the draft MRP NIEM-IEPD was successfully integrated into the MASAS system. The NIEM-IEPD workflow was validated, and finalization and publication of that product is the next step. As part of DRDC/CSS' support for NIEM, a MASAS-NIEM Adaptor was created. This Adaptor receives XML that uses the Draft CAD2CAD Mutual Aid NIEM IEPD and generates a MASAS Entry with the relevant information harvested from it.

Table 6: Outcomes and impacts for mutual aid.

OUTCOME	IMPACT
Development, validation and integration of the MRP NIEM-IEPD into MASAS.	*Offers a standards-based approach for the discovery and utilization of U.S. resources that would be available through mutual aid. Experiment feedback to refine next iteration of NIEM IEPD for Mutual Aid.*
Successfully tested a tabletop cross-border mutual aid exchange.	*Provide demonstration on using a shared mutual aid resource inventory (MASS) and a SA tool (MRP viewer) for enhancing cross-border mutual aid request.*
Drafted a NIMS TYPE I VOST resource type with defined capabilities.	*As a result of the experiment, Humanity Road submitted an official VOST MRP to the state of Virginia that is now a deployable resource in real operations.*

3.2.3 Digital Volunteers to Support Social Media for EM Vignettes

The primary objective of the experiment was to investigate social media-aided cooperation between the DV, EM officials, first responders and NGOs during recovery operations following a severe weather event. CAUSE III tested the ability to integrate digital volunteers and the use of social media to support emergency operations. CAUSE III also contributed to the further development of technological solutions in support of leveraging social media as a viable information source to facilitate information exchanged and to aid in decision-making.

Approximately 76 participants (including 60 volunteers) from across the United States participated in the event (contributing more than 100 work hours), including members of the DHS Virtual Social Media Working Group, U.S. and Canadian VOSTs, and private sector and non-profit organizations such as SeeClickFix, Humanity Road and Crisis Commons. Participants leveraged Virtual-USA (ArcGIS Online), Skype, Google Docs and mock social media platforms to share information and collaborate.

The digital volunteers simulated support for the City of Nashua, New Hampshire Office of Emergency Management by evaluating mock social media during the CAUSE III experiment. They monitored social media for several types of issues, including safety issues that are unable to be transmitted to 911, reports of damage, reports from citizens who are unable to reach response entities, trending concerns and unanswered questions, and other evolving information requirements that were identified as the experiment progressed.

Figure 10 below illustrates the generic types of tasks that were performed by digital volunteers during the experiment, which contributed to enhancing shared SA for Canadian and American response organizations.

Figure 10: Contributions of digital volunteers to CANUS shared SA.

During the experiment, incident-specific information was created in MASAS and exchanged between MASAS and vUSA. The information was received by other systems, including the CAUSE Executive Briefing Tool based on an Esri Story Map. A variety of tools were used to aggregate information from social media and other sources. This summarized version of the social media data enhanced SA and decision-making as shown in Figure 11 below:

- **GeoForm:** Information submitted through the tool was published as an open API for integration into other mapping environments. Data is technology-agnostic.

- **SeeClickFix:**[11] Information submitted through this tool was published as an open API for integration into other mapping environments. Data is technology-agnostic.
- **ArcGIS and the Virtual Interoperability and Information Sharing Engine (VIISE):** Participants used these tools to aggregate multiple data from various feeds (e.g., the open API from the GeoForm and SeeClickFix, the "fire hose" from the Chatter simulated Twitter platforms, 511, power company data, traffic data, weather, hazard mitigation data, etc.).

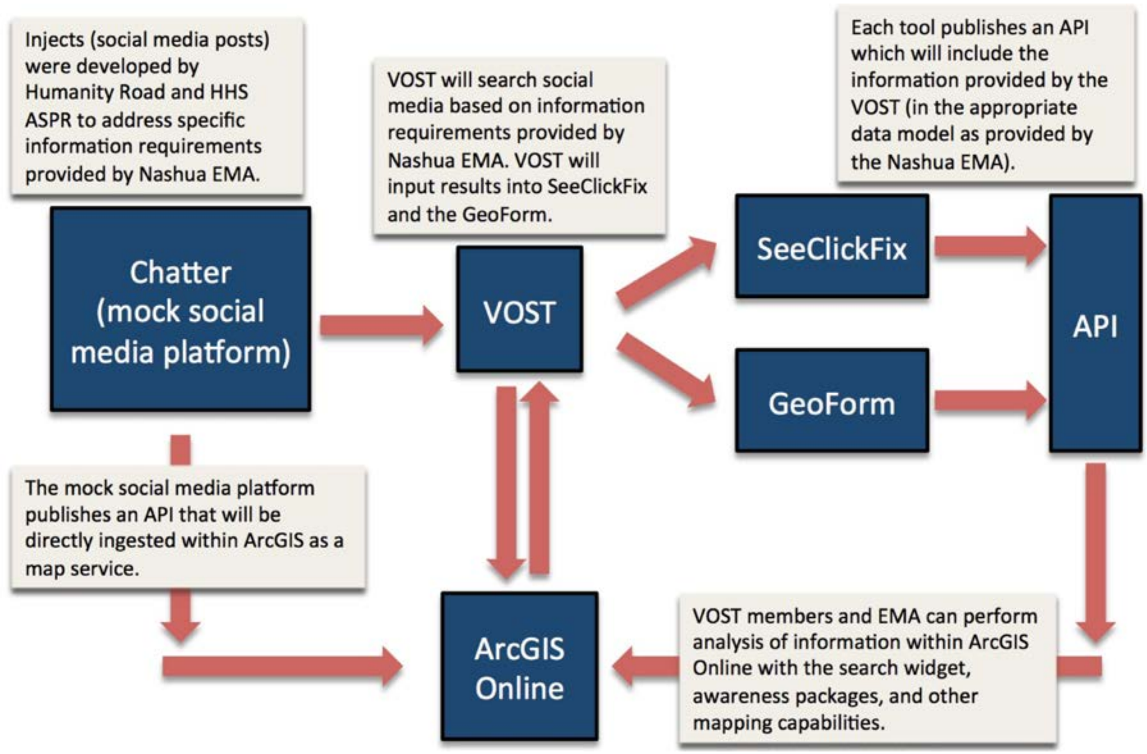

Figure 11: Social media tools to enhance SA and decision-making.

