GEOSPATIAL CONCEPT OF OPERATIONS FOR EMERGENCY MANAGEMENT

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IMPORTANT INFORMATIVE STATEMENTS

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The CSSP is a federally-funded program to strengthen Canada's ability to anticipate, prevent/mitigate, prepare for, respond to, and recover from natural disasters, serious accidents, crime and terrorism through the convergence of science and technology with policy, operations and intelligence.

GEOSPATIAL CONCEPT OF OPERATIONS FOR EMERGENCY MANAGEMENT

for the

Canadian Safety and Security Community

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1 INTRODUCTION

1.0 Purpose

The intended uses of the Geospatial Concept of Operations for Emergency Management are as follows:

1) **Provide a shared reference resource for the Canadian safety and security community that describes the 'who, what, where, when, why' of Federal geospatial capabilities in order to:**
    a. aid with efficient and effective utilization of geospatial capabilities for preparedness, planning and coordination of resources across the Federal safety and security community;
    b. facilitate collaborative activities and optimize open information sharing within the safety and security community as it relates to geospatial data.

2) **Provide a framework for understanding common requirements for geospatial capabilities across the Federal safety and security community based on documenting the current use of geomatics and 'as is' architecture, documenting business and operational requirements, processes and information exchanges, and identifying capability gaps in order to:**
    a. increase interoperability;
    b. provide better geomatics information in support of evidence-based situational awareness and decision making;
    c. address capability gaps by influencing the design of 'to be' or future architectures and enterprise solutions (e.g. Federal Geospatial Platform);
    d. address capability gaps by identifying opportunities for further research and development investments.

3) **Outline a concept for providing and utilizing geospatial capabilities across the Federal safety and security community at a Government of Canada enterprise level in order to:**
    a. better enable the community to function as an organized network within the Federal Committee on Geomatics and Earth Observation;
    b. guide Federal departments and agencies providing support under the Emergency Management Act as to the role that geospatial data can play in EM programs and processes;
    c. foster efficiencies and effectiveness, based on joint planning, improved interoperable information exchange and data sharing, reduced duplication, joint investments in common data and IT infrastructure, and development of standard operating procedures.

This is intended to be an evergreen document, open to change in order to maintain its relevance over a long period of time. Initial versions of the document will be dynamic (i.e. open to edit on or via the GCPedia wiki) until the content is generally accepted by the community.

1.1 Background

Currently there is no comprehensive or enterprise overview of Federal geospatial capabilities for emergency management, how they relate to one another, or where common requirements exist. This gap in documentation, awareness and knowledge can impact overall coordination. As well, there can be impacts resulting in duplication of effort, excessive information management, incompatible standards, inefficiencies in regards to data collection, purchase, and licensing, and a lack of awareness for new entrants into the community.

New technology and ways of doing business are driving change in the safety and security community such as increasingly data-driven decision-making and use of Web 2.0 techniques including social media and cloud computing. At the same time, however, the community is faced with limited financial and human resources in an increasingly diverse risk environment. This presents transformation opportunities to leverage old and new technologies. For example, the Multi-Agency Situational Awareness System has provided a means for sharing geospatially-located emergency events that did not exist previously. The Operations Centres Interconnectivity Portal is building upon the real-time information stream of MASAS to provide a collaborative information sharing platform across Federal agencies. And, over the next three years (effective May 2014), the Federal Geospatial Platform aims to provide more integrated, decision support and improve access, sharing and integration of geospatial data across the Federal government.

In order to benefit from these investments and optimize the usability and relevance of these systems it is essential to have a sound understanding of community user requirements, capabilities and gaps in order to guide future investments in technology and data. In response, the GeoConnections Program facilitated a Community Development project (CSSP-2013-CD-1101), funded by the Canadian Safety and Security Program to study the use of 'open' geospatial data in support of emergency management within the Federal safety and security community. (While there are many forms of 'open' geospatial data, for purposes of the emergency management community within the Government of Canada, open data is intended to refer to data that is available to all users within the Government of Canada through access via the Government of Canada intranet).

1.2 Target Audience

The primary intended audience for the GeoCONOPS document are both the operational and geomatics practitioners ('the community') supporting emergency management activities at the federal level i.e. those who have direct ownership in the key mission areas outlined in this document. Secondary audiences are operational and geomatics practitioners at the provincial/territorial and local levels, as well as other stakeholders with an interest in the community (e.g. technical developers, data architects, business analysts, R&D researchers, emergency planners, policy makers, senior officials).

1.3 GeoCONOPS Community

The community comprises a range of actors, as mentioned above, both operational and geomatics practitioners who provide support to the Federal Emergency Response Plan (FERP).

The community also includes data and information providers who have support roles in emergency management planning or operations. Information providers (e.g. Canadian Hazards Information Service as provider of earthquake alerts) are key to the community.

This community also intersects with the broader Canadian geospatial community, either though emergency management domain-specific forums such as the CANUS Geospatial and Imagery Working Group or through broader coordination mechanisms such as the Federal Committee on Geomatics and Earth Observation or the Canadian Council on Geomatics. A comprehensive list (not necessarily inclusive) of Federal Departments and Agencies considered as the main actors in the community is included in Annex C.

1.4 This Document

The resulting GeoCONOPS document has been developed with input from the EM stakeholders, both operational and technical, who have direct ownership in the key mission areas outlined in this document.

This document outlines Canadian federal geomatics capabilities that are currently or could be leveraged during emergency management operations across the entire emergency management life cycle.

This document is organized as follows:

- Section 2 presents foundational concepts and interpretations of the Canadian geospatial information environment as it applies to the Canadian safety and security community;
- Section 3 provides a high level description of existing spatial data infrastructure and geospatial capabilities for the Canadian safety and security community;
- Section 4 provides a high level description of Canada's emergency management framework;
- Section 5 details an initial geospatial concept of operations in order to address the gaps in the current Canadian geospatial capability as well as addressing the tenants for a whole of government approach to the management of geospatial data for EM;
- Section 6 outlines the methodology employed to develop this body of knowledge;
- Section 7 presents recommendations for addressing capability gaps;
- Section 8 lists the references utilized in the generation of this report;
- Appendix A provides a list of acronyms utilized in the report;
- Appendix B provides a list of definitions of key concepts utilized in the report;

- Appendix C outlines a natural hazard scenario employed in support of the data collection efforts;

- Appendix D provides an overview the DNDAF and the data products generated in support of the project objectives.

2 GEOSPATIAL DATA CONCEPTS

This section presents foundational concepts and interpretations of the Canadian geospatial information environment as it applies to the Canadian safety and security community. A common conceptual foundation enables a low-level of interoperability in the community i.e. allowing practitioners to 'speak the same language.'

2.0 Geospatial Data, Information, and Knowledge

To lend clarity to the concept of geospatial data, the following definitions are employed to differentiate between data, information, and knowledge:

1. **Geospatial data** is information that identifies the geographic location and characteristics of natural or constructed features and boundaries on the earth, typically represented by points, lines, polygons, and/or complex geometric features. This includes original and interpreted geospatial data, such as those derived through remote sensing including, but not limited to, images and raster data sets, aerial photographs, and other forms of geospatial data or data sets in both digitized and non-digitized forms [21]. Data of this nature have geographic positioning information included as part of their attributes in order to define their location, and thereby answer the fundamental question "Where am I?"

1. **Geospatial information** is geospatial data that has been processed or had value added to it by a human or machine process. This can take the form of cartographic products or maps, or simpler graphic decision support products using geospatial information.

2. **Geospatial knowledge** is a structuring of geospatial information, accompanied by an interpretation or analysis. For instance, the hazard community within Canada using geomatics to assist in displaying risk information for phenomenon such as earthquakes or floods.

The geospatial information and knowledge leverage geospatial analytic services (e.g., surface, network) to contextualize the original geospatial data for the purposes of addressing the specific objectives of the decision makers. As an example, geospatial intelligence (GEOINT) is the military process whereby data and information are collected, and processed in order to provide the space-time context regarding adversary movements and forecasting.

2.1 Open Geospatial Data

Open data, as commonly interpreted, implies data that is available to the public at large for personal consumption.

According to the Government of Canada's Open Data website (http://data.gc.ca/eng), open data has a number of characteristics:

- **Availability and Access.** The data must be available as a whole and at no more than a reasonable reproduction cost, preferably by downloading over the Internet. The data must also be available in a convenient and modifiable form.

- **Re-use and Redistribution**. The data must be provided under terms that permit re-use and redistribution, including the intermixing with other datasets.

- **Universal Participation.** Everyone must be able to use, re-use and redistribute with no discrimination against fields of endeavour or against persons or groups. For example, 'non-commercial' restrictions that would prevent 'commercial' use, or restrictions of use for certain purposes (e.g., only in education), are not allowed.

More specifically, DataBC [2] classified open data as data that has been subjected to an assessment process to ensure compliance to policy requirements, and then subsequently made available to the public for "copying, publishing, distribution, transmission and adaptation under the terms of the Open Government License".

For the purposes of this project, the concept of open data goes beyond data that is publically available to also include those data sources that are available within the Federal government enterprise through domestic and international agreements. Data of this nature may not be available to the public at large (i.e. Official Use Only) but can still follow the general principles of Open Data (http://data.gc.ca/eng/open-data-principles) as follows:

Completeness

Datasets released by the Government of Canada should be as complete as possible, reflecting the entirety of what is recorded about a particular subject. All raw information from a dataset should be released to the public, except to the extent necessary to comply with federal Access to Information and Privacy legislation. Metadata that defines and explains the raw data should be included as well, along with any available explanations for how derived data was calculated.

Primacy

Datasets released by the Government of Canada should be primary source data. This includes the original information collected by the Government of Canada and available details on how the data was collected. Public dissemination will allow users to verify that information was collected properly and recorded accurately.

Timeliness

Datasets released by the Government of Canada should be made available to the public in a timely fashion. Whenever feasible, information collected by the Government of Canada should be released as quickly as it is gathered and collected. Priority should be given to data whose utility is time sensitive.

Ease of Physical and Electronic Access

Datasets released by the Government of Canada should be as accessible as possible, with accessibility defined as the ease with which information can be obtained. Barriers to electronic access include making data accessible only via submitted forms or systems that require browser-oriented technologies (e.g., Flash, Javascript, cookies or Java applets). By contrast providing an interface for users to make specific calls for data through an Application Programming Interface (API) make data much more readily accessible.

Machine readability

Machines can handle certain kinds of inputs much better than others. Datasets released by the Government of Canada should be stored in widely-used file formats that easily lend themselves to machine processing (e.g. CSV, XML). These files should be accompanied by documentation related to the format and how to use it in relation to the data.

Non-discrimination

Non-discrimination refers to who can access data and how they must do so. Barriers to use of data can include registration or membership requirements. Datasets released by the Government of Canada should have as few barriers to use as possible. Non-discriminatory access to data should enable any person to access the data at any time without having to identify him/herself or provide any justification for doing so.

Use of Commonly Owned Standards

Commonly owned standards refer to who owns the format in which data is stored. For example, if only one company manufactures the program that can read a file where data is stored, access to that information is dependent upon use of that company's program. Sometimes that program is unavailable to the public at any cost, or is available, but for a fee. Removing this cost makes the data available to a wider pool of potential users. Datasets released by the Government of Canada should be in freely available file formats as often as possible.

Licencing

The Government of Canada releases datasets under the Open Government Licence – Canada agreement. The licence is designed to increase openness and minimize restrictions on the use of the data.

Permanence

The capability of finding information over time is referred to as permanence. For best use by the public, information made available online should remain online, with appropriate version-tracking and archiving over time.

Usage Costs

The Government of Canada releases the data on the Open Government site free of charge.

2.2 Geospatial Data Types

The basic geospatial data types reflect traditional data found on a map. Accordingly, geomatics technology utilizes two basic types of data:

- Spatial data describes the absolute and relative location of geographic features; and

- Attribute data describes characteristics of the spatial features. These characteristics can be quantitative and/or qualitative in nature.

Other data types, in particular image and multimedia data, are becoming more prevalent with changing technology. Depending on the specific content of the data, image data may not be considered either spatial (e.g., photographs, animation, movies) or attribute (e.g., sound, descriptions, narrations).

Two basic types of spatial data graphic images have evolved for storing geographic data digitally. These are referred to as raster and vector data.

In a raster data image, land cover is represented as single square cells with each individual cell being assigned a value corresponding to its land cover type. Collectively these cells represent the distribution of land cover over a defined area of interest. Raster data is good at representing continuous data (e.g., slope, elevation, chemical concentrations) as well as representing multiple feature types (e.g., points, lines, and polygons) as a single feature type (cells). Types of raster data include:

- Satellite imagery derived from remotely sensed satellite data;

- Digital elevation models;

- Digital orthophotos are digitized images originating from a remotely sensed source (e.g., aerial photo) that are enhanced by removing displacement and/or distortion; and

- Graphic files including scanned maps, photographs, and images in TIFF, GIF, or JPEG format.

In the vector data image, features on the earth are represented as points, lines, routes, polygons, and regions. Vector data are good at accurately representing true shape and size and representing non-continuous data (e.g., rivers, road lines, mountain peaks).

2.3 Authoritative Data

The overall value of derived geospatial products is dependent on the quality of the data. Without valid authoritative sources, the validity of the resulting geospatial products may be questionable.

Authoritative data owned and/or produced by the federal entities supporting the Canadian EM framework can be defined as follows:

Authoritative data is data provided by the trusted and delegated body that is mandated to produce and/or manage the specified data. This authoritative body is recognized in the community as having the legitimate authority and/or delegated responsibility to produce, maintain and make available the specific data.

- Rational Authority: Government agencies are by default the “authoritative” sources for data or services that they produce, or for which they have a statutory responsibility. [1]

- Expert Authority: Scientifically authoritative data is defined in the realm of the various professions under which the standards and methodology for data are created.[2]

Moreover, the authoritative source of any geospatial data is responsible for defining the business rules for accessing and sharing of their data across the wider community. In addition, the authoritative data provider should identify any restrictions and classifications that may inhibit dissemination of the data.

In cases where gaps in authoritative data exist, where data is not readily available or accessible, or data layers are supplied in a package of value-added information, the ‘best available’ data may be used to support EM.

Data provided by volunteer technical communities (VTCs) through ‘open’ data sources (e.g. OpenStreetMap), crowd-sourcing (e.g. Ushahidi) and geo-tagged social media do not necessarily fit the above-noted definition of authoritative data; however, there are cases where these sources may be acceptable data sources. For further consideration of the use and validation of non-authoritative data sources, especially as it applies to international humanitarian disaster response efforts, refer to the following reference documents:

- UN Office for the Coordination of Humanitarian Affairs (OCHA). 2011. Disaster Relief 2.0: The Future of Information Sharing in Humanitarian Emergencies (http://www.unocha.org/top-stories/all-stories/disaster-relief-20-future-information-sharing-humanitarian-emergencies)
- United Nations International Expert Meeting on Crowdsource Mapping for Disaster Risk Management and Emergency Response (http://www.un-spider.org/event/5689/2012-12-03/united-nations-international-expert-meeting-crowdsource-mapping-disaster-risk)

2.4 Tasking, Collection, Processing, Exploitation, and Dissemination Process

The transformation of geospatial data to information to knowledge is performed via the Tasking, Collection, Processing, Exploitation, and Dissemination (TCPED) process. Within the context of geospatial data, this process is comprised of the following steps [1]:

- **Tasking** involves the identification and prioritization of geographical areas of interest for which imagery will be collected.

- **Collection** is focused on the acquisition of “raw” imagery from available collectors.

- **Processing** involves conducting image registration, rectification, colour balancing, and other processing requirements to imagery acquired during the collection phase. End products of the processing phase can be defined as geospatial information (e.g., maps).

[1] US DHS GeoCONOPS, p22
[2] US DHS GeoCONOPS, p22

- **Exploitation** encompasses the interpretation required to generate usable end products (i.e., geospatial knowledge). Analysis may be automated or interpreted by trained imagery analysts. Resulting from the exploitation phase is geospatial knowledge.

- **Dissemination** ensures that the imagery and derived products are delivered to the right people at the right time. This can be accomplished via the exchange of physical media, real-time Common Operating Picture (COP), web services, email or other web-based tools.

Final outputs can be viewed as models or decision support products, such as maps for Situation Reports. Based on geospatial data, models provide a means to predict the dynamic performance of scenario events prior to an event actually occurring. To that end, algorithmically accurate models act as a risk mitigation mechanism by allowing more accurate response plans to be developed (and exercised) prior to the incident occurring. There are several unique programs and software applications that provide the modeled information that is required to support early exposure, damage, and loss estimates.

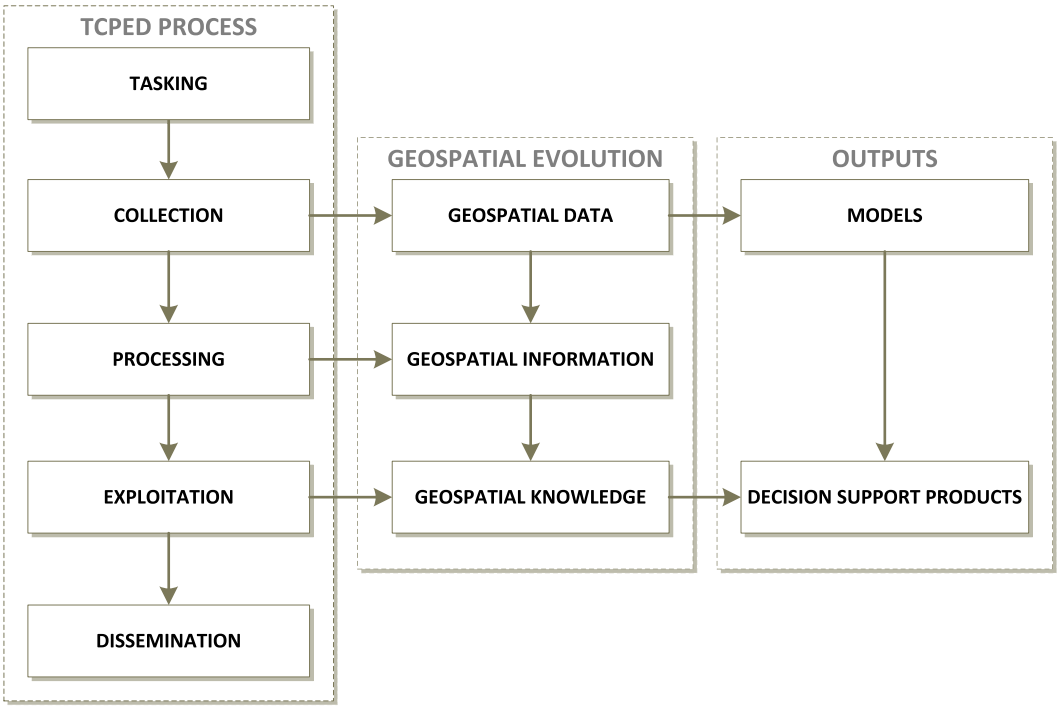


Figure 2-1: Evolution of Geospatial Data

As will be elaborated in later sections, the degree to which Federal agencies execute the TCPED is a function of the departmental mandate and objectives, as well as capabilities and resources allocated to geospatial decision-support. For example, at one end of the spectrum, DND's Mapping and Charting Establishment (MCE) is an organization with a significant number of geo-technicians to address the TCPED process whereas Canada Border Services Agency (CBSA) is limited to only a few geo-technicians.

While the TCPED process is based on traditional intelligence and imagery analysis concepts, it provides a convenient construct for application of the broader information management lifecycle.

3 CANADIAN GEOSPATIAL INFRASTRUCTURE AND CAPABILITIES

3.1 Overview

In the past 15 years, Canadian geospatial capabilities have increasingly leveraged the Canadian Geospatial Data Infrastructure (CGDI). The CGDI is an on-line resource that improves the sharing, access and use of geospatial information. The infrastructure itself consists of data, standards, policies, technologies and partnerships that are in place to allow the sharing and visualization of information on the Internet and to enable the TCPED process.

3.1.1 Tasking

Tasking involves the identification and prioritization of geographical areas of interest for which imagery and other data will be collected. This includes defining collection plans based on information requirements that may be risk-based (e.g. cross-border infrastructure gateways) or event-driven (forecast floods, major security event) or foundational (e.g. filling gaps in coverage).

Planning and tasking of foundation data is described as Minimum Essential Datasets (MEDs) and similarly, datasets can be described as Essential Elements of Information (EEIs) to support a specific theme or emergency function (i.e. flood, earthquake).

Information requirements follow from:

- Departmental mandates and Departmental Emergency Management Plans;
- Federal Emergency Response Plan and Emergency Support Functions;
- Joint planning (e.g. CANUS Cross-border).

Information requirements are further addressed in Section 4.4.

Figure 3-1 depicts an overlay of current Canadian geospatial framework as it pertains to the execution of the TCPED process.

