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ABSTRACT

Intelligent Transportation Systems (ITS) present strategic opportunities for BC. wireless companies. This project identifies a strategic development framework for the emerging ITS industry in BC. The goal is to facilitate BC wireless companies entry into the ITS market in order to create an industry that can compete in this rapidly growing global niche market.

It is recommended that the Wireless Innovation Network of BC (WINBC), a wireless industry association, formulate a political strategy for wireless firms in the ITS industry segment. A strategic framework for building an issue-specific, political strategy is proposed because government actions affect the competitive position of firms and industries. Industry participants may inform and lobby government to address the constraints under its control.

Analysis of the wireless and ITS industries reveal sufficient market size, opportunity and growth potential. Examination of wireless ITS firms in BC confirms the presence of an emerging cluster. Evidence of the economic benefits of clusters provides incentives for government policies that facilitate cluster development. This motivates the need to determine the most effective strategy for actively convincing relevant political decision makers to take actions that specifically benefit the firms in this sector.

The project recommendations are intended to help strengthen the BC wireless ITS cluster and enhance its ability to grow and develop. The actions proposed will improve the competitive position of BC wireless ITS companies internationally.
EXECUTIVE SUMMARY

This project examines facilitators for BC wireless companies entry into ITS markets. It analyzes industry capabilities, technologies, competition, and strategies for success. Finally, it recommends actions for WINBC to engage BC ITS stakeholders including industry, government and academia. The development of wireless ITS firms to compete in the global market will result in employment and economic growth in BC's high technology industries.
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<tr>
<td>APTS</td>
<td>Advanced Public Transportation System</td>
</tr>
<tr>
<td>ATIS</td>
<td>Advanced Traveler Information System</td>
</tr>
<tr>
<td>ATMS</td>
<td>Advanced Transportation Management Systems</td>
</tr>
<tr>
<td>AVL</td>
<td>Automatic Vehicle Location</td>
</tr>
<tr>
<td>CCTV</td>
<td>Closed Circuit Television</td>
</tr>
<tr>
<td>CDMA</td>
<td>Code Division Multiple Access</td>
</tr>
<tr>
<td>CVO</td>
<td>Commercial Vehicle Operations</td>
</tr>
<tr>
<td>DGPS</td>
<td>Differential Global Positioning System</td>
</tr>
<tr>
<td>DMS</td>
<td>Dynamic Message Sign</td>
</tr>
<tr>
<td>DSRC</td>
<td>Dedicated Short Range Communications</td>
</tr>
<tr>
<td>EDGE</td>
<td>Enhanced Data rates for GSM Evolution</td>
</tr>
<tr>
<td>ETC</td>
<td>Electronic Toll Collection</td>
</tr>
<tr>
<td>GPRS</td>
<td>General Packet Radio Service</td>
</tr>
<tr>
<td>GPS</td>
<td>Global Positioning System</td>
</tr>
<tr>
<td>GSM</td>
<td>Global System for Mobile Communications</td>
</tr>
<tr>
<td>ITS</td>
<td>Intelligent Transportation Systems</td>
</tr>
<tr>
<td>LBS</td>
<td>Location Based Services</td>
</tr>
<tr>
<td>MIMO</td>
<td>Multiple Input Multiple Output</td>
</tr>
<tr>
<td>OCR</td>
<td>Optical Character Recognition</td>
</tr>
<tr>
<td>PCS</td>
<td>Personal Communications Service</td>
</tr>
<tr>
<td>RFID</td>
<td>Radio Frequency Identification</td>
</tr>
<tr>
<td>TSP</td>
<td>Traffic Signal Priority</td>
</tr>
<tr>
<td>UWB</td>
<td>Ultra Wide Band</td>
</tr>
<tr>
<td>VICS</td>
<td>Vehicle Information and Communication System</td>
</tr>
<tr>
<td>VLU</td>
<td>Vehicle Logic Unit</td>
</tr>
<tr>
<td>VoIP</td>
<td>Voice over Internet Protocol</td>
</tr>
<tr>
<td>WAVE</td>
<td>Wireless Access in the Vehicular Environment</td>
</tr>
<tr>
<td>WiMAX</td>
<td>Worldwide Interoperability for Microwave Access</td>
</tr>
<tr>
<td>WINBC</td>
<td>Wireless Innovation Network of BC</td>
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1 INTRODUCTION

1.1 Project Purpose

This project will identify a strategic development framework for the emerging Intelligent Transportation Systems (ITS) industry in BC. The purpose is to facilitate BC wireless companies entry into the ITS market in order to develop a Canadian ITS industry positioned to compete in this rapid growth global niche market. The perspective taken on the problem is that of the Wireless Innovation Network of BC (WINBC), a wireless industry association. The association focuses on the cultivation of networks to enhance member’s innovation and endeavours to foster collaboration for leveraging the collective resources and strengths of the wireless cluster in BC.

It is recommended that WINBC formulate a political strategy for wireless firms in the ITS industry segment. Since government actions affect the competitive position of firms and industries, an industry association’s political strategy can be a source of competitive advantage (Vining, Shapiro, Borges, 2005a, p.151). The objective of this strategy is to engage firms and actively persuade relevant political decision makers to initiate actions that will benefit the BC wireless firms in the ITS sector.

1.2 Wireless Technology and Intelligent Transportation Systems

Intelligent Transportation Systems (ITS) are a group of technologies to build, design, manage and operate transportation systems. ITS encompasses a wide range of wireless and wired communications control, electronics and information technologies.
Integrating these technologies into transportation infrastructure and vehicles helps to manage traffic flow, reduce congestion and enhance productivity in order to save lives, time and money. These benefits are evident for both the public and private sector. ITS provides opportunities for the BC wireless sector to build industry capabilities to develop and implement these new technologies.

This analysis focuses on the wireless component of ITS communications. The functions required for wireless ITS communications are:

- Extended area broadcast to users of transportation services and vehicles;
- Extended area interactive communications between service providers and vehicles;
- Short range interactive communications between infrastructure and vehicles, and
- Short range interactive communications between vehicles (Transport Canada, 1996c).