Both the SeeClickFix platform and the GeoForm integrated a data model developed by the DHS VSMWG to help guide and standardize the input of information, ensure the standardization of output, and directly address operational decisions, as shown in Figure 12 below.

[11] SeeClickFix is a web tool that allows citizens to report non-emergency neighborhood issues, which are communicated to local government. Further information can be found here: http://en.seeclickfix.com.

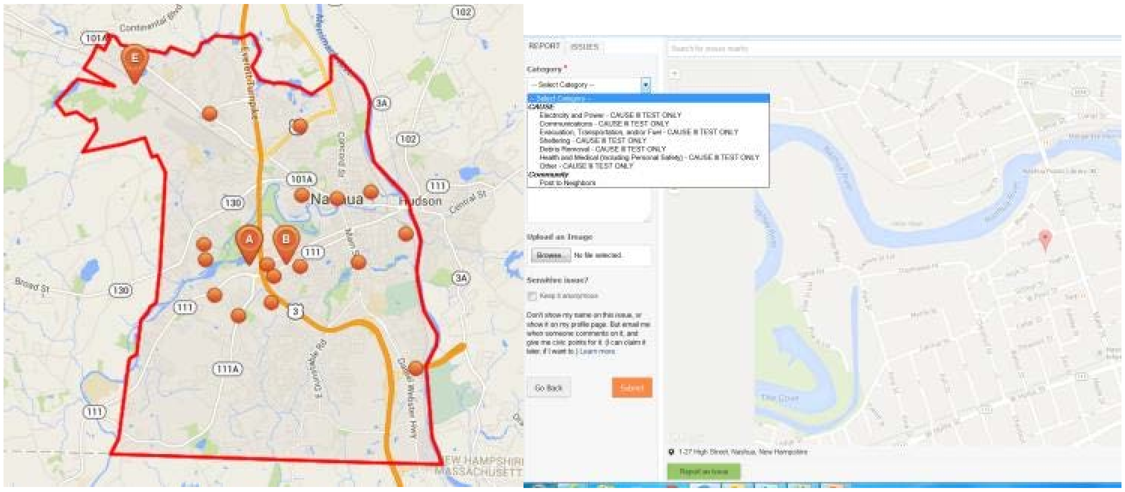

Figure 12: Social media data model for capturing information from digital volunteers.

Figure 13 shows users of the mock social media platform and there were 500 people contributing to the experiment. With 3,677 total Chatter posts during the experiment, participants directly input 2,051 of those messages.

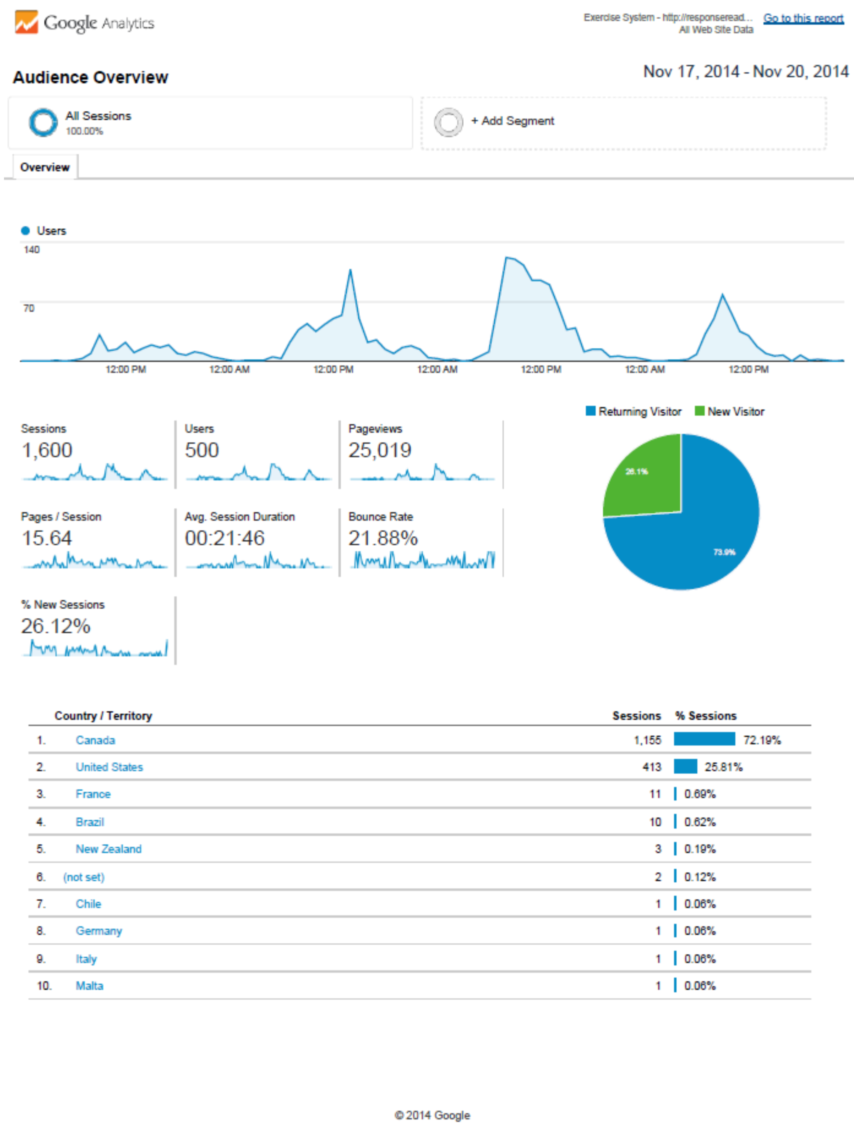

Figure 13: Experiment simulation website Google Analytics overview.

