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CANADIAN GEOSPATIAL DATA INFRASTRUCTURE
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**Canadian Geomatics Community
Strategy “White Paper” and Scenarios**

Hickling Arthurs Low Corporation

2013

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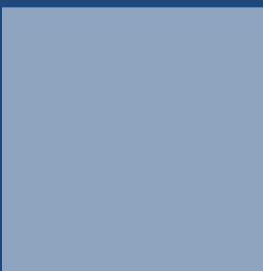
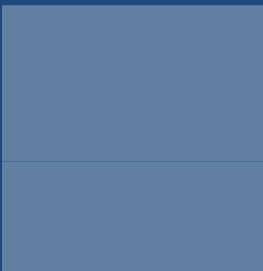
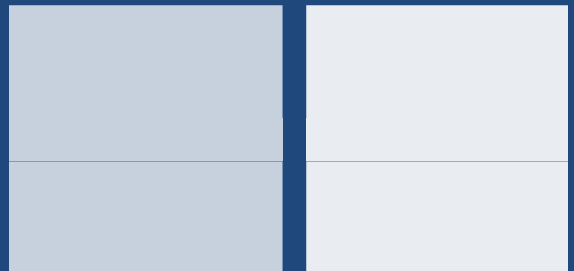
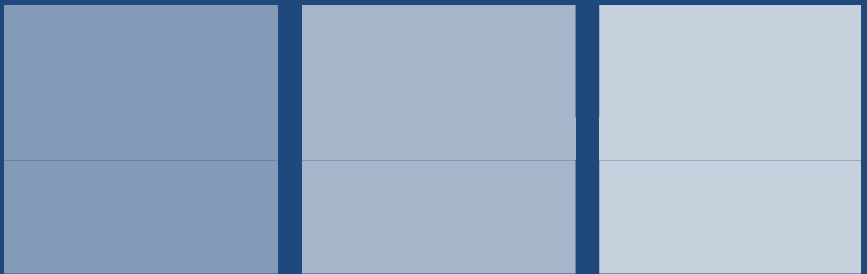
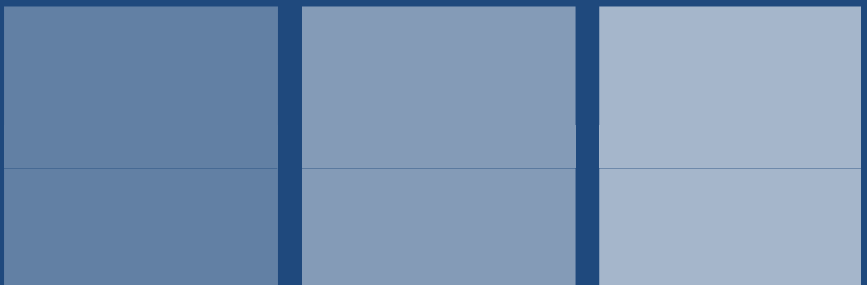
Final White Paper

Canadian Geomatics Community Strategy “White Paper” and Scenarios

Prepared for:
Natural Resources Canada

January 21, 2013

*Canadian Geomatics
Community Round
Table*



HAL Ref: 8144

Executive Summary

This report was prepared under the direction of the Interim Steering Committee (ISC) of the Canadian Geomatics Community Round Table (Round Table). Its purpose is to provide a foundation for the Round Table to prepare a pan-Canadian Geomatics Sector strategy. The contents of the White Paper are drawn from a review of available documents and literature, consultations with selected stakeholders and the authors' own experience.

A goal-oriented scenario planning approach is employed as a framework for structuring the White Paper. This approach to strategic planning puts an organization and its participants (in this case the Round Table, on behalf of the Geomatics Sector) in charge of enacting its future rather than responding to it. As a starting point, possible dimensions of the Sector's future position in the year 2020 – identity, market, business model, governance / leadership, location capacity, data sources and legal and policy framework – are discussed, with several component issues exposed in the form of questions. A “strawman” version of the Sector's desired future is then presented for consideration.

The Sector's future prospects are heavily impacted by external forces, and particularly by drivers of future change. A comprehensive examination was undertaken of change drivers in several categories – political / governance / policy; economic and market; social and demographic; technological; and environmental – and the key drivers are described. The impacts of each driver and the uncertainty of the impacts occurring in each case are indicated. Based on this assessment, two orthogonal axes of uncertainty were chosen that represent impacts on the Sector's future that have some of the greatest uncertainties. Four scenarios are identified based on these axes, which describe very different but plausible futures for the Canadian Geomatics Sector. These scenarios will be examined in detail and fine-tuned at a Round Table workshop.

A framework for the development of a pan-Canadian Geomatics Sector strategy is provided. The importance of alignment of the Sector strategy with government and citizen priorities is highlighted and several such priorities are suggested. The linkage with the goal-oriented scenario planning approach is described and the following components of the framework are discussed: vision, mission, objectives, situational analysis, initiatives and implementation planning. Suggestions of possible vision and mission statements, objectives and initiatives are provided for the Round Table's consideration. The typical elements of an implementation plan are summarized along with the challenges that lie ahead for the Round Table in ensuring implementation follow through. Finally, the importance of this strategic initiative is stressed and the benefits to the Sector of moving forward quickly to capture new opportunities are noted.

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1. Introduction

This chapter briefly outlines the context of a “strategy enabling” project initiated at the June 2012 Canadian Geomatics Community Round Table meeting. It also discusses the methodologies employed for visioning and scenario planning and concludes with a summary of the contents of the document.

1.1 Context for the Project

With the oversight of the Interim Steering Committee (ISC) of the Canadian Geomatics Community Round Table (Round Table), Natural Resources Canada commissioned a strategy enabling project with the objectives of:

- Developing a “White Paper” based on background research concerning key drivers, uncertainties and issues that need to be addressed as part of a pan-Canadian strategic approach;
- Formulating preliminary a “strawman” vision for the Canadian Geomatics Sector and potential future scenarios for presentation and discussion at the January 29 – 30, 2013 Round Table workshop; and
- Constructing a plain language narrative describing no fewer than three viable scenarios for the future of the Canadian Geomatics Sector built on the findings of the White Paper and feedback from participants at the Round Table workshop.

GEOMATICS DEFINITION

For the purposes of the White Paper, geomatics is defined as a 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 GIS).

1.2 Methodologies

Natural Resources Canada commissioned Hickling Arthurs Low Corporation (HAL), in partnership with Know Edge Limited, to conduct the project. The preparation of this White Paper and the accompanying potential future scenarios was founded in two primary research methodologies – document and literature review and stakeholder consultations. The consultants assembled and reviewed documentation on the Geomatics Sector, other sector strategies and scenarios development exercises, and future drivers of change in the Geomatics Sector and its markets, which was provided by the client, sourced from its own files and from an environmental scan. In addition, telephone interviews were conducted with a small selection of experts from within and outside the Sector to round out the picture of possible scenarios for the future. The

White Paper and potential future scenarios were then prepared based on the analysis and synthesis of the collected information. A process called “goal-oriented scenario planning” (Tevis, 2010) was employed, by which an organization (or a sector in this case) can match the world it wants with the world it expects to see.

1.3 White Paper Overview

The White Paper is structured in six chapters, including this introductory chapter, plus three appendices.

Chapter 2 describes scenario planning, introduces the goal-oriented scenario planning process and briefly describes the steps in the process, which are then further elaborated in subsequent chapters.

Chapter 3 lays out for discussion the authors’ “strawman” version of the state of the Canadian Geomatics Sector in seven years’ time – the year 2020. The strategic dimensions of that future vision of the Canadian Geomatics Sector are proposed, and several component issues are exposed for discussion in the form of questions.

Chapter 4 describes the different elements of scenario planning, including: a depiction of the key forces and drivers of change in the Sector, critical uncertainties around those forces, major issues that are facing the Sector, and potential future scenarios.

Chapter 5 provides a high level description of the elements of a strategic framework for moving the Geomatics Sector forward as a community, based on the consideration of alternative scenarios.

Chapter 6 summarizes the key White Paper points and the high level conclusions that can be reached from the research task.

Appendix A lists the references used in the preparation of the White Paper.

Appendix B provides brief summaries of good practices and lessons learned from four other strategy development efforts.

Appendix C summarizes in tabular form the results of the background research and consultations on drivers of future change.

2. Scenario Planning

The purpose of this chapter is to describe scenario planning, introduce goal-oriented scenario planning and briefly describe the steps in the process, which are further elaborated in subsequent chapters.

2.1 Introduction to Scenarios

Organizations and individuals tend to make decisions based on their “mental map” of the future. We can only have a partial understanding of our context, but this helps to shape our particular map of the future, influencing our assumptions about which aspects of the future are important to the choices we face (Shell, 2008). Exploring the assumptions we currently hold about the future, as individuals and collectively, can equip us to act more effectively to help shape the future. Scenarios are a foresight approach to help us recognize when our assumptions are being challenged by events and how to respond successfully.

A scenario is a story that describes a possible future. Decision-makers can use scenarios to think about and discuss the uncertain aspects of the future—or to discover the aspects about which they should be concerned—and to explore the ways in which these might unfold. There is no single answer to how the future will unfold, so sets of scenarios must be created. These scenarios all address the same important questions and all include those aspects of the future that are plausible (i.e., the predetermined elements), but each one describes a different way in which the uncertain aspects of the future could play out.

Scenarios are intended to form a basis for strategic conversation and for considering potential implications of and possible responses to different events, opportunities and challenges. They provide a means of exploring future uncertainties and making more successful decisions.

2.2 The Merits of the Goal-Oriented Approach

There are two styles of foresight based on scenario planning methods – one that is *reactive* (i.e., based on reacting to future forces) and the other that is *creative* (i.e., based on enacting the future that we want to see). The **goal-oriented scenario planning** process is based upon the second or more proactive approach. It is founded on the presumption that a goal-oriented approach to strategic planning can put the organization and its participants (in this case the Round Table, on behalf of the Geomatics Sector) in charge of enacting its future rather than responding to it.

In the ideal context, the stakeholders in the future planning process begin by imagining the ideal future for their organization at a specific point in time, unconstrained by considerations of present circumstances or what competitors will allow them to do. Only when the ideal design of the future is accepted and fully endorsed do they move on to the next phase – planning how to achieve that ideal design based on scenario development. While it is obviously more challenging for this approach to be effective in planning the future of a sector than a single organization, it can work if the engaged stakeholders not only have vision but also have the power and influence to make it happen.

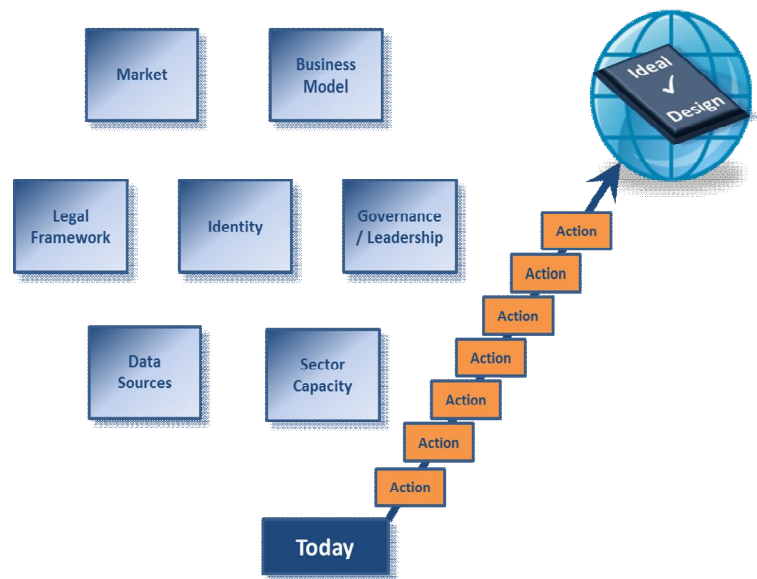
The authors propose the adoption of the goal-oriented scenario planning process as a foundation for the development of a pan-Canadian Geomatics strategy, derived from the work of Tevis (2010), because it offers the potential of helping the Sector to take charge of its future instead of being overtaken by events and driven to a destination by the winds of change. It has been used successfully in the Geomatics domain by the Dutch Cadastre organization (Laarakker, 2012).

The process involves the five steps described in the following sections: 1) developing a vision or “ideal design” model of the future; 2) identifying potential future scenarios; 3) evaluating the future model against the scenarios; 4) mapping actions with potential events; and 5) identifying critical decisions. The scope of this White Paper includes only the first two steps. Steps 3 through 5 will be undertaken by the Round Table and the governing body of the Round Table.

2.3 Developing an “Ideal Design” Model of the Future

The goal in the first step, as illustrated in Figure 1, is to tap the creative thinking of the stakeholders to develop a picture of what the Sector will ideally look like at a certain point in the future – the authors are proposing that this be in 2020. This includes identifying the strategic dimensions of critical importance to the Sector’s future (e.g., identity, market position, capacity, governance, etc.) and the actions that must be taken in each dimension to achieve that ideal design, regardless of the conditions that exist now or may exist in the future. Once again, these are actions which must be taken to get to an unconstrained view of the future.

Figure 1: Developing a Future “Ideal Design” Scenario Based on Creative Foresight

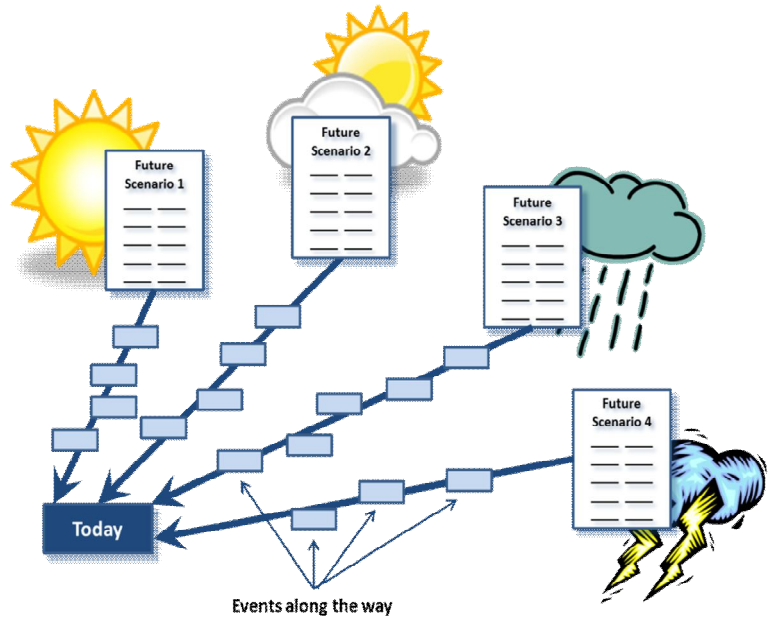


Source: Adapted from Tevis, 2010

2.4 Identifying Potential Future Scenarios

The second step involves the use of the more traditional scenario planning process to identify the potential future environmental conditions that the Sector may face, as illustrated in Figure 2. It is essential to initially identify and describe the key forces or drivers of change that will impact the Sector, the expected severity of those impacts in 2020, and the relative level of uncertainty of the impact occurring. Once identified, uncertainties that have some commonality can be reduced to a single spectrum or axis of uncertainty. Simplifying the entire list of related uncertainties into two orthogonal axes provides a means of defining a matrix of four very different, plausible quadrants of uncertainty, or plot lines. Each of these four corners forms a potential future environmental scenario that the Sector will have to face. Events shaping each of the scenarios are also identified.