1.3 Project Methodology

In order to analyze the local wireless industry and emerging ITS market, interviews were conducted with stakeholders in the private sector, the government and industry associations to assess potential alternative strategies. Quantitative and qualitative analyses were applied to available industry data for evaluation. First, the wireless and ITS industry were examined to determine size and growth potential. Next, the wireless ITS firms in BC were analyzed in detail for competitive advantage. This served as a foundation for proposing a framework from which to develop a strategic course of action. The strategy development process of this project involves an industry analysis, cluster analysis, implications analysis, political strategy development and action planning and organizing for WINBC.
A comprehensive industry analysis provides a framework for identifying government actions that will affect wireless firms in the ITS industry sector. An augmented Porter’s 5 forces model that recognizes the role of government provides the underlying purpose and logic for a comprehensive strategy (Vining et al, 2005a, p. 150).

Cluster theory and models are applied to the emerging ITS industry in BC. The cluster approach asserts that the regional environment enhances the competitive position of individual firms and the industry overall. The positive spillover effects and synergies companies generate when they operate in a focussed area have potential to increase economic growth and industry competition locally. For this reason, clustering is an appropriate strategy for BC wireless companies to enhance competitiveness in the ITS market globally.

Government policies and practice affect productivity and innovation advantages and hence opportunities for clusters. This provides motivation and incentives for private sector collective action. “Government investments focused on improving the business environment in clusters have the potential to earn a higher return than those aimed at individual firms, industries or the broad economy.” (Porter, 2000, p. 27)

A cluster approach can prioritize and influence public policies to positively impact the competitive position of firms. Collaboration at different levels of government is necessary for effective solutions. Overall, cluster participants need to inform and lobby government to contend with the forces under its control (Porter, 2000, p. 29). For this reason, a strategic framework for building an industry segment, issue specific, political strategy is proposed. Finally, a strategic plan for WINBC is recommended to engage firms strategically with the government.
1.4 Problem Definition

As will be shown, Intelligent Transportation Systems (ITS) present potential strategic opportunities for BC wireless companies. This project conducts a detailed analysis of the wireless ITS industry in BC in order to determine the most effective strategy for convincing political decision makers to take actions that specifically benefit the firms in this sector.
2 WIRELESS TECHNOLOGY AND INTELLIGENT TRANSPORTATION SYSTEMS INDUSTRY ANALYSIS

New Technologies present both new opportunities and new challenges. When these technologies have far-reaching impacts, society cannot afford to allow itself to be driven by either the technology or the marketplace without attempting to channel the consequent changes in directions that produce the best possible results for all parties. (Robinson & Ridley, 1994, par. 1)

2.1 Industry Opportunity

Intelligent Transportation Systems (ITS) consist of a diverse range of technologies integrated into transportation to achieve safe, efficient and reliable systems. The technologies include sensors and controls, communications, computer informatics and electronic devices in transportation and vehicles to save lives, time, money and energy. These dynamic systems consider the interaction of the vehicle, the infrastructure and the driver or user. ITS technologies encompass industries such as transportation, telecommunication and car manufacturing.

New wireless and integrated technologies have potential applications in Intelligent Transportation Systems (ITS) since they promise to deliver flexible, efficient and cost effective services (Biesecker, 2000, p. xiii). Emerging Intelligent Transportation Systems (ITS) generate the need for wireless technologies. The demand for wireless communications in ITS is growing rapidly as governments, companies, and individuals increasingly seek voice, data, and video services. Wireless communications technologies enable high-speed connections between fixed and mobile devices for integrated voice, data, and video services.
Applying new wireless technologies to ITS services provides voice, data, and video communications for transportation operations. Services include: vehicle to vehicle communications (V2V); vehicle to roadside communications infrastructure (V2I); traffic management center communications; and emergency communications from incident management centers to mobile public safety units (Bolduc, 2006). Transportation related supporting applications include traveller information, integrated traffic management, emergency management and public safety (Biesecker, 2000, p. xiii).

ITS are emerging as a global market with potential benefits for both private and public sectors including integration, efficiency, safety, productivity and general mobility (Transport Canada, 1996a). These benefits provide significant incentives to both sectors for developing an industrial base and public infrastructure.

2.1.1 Wireless Technology Overview

Wireless technology may be generally categorized by the type of wire displaced as follows:

- **Cellular PCS wireless** displaces phone lines.

- **Fixed wireless** displaces cables connecting residences and businesses to main stations. Example: WiMAX wireless broadband.

- **Wireless local area networks (WLANs)** displaces ethernet cables connecting local area networks (LANs). Example: WiFi (802.11b).

- **Personal area networks (PANs)** displaces electronic devices cable connections (such as PCs to printers). Example: Bluetooth (Athena Institute, 2002, p. 12).

Wireless technologies may compete against or complement each other depending on the industry context.
2.1.2 Wireless Products and Services

The wireless technology categories described above may fall into various classes of products and services. Wireless products and services include equipment which consists of infrastructure and end user products, carriers which include companies providing networks, software which includes systems and applications and services such as provisioning and payment. These categories have been organized into a table below:

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Fixed Wireless</th>
<th>Wi-Fi WLANs</th>
<th>Short Range PANs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Components, cellular base stations and towers, networking, antennas, devices (handsets, PDAs)</td>
<td>Antennas, consumer premises equipment, non-line of sight equipment</td>
<td>802.11b cards and access points</td>
<td>Bluetooth compatible handsets, PCs, printers, other peripherals</td>
</tr>
<tr>
<td>Carriers</td>
<td>Nokia rooftop terabeam</td>
<td>National carriers Boingo Wireless Internet T-Mobile Hotspot Regional/Local carriers</td>
<td>DNA</td>
</tr>
<tr>
<td>National carriers such as AT&amp;T Wireless, T-Mobile, Nextel Regional carriers such as Western Wireless Data-focused carriers such as Cingular, Interactive, Bell South, Mobitex Virtual carriers such as Virgin Mobile</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Software</td>
<td>Network authentication, portal software, security</td>
<td>Operating system extensions, client software, security, authentication, roaming, support for legacy apps, systems management</td>
<td>Bluetooth protocol software, Bluetooth software development kits</td>
</tr>
<tr>
<td>Billing, provisioning, application development and delivery, operating systems, synchronization, business apps, ring tones, security</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Services (beyond carrier service)</td>
<td>Short Message Service (SMS), payment systems, application hosting, systems integration and custom applications, provisioning, games content services, location based services</td>
<td>Fixed wireless consulting</td>
<td>Conformance testing, profile interoperability, testing, Bluetooth installation consulting</td>
</tr>
<tr>
<td>Fixed wireless consulting</td>
<td>WLAN consulting, vertical specific software access</td>
<td></td>
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</tr>
</tbody>
</table>

Based on: Athena Institute, 2002
2.1.3 Wireless Value Chain

BC's wireless industry is characterized by a diversity of technologies that span the entire spectrum of the wireless value chain. The value chain concept conceptualizes both the internal dynamics of the industry as well as its external interaction with other industries (Porter, 1985). It illustrates the procedure of creating, transforming and providing products and services to users. The wireless value chain diagram by WINBC (2004) represents the supply dependencies and technological interaction of the wireless industry.