Social network analysis was used to analyze Chatter (mock Twitter) data collected during the experiment, and the resulting network is shown in Figure 14. The network consists of 233 nodes, each representing a Chatter account created during the experiment, and 1,417 unique connections between the nodes. The color of the nodes distinguishes between the puppet inject (blue) and human (red) accounts. The size of the nodes and the associated text relates to the prominence of the nodes within the network in terms of having a high degree of influence and being effective at disseminating information. @Hfxgov and

@redcrosscanada were identified as the most influential Chatter accounts, based on how many times they were referred to during the experiment by others users. The overall network is divided into two distinct communities - one consisting exclusively of 'human' accounts (red) and the other almost entirely of 'puppet' accounts (blue). This is an artifact of using a social media simulator and illustrates one limitation of using pre-scripted, automatic injects for one-way communication.[1]

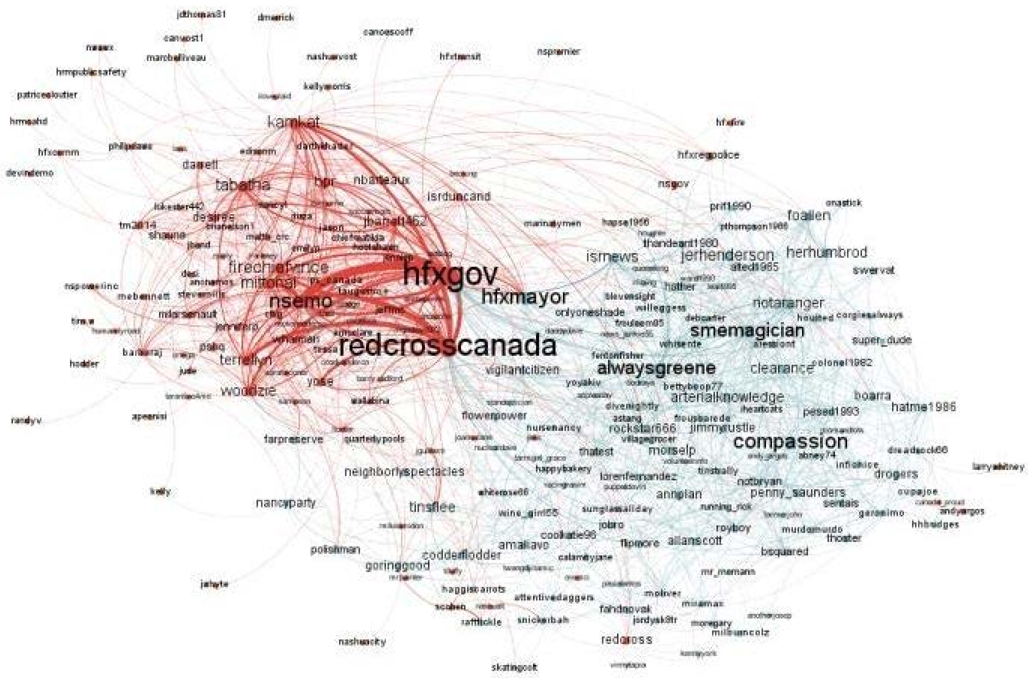

Figure 14: Chatter (Twitter equivalent) network generated from the data collected during the experiment.

Table 7: Outcomes and impacts for social media and digital volunteers.

OUTCOME	IMPACT
A working model for the integration of non-traditional/digital volunteer support within the emergency response operational workflow.	*This establishes social media and digital volunteer support as a viable option for support in emergency response and recovery to enhance existing capabilities.*
A working method for the input of information from non-traditional sources (e.g. the public, VOST, response partners, etc.) to directly satisfy information requirements of official response organizations, and integrated within the emergency response operational workflow.	*This ensures information identified via social media channels directly supports the needs of the EMA, and that it is easily available for use by the EMA via whatever means available.* *This also enables the public, non-traditional groups or organizations to proactively support emergency response and recovery, in a meaningful way, without getting in the way of official response activities.*
A working model for VOST as an official NIMS-typed mutual aid resource. Further discussion regarding NIMS-resource typing of VOST is a next step.	*This will assist in the standardization of VOST capabilities, output and expectations, and training needed. This will, in turn, support the integration of VOST as an official resource in response and recovery and as part of NIMS.*

4 Summary, Recommendations and Observations

The findings from this work will inform the Canadian and DHS S&T community with respect to the application of integrated tools that will enhance shared SA across the border. Future efforts to improve the coordination of responses during cross-border events should consider the outcomes, technology innovations and observations that were generated as a result of conducting CAUSE III.