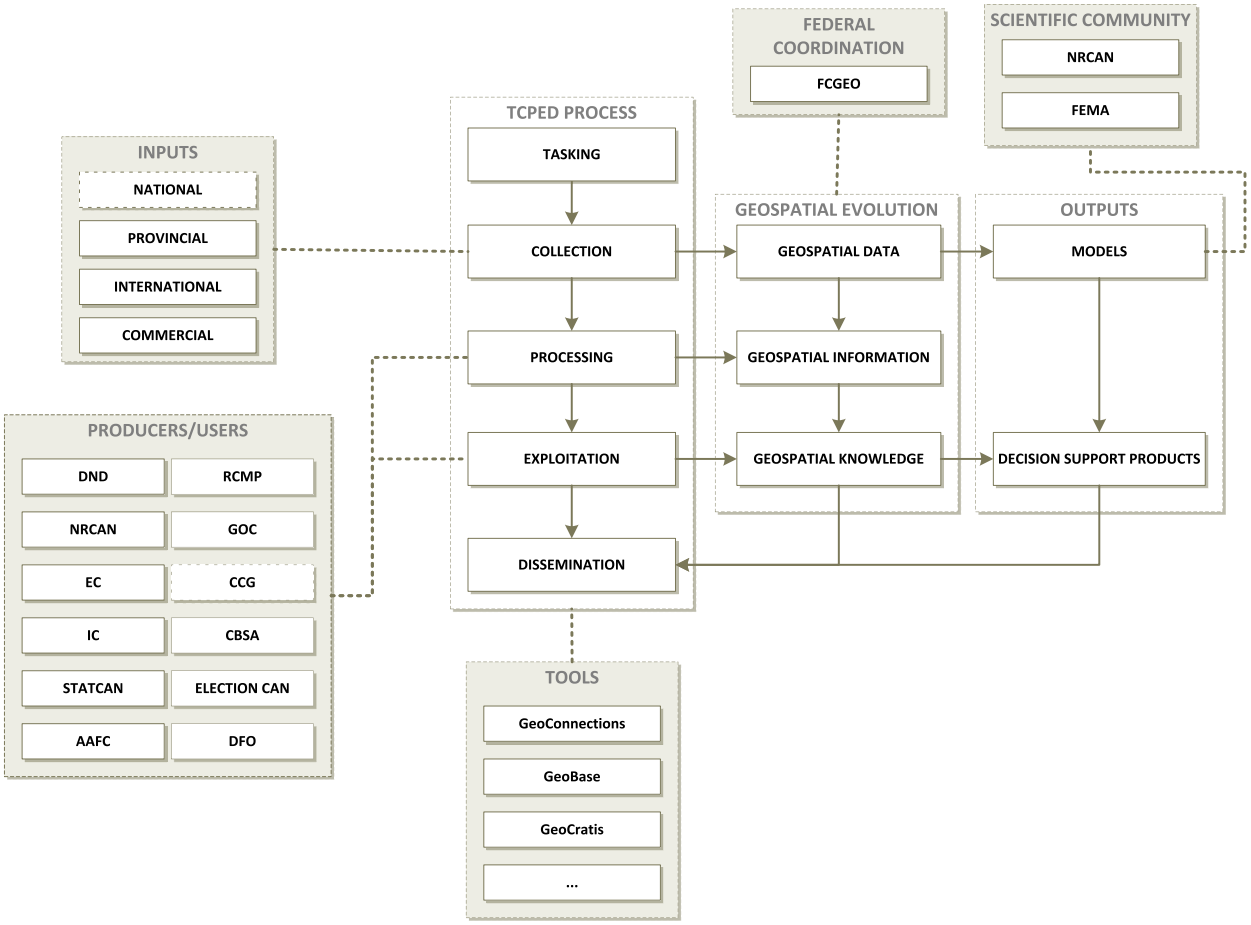


Figure 3-1: Canadian Federal Geospatial Landscape for Safety and Security

Of note, the following Canadian entities have been highlighted:

1. **Inputs** are the entities that collect geospatial data (refer to Section 3.1.2.1);

2. **Federal coordination** refers to FCGEO as the coordinating committee representing custodians of geospatial data collected at the Federal level (refer to Section 3.1.2.2);

3. **Producers/Users** represent a sample of Canadian Federal departments with a capability to perform processing and exploitation of geospatial data with the intent of producing information and knowledge (refer to Section 3.1.3);

4. **Tools** depict existing mechanisms in place to assist with the sharing of geospatial data, information, and knowledge (refer to Section 3.1.4); and

5. **Scientific Community** depicts those organizations that provide scientific support to the development of models.

The subsequent sections provide details regarding each of the TCPED phases with the intent of providing a general understanding of the current state in Canada.

3.1.2 Collection

Geospatial data is collected by Federal, Provincial, Territorial, Regional, and Municipal governments, commercial industry and non-governmental organizations. International governments and commercial sources outside of Canada may provide data describing the Canadian landscape, such as that required for disaster management (e.g. US NASA MODIS imagery for wildfire monitoring) or planning for a major international event (e.g. NGA support to Canadian authorities for Olympic Games).

3.1.2.1 Data Sources

Sources that support the collection of the geospatial data in its original format can be grouped according to the following categories:

1. **Federal.** Federal departments provide foundation data based on mandates and research conducted by their scientific community.

   Table 3-3 identifies several resources that offer free, open Canadian data that can be used to generate geospatial products.

Table 3-1: Federal Geospatial Foundation Data Sources

Data	Source	
GeoGratis	Natural Resources Canada	http://www.geogratis.gc.ca/
GeoBase	Natural Resources Canada	http://www.geobase.ca/
GeoConnections Discovery Portal	Natural Resources Canada	http://geodiscover.cgdi.ca
Atlas of Canada	Natural Resources Canada	http://atlas.nrcan.gc.ca
Open Data Pilot Project	Government of Canada	http://www.data.gc.ca
AAFC Geospatial Products	Agriculture and Agri-Food Canada	http://www.agr.gc.ca/eng/?id=1343066456961
Maps, Geography, Remote Sensing and Geospatial Analysis	Statistics Canada	http://www.statcan.gc.ca/mgeo/index-eng.htm http://www.statcan.gc.ca/pub/21f0003g/2011000/geo-eng.htm
Maps and Cartographic Products	Elections Canada	http://www.elections.ca/content.aspx?section=res&dir=cir/maps&document=index&lang=e

2. **Provincial / Territorial.** Provinces and Territories build and maintain an up-to-date knowledge base of Canada's landmass and resources including topographic, maritime, aeronautical and geoscience information. Created as a result of running government programs and services in areas of provincial jurisdiction, the data also helps develop policy and inform business decisions at the Federal level, especially in areas of shared responsibility, such as safety and security.

   The Canadian Council on Geomatics, created in 1972, is the major federal-provincial-territorial consultative body for geographic information management. Its aims are to provide a forum for exchanging information on programs, to consider common operational issues, to discuss proposed legislation relevant to geomatics (particularly land surveying), and to develop and promote national geomatics standards. (http://www.ccog-cocg.ca/)

   Examples of provincial and regional sources are presented in Table 3-2.

Table 3-2: Provincial/Territorial Data Portals

AOI	Data Portal	Link
AB	GeoDiscover Alberta	https://geodiscover.alberta.ca/geoportal/
BC	GeoBC	http://www.geobc.gov.bc.ca/
MB	Manitoba Land Initiative	https://mli2.gov.mb.ca/
NB	GeoNB	http://www.snb.ca/geonb1/e/index-E.asp
NL	Dept of Environment and Conservation	http://www.env.gov.nl.ca/env/maps/index.html
NS	GeoNOVA	http://www.novascotia.ca/geonova
NT	Northwest Territories Centre for Geomatics	http://Geomatics.gov.nt.ca
NU	-	-
ON	Land Information Ontario	http://www.mnr.gov.on.ca/en/Business/LIO/
PE	-	-
QC	Le Québec géographique	http://www.quebecgeographique.gouv.qc.ca/
SK	GeoSask	https://www.geosask.ca/Portal/
YT	Yukon Spatial Data Clearinghouse	http://www.geomaticsyukon.ca/

3. **International.** There are numerous international allies that provide Canadian institutions with valuable geospatial information. The most notable of these allies is the United States, with the HLS GeoCONOPS [1] providing a catalogue of geospatial resources currently in existence.

The National Geospatial-Intelligence Agency (NGA) collaborates with DND to provide GEOINT[3] products and services to address the needs of the decision makers, warfighters and first responders. Both organizations support the Cross-Border Infrastructure Plan (CBIP) that establishes a common Canada/US (CANUS) database that provides a foundation for fulfilling the Defense, Homeland Security and Public Safety missions of both countries [16]. Building on the base map information from The National Map (US), and the National Topographic Data Base (CA), the CBIP provide CANUS partners and customers with high-resolution geospatial data (to include feature, imagery and elevation data). It also allows the generation of common hardcopy and softcopy products and the distribution of common information services. CBIP provides a single and integrated geospatial database for all imagery, geospatial data, and GEOINT datasets and related products. CBIP enables the CA and US Defense, Homeland Security, and Public Safety and Security communities to:

a. Create a common operational picture of the CA-US Border;

b. Provide multi-dimensional situational awareness products;

c. Promote interoperability over the entire border region; and

d. Develop or exploit existing networks to host the database.

4. **Industry**. Industry geospatial collectors include MacDonald, Dettwiler and Associates Ltd. (MDA), who is the operator and data distributor of RADARSAT satellite imagery, as well as companies such as DMTI Spatial Inc., who provide datasets to a number of departments and agencies in the Government of Canada.

3.1.2.2 Federal Geomatics Coordination

Federal Committee on Geomatics and Earth Observation: FCGEO is focused on:

- Providing whole-of-government leadership in establishing priorities for geomatics and Earth observation and their application in support of government priorities, decision-making, and Canada's competitive advantage, and,

- Enhancing the responsiveness, efficiency and sustainability of the federal geomatics and Earth observation infrastructure.

FCGEO membership consists of 20 federal departments and agencies. These organizations are producers and/or users of geospatial data, or have an interest in geomatics-related infrastructure. More information about FCGEO can be found here: http://www.nrcan.gc.ca/earth-sciences/geomatics/canadas-spatial-data-infrastructure/8900

Canada-United States Geospatial and Imagery Working Group (GeoIWG) (also known as CANUS Geo-Int WG): The mission of the GeoIWG is to coordinate and fulfill CANUS geospatial intelligence requirements in support of the Basic Security Document, the Civil Assistance Plan

[3] Geospatial intelligence, or GEOINT is the exploitation and analysis of imagery and geospatial information to describe, assess and visually depict physical features and geographically referenced activities on the Earth. GEOINT consists of imagery, imagery intelligence and geospatial information. (taken from NGA website - https://www.nga.mil/Pages/default.aspx)

and other subordinate operational plans. The GeoIWG serves as a vehicle to lay out a framework whereby Canadian and US Agencies and OGDs, both military and civilian, can begin to realize the efficiencies of a shared vision and strong partnership by taking advantage of respective capabilities to best address massive Geo Int production requirements such, as the Cross Border Infrastructure Plan (CBIP) or challenges like the Geospatial Intelligence support to the 2010 Olympics.

At present, and without a formal community of interest construct for safety and security within FCGEO, the CANUS GeoIWG serves the Canadian safety and security geomatics community of practice in terms of welcoming OGD participation and advancing collective interests.

3.1.3 Processing and Exploitation

Many Canadian federal organizations will acquire, process and exploit geospatial data for their own purposes. As indicated by the interviews with the EM community, minimal to moderate sharing of geospatial information typically occurs due to the lack of both knowledge of these sources and an effective data exchange infrastructure. However, some organizations will provide geospatial data and services that are available for consumption by the public at large as outlined in Table 3-3.

Table 3-3 highlights a subset of Federal EM organizations with a geospatial component. For each organization, the following information is provided:

1. Name of the organization and the governing department;

2. Overview of the organization's mandate and/or area of responsibility;

3. Sample products and services provided by the organization's geospatial capability.

The principle departments or agencies that produce data within the Government of Canada are indicated with an asterisk (*).

This list is not meant to be a comprehensive list of organizations with a geospatial capacity, but intended to provide a sampling of the Canadian capability with an indication of the types of products being developed.

Table 3-3: Federal Geospatial Capabilities

Organization	Overview	Sample Products
Mapping Charting Establishment (DND)	DND's MCE organization is responsible for providing geospatial information to the Canadian Forces. Using satellite technologies, this group provides timely and accurate mapping and charting support to both the DND/CAF and other government departments.	• Initial Operational Dataset (IODS): Products generated to satisfy a 24-hour response time. Typically briefing maps produced at a scale of 1:1,000,000 using off-the-shelf sources obtained from hard-copy maps and Internet image files. End delivery is a raster product with map surround and some vector graphics. Produced for briefing purposes and as aids to pre-reconnaissance. • Minimum Essential Dataset (MEDS): Seven-day response planning maps produced at a scale of 1:250,000. Data used are from vector sources obtained through Vector Product Format (VPF) and/or by heads-up digitizing of geocoded data. Produced showing the location where the operation is taking place. Produced for reconnaissance purposes prior to the deployment of troops. • Mission Specific Dataset (MSDS): Specialty maps produced in 30 days at a scale of 1:50,000. Product outlines information specific to the area of interest with value-added information (e.g., perspective views, lines of sight, and 3D fly-throughs). Used by deployed troops. • Digital Nautical Chart: Vector-based digital database containing maritime significant features essential for safe marine navigation
Canadian Joint Operations Command (DND)	Canadian Joint Operations Command is responsible for conducting full-spectrum Canadian Armed Forces domestically and internationally.	• Similar products as MCE with a focus to support CAF operations
Joint Information and Intelligence Fusion Centre (JIIFC) Detachment (DND)	Detachment responsible for fusing large amounts of information, including video, photographs, map displays and other data collected from various sources.	• Geospatial products similar in nature to MCE
Emergency Geomatics Service (NRCan)*	EGS responds to federal requests for assistance through the Department of Public Safety and the Department of National Defence. Derived flood extent products are generated in near-real time and provided to end-users through a secure web mapping service.	• Satellite imagery derived products in support of floods and ice jams. The team has provided highly useful satelite derived flood extent polygons to decision makers at the provincial and federal levels of government. They have develop algorithms and standard operating procedures that are able to make the information available in some cases four hours after image acquistion. At the moment this capability exists for flooding and ice jams. • Conducting R&D for flooding in urban areas, damage assessment, coastal inundation, use of UAV sensor platform.
Canadian Hazards	The service conducts	• Earthquakes Canada is the authoritative

Organization	Overview	Sample Products
Information Service (NRCan)	monitoring and provides hazard information and products on an ongoing basis and in response to emergency situations involving earthquakes, tsunamis, volcanic eruptions, landslides, geomagnetic storms and radiological / nuclear incidents. This is accomplished through the provision of remote sensing, geomatics and material support by ESS to government agencies responsible for emergency response. Additionally, the service discharges NRCan responsibilities for ongoing monitoring under the Comprehensive Nuclear Test Ban Treaty.	source of recent and historical Canadian earthquake information. Along with providing the ability to find earthquakes, data and real-time waveforms Earthquakes Canada provides general earthquake information, the ability to report an earthquake and tools for engineers to calculate hazards. • Space Weather Canada provides space environment forecasts and short-term and long-term forecasts of geomagnetic activity in Canada as well as information about effects on technology. • The Public Safety Geoscience Program undertakes hazard research to support risk reduction from the effects of space weather, earthquakes, tsunamis, volcanoes and landslides. The program has been adapting FEMA's Hazards US-Multi-Hazard (HAZUS) loss estimation tool for natural hazards for use in Canada. HAZUS is a nationally applicable standardized-based model which provides loss estimates for flood, hurricane (wind), and earthquake events. • Under the Federal Nuclear Emergency Plan, Natural Resources Canada (NRCan) has a commitment to provide emergency response radiometric surveying. The Emergency Radiation Mapping (ERM) project is responsible for assembling a response group, deploying the remote sensing units, and providing technical expertise, as required.
Canadian Forest Service (NRCan)	Canadian Wildland Fire Information System	• The Canadian Wildland Fire Information System (CWFIS) creates daily fire weather and fire behavior maps year-round and hot spot maps throughout the forest fire season, generally between May and September. CWFIS is a computer-based fire management information system that monitors fire danger conditions across Canada. Daily weather conditions are collected from across Canada and used to produce fire weather and fire behavior maps. In addition, satellites are used to detect fires. • Data products: http://cwfis.cfs.nrcan.gc.ca/datamart
GeoMet (Environment Canada)*	GeoMet provides access to the Environment Canada's Meteorological Service of Canada raw numerical weather prediction model data layers and the weather radar mosaic via two Open Geospatial Consortium web service standards. Meteorological layers are dynamically served through the Web Map Service standard to	• Current weather conditions and forecast feeds containing the latest conditions and 7 day forecast for a town/city; • Warning feeds that alert the subscriber when a watch or warning is in effect for a selected region. Significant differences in regional geography and seasonal conditions put Canada at risk for a wide range of hazardous weather conditions including ice storms, blizzards, heat waves and hurricanes. Environment Canada's Meteorological Service provides Canadians advance notice

Organization	Overview	Sample Products
	enable end-users to display meteorological data within their own tools and on interactive web maps, and for display in tools such as Google Earth™. Environmental Emergencies Management System (E2MS) The Environmental Emergencies Program protects Canadians and their environment from the effects of environmental emergencies through the provision of science-based expert advice and regulations. The primary role of Environment Canada's National Environmental Emergencies Centre (NEEC) is to provide the Department's unique technical and scientific environmental advice and assistance to the lead agency in the event of an environmental emergency.	about potentially hazardous weather; and, • Marine feeds that consist of the latest marine weather updates, as well as watches and/or warnings for an entire area. Special alerts and information products help to warn mariners of when hazardous marine weather, ice conditions or icebergs could threaten their safety. • Air Quality Indicators: Tracks the ambient concentrations of fine particulate matter, ozone, sulphur dioxide, nitrogen dioxide, and volatile organic compounds at the national and regional level and at the local monitoring-station level. These indicators are intended as state/condition indicators to inform decision-makers and the public about the state of the environment and the progress toward improved ambient air quality in Canada. • Canada's lightning detection network: http://weather.gc.ca/lightning/index_e.html
Canadian Hurricane Centre (EC)	The Canadian Hurricane Centre (CHC) provides Canadians with meteorological information on hurricanes, tropical storms and post-tropical storms to help them make informed decisions to protect their safety and secure their property.	• Hurricane Track Maps
Canadian Ice Service (EC)	Provides the most accurate and timely information about ice in canada's navigable waters. We work to promote safe and efficient maritime operations and to help protect canada's environment. Integrated Satellite Tracking Of Pollution (ISTOP).	• Ice Bulletins (ice forecasts including ice warnings, seasonal summaries, seasonal outlooks) and iceberg bulletins; • Ice and Iceberg Charts; • Images; • Reference Maps. • Satellite imagery analysis to detect oil spills and report on illegal and accidental oil pollution in our marine environment.

Organization	Overview	Sample Products
Agri-Geomatics Service of Agriculture and Agri-Food Canada (AAFC)*	The geospatial products and services offered provide online access to agriculture-related maps, geospatial data and tools that help make better decisions for environmentally responsible yet competitive agriculture. (http://www.agr.gc.ca/eng/?id=1343066456961)	• Maps to view drought conditions, land patterns, soils landscapes, or imagery of agricultural fields; • General tools to calculate distances, measure areas, create buffers, and print maps; • Application-specific tools to calculate fencing costs, or to determine the available herbaceous and woody "opportunity" biomass within a specific area; and • Access to geospatial data as web services for use in existing software or to develop new applications.
National Operations Center – Geospatial Intelligence Unit (RCMP)	The NOC's mandate is to gather and process information required to support strategic-level decision-making, and to strategically coordinate and/or manage the RCMP's national-level response to national security, natural, technological failures and/or cyber events. In support of the NOC's law enforcement duties, geomatics products are generated.	• Maps and imagery products to support investigations
Canada Border Services Agency	CBSA ensures the security and prosperity of Canada by managing the access of people and goods to and from Canada.	• Provide regional offices with geospatial information • Creating imagery of Canadian ports of entry
Government Operations Center (PS Canada)	The GOC provides strategic-level coordination on behalf of the Government of Canada in response to an emerging or occurring event affecting the national interest.	• The GOC produces products and provides geomatics services for the GOC itself in order to maintain national level situation awareness and for senior officials in the Government of Canada to support decision making.
PS Canada – Critical Infrastructure	This organization conducts risk and field assessments of critical infrastructure and properties to understand vulnerabilities for the purposes of adopting preventive measures	• Virtual risk analysis cell (VRAC) products to conduct joint risk analyses of cross-border assets and systems • Regional resiliency assessment project (RRAP) products, to assess vulnerabilities of regional infrastructure and identify actions to mitigate risks
Fisheries and Oceans	DFO is the lead federal department as it pertains to managing Canada's fisheries and safeguarding its waters.	• Canadian Hydrographic Service: Displays the geographical extent of products produced by the Canadian Hydrographic Service, including: individual paper charts, vector Electronic Navigational Charts, and digital raster charts collection..

Organization	Overview	Sample Products
		• Arctic Voyage Planning Guide - A compilation of data and services relevant to mariners travelling in the Arctic region of Canada.
Earth Observation Applications & Utilizations (Canadian Space Agency)*	The Canadian Space Agency looks to develop and apply space knowledge for the benefit of Canadians and humanity. The EOAU division manages programs and activities that support and promote the development and use of Earth Observation technologies and applications	• Use of RADARSAT-2 to predict and measure the impacts of climate change, for example • Support operational environmental applications, such as pollution detection, ice monitoring and mapping, wetlands mapping, coastal change detection and accurate weather and climate forecasting and modeling.
Public Health Agency of Canada	PHAC is responsible for promoting health, preventing and controlling chronic/infectious diseases, as well as preparing for and responding to public health emergencies.	• Products to estimate health risks due to exposure to hazards (e.g., cancer risk from routine operations of a nuclear-generating station) • Employed satellite imagery to improve monitoring of the risk of microbial contamination (e.g., E. coli) in recreational waters
Aboriginal Affairs and Northern Development Canada	AANDC supports Aboriginal people and Northerners in their efforts to improve social well-being and economic prosperity; develop healthier, more sustainable communities; and participate more fully in Canada's political, social and economic development.	• NT GeoViewer is the web mapping application displaying settled land claims, land withdrawals, marine reqions, and areas under protection. It contains spatial, digital data maintained by AANDC and others that are useful to AANDC users. • Aboriginal and Treaty Rights Information System (ATRIS) s a Web-based information system intended to map out the location of Aboriginal communities and display information pertaining to their potential or established Aboriginal or treaty rights
Health Canada	HC is responsible for helping Canadians maintain and improve their health	• Specialised decision-support and geomatics products as part of the federal nuclar emergency program.
DRDC - Centre for Security Science	DRDC CSS operates in partnership with PS Canada to provide science and technology services and solutions to address public safety and security priorities.	• Technology operationalization of MASAS (refer to Section 4.5.1)

3.1.4 Dissemination and Information Sharing

Information is shared across the Canadian geospatial community through multiple tools and systems. The individuals involved are typically knowledgeable of the information requirements for the given situation and whether the data is available to them.

Ideally, sharing geospatial information would occur in near real-time; however, geospatial data sharing in Canada relies on peer-to-peer transactions built upon a social network of geospatial practitioners. Specifically, sharing of information tends to be facilitated through email and physical media (i.e. hard drives). While this is effective in promoting information data sharing and general wide area access, it does not provide a consolidated or managed source for either.

Information sharing at the technical level can leverage a broad array of specifications and standards. Of note, the Open Geospatial Consortium (OGC) has geospatial specifications that enable interoperability between systems employed by organizations that may be operating in different jurisdictions with diverse networks (OGC specifications are further described in Section 3.1.6). OGC-compliant systems allow a network of heterogeneous systems to exchange information before, during, and after an incident occurs. Section 3.1.6.2 outlines some of the key specifications endorsed for use in Canada.

Information sharing from an EM perspective is discussed in Section 4. Of note, Public Safety Canada has initiatives in place to support the exchange of EM-related information through a series of interoperability initiatives (e.g., Communications Interoperability Action Plan [12]), as well as implementation of tools such as the Operations Centres Interconnectivity Portal (OCIP) and the Multi-Agency Situational Awareness System (MASAS) (Refer to Section 4.5 for additional details on these systems).

Satellite imagery is massive in file size (it can easily exceed 500MB) and cannot be transferred via email (which typically has a limit of 5MB). As a result, the GOC established a File Transfer Protocol (FTP) site to facilitate the dissemination of satellite imagery. The address of this FTP site is referenced within the Plan for Accessing Satellite Imagery for Emergency Management (see Section 3.0.9).

3.1.5 Symbology and Taxonomy

In addition to the TCPED business model and associated vocabularies, the community also leverages a suite of vocabularies, taxonomies, and data dictionaries to support structured information exchange and visualization in support of interoperability.