Table 2-2: Wireless Value Chain

![Diagram of Wireless Value Chain]

Source: © WINBC, 2004, used by permission.

2.1.4 BC Wireless Industry Description

The performance of the BC wireless industry has improved over time with revenue increasing activities. Aggregate wireless industry descriptors from the 2005 WINBC Wireless Survey including revenue, employees, company age, availability of qualified employees, R&D, investment and critical success factors are presented below. Revenue for the wireless industry in BC is estimated at over $1 billion. This level of revenue represents a significant industry for BC in terms of its economic contribution. In
2005, wireless represented 0.6% of BC’s GDP of $169 billion (BC Stats, 2006). Fifty-two percent of companies are cash flow positive. Since 2002, revenue has increased 27% and is projected to increase 46% to the end of 2006.

There were 216 BC wireless companies employing 5,153 people in 2005. Since 2002, employment has increased 39% and is expected to increase 33% to the end of 2006.

Companies that started up from 1999-2001 comprise 50% of the wireless industry and 44% were incorporated prior to 1999. This makes the wireless industry in BC predominantly made up of young companies.

The availability of qualified employees is rated 80% satisfactory by wireless companies. Qualified employees include 75% with university degrees and 24% with graduate degrees.

R&D spending by BC companies was $40 million in 2004 and is expected to increase to $65 million in 2006. Eighty-four percent of companies have reference customers while only 16% are still in the technology development stages. BC companies compete in over 30 vertical markets worldwide. Many are developing solutions based upon emerging technologies such as UWB, WiMAX, MIMO and RFID.

Investment sought by BC wireless companies is targeted at $127 million over the following two years. Seventy-four percent of companies are private with funding generated from cash flow, business owners and government resources.

Critical success factors for future growth of wireless companies include sales execution, access to target markets and new technologies. According to 77% of the
companies surveyed, growth will result from new products and technologies. Continuous innovation in wireless requires access to R&D and testing facilities (WINBC, 2005).

BC wireless companies represent part of a world wide market projected to grow to almost $670 billion US by 2008 (IDC, 2005). With a 30 year history, and forecasted growth of 15% a year, BC companies have the potential to be one of the strongest and most diverse wireless clusters in North America. An evaluation of the BC cluster is later provided for comparison to neighboring Alberta and Washington clusters.

2.1.5 Wireless Industry Segments

The preceding metrics are good indicators of the strength and leadership of BC wireless companies. Not including the wireless service providers, there are approximately 50 wireless companies in BC that demonstrate world class potential with leadership and strength. The BC wireless industry may be further segmented on the basis of strengths and market success in the following segments:

- **Wireless Carrier / Operators and the associated Retail Services** is the largest segment based on employment and revenues, representing approximately 2,500 people in BC and currently estimated at $1 billion in sales. Pillar companies include Bell, Glentel, Rogers, and Telus.

- **Devices and Components** represents sales of $250 million and employment of approximately 2,000 in BC. Pillar companies are Nokia, Sierra Wireless, Digital Dispatch and Omnex Controls.

- **Enterprise-Class Solutions** represent sales of $150 million and employment of 1,700 people. There are an extensive number of pillar companies such as AirIQ, Digital Dispatch Systems, Epic Data, eXI Wireless Inc./ VeriChip, Itron, Maddocks Systems,
MDSI, Municipal Software Corporation, Strategic Technologies, and Tantalus-Systems.

- **Carrier Class and Infrastructure** represents sales of $40 million and employment of approximately 500 people. Pillar companies include AirG, Dyaptive, PMC Sierra, Sierra Wireless, UT Starcom (WINBC, 2006a).

These segments create a cluster of interconnected firms in BC with potential for both competition and cooperation.

### 2.1.6 Wireless Sub Clusters

Wireless subtype provides another perspective for analyzing the BC wireless industry potential. According to WINBC Wireless Strengths Analysis (WINBC, 2006a) four significant subtypes emerge based on strength, indicated by employees and market success, indicated by revenue:

- **Mobile Work Force**: This cluster covers computing over wireless networks to enable mobile workers. With an estimated 700 people, it is the strongest cluster with leaders such as MDSI, Municipal Software, Infowave, Flowfinity, TenDigits, DataWave and Enterra.

- **Mobile Applications and Wireless Entertainment**: This group develops applications, entertainment and gaming for deployment to mobile devices. An estimated 500 people work in leading companies such as AirG, Empower, Foundation 9, and Intrinsyc.

- **Ruggedized Embedded Solutions**: This cluster serves markets such as public safety, military, maritime and ambulances. The sector employs 300 people and includes companies like Sierra Wireless, SkyTrac and Spectrum Signal Processing.
Intelligent Transportation Systems (ITS): This cluster provides wireless technologies for transportation systems and employs 500 people. It includes pillar companies such as WebTech Wireless, Novax Industries, In Motion Technologies and Streetlight IQ.

This subsystem segmentation further demonstrates that there is potential for a wireless cluster in BC with several competing firms in each subcluster. Overall, BC wireless companies are contributing to the efficiencies and competitiveness of other industrial sectors such as ITS both regionally and internationally.

2.1.7 Wireless Technology

2.1.7.1 3G Evolution

Wireless technology is rapidly evolving. The evolution to third generation (3G) wireless requires upgrading cellular mobile telecommunications networks for new third generation technologies over the period 1999 to 2010. 3G technologies enable networks to provide an expanding range of advanced services. Improved spectral efficiency achieves greater network capacity. This evolution in technology affects trends in industries such as transportation. The following table illustrates first to third generation wireless technologies:

<table>
<thead>
<tr>
<th>1G</th>
<th>2G</th>
<th>2.5G</th>
<th>2.75G</th>
<th>3G</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analog</td>
<td>CDMA IS-95</td>
<td>CDMA 2000</td>
<td>1xEV-DO</td>
<td>1xEV-DV</td>
</tr>
<tr>
<td></td>
<td>TDMA</td>
<td>WCDMA (UMTS) &amp; HSDPA</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>GSM</td>
<td>GPRS</td>
<td>EDGE</td>
<td></td>
</tr>
</tbody>
</table>

Source: created by author
2.1.7.2 Emerging Technologies and Standards

Emerging and potentially revolutionary technologies have a high impact on the evolving wireless industry. According to the WINBC 2005 Wireless Industry Survey, BC companies are developing solutions based upon emerging technologies such as UWB, WiMAX, MIMO and RFID (WINBC, 2005). A description of these emerging wireless technologies is included in Appendix A.