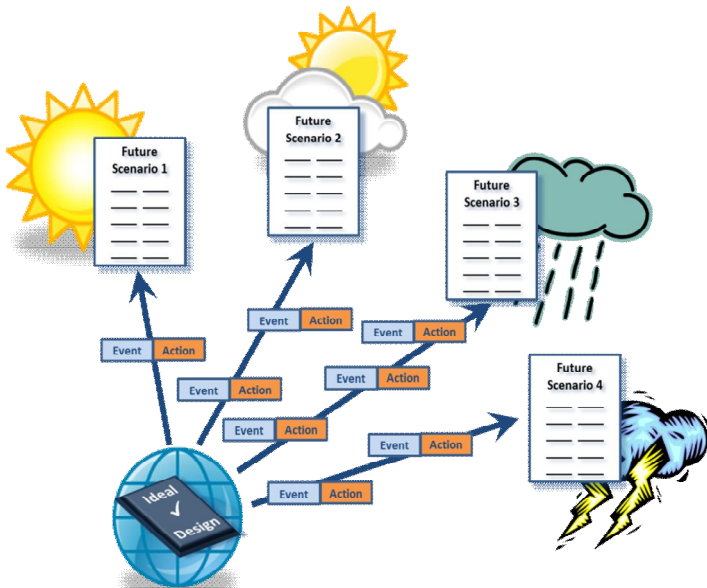
Figure 2: Identifying Future Environmental Scenarios and the Forces Leading to Them



Source: Adapted from Tevis, 2010

Figure 3: Evaluating the Ideal Design Model against Potential Future Scenarios

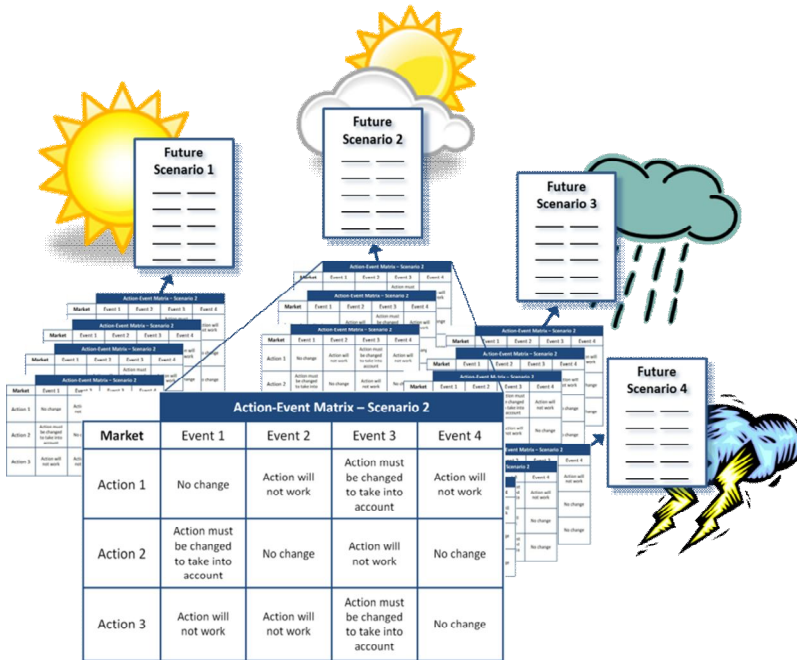
2.5 Evaluating the Future Model against the Scenarios



Source: Adapted from Tevis, 2010

The next step is to evaluate the ideal future against the potential future scenarios. This maps the outlined actions required to achieve the ideal future, derived in the first step, with the scenarios and associated events determined in the second, as illustrated in Figure 3. This step introduces the potential constraints on the Sector's desired actions due to future events, using an action-event matrix, which is described more fully in the following section.

Figure 4: Constructing Action-Event Matrices to Aid Evaluation



Source: Adapted from Tevis, 2010

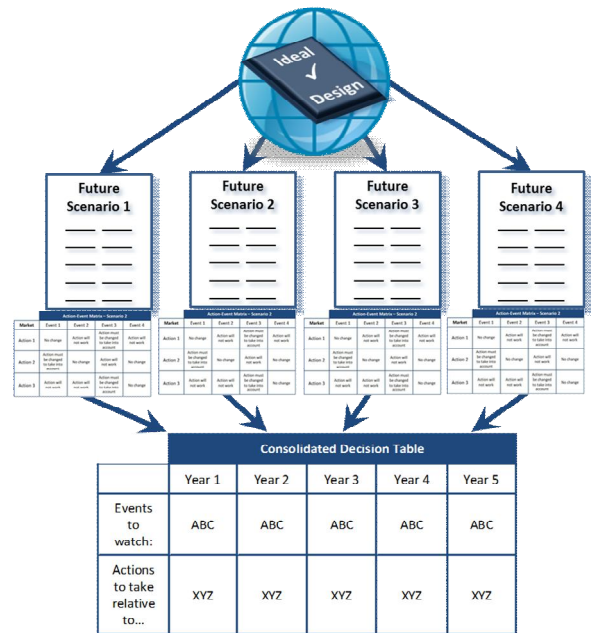
2.6 Mapping Actions with Potential Events

The fourth step involves developing matrices, based upon the strategic dimensions defined in step one, which map the actions the Sector intends to take against the potential events it may face in a particular scenario, as illustrated in Figure 4. The mapping of key actions with key events provides the basis for discussing the impacts of the event on the action, and making decisions on changes to be made to the action to help mitigate the impacts.

2.7 Identifying Critical Decisions

In the final step of the process, illustrated in Figure 5, the matrices produced in step four are consolidated into a series of decision tables that can be used to guide the formulation of the pan-Canadian strategic plan. In particular, this information will help to define realistic actions when developing strategic Initiatives (see Section 5.7).

Figure 5: Developing Decision Tables



Source: Adapted from Tevis, 2010

3. The Sector’s Desired Future

As suggested in Chapter 2, an effective way of conducting strategic planning using scenarios is to start with defining the future desired by the stakeholders by identifying the strategic dimensions that are critically important to the Sector’s “ideal state”.

This chapter proposes the strategic dimensions of a possible ideal state of the Canadian Geomatics Sector, with several component issues exposed in the form of questions. The final section defines a “strawman” Vision for the Canadian Geomatics Sector in the year 2020.

3.1 Strategic Dimensions of a Future Vision

3.1.1 Identity Dimension

What is distinctive about the future Canadian Geomatics Sector? How is it perceived by citizens, the private sector, the public sector and politicians? Is it a low profile maintainer of increasingly pervasive location infrastructure? Is it invisible to citizens? Is it positioned as a high profile enabler of economic development, environmental / natural resource management, societal support, etc.? Is it measurably significant to citizens and politicians?

3.1.2 Market Dimension

What are the characteristics of the Geomatics Sector’s markets? How ubiquitous is the use of location information in the public and private sectors? Is the Sector well prepared for the impact of disruptive technologies on the market? What markets will the Sector create or participate in by 2020? Is it focused on the requirements of the public sector to support evidence-based policy and efficient service delivery, with the reuse of the public sector location information by the private sector and citizens just a bi-product of this process? Or is it led by the needs of business and the consumers? And what is the scope of this market – is it the traditional core geomatics products and services or everything location-enabled?

3.1.3 Business Model Dimension

What is the role of government? Should government create clear policies and plans that help to shape the market and provide certainty that facilitates private sector investment (e.g., a national space plan and a long term SDI sustainability plan)? Should SDIs be produced primarily by the public sector or should the private sector assume a more prominent or even leadership role? Should the public sector just deliver core reference geography and leave development of value-added products and services to the private sector? Should the delivery of authoritative public

sector location information be judged as a ‘public good’ and become an integral part of the open data initiative? Should public sector location information be accessible through its own unique portal or should it be fully integrated and disseminated within wider public sector information portals? What impact will emerging opportunities such as northern exploration/resources/development, international markets, open data, strategic partnerships (LIDAR and space-based data complementarity) have on the Sector? Should the Canadian private sector compete with the global players across a wide range of general location information services or should it strategically focus on specialized niche services?

3.1.4 Governance / Leadership Dimension

Has leadership of Canadian SDI initiatives by the public sector, with a degree of collaboration with the private sector, been effective? Has infrastructure and capacity across both the public and private sectors been effectively delivered? How much more public sector led intervention and stimulus is now required? If there were more opportunities for the private sector to invest in the Canadian Geomatics Sector within an agreed and stable policy framework then would there be sufficient momentum within the sector to allow the public sector to significantly reduce their interventions? What kinds of partnerships between the public sector and the private sector would contribute to increased international competitiveness? Is it time to rethink the collaboration model and adjust roles and responsibilities?

3.1.5 Location Capacity Dimension

How can “knowledge” workers make more effective use of location information and value add to the Canadian economy and society? How can sufficient capacity across the Canadian landscape to take advantage of this information source be most effectively developed in both professional and societal domains? Should the capacity building to fill these skills gaps be focused on location-enabling a wide range of professions? Should measures be taken to enhance location awareness of Canada’s senior decision-makers? Are Geomatics practitioners being trained to meet current and future requirements? As the management of location information requires considerable skills to ensure its integrity and quality, should new professional certification programs be introduced to ensure that skills are obtained and maintained?

3.1.6 Data Sources Dimension

Is it time to move from the initial focus of Canadian SDI initiatives on providing access to primarily land based, authoritative location data, to being an integrator of multiple sources of data? Can the Sector develop tools and methodologies to integrate and analyze a broad range of information (including data collected from ground-based, airborne and satellite sensors) about land, sea and air to understand and model change and to design mitigation strategies for global challenges of the 21st century, such as climate change and the development and protection of the Arctic? Could such tools be widely available and accessible? Is it time to rethink the current, limited scope and position the Sector as an integrator of these multiple sources of data? Is it time

to fully integrate crowd-sourced data and data from real-time sensors? Is it time to extend the SDI model to include information within buildings?

3.1.7 Legal and Policy Framework Dimension

How can the Sector ensure that personal information, including personal location information collected through Location-Based Services and social media applications, is used and distributed so as not to infringe on the privacy rights of citizens? Is it true that the Y-generation generally accepts their private information being exposed, and if so, what are the implications for the Sector? Is there a need to location-enable and strengthen legal and policy frameworks to ensure that no legal show stoppers emerge? Are clear, standardized definitions and guidance required to demystify how and when data must be classified and for how long before they are made accessible?

Should Canadian governments be mandated – as European Union member states are under the INSPIRE Directive – to provide environmental information services to agreed standards? Is it still effective for Canada's SDI initiatives to operate under a cooperative model? Should federal, provincial and municipal government organizations be mandated to participate in providing standardized location data through new legislation, regulations or formal policies?

3.2 Vision 2020

A proposed vision for the Canadian Geomatics Sector in the year 2020 is described in terms of the key dimensions in the following sections.

3.2.1 Identity

- The Canadian Geomatics Sector has senior champions at all levels of government.
- The private sector has significantly increased economic impact and strong governance and effectively coordinates international marketing activities.
- The NGOs active in the Geomatics Sector are engaged and have an important end user guidance role within the Sector's governance structure.
- Citizens clearly understand how they can engage and collaborate with the (Geomatics) Sector to derive direct benefits. They also understand how the Sector is delivering significant benefits to the Canadian economy, society and environment.
- Politicians clearly comprehend why they have invested in implementing a pan-Canadian strategy and can identify and provide examples of the benefits to the Canadian economy, environment and society.
- Internationally, Canada is perceived to be an exemplar and world leader in the Geomatics domain.

3.2.2 Market

- The private sector is more robust as a result of stronger collaboration and a strengthened leadership role, and is assisting consumers and citizens in a location-enabled society and supporting the public sector to deliver evidence-based policies and efficient services.
- The Geomatics Sector delivers location data, and provides a platform to encourage innovation and investment in creating value-added information and analysis services.
- Canada's senior public and private sector decision makers ensure that location analysis is an integral part of their decision making process, wherever appropriate.

3.2.3 Business Model

- The public sector (government, NGOs and academia) and private sector collaboratively define an optimal business model.
- Canadian governments create clear policies and plans that help to shape the market and provide certainty that facilitates private sector investment. Through considerable capacity building, the Sector has become competitive internationally and strategically focused on specialized niche services.
- A strategic approach to the collection and dissemination of public sector information (PSI) is adopted. There is consensus on a contemporary National Information Framework (NIF), which includes all key datasets to meet currently anticipated needs of government and other key sectors in the Canadian economy. The Geomatics Sector has changed what location data it collects and manages based on the context of producing a NIF that is attuned to Canada's long term economic and social needs.
- The role of the public sector is to deliver authoritative public sector location information. The role of the private sector is to develop value-added products and services.
- The delivery of authoritative and other public sector location information is recognized as a 'public good' and an integral part of open data initiatives, enabling private sector value-added product and service development.

3.2.4 Governance / Leadership

- The level of public sector led intervention and stimulus in the Canadian Geomatics Sector has significantly reduced over time. The widespread adoption of standards and open toolkits makes it easy and inexpensive for stakeholders to engage and support the strategic aims of the Sector.
- The role of the private sector in the governance of the Sector has matured and increased so that there is a more balanced collaborative governance model.
- Public sector users of location information and services, rather than public sector data producers, lead the public sector element of the governance of the Geomatics Sector. The Sector has become business- and user-led.