3.1.5.1 Canadian Emergency Management Map Symbology & Taxonomy

The Emergency Mapping Symbology (EMS) is designed to be used in both single and multi-agency emergency mapping applications to facilitate interoperability and situational awareness. The symbology is promulgated by a common use approach to community adoption and is currently not under consideration for formal standardization. The symbology includes both a set of map symbols and a taxonomic classification of the entities under consideration. Incident, infrastructure and operation are considered categories in the EM

domain. Symbols are designed to visually pop out from the field of view, regardless of the map or imagery background.

The process of developing EMS taxonomy was heavily influenced by three principal published sources: (i) MIL-STD 2525C and ANSI INCITS 415-2006 (Homeland Security Mapping Standard Point Symbology for Emergency Management), from which it was derived, (ii) CAP-CP, the Canadian Profile of the Common Alerting Protocol, and (iii) the NIDM (the Canadian National Infrastructure Data Model), which was developed from the (US – Canada) Cross-Border Infrastructure Plan. This version of the EMS, developed by the GeoConnections Program in 2009, is used in MASAS-X for regular training, exercises and operations, as well as in many commercial crisis management and geographic information systems.

Since early 2014, the original online host site [www.emsymbology.org] has been decommissioned. Documentation describing guidelines for use, design principles and a full description of the taxonomy can be found here: http://cms.masas-x.ca.s3.amazonaws.com/EMS_Symbology_v1.0.pdf

Version 1.0 symbol icons can be found here: http://cms.masas-x.ca.s3.amazonaws.com/EMS_Symbology_v1.0_full.zip

During 2011-12, a Version 2.0 EMS was developed that extends the symbols to include Search and Rescue and Crime Mapping and further develops and updates the taxonomy for the Common Alerting Protocol – Canadian Profile, All-Hazards Risk Assessment Taxonomy, the Universal Task List – Animal Emergency Working Group, and the United Nations Office for the Coordination of Humanitarian Affairs (OCHA) icons. This activity also considered taxonomic approaches from the National Information Exchange Model (NIEM) and the NATO Tactical Situation Object. This version has not been widely adopted and will require further investigation and governance within the safety and security community.

3.1.5.2 Common Alerting Protocol-Canadian Profile Location References

The Common Alerting Protocol (CAP) is a simple but general format for exchanging all-hazard emergency alerts and public warnings over all kinds of networks. CAP allows a consistent warning message to be disseminated simultaneously over many different warning systems, thus increasing warning effectiveness while simplifying the warning task. The Canadian Profile of the Common Alerting Protocol (CAP) is a set of rules, and managed lists of values, that are recommended for use in Canada. It is often referred to as the CAP-Canadian Profile or simply CAP-CP. EM Symbology (Section 3.0.6.1) incorporates CAP-CP Event References.

Geospatial locations pertaining to alerts and warnings follow the Statistics Canada - Standard Geographical Classification (SGC). A full description can be found here: http://www.cap-cp.ca/index.php/en/

3.1.5.3 Infrastructure Data Models

Data models organize features of interest to the safety and security community and enable geospatial interoperability and information sharing.

The Cross-Border Infrastructure Plan (described in Section 3.0.3.1.) guides the TCPED process serving as the foundation for data collection prioritization and planning and describing the Minimum Essential Data Sets (MEDS) required to support the safety and security mission. Minimum Essential Datasets are the minimum essential data needed to collect, acquire, and compile data for the Cross Border Infrastructure Plan comprising five categories: critical infrastructure, important industry, high-value or symbolic targets, miscellaneous, and base map information.

Critical infrastructure data is defined as those industries, institutions, and distribution networks and systems that provide a continual flow of the goods and services essential to continental defense and economic security and to the health, welfare, and safety of the citizens of the two countries.

3.1.6 Interoperability Standards

Technical and data standards allow diverse data sources, services, applications and systems to operate with each other. The harmonization of standards is fundamental to ensuring the efficient exchange of location-based information. Standards for geospatial interoperability provide consistent and interoperable patterns for creating, reproducing, updating and maintaining geographic information and services for decision-makers in the public and private sectors, and for all Canadians. Standards have been developed to address specific interoperability challenges. Geospatial standards are technical documents that detail interfaces or encodings. Software developers and data producers use these documents to build open interfaces and encodings into their products and services. The standards also provide an indicator of quality, including the structure for encoding metadata to help identify geospatial data.

Technology standards allow different systems and services to work together through standard interfaces. Ideally, when the standards are implemented in products or online services independently, the resulting components ‘plug-and-play’, that is, they work together seamlessly. Standards facilitate the development, sharing, and use of *geospatial data.* The more standardized the structure and content of information, the more effectively it can be accessed, exchanged and used by both humans and machines. Standards are necessary for facilitating robust, open transfer of spatial data packages between platforms, especially in a varied network of computers that are managing a diverse range of spatial data stores and data types.

3.1.6.1 List of compliant standards

The following list of standards are described and used in the Canadian Geospatial Data Infrastructure (CGDI), and aim to provide consistent and interoperable patterns for creating, reproducing, updating and maintaining mapping information for decision-makers in the public and private sectors, and for all Canadians.

The key types of standards that impact spatial data infrastructures are:

Semantics

In the content of geospatial data, semantics refers to the meaning and structure of concepts used to represent various geographic phenomena. Standards in this category provide information on the properties of the datasets as well as their context.

- **Digital geospatial metadata** captures the basic characteristics of a geographic data or information resource, and represents the *who, what, when, where, why* and *how* of the resource. More information on digital geospatial metadata...
- **North American Profile of ISO19115:2003** - Geographic Information - Metadata was prepared to meet the specific geographic needs of data producers and users in Canada and the U.S. More information on NAP...

*This profile of metadata, along with use of the Web Map Server Interface, is part of a suite of specifications that have been adopted as a Treasury Board of Canada Secretariat standard. For full text of the Standard on Geospatial Data see: http://www.tbs-sct.gc.ca/pol/doc-eng.aspx?section=text&id=16553

Syntax and Encodings

The syntax of geospatial information relates to how the information is coded to allow communication between systems. The syntax is the encoding format used for the transfer and the visualization of geographic data.

Rules in encoding standards allow spatial information defined in an application schema to be coded into a system-independent data structure suitable for transport or storage. Encoding rules specify the types of data to be coded, and the syntax, structure and coding schemes used in the resulting data structure, which may be stored on digital media or transferred using transfer protocols.

- **Geography Markup Language** (GML) is an XML application that provides a specialized vocabulary for working with geographic data. The main purpose of GML is to provide a standard means for representing information about geospatial features. More information on GML...
- **GeoRSS** provides a way to encode location in RSS and Atom feeds. It allows users to perform geographic searches on feeds, or to map information found in feeds. More information on GeoRSS...
- **Keyhole Markup Language** is an XML language for expressing geographic annotation and visualization within Internet-based, two-dimensional maps and three-dimensional Earth browsers. More information on KML...

A full list of CGDI-compliant encoding standards can be found here: http://www.nrcan.gc.ca/earth-sciences/geomatics/canadas-spatial-data-infrastructure/8902

3.1.6.2 Services

Standards for web services provide capabilities for manipulating, transforming, managing, or presenting geographic information. The goals of web service interoperability are to provide

seamless and automatic connections from one software application to another and the seamless flow of data between web-based applications and services. Web services encapsulate linguistic resources and tools and combine them in a common service-oriented architecture.

- A **Web Map Service** (WMS) defines an interface that allows a client to get maps of geospatial data and gain detailed information on specific features shown on the map. More information on WMS...
- A **Web Feature Service** (WFS) allows a client to perform data manipulation operations on one or more geographic features. WFS offers direct fine-grained access to geographic information at the feature and feature property level. More information on WFS...
- A **Gazetteer** is an online "dictionary" of geospatial words or terms, with or without applicable feature geometries. The **Gazetteer Service** can be used to relate place names to stored geometry. More information on the Gazetteer Service...
- A full list of CGDI-compliant web service standards can be found here: http://www.nrcan.gc.ca/earth-sciences/geomatics/canadas-spatial-data-infrastructure/8902

3.1.6.3 Standards Development

While CGDI-compliant standards represent the core specifications required for geographic information exchange, the OGC and other organizations provide a series of standards and specifications that are available to use or are in development. These may also be applicable to the safety and security community.

Open Geospatial Consortium: Emergency and Disaster Management Domain Working Group. The purpose of the EDM DWG is to promote and support the establishment of requirements and best practices for web service interfaces, models and schemas for enabling the discovery, access, sharing, analysis, visualization and processing of information to the forecasting, prevention, response to and recovery from emergency and disaster situations. (http://www.opengeospatial.org/projects/groups/edmdwg)

Canadian General Standards Board – Committee on Geomatics: (http://www.tpsgc-pwgsc.gc.ca/ongc-cgsb/publications/catalogue/index-eng.html)

Organization for the Advancement of Structured Information Standards: OASIS is a non-profit consortium that drives the development, convergence and adoption of open standards for the global information society. The OASIS Emergency Management Technical Committee creates vendor-neutral and platform agnostic standards for organizations and agencies to more easily exchange emergency information. (https://www.oasis-open.org/committees/tc_home.php?wg_abbrev=emergency)

The Emergency Data Exchange Language (EDXL) is a broad initiative to create an integrated framework for a wide range of emergency data exchange standards to support operations, logistics, planning and finance.

EM-TC standard efforts include:

- EDXL Common Alerting Protocol (EDXL-CAP)
- EDXL Distribution Element (EDXL-DE)
- EDXL Hospital AVailability Exchange (EDXL-HAVE)
- EDXL Resource Messaging (EDXL-RM)
- EDXL Reference Information Model (EDXL-RIM)
- EDXL Situation Reporting (EDXL-SitRep)
- EDXL Tracking Emergency Patients (EDXL-TEP)

Digital Geographic Information Working Group: DGIWG is the multi-national body responsible for geospatial standardization for the defence organizations of member nations. DGIWG geospatial standards are built upon the generic and abstract standards for geographic information defined by the International Organization for Standardization (ISO TC/211). DGIWG makes use of the service specifications endorsed by the Open Geospatial Consortium (OGC).

DGIWG defines information components for use in the development of product specifications and application schemas for military geospatial data. DGIWG also establishes service specifications, encoding formats and testing methodologies to meet military geospatial intelligence requirements.

DGIWG also maintains an extensive Knowledge Base of documents related to geospatial standardization, and historical documents such as previous versions of the DGIWG DIGEST exchange standard. (http://www.dgiwg.org/dgiwg/)

National Information Exchange Model: NIEM is a community-driven, standards-based approach to exchanging information active across several safety and security-centric domains including Biometrics, CBRN, Emergency Management, Immigration, Infrastructure Protection, Intelligence, Justice, Maritime, and MilOps.

The Geospatial Enhancement for NIEM (Geo4NIEM) initiative is a collaboration of the NIEM Program Management Office (PMO), the Open Geospatial Consortium (OGC), the Department of Homeland Security, and the Program Manager for the Information Sharing Environment (PM-ISE) to enhance NIEM's geospatial exchange capabilities. (https://www.niem.gov/technical/Pages/Geo4NIEM.aspx)

3.1.7 Operational Policies

Geospatial operational policies are a broad range of practical instruments such as guidelines, best practices, directives, procedures and manuals that address topics related to the lifecycle of geospatial information (i.e., collection, management, dissemination, and use). These policies apply to the day-to-day business of organizations and address legal and administrative requirements, and make issues such as data access, quality, ownership and integrity easier to manage.

3.1.7.1 Access, Management and Dissemination

How to Share Geospatial Data Primer

This primer (2012) is intended to inform those who produce or use geospatial data about the realities and challenges of geospatial data sharing. This primer discusses possible data sharing models, and highlights best practices for data sharing.

Geospatial Data Archiving and Preservation - Research and Recommendations Executive Summary
This report (2011) is written to meet the following objective: conduct research and provide analysis and recommendations on the issue of archiving and CGDI geospatial data assets, including solutions for perpetual access. The report is based primarily on research of available documents and literature, supplemented by consultations with a primary stakeholder, Library and Archives Canada.

Primer on Policy Implications of Cloud Computing
This document (2012) is intended to inform Canadian Geospatial Data Infrastructure (CGDI) stakeholders about the nature and scope of cloud computing and the realities, challenges and good practices of related geospatial operational policies. It introduces key issues in geospatial operational policy such as liability, privacy and confidentiality, security, licensing, copyright, archiving, regulations and standards; imperative to the success of any venture into cloud computing.

Volunteered Geographic Information Primer
This document (2012) is intended to inform Canadian Geospatial Data Infrastructure (CGDI) stakeholders about the nature and scope of Volunteered Geographic Information (VGI) and the realities, challenges and good practices of related geospatial operational policies. It introduces key issues in geospatial operational policy such as data quality, liability, privacy, security, licensing and copyright; imperative to the success of any venture into VGI.

GeoConnections Framework Data Guide
This online course (2009) is designed to introduce you to framework data concepts, sources and uses.

The Dissemination of Government Geographic Data in Canada: Guide to Best Practices
Broad-based consultation (2008) with government departments and agencies and the geomatics industry informed and guided the development of the integrated framework for the licensing of government geographic data recommended in this guide.

Archiving, Management and Preservation of Geospatial Data - Summary Report and Recommendations
This summary report (2005) is intended primarily for creators and custodians of geospatial data. It summarizes the state of geographic information archival practices and provides recommendations for the proper preservation of this data over the long term.

3.1.7.2 Protected Information

Intellectual Property Law Backgrounder
This document (2011) provides an overview of Canadian intellectual property (IP) law with a focus on its relevance to protecting geospatial data, information and products. The focus in this paper is on confidential information, copyright, trademarks and patents, although copyright is the predominant basis for the protection of geographic data and related information products.

Geospatial privacy awareness and risk management guide for federal agencies
One topic of particular concern to GeoConnections stakeholders is privacy. Working (2010) with guidance from the members of the Federal Government Geospatial Privacy Advisory Group, GeoConnections has developed this Geospatial Privacy Awareness and Risk Management Guide for Federal Agencies.

More information on other operational policies and new documents will be made available as they are developed here: http://www.nrcan.gc.ca/earth-sciences/geomatics/canadas-spatial-data-infrastructure/8904

3.1.8 Standard Operating Procedures and MOUs

3.1.8.1 Plan for Accessing Satellite Imagery for Emergency Management

This plan provides guidelines for requesting earth observation data (i.e. satellite imagery) via the Government Operations Centre (GOC) including requests that require activation of the International Charter on Space and Major Disasters. The aim of the Charter is to provide a unified system to supply earth observation data to those countries affected by natural or human-induced emergencies, thus helping to mitigate the impact on human life and infrastructure. Events handled through Charter imagery are typically short in duration.

The GOC and Canadian Space Agency form the primary partners responsible for the coordinating the requests for satellite imagery for emergency management and, depending on the source of the request and type of request being made, the Canada Centre for Mapping and Earth Observation (CCMEO) and the Canadian Ice Service (CIS) will be involved in the provision of imagery and associated products.

The latest version of the Plan is available upon request from the Government Operations Centre.

3.1.8.2 DND-P/T Memorandum of Understanding

Under the auspices of the Canadian Council on Geomatics (CCOG), and as a proposed annex to the Geomatics Accord 2014, DND is leading development (at time of writing) of a MOU between DND and the Provinces and Territories concerning 'Cooperation in the Field of Geospatial Information/Data Sharing.' It is expected that geospatial information and data including maps, air photos, remotely-sensed images, geodetic, survey, gravimetric and other geomatics as well as geoscience data and related products in both digital and/or hardcopy formats will be able to be exchanged in order to support national defence and security, emergency preparedness incidents and response to man-made or natural disasters.

Given future progress on this activity, provincial and territorial contacts for public safety and geomatics should be added to this GeoCONOPS document.

3.1.8.3 NRCan Emergency Geomatics Service SOP

Formal requests from other departments are received by the NRCan Departmental Emergency Operation Centre (DEOC) on a 24/7 basis. This request is then communicated to NRCan/Earth Sciences Sector (ESS)/Canadian Hazard Information Service (CHIS) and Canada Centre for Mapping and Earth Observation (CCMEO), who coordinate access to current geospatial information and maps, including satellite imagery either using data from an archive or through acquisition and processing from available satellite systems operated by Canada or other countries. It is important to note that the coordination of Radarsat-2 acquisition is performed by Public Safety Canada, Government Operations Centre, who also activates the International Charter on Space and Major Disasters (http://www.disasterscharter.org/web/charter/members).

Various geospatial processes may be initiated, including extent mapping, change detection, spatial feature extraction and the production of custom maps. Appropriate digital geospatial information products are made available on-line to Public Safety Canada (PS), the Department of National Defence (DND), and various Provincial, Territorial and International agencies involved in emergency response. The SOP is an internal tactical document, available to EGS clients upon request.

3.1.8.4 OCIP Business Process Concept of Operations

For authorized account holders on OCIP, the OCIP CONOPS outlines the people, processes, infrastructure and software required to provide the information technology system to all Member Organizations who operate Operations Centres and wish to share information amongst them.

3.1.8.5 MASAS-X SOP & Acceptable Use Policy

For authorized account holders of MASAS-X, an Acceptable Use Policy and SOP is available that outlines considerations for account information, access rights, training, exercising, user roles, appropriate use, privacy considerations, data retention, restricted content, and much more. (www.masas-x.ca)

4 CANADIAN EMERGENCY MANAGEMENT FRAMEWORK

4.0 Overview

The local government (e.g., municipality) directly affected by an incident has the initial authority and responsibility for responding to emergencies and hazards. However, the magnitude or characteristics of the EM response may necessitate additional or specialized resources. In these situations, provincial and/or federal EM resources can be activated upon request or when the nature of the emergency clearly falls under the provincial or federal jurisdiction.

In Canada, the federal response to emergencies is guided by the Emergency Management Act6 which provides roles and responsibilities for federal Ministers, enhances collaboration and improves information sharing across the three levels of government (federal, provincial/territorial, and municipal), as well as between the government and non-governmental organizations, including the private sector. The fundamental goals of the information sharing component are to facilitate the ability to assess threats and vulnerabilities, improve warning and reporting capabilities and develop better mitigation strategies and responses to potential emergencies. A further intent of the EMA is to strengthen the federal government's readiness to respond to all-hazards events that create major emergencies and that have the capacity to affect the safety and security of Canadians. The EMA mandates that all Canadian federal government departments are responsible for establishing an all-hazards EM process that can be activated in response to national emergencies.

According to the EMA, Ministers are required to identify the risks that fall within their departmental mandates (e.g., those with the potential to impact critical infrastructure) and to do the following tasks:

- Prepare emergency management plans in respect of those risks;
- Maintain, test and implement those plans; and
- Conduct exercises and training in relation to those plans.

Whereas the EMA provides guidance to federal departments concerning their roles and responsibilities, there are numerous companion documents that operationalize each phase of the EM framework (refer to Section 6.2.2). Most notably, the Federal Emergency Response Plan (FERP) articulates the federal emergency response and provides the EM structure, framework and concept of operations for coordinating the federal response activities. Once the FERP has been invoked the federal departments are responsible for ensuring that their EM processes are activated, as appropriate, and prepared to respond to the emergency. The FERP structure designates federal agency responsibilities according to a set of ESFs intended to reflect the complex nature of federal departmental emergencies. The FERP identifies thirteen ESFs; each ESF points to the competencies of a specific federal department to lead the federal coordinated response.

The following sections articulate the pertinent aspects of the Canadian EM framework to provide an understanding not only of the operational environment but also where and how geospatial data is currently be employed to support operations. Moreover, this understanding of the Canadian EM landscape helps to also identify those areas whereby geospatial data could be leveraged further.

4.1 Canadian EM Command and Control (OV-2)

Figure 4-1 provides an inter-departmental view of the EM structure in the event that an incident spans the jurisdiction of the multiple government levels and multiple departments.

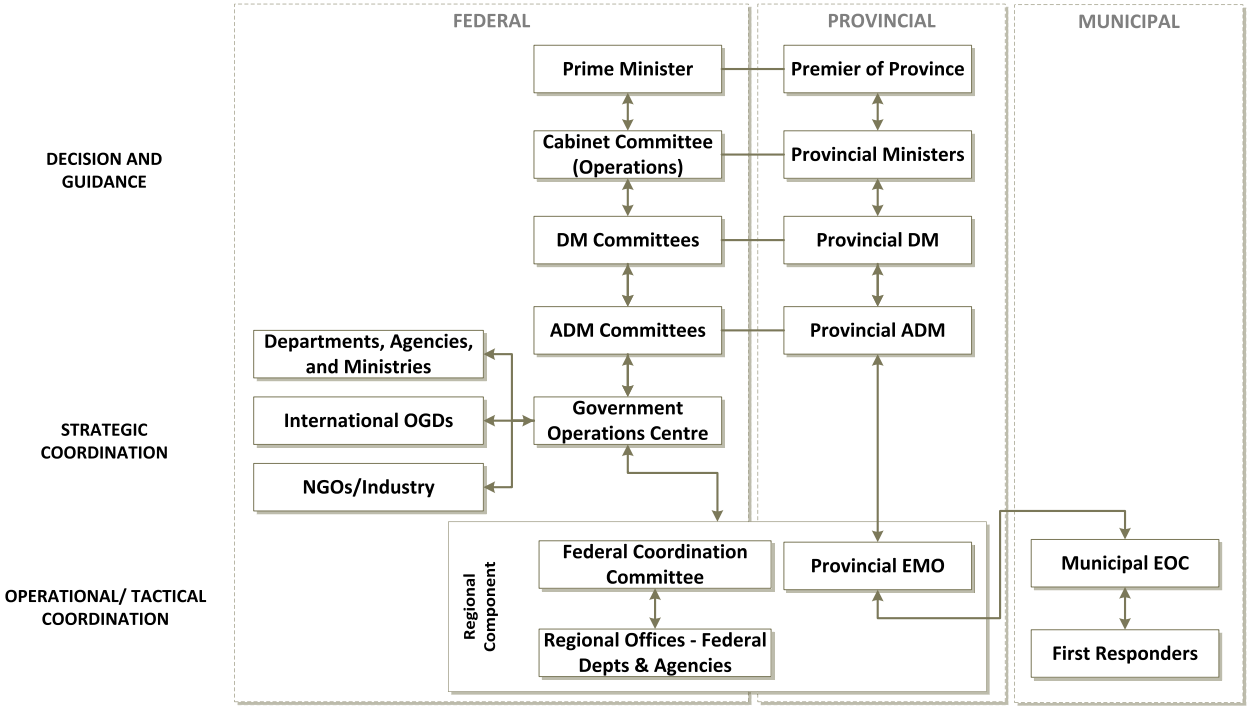


Figure 4-1: EM Inter-Departmental View

Of significance, the OV-2 depicts both the vertical and horizontal information exchanges. Within each level of government, there exists a governance structure whereby vertical exchange of information can be generally characterized as direction flowing downwards from decision makers and situation updates flowing upwards to support the decision makers. In the event of incidents spanning multiple levels of government, information is exchanged between departments in order to coordinate a whole of government response.