2.1.7.3 Timing and Impact of Disruptive Technologies

The international organization, CTIA-The Wireless Association, represents all wireless communications sectors and distributes timely information on the latest policy and technical developments. CTIA projections for commercialization and timing of emerging wireless technologies with potential application to ITS are indicated by the table below:

<table>
<thead>
<tr>
<th>Technology</th>
<th>Peak Speed</th>
<th>Average Throughput</th>
<th>Timing</th>
</tr>
</thead>
<tbody>
<tr>
<td>CDMA 1XEV-DO</td>
<td>2.4 Mbps</td>
<td>300-500 Kbps</td>
<td>2002/2003</td>
</tr>
<tr>
<td>WCDMA</td>
<td>2 Mbps</td>
<td>150-200 Kbps</td>
<td>2003/2004</td>
</tr>
<tr>
<td>HSDPA</td>
<td>14 Mbps</td>
<td>150-200 Kbps</td>
<td>2003/2004</td>
</tr>
<tr>
<td>TD-CDMA</td>
<td>2.4 Mbps</td>
<td>600-700 Kbps</td>
<td>2005/2006</td>
</tr>
<tr>
<td>TD-SCDMA</td>
<td>1.3 Mbps</td>
<td>300-500 Kbps</td>
<td>2006</td>
</tr>
<tr>
<td>OFDM</td>
<td>2-3 Mbps</td>
<td>300-500 Kbps</td>
<td>2005+</td>
</tr>
<tr>
<td>WiMAX (80s.16g)</td>
<td>70 Mbps</td>
<td>1-2 Mbps</td>
<td>2007</td>
</tr>
<tr>
<td>Mobile Fi (802.2)</td>
<td>70 Mbps</td>
<td>1-2 Mbps</td>
<td>2008</td>
</tr>
</tbody>
</table>

*Data source: Gallagher, 2005*

Next generation technologies create competition, new entrants and increase penetration rate. The predicted disruptive impact of emerging wireless technologies based
on a scale from 1-10 where 10 is the highest disruptive potential to the current environment, are indicated by the chart below:

Table 2-5: Disruptive Impact of Wireless Technologies

![Bar Chart]

Adapted from: Gallagher, 2005

As we have seen from the previous section the wireless industry is characterized by rapidly evolving technology and changing competitive conditions.

2.1.8 Wireless Constraints

Certain wireless industry projections have failed to transpire as expected. Despite optimistic forecasts, 3G wireless implementation in Canada is constrained by insufficient capital, technical obstacles, low consumer demand and high telecommunication companies debt loads. As a result, the communications infrastructure necessary for ITS deployments is restricted. Predictions of success for location-based services based on the E911 mandate have encountered technical obstacles. The goal of E911 is to allow carriers to locate a cellular caller that is a crime or accident victim. This capability could promote location-based services such as getting directions for consumers. However, implementation and consumer participation in location based services has not emerged in strength except for applications related to tracking and directions for commercial fleets.
(Athena Institute, 2002). As a result, local wireless firms have concentrated their offerings on LBS for commercial services.

Overall, demand for wireless communications to improve industries effectiveness and efficiency is increasing. For that reason, the ITS industry will be analysed next for potential wireless applications.

2.2 Intelligent Transportation Systems (ITS) Industry

Intelligent Transportation Systems (ITS) technologies require wireless communications to build, design, manage and operate transportation systems. Wireless communications for ITS require extended area broadcast and interactive and short range interactive between vehicles and roadside.

The ITS industry’s global market potential is substantial. Annual worldwide sales are projected to be US$ 43 billion in 2006, and reach US$ 66 billion by 2011. From 1996-2011, cumulative sales are forecast to exceed US$ 430 billion. The Canadian share of the global market is estimated at US$ 2.9 billion in 2006 and $4.7 billion by 2011 (Transport Canada, 1996a).

2.2.1 Market Segments

ITS technologies function within vehicles, users, infrastructure and communications system components. ITS capabilities may be segmented into user services as follows:

- Travel and Transportation Management;
- Travel Demand Management;
- Public Transportation Operations;
• Electronic Payment;
• Commercial Vehicle Operations;
• Emergency Management; and
• Advanced Vehicle Control and Safety Systems (Transport Canada, 1999b).

2.2.2 International Opportunities

Canada’s share of ITS global sales is primarily an export market to the US. Emerging industrialized countries in South America are a prospective market for Canadian capabilities in ETC, ATMS and CVO. Industrialized countries such as those in Western Europe provide a potential market. These countries have ITS needs for CVO, ETC and public transit applications with characteristics similar to the US (Transport Canada, 1996a).

Priority ITS user service markets by international region are summarized by the table below:
### Table 2-6: ITS Priority User Service Markets by Region

<table>
<thead>
<tr>
<th>Region</th>
<th>Major Thrusts</th>
<th>Initial Applications (near to mid-term)</th>
<th>Secondary Applications (longer term)</th>
</tr>
</thead>
<tbody>
<tr>
<td>North America</td>
<td>Commercial vehicle operations</td>
<td>Freight mobility</td>
<td>Automated safety inspections</td>
</tr>
<tr>
<td></td>
<td>Electronic payment services</td>
<td>CV electronic clearance</td>
<td>On-board safety monitoring</td>
</tr>
<tr>
<td></td>
<td>Emergency management</td>
<td>CV admin. processes</td>
<td>HAZMAT response</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Electronic payment services</td>
<td>Route guidance</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Emergency notification</td>
<td>Public transportation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Emergency vehicle management</td>
<td>management</td>
</tr>
<tr>
<td>Europe</td>
<td>Transportation management</td>
<td>Traffic control</td>
<td>Incident management</td>
</tr>
<tr>
<td></td>
<td>Electronic payment services</td>
<td>Route guidance</td>
<td>Enroute driver information</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Traveller services information</td>
<td>Freight mobility</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Electronic payment services</td>
<td>CV electronic clearance</td>
</tr>
<tr>
<td>Japan</td>
<td>Transportation management</td>
<td>Traffic control</td>
<td>Traveller services information</td>
</tr>
<tr>
<td></td>
<td>Travel demand management</td>
<td>Enroute driver information</td>
<td>Demand management</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Incident management</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pre-trip travel information</td>
<td></td>
</tr>
</tbody>
</table>

Based on: Transport Canada, 1996a

The US market is a key area of potential demand with a close match to Canadian skill sets. Alliances are present, government cooperation is underway, international partnerships are successful and the competitive environment is understood.