3.2.5 Location Capacity

- Capacity-building programs have been implemented across Canadian society using all stakeholders in the Geomatics Sector to build a location-enabled society. The primary and secondary education systems have been enhanced to include location skills.
- The tertiary education system has been changed to ensure that a range of professionals that use location information in their day to day work (e.g., planners, health service providers, etc.) are competent in directly accessing and using location information and tools. The prominence of the specialized GI professional has diminished relative to that of the GI generalist.
- The Geomatics academic sector in Canada has aligned its research agenda to support the wider Geomatics Sector and is significantly contributing to key issues, including big data, spatial modelling and analysis of complex environmental systems, and the location-enabled society. The academic sector is a world leader and significantly supporting capacity building across the Geomatics Sector.
- A new Information Management profession has emerged and the management of location information is an integral part of this profession. Data Scientists with the skills to exploit the potential of big data to create new value, products and services are also a key part of this profession.

3.2.6 Data Sources

- Canadian SDIs provide seamless access to a broad range of information about land, sea and air and location information integrated with other important information (e.g., statistical, environmental, socioeconomic, infrastructure, etc.).
- Canadian SDIs collaborate and engage with wider international / regional SDIs (e.g., the circumpolar Arctic region), to understand and model cross-border issues. Canada is a significant contributor to global SDI initiatives, including the United Nations Global Geographic Information Management initiative.
- A wide range of innovative data sources are supported, including data from real-time ground-based, airborne and space sensors, and the SDI model is extended to include information within buildings.
- Crowd-sourced information is a key source of location information and citizens are encouraged to contribute. Crowd-sourced mapping solutions, such as OpenStreetMap, have a distinct and complementary role in the Canadian SDI.

3.2.7 Legal and Policy Framework

- Technological developments are leading us towards a location-enabled society. The legal and policy frameworks required to facilitate the development of such a society – a society which feels confident in using and actively and passively creating location information and location-enabled services – are being proactively developed in parallel with these technological developments.

- A consistent and transparent legal and policy framework in areas such as privacy, national security, liability and intellectual property has been developed and is evolving as continuous technological change presents new challenges.
- Canada's SDI initiatives operate successfully under a cooperative model; there has been no need to enforce participation and compliance through new legislation.

4. Potential Future Scenarios

This chapter describes the different elements of scenario planning, including: a depiction of the key environmental forces and drivers of change in the Sector, critical uncertainties around those forces, major issues that are facing the Sector, and potential future scenarios for discussion.

4.1 Key Drivers of the Sector's Future

The Geomatics industry is in a state of transformation, being reshaped by broad paradigm shifts that are well beyond its control. While rapid change has been underway during the past 25 years, it has been incremental. These changes have included, for example: rapid increases in the power of computing technology and applications, which has increased the efficiency and reduced the labour content of data collection and processing; shift in applications from client/server-based to web-based; relatively limited data availability to a “fire hose” of data, especially satellite EO data; proprietary solutions to interoperable solutions; and static to mobile appliances and applications. Such drivers of change, while significant, have been largely manageable since their emergence was at a rate that both the private and public sectors could comfortably absorb, adapt to and benefit from.

However, the emerging paradigm – ubiquitous geography or geography as context – is a much more rapidly occurring shift that is presenting opportunities for serious new players to enter and reshape the market. The dominant role of such new players as Google, Microsoft and Apple with their consumer-focused applications, and the rapid emergence and growth of the location-based services segment, all within the past 5 years, are evidence of this shift. Society is much more location-aware and geography is becoming commonplace in our daily lives through the combination of social networking and location information, from planning our next vacation, to connecting with friends, to finding a good restaurant.

So what has happened; why is this change taking place? We first highlight the broad paradigm shifts that are impacting the Geomatics Sector, followed by an examination of key drivers of change – political, economic, social and demographic, technological and environmental – that will influence the Sector's future. These drivers are summarized in this section, and tables are provided in Appendix C that describe them in more detail, including their anticipated impacts and the relative level of uncertainty of those impacts occurring.

The key overarching change drivers and paradigm shifts that have an impact on all sectors of the economy can be summarized as follows:

- *Pace of change* – Change is happening at an accelerated rate. For example, it took 13 years for the TV to reach an audience of 50 million world-wide, the Internet four years, the iPod

three years and Facebook just two years. These technologies are also highly disruptive and have the power to change entire incumbent industries (e.g., the music recording industry has been transformed since the iPod arrived). The rapid evolution of technologies such as smart phones and nanotechnologies will continue this trend.

- *Speed of communication* – The Internet has transformed the transmission of information, and consumers expect to have access to news and current information in real-time.
- *Communication medium* – The Web is integrated into daily life, from communicating with friends, to sharing photos, to planning trips, to purchasing products.
- *Ubiquitous computing* – Web-connected appliances are mushrooming. In 1992 there were 1 million internet devices, by 2008 this had grown to 1 billion, and is expected to grow to 10 billion by 2016. There are chips in everything and they are all being connected across the Internet. The “Internet of Things” has arrived.
- *Cultural change* – The generation growing up with these changes, the wired generation (sometimes referred to as “Generation Y”) has adapted to this new environment. This cultural or behavioural change has included a refreshing new view of the work / leisure balance and a full embracing of social networking.
- *Moving targets* – The rate of generation of new technical information is also accelerating, with the amount now doubling every two years. This has serious consequences for academic institutions and their students and an existing workforce that is struggling to keep pace with this change.
- *Globalisation* – the market for location information services is no longer local to nations, but has become a global business.

As noted previously a vast range of factors in the Sector’s external environment, their future outcomes or impact, and related uncertainties are described in Appendix C. The factors that have both significant impact and demonstrate high levels of uncertainty are particularly important in scenario thinking because they define the range of possible futures and they are the factors that will lead to divergence in the future (MMSD North America, 2002). Table 1 provides a summary of the authors’ assessments of these key factors.¹

Table 1: Consolidated Drivers of Change, Their Impacts and Uncertainties

Change Driver	Impact	Uncertainty
The open data movement can raise the Geomatics Sector’s profile and influence, but such recognition, and future resources to ensure location data infrastructure sustainability, will only come with proactive efforts.	High	Medium
Rapidly growing business and consumer appreciation of location information value presents great opportunities, but capturing them will require the Geomatics Sector to move up the value chain, learn to play in the broader information landscape and adopt new business models.	High	High
Complex modeling of integrated data sets to support policy development is	High	Medium

¹ Note that some of the factors appeared in more than one driver table but from slightly different perspectives and they were consolidated.

Change Driver	Impact	Uncertainty
another important opportunity, requiring skills upgrading, joint efforts between Geomatics and other professionals, and more effective communication with policy makers.		
Government deficit cutting represents a serious threat to sustainability of SDI and data collection and maintenance programs in the short to medium term, and presents opportunities for innovative partnering.	High	Medium
Requirements for “authoritative” location data will be driven by government operational, legal and international reporting requirements but fiscal restraint will require innovation, including exploiting the potential of VGI.	High	Medium
As society becomes increasingly aware of its dependency upon a properly functioning spatial data infrastructure, legislative frameworks to regulate the functioning of the SDI and ensure delivery of authoritative data may become necessary.	High	High
An important element in the Geomatics industry’s ability to invest and create new jobs is a business-supportive government policy environment (e.g., long-term space plan, CGDI sustainability plan).	High	Medium
Dealing with environmental challenges will be a key means for the Geomatics Sector to demonstrate its value. Strategically important opportunities include: complex modeling of integrated land, marine and air data sets for climate change, flood forecasting, etc.; emergency response and disaster recovery; building energy performance modeling and monitoring; strengthening land governance to prevent “land grab” abuses; and environmental protection of the circumpolar Arctic region.	High	Medium
Global value chains will predominate, increasing competition at home and internationally, but providing opportunities for agile Canadian Geomatics firms to become best in class niche service providers (e.g., smart infrastructure and logistics) that can plug into these value chains.	High	High
Crossover of smart location applications from the consumer to the business market will have a significant impact on traditional Geomatics players, but present partnering opportunities for innovative firms willing to adopt new business models.	High	Medium
Citizens as both important users and contributors of location data will be an increasingly dominant market force, presenting exciting new opportunities for the Geomatics Sector along with important challenges (e.g., adoption of new business models, shift from desktop and server base applications to mobile apps, etc.).	High	High
Capturing the opportunities represented by dominant technology drivers such as centimeter level mobile positioning, free EO space data, management of petabytes of “big data”, cloud services and immersive video will be a major factor in the Geomatics Sector’s success in transforming to a new market paradigm.	High	High
The willingness and capacity of the Geomatics community’s constituent parts to act strategically as a unified Sector will have a critical impact on its ability to influence public sector policy and funding decisions and capture a share of the rapidly changing domestic and international market.	High	High
Fiscal pressures will force all levels of government to rethink what public sector information (PSI) they provide. This rationalization of PSI must be strategic in nature to ensure that PSI can support Canada’s economic,	High	Medium

Change Driver	Impact	Uncertainty
social and environmental needs in the 21 st century. The government Geomatics Sector needs to cast off much of its legacy and radically rethink what location information it needs to capture and maintain in the future.		

4.2 Possible Scenarios for the Future

While there are numerous ways of framing scenarios, the most prevalent method involves defining at least two axes of (critical) uncertainty. Applying the axial method required the review of the above consolidated list of top drivers and then the designation of two of them for the purpose of scenario axes. The drivers not selected were not ignored in the process but remained as lenses for the analytical process of populating the scenarios and describing the scenario stories.

To build the scenarios for the future, the authors propose the following axes of uncertainty:

1. Role of the Citizen

This axis considers just how engaged citizens will be with the Geomatics Sector. At one extreme we have citizens who are fully engaged with the Geomatics Sector, contribute to the capture and maintenance of location data, directly use the location data to challenge and improve public services, to manage their local amenities, and to engage with and connect to global issues, such as climate change, sustainable natural resources and food security. At the other end the Sector continues to be inward looking with a strong focus on delivery of information and services to the public sector professionals to formulate policies and to support the delivery of effective public services. This axis would determine just how citizen centric the future strategy would be.

2. Sector Structure and Cohesion

This axis portrays the variation in cohesiveness of the key stakeholders across the Geomatics Sector. At one end of the axis the relationship between the private and public sectors has been clarified and there are robust and stable policies in place to encourage innovation and growth within the private sector, leading to higher international competitiveness. The Sector has come together around a common vision of the future and Sector leaders are working to create a strong unified Sector with a clear identity, embracing both the core Geomatics groups as well as the expanded location information community (i.e., ICT, LBS, etc.). At the other end of the axis, the Sector is highly fragmented, with the relationship and roles between the public and private sectors very uncertain. The Geomatics community has no clear identity and the Sector is being absorbed into other sectors.

3. Authoritative Location Information Value

This axis encapsulates the significant changes taking place in the source, quality, cost and perceived value of different types of location data. At one extreme lie the Accurate, Authoritative and Assured (AAA) location datasets normally produced by government. The value of AAA information provided by Geomatics professionals is understood to be a critical underpinning for decision-making on societal priorities, and the necessary resources for its continued creation and maintenance are available in the market. At the other end lie products like OpenStreetMap and Google Maps that are aimed at the consumer market, but are increasingly being used in business and government. There is little market value placed on authoritative information in the marketplace.

4. Role of Government

This axis reflects the potential changes in the role of government (federal, provincial / territorial and municipal) in the Geomatics Sector. At one end of the axis, government is a very dominant stakeholder driving and stimulating the Sector with interventions, products and value-added location information services. At the other end of the axis the public sector is a low key enabler and regulator that encourages the private sector to thrive across the Geomatics Sector. This change in the role of the public sector may happen by design or may be forced upon the Sector by fiscal constraints.

5. Industry Position

This axis describes the options open to the Geomatics private sector in Canada. One end of the axis represents a repositioned Sector that has embraced the consumer market and is more citizen-centric, has recognized the dramatic market shifts and has moved up the value chain to strategically focus on specialized value-added location information services to both consumer and business markets, and is recognized as a global leader in specific niche services. Some industry consolidation has occurred and new partnership models have been developed, involving both the private and public sectors, to regain the industry's international competitiveness. The industry has a bright future. The other end of the axis reflects the status quo with a highly fragmented Sector that is primarily focused on location data products and services in the business market, is facing declining international competitiveness and is hoping that the B2C global players will stop eroding its markets. The industry faces a bleak future.

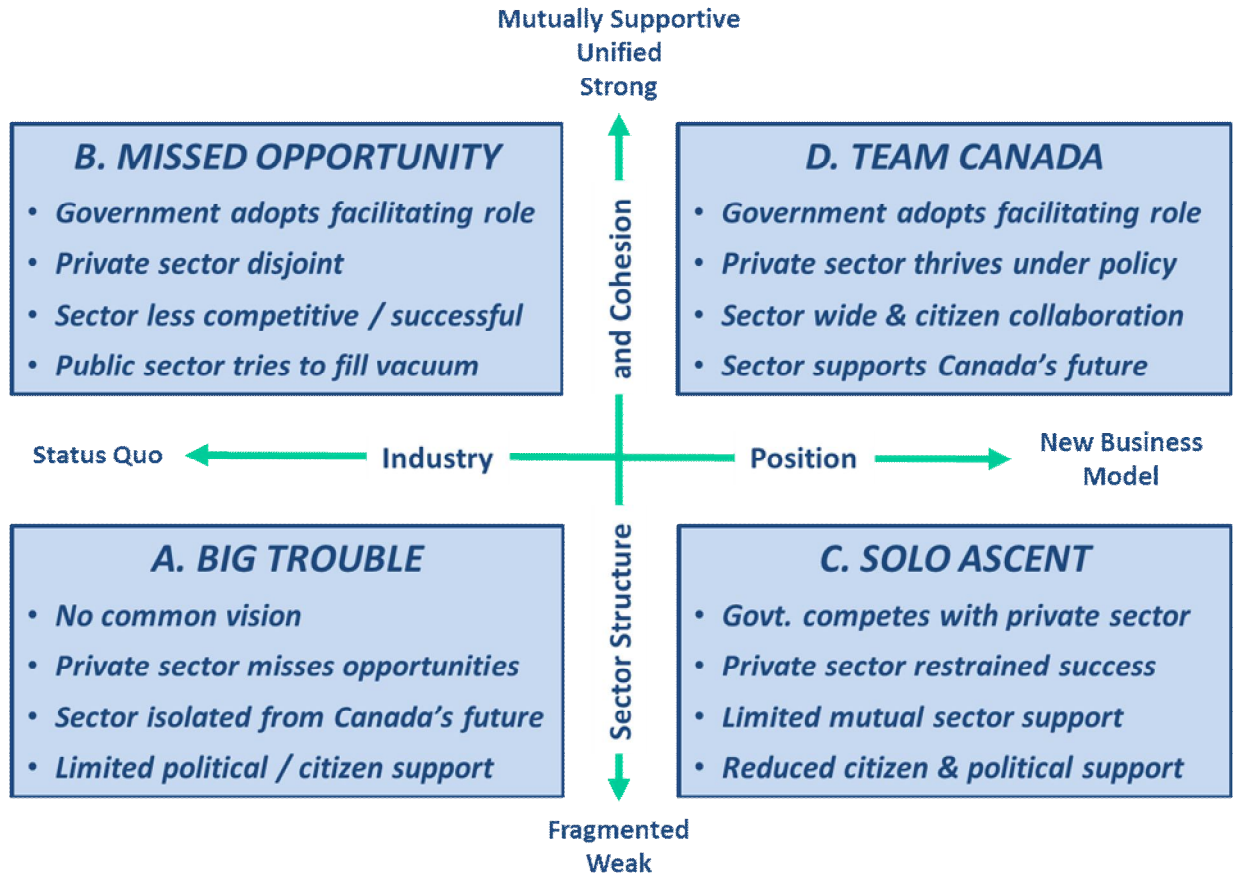
4.3 Scenarios for Discussion

Following the identification of the major drivers of change impacting the Geomatics Sector and the range of axes of uncertainty that could be used to derive the four scenarios for discussion at the workshop, the authors have decided to select “Sector Structure and Cohesion” and “Industry Position” as the axes of uncertainty. These axes provide an excellent set of scenarios to support discussion around how the government could react to fiscal pressures, how the private sector

could respond to the global commercial challenges of B2C competitors, how the stakeholders in the Sector could collaborate more effectively, how the public sector could engage and support the private sector, and how the Geomatics Sector could become more citizen centric.