4.1 Outcomes

- The CAUSE III Northeastern experiment successfully applied the vUSA–ArcGIS Online platform to register, discover and publish shared services. The vUSA–ArcGIS Online platform also enabled efficient development and delivery of applications used during the experiment, including the VOST GeoForm, the Shelter Management Tool and the CAUSE III Story Map interactive briefing tool. The user and group based sharing model required that users have a paid ArcGIS Online for Organizations account, other than in cases where the content being shared was specifically tagged for public viewing.
- Integrating the role of VOSTs within the traditional EM domain (e.g., through the introduction of the VOST MRP) will be an important precursor to the adoption of SMEM as a source of useful information for responding to emergency events.
- The mutual aid workflow between local, state, National Guard and international entities was examined during the experiment during a tabletop discussion that was held in the United States. during CAUSE III. This effort identified a need for exercises that will test the full mutual aid lifecycle. The lifecycle includes a planning phase (e.g., development of a Threat and Hazard Identification and Risk Assessment) and pre-scripted mission assignments preceding the exercise. The exercise would also include the use of existing U.S. tools (e.g., MASS) to make and track mutual aid requests.
- The open API that was provided by Chatter improved SA and enabled the mapping of SMEM content in ArcGIS Online. The open API also provided spatial filters on social media data. The same approach to using an open API could be used with 'real-life' social media sources such as Twitter.
- Thousands of social media injects were developed and were made available for exercise participants, including VOSTs, through the Chatter application.
- Many of the technologies used during CAUSE III (i.e., IPAWS, MASAS, the vUSA ArcGIS Online platform and MASS) required participants to have a unique login to access the capabilities. This resulted in participants having to manage multiple logins during the experiment.

4.2 Technology Innovation

The following technology-focused observations were noted as a result of conducting the Northeastern scenario-based experiment in CAUSE III:

- **MASAS integration** – Model tools and workflows now exist for U.S. agencies to consume/publish Canadian MASAS data from within their native geospatial applications.
- **vUSA integration –** Connected over 60 named users to the NISC vUSA ArcGIS Online CAUSE III Group, including representatives from federal, state, local, military, non-profit and private sector.
- **Mutual Aid Exchange –** Cross-border mutual aid resource requests were accelerated through a Mutual Aid MRP NIEM IEPD exchange. These requests enabled MRP data from MASS to be exchanged with MASAS. The MASAS-NIEM Bridge was created to allow sharing of NIEM IEPDs with MASAS, with specific attention on the CAD2CAD NIEM IEPD.
- **Operational Ready MASAS-IPAWS integration –** Integration of MASAS and IPAWS was conducted using a formally developed MASAS-IPAWS Bridge capability that is capable of joining MASAS hubs with IPAWS under various scenario injects (i.e., relay of Public Alerts, official-to-official via COGS, relay of specific messages in MASAS that are flagged to move to IPAWS, monitoring of specific MASAS Account to relay all traffic on that account to IPAWS).
- **Local, municipal, state, provincial and federal interoperability –** Integration of 12 systems and toolsets was achieved across the full range of government levels and across the CANUS border.
- **On-the-fly fusing of tasking information –** A task list, generated via Google Docs by CanVOST, was integrated into ArcGIS Online to quickly create a HRM-specific Story Map. This task was completed quickly (i.e., less than 5 minutes), which provided a map-based summary of the most critical tasks/issues that warranted HRM's attention.
- **SMEM Tools –** A variety of tools (i.e., GeoForm, SeeClickFix Map widget) were developed to enable VOST members to submit data from social media sources that would satisfy the emergency managers' information requirements.
- **Damage Assessments –** Information related to damage sustained during the hurricane was gathered via the Collector App. This data set was integrated into the mutual aid request process that involved local, state and National Guard authorities.
- **Executive Briefing Tools –** A common operating picture / briefing tool was developed using the Esri Story Map template. The tool provided access to interactive maps, pictures and video relevant to the simulated hurricane event. The viewers were successfully deployed to provide Executive, Commander and VIP briefings.

4.3 People-Focused Observations/Considerations

Recommendation #1: Training is needed to prepare and exercise cross-border planning, response and coordination. Training should be focused on regular cross-border scenario-based tabletop exercises that familiarize operators with using SA tools (e.g., IPAWS, MASAS and the NAAD System) to exchange time-sensitive information such as alerts, warnings and notifications to officials on both sides of the border.
Next steps include:

- Incorporate training and collaboration needs in CAUSE IV planning.
- Formally engage the IEMG, PN EMA and NEMA as partners in the process.
- Develop standard templates for VOST guidance (requiring further input by agencies).
- Develop cross-border working group with members of DHS S&T, DHS OEC, DRDC CSS, FEMA (regions) and other stakeholder groups.
- Develop outreach and training materials, and pilot the training with communities of interest.

Recommendation #2: The roles and responsibilities of the digital volunteers, the technology that will be used, and the methods of interaction with the EMOs need to be refined to ensure that the expectations for this integrated approach are understood by all personnel and can be effectively managed. Digital volunteers can provide specific support to the traditional EMOs through the use of social media during emergency response and recovery operations. This will require a direct effort to identify the types of information requirement that can be addressed through collaborative efforts between the VOSTs and the EMOs.

Recommendation #3: EMO personnel must develop an understanding of how social media can be integrated with emergency operations and procedures. The EMO personnel must be confident in their ability, based on their experience and knowledge, to use social media appropriately in order for them to actually use it during an emergency operation.

4.4 Technology Recommendations

Recommendation #1: Emergency managers need to have access to tools that can support decision-making processes within their organizations. These tools must be tested and approved for use by an EMO before they can be used during an emergency operation. The tools should optimize the searching and filtering of data by spatial or semantic algorithms that are aligned to information requirements that can be altered depending upon the outcomes of the response and recovery operations. Trend analysis and real-time semantic analysis and classification are also lacking.