4.1.1 Federal Level

At the federal level within the Canadian EM framework, a clear governance structure is defined within existing EM documentation [13]. The following sections provide an overview of these organizations.

4.1.1.1 Decision and Guidance

Decision and guidance follows a governance path from the Prime Minister through the following committees:

1. **Cabinet Committee** provided day-to-day coordination of the federal government's agenda with respect to issue management, legislation and house planning, and communications. In the event of a major incident, this will be the governing body authorizing major decision.

2. **Deputy Minister (DM) Committee**, chaired by the Federal Coordination Officer (typically the DM PS), is the coordinating body for the federal government's response and is responsible for providing advice as well as situation awareness (SA) to the ministers.

3. **Assistant Deputy Minister (ADM) Committees** consist of the ADM Emergency Management Committee (EMC) and the ADM National Security Operations (NS Ops). Co-chaired by a PS ADM and an OGD ADM, these committees support the FCO, coordinate and recommend options to DM EMC and Cabinet operations, as well as coordinate recovery or long-term management of some issues.

4. **Director General (DG) Community**, chaired by the DG GOC, provides leadership and direction to the federal departments and agencies including confirming risk analysis, providing planning guidance, approving concepts of operations and informing higher-level authorities of issues.

4.1.1.2 Strategic Coordination

Within the Canadian federal government, there are numerous departments, agencies, and organizations pertinent to the EM infrastructure. Ultimately, the scope of an emergency will dictate the role of federal government institutions. Participating emergency operation centers (EOCs) will play the role as Primary Lead Department (PLD) or Support Department (SD) to the federal level PLD. These relationships within the Canadian emergency response framework at the federal level are guided by the FERP and departmental mandates. As per the FERP [13], the roles of the primary, supporting and coordinating departments are outlined below:

1. A **primary department** is a "federal government institution with a mandate related to a key element of an emergency". Multiple federal government institutions may be designated as primary departments if the nature of the emergency necessitates a response of this nature.

2. A **supporting department** is a "federal government institution that provides general or specialized assistance to a primary department in response to an emergency".

3. Public Safety Canada is designated as the federal **coordinating department** based on the Emergency Management Act. As such, Public Safety Canada is responsible for engaging those federal government institutions relevant to the emergency at hand.

As documented in the FERP [13], functions most commonly used in providing federal support to provinces and territories or federal-to-federal assistance in response to a request for assistance during an emergency are grouped into thirteen emergency support functions (ESFs). As presented in Table 4-1, ESFs are allocated to federal government institutions in a manner consistent with their mandated areas of responsibility. These ESFs are used to augment and support the primary federal government department, assist provincial/territorial governments or to support the Government Operations Centre (GOC) in coordinating a whole of government response to an emergency.

Table 4-1: FERP Emergency Support Functions

#	Emergency Support Function	Minister(s) with Primary Responsibility
1	Transportation	Transport Canada

#	Emergency Support Function	Minister(s) with Primary Responsibility
2	Telecommunication	Industry Canada
3	Agriculture and Agri-Food	Agriculture and Agri-Food Canada Canadian Food Inspection Agency
4	Energy Production and Distribution	Natural Resources Canada
5	Public Health and Essential Human Services	Health Portfolio, Public Health Agency of Canada and Health Canada
6	Environment	Environment Canada
7	Human and Social Services	Human Resources and Skills Development Canada
8	Law Enforcement	Royal Canadian Mounted Police
9	International Coordination	Department of Foreign Affairs and International Trade Canada
10	Government Services	Public Works and Government Services Canada
11	Logistics Operations Management	Public Safety Canada, Operations Directorate
12	Communication	Public Safety Canada, Communications Directorate
13	Border Services	Canada Border Services Agency

The following sections provide an overview of these organizations with a particular focus on PS Canada which acts the coordinating department for incidents requiring coordination across multiple organizations.

4.1.1.2.1 Public Safety Canada

As the coordination department, Public Safety Canada has a distinct role when dealing with domestic emergencies and incidents. PS Canada fulfills the government role to secure the public's safety and security by minimizing a continuum of risks to Canadians. Public Safety Canada provides expertise in operations, situational awareness, risk assessment, planning, logistics, and finance and administration relevant to its coordination role. During escalation of the FERP [13], other federal government institutions provide support to these areas.

Due to the complex nature and interdependencies associated with responses to large-scale emergencies, command and control for federal EM responses will span organizational structures. PS Canada houses the Government Operations Centre (GOC) which provides strategic level coordination and direction on behalf of the Government of Canada in response to an imminent or real emergency situation. Information handled by the GOC is verified, analyzed and distributed to the appropriate response organizations (e.g., federal EOCs) via operational links. Effective incident management requires an ability to share planning assumptions and develop shared situation awareness. Each department has extensive critical information (geospatial) requirements that must be satisfied to support collaborative planning and effective coordination of the emergency response. If necessary, the GOC can serve as the focal point for emergency government operations, as well as help officials from other departments and agencies analyze and respond to emergency situations. It coordinates the response to help provincial or territorial governments support their local authorities and first responders.

Furthermore, the ability of the EOCs to exchange information with other departmental EOCs is important to the overall success of an emergency response mission. To that end, reliable interoperability strengthens the collaboration and communication between federal EOCs.

4.1.1.2.2 ESF Organizations

In addition to Public Safety Canada, the remaining federal departments responsible for an ESF are presented in Table 4-2. For each department, an overview of the organizations is presented, as well as any pertinent EM documentation that is readily available via open sources. Specific, roles and responsibilities for these organizations as they pertain to their ESF are captured in Appendix A of the FERP [13].

Table 4-2: ESF Organizations

#	ESF	Primary	Description	Pertinent EM Documentation
1	Transportation	Transport Canada (TC)	TC is a primary department responsible for preventing and responding to emergencies that disrupt the national or regional transportation systems or to incidents involving the transportation of dangerous goods. Transport Canada makes contingency plans for, trains for, and responds to all emergencies that affect and/or require the support of any part of the national transportation system.	2012 Emergency Response Guidebook http://www.tc.gc.ca/eng/canutec/guide-menu-227.htm
2	Telecommunication	Industry Canada	Industry Canada is the federal government department responsible for continuity of telecommunications. In times of emergency, including cyber-attack, the facilitation of the rapid repair, replacement and expansion of telecommunications systems is Industry Canada's highest priority. Industry Canada's Emergency Telecommunications team develops best practices in emergency planning and foster important links within the telecommunications community. Through this collaboration, the team develops national programs, establishes mutual aid agreements and plans, and provide coordination assistance for emergency telecommunications in response to a crisis or disaster.	Emergency Telecommunications http://www.ic.gc.ca/eic/site/et-tdu.nsf/eng/wj00302.html

#	ESF	Primary	Description	Pertinent EM Documentation
3	Agriculture and Agri-Food	Agriculture/Agri-Food Canada (AAFC)	AAFC provides information, research and technology, and policies and programs to achieve security of the food system, health of the environment and innovation for growth.	None found
		Canadian Food Inspection Agency (CFIA)	CFIA ensures that Canadians have access to a continuous and secure supply of safe food by assessing food quality and inspecting commercial food products and manufacturers, and delivering quarantine services. CFIA also sets policy on, and monitors, plant and animal product imports to reduce the risk of disease and to sustain plant and animal health and safety.	CFIA Framework for Food Safety Investigation and Response (http://www.inspection.gc.ca/food/safe-food-production-systems/food-recall-and-emergency-response/framework/eng/1379341287419/1379343502268) Food Recall and Emergency Response (http://www.inspection.gc.ca/food/safe-food-production-systems/food-recall-and-emergency-response/eng/1300375639646/1300376138588)
4	Energy Production and Distribution	Natural Resources Canada	NRCan seeks to enhance the responsible development and use of Canada's natural resources and the competitiveness of Canada's natural resources products. They are an established leader in science and technology in the fields of energy, forests, and minerals and metals and use their expertise in earth sciences to build and maintain an up-to-date knowledge base of the Canadian landmass.	2012 Strategic Emergency Management Plan Emergency Management Plans (e.g., forest disturbances, space weather, geological hazards) Emergency Management Plan: Geomatics Support
5	Public Health and Essential Human Services	Public Health Agency of Canada (PHAC)	PHAC is responsible for protecting and promoting the health and safety for all Canadians. The Agency works closely with provinces and territories by keeping Canadians healthy by focusing on effective efforts such as preventing chronic diseases like cancer and heart disease, preventing injuries, and responding to public health emergencies.	Food-borne Illness Outbreak Response Protocol (FIORP) (http://www.phac-aspc.gc.ca/zoono/fiorp-mitioa/index-eng.php#toc5)

#	ESF	Primary	Description	Pertinent EM Documentation
		Health Canada	Health Canada is the lead federal department responsible for coordinating the response to a nuclear or radiological emergency under the Federal Nuclear Emergency Plan (FNEP). Health Canada partners with the United States to deal with a potential or actual radiological event that could affect both countries or be of a magnitude that assistance is required. Health Canada is also responsible for: •Providing emergency health care for First Nations and Inuit communities. •Implementing the Foodborne Illness Outbreak Response Protocol, in partnership with CFIA. •Decreasing the adverse health outcomes and economic losses associated with extreme events and reducing the impact of disasters and extreme weather at the local level through the Applied Research and Analysis Directorate. •Providing support and scientific expertise for chemical emergencies through the Chemical Emergency Response Unit.	Federal Nuclear Emergency Plan http://www.hc-sc.gc.ca/hc-ps/pubs/ed-ud/fnep-pfun-1/index-eng.php
6	Environment	Environment Canada	Within Environment Canada, the Environmental Emergencies Program's mission is to reduce the frequency and consequences of environmental emergencies involving the unplanned, uncontrolled or accidental release of hazardous substances, such as oils or chemicals.	Environmental Emergency Regulations http://www.ec.gc.ca/ee-ue/default.asp?lang=En&n=9605FFBD-1
7	Human and Social Services	Human Resources and Skills Development	ESDC's mission is to build a stronger and more competitive Canada, to support Canadians in making choices that help them live productive and rewarding lives, and to improve Canadians' quality of	None found

#	ESF	Primary	Description	Pertinent EM Documentation
		Canada	life.	
8	Law Enforcement	Royal Canadian Mounted Police	Provides advice on national safety and security policies, enforces Canadian laws, prevents crime, and maintains peace, order and security. In addition, the RCMP has responsibility to prevent, detect and investigate offences against federal statutes, maintain law and order and prevent, detect and investigate crime in the provinces, territories and municipalities where it has a policing contract. The RCMP also provides investigative and protective services to other federal departments and agencies; protects Canadian and foreign dignitaries and their official residences; and provides all Canadian law enforcement agencies with specialized police training and research, forensic laboratory services, identification services and informatics technology.	None found
9	International Coordination	Department of Foreign Affairs, Trade, and Development	The mandate of Foreign Affairs, Trade and Development Canada is to manage Canada's diplomatic and consular relations, to encourage the country's international trade and to lead Canada’s international development and humanitarian assistance.	None found
10	Government Services	Public Works and Government Services Canada	PWGSC has a number of responsibilities to support a national response, such as supporting emergency procurement if necessary and maintaining awareness of the status of federal infrastructure in any affected areas.	None found
11	Logistics Operations Management	Public Safety Canada	Refer to Section 4.1.1.2.1	Refer to Section 6.2.2
12	Communication	Public Safety	Public Safety Canada has the responsibility to coordinate and manage the public information	Refer to Section 6.2.20

#	ESF	Primary	Description	Pertinent EM Documentation
		Canada	requirements of any national emergency response.	
13	Border Services	Canada Border Services Agency	CBSA manages the nation's borders by administering domestic laws, international agreements, and conventions governing trade and travel. The Agency brings together all the major players involved in managing the movement of people and goods across our borders. It integrates customs functions, intelligence, enforcement functions and overseas interdiction, and food, plant and animal inspection at the border functions.	None found

4.1.1.2.3 Supporting EM Organizations

Additional federal organizations that do not have a formal role as the primary Department for an ESF but still relevant to the Canadian EM framework were also consulted. These organizations include the following:

- **Aboriginal Affairs and Northern Development Canada (AANDC).** AANDC supports emergency management that impact First Nation communities. Emergencies that most commonly impact First Nations are floods, fires, search and rescue, or community infrastructure failures (e.g., roads, bridges). (Refer to http://www.aadnc-aandc.gc.ca/eng/1309369889599/1309369935837 for EM related documentation),

- **Department of National Defence.** DND responds to requests for support as part of its responsibilities for the provision of assistance to the civil authorities in response to an event. This support has come in a variety of forms such as the provision of logistical support to air evacuation of remote northern communities during floods or forest fires to support to provinces during major Hurricanes.

- **National Search and Rescue Secretariat (NSS).** The NSS seeks to provide leadership to the National Search and Rescue (SAR) program. The National SAR Knowledge Management Information System is one way the NSS is trying to improve the national SAR system through facilitating improved information sharing.

Each one of these organizations provides a supporting role, depending on the nature of the incident, as per the FERP.

4.1.1.3 Operational/Tactical Coordination

At this level, federal departments rely on their regional offices for responding to the incident. These offices will provide direct on-site support to the provinces/territories while reaching back

to their federal counterparts for assistance as required, as well as providing situational updates that can in turn be passed along to the senior level decision makers.

4.1.2 Provincial/Territorial Level

Due to the diversity and vast number of existing provincial/territorial entities, these elements have not been decomposed in Figure 4-1 beyond their high-level relationships and aggregated organisational structure with respect to an incident response. As such, this generic framework is intended to be applicable to diverse geographical contexts.

Provincial Emergency Management Organizations (EMO) look to ensure the safety and security of individuals, their property and environment by providing for a prompt and coordinated response to an emergency. The precise composition and responsibilities of EMOs varies across different locales; however, there is typically a common infrastructure. Specifically, EMOs have EOCs which are a physical locations housing individuals with the expertise and authority to make decisions in relationship to their area of operation and authority in the event of a natural hazard. Examples include Nova Scotia's Joint Emergency Operations Centre and British Columbia's Provincial Emergency Coordination Centre.

4.1.3 Municipal Level

The organizational structure and relationships between municipal entities is conceptually consistent with the provincial/territorial level. Municipal agencies include Public Works and Utilities, Public Health and Community Services, and first responders (i.e., EMS, police and fire). The municipal entities have not been decomposed in Figure 4-1 due to the diversity and vast number of existing elements. Moreover, this generic framework is intended to be applicable to a diverse set of geographical contexts.

4.2 Objectives and Goals (OV-5a)

Figure 4-2 presents the EM goal hierarchy as defined through review of documentation and feedback from the interviews with EM stakeholders. This inventory illustrates the hierarchical relationship between child and parent goals. Goals in bold have been initially identified as candidate areas for geospatial support.

The four goals are in accordance with PS Canada's approach to EM and can be defined as follows:

1. **Prevention and Mitigation** looks to reduce the impacts, including financial, of disasters on Canadian communities. Public Safety Canada employs a risk-based and all-hazards approach when collaborating with provincial and territorial governments, and stakeholders to promote disaster prevention and mitigation. The National Disaster Mitigation Strategy which was introduced in 2008 provides guidance in this area.

2. **Emergency Preparedness** ensures the necessary precautions are in place and that long-term preparations are performed. This involves planning, organizing, training, equipping, exercising and evaluating – all efforts to reduce or eliminate risks and impacts; hence, creating conditions for successful response to emergencies. Specific activities include:

a. Developing contingency plans to identify potential threats and put in the place the required standard operating procedures (SOPs) to address these incidents should they arise;

b. Establishing a structure to manage the security such as infrastructure (i.e., command centers), personnel, command relationships, Memorandum of Understanding (MOUs), processes, and technology;

c. Adopting preventative measures to minimize the need to perform crisis management. A proactive stance is adopted by the EM community with the objective of maintaining an adequate level of situation awareness in order to anticipate or predict events; and

d. Integrating mandate-specific all-hazards risk assessment as the planning premise. The All-Hazards Risk Assessment (AHRA) will help identify, analyze and prioritize the full range of potential threats. The process takes into account vulnerabilities associated with specific threats, identifies potential consequences should a threat be realized, and considers means to mitigate the risks.

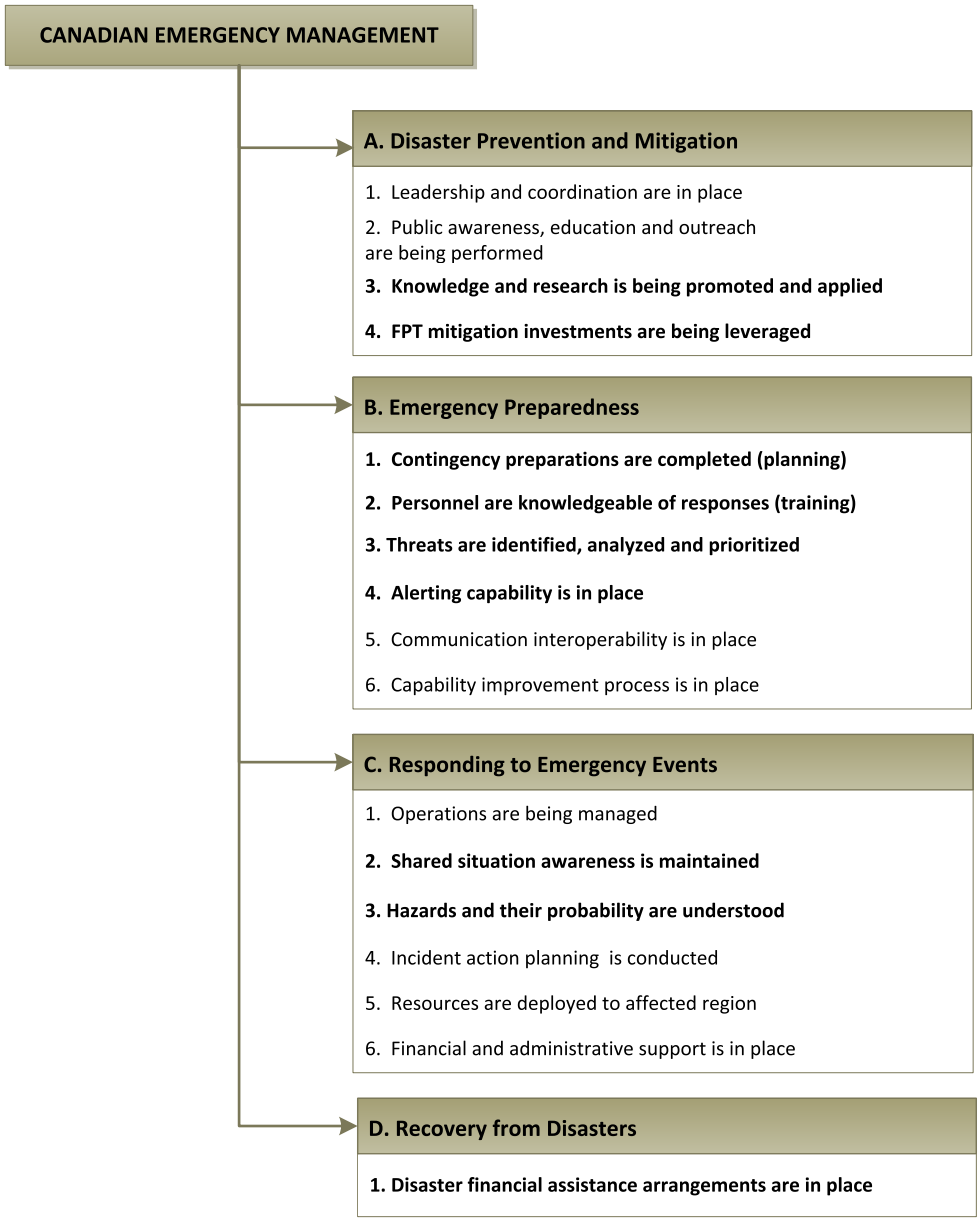


Figure 4-2: EM Objectives and Goals

3. **Responding to Emergency Events** involves those activities that are undertaken in the event of an emergency. The FERP provides guidance in this area. Emergencies are initially managed at the local level, but local authorities will seek assistance from the provinces and territories, if required. If the emergency escalates beyond their capabilities, the provinces or territories seek assistance from the federal government. The National Emergency Response System (NERS) was developed to facilitate a cross-jurisdictional response in this situation. The coordination and provisioning of resources can move quickly from the local to the national level, as required during an emergency. PS Canada's Regional Offices across the country serve as the Department's primary link to provincial and territorial emergency management counterparts, as well as federal departments in the region, to ensure a whole-of-government response.

4. **Recovery from Disasters** is required in the event of a large-scale natural disaster where response and recovery costs exceed what individual provinces and territories could reasonably be expected to bear on their own. Based on an assessment of damages, PS Canada provides financial assistance to the provincial and territorial governments through the Disaster Financial Assistance Arrangements (DFAA).

4.3 Processes (OV-5b)

The following sections provide an overview of the key references that guide the generation of the EM processes for achieving the goals that were presented in the previous section as part of the OV-5a architecture data product. To present the processes would be a significant undertaking as each organization will have its own distinct set of processes; however, they should follow the guidance presented herein.

4.3.1 Disaster Prevention and Mitigation

All levels of Canadian governments worked together to develop this National Disaster Mitigation Strategy (NDMS) for Canada [8]. The NDMS supports all-hazards emergency management, with a focus on reducing the risks associated with natural hazards. Mitigation actions include all structural and non-structural risk treatments appropriate to hazards, and leverage or incorporate new, existing and developing disaster risk reduction programs. Finally, the Strategy acknowledges that disaster mitigation includes measures enacted at the local government level, which are critical to creating safe, secure and prosperous communities across Canada.

The goal of the NDMS is: *To protect lives and maintain resilient, sustainable communities by fostering disaster risk reduction as a way of life.* The following principles reflect how this goal should be developed:

- Preserve Life – Protect lives through prevention.
- Safeguard Communities – Enhance economic and social viability by reducing disaster impacts.
- Fairness – Consider equity and consistency in implementation.
- Sustainable – Balance long-term economic, social and environmental considerations.
- Flexible – Be responsive to regional, local, national and international perspectives.
- Shared – Ensure shared ownership and accountability through partnership and collaboration.

The proposed Strategy will establish ongoing national disaster mitigation program activity areas. Implementation of program activities will be structured around four key elements:

- Leadership and Coordination;
- Public Awareness, Education and Outreach;
- Knowledge and Research; and

- Federal/Provincial/Territorial Cost-Shared Mitigation Investments.

4.3.2 Emergency Preparedness

Public Safety Canada developed the Emergency Management Planning Guide [9] to assist all federal government institutions in developing their all-hazards Strategic Emergency Management Plans (SEMP). A SEMP establishes a federal government institution's objectives, approach and structure for protecting Canadians and Canada from threats and hazards in their areas of responsibility and sets out how the institution will assist the coordinated federal emergency response. EM plans, such as the SEMP, represent an institution's planning associated with its "external" environment. Business continuity plans (BCPs), by contrast, represent an institution's planning associated with its "internal" efforts to ensure the continued availability of critical services to Canadians in the event of an incident/emergency affecting the organization. Despite this general distinction, EM planning and business continuity planning are complementary.