Figure 6 illustrates how the two selected axes of uncertainty have been used to derive the four scenarios briefly described in the following sections.

Figure 6: Scenario Framework



A. Big Trouble

This scenario describes a situation where complacency sets in across both the private and public sectors. There is no consensus built across the entire Geomatics Sector and no common vision established to drive the Sector to a new and successful position. The lack of vision leads to falling support for the Sector from government as the Sector becomes increasingly detached from mainstream policy issues and citizens rarely get engaged with the Sector.

The private sector is in disarray, does not reposition and respond to the dramatic market shifts and does not move up the value chain to strategically focus on specialized value-added location information services to both consumer and business markets. Instead, the status quo is retained

and there is no consolidation, increase in capacity or significant investment in the Sector. Competition from the global location information service players continues to increase and the size of the private sector diminishes.

The combination of a private sector with reduced capacity, ambition and competitiveness, and a public sector unable to finance and support their aspirations, leads to a Geomatics Sector that cannot capitalize on the opportunities to deliver significant benefits to Canada's society and economy.

B. Missed Opportunity

This scenario describes a situation where the relationship between the private and public sectors has been clarified and the government adopts a facilitating role to ensure that the private sector can thrive within an enabling and stable policy framework; there is a common vision. The government keeps a light regulatory touch on the Sector to ensure the legislative framework is appropriate for new uses of location information and to safeguard that Accurate, Authoritative and Assured (AAA) location datasets critical to underpinning decision-making on societal priorities, continue to be made available to a fit for purpose quality. The government's open data policy is strategically driven and continues to effectively support information needs of the citizen and encourages entrepreneurship and innovation that leads to enhanced economic development. The government is still responsible for delivering core reference geographies and has increased its value-added services capability to meet growing demand for data integration and modeling to help solve complex horizontal policy issues.

The private sector is slow to react to the government's reposition in the Sector, slowed down by a lack of capacity in the Sector, a limited understanding of the requirements for specialized value-added location information services to both consumer and business markets and an inability to gain consensus across the private sector. The lateness of the private sector's response allows the global location information service players to increasingly take control of the Sector, significantly reducing the effectiveness of the Canadian Geomatics Sector. This late and uncoordinated entry into new markets jeopardizes the competitiveness of the Sector. The government is disappointed by the weak response to the challenge by the private sector and becomes more ambitious in its plans to support the consumer and business in the location market.

C. Solo Ascent

This scenario describes a situation where the relationship between the public and private sectors is relatively uncooperative with limited mutual support, and as a result the Sector is fragmented. The government continues its operational role in the Geomatics Sector of managing and delivering location information services, including an increasing number of value-added services. There is a low level of support for the government's location information activities by the private sector (e.g., outsourcing), but the government still competes with elements of the private sector. The government does not provide an enabling and stable policy framework within

which the private sector can safely invest, consolidate and take on new challenges. The government Geomatics organizations are experiencing challenges in delivering against their remit, and are slow to engage the citizen and finding it increasingly difficult to obtain on-going political support. This has a knock on effect on the private sector.

Despite government not providing proactive support for the private sector through appropriate policies and long-term planning, the private sector pushes ahead with repositioning itself by moving up the value chain to strategically focus on specialized value-added location information services to both consumer and business markets. Due to lack of enabling support from the government and the longer time to build capacity, the private sector takes longer to penetrate and gain a foothold in the specialized value-added location information services market. The private sector is subsequently exposed to higher risks of competition from the global location information service players and as a result obtains less market share in Canada and internationally.

D. Team Canada

This scenario describes a situation where the relationship between the private and public sectors has been clarified and the government adopts a facilitating role to ensure that the private sector can thrive within an enabling and stable policy framework. The government has adopted stable long-term program planning, encouraging the private sector to invest and create new jobs. There is a common vision and the Sector has expanded to include the wider location information community. The government keeps a light regulatory touch on the Sector to ensure the legislative framework is appropriate for new uses of location information and to safeguard that Accurate, Authoritative and Assured (AAA) location datasets critical to underpinning decision-making on societal priorities, continue to be made available to a fit for purpose quality. The government's open data policy is strategically driven and continues to effectively support information needs of the citizen and encourages entrepreneurship and innovation that leads to enhanced economic development. The government is still responsible for delivering core reference geographies and has increased its value-added services capability to meet growing demand for data integration and modeling to help solve complex horizontal policy issues.

In response to this facilitating role of government, the private sector has repositioned itself to embrace the new markets and is much more citizen-centric. The private sector has recognized the dramatic market shifts and has moved up the value chain to strategically focus on specialized value-added location information services to both consumer and business markets. Some industry consolidation has occurred and new partnership models have been developed, involving both the private and public sectors, to regain the industry's international competitiveness. The consequence is that the overall Canadian Geomatics Sector collaborates effectively, has shared leadership, is recognized as a global leader and delivers significant and well acknowledged benefits to Canada's society and economy.

5. Strategic Framework

This chapter provides a high level description of the elements of a strategic framework for moving the Geomatics Sector forward as a community, based on the consideration of alternative scenarios. It is intended to provide guidance on a possible approach to the development of a Pan-Canadian Geomatics Sector Strategy. Included are considerations of: alignment with overall common priorities of Canadian governments and citizens; a common vision and mission; objectives; situational analysis; initiatives; and strategy implementation.

5.1 Alignment with Government and Citizen Priorities

An important element of the “strawman” vision for the Geomatics Sector discussed in Section 3.8 is the recognition and acceptance by both politicians and citizens of the Sector’s unique role and contributions. This will only be achieved if those contributions are perceived to be of value to the Canadian economy and society. Accordingly, the development of strategies to realize Vision 2020 should include examining and articulating shared priorities for the nation and defining actions to align the Sector’s offerings with the priorities, as well as helping to shape those priorities. In addition, action will be required on the communications front, to raise awareness about the Sector’s past and present contributions and its plans for renewal and repositioning in the future.

Defining the common priorities across Canadian government levels and sectors of society is challenging. Based upon the literature research and consultations conducted for the White Paper, the authors have identified the following possible priorities, which are aligned with a citizen-centric, open-information oriented Sector strategy approach, as a starting point:

- *Economic Growth and Development* – Expanding and diversifying the Canadian economy is expected to remain a common thrust for governments seeking revenues to cover public services and citizens seeking job security. As the knowledge economy continues to grow, the need to compete globally, innovate and diversify from Canada’s dependence on resource sector revenues is expected to increase in priority.
- *Improved Healthcare* – The impact of the aging Baby Boom generation on Canada’s healthcare system will peak during the next five years, stretching the system to breaking point. This impact is expected to fuel increasing public demand for increased healthcare funding and pressure from governments for reform of and productivity improvement in the system.
- *The Environment* – The challenges of balancing resource development with environmental protection are expected to escalate. While economic growth is currently a higher priority for both governments and citizens, it is expected that the pendulum will swing as evidence of the

impacts of such development on the planet and the quality of life of its citizens continues to mount. Citizens will increasingly demand more responsible development with reduced carbon footprints and will need to be connected to these global challenges of the 21st century more effectively.

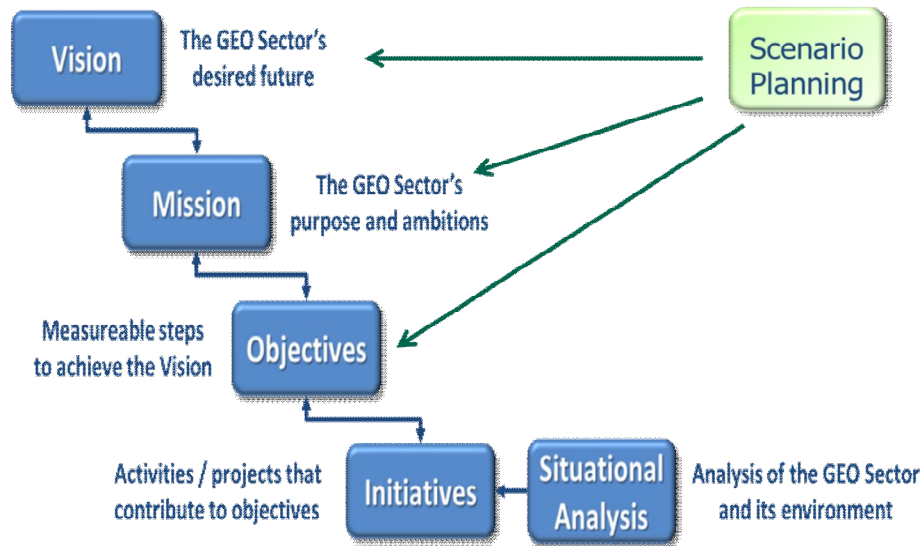
- *Open Government* – The impact of the Internet and social networking is expected to place growing demands on governments for the release of information that has been collected at public expense. As citizens become more empowered, they will expect to take a more proactive role in public policy debate and development, and governments will recognize the potential of the technology and the sharing of information for improved citizen engagement. Public sector information, including location information, will need to be re-aligned with these new requirements.

5.2 Strategic Framework Components

The goal-oriented scenario planning process is based upon a proactive approach to strategic planning that places the Round Table, on behalf of the Geomatics Sector, in charge of enacting its future rather than responding to it. The key outputs from the scenario planning process are an agreed Vision of the Geomatics Sector with enabling actions that have been tested against the events associated with different scenarios. These outputs can be directly fed into the strategic framework components supporting the formulation of the Pan-Canadian Geomatics Sector Strategy; the vision and mission have been directly created and the enabling actions can guide the strategic objectives. The process of scenario planning and debating the future of the Geomatics Sector will have raised the understanding of all participants to a common level, making the formulation of the Pan-Canadian Geomatics Sector Strategy easier in the multi-stakeholder environment.

This section provides some key building blocks to help the Round Table construct a Pan-Canadian Geomatics Sector Strategy. The components of the strategic framework are illustrated in Figure 7, following which each is briefly described.

Figure 7: Strategic Framework Components



A **Vision** statement describes the future “ideal state” that the organization desires. It is usually expressed as a succinct and memorable single statement that is then expanded upon in statements that provide a more complete description of the desired future state. It is a long-term view and concentrates on a specific point in the future. A good Vision statement will inspire and motivate the stakeholders to take the necessary actions to ensure that the vision is realized.

A **Mission** statement describes the purpose and ambitions of the organization and what it does to realize the Vision. It can also be expressed succinctly in a single statement and expanded upon in a narrative description. It is applicable both now and in the future and identifies service, to whom, guiding value, success measure and uniqueness. A good Mission statement acts as guidance for the day to day activities of all the organizations and people that share the common Vision.

Objectives are measurable steps that in combination lead to the realization of the Vision. Sometimes referred to as S.M.A.R.T. objectives (see sidebar), they answer who, what, where, when and how questions.

Initiatives are projects and activities that are undertaken by different stakeholders to contribute to the attainment of Objectives and the realization of the Vision. They involve the investment of financial and human resources in meeting Objectives and dealing with key issues.

S.M.A.R.T. OBJECTIVE

- **Specific**, well defined and clear so that it will be easily understood by anyone with a basic knowledge of the sector;
- **Measurable** in terms of concrete criteria for measuring progress toward the attainment of the objective;
- **Achievable**, realistic and neither out of reach nor below standard performance, taking into account available resources and time;
- **Relevant** to the needs of the sector and its markets; and
- **Time-bound**, with specific target dates that ensure a focused effort on obtaining the objective.

Initiatives are typically defined after a **Situational Analysis** has been undertaken of the organization and its environment as it is currently and how it may develop in the future. A common approach is called S.W.O.T. Analysis, a strategic planning tool used to evaluate the strengths, weaknesses, opportunities and threats affecting the achievement of an objective, which involves examining the internal and external environment of an organization. In this case, the “organization” is the Canadian Geomatics Sector and the “objective” is to realize the Sector’s vision of the future in 2020. This analysis can help the Sector to identify strategically important issues that may affect the attainment of objectives and to define effective Initiatives.