Next steps include:

- Establish a binational working group to identify opportunities, potentially leveraging the VSMWG.

- Identify and develop baseline search parameters by event type (e.g., critical "event-type" indicators), including thresholds for each variable.
- Identify private sector partners for further research and development relating to this topic (to be employed/tested in CAUSE IV).

Recommendation #2: A central issue related to cross-border mutual aid is the need to align local, state, national and bi-national approaches for resource management. To that end, the following next steps are recommended:

- Complete updates to the draft Mutual Aid MRP IEPD, including:
  - Coordinate with U.S. and Canadian agencies to ensure interoperability and appropriate use of standards for the MRP descriptions.
  - Resource Name should be included in the schema as there is no way to provide a simple descriptive name for the MRP.
  - To improve precision and interoperability, a point is recommended over a cylinder for representing the Resource Location.
  - The current schema provides the ability to provide a location for the incident, but not the MRP home position or current/deployed position.
  - The schema should support the ability to update information about the resource (e.g., requests, MRP operational status).
- Explore partnership opportunities with NEMA and the EMAC Executive Task Force and EMAC Committee to explore the viability of broadened usage of EMAC OS beyond U.S. borders.
- Research and prototyping for incident and resource exchange needs for all levels of organizational information exchange (local, regional, state/province/territory, federal and international).
- Develop API and data model concepts. MASAS may be considered as a starting point and capabilities may be introduced into pure Computer-Aided Dispatch (CAD) systems, but non-CAD incident systems should also be considered.

Recommendation #3: Ensure information exchange is standardized for users to enhance their ability to develop coordinated response plans. This includes standardizing the VOSTs as NIMS-compliant resource typing. In addition, software tools that integrate with social media platforms are required to ensure information being submitted is standardized, applicable and in the appropriate format needed by the EM community for operations.

Next steps include:

- Further develop data schema employed in CAUSE III to address complete list of essential elements of information (EEI) to identify and develop standard information and baseline reporting requirements.
- Work with National Integration Center to develop NIMS-related recommended standards for data model, VOST capabilities and VOST resource typing to identify implementation challenges and gaps to be tested in CAUSE IV.

Recommendation #4: Develop a CANUS national-level information exchange for cross-border exchange of NIEM and other standards-based information. For example, in order to align with NIEM Computer Aid Dispatch exchange efforts, Canada should consider the creation of a national-level exchange for information specifically related to incidents. This effort would be an extension of the work that was performed in Kelowna, British Columbia, which integrated the CAD system to the MASAS to allow information exchange from the municipal level through to the national level. A consistent service for Canadians to use increases the value of sharing NIEM-based information to responders. Key elements to consider in this incident information exchange are references to incidents (i.e., type, name, owner agency, nationally unique identifier, etc.) and resources (requests/responses, inventory, etc.). This information exchange is required to allow broad use across Canada's diverse services and domains and to ensure long-term and appropriate integration with the United States.

Next steps include the following:

- Formation of technical working group to further determine operational and technical requirements.
- Research and prototyping for incident and resource exchange needs for all levels of organizational information exchange (local, regional, state/province/territory, federal and international).
- Endorsement of NIEM Core (v3.0) as a native exchange format.

4.5 Process-Policy Observations/Considerations

Recommendation #1: VOSTs can provide simultaneous mutual aid to multiple stakeholders in both Canada and the United States. This unique provision, since other forms of mutual aid can only be applied to one mission, needs to be represented in the MASS and other mutual aid inventories. In order to improve access to mutual aid resources available from the U.S. National Guard, National Guard Mission Package definitions should be cross-walked with civilian MRPs (based on NIMS). The 'loose-coupling' of these resource types should be included in a future version of the Mutual Aid IEPD.Next steps should include providing this recommendation to NEMA and the FEMA NIC for consideration.

Recommendation #2: Various CONOPS for individual VOSTS have been developed (e.g., CONOPS exist for CanVOST and the Clark Regional Emergency Services Agency VOST); however, a model CONOPS to cover the binational CANUS VOST operations will support the conditions of use including:

- How VOSTs respond to mutual aid requests using effective information workflows between VOSTs and EMAs/EMOs;
- Decision workflows for identifying relevant information based on pre-defined information requirements that are established by emergency managers; and
- Identifying relevant tools and processes that can be used to provide support.

The U.S. study team generated a social media model that depicts a mature integration of social media within the traditional EM operations (Figure 15).