The qualifier "strategic" is used to differentiate this high-level plan from other types of emergency management plans, including operational plans. Many federal government institutions already have specific planning documents or processes to deal with aspects of emergency management that relate to their particular mandates; many also have a long track record of preparing and refining BCPs. The development and employment of a SEMP is an important complement to such existing plans, because it promotes an integrated and coordinated approach to emergency management planning within federal institutions and across the federal government. To promote a more uniform structure and approach across federal government institutions, these existing plans, procedures and internal processes are to be assessed, and modified or adapted as required, in order to take this Guide into account and to incorporate other resources such as the FERP (e.g., emergency support functions) and other policy documents.

4.3.3 Responding to Emergency Events

The Emergency Management Act [6] defines emergency management as the prevention and mitigation of, preparedness for, response to, and recovery from emergencies. Under the Emergency Management Act, the Minister of Public Safety is responsible for coordinating the Government of Canada's response to an emergency. The FERP is the Government of Canada's "all-hazards" response plan and was developed by Public Safety Canada in consultation with federal government institutions. Federal government institutions are responsible for developing emergency management plans in relation to risks in their areas of responsibility in accordance with processes and mechanisms outlined in the FERP. To that end, individual departmental procedures and plans collectively support the strategic objectives outlined in the FERP and therefore contribute to an enterprise Government of Canada response.

4.3.4 Recovery from Disasters

The Government of Canada supports the efforts of communities to recover from the tragic consequences resulting from emergencies. Public Safety Canada provides financial assistance to provincial and territorial governments through the DFAA, in the event of a large-scale natural disaster where response and recovery costs exceed what individual provinces and territories could reasonably be expected to handle on their own. The DFAA guidelines provide details on provincial and territorial disaster expenses that are eligible for federal cost-sharing.

4.4 Information Requirements (OV-3)

Based on the earthquake scenario, numerous essential elements of information (EEI) have been identified to support the EM response activities. In turn, these EEIs have been mapped to the ESF and department that would require this information. Note, all of these EEIs have a geospatial component.

Table 4-3: Earthquake EEIs[4]

	Essential Elements of Information	ESF	Department
1	Effected Area	All	
2	Access to Effected Area	ESF 1 ESF 11	Transport Canada Public Safety Canada, Operations Directorate
3	Jurisdictional Boundaries	ESF 11	Public Safety Canada, Operations Directorate
4	Hazard specific information and Predictive Modeling	ESF 4 ESF6	Natural Resources Canada Environment Canada
5	Status of Critical Infrastructure	ESF 10	Natural Resources Canada
6	Casualties	ESF 5 ESF 11	Health Portfolio Public Safety Canada, Operations Directorate
7	Displaced Population	ESF 11	Public Safety Canada, Operations Directorate
8	Shelter Requirements	ESF 11	Public Safety Canada, Operations Directorate
9	Structure Damage	ESF 11	Public Safety Canada, Operations Directorate
10	Essential Facilities	All	
11	Transportation System Damage	ESF 1 ESF 11	Transport Canada Public Safety Canada, Operations Directorate
12	Water and Power Outages	ESF 4	Natural Resources Canada
13	Weather	ESF 6 ESF 11	Environment Canada Public Safety Canada, Operations Directorate
14	Demographics	ESF 7	Human Resources and Skills Development Canada
15	Damage Assessments	All	
16	Telecommunication Status	ESF 2	Industry Canada
17	Status of Provincial Response	ESF 11	Public Safety Canada, Operations Directorate
18	Status of Federal Facilities and Employees in Region	ESF 10	

[4] Table structure was taken from Department of Homeland Security (DHS) Homeland Security Geospatial Concept of Operations (GeoCONOPS) Version5.0 June 2013. Since the ESFs in the US and Canada are slightly different, the table was modified and made more relevant to a federal response in Canada.

4.5 Systems (SV-1)

The previous sections presented the operational activities performed in EM and the responsible operational nodes that perform them. Systems and Services Views facilitate identifying the systems (and services) components used by operational nodes to perform those activities. The SV architecture data products describe systems and interconnections providing for, or supporting, functions. SV products focus on specific physical systems with specific physical (geographical) locations. The relationship between architecture data elements across the SV to the OV can be exemplified as systems that are procured and fielded to support organizations and their operation.

The Systems Interface Description (SV-1) is presented in the following section.

4.5.1 Information Sharing

Figure 4-3 depicts the information exchange mechanisms and primary applications that the EM community relies upon for incident management activities. It was determined through the interviews that information sharing between multiple entities involved in response to a security incident is not optimized. Most of the communication between federal organizations relies on standard methods such as e-mail and telephone. Organizations are beginning to leverage tools, such as OCIP and MASAS, to support the timely and accurate exchange of information. However, these tools have not been uniformly applied across government departments.

Recent experimentation and technology demonstrations (i.e. CAUSE Resiliency Experiment Series) have recognized that the adoption of technology is likely to shift the reliance from voice/e-mail communications to information exchanges facilitated through integrated SA tools. Although certain decisions will never be made in isolation, the speed for integrating information relevant to them can be dramatically reduced. This acceleration of process will include the initial notification of the event as well as the coordination of responses throughout the duration of the event. Therefore, updates to the technology system should accommodate these anticipated changes in use. (http://www.science.gc.ca/default.asp?lang=En&n=443E9A35-1&offset=4&toc=show).

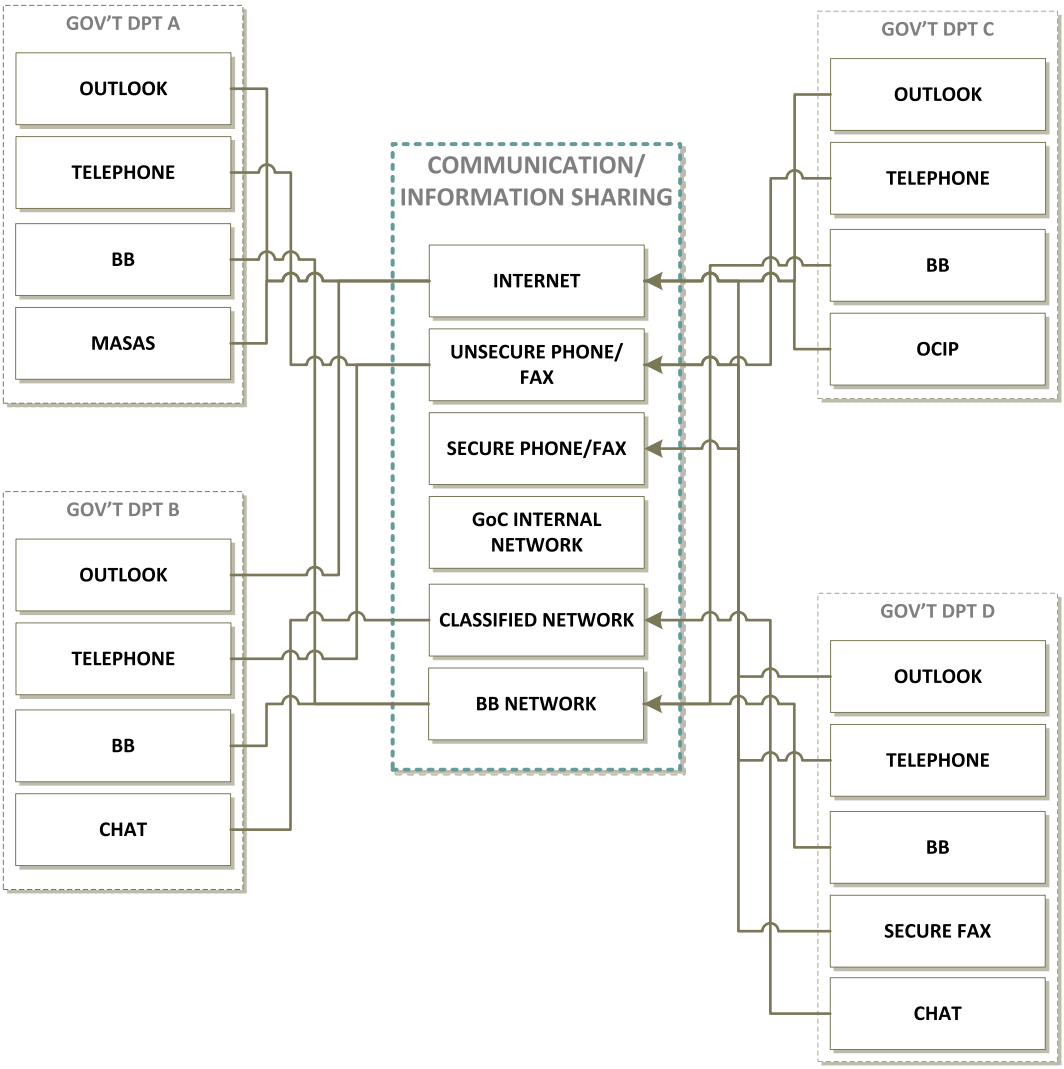


Figure 4-3: EM Systems for Information Exchange

Decision support aids include software applications to log and monitor incidents, and to task and monitor execution. Many key stakeholders also have mature command and control (C2) systems to exploit. To promote and improve interoperable voice and data communications within the EM community, PS Canada has a series of initiatives under the Communications Interoperability Strategy for Canada [12] and the Communications Interoperability Action Plan [18]. These include tools such as Operations Centres Interconnectivity Portal and Multi-Agency Situational Awareness System.

Operations Centres Interconnectivity Portal (Figure 4-4) is a Microsoft SharePoint application that allows Federal Emergency Operating Centres to improve the management of incident/special event-related information by facilitating the immediate sharing and accessing of incident data and thereby improving situational awareness. To that end, the application is intended to support the following activities:

- Identification of threats, hazards, incidents, emergencies, or disasters affecting mandates at the federal level;

- Development and maintenance of shared awareness of threats, hazards, incidents, emergencies, or disasters affecting departmental mandates;

- Facilitation of coordination and communication between key stakeholders engaged with responding to incidents; and

- Implementation of emergency plans.

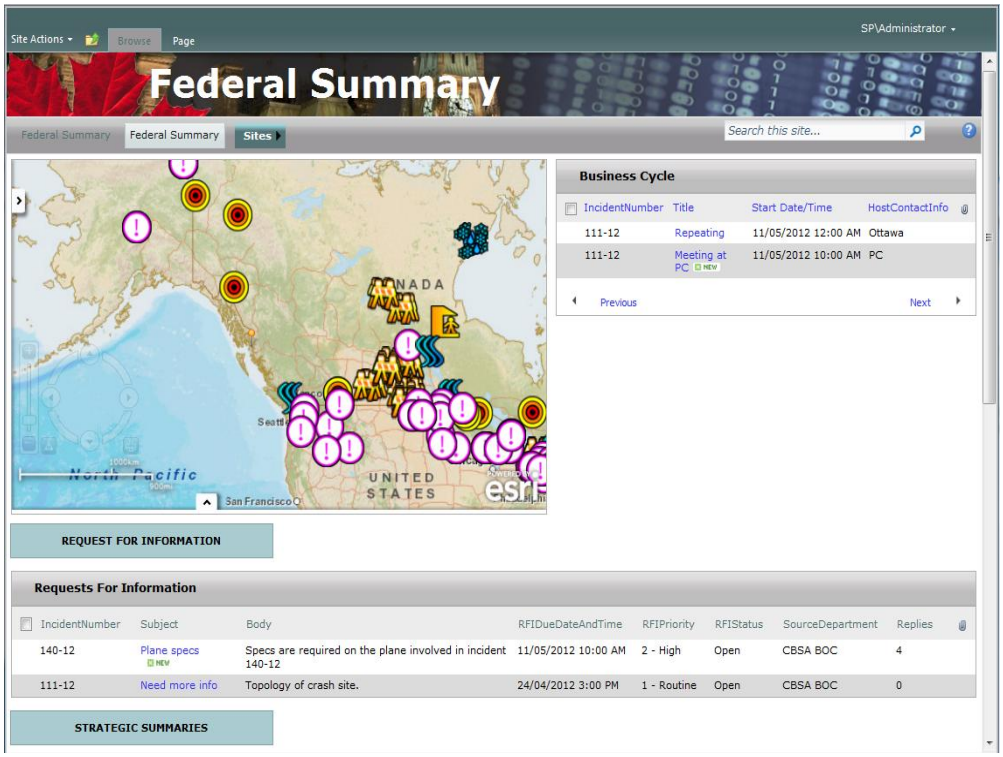


Figure 4-4: OCIP

The Multi-Agency Situational Awareness System (https://www.masas-x.ca/en/) is a system that 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 (Figure 4-5). MASAS-X at its core is a server-based, non-visible system that supports a graphical user interface, such as Javascript and Flex viewers, mobile applications and interfaces with commercial-off-the-shelf crisis management and alerting tools.

Information shared includes alerts for current and forecasted weather, road closures, natural hazard alerts, wildfire perimeters, search and rescue activities, and pandemics. Moreover, MASAS also supports the exchange of documents, pictures, audio and video files as well as geospatial products such as situation reports associated with a specific alert or incident. The application employs open standards and an open architecture to facilitate its adoption by the larger Canadian EM community. MASAS-X is only populated with unclassified authoritative information and is accessible only by authorized public safety officials. Therefore, it will not include information that is deemed to be unsuitable for widespread sharing.

The MASAS initiative is led by the Defence Research and Development – Center for Security Science, PS Canada and NRCan.

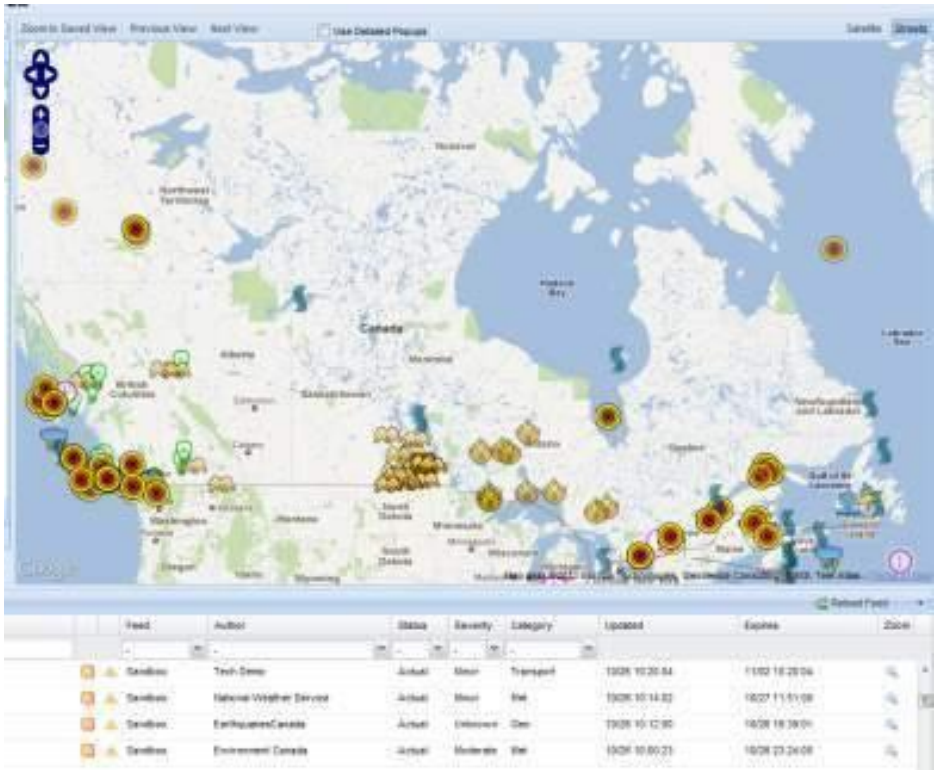


Figure 4-5: MASAS

These tools primarily support the federal government operations centres. OCIP has greatly improved and streamlined the information exchange between Operations Centres; however, OCIP was not specifically designed to facilitate geomatics information sharing. Rather, MASAS provides the exchange of operational information through the use of operational and geomatics standards and feeds into OCIP.

5 CONCEPT OF OPERATIONS

In combination with previous sections, this section is intended to outline basic concepts and common practices for effective and efficient enterprise-level geospatial support to emergency management operations.

The Recommendations section suggests areas for further development of this concept of operations.

5.0.1 Alignment with Canadian EM Framework and FERP

The Emergency Management Framework for Canada and the Federal Emergency Response Plan establish a CONOPS for a comprehensive, all-hazards approach to incident management within the Federal government. The key principles, roles, and structures that organize the Canadian EM community are defined. Moreover, it describes how all participating entities (e.g., all levels of government, private sector, and non-government organizations) apply these principles for a coordinated, effective national response.

The geospatial CONOPS documented herein aligns to the Canadian EM framework including the emergency support functions (ESF) outlined in the FERP and other support elements through the depiction of geospatial information required to provide key mission support. The alignment of the geospatial CONOPS to the Canadian EM framework can be used to support geospatial information and communication management during an incident in the following manners:

- **Preparedness and Planning.** The CONOPS supports preparation and planning by providing an understanding of geospatial data that can be used to assist the development of risk assessments, mitigation strategies, and response and recovery protocols.

- **Coordination.** By identifying authoritative sources, the CONOPS can assist in reducing duplication of efforts in the collection, production, and exploitation of geospatial data.

- **Standardized Approach.** The CONOPS provides a venue for sharing information related to planning, training, and development of policies and standard operating procedures. In other words, the CONOPS could support a standardized way of using geomatics for EM within the Canadian federal government.

5.0.2 Target users of geospatial data

The GeoCONOPS and any approaches for facilitating the exchange of geospatial data, information, and knowledge must satisfy the unique needs for three different user populations:

1. **Policy Users.** The objective of the Federal Policy for Emergency Management is: “To promote an integrated and resilient whole-of-government approach to emergency management planning, which includes better prevention/mitigation of, preparedness for, response to, and recovery from emergencies” [20]. Those officially charged with developing policy need access to hazard information which is geospatially enabled to conduct risk assessments, which in turn will support the development of emergency plans and arrangements.

2. **Operational Users.** Use geospatial products to support their decision making with respect to understanding the incident; and therefore, to assist in managing the activities of their organization. Currently, the users of this type in the federal government rely on geo-technicians to produce map products for risk assessment and situational awareness.

3. **Geomatics Users.** They need to the ability to discover data and information and the ability to extract that data and use it and view it in their own systems. A simple viewer is not sufficient for the geo-technicians as they need to extract data discovered and bring that system to their desktop GIS. They also require an environment to share the results of their geo-analysis. This will support other Geomatics users in other organizations and potentially reduce duplication of effort.

5.1 Strategic Objectives

The ability for stakeholders to effectively exploit geospatial data, information, and knowledge should be facilitated. Moreover, any concept of operations should address some of the key challenges within the geospatial and EM communities as identified from the literature review and interviews. The following strategic objectives highlight opportunities to facilitate effective geospatial data exploitation:

1. **Access to open data.** Improved, seamless access to open, freely available, easily accessible Canada-wide authoritative geospatial data sets.

2. **Data discovery.** Facilitate the discovery of relevant geospatial data and knowledge by ensuring that all stakeholders are aware of what foundational and other geospatial data is available for re-use.

3. **Sharing of tools and techniques.** In addition to facilitating the exchange of data, enable the sharing of geospatial tools and techniques (i.e. tradecraft).

4. **Common foundational data.** Promote the use of single authoritative sources for the provision of accurate foundational and thematic data. By ensuring consistency in the origin of the source data helps to ensure consistency in products being subsequently generated or derived. In turn, recommend that the data be defined and maintained by the organizations closest to the source.

5. **Provide a visible list of authoritative sources.** Provide visibility and understanding of ‘knowing where to go to the get the data’.

6. **Support all user types.** Support the assortment of consumers (e.g., policy, operational, geomatics) employing geospatial data for their own specific purposes.

7. **Reduce duplication of effort.** Avoid the duplication present in the acquisition and collection of new geospatial data by coordinating efforts through FCGEO initiatives.

8. **Incorporation of new data or information feeds.** Make the most effective use of “new” social media feeds to improve the coverage, currency, accuracy and quality of core data and to establish the mechanisms to integrate these feeds with traditional geospatial feeds. A

design of the Canadian framework must allow easy integration of future new data types and services.

9. **Unified view of the world.** Provide a common, current map based on access to authoritative data. Having a (near) real-time product to display geospatial information as it pertains to the unfolding incident is more informative for senior management as opposed to a static map.

10. **Interoperability with existing systems.** Systems should be compatible to support the exchange of information with existing EM tools, such as OCIP and MASAS. For example, provide the authoritative source for OCIP and MASAS base maps.

5.2 Concepts

5.2.1 Overview

Based on the guidelines stipulated in the previous section, a concept of operations for the management of geospatial data for the EM community is presented in Figure 5-1. This diagram is intended to provide a high-level overview of the functional areas that require accommodation in a 'to be' geospatial architecture in order to address the needs of the EM community. The subsequent sections provide a more detailed discussion of each of the functional areas.