5.3 Vision Statement

A “strawman” version of the future state of the Geomatics Sector in 2020 was portrayed in Section 3.8. This provides a starting point for the Round Table’s work in articulating a Vision statement and expanding on this statement. Possible Vision statements are:

1. *The Canadian Geomatics Sector is serving business and consumer markets and its contributions to the economy and to society are well understood and recognized.*
2. *The contributions of location information to the economy and to society are understood, highly valued and recognized.*
3. *The Canadian Geomatics Sector is recognized at home and abroad for its excellence in location information products and services.*
4. *The location information market is dynamic and growing and the Canadian Geomatics Sector is a world-leading player.*
5. *The Canadian Geomatics Sector is a dynamic, unified force for the delivery of highly valued location information.*
6. *The Canadian Geomatics sector engages citizens and businesses to deliver a caring, innovative and economically successful Canada.*
7. *The Canadian Geomatics sector supports citizens and businesses to engage in the process of delivering a caring, innovative and economically successful Canada.*

Once a Vision has been agreed upon by the Round Table, actions to realize the Vision will be defined. To reiterate, this is an unconstrained view of the future and the actions which must be taken to get there. Following through with the goal-oriented scenario planning process will involve evaluation of the Vision against the potential future scenarios and ultimately production of the series of decision tables that can be used to guide the formulation of the remaining components of the strategic framework (See Section 2.7).

5.4 Mission Statement

Once the Round Table chooses a Vision statement, it will articulate a compatible Mission statement and expand on this statement. Possible Mission statements are:

1. *We provide high value-added location information products and services to meet decision making and policy development needs that are recognized as world class in addressing priority economic, environmental and societal needs.*
2. *We make recognizable, highly valued contributions to the Canadian economy and society by providing location information products and services to meet decision making and policy development needs.*
3. *We help to meet decision making and policy development needs by providing world class location-enabling products and services that have recognized value.*

5.5 Objectives

The “strawman” Sector vision in Section 3.8 identifies strategically important dimensions that provide a framework for the definition of Objectives, and the possible formation of working groups to address initiatives and implementation actions for each. Possible objectives are suggested below for the Round Table’s consideration.

*Objective 1: By the year 2020, create an **identity** for the Geomatics Sector that is clear and well understood by public and private sector senior decision-makers and the public nationwide, through recognized contributions to national priorities.*

*Objective 2: By the year 2020, broaden the Sector’s products and services to address demand for high value-added location information products and services in domestic and international B2B and B2C **markets**, through industry consolidation, effective partnering and adoption of an extended value chain.*

*Objective 3: By the year 2020, adopt a modified Sector **business model** based on government focus on location infrastructure, open data and supportive policy environments and industry focus on value-adding, through negotiation*

of respective roles and definition of required changes in structures, policies and responsibilities.

*Objective 4: By the year 2020, adopt a new Sector **leadership / governance** model that is business- and user-led, through engagement of the broader location industry to redefine and strengthen the private sector and of the user community to more effectively address their needs.*

*Objective 5: By the year 2020, create a strong **capacity** to location-enable government and society in the development of effective policies and solutions to society's priority concerns and needs, through delivery of new tools and resources in the education system and professionalization of the tasks involved in maintaining the location infrastructure and exploiting the potential of big data.*

*Objective 6: By the year 2020, provide easy access to integrated location **data sources** in Canada and internationally, through expansion of Canada's SDI to include data in most demand and effective partnering with other nations to build a global SDI.*

*Objective 7: By the year 2020, establish a **legal and policy framework** that is proactive and facilitates the location-enabling of Canadian government, business and society, through removal of legal barriers to location information use.*

5.6 Situational Analysis

If the Round Table chooses to use S.W.O.T. methodology for the situational analysis, it can build upon the work conducted for the White Paper on drivers of future change. The results of the analysis are often presented in the form of a matrix as illustrated in Table 2, which identifies a few example strengths, weaknesses, opportunities and threats.

Table 2: S.W.O.T. Analysis Framework

	Helpful to achieving the objective	Harmful to achieving the objective
Internal attributes of the organization	<p>Strengths</p> <ul style="list-style-type: none"> World class SDI Solid private-public sector linkages Emerging leadership model 	<p>Weaknesses</p> <ul style="list-style-type: none"> Industry fragmentation Limited recognition of changing market paradigm No clear Sector identity
External attributes of the environment	<p>Opportunities</p> <ul style="list-style-type: none"> Growing consumer interest in location Increasing demand for horizontal policy solutions Increasing demand for high value-added location products and services 	<p>Threats</p> <ul style="list-style-type: none"> B2C competitors entering Sector market space Declining demand for processed data Government budget constraint and shifting priorities

The analysis of change drivers has identified many of the external threats and opportunities facing the Geomatics Sector, but some additional analysis will be required, particularly of the competitive environment. The White Paper has also identified some of the Sector's inherent strengths and weaknesses, but additional focus on the internal environment will be required. The results of the Canadian Geomatics Environmental Scan and Economic Value Study will also feed into this analysis. The resulting S.W.O.T. matrix will provide additional insight about the Sector's current position and inform the development of specific Initiatives in response, to help ensure that Objectives are met.

5.7 Initiatives

Once the Round Table has agreed upon the Objectives that will contribute to the realization of the Vision and further analyzed the Geomatics Sector's current situation, the demanding task of identifying specific Initiatives to meet the Objectives will be undertaken. This will include consideration of how the initiatives under the previous Six Point Action Plan and other major initiatives within the Geomatics Sector fit into the strategic framework. Table 3 provides some initial directions for this task.

Table 3: Potential Initiatives to Achieve Geomatics Sector Objectives

Objective	Initiatives
1. Identity	<p>Design and execute a national outreach and awareness building campaign (i.e., marketing plan) to communicate the role and value of the Geomatics Sector.</p> <p>Develop case studies of successful applications of location information in different economic sectors, including documented cost and time savings</p> <p>Identify specific new opportunities to showcase the value of location information in contributing to national policy priorities</p> <p>Incorporate findings from the Geomatics Sector Environmental Scan and Economic Value Study into redefinition of the Sector's identity</p>
2. Market	<p>Develop communication materials to build Geomatics Sector awareness of the rapid market changes and the urgency of addressing new threats and opportunities, based on annual market studies</p> <p>Develop mechanisms to promote the merits of industry restructuring, an extended value chain, development of targeted value-added products and services, and partnering to address priority domestic and international market demands</p> <p>Identify opportunities for the Geomatics Sector to partner with B2C players to better serve both the B2C and B2B location markets</p>
3. Business Model	<p>Develop proposals for differentiating and reconciling public and private sector roles and responsibilities and promote their adoption</p> <p>Secure a sustainable solution to the widespread adoption of Open Data by government</p> <p>Develop guidance on change management to help facilitate the adoption of the new model</p> <p>Identify changes in government policy and potential interventions that would facilitate the migration of the industry to higher value-added products and services</p>
4. Governance / Leadership	<p>Develop an engagement plan for the Geomatics Sector to raise stakeholder awareness of the Round Table's role and the strategic plan and engage the community as active participants in strategy implementation</p> <p>Develop strategies to engage key players in the broader location industry to partner with the Geomatics Sector in repositioning the Sector and its role</p> <p>Develop a Pan-Canadian Location Accord and oversee its ratification by key public and private sector stakeholders</p> <p>Develop strategies to engage location information users in future Geomatics Sector governance</p> <p>Explore innovative new governance models that will accommodate the needs of the wide range of stakeholders</p>
5. Location Capacity	<p>Inventory current location capacity resources in the education system to identify gaps and opportunities for both professional and non-professional location information users</p> <p>Engage education system stakeholders in the design and development of additional resources to address gaps and opportunities</p> <p>Engage the academic community in strategy development for identifying and addressing new innovation requirements and research to meet emerging market demands</p>
6. Data Sources	<p>Develop and implement a plan to integrate and make all location data (land, sea and air) required to address Canadian government and citizen priorities easily</p>

Objective	Initiatives
	accessible as a key element of open data initiatives Build effective mechanisms to integrate crowd-sourced location data into SDI initiatives Develop strategies to position Canada as a leading contributor to global SDI initiatives
7. Legal and Policy Framework	Identify key legal and policy impediments to location-enablement and contribute to amending existing or drafting new legislation or policy to remove those obstacles Strengthen the voluntary model of SDI development and use in Canada by developing and implementing a data stewardship model and identifying and removing remaining barriers to sharing data through the infrastructure Assess and document the requirements for professional certification of certain Geomatics Sector activities and build the case for a mandatory or voluntary certification program

5.8 Implementation Planning

The final component of the strategic framework is the development of strategy implementation plans. At this point the strategic process to realize Vision 2020 will move out of the hands of the Round Table into the hands of stakeholders, with the Round Table monitoring progress. Each stakeholder (e.g., government organization, association, NGO, academic institution and company) that has been engaged in the strategy development process under the Round Table's leadership will be encouraged to take action. This will involve the development and execution of implementation plans that contribute to the execution of the agreed upon Initiatives, including how the activities under the previous Six Point Action Plan and other major Sector initiatives fit in. Such implementation plans typically encompass the following:

- *Activities* – The specific projects that will be undertaken or actions that will be taken to address the strategic Initiatives.
- *Linkages* – How the plan links to a previously defined Objective(s) and Initiative(s) and contributes to their achievement.
- *Resources* – The sources and extents of the resources (i.e., financial, human, technological, etc.) that will be required to complete the plan.
- *Timeframe* – The schedule for the project or activities indicating key milestones and targeted completion.
- *Performance measurement* – The criteria that will be used to determine if the plan has been successful and the tools that will be used for success measurement and for progress monitoring.

The success of a strategic planning exercise ultimately rests upon how well implementation efforts are planned and executed. Following through on the planned actions within an organization is a demanding process, requiring persistence and the use of effective performance

measurement techniques. The present context presents an even greater challenge because many of the implementation activities will be undertaken by organizations and groups that are beyond the direct control of the Round Table.

However, similar efforts have been successful in other sectors. The Geomatics Sector can take advantage of the good practices and lessons learned from experiences in other sectors that are described in Appendix B. In summary, the keys to success include: a common vision and understanding of how stakeholder groups can contribute towards the vision, a thorough, well designed strategic framework, effective communications and stakeholder engagement, and strong leadership from strategy champions, which could be demonstrated through a Pan-Canadian Location Accord.

6. Summary and Conclusions

This White Paper provides a solid foundation for the Round Table to develop a pan-Canadian strategy for the future growth and success of the Geomatics Sector. A scan of the literature and documentation of key trends and developments in the Sector's environment, supplemented by selected consultations with stakeholders, identified a wide range of drivers of change that are impacting the Sector and its markets. Using the goal-oriented scenario planning model, the authors established the context for a Round Table workshop on scenario planning. This included the creation of a "strawman" vision of the Sector's "ideal state" in the year 2020, and potential future scenarios based on impacts and uncertainties of key driving forces.

A high level strategic framework is described to stimulate the Round Table's thinking as it plans next steps in the pan-Canadian strategy development process. The framework includes preliminary Vision and Mission statements for consideration, along with suggested Objectives and example Initiatives along with the potential use of Situational Analysis to inform the development of those Initiatives. Considerations for moving the process forward to the Implementation Planning stage are also provided.

The development and implementation of a strategy by the Round Table on behalf of the Canadian Geomatics Sector is an undertaking involving considerable effort and complexity. Challenges that the Round Table will face include:

- Identifying and obtaining strong, high level leadership for the initiative across the stakeholder groups.
- Developing widespread support for and engaged commitment to the undertaking from across the Geomatics community;
- Engaging representation from the broader location information community to ensure that the strategy will be effective in repositioning the Sector;
- Understanding the needs of citizens and engaging them in the process to ensure a more citizen-centric strategy.
- Securing the resources to complete the undertaking in an effective and expeditious manner; and
- Developing the mechanisms to facilitate the Round Table's work in negotiating the assignment of implementation activities and monitoring their progress.
- Ensuring that the proposed strategy is supportive of the wide range of related strategies in the policy landscape.
- Having the confidence to introduce a radically new strategy for the Geomatics Sector and change it over time as new issues emerge.

The Geomatics Sector has a historic opportunity to proactively address these challenges and move forward quickly on a strategic path. The Canadian Geomatics Community Round Table has

brought together Sector leaders that have demonstrated an interest in taking strategic action to reposition the Sector so that it can capitalize on new opportunities to contribute to Canada's economy, environment and society. Taking advantage of this momentum to meet and address these challenges is both important and timely. Location awareness has never been higher, the complexity of making critical decisions and policies that will shape the future of Canada and its peoples has never been greater, and location-enablement of those processes will be a valuable contribution. *Carpe diem – Seize the day!*

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B. Good Practices in Defining Sector Strategies

This appendix summarizes information gleaned from the examination of other sector strategy development efforts. Table 4 identifies those strategy documents and the good practices and lessons learned that can help inform the development of a strategic framework for the Canadian Geomatics Sector.