Emerging industrialized countries in South America are a secondary market for traffic management, freight mobility and ETC. Europe is a potential market, however business practices and culture frequently discourage foreign companies except for completely complementary technology alliances. Japanese markets are strong in some ITS areas but are a poor match with Canadian skills. This market is not highly accessible except for the possibility of niche technology component supply (Transport Canada, 1996a).
2.2.3 Market Size and Growth

Projecting future ITS global market size is challenging due to market structure, complexity and geography. However, the need for transportation worldwide has created strong demand and high growth. Global market ITS forecasts may be grouped into application areas indicated by the commonly used industry acronyms that correspond to user services:

- Advanced Transportation Management Systems (ATMS), correspond to Travel and Transportation Services;
- Electronic Toll Collection (ETC), correspond to Electronic Payment Services;
- Commercial Vehicle Operations (CVO), correspond to Commercial Vehicle Operations Services;
- Advanced Public Transportation Systems (APTS), correspond to Public Transportation Operations Services;
- Advanced Traveler Information Systems (ATIS) correspond to Travel Demand Management and Transportation Management Services.

Transport Canada and SRI Consulting have developed estimates based on market structure, development issues and growth forecasts. These estimates include consideration of financial and political issues, targeted customers and benefits of ITS technologies. The table below shows the potential ITS market forecast for these application areas:

---

18
The technology applications forecast to develop most rapidly are CVO in North America, ATMS and ATIS in Japan, transit signal priority and coordination in Europe and ETC in North America (Transport Canada, 1996a).

2.2.4 Cumulative Industry Revenue

By the year 2011, ITS technologies sales revenue worldwide for equipment and services is projected to be over $66 billion per year. Based on these forecasts, a projected cumulative market between 1996 and 2011 for ITS sales worldwide may reach over US$434 billion as charted below.

Table 2-8: Extended World ITS Cumulative Market Forecast 1996 - 2011

Data source: Transport Canada, 1996a
The next table summarizes the projected Canadian market share of global sales based on a Transport Canada survey and fundamental intelligence gathered on Canadian industry capabilities.

Table 2-9: Projected Canadian ITS International Market Sales

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>ATMS</td>
<td>63</td>
<td>117</td>
<td>210</td>
<td>278</td>
</tr>
<tr>
<td>ETC</td>
<td>43</td>
<td>164</td>
<td>320</td>
<td>477</td>
</tr>
<tr>
<td>CVO</td>
<td>114</td>
<td>735</td>
<td>2,031</td>
<td>3,464</td>
</tr>
<tr>
<td>APTS</td>
<td>6</td>
<td>14</td>
<td>39</td>
<td>41</td>
</tr>
<tr>
<td>ATIS</td>
<td>21</td>
<td>161</td>
<td>356</td>
<td>509</td>
</tr>
<tr>
<td>Total</td>
<td>248</td>
<td>1,191</td>
<td>2,956</td>
<td>4,768</td>
</tr>
</tbody>
</table>

Data source: Transport Canada, 1996a

2.2.5 Domestic Opportunities

Domestic opportunities in ITS are driven by government spending on transportation infrastructure. Demand conditions to keep Canada's transportation system competitive through the implementation of ITS include:

- Congestion in densely populated corridors;
- Maintaining and improving existing infrastructure to meet growing demand;
- Ensuring transportation system safety and protection of critical infrastructure, for example meeting federal mandates for safety and security (E911);
- Providing user services more efficiently and effectively;
- Meeting traveler demand with services such as web portals, 511 services and alerts to mobile devices.

Regionally, the major metropolitan areas of Canada represent a potential capital equipment market of $106 million for procurement of ITS infrastructure and wireless
communications equipment. Including ITS User Services, the market is an estimated $292 million. Eight metropolitan areas in Canada have potential for ITS implementation on a large scale, increasing the potential domestic market demand (Transport Canada, 1996b).

The 2006 Federal budget allocated $2 billion for renewal of the Canadian Strategic Infrastructure Fund, $2.2 billion to the Municipal Rural Infrastructure Fund and $2.4 billion to the Highways & Border Infrastructure Fund over 5 years (Spencer, 2006).

2.2.5.1 BC Ministry of Transportation

The BC Ministry of Transportation plans and provides transportation networks and services. It develops and implements transportation policies and administers transportation regulations. A $2 billion investment in transportation improvements over the next three years is intended to capture economic opportunities in trade, tourism and resources (BC Ministry of Transportation, 2006), providing opportunities for the local BC wireless ITS industry.

High economic and population growth in BC is increasing demand for transportation. Rapid expansion leads to the need for transportation infrastructure, road improvements, maintenance and travel demand management. BC is a gateway for trade between Asia and North America that requires major investments to remain competitive with other US Pacific gateways. The movement of people and goods through BC depends on an efficient, cost-effective and integrated transportation system. As a result, the Ministry has invested $3 billion in a Gateway Strategy to open up key economic gateways.
Preparation for the 2010 Olympic and Paralympic Winter Games is underway and will require critical transportation infrastructure improvements to meet the demands of the games. This is an opportunity to showcase transportation improvements and shape future travel behavior (Jacobsen, 2006).

The provincial investment strategy depends on partnerships with local governments, the federal government and the private sector. The primary objectives for the Ministry of Transportation are the provision of transportation infrastructure to reduce congestion and increase public safety. This depends on effective transportation policy and regulations to stimulate further investment (BC Ministry of Transportation, 2006).

The ITS Strategic Plan for BC below addresses the challenges of population growth, trade growth, efficiency and safety.