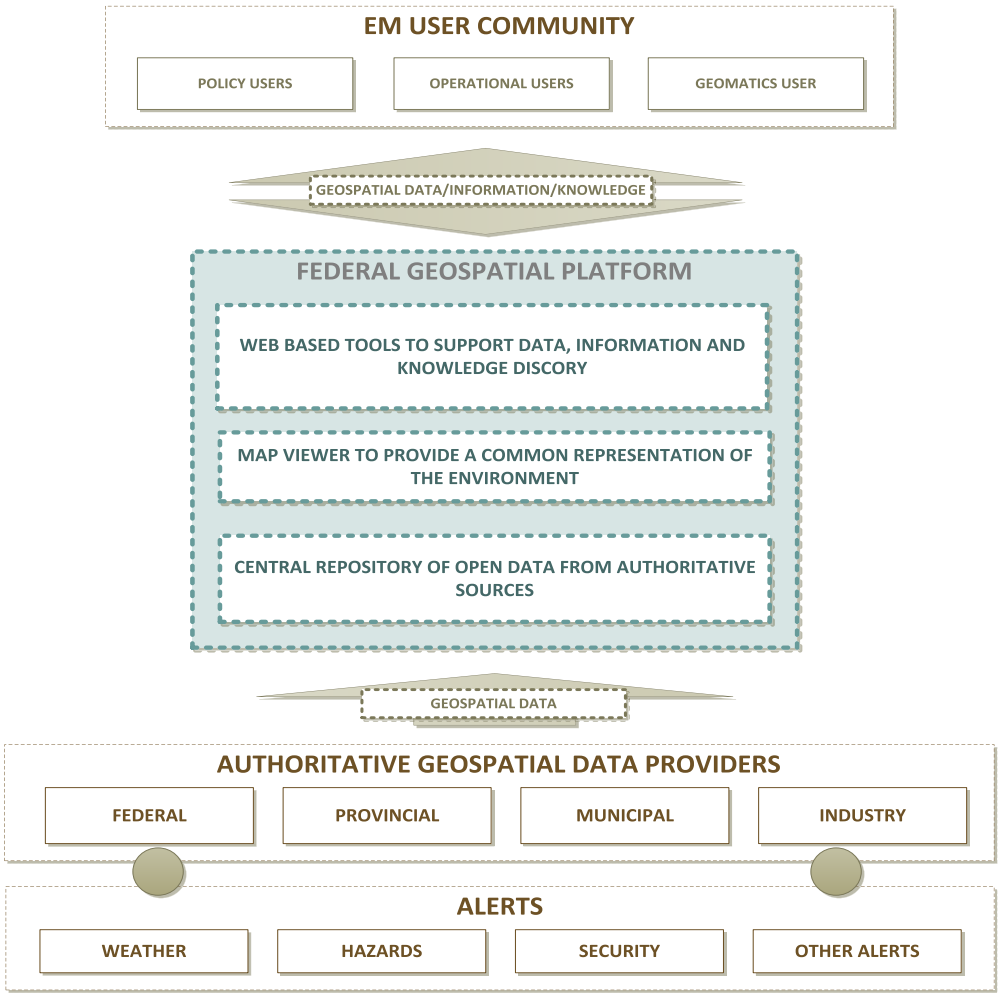


Figure 5-1: Concept of Operations

5.2.2 Interoperable Web Services

With the intent of increasing access to geospatial information and promoting interoperability to form a common operating picture, web services and standards are to facilitate the sharing of this type of data. These include the data portals, specifications and standards outlined in Section 3. The challenge with these tools and services is that they currently do not meet the needs of each user type (i.e., policy, operational or geomatics) of the Federal EM Community.

Future 'to be' architecture, such as that promoted by the FGP, offers an opportunity to use all of these portals and knowledge in a practical way to enable the EM community in the Government of Canada. In accordance with the aforementioned requirements, geospatial web services will facilitate the following:

1. Discovery through the provision of search services to find geospatial data, information, knowledge, and services;

2. Visualization of geospatial data and products;

3. Access to most up-to-date data directly from the authoritative source responsible for ensuring its currency and accuracy; and

4. Immediate access to the geospatial data without having delays associated with factors, such as processing orders, and converting data to a specific GIS format.

As such, web services will range from requests for an image of a map to information regarding a specific location. Web services enable interoperability, thereby allowing various systems to exchange geospatial data. Applying OGC specifications, for example, will facilitate interoperability of this nature.

5.2.3 Common Foundation Map

A single common view of the world through a map viewer would ensure that all EM stakeholders are working from a unified starting point. Currently, there are a number of base maps being used by the EM community in the Government of Canada that come from different sources. Based on the Essential Elements of Information outlined in Section 4.4, it is understood that different departments will produce different products and services which are in line with their respective mandates. However, the base map should provide a common reference base. This not only applies to map products but also for the map bases of command and control software tools. The Cross Border Infrastructure Plan is the initial starting point for this foundation.

5.2.4 Common View

Likewise, for visualization of real-time events and phenomena, EM practitioners should use a common taxonomy and set of symbols (i.e. EM Symbology, Section 3.1.5.1) to portray information and promote a common understanding of emergency events, operations and infrastructure.

5.2.5 Shared Data

Based on the requirements defined in the previous section, Figure 5-2 represents a conceptual view with respect to facilitation of sharing and disseminating geospatial information within the Canadian context. All geospatial data, information, and knowledge would be housed in one or more central repositories in order to provide visibility into available content that can be reusable for the individual departmental objectives. This would provide a common framework from which individual consumers can base their decisions with the aim of reducing duplication of effort and increasing efficiency of data discovery.

The mechanisms to enable this approach to shared data include the operational policies, SOPs and standards outlined in Section 3.

5.2.6 Information Exchange

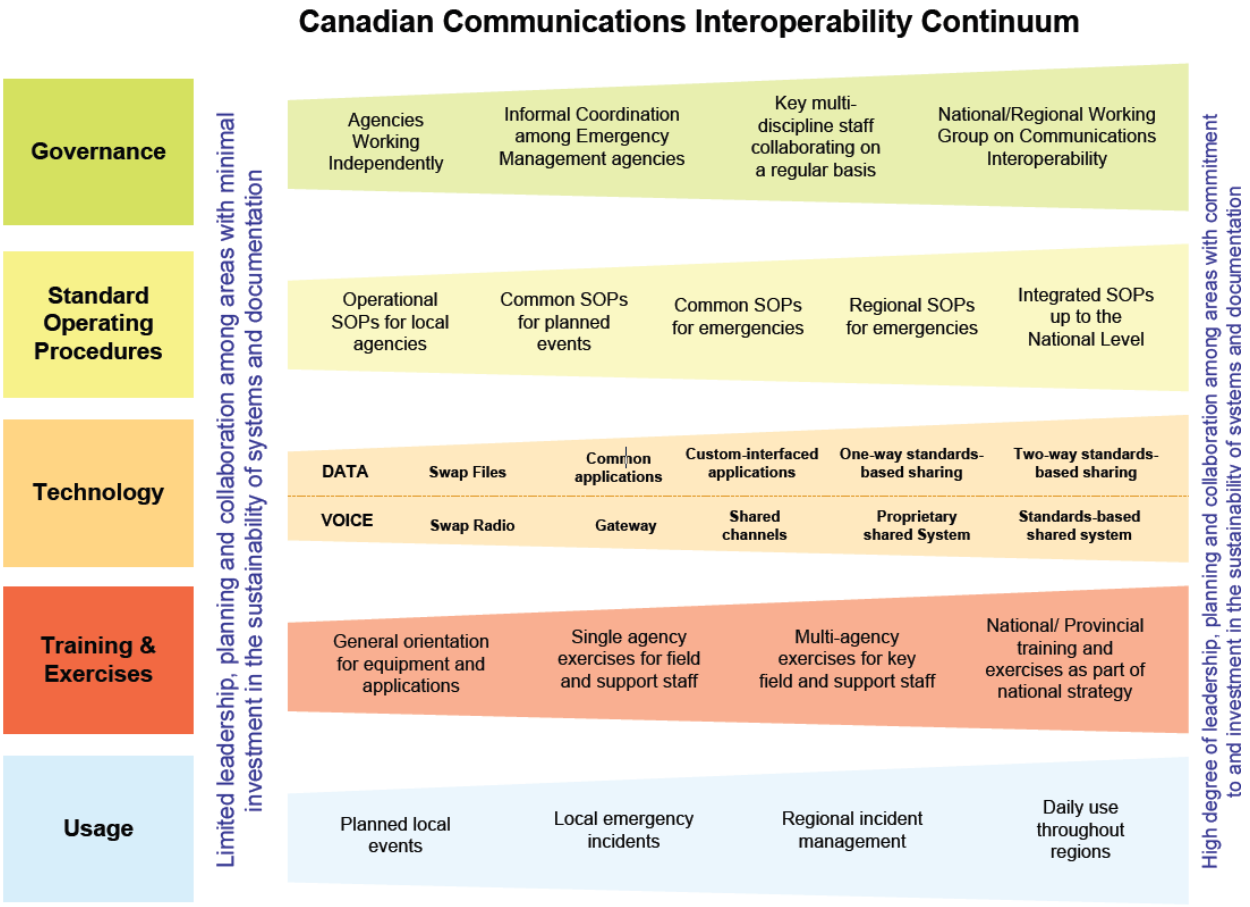
At the Federal level, MASAS will serve as the authoritative data 'pipeline' for real-time alerts and event reporting. Client viewers and systems (e.g. OCIP) will hook into MASAS to enable a common operating picture for situational awareness across the Government of Canada.

5.2.7 Governance and Coordination

Coordination of geospatial data across the TCPED process will occur under the auspices of FCGEO and the CANUS IWG.

5.2.8 Interoperability Assessment

The Canadian Interoperability Continuum can be used as a means of suggested action items and criteria for measuring capability improvements in the geospatial for EM community.


Canadian Communications Interoperability Continuum
Governance
Standard Operating Procedures
Technology
Training & Exercises
Usage
Limited leadership, planning and collaboration among areas with minimal investment in the sustainability of systems and documentation
Agencies Working Independently
Informal Coordination among Emergency Management agencies
Key multi-discipline staff collaborating on a regular basis
National/Regional Working Group on Communications Interoperability
Operational SOPs for local agencies
Common SOPs for planned events
Common SOPs for emergencies
Regional SOPs for emergencies
Integrated SOPs up to the National Level
DATA
Swap Files
Common applications
Custom-interfaced applications
One-way standards-based sharing
Two-way standards-based sharing
VOICE
Swap Radio
Gateway
Shared channels
Proprietary shared System
Standards-based shared system
General orientation for equipment and applications
Single agency exercises for field and support staff
Multi-agency exercises for key field and support staff
National/ Provincial training and exercises as part of national strategy
Planned local events
Local emergency incidents
Regional incident management
Daily use throughout regions
High degree of leadership, planning and collaboration among areas with commitment to and investment in the sustainability of systems and documentation

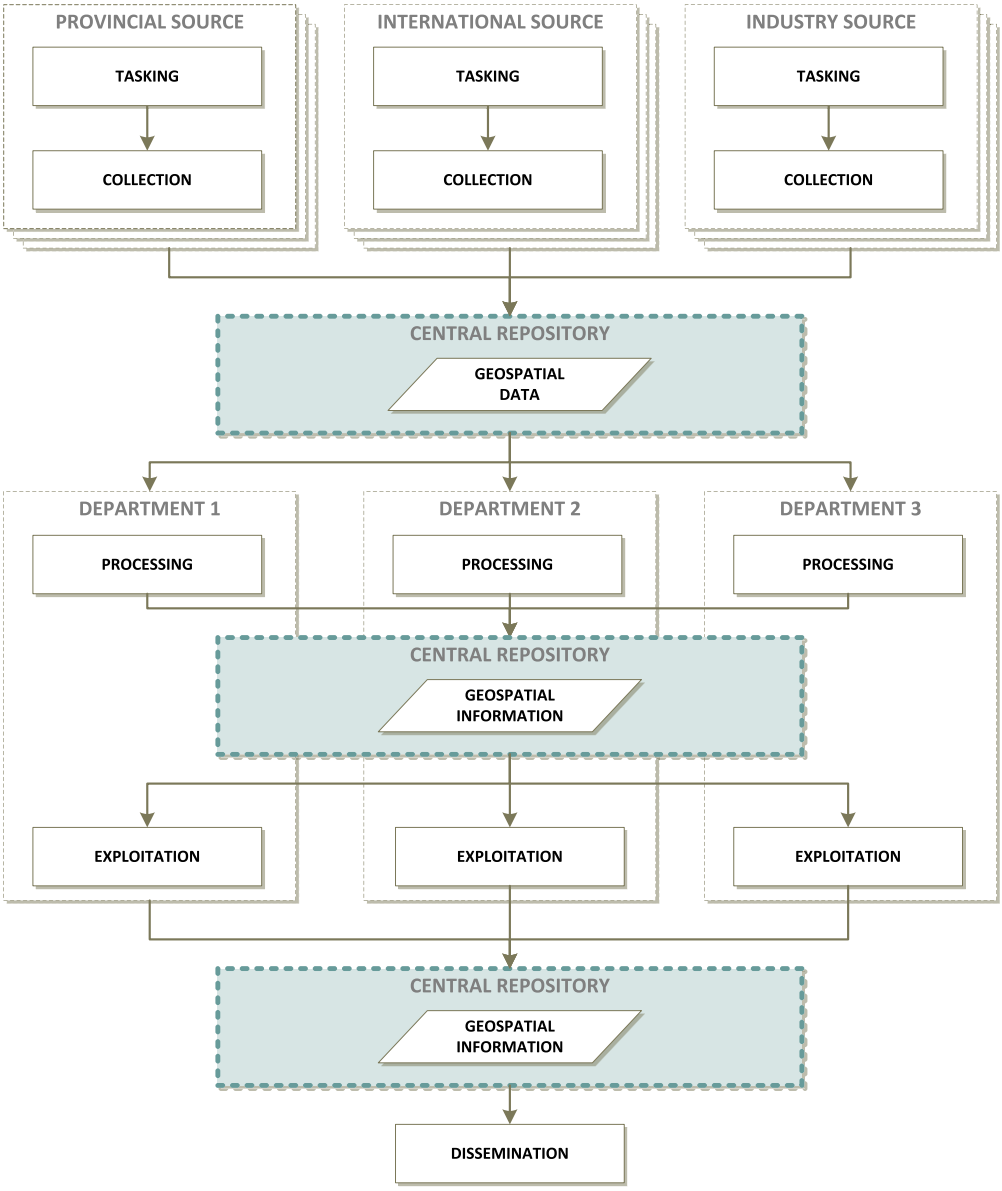


Figure 5-2: Data Sharing and Dissemination CONOPS

5.3 Next steps

See Recommendations Section.

6 METHODOLOGY

This section describes the methodology used to establish information requirements, develop the architecture views and draft the concept of operations.

Figure 6-1 illustrates that there are three major steps in developing architectures.

1. Step 1 “Problem Definition” gathers and analyses data with respect to stakeholders’ high-level problem space. In turn, this allows stakeholders and designers to reach a consensus with respect to the problem to be solved.

2. Step 2 “Development” provides guidelines that determine which set of architecture views should be developed.

3. Step 3 “Analysis and Validation” describes how each view can help in validating and analysing the current and future capabilities to resolve the stakeholders’ problems.

All the steps are discussed in detail in the following subsections.

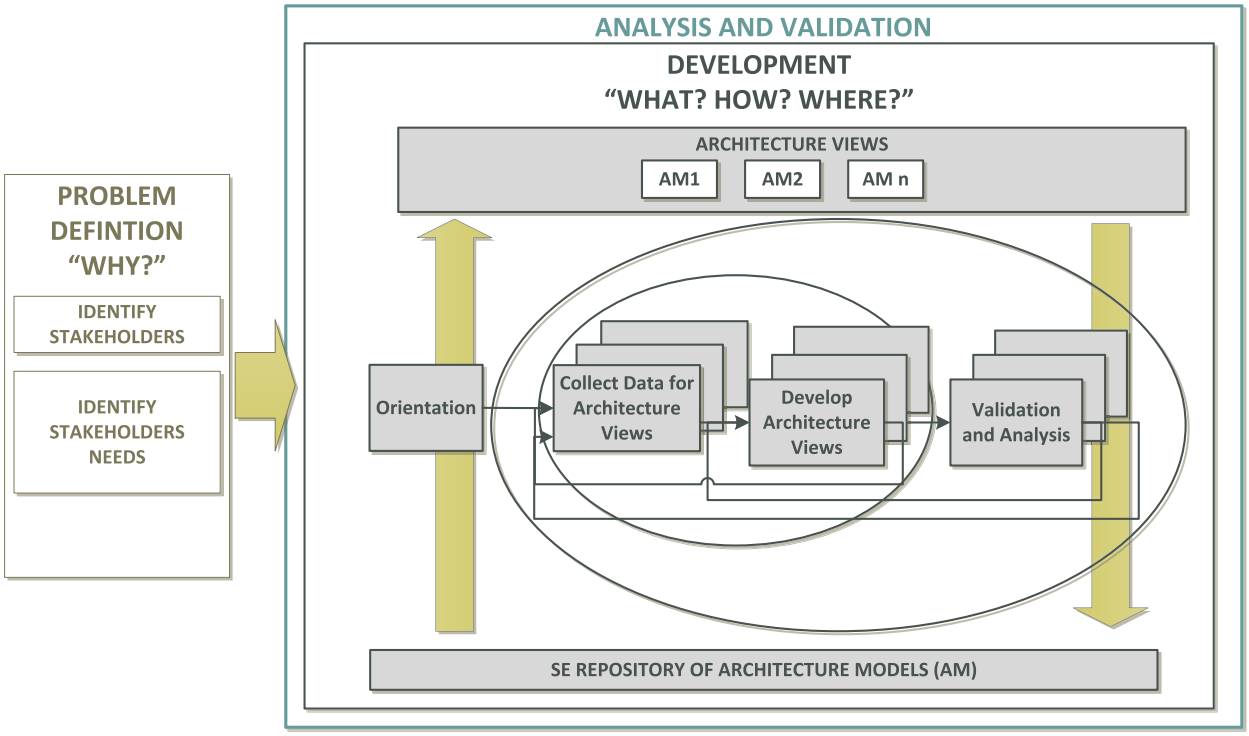


Figure 6-1 Methodology

The “Problem Definition” area depicts the focus of the EM project whereby initial capability needs are captured from interviewing stakeholders, reviewing documents or any other relevant sources of information. The needs of the stakeholder represent the top-level business requirements and should be raw input that is expressed in user terms. This important task helps properly gather stakeholder opinions regarding current gaps, future gaps and needs from the new capability.

Below is a description of the four major architectures that assist in the development of requirements for the three phases:

1. The **Business Architecture** defines the business strategy, governance, organization, and key business processes;

2. The **Data Architecture** describes the major types and sources of data necessary to support the business in a way that can be understood by stakeholders;

3. The **Application Architecture** provides a blueprint for the individual applications to be deployed, their interactions, and their relationships to the core business processes of the organization; and

4. The **Technology Architecture** describes the logical software and hardware capabilities required to support the deployment of business, data, and application services. This includes IT infrastructure, middleware, networks, communications, processing, and standards.

The EM architecture is at the "Problem Definition" level, and therefore, the requirements are captured and defined at a high level in order to guide the design of solutions at the conceptual level. To that end, a business architecture is being developed as part of this project. More detailed data collection would be required to generate specific system requirements for further technology development.

6.0 Method

The Capability Engineering Process (CEP) as illustrated in Figure 6-2 has been followed to guide the methodology for this project. The objective is to apply an iterative process whereby capabilities will build on the preceding one to achieve a desired degree of accuracy.

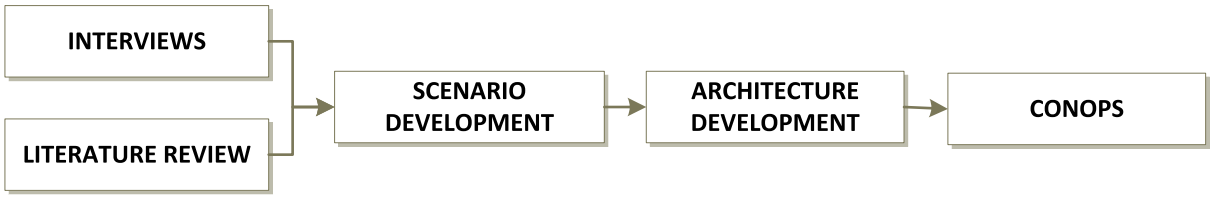


Figure 6-2: Capability Engineering Process (CEP)

In conjunction with the CEP methodology, this project makes use of the DNDAF to provide a coherent framework to capability engineering and capability management in the enterprise environment from concept through development and disposal. While this framework was originally conceived for the Department of National Defence (DND), DNDAF can also be effectively applied for a non-defence enterprise environment.

6.1 Interviews

6.1.1 Purpose

In support of the project objectives and outputs, the project team employed a collaborative approach to engage the EM community to define the enterprise-level view of requirements of

the community. As such, a series of interviews between the project team and the community were conducted during January and February 2014 as the best survey methodology fit for the initial level of inquiry to identify reliable and valid baseline data.

The intent of the interviews was to capture information related to the activities of the EM community in order to represent an integrated view of current emergency management processes as a result of natural disasters, such as an earthquake or floods. In turn, the main goal of this data collection effort was to understand how geospatial products and services can support the advance of Canada's national capabilities to prepare for, prevent, respond to and recover from high-consequence public safety and security events (all-hazards) within the areas of Emergency Management. The interviews provided the opportunity to appreciate more fully individual and organizational roles and responsibilities as defined in the documentation, to explore issues, as well as identify current shortcomings.

Information being collected included, but was not limited to, the following:

- Roles and responsibilities in emergencies;
- Organizational, role, or other relationships among EM organizations and relevant stakeholders;
- Information exchanges (with a focus on geospatial data) both internal and external to the EM community of practice;
- Processes related to the management of EM responses; and
- Systems and networks currently employed to conduct business as it pertains to both EM and geomatic activities.

Interviews were informal and conducted in a format similar to a "brainstorming session". The project team presented several visual artifacts from the analysis of the interview data (e.g., process diagrams) for review and validation by select members of the EM community. Interviews were approximately one hour in duration and conducted on-site in order to minimize the disruption to the schedule of each member of the EM community. Participation in the interviews was completely voluntary.

6.1.2 Target Audience

The intent of the data collection effort was to gather information from different departments representing a cross-section of the EM community. Given the scope of the project, not all departments were included as part of the interview process. Table 6-1 lists the departments from EM community that were interviewed as part of this project. Individuals were generally emergency managers (i.e., operational representation); in some cases existing geomatics support was interviewed at the same time or separately.

Table 6-1: EM Departments

	Departments	Operational /Policy	Geomatics
1	Department of National Defence	X	X

	Departments	Operational /Policy	Geomatics
2	Government Operations Center (Public Safety Canada)	X	X
3	Natural Resources Canada – Emergency Geomatics Service	X	X
4	Aboriginal Affairs and Northern Development Canada	X	
5	National Search and Rescue Secretariat	X	
6	Public Safety Canada – Critical Infrastructure Policy	X	X
7	Canadian Food Inspection Agency	X	X
8	Natural Resources Canada – Canadian Hazards Information Service		X
9	Canada Border Services Agency		X

6.2 Literature Review

6.2.1 Geospatial

Best practices for producing a geospatial CONOPS was leveraged from existing sources such as the following:

1. Homeland Security (HLS) Geospatial Concept of Operations (GeoCONOPS) Version 5. [1];
2. DataBC Concept of Operations [2];
3. Department of Defence's Geospatial Intelligence in Joint Operations doctrine [3]; and
4. European Public Sector Information Platform's topic report Open Data in Natural Hazards Management [4].
5. US National Oceanic and Atmospheric Administration. Integrated Ocean Observing System: Data Management and Communications Concept of Operations

6.2.2 Canadian Emergency Management

A document review preceded the interviews with the various federal departmental EM and geospatial stakeholders. Significant EM documentation currently exists; and therefore, the bulk of the data collection effort relied upon the literature review to provide the framework and processes for further investigation via the interview process. Figure 6-3 lists the pertinent documentation that articulates Canada's overall approach to EM, as well the most relevant reports categorized by the four areas: Disaster Prevention and Mitigation, Emergency Preparedness, Responding to Emergency Events, and Recovery from Disaster. These documents are maintained by Public Safety Canada (PS Canada) [5].

Figure 6-3: Pertinent Canadian EM Documentation

Moreover, individual departments will have in place documented EM processes that are tailored to their specific mandates as it pertains to the prevention, preparedness, response and recovery in the event of a disaster.