Table 4: Strategy Development Good Practices and Lessons Learned

Strategy Document	Good Practice	Lesson Learned
<p><i>A vision for Canada's forests: 2008 and beyond</i> (Canadian Council of Forest Ministers, 2008)</p>	<p>Identification and engagement of political champions (Canadian Council of Forest Ministers – CCFM)</p> <p>Alignment with political and citizen priorities</p> <p>A clear and succinct vision statement</p> <p>A long-term focus, articulated in a series of five-year strategies that are adjusted based on changing approaches, issues, and emphases</p> <p>Identification of the importance of whole community support of, and engagement in realizing, the vision</p> <p>Identification of the requirement for effective partnerships between the segments in the forestry sector, and with aligned sectors, for future success</p> <p>Clear articulation of the roles and responsibilities of the key segments of the sector (i.e., the champion – CCFM, governments, forest companies, woodlot owners, etc.)</p> <p>Creation of a Criteria and Indicators Framework as a tool for measuring progress on goals and towards the vision</p> <p>Identification of specific means and venues for creating awareness of the sector vision and communicating progress on its strategic plan</p>	<p>Recognition of the need to balance economic and environmental goals</p> <p>The increasing importance of integrating the interests and contributions of other sectors and communities into the forestry sector strategy (e.g., Aboriginal businesses, urban citizens, other resource sectors, tourism sector, etc.)</p> <p>Recognition of the need to transform the sector (e.g., increased R&D to diversify the array of products, value-added opportunities, adjustment in public policies and institutions, improved training and education)</p> <p>Emphasis of the sector's role in helping to mitigate and adapt to the impacts of climate change</p> <p>Recognition of the need for changes in progress assessment indicators as new issues emerge</p>

Strategy Document	Good Practice	Lesson Learned
	A focus on a few critically important goals aligned with the future vision	
<p><i>British Columbia's Technology Strategy – Building B.C.'s Economy</i> (Ministry of Jobs, Tourism and Innovation, 2012)</p>	<p>Identification and articulation of the critical importance of technology to today's and tomorrow's economy and jobs (e.g., tech job growth twice the average in BC, with wages 1.5 times the average)</p> <p>Illustration of specific technology impacts across economic sectors</p> <p>Emphasis of the importance of collaboration between industry, academia and government segments of the technology sector</p> <p>Commitment to develop a government procurement program that can help new businesses bridge the pre-commercialization gap, and give them a chance to enter the marketplace</p>	<p>Recognition of the need to create effective linkages between the knowledge and resource sectors to improve resource development productivity and create new value-added products and services</p> <p>Identification of the need to support small and medium sized enterprises as the engines of innovation, and creation of a new commercialization program to provide them with access to innovation talent in post-secondary institutions</p> <p>Recognition of the need to review past research and innovation funding to identify means of achieving greater economic benefit from future funding allocations</p>
<p><i>Realizing the Power of Location: A Location Information Strategy for Western Australia</i> (State of Western Australia, 2010)</p>	<p>Alignment of the strategy with governments' priorities (e.g., reducing duplication and improving efficiencies, improving access to public sector data and Government 2.0, managing population growth, adapting to climate change and ensuring sustainable development)</p> <p>Recognition of the value of location information as a complete value chain: from data collection, to its management, maintenance, compilation and finally its use, through intelligent analytical tools for planning and superior decision making</p> <p>Identification of the strategy benefits, including the use of case studies to illustrate specific benefits of location information in different sectors and applications</p> <p>A clear and succinct vision statement and goals</p> <p>Identification of strategic initiatives and actions to help address government priorities</p> <p>Development of location based solutions for two high</p>	<p>Recognition that the status quo (i.e., fragmented data holdings in varying formats and standards, lack of an infrastructure to facilitate data sharing and integration, etc.) is inadequate to address the emerging challenges of changing citizen expectations and demands for more and better public information</p> <p>Recognition of the need for ongoing assessment of, and alignment to, key Government strategies to ensure that the strategy continues to support the State's priorities</p> <p>Identification of the following key requirements for strategy success:</p> <ul style="list-style-type: none"> ▪ stakeholder engagement and awareness-raising; ▪ a flexible governance structure; ▪ a performance measurement framework; and ▪ input and commitment of government, industry and academia

Strategy Document	Good Practice	Lesson Learned
	<p>priority government projects as a means of demonstrating that the strategy supports the State's key initiatives</p>	<ul style="list-style-type: none"> ▪ involvement of the private sector as a key stakeholder in the strategy formulation process
<p><i>New Zealand Geospatial Strategy</i> (Land Information New Zealand, 2007)</p>	<p>Cabinet agreement to the establishment of a national spatial data infrastructure (SDI) that will effectively connect geospatial information with users, gained by Land Information New Zealand (LINZ)</p> <p>Research that identified an NSDI as the best intervention in the short term for removing key barriers to greater use of government geospatial information</p> <p>Research that also identified, through economic modelling, which activities will contribute the most productivity benefits to the economy – this clarified the priorities</p> <p>An inclusive partnership with central and local government, business, academia, and the open data community that was formed to support the initiative</p> <p>Integration of the initiative into the broader arena for open data, which helped ensure that the national SDI formed a key part of New Zealand's knowledge infrastructure and a key role for geospatial data within the wider framework of the Directions and Priorities for Government ICT</p> <p>A multi-pronged approach to building capacity through research, education and immigration policy</p>	<p>Top level support within the Cabinet ensured success of this NSDI initiative</p> <p>Economic studies provided the evidence to promote the importance of the initiative and to set priorities for implementation and to ensure maximum benefits to the New Zealand economy in the short to medium term</p> <p>Integration and support of wider government policies (e.g., open data) safeguarded the support and funding of this initiative</p> <p>Capacity building was identified early as a critical success factor and measures implemented quickly to build capacity</p> <p>This was a broad and inclusive initiative involving a wide range of stakeholders</p>

C. Drivers of Change

This appendix summarizes in tabular form the results of the background research and consultations on drivers of future change. In each table, the first column identifies the driver, the second column describes different impacts of the driver, the third column rates the anticipated level of impact on the Geomatics Sector in 2020 (high – H, medium – M or low – L) in each case and the final column rates the relative level of uncertainty of the impact occurring in 2020 (high – H, medium – M or low – L) in each case.

The sources of this information include (Coote, Feldman, & McLaren, 2010), (Dawson, 2012), (Geographic Information Panel, 2008), (Hickling Arthurs Low, 2011), (Hinse, 2012), (IBM, 2012), (Kallai, 2003), (Maloney, 2012), (Mackenzie, 2012), (McKinsey Global Institute, 2011), (National Geospatial Advisory Committee, 2009), (Ordnance Survey, 2012), (Policy Horizons Canada, 2012), and (Shukle, 2012).

C.1 Political / Governance / Policy Drivers and Impacts

Political institutions have a significant influence on the Geomatics Sector, not only because governments are primary users of the Sector’s products and services but also because public policy directions have important impacts on the market. Table 5 identifies some key political / governance / policy change drivers and their impacts on the Canadian Geomatics Sector.

Table 5: Political / Governance / Policy Drivers and their Impacts on the Sector

Political Driver	Impacts	Impact (2020)			Uncertainty (2020)		
		H	M	L	H	M	L
1. Open government	<ul style="list-style-type: none"> ▪ As the citizenry becomes increasingly informed and engaged, pressure to make location data and other public sector information free to reuse and easily accessible and useable will increase further, making cost recovery from sale of location data extremely challenging. ▪ Pressure to adopt common data licensing models will mount as consumers begin to experience licensing conflicts with multiple data sources. ▪ The Sector is well positioned to be the “poster child” of the open data movement, with the investments that have been made in SDI initiatives, but such recognition, and future resources to ensure infrastructure sustainability, will only come with proactive efforts to raise the Geomatics Sector profile. 	✓				✓	
			✓			✓	
		✓				✓	

Political Driver	Impacts	Impact (2020)			Uncertainty (2020)		
		H	M	L	H	M	L
	<ul style="list-style-type: none"> In order to take advantage of the business opportunities that opening government data is intended to stimulate, Geomatics innovators will need to learn to play in the broader information landscape and adopt new business models. For the Sector to take full advantage of this opportunity to innovate and create new business opportunities, citizens and communities will require capacity building. 	✓			✓		
2. Finding horizontal solutions to key policy issues	<ul style="list-style-type: none"> The pressure to collaborate will increase as the shift towards more holistic and inter-disciplinary means of tackling public policy priorities continues, and the Geomatics Sector is a leader in making collaboration work. Pressure will increase to produce complex modeling of integrated data for “what if” scenario development and strategic impact assessments in support of policy development, and location will be a critical element to enable visualization of different scenarios and impacts.² Higher demands for interoperable information services will encourage the elimination of data and systems “stovepipes” within government, and test the capabilities of SDI implementations. Location information will increasingly be brought to bear to help deal with priority horizontal issues such as integrated resource and environmental policy development, land use planning and land stewardship, devolution of land management responsibilities, responsible resource development, public safety and security and disaster management and recovery. 		✓				✓
		✓				✓	
			✓				✓
3. Overall budget restraint, government downsizing and changing priorities	<ul style="list-style-type: none"> Governments struggling to meet the growing health care demands of an aging population with increasing incidence of multiple chronic health conditions will be further tempted to find resources by cutting less visible and politically sensitive government services, like Geomatics, necessitating proactive measures to communicate the value of these services. Since the Internet has emerged, and the creative dynamism this has brought with it has shaken the notion that content needs to be paid for at the point of use, government Geomatics organizations face an uphill battle in accessing funding for creation and maintenance of the authoritative data required to underpin social and economic 	✓				✓	
			✓			✓	

² Views provided by interviewee

Political Driver	Impacts	Impact (2020)			Uncertainty (2020)		
		H	M	L	H	M	L
	<p>development.</p> <ul style="list-style-type: none"> Cost reduction and efficiency requirements will see more government Geomatics organizations outsourcing processes to the private sector, partnering with VGI data providers and others, and focusing on the roles of commissioning and managing the delivery of a complete location information framework. Increasing costs of data management and infrastructures are causing pressures on governments, particularly in a period of fiscal restraint. Streamlining expenditures through collaborative and common innovative solutions will offer new opportunities for cost containment and increased efficiencies (e.g., cloud computing, spatial data infrastructures, and shared procurement of satellite and airborne imagery). Government cost cutting exercises are creating opportunities for location-based analyses to be used to identify potential areas for efficiency savings in delivering public services. 		✓			✓	
4. Shifting responsibilities	<ul style="list-style-type: none"> Driven by the demands of fiscal restraint and the collaborative SDI development model in Canada, framework data collection overlap will be virtually eliminated, with data being collected once, closest to source. At the federal level, the focus will be on consolidation and integration of data from provinces / territories, and at the provincial level, efforts to acquire and integrate local government data will increase. 		✓				✓
5. Authoritative location data	<ul style="list-style-type: none"> If location data becomes more fully integrated within decision-support tools, the importance of authoritative, trusted data will become more widely recognized, and the role of government to provide such data may be more clearly understood and accepted and resources will be made available for its maintenance. At least two key requirements will ensure that authoritative location data will continue to be required: government’s legal responsibilities and requirements for international reporting (e.g., climate change, forest cover, CO₂ emissions, etc.), which will require integration of location data with other types of data.³ Challenges to the “authoritativeness” of government location data, especially in high population areas, are being mounted by the 		✓		✓		
			✓			✓	
			✓			✓	

³ Views provided by interviewee

Political Driver	Impacts	Impact (2020)			Uncertainty (2020)		
		H	M	L	H	M	L
	proponents of crowd-sourced data who claim that their data is more accurate and current.						
6. Ideological versus evidence based policy- and decision-making	<ul style="list-style-type: none"> In the political arena, tensions exist between these different approaches to policies and decisions. Should the ideological based approach predominate, the value of authoritative location data may be perceived to be less, with a resulting diminishment of available resources for its creation and maintenance. 		✓			✓	
7. Legislated spatial data infrastructure	<ul style="list-style-type: none"> As society becomes increasingly aware of its dependency upon a properly functioning spatial data infrastructure (similar to the dependency upon the transportation and utility infrastructure), political pressure may mount to install legislative frameworks to regulate the functioning of the SDI and ensure delivery of authoritative data (e.g., this has happened in the European Union through the INSPIRE directive that mandates member states to make environmental data available for policy formulation). 	✓			✓		
8. The environmental agenda	<ul style="list-style-type: none"> Growing public concern about environmental degradation due to increasing pollution and global climate change is driving public sector investments in new location data sources, particularly from ground-based sensor webs and satellite EO sensors (e.g., the EU's Copernicus initiative – formerly the Global Monitoring for Environment and Security (GMES) initiative). 		✓				✓
9. Business-supportive government policy	<ul style="list-style-type: none"> Canada needs an innovation system focused on market results, competitive IP and public support to all players in the system that matches OECD norms. Certain types of government policy setting can serve as a stimulus to industry, such as: <ul style="list-style-type: none"> open data policies at the federal, provincial and local levels can provide access to more high quality location data that applications can be built upon, stimulating innovation and economic development. “green economy” policies can result in new infrastructure development that requires location data and services for planning and construction. liability assignment policies can force utilities to conduct accurate as-built surveys or face 		✓		✓		
			✓				✓
			✓			✓	
			✓		✓		

Political Driver	Impacts	Impact (2020)			Uncertainty (2020)		
		H	M	L	H	M	L
	liability for damages resulting from inaccurate location information ⁴ <ul style="list-style-type: none"> ○ long term plans can help provide stability and encourage industry to invest and create new jobs (e.g., space plan, CGDI sustainability plan) 	✓				✓	
10. Focus on northern economic development	<ul style="list-style-type: none"> ▪ In Canada, the combination of climate change and federal government policy priorities (i.e., arctic sovereignty, social and economic development, environmental protection and governance devolution) have resulted in increased activity in the north and rising demand for location information, including marine information. ▪ Location services have the potential to help focus the provision of resources to activities in geographical locations where they are most needed, thereby enabling an increase in productivity (i.e., achieving more economic activity using the same or fewer resources). 	✓				✓	
		✓			✓		

C.2 Economic and Market Drivers and Impacts

The overall state of the economy, economic shifts and economic circumstances in the location marketplace influence the health of the Sector and its future prospects. Since the public sector is a key buyer of location products and services, the impact of economic downturns on government spending is a particularly important factor. Table 6 identifies some of the most important economic drivers and their impact on the Geomatics Sector.