Figure 2-1: BC Provincial ITS Strategic Plan

Based on: ITS Corporation and IBI Group in Association with Lockheed Martin, Delcan Corporation, Shaflk Engineering, PBA Engineering, 2001
The BC Ministry's current priorities are key transportation infrastructure improvements for economic growth and trade. The strategy is to develop public-private partnerships to leverage private investment (BC Ministry of Transportation, 2006). The following BC Ministry of Transportation Service Plan for transportation improvements indicates substantial capital investment leveraged through public-private partnerships and design-build-finance-operate arrangements:

Table 2-10: BC Ministry of Transportation Service Plan 2006/07

<table>
<thead>
<tr>
<th>Performance Measures</th>
<th>2006/07 Target</th>
<th>2007/08 Target</th>
<th>2008/09 Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Private investment capital leveraged through public-private partnerships</td>
<td>$104.1 M</td>
<td>$153.3 M</td>
<td>$247 M</td>
</tr>
<tr>
<td>Federal funding investment leveraged (capital)</td>
<td>$70 M</td>
<td>$99 M</td>
<td>$96 M</td>
</tr>
</tbody>
</table>

Data Source: 2006/07-2008/09 Service Plan BC Ministry of Transportation, 2006

2.2.5.1.1 Gateway Program

The BC government established the Gateway Program to manage growing regional congestion. The improvements proposed are intended to create a more effective transportation network for supporting faster movement of resources, facilitating economic growth, increasing transportation options and improving links to growing populated areas.

The Gateway Program goals are to:

- Improve the movement of people and goods and to address congestion throughout the region;
- Improve access to gateways such as ports, railways, airports and border crossings through better connections;
- Improve reliability and safety;
• Improve the regional road network and communities quality of life by keeping regional traffic off local streets;
• Facilitate better connections between transit networks; and
• Reduce travel times during peak periods (Province of BC, 2001).

The Gateway Program addresses the key challenges of the BC Ministry of Transportation to invest in transportation infrastructure and ITS to support forecast population and economic growth.

2.2.5.2 Greater Vancouver Transportation Authority (TransLink)

TransLink is an integrated regional transportation network authority that plans, finances and manages transportation services and capital projects. Public transit services are delivered through subsidiary companies and contractors. Maintenance and improvements of the major road network are conducted in partnership with the municipalities.

TransLink’s ITS Program improves the operating efficiency and safety of the regional transportation network by developing computer, communications, traffic control and information processing technologies. The ITS Corporation, TransLink’s operating subsidiary, works with stakeholders for the development of regional and provincial ITS projects. The ITS Corporation’s Board of Directors spans all government levels, private sector and representatives of the transportation industry. The ITS Department of Translink provides technical and administrative support to these agencies and internal departments (Greater Vancouver Transportation Authority, 2005).
The Three Year (2005-2007) Implementation Strategy included several transportation technology projects initiated in 2005 and scheduled for completion in 2007:

- Regional Advanced Traveller Information System (ATIS);
- Condition Acquisition Reporting System (CARS);
- Integrated Regional Signal System (IRSS);
- Smart Card for Electronic Fare Payment;
- SmartBus Research (Greater Vancouver Transportation Authority, 2004).

Translink’s proposed capital contributions for ITS projects in 2006 totalled approximately $1,000,000 (Greater Vancouver Transportation Authority, 2006). A technical inventory of Translink wireless ITS projects under the ITS Corporation of BC is provided in the following table:

<table>
<thead>
<tr>
<th>Project</th>
<th>Regional Application</th>
<th>Technologies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regional ITS Telecommunications Network</td>
<td>GVRD</td>
<td>Integrated broadband network</td>
</tr>
<tr>
<td>Integrated Regional Signal System Coordination</td>
<td>GVRD</td>
<td>Network layer (TCP/IP), session (SOAP), presentation (XML), application (TMDD &amp; MS/ETMCC)</td>
</tr>
<tr>
<td>Regional Traffic Management Centre</td>
<td>GVRD</td>
<td>Loop detectors, traffic signals, CCTV, signal priority</td>
</tr>
<tr>
<td>ATIS</td>
<td>Hwy 99/15</td>
<td>Loop detectors, VMS, CCTV</td>
</tr>
<tr>
<td>Electronic Tolling</td>
<td>Golden Ears</td>
<td>DSRC, ATIS, NTCIP protocols</td>
</tr>
<tr>
<td>Weight in motion</td>
<td>Port Mann Bridge</td>
<td>Loop detectors, CCTV, SRDC, AVI</td>
</tr>
<tr>
<td>CCTV</td>
<td>Pattullo, Knight &amp; Lions Gate Bridges</td>
<td>CCTV</td>
</tr>
<tr>
<td>License plate recognition</td>
<td>Sea to Sky highway</td>
<td>CCTV</td>
</tr>
</tbody>
</table>

*Data Source: Kitasaka, Keenan, Manager ITS, Translink, 2006*
2.2.5.3 Regional Telecommunications Plan (RTP)

The Regional ITS Strategic Plan (2002) identified a need for a Regional Telecommunication Network. A jointly funded Ministry of Transportation and TransLink project was proposed and sponsored by the ITS Corporation to study and document the public sector telecommunications corridors, including bandwidth and speeds, to support ITS technology. The purpose of the Regional Telecommunication Plan is to improve management of existing infrastructure, to establish a communication infrastructure policy and to share existing infrastructure. The overall goal is to develop a plan for an integrated broadband network to support ITS initiatives. Specific project objectives include: developing an inventory of available public and private broadband infrastructure; identifying regional ITS deployments and associated bandwidth requirements; developing a high level regional network architecture; developing business, governance, funding and sustainability models and preparing an implementation plan and budget (Livolsi & Shira, 2006).

2.2.5.4 Greater Vancouver Regional District (GVRD)

The GVRD is a partnership of 21 municipalities and an electoral area that constitute the Greater Vancouver metropolitan area. The role of the GVRD is to manage growth and development. It delivers essential utility services that are economically efficient to supply regionally. The GVRD provides its services through direct provisioning and contracting.

The Livable Region Strategic Plan (LRSP) is the GVRD’s regional growth strategy used by all levels of government as the framework for regional land use and transportation decisions. The Transportation Choice Policies contained in the LRSP are
based on a medium and long range transportation plans for Greater Vancouver.

According to the 2004 annual report on the LRSP, a significant increase in transit rider-
ship and rapid transit projects indicates progress toward achieving transportation choice.
The Provincial Gateway Program proposed several large-scale projects consistent with
the regional growth strategy. The ongoing LRSP review process is used to evaluate the
long term transportation network requirements to support the region to 2031 (GVRD, 2004).
This provides significant opportunities for local wireless ITS firms to meet
regional demand by participating in the regional growth strategy review process. The
process is in the pre-proposal stage, considering key issues and possible policy options in
consultation with the GVRD’s Technical Advisory Committee.