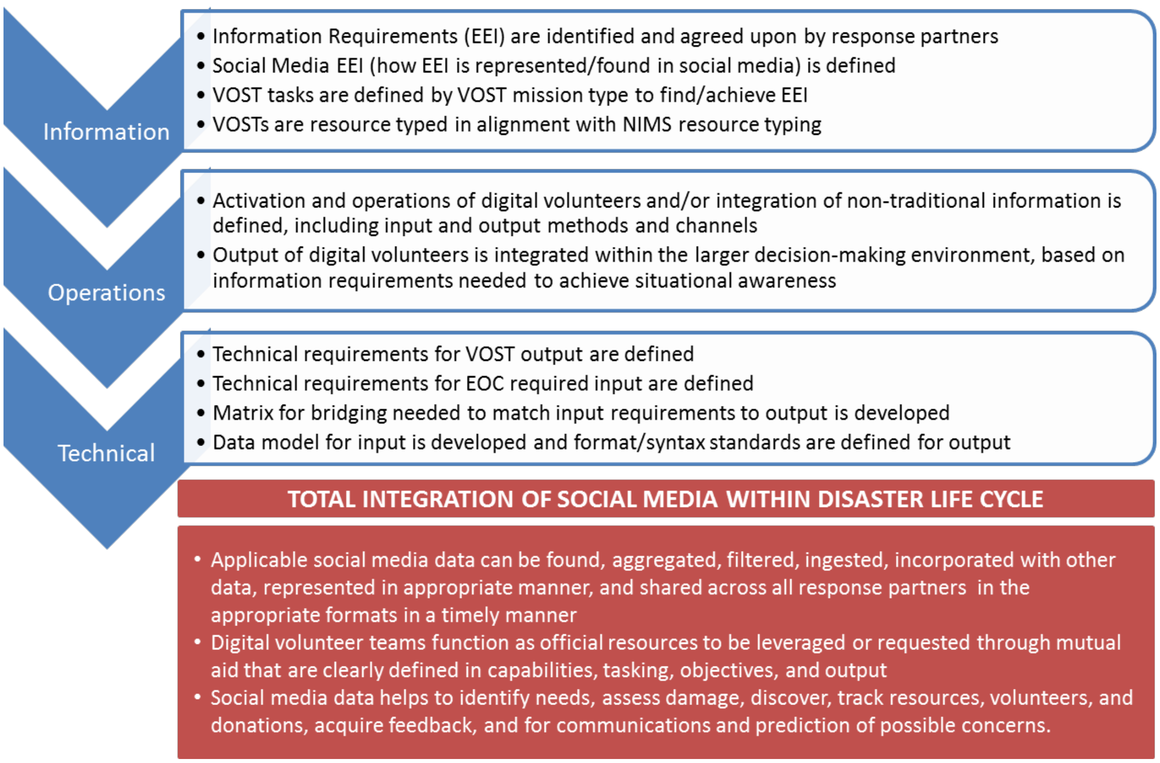

Figure 15: Full integration maturity model.

Next steps should include providing this recommendation to NEMA and the FEMA NIC for consideration.

Recommendation #3: While CAUSE III focused on a cross-border IEMAC-based Hazmat request between Canada and U.S. agencies, further policy and procedures are under development. Key IEMAC priorities are the formalization of Hazmat resource typing and resource mapping to permit the creation of deployment models. These models will assist in the efficient strategic movement of personnel and equipment in times of crisis. Consideration could be given to expanding the stakeholder group to include industry representatives and resources. Future CAUSE experiments provide an ideal medium to validate and permit “practice” in a safe, closed environment of the agreement components ensuring functionality is in place a time of crisis.

Recommendation #4: Identify and prioritize border SA Essential Elements of Information, and develop data models and deployable templates that can be scaled for use on both sides of the border. Considerations could be provided to the White House Incident Management Information Sharing Subcommittee. Next steps should include partnering with the IMIS-SC and National Information Sharing Consortium to include Border Situational Awareness EEIs as part of their strategy.

4.6 Conclusion

This report presents the design, execution and findings from the Northeastern experiment that was performed as part of the third cross-border experiment in the CAUSE Resiliency experiment series. This experiment supported the intent of the BTB Action Plan. The Northeastern experiment was focused on the use of social media technology by digital volunteer organizations as a means to support traditional emergency response organizations, enhance awareness of cross-border emergencies through the application of interoperable SA tools, and testing of cross-border mutual aid processes during the response and early recovery operations following a large hurricane.

The cooperation between the EM organizations and the digital volunteers (VOSTs) has the potential to improve the exchange of AWNs and provide personnel with a clear understanding of the unique roles and responsibilities of each organization. In addition, these roles and responsibilities must be supported by the tools and the operators’ ability to use them to exchange time sensitive information during a border-relevant crisis. The EM organizations that identify specific information requirements can benefit from the involvement of the VOSTs, providing these volunteer organizations can deliver the requested services, and the volunteers are available to support the operation.

The exchange of information between Canada and the United States through the integrated SA tools is essential for supporting coordinated response plans. The potential for categorizing the VOSTs’ capabilities (through resource typing) in a standard way is valuable so that the EMOs understand which tasks the VOSTs are equipped to perform prior to requesting their assistance. The standardization of the tools and the technology development that supports the delivery of mutual aid will continue to be a necessary component for improving cross-border response and recovery operations.

References

[1] Kaminska, K. Dawe, P. et al. 2015. Digital volunteer supported recovery operations experiment. Scientific Report, Defence Research and Development Canada.

[2] Joint CA-U.S. CAUSE III Western Report. In preparation.

[3] Public Safety Canada. January 2009. Federal Emergency Response Plan (FERP), https://www.publicsafety.gc.ca/cnt/rsrcs/pblctns/mrgnc-rspns-pln/index-eng.aspx

[4] U.S. Dept. of Homeland Security – FEMA. National Response Framework, NRF Resource Center. January, 2008. http://www.fema.gov/pdf/emergency/nrf/nrf-core.pdf

[5] Public Safety Canada. Aug 07, 2007. Minister Day Announces the New Emergency Management Act. Press Release. http://bit.ly/1GdfaIw.

[6] Government of Canada. August, 2008. Emergency Management Act. http://laws-lois.justice.gc.ca/eng/acts/E-4.56/FullText.html Public Safety Canada. December 2011.

[7] Beyond the Border Strategy and Action Plan. http://actionplan.gc.ca/grfx/psec-scep/pdfs/bap_report-paf_rapport-eng-dec2011.pdf.

[8] U.S. White House. February 2011. Beyond the Border Action Plan. http://www.dhs.gov/xlibrary/assets/wh/us-canada-btb-action-plan.pdf.

[9] Galbraith, J., M. Miller and G. Li. October 2012. CAUSE Resiliency (West Coast) Experiment Final Report, DRDC CSS CR 2012-011.