The information gathered proved sufficient to capture the operating concepts in terms of architecture products. The model was extended and expanded to represent the key business processes. A representative activity sequence model was created. One of the advantages of a systemic approach is that this model is explicit and can be validated and changed if required. Equally significant, the model provides a departure point for exploratory modelling and options analysis.

6.3 Scenario Development

The reason for the earthquake scenario was to ensure that the data collection effort (i.e., interview process) focused its attention on those sequences of events that are particularly demanding from a workload perspective, or are likely to be areas whereby geospatial support could be provided to aid the EM community. Moreover, it is recognized that the EM practitioners deal with a broad range of natural disasters and man-made threats; however, the earthquake (and flood) scenario was most topical and therefore used to anchor the interviews. The use of the scenario also prevented unnecessary effort in analyzing similar functions that are unlikely to provide any added value.

For this effort, a natural disaster scenario involving an earthquake was employed. Extracts from the complete scenario are presented in APPENDIX D.

6.4 Architecture Views Development

Based on the data collected from the interviews, a baseline (AS-IS) architecture was created to document the current people, processes, and tools employed by the EM community, with a focus on those parts that are concerned with geospatial data. The development of the architecture views will employ the DNDAF approach [14].

6.4.1 Department of National Defence Architecture Framework

Understanding DNDAF is a necessary prerequisite to better comprehend the rationale for the analysis that was utilized for this project. Details regarding DNDAF are presented in APPENDIX E.

6.4.2 EM Architecture Data Products

To address the requirements of project, the following architecture data products have been generated:

- **Operational Node Connectivity Description (OV-2)** depicts the significant operational node dependencies associated with the information flow/exchange requirements necessary to conduct the operational activities depicted in the OV-5 architecture data product. OV-2 is an important tool in translating concepts into capability gaps and linking operational nodes to activities. With respect to the EM environment, the OV-2 illustrates the primary entities at the three levels of command pertaining to the EM (i.e., decision and guidance, strategic coordination, and operational/tactical coordination)

- **Operational Information Exchange Matrix (OV-3)** details the exchange of information between operational nodes (OV-2). Within the EM context, information must be exchanged vertically within a department to address a hazardous incident under single departmental jurisdiction, but also horizontally in the event of a multi-departmental hazard.

- **Functional Mode (OV-5a)** defines the operation requirement scope to the desired level of operational activities or business functions. OV-5a focuses on “what must be done”, leaving “how it is done” to be further developed in the Operational Process Model (OV-5b). The OV-5a describes the hierarchical relationships and dependencies among operational activities or business functions. The EM OV-5a describes the hierarchical relationships and dependencies among operational activities as it pertains to the federal EM mandate as dictated by the Emergency Management Act [1].

- **Operational Process Model (OV-5b)** describes functional activities, describing capability requirements and relating these to specific mission scenarios in support of a set of missions that comprise a capability portfolio. The EM processes focus on the four pillars of EM functions ranging from preparedness to recovery.

- **Systems Interface Description (SV-1**) identifies system nodes and interfaces, and relates these to the operational nodes reflected in the OV-2. The SV-1 can be thought of as a systems representation of OV-2 dependencies.

6.4.3 Map Architecture Views to Objectives

After identifying the appropriate architecture framework, the architecture views that contribute to satisfying the project objectives were chosen and mapped to those objectives. Table 6-2 provides a mapping of the DNDAF architecture products to the project objectives as detailed in APPENDIX E - DNDAF Architecture Views

Table 6-2: Architecture Views Mapped to Project Objectives

	Project Objectives	Architecture Product
1	To better understand the role of open geospatial data in support of Federal safety and security objectives. The project will perform a requirements analysis to assess Federal geomatics capabilities that support Government of Canada policy objectives, to determine gaps and to provide recommendations to address the gaps	OV-2, OV-3, OV-5a
2	To develop a concept of operations for Federal safety and security geospatial activities.	OV-2, OV-3, OV-5, SV-1
3	To bring together the Federal safety and security community in order to extract detailed functional requirements for the Federal Geospatial Platform based on commonly-accepted user-centered engineering methods.	OV-2, OV-3, OV-5, SV-1

6.5 Development of Concept of Operations

Based on the data collected as part of the interview process, a concept of operations for Federal safety and security geospatial activities was initially developed. In simple terms, the geospatial CONOPS captures knowledge of 'who gets what information, when, why, and how' and is presently aimed at being used to communicate requirements. This CONOPS considers safety and security objectives, and emergency management functions, and then defines capabilities in terms of production, access, discovery, dissemination, coordination, process, policies, technology, interoperability, resourcing and further research and development innovation activities for open geospatial data and information products and services.

7 CAPABILITY GAPS, REQUIREMENTS & RECOMMENDATIONS

This section outlines high-level gaps in capabilities, specific requirements (in support of capabilities) and some general recommendations for advancement of the geomatics community in support of safety and security.

7.0 General Recommendations

- Geospatial data that is tasked, collected, processed, exploited and disseminated within the emergency management community should follow open data principles to the broadest extent possible given security and sensitivity considerations in the EM community. These principles are outlined in Section 2. The limits and constraints to which the EM community can apply these principles merits further discussion or follow-up activity as outlined below, but in general should be provided via seamless access, freely available, easily accessible Canada-wide authoritative geospatial data sets.

- Given that the scope of Federal EM operates within a concept of operations spanning the GoC enterprise (i.e. FERP), a similar approach to the supporting geomatics infrastructure should be adopted in order to ensure capability gaps are addressed and efficiencies are achieved across the GoC enterprise. This would result in reduced duplication of geomatics investments while achieving common purpose.

- As a follow-up to this initial version, the GeoCONOPS document should be disseminated for further community review and presented to FCGEO for consideration of adoption and maintenance (including a change management process).

- Federal, Provincial, Territorial and regional contacts for public safety and geomatics should be added to this document as an appendix. The P/T portion of this activity should be directed through the Canadian Council on Geomatics.

7.1 Capability Gaps

- In general, limited assessments to determine specific geospatial capability gaps have been undertaken at a GoC enterprise level or on a scenario-based approach. The earthquake scenario (utilized to support development of this GeoCONOPS) has received ad hoc attention from a geomatics support perspective, but other hazard and threat scenarios would benefit from further assessment.

- There continues to be opportunities to improve interoperability across the EM community. Further assessment of gaps in interoperability should be undertaken, at a GoC enterprise level. The Canadian Communications Interoperability Continuum (Section 5) provides a relevant framework for undertaking further capability gap assessments and performance measurement.

- Documentation of actions for addressing capability gaps could be included in future iterations of the GeoCONOPS.

- **Data discovery is problematic**. Geospatial data discovery and associated operating procedures within the Federal geomatics safety and security community relies heavily upon a social network at the working level. Given the relative small size of the Canadian geomatics community, the majority of the existing knowledge and information sharing is based on trusted relationships. This knowledge needs to be retained and shared. Data discovery of this nature is neither sustainable, nor effective as the composition of individuals is continually evolving. To address this, the GeoCONOPS and its coordination and implementation, requires sustainable governance within an organized committee such as FCGEO.

- Geospatial data sharing in the EM community relies on peer-to-peer transactions built upon a trusted social network of geospatial practitioners. Specifically, sharing of information tends to be facilitated through email and physical media (i.e. hard drives). While this is effective in promoting information data sharing, it does not promote wider community access or provide a consolidated or managed source for broader, re-usable open data dissemination.

- **No clear definition of authoritative geospatial data sources.** To provide a uniform understanding of the problem space, organizations should be leveraging the same geospatial sources for each category of essential element of information (e.g., natural hazards, critical infrastructure, petroleum) to produce their specific products. The Canadian EM community would benefit from a well-defined list of authoritative organizations acting as the custodians of particular components of geospatial data with the mandate to maintain its accuracy and currency. A number of initiatives have been undertaken to define authoritative data sources; however, no decisions have been made to endorse a single approach. There is also an emerging movement towards volunteered geographic information as a source for base map updates or real-time geospatial intelligence that is not well understood. This approach would need to rectify competing or complementary sources including the Cross-Border Infrastructure Plan Minimum Essential Datasets, NRCan's Critical Infrastructure Information Identification – Project Report [17], and emerging definitions of High-Value Datasets within the FGP initiative and the combination of open (government) data, commercial data, and other open 'volunteered' sources required to support an authoritative common operating picture.

- **A Common Symbology Framework is Lacking**. In Canada, efforts have been made to develop the Emergency Management Taxonomy and Symbology. However, there is no web presence or governing authority to house the symbols or to oversee a change management process. For cross-border purposes, integration with the US is required to enable the development of a North American Emergency Management Taxonomy and Symbology standard. Maine has already adopted this standard (Canadian EMS), but broad-based adoption across the CANUS border is recommended.

- **Lack of effective geospatial data exchange.** Upon discovering existing geospatial data, the mechanisms and governance must be in place to support the effective and efficient sharing of this information between Canadian EM stakeholders. To that end, additional efforts are required to develop, promote, and implement information exchange standards as well as the technological infrastructure to facilitate this initiative. The Geospatial for NIEM (Geo4NIEM) initiative is investigating (and subsequently implementing) the standard use of embedded geography markup language with NIEM. This specification merits further investigation for testing and potential implementation.

7.2 FGP-Specific Recommendations

- Opportunities to achieve core elements proposed in this GeoConOps (i.e. common foundation map) would be realized with enterprise-level integration activities. Specifically, integration between the emerging Federal Geospatial Platform with MASAS, and subsequently OCIP and other systems would aid with producing a common operating picture.

- Similarly, the FGP needs to accommodate certain geomatics layers (e.g. infrastructure, buildings, hazards) that would support fundamental geospatial analysis required for Canada-wide adoption of the Hazus loss estimation tool.

- For data that is sensitive in nature (UNCLASS) or for geomatics services requiring a high level of system resilience, integration and interoperability with the High-Resiliency Environment should be considered.

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APPENDIX A - ACRONYMS

The following list identifies the acronyms and abbreviations used throughout this document:

AANDC	Aboriginal Affairs and Northern Development Canada
ADM	Assistant Deputy Minister
AHRA	All-Hazards Risk Assessment
AOI	Area Of Interest
ASWG	Arctic Security Working Group
C3I	Communications, Command, Control and Intelligence
CANUS	Canada/United States
CAP-CP	Common Alerting Protocol - Canadian Profile
CapV	Capability View
CAUSE	Canada-U.S. Enhanced Resiliency Experiment
CBF	Cartographic Boundary Files
CBIP	Cross Border Infrastructure Plan
CBSA	Canada Border Services Agency
CCOG	Canadian Council on Geomatics
CDD	Canadian Disaster Database
CI	Critical Infrastructure
CIWG	Communications Interoperability Working Group
CSS	Centre for Security Science
CEP	Capability Engineering Process
CFIA	Canadian Food Inspection Agency
CFS	Canadian Forest Service
CGDI	Canadian Geospatial Data Infrastructure
CHIS	Canadian Hazard Information Service
CONOPS	Concept of Operations
COP	Common Operating Picture
CV	Common View
CWFIS	Canadian Wildland Fire Information System
DRDC	Defence Research and Development Canada
DFAA	Disaster Financial Assistance Arrangements
DG	Director General
DGIWG	Digital Geographic Information Working Group
DM	Deputy Minister
DND	Department of National Defence
DNDAF	Department of Defence Architecture Framework
EC	Environment Canada
EEI	Essential Elements of Information
EGS	Emergency Geomatics Service
EM	Emergency Management
EMA	Emergency Management Act
EMC	Emergency Management Committee
EMO	Emergency Management Organization
EMS	Emergency Mapping Symbology
EOC	Emergency Operation Center

ESF	Emergency Support Functions
FCGEO	Federal Committee on Geomatics and Earth Observations
FED	Federal Electoral Districts
FERP	Federal Emergency Response Plan
FGP	Federal Geospatial Platform
GeoCONOPS	Geospatial Concept of Operations
GEOINT	Geospatial Intelligence
GIS	Geographic Information System
GoC	Government of Canada
GOC	Government Operations Center
GPS	Global Positioning System
GeoRSS	Geographical Rich Site Summary
HAZUS	Hazards United States
HLS	Homeland Security
HRE	High Resilience Environment
IODS	Initial Operational Dataset
IV	Information View
KML	Keyhole Markup Language
LIDAR	Light Imaging Detection and Ranging
MASAS	Multi-Agency Situational Awareness System
MASAS-X	MASAS Information Exchanges
MCE	Mapping and Charting Establishment
MEDS	Minimum Essential Dataset
MODIS	Moderate Resolution Imaging Spectroradiometer
MSDS	Mission Specific Dataset
NASA	National Aeronautics and Space Administration
NATO	North Atlantic Treaty Organization
NDMS	National Disaster Mitigation Strategy
NERS	National Emergency Response System
NGA	National Geospatial-Intelligence Agency
NHN	National Hydro Network
NIEM	National Information Exchange Model
NRCan	Natural Resources Canada
NS Ops	National Security Operations
NSS	National Search and Rescue Secretariat
NTDB	National Topographic Data Base
OASIS	Organization for the Advancement of Structured Information Standards
OCIP	Operations Centres Interconnectivity Portal
OGC	Open Geospatial Consortium
OGD	Other Government Departments
OV	Operational View
PHAC	Public Health Agency of Canada
PLD	Primary Lead Department
PS	Public Safety Canada
RFI	Request for Information
ROI	Region of Interest

RRAP	Regional Resiliency Assessment Project
S&T	Science and Technology
SA	Situation Awareness
SAR	Search and Rescue
SD	Support Department
SecV	Security View
SEMP	Strategic Emergency Management Plan
SME	Subject Matter Expert
SOREM	Senior Officials Responsible for Emergency Management
SOPs	Standard Operating Procedures
StratV	Strategic View
SV	System and Service View
TCPED	Tasking, Collection, Processing, Exploitation, and Dissemination
TV	Technical Standards View
UAV	Unmanned Aerial Vehicle
VRAC	Virtual Risk Analysis Cell
VTC	Volunteer Technical Community

APPENDIX B - GLOSSARY

All-Hazards Risk Assessment (AHRA) will help identify, analyze and prioritize the full range of potential non-malicious and malicious threats. The process takes into account vulnerabilities associated with specific threats, identifies potential consequences should a threat be realized, and considers means to mitigate the risks.

Authoritative Data Data provided by the trusted and delegated body that is mandated to produce and/or manage the specified data. This authoritative body is recognized in the community as having the legitimate authority and/or delegated responsibility to produce, maintain and make available the specific data.

Capability A capability is a combination of plans, people and equipment that allow the [organization] to act in a specific way in a specific situation to achieve mission objectives (DRDC).

Capability Gap In force development, the difference between a current capability and the capability goals that emerge from the capability-based planning process.

Capability-Based Planning A planning approach that involves developing, prioritizing, selecting and evaluating adaptable Prevent, Protect, Respond and Recover mission capabilities, to reach a target level of preparedness based on a detailed assessment of identified threats and risks, within an economic framework and according to the requirements of responders, populations, institutions and organizations.

Concept of Operations: A CONOPS is a user-oriented document that "describes systems characteristics for a proposed system from a user's perspective. A CONOPS also describes the user organization, mission, and objectives from an integrated systems point of view and is used to communicate overall quantitative and qualitative system characteristics to stakeholders." A CONOPS "describes the proposed system in terms of the user needs it will fulfill, its relationship to existing systems or procedures, and the ways it will be used. CONOPS can be tailored for many purposes, for example, to obtain consensus among the acquirer, developers, supporters, and user agencies on the operational concept of a proposed system. Additionally, a CONOPS may focus on communicating the user's needs to the developer or the developer's ideas to the user and other interested parties"2376

Cross Border Infrastructure Plan
The main purpose of CBIP is to enable Federal Government organizations to plan and fulfill their Homeland Security, Defense and Public Safety missions. The CBIP database is a warehouse of mission-critical geospatial and remote sensing information needed to increase readiness about potential threats and vulnerabilities, and to reduce response and recovery times in the event of natural or terrorist-caused disaster within the border region. CBIP also provides the Minimum Essential Data Sets (MEDS) of geospatial information and critical infrastructure data over the border region that are necessary to support continental and domestic military or civil assistance operations.

Canada Centre for Mapping and Earth Observation (CCMEO) is the Government of Canada's centre of excellence for remote sensing and mapping.

Canadian Geospatial Data Infrastructure The CGDI is an on-line resource that improves the sharing, access and use of geospatial information – information tied to geographic locations in Canada. It helps decision-makers from all levels of government, the private sector, non–government organizations and academia make better decisions on social, economic and environmental priorities. The infrastructure itself consists of data, standards, policies, technologies and partnerships that are in place to allow the sharing and visualization of information on the Internet.

Canadian Hazard Information Service The service conducts monitoring and provides hazard information and products on an ongoing basis and in response to emergency situations involving earthquakes, tsunamis, volcanic eruptions, landslides, geomagnetic storms and radiological / nuclear incidents. This is accomplished through the provision of remote sensing, geomatics and material support by ESS to government agencies responsible for emergency response. Additionally, the service discharges NRCan responsibilities for ongoing monitoring under the Comprehensive Nuclear Test Ban Treaty.

Concept of Operations (CONOPS) A concise description of how an organization is to operate in order to achieve specific goals.

Common Operating Picture (COP) A common operating picture is established and maintained by gathering, collating, synthesizing, and disseminating incident information to all appropriate parties. Achieving a common operating picture allows on-scene and off-scene personnel to have the same information about the incident.

Consequence management Measures and activities undertaken to alleviate the damage, loss, hardship and suffering caused by emergencies. It also includes measures to restore essential services, protect public health, and provide emergency relief to affected governments, businesses, and populations.

Disaster A social phenomenon that results when a hazard intersects with a vulnerable community in a way that exceeds or overwhelms the community's ability to cope and may cause serious harm to the safety, health, welfare, property or environment of people; may be triggered by a naturally occurring phenomenon which has its origins within the geophysical or biological environment or by human action or error, whether malicious or unintentional, including technological failures, accidents and terrorist acts.

Emergency A present or imminent event that requires prompt coordination of actions concerning persons or property to protect the health, safety or welfare of people, or to limit damage to property or the environment.Emergency Operations Centre A designated facility established by an agency or jurisdiction to coordinate the overall agency or jurisdictional response and support to an emergency.

Emergency plan A documented scheme of assigned responsibilities, actions and procedures, required in the event of an emergency. It contains a brief, clear and concise description of the overall emergency organization as well as a designation of responsibilities and procedures (including notifications) involved in coping with any or all aspects of a potential credible emergency.

Incident An occurrence, either human caused or by natural phenomena, that requires action by response personnel to prevent or minimize loss of life or damage to property, environment and reduce economic and social losses.

Department of Defence Architecture Framework is the overarching, comprehensive framework and conceptual model enabling the development of architectures to facilitate the ability of Department of Defense (US) managers at all levels to make key decisions more effectively through organized information sharing.

Earth Observation is the gathering of information about the Earth from remote sensing technologies such as satellites.

Emergency Management Act sets out the leadership role and responsibilities of the Minister of Public Safety and Emergency Preparedness, including coordinating emergency management activities among government institutions and in cooperation with the provinces and other entities. Responsibilities of other federal ministers are also set out in the Act.

Emergency Operation Centre A designated facility established by an agency or jurisdiction to coordinate the overall agency or jurisdictional response and support to an emergency.

Emergency Support Functions provide the mechanisms for grouping certain functions. Specifically, these are the functions most frequently used in providing federal support to provinces/territories or assistance from one federal government institution to another during an emergency. Emergency Support Functions are allocated to government institutions in a manner consistent with their mandate. They include policies and legislation, planning assumptions and concept(s) of operations to augment and support primary departmental programs, arrangements or other measures to assist provincial governments and local authorities, or to support the Government Operations Centre in order to coordinate the Government of Canada's response to an emergency.

Federal Committee on Geomatics and Earth Observations (FCGEO) is a committee focussed on: 1) providing proactive, whole-of-government leadership in establishing priorities for geomatics and Earth observation and their application in support of government priorities, decision-making, and Canada’s competitive advantage, and,2) collectively enhancing the responsiveness, efficiency and sustainability of the federal geomatics and Earth observation infrastructure. The FCGEO membership is drawn from 20 federal departments and agencies that are producers and/or consumers of geospatial data, or have an interest in geomatics-related activities, requirements and infrastructure.

Federal Emergency Response Plan is designed to harmonize federal emergency response efforts with those of the provinces/territorial governments, non-governmental organizations, and the private sector.

Federal Geospatial Platform (FGP) will be a collaborative online environment consisting of authoritative geospatial data, services, and applications, built on a shared infrastructure that will enable the government's most relevant information to be managed spatially, analyzed, and displayed in a visual context to enhance decision-making support of government priorities.

Geospatial Enhancement for NIEM (Geo4NIEM) The Geospatial Enhancement for NIEM (Geo4NIEM) initiative is a collaboration of the NIEM Program Management Office (PMO), the Open Geospatial Consortium (OGC), the Department of Homeland Security, and the Program Manager for the Information Sharing Environment (PM-ISE) to enhance NIEM's geospatial exchange capabilities.

Geospatial Intelligence (GEOINT) is the exploitation and analysis of imagery and geospatial information that describes, assesses and visually depicts physical features and geographically referenced activities on the Earth.

Government Operations Centre (GOC) provides an all-hazards integrated federal emergency response to events (potential or actual hazards, natural or human-induced, either accidental or intentional) of national interest. It provides 24/7 monitoring and reporting, National-Level situational awareness, warning products and integrated risk assessments, as well as national-level planning and whole-of-government response management.

Geomatics is defined as the modern discipline which integrates the tasks of gathering, storing, processing, modeling, analyzing, and delivering spatially referenced or location information. It encompasses the disciplines of surveying, hydrography, mapping, remote sensing (often called earth observation) and geographic information processing, often called geographic information systems (or GIS).

Global Positioning System (GPS) is a U.S.-owned utility that provides users with positioning, navigation, and timing (PNT) services.

Hazard A condition or entity with the capability to cause an adverse effect. A potentially damaging physical event, phenomenon or human activity that may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation

HAZUS Hazards US (Multi-Hazard) is a quantitative risk assessment and decision-support tool for natural hazard risk mitigation and emergency management. Hazus is a GIS-based tool that models physical damage and economic and social losses from natural hazards such as earthquakes, floods and hurricanes.

Multi-Agency Situational Awareness System (MASAS) is a multi-stakeholder federally-led initiative that aims to develop and support capabilities that will enable the sharing of location-based situational awareness information and alerts between emergency management and response agencies using open standards and an open architecture. The MASAS initiative is led by the Defence R&D Canada – Centre for Security Science, in partnership with Public Safety Canada and Natural Resources Canada.

Minimum Essential Dataset the minimum essential data needed to collect, acquire, and compile data for the Cross Border Infrastructure Plan comprising five categories: critical infrastructure, important industry, high-value or symbolic targets, miscellaneous, and base map information.