2.2.5.5 Vancouver International Airport Authority (YVR)

The Vancouver International Airport Authority (YVR) addresses requirements to
meet future growth in a 20-Year Master Plan. This plan is a roadmap for managing
growth in passenger, aircraft and cargo volumes in order to achieve gateway strategy and
sustainability objectives.

To accommodate expected growth to 2027, additional terminal facilities, taxiway
enhancements and a new runway will be required. Road access to the airport is a
significant planning issue. As growth continues, alternative transportation, such as the
Canada Line, will become essential to maintaining traffic flow. Provincial industries rely
on the airport for convenient and efficient connections worldwide (Vancouver
International Airport Authority, 2006). For this reason, local wireless ITS firms may
target this potential opportunity for improving transportation efficiency.
2.2.5.6 Vancouver Port Authority (VPA)

The Vancouver Port Authority (VPA) is a major economic gateway trading $43 billion in goods with over 90 economies annually. The port supports economic development and benefits stakeholders including customers and supply chain participants such as shipping lines, terminal operators, railways and truck operators (VPA, 2006a).

The VPA must improve supply chain reliability and efficiency to meet the anticipated triple growth in container business between 2006 and 2020. The strategic trucking program incorporates projects and initiatives undertaken to address container terminal capacity expansion and productivity improvements. The truck monitoring program uses advanced technology applications to develop automated management reporting and communications. The Radio Frequency Identification (RFID) Project is a pilot to monitor trucks and gather metrics such as turnaround time at port facilities, turnaround at container terminals, truck transactions at each facility and reservation compliance. The Optical Character Recognition (OCR) Project will allow trucks to proceed through the gates without stopping. The current challenges of this program include integration and data exchange standards (VPA, 2006b). These pilot projects provide an opportunity for local wireless ITS firms to showcase their capabilities and demonstrate the benefits of ITS applications.

2.2.5.7 Summary of Domestic Opportunities

In summary, the federal government has spent $4.7 million under the ITS R&D Plan and $14.6 million under the ITS Deployment Plan. Infrastructure funding and the Pacific Gateway have emerged as federal priorities (Spencer, 2006). The table below demonstrates that there are substantial transportation investments being made in the
region by all levels of government that require an ITS spending component with planning underway.

Table 2-12: Pacific Gateway Investments

<table>
<thead>
<tr>
<th>Agency</th>
<th>Funding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Translink</td>
<td>$4 billion</td>
</tr>
<tr>
<td>Provincial Gateway Program</td>
<td>$3 billion</td>
</tr>
<tr>
<td>Vancouver International Airport</td>
<td>$1 billion</td>
</tr>
<tr>
<td>Vancouver Port Authority</td>
<td>$1 billion</td>
</tr>
<tr>
<td>Federal Government of Canada</td>
<td>$600 million</td>
</tr>
</tbody>
</table>

Data Source: Jacobsen, Pat. CEO Translink, 2006

There is considerable opportunity in the ITS market in the immediate region, with limited constraints. Demand is rising due to expansion in trade and growth in population, specifically in the Pacific Gateway.

Overall, the value and anticipated growth of the ITS market appears sufficient to justify R&D to competitively position BC’s industry to capture its global share. The Canadian ITS industry may gain experience, revenue and market partners in global markets while the domestic markets develop. As domestic markets grow, companies with global experience and proven competitively priced products will be in a position to dominate the Canadian industry.

However a further analysis of the competitive situation, market constraints, technological constraints such as standards and interoperability is required before recommending any action. The next section presents an analysis of government and international competitive forces faced by the ITS industry.
2.3 Competitive Forces Analysis of the ITS Industry

This analysis of competitive forces and their profitability impact on firms will provide the basis for a comprehensive wireless ITS industry strategy. Competitive forces affect the wireless cluster growth and provide a rational for economic development. The following Porter’s competitive forces model that includes government as a force forms the foundation for a logical political approach.

2.3.1 Government

Government actions shape the competitive environment directly by impacting firms, and indirectly by impacting suppliers, buyers, substitutes and entrants (Vining, et al, 2005a, p. 153). Industry Canada provides geographical and sector support by providing business analysis, trade, policy, investment and technology research. The government of Canada, Industry Canada and the National Research Council have undertaken studies to make recommendations for cluster development and growth, improving policy decisions and designing new initiatives. These studies identified the need for increasing cluster synergy by developing regional integrated cluster strategies. However, the policy direction of the government of Canada has not yet reflected these recommendations and the federal government still intends to consult further with the cluster communities on an as needed basis (Industry Canada, 2004).

The federal government’s Strategic Highway Infrastructure Program (SHIP) provided $600 million in funding for Innovation Through Partnership from 2001 to March, 2006. Under Transport Canada’s ITS Research Development Plan, $1 million of SHIP funding was invested in R&D. This initiative supported the adoption of ITS technologies to promote safety and efficiency (ITS Canada, 2006). The federal
government has recognized that a world class infrastructure is key to maintaining
Canada’s international competitiveness. Under the federal ITS R&D Plan, $4.7 million
has been invested and under the ITS Deployment Plan, $14.6 million has been invested
provincially with 10 contracts and contribution agreements (Spencer, 2006).

The ITS Policy Branch of Surface Transportation Policy leads the planning,
development and implementation of a comprehensive policy framework for Transport
Canada. Transport Canada’s national ITS Plan consists of an ITS Architecture that
ensures integration of products and services nationally. The ITS Architecture provides a
framework for coordination of ITS deployment in the public and private sectors. The
framework promotes compatibility of ITS elements and ensures unified ITS
implementation regionally.

The ITS Architecture defines physical component interaction of transportation
systems involving travellers, vehicles, roadside infrastructure, and control centres. It
specifies the communications and information system requirements, data sharing and
usage, and interoperability standards necessary for integrated ITS deployment. The ITS
Architecture denotes component functions and information flows among elements to
attain overall system goals (Transport Canada, 2000).
The Canadian ITS Architecture was developed following a review and analysis of international ITS architectures and standards. ISO TICS, USA User Services, European KAREN Project and Japanese ITS Services provided relevant points of reference. The Canadian environment and appropriate ITS technologies were assessed to determine suitable features for widespread deployment within Canada.