Table 6: Economic and Market Drivers and their Impacts on the Sector

Economic and Market Driver	Impacts	Impact (2020)			Uncertainty (2020)		
		H	M	L	H	M	L
1. Globalization	<ul style="list-style-type: none"> ▪ Important policy and investment decisions in Canada will increasingly be influenced by global forces, with more open trade and less domestic industry protection, resulting in intensified competition in the location market. ▪ Industry consolidation is occurring with acquisitions focused on creation of vertical value chains encompassing data collection, management and 	✓				✓	
			✓			✓	

⁴ Views provided by interviewee

Economic and Market Driver	Impacts	Impact (2020)			Uncertainty (2020)		
		H	M	L	H	M	L
	<p>applications technologies and services (e.g., Trimble, Rolta and Hexagon).⁵</p> <ul style="list-style-type: none"> Global value chains will be divided into smaller and smaller tasks in the emerging “project economy”, with more job instability and fewer benefits. Outsourcing by global players of parts of their location information value chain will grow, providing opportunities for agile and innovative Canadian Geomatics firms. If information service providers cannot easily access Canadian data with limited restrictions on reuse, they will source alternatives globally. 	✓				✓	
2. Economic power shifts	<ul style="list-style-type: none"> The BRIC⁶ and “Next Eleven (N-11)”⁷ countries will play a much more significant role in shaping global policy and they will bring new values, norms and priorities so that building consensus on responses to global issues may be more difficult. Canada can maintain its relative global influence by carving out a niche in providing new collaboration processes for idea-generation and consensus-building to help identify solutions that work for everyone; Geomatics can play an important role in these processes. China and India have money to invest and Canadian companies are on their radar, so attractive Geomatics companies could face the decision of being acquired or competing. Intellectual capital is growing rapidly in China and India, producing an R&D advantage that Canadian Geomatics players can access through partnerships and alliances. Competition from companies in lower wage countries will continue to increase in both domestic and international markets. 		✓		✓		
3. Global economic uncertainty, with overall world growth below trend for the next 2 years (NIESR, 2012)	<ul style="list-style-type: none"> Concerns about uncertainty will dampen private sector willingness to invest and create new jobs. Governments will continue to place a priority on deficit and debt reduction. The Conference Board of Canada has indicated that growth in Canada could well be reduced due to the following issues (The Conference Board of Canada, 2012): 		✓			✓	
			✓			✓	
			✓			✓	
			✓			✓	

⁵ Views provided by interviewee

⁶ Brazil, Russia, India and China (see http://www.goldmansachs.com/gsam/individuals/products/growth_markets/bric/index.html)

⁷ Bangladesh, Egypt, Indonesia, Iran, Mexico, Nigeria, Pakistan, Philippines, Turkey, South Korea, and Vietnam (see http://www.goldmansachs.com/gsam/individuals/products/growth_markets/n11/index.html)

Economic and Market Driver	Impacts	Impact (2020)			Uncertainty (2020)		
		H	M	L	H	M	L
	<ul style="list-style-type: none"> ○ Despite the improving global situation, Canada’s near-term performance is being held back by significant fiscal restraint. A return to full employment will not occur until 2016. ○ Beyond 2016, economic growth will align with easing potential output growth, a result of the exodus of baby boomers from the labour market. ○ Steady growth in global demand for energy and other commodities will continue to stimulate investment and production in Canada—a favourable condition that will also keep the currency strong in relation to the US dollar. ○ Strong immigration will not reverse Canada’s aging trend. ○ By 2035, Canada’s population will reach 44 million, roughly 10 million more than today. ○ The recession has left the federal and many provincial governments mired in deficit. Provincial governments will find it particularly difficult to correct the situation as aging boomers put pressure on health care budgets. At the same time, the federal government is expected to play a smaller direct role in tomorrow’s economy. 						
4. Spatial not so special	<ul style="list-style-type: none"> ▪ Ubiquity of location information means high volume use of online data, resulting in increased competition and downward pressure on prices, encouraging Geomatics companies focused on the data collection and processing business to move up the value chain to avoid failure. 	✓				✓	
5. Business to Consumer (B2C) market growth	<ul style="list-style-type: none"> ▪ While the highest growth segment for location information is the B2C market, with over 100 million people using web maps each month, virtually none of these data are provided by the traditional Geomatics industry players and none of them are paid for by the end user. ▪ Even if Geomatics businesses do not see a role in the B2C market, they may soon be facing competition in the business to business (B2B) market space from crossover B2C players that have developed challenging cost and business models. Increasingly, the consumer to business (C2B) market is emerging as consumer applications are finding roles within the business environment. Partnerships and alliances with B2C players may be the most suitable response. ▪ Software developers in the B2C market use an 	✓					✓
		✓				✓	

Economic and Market Driver	Impacts	Impact (2020)			Uncertainty (2020)		
		H	M	L	H	M	L
	<p>entirely different business model – sales of apps at the cost of a cup of coffee through application stores linked to mobile phone operating systems, with limited investment in sales and marketing or distribution channels (e.g., over 15% of applications on Apple’s AppStore utilize location in some way). Savvy Geomatics software companies will embrace this new business model to expand their markets.</p> <ul style="list-style-type: none"> ▪ The importance of address and road network data and mobile tracking data from cellular – for routing, proximity analysis and client profiling – will increase. ▪ More demand for point location analytics will require the development of new or enhancement of existing skillsets in the Geomatics Sector. 		✓			✓	
6. Growth prospects in specific user sectors	<ul style="list-style-type: none"> ▪ Geomatics companies have an opportunity to refocus their expertise to location data aggregation and intelligence provision, interpreting the data they collect or access and integrating it with other data sources to provide more complete information solutions to industries that have hitherto adopted location information on only a very limited basis. ▪ There is potential for growth in the transportation and logistics sectors as, for example, the growth in internet commerce increases the demand for more precise predictions of time of package delivery. ▪ Expenditures in the infrastructure sector are expected to top \$35 trillion between now and 2035 (IEA World Energy Outlook 2012), and more precise locations of utilities are required to reduce maintenance costs and minimize outages, especially electricity outages that have a significant impact on chip technologies (it is estimated that such technologies will consume more than 60% of power usage in the US by 2015).⁸ Smart infrastructure will increasingly be rolled out. ▪ The insurance sector also represents growth potential for smart location services related to the geographic pattern of risk distribution. ▪ While LBS have been consumer focused, there is significant application potential in the enterprise, for tracking mobile workers (and other assets) in such sectors as construction, transportation and utilities, and for sharing real-time information between those workers and the office. ▪ Location will be a property of most data and new opportunities are arising as use of location 	✓					✓
		✓					✓
			✓			✓	
				✓	✓		
			✓			✓	

⁸ Views provided by interviewee

Economic and Market Driver	Impacts	Impact (2020)			Uncertainty (2020)		
		H	M	L	H	M	L
	<p>analytics transcends into and becomes commonplace in the social, health and economic sectors.</p> <ul style="list-style-type: none"> Specific location-based health applications include tracking of wireless health monitors on high-risk patients, and monitoring and reporting health risk factors (e.g., air, water, food and radiation contamination). 	✓				✓	
7. Satellite imagery market growth	<ul style="list-style-type: none"> The rapidly increasing availability of space EO imagery provides important opportunities for the Geomatics Sector to develop new applications for environmental monitoring, natural resources exploration and exploitation, land planning and development, etc. Ability to compete with EU-based firms that have access to significant public sector applications development funding will be a critical success factor. 	✓			✓		
8. Airborne imagery market shrinkage	<ul style="list-style-type: none"> As more and more high resolution satellite imagery with shorter repeat coverage cycles becomes more accessible at lower costs, the demand for aerial imagery will decline to a primary focus on near real-time applications. Unmanned aerial vehicles (UAVs) will provide an increasingly attractive alternative to aerial imagery capture from fixed wing aircraft, providing cost savings and access to areas that might be otherwise inaccessible. 			✓			✓
9. Crowd funding	<ul style="list-style-type: none"> Access to pooled financial resources through the Internet will provide a new means for Geomatics start-ups and small companies to grow their business, but government regulation may be required to prevent fraud.⁹ 			✓	✓		

C.3 Social and Demographic Drivers and Impacts

An array of social and demographic drivers are having significant impacts in the location information market, opening up previously unimaginable consumer applications of location data and technologies. Key drivers and their impacts are presented in Table 7.

⁹ Views provided by interviewee

Table 7: Social and Demographic Drivers and their Impacts on the Sector.

Social and Demographic Driver	Impacts	Impact (2020)			Uncertainty (2020)		
		H	M	L	H	M	L
1. Influence of the wired generation or “Generation Y”	<ul style="list-style-type: none"> ▪ The blurred distinction between work and social lives will be a major driver of the crossover between the user interfaces and tools of the social web and those in the workplace. ▪ More market affinity with “open” (data, standards, software) will require suppliers of proprietary products and services dependent on licensing and maintenance fees to re-examine their business models. ▪ There will be a growing expectation that “openness” will lead to greater civic participation and influence on public services. ▪ An expectation that digital content should be available free online, and an increasing willingness to challenge the legal rights of content owners, will encourage information providers to access new delivery channels and find viable new business models. 			✓			✓
2. Location awareness	<ul style="list-style-type: none"> ▪ Citizens’ growing familiarity with technology and handling of data streams will make them increasingly adept at recognizing trends (spatial, temporal and causal) within the vast quantities of data that will be available, placing greater demands on the Geomatics Sector to ensure that location data is of high quality. 			✓		✓	
3. Crowd-sourcing / volunteered geographic information (VGI)	<ul style="list-style-type: none"> ▪ The emergence of Internet mapping sites like OpenStreetMap and Wikimapia has raised the public’s interest in being active contributors to the location information in their communities (the so-called “producers”¹⁰), and acts as a valuable mechanism to encourage public participation and engage and empower citizens. ▪ Government Geomatics agencies have an opportunity to capitalize on the potential of VGI to contribute to authoritative data maintenance, but will be challenged to deal with the technical and policy issues surrounding their efforts to do so (e.g., quality control, security, licensing, etc.). ▪ As crowd-sourced content continues to improve, placing pressure on government authoritative data providers to justify expensive data maintenance 		✓				✓
		✓				✓	

¹⁰ In the location data context, individuals that are involved in both the production and use of the data, such as active VGI contributors

Social and Demographic Driver	Impacts	Impact (2020)			Uncertainty (2020)		
		H	M	L	H	M	L
	programs, collaboration between these two groups will improve.						
4. Concern about privacy invasion	<ul style="list-style-type: none"> ▪ The pressure in some segments of society to ensure location privacy¹¹ and to prevent re-identification¹² of individuals will increase, although generation Y seems to be less concerned with privacy invasion. ▪ Resolving ethical issues such as privacy may result in a re-emergence of the debate about the need for professional certification of Geomatics practitioners. ▪ Demands will increase for regulatory protection of individuals' privacy, requiring the Sector to be informed participants in the policy debate and formulation. 		✓			✓	
			✓			✓	
				✓		✓	

C.4 Technological Drivers and Impacts

Technology is the backbone of location products and services and rapid technological change is having significant impacts on how location information is produced and consumed. Table 8 identifies the key change drivers in technology and how those drivers are impacting the Geomatics Sector in Canada.

Table 8: Technological Drivers and their Impacts on the Sector.

Technological Driver	Impacts	Impact (2020)			Uncertainty (2020)		
		H	M	L	H	M	L
1. Location information ubiquity	<ul style="list-style-type: none"> ▪ The emergence of free, easily accessible location data on the Internet has contributed to the increased embedding of that data into IT applications in almost all domains, and a shift in the dominance of users from specialist to generalist. ▪ Location tools are being added to business intelligence systems (e.g., Oracle, IBM and SAP) to enhance the effectiveness and expand the functionality of such systems, helping to expose the benefits of location data use.¹³ 	✓					✓
			✓				✓

¹¹ Preventing the invasion of a person's privacy through the use of location imaging (e.g., satellite, airborne or street level images)

¹² Loss of privacy through the possible combining of publicly available and privately held data layers or types with geographic coordinates.

¹³ Views provided by interviewee

Technological Driver	Impacts	Impact (2020)			Uncertainty (2020)		
		H	M	L	H	M	L
2. Technology convergence	<ul style="list-style-type: none"> Mobile devices with integrated voice and data communication, camera, GPS, compass, inclinometer, etc. will turn ordinary citizens into mobile sensors, contributing to the demand for and supply of previously unimaginable amounts of location data. 	✓				✓	
3. Pervasive location tracking – knowing where everyone with a mobile device is, all the time	<ul style="list-style-type: none"> As data is crowd-sourced passively¹⁴, privacy concerns may increase, although generation Y seems less concerned about this issue. With GPS being installed in all new mobile devices, there is considerable B2C business potential to be derived from location tracking. For example, with more accurate triangulation and faster processing of higher data volumes, mobile phone operators are already tracking the movements of individuals and this location data is being collated, packaged and sold on to users such as retailers. 		✓			✓	
4. “Continuous turmoil of change”	<ul style="list-style-type: none"> The continuous evolution of technologies is leading to rapid changes in jobs and skill requirements, imposing pressure on Geomatics organizations to invest increasingly in change management and skills upgrading. Like all periods of rapid technological change, many different market forces cause different systems to develop to address often very different market needs. This will result in a large number of location-enabled systems that only interact at a minimum level, requiring standards that bridge semantic incompatibilities. 			✓			✓
5. Mainstreaming of open source software	<ul style="list-style-type: none"> Government budget constraints will help to accelerate the move to open source solutions, removing many of the perceived barriers to wider adoption and driving a virtuous circle, where the value will grow as more users adopt and feedback improvements. As prices of software licences from the large vendors are forced down, they will move increasingly to enterprise licensing deals to encourage dependence and the spread of usage. Substantial commercial companies will create support facilities around open source GIS, following ICT sector patterns (e.g., IBM funding of Linux as competition to Windows). 		✓			✓	
6. Centimetre positioning in a	<ul style="list-style-type: none"> A GNSS universe of some 100 plus satellites by the end of this decade, integrated with other sensor 						

¹⁴ Data collected from a device without the owner’s knowledge or permission, such as travel patterns derived from data transmitted from their smartphone automatically and in real time

Technological Driver	Impacts	Impact (2020)			Uncertainty (2020)		
		H	M	L	H	M	L
mobile environment	sets (typically low cost Micro-Electro-Mechanical Systems (MEMS) devices and compasses), will mean that positioning devices will work reliably in far more places than they currently do, and applications enabled by the technology will spiral upwards in terms of volume and sophistication.	✓					✓
7. Canada’s long term commitment to satellite SAR data	<ul style="list-style-type: none"> Canadian Government support of the Radarsat Constellation Mission Synthetic Aperture Radar (SAR) program signals new opportunities in disaster management, ecosystem and water-quantity monitoring, and ocean and coastal surveillance applications. 	✓				✓	
8. Data volume growth (e.g., LiDAR, laser scanned point clouds, 10-30 cm EO data from 385 instruments by 2015, crowd-sourced data, etc.)	<ul style="list-style-type: none"> This will dramatically increase the complexity of managing the underlying databases in the petabyte size range and increase the importance of effective metadata and even faster, larger processing configurations. Database management systems will need to evolve to cope with the demands of huge volumes of data, including real time 3D location information feeds, and the challenges of finding the right information at the right time. With estimates of daily data production as high as 2.5 quintillion bytes¹⁵, much of it georeferenced, reliance on “big data”¹⁶ technologies, such as massively scalable, distributed systems for processing unstructured and semi-structured data, will continue to grow. With a shift to automatic collection of ground data in point clouds, land surveyors will need to adapt to this new measuring approach or see their role as specialist data collectors increasingly marginalized. With Smart Grid technology being implemented across the electrical power infrastructure, electric utilities will have 10,000 times as much data as they had before, much of it georeferenced.¹⁷ 	✓					✓
9. Exploitation of “big data”	<ul style="list-style-type: none"> The scale and scope of changes that big data are bringing about are at an inflection point, set to expand greatly, as a series of technology trends accelerate and converge. Incumbents tied to legacy business models and infrastructures will have to compete with agile new attackers that are able to 		✓				✓

¹⁵ See <http://www-01.ibm.com/software/data/bigdata/>

¹⁶ Data sets whose size is beyond the ability of typical database software tools to capture, store, manage, and analyze. Note that the definition can vary by sector, depending on what kinds of software tools are commonly available and what sizes of datasets are common in a particular industry (McKinsey Global Institute, 2011).