[10] Vallerand, A., D. Boyd et. al. July 2013. Canada-U.S. Enhanced Resiliency Experiment II on Enhancing Trans-Border Resilience in Emergency and Crisis Management DRDC-CSS-TRR-2013-006.

[11] Wimberly, R. January 9, 2015. New Alerting Channels Have Proliferated But Challenges Remain. Emergency Management Magazine. http://www.emergencymgmt.com/disaster/New-Alerting-Channels-Challenges-Remain.html.

[12] DHS First Responders Group. 2013. CAPSTONE 2014 Situational Awareness Symbology Brief. http://www.cusec.org/capstone14/documents/CAPSTONE_S%26T_Symbology.pdf.

[13] DHS S&T First Responders Group. October 2014. CUSEC CAPSTONE 2014 After-Action Report. http://www.cusec.org/capstone14/documents/DHS_CAPSTONE_AAR.pdf.

[14] Northern Emergency Management Assistance Compact (NEMAC), Draft Operations Manual. November 2013. http://www.nemacweb.org/wp-content/uploads/2014/10/DRAFT_NEMAC_Ops_Manual_112613.pdf.

[15] Pacific Northwest Emergency Management Arrangement (PNEMA). PUBLIC LAW 105–381—NOV. 12, 1998. http://www.gpo.gov/fdsys/pkg/PLAW-105publ381/pdf/PLAW-105publ381.pdf.

[16] Pacific Northwest Emergency Management Arrangement (PNEMA). Annex A and B. 1996. http://www.pnwbha.org/reports/PNEMA-annex-a-and-b.PDF

[17] The Emergency Management Assistance Compact. National Emergency Management Association. September 2014. http://www.state.me.us/mema/response/mema_response_iemac.html.

[18] International Emergency Management Group Website, http://www.iemg-gigu-web.org/mou-e.asp.

[19] San Su, Y., C. Wardell III and Z. Thorkildsen. June 2013. Social Media in the Emergency Management Field: 2012 Survey Results. IPP-2013-U-004984. NEMA/CNA Joint report. https://www.cna.org/sites/default/files/research/SocialMedia_EmergencyManagement.pdf.

[20] Virtual Social Media Working Group and DHS First Responders Group. January 2012. Social Media Strategy. http://www.firstresponder.gov/TechnologyDocuments/Virtual Social Media Working Group VSMWG Next Steps Social Media for Emergency Response.pdf.

[21] Virtual Social Media Working Group and DHS First Responders Group. June 2014. Using Social Media for Enhanced Situational Awareness and Decision Support. http://www.firstresponder.gov/TechnologyDocuments/Using Social Media for Enhanced Situational Awareness and Decision Support.pdf.

[22] Kaminska, K. and B. Rutten. May 2014. Social Media in Emergency Management: Capability Assessment, DRDC-RDDC-2014-R16.

[23] Kaminska, K., P. Dawe, and B. Rutten. December 2013. Social Media for Emergency Management Expert Roundtable Workshop: Summary of Findings, DRDC CSS TN 2013-046.

[24] Kaminska, K., P. Dawe and B. Rutten. April 2014. Digital volunteer-supported recovery operations experiment: planning and design considerations, CSSP-2013-TI1034-Z8.

[25] Virtual Social Media Working Group and DHS First Responders Group. September 2012. First Responder Communities of Practice Virtual Social Media Working Group Community Engagement Guidance and Best Practices. http://www.firstresponder.gov/TechnologyDocuments/Virtual Social Media Working Group VSMWG Community Engagement.pdf

[26] U.S. FEMA. Overview of Stafford Act Support to States. National Response Framework. http://www.fema.gov/pdf/emergency/nrf/nrf-stafford.pdf.

[27] Emergency Management Agency Compact. February 13, 2015. How EMAC Works. http://www.emacweb.org/index.php/learnaboutemac/how-emac-works.

[28] DHS SAFECOM. The Interoperability Continuum. http://www.dhs.gov/safecom.

[29] Forbes, K. January 2014. CSSP Task 13 Evaluation Framework. ISR Contractor Report, 6048-01-02, 2014.

[30] FEMA National Integration Center (NIC). Resource Typing Library Tool. https://rtlt.ptaccenter.org.

[31] Canadian Interoperability Technology Interest Group, retrieved from: http://www.citig.ca/what-is-interoperability.aspx.

[32] Justice Institute of British Columbia. Programs and Courses. http://www.jibc.ca/.

[33] Social Media in Emergency Management Course IS-42. FEMA http://training.fema.gov/is/courseoverview.aspx?code=is-42.

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Annex A Acronym List

BTB	Beyond the Border
CANUS	Canada-U.S.
CAP	Common Alerting Protocol
CAUSE	Canada-U.S. Enhanced Resiliency
CIWG	Communications Interoperability Working Group
COG	Common Alerting Group
COP	Common Operating Picture
CSS	Centre for Security Science
DHS	Department of Homeland Security
DHS S&T	Department of Homeland Security Science & Technology Directorate
DoDAF	Department of Defence Architecture Framework
DRDC	Defence Research and Development Canada
EDXL	Emergency Data Exchange Language
EEI	Essential Elements of Information
EM	Emergency Management
EMA	Emergency Management Agency
EMAC	Emergency Management Assistance Compact
EOC	Emergency Operations Centre
EOS	EMAC Operating System
FEMA	Federal Emergency Management Agency
GeoRSS	Geographical Rich Site Summary
GOC	Government Operations Centre
IEPD	Information Exchange Policy Document
IPAWS	Integrated Public Alert and Warning System
KML	Keyhole Markup Language
MASAS-X	Multi-Agency Situational Awareness Systems National Information Exchanges
MASS	Mutual Aid Support System
MRPs	Mission Ready Packages
NAAD	National Alert Aggregation & Dissemination System`
NASA TLX	National Aeronautics and Space Administration Task Load Index
NEMA	National Emergency Management Association
NGOs	Non-Governmental Organizations
NIEM	National Information Exchange Model
NIMS	National Incident Management System
NISC	National Information Sharing Consortium
OASIS	Organization for the Advancement of Structured Information Standards
OCIP	Operations Centre Interconnectivity Portal
OGC	Open Geospatial Consortium
P/T	Provincial/Territorial