National Disaster Mitigation Strategy (NDMS) Responding directly to national consultation findings, the NDMS supports all-hazards emergency management, with an initial focus on reducing risk posed by natural hazards, an area that stakeholders agree requires urgent attention.

NATIONAL EARTH OBSERVATION DATA FRAMEWORK & CATALOGUE THE NEODF CATALOGUE ENABLES PUBLIC AND GOVERNMENT USERS TO INTELLIGENTLY SEARCH AND EASILY ACCESS THE GOC EO RAW AND PRODUCT ARCHIVES MANAGED BY NRCAN. THE SEARCH CAPABILITY FEATURES ADVANCED GEOSPATIAL "REGION OF INTEREST" (ROI) OPERATORS, HIGH-QUALITY QUICKLOOK IMAGES, AND TOOLS TO MANAGE QUERIES AND ARCHIVE ACCESS.

National Emergency Response System (NERS) The National Emergency Response System provides for the harmonization of joint federal, provincial and territorial response to emergencies. It supports and facilitates procurement and logistics coordination between all levels of government, the private sector, non-governmental organizations and international stakeholders. Although in most instances it applies to federal support at the request of a province or territory, it can also be used in instances where provinces or territories support federal response to an emergency under federal jurisdiction.

National Information Exchange Model (NIEM) is a community-driven approach for the exchange of data amongst organizations. NIEM enables organizations to efficiently and effectively exchange information in real time with their partners to enable them to deliver on their missions. (See also Geo4NIEM)

Natural Disaster A naturally occurring calamitous event bringing great damage, loss, or destruction such as tornadoes, hurricanes, widespread flooding, wildland fires, earthquakes, and related occurrences.

Natural Hazards A threat attributable to forces of nature.

Operations Centres Interconnectivity Portal maintains an operational capability to enable the immediate sharing and accessing of UNCLASSIFIED incident data and

related information between the various Federal Operations Centres in order to improve their situational awareness.

Open Geospatial Consortium (OGC) is an international industry consortium o**f** over 450 companies, government agencies and universities participating in a consensus process to develop publicly available interface standards. OGC® Standards support interoperable solutions that "geo-enable" the Web, wireless and location-based services and mainstream IT.

Open Data Data that is made freely available by way of portals, metadata, and search tools for reuse by governments, citizens, voluntary organizations, academia, and the private sector in new and unanticipated ways.

Primary Department A federal department with the legislated mandate related to a key element of an emergency. Depending on the nature of the emergency, there may be multiple primary departments.

Remote Sensing is the science (and to some extent, art) of acquiring information about the Earth's surface without actually being in contact with it. This is done by sensing and recording reflected or emitted energy and processing, analyzing, and applying that information. Today, the use of orbiting satellite sensors and the satellite imagery they provide are fundamentally changing how Canadians view their nation and their planet.

Request for Information (RFI) is a fundamental service offered by military intelligence agencies to provide timely and relevant information to commanders and warfighters in response to their unique information requirements that often cannot be readily fulfilled from local sources of information.

Risk The combination of the likelihood and the consequence of a specified hazard being realized; refers to the vulnerability, proximity or exposure to hazards, which affects the likelihood of an adverse impact.

Situation Awareness (SA) The continual process of collecting, analyzing, and disseminating intelligence, information, and knowledge. This process allows organizations and individuals to anticipate requirements and to respond effectively.

Supporting Departments are federal departments that provide general or specialized assistance to a primary department during an emergency.

Tasking, Collection, Processing, Exploitation, and Dissemination (TCPED) Defines and manages data architectures within the National System for Geospatial Intelligence (US). This TCPED domain ontology is a collection of semantic structures created to manage the NSG data architecture at the enterprise level.

Threat The presence of a hazard and an exposure pathway; threats may be natural or human-induced, either accidental or intentional.

Unmanned Air Vehicle (or Unmanned Aerial Vehicle) A power driven aircraft, other than a model aircraft, that is operated without a flight crew member on board. Unmanned air vehicles have been given many names, but are most commonly referred to as unmanned aerial vehicles (UAV), unmanned air vehicles, remotely operated aircraft or remotely piloted vehicles. Unmanned air vehicles may take the form of airships, aeroplanes or rotorcraft. Basically, they could be considered to be any unmanned aircraft that performs a useful mission and can be remotely controlled or has autonomous flight capability.

Ushahidi A non-profit technology company that specializes in developing free and open source software for information collection, visualization and interactive mapping.

Vulnerability A condition or set of conditions that may allow a threat to adversely affect an asset.

APPENDIX C - ACTORS

Aboriginal Affairs and Northern Development Canada
Emergency Issues Management Directorate

Agriculture and Agri-Food Canada

Canada Border Services Agency
National Border Operations Centre

Canadian Food Inspection Agency
National Emergency Operations Centre

Canadian Security Intelligence Service

Canadian Space Agency

Defence Research and Development Canada

Department of National Defence
Canadian Joint Operations Command (CJOC)
Canadian Forces Joint Imagery Centre (CFINTCOM)
Mapping and Charting Establishment (CFINTCOM)

Environment Canada
Canadian Ice Service
Environmental Emergencies Program
Meteorological Service of Canada

Fisheries and Oceans
Canadian Coast Guard
Canadian Hydrographic Service

Foreign Affairs, Trade, and Development
Security and Emergency Management Bureau

Health Canada
Nuclear Emergency Preparedness and Response Division

Natural Resources Canada
Canadian Forest Service
Canadian Hazard Information Service

Canada Centre for Mapping and Earth Observation
Emergency Geomatics Service
Public Safety Geoscience Program

National Search and Rescue Secretariat

Public Health Agency of Canada
Office of Situational Awareness and Operations

Public Safety Canada
Critical Infrastructure Policy Division
Government Operations Center

Privy Council Office
Security Operations - Crisis Management Cell

Transport Canada
Emergency Preparedness Directorate

Royal Canadian Mounted Police
National Operations Centre - Geospatial Intelligence Section

APPENDIX D - NATURAL HAZARD SCENARIO

The following sections are extracts from NRCan's earthquake scenario [15] on the West Coast of Canada. This was used to assist the interview team in extracting information regarding the participant's and their organization's roles in responding to this event at the Federal level.

A.1 Conditions

A.1.1 Weather

From 10 February to 20 February, 2012 simulated temperatures across southwestern British Columbia (BC) and Vancouver Island have been typical of the season ranging from -6º to 8º Celsius (C), average 5.9° C. Rainfall and snow have been average for February with 175 millimetres (mm) of rain and 10 mm of snow from the first of the month. Consequently, soils are saturated. Overcast and rainy conditions are forecast to persist for the remainder of February with occasional breaks in the cloud cover.

A.1.2 Social

There are no significant events taking place in southwestern BC and there have been no natural, accidental intentional, or medical emergency incidents of note.

A.2 Event

A.2.1 Earthquake

At 0605 Pacific Daylight Time (PDT) 16 February, 2012 (1405 Coordinated Universal Time (UTC), 0905 Eastern Daylight Time (EDT)) a simulated 7.3 magnitude earthquake occurs at 49.27º North and 123.53º West. The earthquake is a crustal, surficial event along a northwards dipping fault in the Strait of Georgia with epicenter 30 km west of Vancouver.

The earthquake lasts for over 60 seconds and causes violent to strong shaking across Greater Vancouver, and light to strong across southwestern BC, northwestern Washington State (WA), and southern Vancouver Island. The shaking is sufficiently intense to cause moderate to heavy damage in Vancouver and on Vancouver Island, and very light to light damage across the rest of southern BC. Aftershocks of the crustal event range from 4.0 to 6.0 magnitude.

A.2.2 Liquefaction and Landslides

The crustal earthquake triggers large volume landslides on the saturated slopes and riverbanks of the Greater Vancouver area and along the Sea-to-Sky Highway north as far as Whistler. In Richmond, New Westminster, Delta, and Port Coquitlam landslides are exacerbated by liquefaction of the Fraser Delta and river banks along large portions of those communities have failed.

A.2.3 Tsunami

The crustal earthquake main shock triggers substantial shaking of the sea floor, which triggers underwater landslides across the Strait of Georgia. The main shock produced ground displacements of the fault in the order of 2 metres. Several landslides displace enough water to

generate three separate tsunami series that strike the southern mainland coast at 15 minute intervals starting at 0630 hrs PDT. Wave heights range from 4 to 10 m and on-shore run-ups from 8 to 20 m depending upon local topography. The tsunamis inundate northern and southern coastal parts of Vancouver, southern North Shore, Richmond, and Tsawwassen, as well as communities along the shores of the Fraser River, Burrard Inlet, and Howe Sound.

West Coast and Alaska Tsunami Warning Center (WCATWC) tsunami messages are typically issued based on seismic data indicative of seabed shifting that displaces large volumes of water. Initial data from the crustal event would not suggest generation of a seismically induced tsunami and in this case no WCATWC tsunami message would be issued.

A.3 Effects

A.3.1 Buildings and Infrastructure

The effects of the crustal earthquake are significant across the Greater Vancouver area and north to Whistler. The main shock collapsed many older (pre-1970s) commercial and residential buildings. Table B-1 provides preliminary estimations of damage to residential buildings.

Table B-1: Preliminary Damage Estimates

Slight	Moderate	Extensive	Complete
141,000	71,000	17,000	4,000

Preliminary estimations indicate that economic losses to residential buildings could exceed **FINANCIAL INFORMATION REMOVED**

Transportation infrastructure is significantly damaged with partial collapse of several bridges and tunnels. The Sea-to-Sky Highway has been severed at four different locations by landslides and Vancouver Harbour facilities were inundated by the tsunamis. Vancouver energy and telecommunications infrastructure are also effectively inoperable due to a combination of localized failures and surging demand. Table B-2 shows preliminary modelled estimations of number of households without power.

Table B-2: Preliminary Modelled Estimations of Households w/o Power

At Day 1	At Day 3	At Day 7	At Day 30	At Day 90
228,000	138,000	55,000	11,000	330

A.3.2 Casualties

Casualties are divided by severity levels and numbers expected thus:

- 6,000 Level 1 casualties: Injuries will require medical attention but hospitalization is not needed.
- 1,000 Level 2 casualties: Injuries will require hospitalization but are not considered life-threatening.

- 200 Level 3 casualties: Injures will require hospitalization and can become life-threatening if not promptly treated.

- 300 Level 4 casualties: Victims killed by the earthquake.

A.3.3 Debris generation

It is initially estimated that 5 million tonnes of debris will be generated. This will require approximately 200,000 truckloads (at 25 tonnes/truck) to remove the debris generated.

A.3.4 Fire Following Earthquake

Between 40 and 50 ignitions that will burn about 1 sq. mile or 0.1% of the Metro Vancouver region are expected.

APPENDIX E - DNDAF ARCHITECTURE VIEWS

DNDAF views being generated to understand the DSO concept of operations prior to focusing on utilization of the systems to execute the process.

A.4 DNDAF Overview

Figure D-1 illustrates the components that comprise DNDAF; views group together one or more architecture data products and each architecture data product is composed of finite data elements.

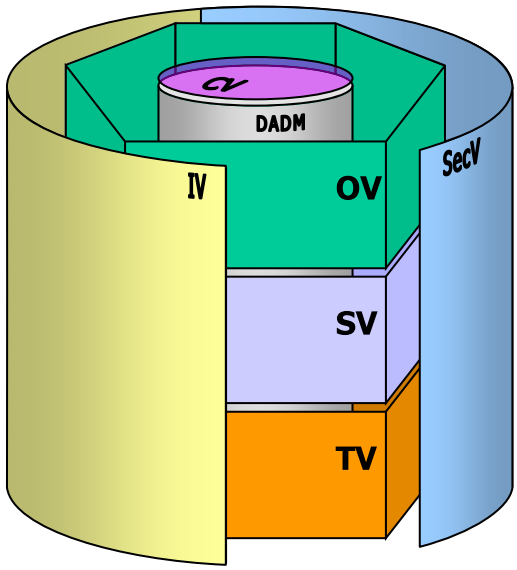

Figure D-1: DND Architecture Framework [4]

In the current instantiation of DNDAF, there are eight major views that are integrated to articulate a given architecture [14]:

- **Common View (CV).** The CV captures overarching aspects that relate to all views while defining the scope, context, and definitions within the architecture.

- **Strategic View (StratV).** The StratV guides the architect in the strategic business discussion to support the use of the enterprise architecture. It provides common points of reference in the area of strategy to support the discussion.

- **Capability View (CapV).** The CapV captures the enterprise goals associated with the overall vision to achieve a desired effect. CapV supports the process of analyzing and optimizing the delivery of capabilities in line with strategic intent through combinations of means and ways to perform a set of tasks or activities.

- **Operational View (OV).** The OV is a description of the tasks and activities, operational elements, and information exchanges required to accomplish missions. The OV contains graphical and textual products that comprise an identification of the operational nodes and elements, assigned tasks and activities, and information flows required between nodes. It defines the types of information exchanged, the frequency of exchange, which tasks and

activities are supported by the information exchanges, and the nature of information exchanges.

- **System and Services View (SV).** The SV is a set of graphical and textual products that describes systems, services, and interconnections providing for, or supporting operational activities. The SV system functions and services resources, and components may be linked to the architecture artifacts in the OV. These system functions and service resources support the operational activities, and facilitate the exchange of information among operational nodes.

- **Technical Standards View (TV).** The TV is the minimal set of rules governing the arrangement, interaction, and interdependence of system parts or elements. Its purpose is to ensure that a system satisfies a specified set of operational requirements. The TV includes a collection of the technical standards, implementation conventions, standards options, rules, and criteria organized into profile(s) that govern systems and system elements for a given architecture.

- **Information View (IV).** An IV defines the overall pattern or structure that is imposed on the information design and an information plan that defines information units and how they are to be completed. The IV provides the definitions and structure of the information that an organization requires to make decisions and manage its resources.

- **Security View (SecV).** The SecV provides visibility on those attributes of the DND/CF architecture that deal with the protection of assets. Consequently it deals with the security and information assurance architecture of the DND/CF.

Each of the views depicts certain architecture attributes. Some attributes bridge two views and provide integrity, coherence, and consistency to architecture descriptions.

It is important to realize that DNDAF is an integrated architecture framework. As such, architecture data elements defined in one product are the same as architecture data elements in another product. In other words, DNDAF has integrated common points of reference linking together architecture data elements thereby ensuring relationships between the architecture data products as well as linkages between the views (operational, systems, and technical standards).

Figure D-2 provides the generic sequencing used in developing the project's DNDAF architecture data products. The product ordering illustrates the inter-relationships between products and the dependencies among them. This chronology does not imply a rigid course of events; however, there is an order of precedence that is required to ensure data integrity. A brief description for each view is provided in the following subsection with additional information located in the DNDAF Manual [4].

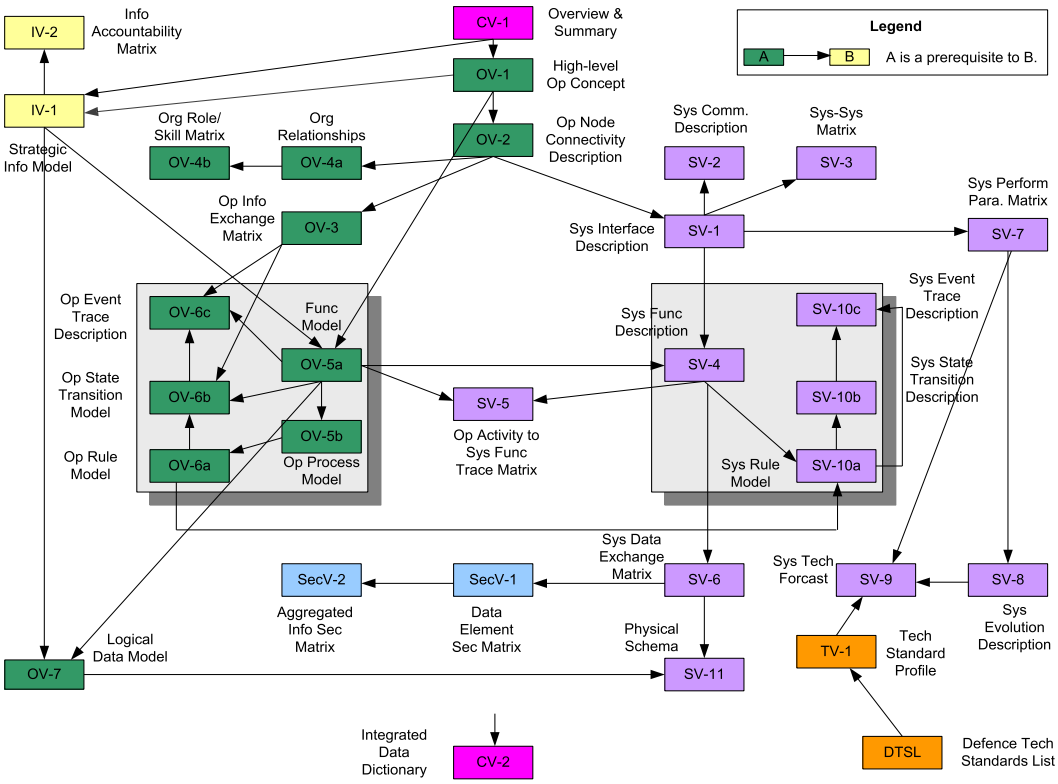

Figure D-2: Architecture Products Development Sequence

The following sections provide a more detailed description of the following views:

- High-Level Operational Concept Graphic (OV-1);
- Operational Node Connectivity Description (OV-2);
- Operational Node Information Exchange Matrix (OV-3);
- Functional Model (OV-5a);
- Operational Process Model (OV-5b); and
- Systems Interface Description (SV-1).

A.5 High-Level Operational Concept Graphic (OV-1)

The purpose of OV-1 is to provide a high-level description of what the architecture project will deliver, in what manner, in which environment, using which assets involving which organizations, roles and/or organization types. This view is intended to help orient and focus discussions with stakeholders. As such, this architecture data product is a graphical representation of the concept of operations.

A.6 Operational Node Connectivity Description (OV-2)

The objective of the OV-2 graphic and supporting documentation is to capture the key players and the interactions necessary to conduct the corresponding operational activities detailed in OV-5. The following description is from the DND Architecture Framework, Volume II [4]:

- **Product Definition.** OV-2 graphically depicts the operational nodes (or organizations) with need lines between those nodes that indicate a need to exchange information. The graphic includes internal operational nodes (internal to the architecture) as well as external nodes.

- **Product Purpose.** OV-2 is intended to track the need to exchange information from specific operational nodes (that play a key role in the architecture) to others. OV-2 does not depict the connectivity between the nodes. OV-2 and OV-3 enables architects to develop the logical design for the architecture and sets the initial scope, requirements and constraints for the physical design in the System View.

The OV-2 architecture data product diagrammatically depicts the relationships between two primary classes of elements:

- **Operational Nodes.** An operational node is an element of the operational architecture that produces, consumes, or processes information. An operational node includes, but is not limited to, representing an operational/human role (e.g., IC), an organization (e.g., Privy Council Office) or organization type, i.e., a logical or functional grouping (e.g., Emergency Operations Team). The notion of operational node will also vary depending on the level of detail addressed by the architecture effort.

- **Needlines and Information Exchanges.** A needline documents the requirement to exchange information between nodes. The needline does not indicate how the information transfer is implemented.

A.7 Operational Node Information Exchange Matrix (OV-3)

The OV-3 Operational Node Information Exchange Matrix is defined as follows:

- **Product Definition.** OV-3 details information exchanges and identifies who exchanges what information, with whom, and why the information is necessary.

- **Product Purpose.** OV-3 details and describes the need to exchange information between operational nodes and external nodes (i.e., operational nodes that are not strictly within the scope of the architecture project but are important sources of information required by internal nodes or important destinations for information provided by internal nodes). The OV-3 enables management to determine the criticality and feasibility of satisfying the Information Exchange Requirement (IER).

The primary class of elements represented in the OV-3 is the following:

- **Needline Exchange.** A needline exchange documents the information exchanged (and its attributes) between nodes.

A.8 Functional Model (OV-5a)

The OV-5a Functional Model is defined as follows:

- **Product Definition.** OV-5a is a decomposition model that describes subordinate and related activities that are conducted to achieve the objective of the architecture project. It describes what must be done and identifies the relationships between the activities.

- **Product Purpose.** OV-5a describes the functions and their relationships, which are required in order to achieve the project objectives. This view describes "what must be done" without prescribing "how it is to be done", thus allowing investigation of different solutions.

The primary class of elements represented in the OV-5a is the following:

- **Operational Activities.** The operational activities are an action or process needed to fulfill a mission, task, or role

A.9 Operational Process Model (OV-5b)

The OV-5b Operational Process Model is described as the following:

- **Product Definition.** The OV-5b depicts the sequence of interconnected activities and their relevant inputs and consequent outputs which make up a business or operational process.

- **Product Purpose.** OV-5b describes "how" the objectives and goals (i.e., "what") as described in the Functional Model (OV-5a). The Operational Process Model includes the sequence of the activities. The sequence of the process is often based on the approach to accomplishing the mission. In other words, different process flows will result from different ways that a service is delivered, the equipment used or the people involved. By separating the function i.e. what has to be done (OV-5a) from the process flow, i.e. how the organization accomplishes its mission (OV-5b), the architect is free to specify the approach to implementing the business functions in the most appropriate fashion.

  OV-5 can be used to:

  - Delineate lines of responsibility for activities when coupled with OV-2;

  - Uncover unnecessary operational activity redundancy;

  - Make decisions about streamlining, combining, or omitting activities;

  - Define or flag issues, opportunities, or operational activities and their interactions (information flows among the activities) that need to be scrutinized further; and

  - Identify critical mission threads and operational information exchanges by annotating which activities are critical (i.e., identify the activities in the model that are critical).

The primary classes of elements represented in the OV-5b are the following:

- **Operational Activities.** The operational activities are an action or process needed to fulfill a mission, task, or role

- **Operational Information.** Operational information is the data that is being passed between operational activities (and operational nodes).

A.10 Systems Interface Description (SV-1)

The SV-1 is described by DNDAF [4] as the following:

- **Product Definition.** The Systems Interface Description depicts systems nodes and the systems resident at these nodes to support organizations/human roles represented by operational nodes of the Operational Node Connectivity Description (OV-2). SV-1 also identifies the interfaces between systems and systems nodes.

- **Product Purpose.** SV-1 identifies systems nodes and systems that support operational nodes. Interfaces that cross organizational boundaries (key interfaces) can also be identified in this product. Some systems can have numerous interfaces. Initial versions of this product may only show key interfaces. Detailed versions may also be developed, as needed, for use in system acquisition, as part of requirements specifications, and for determining system interoperability at a finer level of technical detail.

The primary class of element represented in the SV-1 architecture data product is the following:

- **Components.** A component represents the physical or logical element that performs a specific function or functions. In the DSO context, components are synonymous with the software and human systems required to support the execution of the various mission types.