¹⁷ Views provided by interviewee

Technological Driver	Impacts	Impact (2020)			Uncertainty (2020)		
		H	M	L	H	M	L
	<p>quickly process and take advantage of big data.</p> <ul style="list-style-type: none"> A critical shortage of the analytical and managerial talent necessary to make the most of big data is a significant and pressing challenge¹⁸, the resolution of which will advantage those nations that take swift action. “Data scientists”¹⁹ with the deep analytical skills to exploit the full potential of big data are in particularly short supply. Location-based services exploiting big data have the potential to create up to \$700 billion consumer surplus value, but policy makers will often need to push the deployment of big data innovations for consumers to benefit. 	✓					✓
10. The “Internet of Things” and demand for linked data	<ul style="list-style-type: none"> Similar to the www where documents are linked together, the importance of linking data together, particularly by location, is likely to grow, and location information can act as a platform that will support the evolution of this connected ecosystem. 		✓				✓
11. Cloud computing	<ul style="list-style-type: none"> Software as a service (and bundling with data as a service) will become an increasingly attractive alternative to the purchase and maintenance of proprietary software, as the popularity of cloud computing and the market domination by non-professional GI users grows, significantly impacting current Geomatics business models. Analysis and reasoning may start to form part of Spatial Data Infrastructures, as the concepts of infrastructure as a service (IaaS), platform as a service (PaaS), and software as a service (SaaS), evolve further to model as a service (MaaS). Users will increasingly want their location information accessible to anyone, anywhere and anytime on the device of their choice and use of the cloud will facilitate such access. Cloud solutions offer potential cost reductions for organizations struggling with the costs of spatial data infrastructure and data maintenance. In the near term, lack of cloud computing standards may pose problems for SDI operations wishing to adopt cloud solutions (i.e., vendor lock-in and interoperability issues). 	✓				✓	

¹⁸ For example, McKinsey projects that demand for deep analytical positions in a big data world could exceed the supply being produced by 140,000 to 190,000 positions in the US by 2018.

¹⁹ Data analysts with strong business acumen, coupled with the ability to communicate findings to both business and IT leaders in a way that can influence how an organization approaches a business challenge; someone who can sift through data with the goal of discovering a previously hidden insight, which in turn can provide a competitive advantage or address a pressing business problem.

Technological Driver	Impacts	Impact (2020)			Uncertainty (2020)		
		H	M	L	H	M	L
12. Dominance of the browser	<ul style="list-style-type: none"> As the browser becomes the dominant user environment, the desktop will be increasingly confined to specialized applications and very challenging or secure environments. User-centred design, as exemplified by Google, will become an increasingly important focus of software development. 			✓		✓	
13. Immersive video / augmented reality	<ul style="list-style-type: none"> Within ten years all smart phones (or whatever replaces them) will likely be able to film 360 degree 3D video and wirelessly stream it in real time. Worn by workers (e.g., police officers, firefighters, utility workers, etc.), such devices may allow their colleagues in the office or in the field to see what they are seeing. Data from this network of devices, combined with sensors mounted in many vehicles, at street intersections, etc. will be merged in real time to provide an augmented reality view of the world. The dynamic graphics and 3D visualization common in the video games industry, along with the increased availability of high resolution location data, may help to drive a new generation of more diverse Geomatics software capable of 4D visualization. Demands will increase for adding the 4th dimension of time to data, in order to learn from the past and model the future, requiring the archiving of time-referenced location data. 		✓		✓		
14. Increased systems complexity	<ul style="list-style-type: none"> Peer-to-peer sensor webs will integrate intelligent sensors, high speed data processors, high bandwidth wireless infrastructure and data base technology for real-time data synthesis and analysis applications for monitoring of air quality, water resources, disease threats, etc.; location will be a key attribute. 		✓			✓	
15. Broadband and cellular network capacity	<ul style="list-style-type: none"> Canada's commitment to building high-speed broadband networks to "underserved" regions lags far behind national digital programs in such countries as the United States, Britain and Australia, potentially contributing to the country's poor record of productivity growth and inhibiting the full potential of a distributed spatial data infrastructure (especially in regions like the Arctic). While the speed of networks will continue to improve, capacity constraints to handling high volumes of location (and other high resolution imagery like video) data may cause user disillusionment with mobile devices and their 		✓				✓

Technological Driver	Impacts	Impact (2020)			Uncertainty (2020)		
		H	M	L	H	M	L
	location data handling capabilities.						

C.5 Environmental Drivers and Impacts

Environmental issues such as climate change, pollution, global food and water shortages, and severe weather events are becoming increasingly sensitive political challenges and the Geomatics Sector can play a central role in contributing to mitigation and workable solutions by providing an important means of integrating and assessing consequences, modeling different scenarios, etc. Some of the key environmental change drivers are presented in Table 9, together with their impacts on the Sector.

Table 9: Environmental Drivers and their Impacts on the Sector.

Environmental Driver	Impacts	Impact (2020)			Uncertainty (2020)		
		H	M	L	H	M	L
1. Global climate change rate reduction and adaptation	<ul style="list-style-type: none"> Geomatics professionals have a key role to play in responding to climate change through the effective management and use of information on the natural and built environments and the application of good land governance to help mitigate the damaging impacts on our world and society. 	✓				✓	
	<ul style="list-style-type: none"> The modeling of environmental phenomena such as climate change is increasingly demanding fully integrated environmental information in the land, marine and air domains that have traditionally been managed separately, and location information has a key role to play in such integration efforts. 	✓				✓	
	<ul style="list-style-type: none"> Location information and the professionals in its use can contribute to the increasing sophistication required in the analysis, presentation and understanding of uncertainty issues (e.g., how to communicate probabilistic-based information sets), an issue of particular relevance for scenario forecasting such as climate change or flood risk analysis. 		✓			✓	
	<ul style="list-style-type: none"> There will be an increasing demand for building infrastructure management applications (monitoring, recording and reporting on transformers, lights, air conditioners, etc.) driven by environmental regulation on building energy efficiency (e.g., in the EU, every new building will have to be designed to be “near zero” energy after 2020, and in the US, 		✓			✓	

²⁰ Views provided by interviewee

Environmental Driver	Impacts	Impact (2020)			Uncertainty (2020)		
		H	M	L	H	M	L
	<p>every new federal building will have to be “net zero” energy after 2030). This will require precise three-dimensional energy performance modeling based on building information models (BIM) and geolocation of the building in relation to historical weather patterns, nearby structures, etc.²⁰</p> <p>Since environmental issues don’t stop at national boundaries, there will be a need to participate in regional and increasingly global SDIs (e.g., circumpolar Arctic SDI).</p>	✓					✓
2. Global food and water security	<ul style="list-style-type: none"> ▪ Growth in world population and food and water shortages in certain regions resulting from more frequent environmental disasters (i.e., droughts, floods, severe storms, etc.) combine to threaten global food and water security. Some countries may respond by protecting agriculture and natural resources to build national resilience and more robust value-chains, and to facilitate the transition to sustainability. ▪ Water shortages in some regions will require new methods and infrastructure for transporting massive volumes of water from regions that have excess reserves; location information will be required for planning and implementation. ▪ As a result of a global search for land for large scale agricultural production, significant areas in Africa, India and South America have now been bought or leased by foreign countries or corporations (so-called “land grabbing”). The Geomatics Sector has an important role to play in strengthening land governance across the globe to prevent abuses (e.g., removing local people from the land, loss of common grazing land, etc.). ▪ Good location information management can assist land governance to not only control and manage the effective use of physical space, but also ensure sound economic and social outcomes. 		✓			✓	
3. Carbon footprinting	<ul style="list-style-type: none"> ▪ As an increasing emphasis is placed on more immediate and direct “footprinting” of the consequences of everyday decisions on the environment (e.g., increasing granularity in the insurance market as better tools and datasets become available to assess environmental risks), there is an important role for high quality location information. 		✓			✓	
4. Environmental activism	<ul style="list-style-type: none"> ▪ Citizen concern about the deteriorating state of our environment will continue to rise, and expectations are high concerning ownership of or access entitlement to environmental information, most of 			✓		✓	

Environmental Driver	Impacts	Impact (2020)			Uncertainty (2020)		
		H	M	L	H	M	L
	<p>which is connected to location.</p> <ul style="list-style-type: none"> ▪ Crowd-sourcing of data (e.g., biodiversity observations, stewardship activities, etc.) by “amateur environmentalists” (i.e., citizen science) will grow rapidly, most of which will be georeferenced but may have little or no involvement of the Geomatics community. ▪ Paradoxically, because the deluge of information (often conflicting) may breed citizen skepticism, how the information is presented becomes increasingly important as does telling the story associated with the information in a compelling way. The Geomatics profession has a potential role to play in the process of helping to communicate complex environmental decisions to citizens (e.g., augmented reality type solutions). ▪ Citizens are increasingly engaging with global environmental challenges of the 21st century. The Geomatics profession has an opportunity to connect citizens to these global issues so that they can effectively participate in formulating and implementing solutions. 			✓			✓
5. Emergency response, and disaster management and recovery	<ul style="list-style-type: none"> ▪ Location-based initiatives are required to more effectively integrate a wide range of environmental information to support better prediction modeling and to help manage disaster recovery. ▪ Three-dimensional models of the built environment (building facilities and above ground and underground infrastructure) and 3D cadastre (for multi-owner building units like condominiums) will be needed to support faster and more effective response to emergency situations in order to reduce loss of life and property damage (e.g., the Sydney Downunder project²¹). 	✓					✓
			✓				✓

C.6 Other Drivers and Impacts

Table 10 identifies several other change drivers in the environment within which the Geomatics Sector operates and their impacts on the Sector.

Table 10: Other Drivers and their Impacts on the Sector.

²¹ See <http://geospatial.blogs.com/geospatial/2011/08/gita-anz-2011-sydney-down-under-compiles-comprehensive-digital-model-of-urban-infrastructure.html>

Other Driver	Impacts	Impact			Uncertainty		
		H	M	L	H	M	L
1. Geomatics Sector fragmentation and heterogeneity	<ul style="list-style-type: none"> The structure of the Canadian Geomatics industry (i.e., very few large firms and predominantly small and micro businesses) will continue to limit its ability to successfully compete in the international market, and will increasingly threaten its domestic competitiveness. The scope of the Sector will become more difficult to define as location information becomes increasingly embedded in other domains and the community's heterogeneity grows. This will impact the Geomatics Sector's ability to agree upon strategic directions and take collective action. 	✓				✓	
2. Increasing difficulty in tracking data provenance and enforcing licences	<ul style="list-style-type: none"> The growth in the amount of data, the number of actors in the data creation processes and the interconnectivity of these parties will make ownership tracking an increasingly difficult task. User tolerance for pricing and licensing models that are seen to be too complex, rigid and costly is decreasing rapidly, and has been one of the strongest factors in the rapid growth and popularity of VGI sites. Consumer use of location data may become effectively free at the point of use in virtually all circumstances due to the combination of open data availability and the hacking and piracy of licensed data. Given the easy transportability of data and the sharing of data between countries, licence enforcement will become increasingly difficult in the absence of a multinational legal or policy framework 		✓	✓		✓	✓
3. Uncertainty of liability exposure	<ul style="list-style-type: none"> While government location data providers normally publish disclaimers that are intended to absolve them of any litigation risk, there have been examples of attempts being made to seek legal redress where other types of government data were proven to have been inaccurate and the user has suffered a loss. Professional users making high impact decisions may advocate the development of a "warranted" data model, where at least some attributes of data specification will contain a form of guarantee. 		✓		✓		
4. New skills requirements	<ul style="list-style-type: none"> Given the growth in the size and complexity of accessible location data, and the challenges of data modeling, there may be shortages of skilled people with mathematics and computer science backgrounds who truly understand the inter-relationships between data models and data flow. For the true potential of location data use in improved policy and decision making to be realized, Geomatics 			✓		✓	

Other Driver	Impacts	Impact (2020)			Uncertainty (2020)		
		H	M	L	H	M	L
	<p>practitioners need improved skills in areas such as communication, presentation and influencing, with the use of visualization technologies of particular importance.</p> <ul style="list-style-type: none"> Those involved in policy and decision making roles in user organizations will also need basic skills development in use of and access to simple and intuitive tools that allow them to manipulate the data, rather than always working through back office Geomatics specialists. 	✓					✓
5. Shifts in the roles and impacts of the private and public sectors	<ul style="list-style-type: none"> The traditional role of government Geomatics agencies as the primary providers of location data is increasingly being taken up by the private sector, which has been largely responsible for the emergence of consumer interest in and use of such data. Traditionally, National Mapping and Cadastral Agencies (NMCAs) have taken the lead in NSDI initiatives within government. However, NMCAs are primarily data capture specialists and in many ways ill equipped to understand the changing requirements of end users of location information. As more government organisations become location-enabled, their roles within NSDI governance will strengthen and increasingly they will take the lead as location information consumers. Where issues cross national boundaries (e.g., disaster recovery, emergency response, etc.), private sector data providers are being more successful in meeting location data needs, while public sector providers attempt to catch up through supra-national and intergovernmental mechanisms. 		✓				✓
6. National Information Framework	<ul style="list-style-type: none"> The public sector produces vast quantities of information, including location information. The growth in information production has been incremental and ad hoc, driven by new policies and legislative requirements. There has been no strategic approach to the information collected and limited rationalisation over the years. There is therefore a need to create a contemporary National Information Framework (NIF)²² which includes (at least) all key datasets to meet currently anticipated needs in governments and other key sectors in the Canadian economy. The Geomatics Sector should rethink what location data it should collect and manage in the future based on producing a NIF that is attuned to Canada’s long term economic and social needs. 	✓					✓

²² <http://www.nationalarchives.gov.uk/documents/nif-and-open-data.pdf>

Other Driver	Impacts	Impact (2020)			Uncertainty (2020)		
		H	M	L	H	M	L
	<ul style="list-style-type: none"> The legacy of the mapping era has been the “topographic map” paradigm for presenting location data. Given the now available technologies and sources of data, it is time for this underlying paradigm to be refreshed. 	✓				✓	



Hickling Arthurs Low Corporation

150 Isabella Street
Suite 1300
Ottawa, ON
K1S 1V7

Phone: 613.237.2220
Fax: 613.237.7347
Email: hal@hal.ca