PSAF	Public Safety Architecture Framework
PSBN	Public Safety Broadband Network
PS	Public Safety Canada
REST	Representational State Transfer
S&T	Science and Technology Directorate
SA	Situational Awareness
SMS	Short Message Service
SOPs	Standard Operating Procedures
SoS	System-of-Systems
SQL	Structured Query Language
SWIMS	State Wide Incident Management System
TDL	Test Development Lab
VOST	Virtual Operations Support Team
vUSA	Virtual USA
WMS	Web Map Service

Annex B Experiment Schedule

Table A8: Experiment schedule for November 18, 2014.

Time (AST)	DVSROE Events		NS EMO Conference
08:30	Registration		Training presentation
09:00	Venue set up complete		Community Events Planning Guide
09:30	Introduction to experiment		
10:00	Hands on demonstration of technology used		(10:15) Facilitated Discussion on EM Issues
11:00	Walk through vignette		(11:15) Wrap-up and closing remarks
12:00	Lunch		
12:30	Experiment Start State Briefing (Experiment Starts)		
	Canada Scenario Events	U.S. Scenario Events	CRC Disaster Management Forum
13:00	Observation of U.S. events / Pre-Activation	(U.S.) Storm Tracking/Monitoring Situational Awareness and EOC Activation	Opening remarks
13:30			(13:15) Alberta Floods 2013
14:30	Observation of U.S. events / Pre-Activation	(U.S.) Alerts and Warnings/VOST	(14:15) Innovation in Emergency Management
16:00	After Action Review (AAR)		(15:45) Severe Weather Trends in Frequency and Complexity of Disasters
17:00	Conference reception		

Table A9: Experiment schedule for November 19 2014.

Time (AST)	**DVSROE Events**		**CRC Disaster Management Forum**
08:30	Registration Opens		Digital Volunteer-Supported Recovery Operation Experiment (DVSROE)
09:00	Review of Day 1 and scenario update		Transportation Emergencies: Lac-Mégantic Derailment
	Canada Scenario Events	U.S. Scenario Events	CRC Disaster Management Forum
09:30	(CA) Activation	(U.S.) Operations/VOST	Transportation Emergencies (continued)
10:00			Preparedness in First Nations Communities
11:00	(CA) Rumour Control and Intervention Messaging	(U.S.) Operations/VOST	
11:30			HAZMAT Response Panel
12:00	Lunch		
12:30			Lunch
	Canada Scenario Events	U.S. Scenario Events	CRC Disaster Management Forum
13:00	Observation of US events / Pre-Activation	(U.S.) Storm Tracking/Monitoring Situational Awareness and EOC Activation	Lunch (continues)
13:30			Digital Volunteer-Supported Recovery Operation Experiment (DVSROE) (Program Check-In)
14:00			The Un-Session Session
14:30	(CA) Supplies Situation Awareness	(U.S.) Mutual Aid/VOST	
16:00	AAR		
17:00	Conference reception		

Table A10: Experiment schedule for November 20 2014.

<table>
<tr><th>Time (AST)</th><th colspan="2">DVSROE Events</th><th>CRC Disaster Management Forum</th></tr>
<tr><td>08:30</td><td colspan="2">Registration Opens</td><td rowspan="2">Clearing Road Blocks to Recovery: Critical Infrastructure Panel</td></tr>
<tr><td>09:00</td><td colspan="2">Review of Day 1 and scenario update</td></tr>
<tr><td></td><td>Canada Scenario Events</td><td>U.S. Scenario Events</td><td>CRC Disaster Management Forum</td></tr>
<tr><td>09:30</td><td rowspan="2">(CA) Shelter Management</td><td rowspan="2">(U.S.) Mutual Aid/VOST</td><td>Clearing Road Blocks to Recovery (continued)</td></tr>
<tr><td>10:00</td><td rowspan="2">(10:15) DVSROE Wrap-up</td></tr>
<tr><td>11:00</td><td rowspan="2">(CA) Recovery Situational Awareness with Support from Digital Volunteers</td><td rowspan="2">(U.S.) Mutual Aid/VOST</td></tr>
<tr><td>11:30</td><td rowspan="2">(10:45) Ebola: Responding globally; Preparing locally</td></tr>
<tr><td>12:00</td><td colspan="2" rowspan="2">Lunch</td></tr>
<tr><td>12:30</td><td>(11:45) Closing remarks</td></tr>
<tr><td></td><td>Canada Scenario Events</td><td>U.S. Scenario Events</td><td rowspan="4"></td></tr>
<tr><td>13:00</td><td>U.S.-Led Mutual Aid</td><td>(U.S.) Mutual Aid/VOST</td></tr>
<tr><td>14:00</td><td>(CA) Physical Volunteer Organization</td><td>(U.S.) Mutual Aid/VOST</td></tr>
<tr><td>15:00</td><td colspan="2">AAR</td></tr>
<tr><td>17:00</td><td colspan="3">End</td></tr>
</table>