The ITS Architecture contains ITS User Services that incorporate context specific issues including population dispersion levels, bilingual language requirements, extreme climate conditions, metric system, legislative concerns, existing communications infrastructure and regulatory issues. Canadian context specific ITS User Services targeted for domestic deployment are listed in the following table:

<table>
<thead>
<tr>
<th>Table 2-13: ITS User Services for Canada</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Traveller Information Services</strong></td>
</tr>
<tr>
<td>- 1.1 Traveller Information</td>
</tr>
</tbody>
</table>
The federal government’s ITS Deployment Plan requires competitive calls for funding projects. Funding toward general deployment projects must be consistent with provincial/territorial ITS Strategic Plans and priorities. Agreements have been signed with seven provinces and all others are in the negotiation stages (Spencer, 2006).

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Based on: Transport Canada, 2000
In section 2.4, the Canadian ITS Architecture and Deployment Plan will be compared to other national policies and standards.

2.3.2 Suppliers, Buyers and Government Policy: P3s and Procurement

The provincial government's goal is to produce more jobs per capita by investment in major infrastructure and public-private partnerships providing economic benefits. This strategy is an opportunity for private sector wireless firms to partner with government for technology deployment funded by the public sector through service level contracts. Public Private Partnerships (P3s) are methods governments utilize to reduce immediate expenditures and reduce the cost of major infrastructure projects. P3s bring benefits of private sector management, reduce capital costs and shifts risks to the private sector. The rationale is cost savings; however P3s are often prone to conflict (Vining, Boardman, Poschmann, 2005b). P3 contracting in ITS is complex and subject to changes in technologies and market forces.

The current federal government funding strategy for ITS relies heavily on partnerships and private sector funding, as shown by the table below.
2.3.3 Rivalry and Government Policy

The major forces that influence rivalry between ITS firms and government include transportation and communication specific regulation, industry specific tax and policy, trade policy, ownership policies and anti-trust policy (Vining, et al, 2005a). The government is both a buyer and supplier of public infrastructure. Government policies on supplier procurement and contracting have an affect on industry profitability. Federal government objectives are to receive the best value in the acquisition of goods, services and construction (Government of Canada, 2004).

Procurement and contracting policies of the federal, provincial and municipal governments are intended to encourage competition. International trade is under federal jurisdiction. Government policies must comply with trade obligations under the North American Free Trade Agreement (NAFTA), the World Trade Organization Agreement on Government Procurement (WTO-AGP), and the Agreement on Internal Trade (AIT) (Government of Canada, 2004).

NAFTA harmonizes trade-related transport activities across international borders between Canada and the US. Canada also commits to harmonize transportation services, including ITS user services, under the NAFTA (Johnson, 2004).
The BC government is a party to the national Agreement on Internal Trade (AIT). The agreement promotes open, efficient and stable domestic markets for job creation, economic growth and sustainability (Industry Canada, 2006). This provides BC suppliers with greater access to procurement opportunities in other provinces and the federal government. BC Bid provides access to opportunities issued directly by ministries such as the BC Ministry of Transportation. Procurement planning for the provincial government requires that the ministry ensure a cost / benefit justification exists and the contract is consistent with policy, applicable legislation, trade and collective agreements (BC Ministry of Finance, 2006).

2.3.4 Entry Barriers and Government Policy

In the past, nations have placed entry restrictions on industries with natural monopoly characteristics such as telecommunications, transportation and power. The elimination of regulatory entry barriers in Canada has threatened incumbent profits, however not overall industry profitability (Vining, et al, 2005a).

The purpose of the Agreement on Internal Trade is to remove trade barriers within Canada and to establish efficient domestic markets. International trade policies such as the WTO, NAFTA and FTAA are intended to assist Canadian companies entering export markets and to create opportunities in emerging markets (Foreign Affairs and International Trade Canada, 2006).

The recent Trade, Investment and Labour Mobility Agreement between BC and Alberta, signed in April 2006, is an initiative that breaks down barriers to trade by enhancing competition between provinces (BC Competition Council, 2006b).
2.3.5 Summary of Government Forces

The federal funding strategy depends on partnerships and high private investment, increasing the attractiveness and profit potential for local wireless ITS firms. In addition, entry into domestic and international markets for Canadian companies is supported by government policy, although preferential local contracting is not aggressively supported by free trade policies within Canada and internationally. Hence, the competitive forces analysis reveals that the government has high power as both a buyer and supplier of ITS infrastructure.

The Canadian ITS Architecture and BC ITS Strategic Plan directly influence the market demand for wireless ITS applications and opportunities for local firms. The opportunity for the BC wireless cluster in the region is both large and strongly influenced by federal and provincial government funding and policy. The BC Ministry of Transportation Service Plan for transportation improvements requires substantial capital investment leveraged through public-private partnerships which enhances the potential participation in these government initiatives. The current situation of a growing cluster and major government investment suggests that this is a crucial time in the future development of the BC ITS cluster. Actions by government, industry and individual firms can have major repercussions at this juncture. An integrated cluster strategy is needed to cover the full range of technologies required in ITS.

As presented in section 2.1.4, the BC wireless ITS cluster is strategically important to the provincial government in terms of contributing to economic prosperity and exports. Therefore, chapter 3 will focus on the BC wireless/ITS sector from the cluster perspective. Next, the international situation for ITS is assessed.
2.4 Competitive Forces: International

The opportunities and benefits ITS offers are widely recognized internationally as section 2.2.2 on international opportunities demonstrated. Examination of global competition reveals successful government policies and regional initiatives. Investigating different governmental approaches to increase ITS competitiveness provides a benchmark for Canadian activities.

Japan, Europe and the US are leaders in developing and deploying ITS technologies, the Japanese since the 1970’s, the Europeans since 1980’s, and the US since the 1990’s. Governments, partnering with the private sector, are spending billions on R&D, demonstrations, and deployment of ITS. These countries have built ITS industrial foundations from strong defence and high technology industries. The ability to develop ITS capabilities appears to depend significantly on the constitutional structure and the policy instruments in place to foster cooperation (Transport Canada, 1996a).

2.4.1 USA

The US National ITS Architecture is a framework for ITS planning, defining, and integration. At version 5.1, it has matured to reflect a broad range of ITS industry contributions. The Architecture defines:

- functions required for ITS (e.g. gather traffic information, request a route);
- physical components or subsystems where functions exist (e.g. field, vehicle);
- information and data flows that connect components into an integrated system (US DoT, 2005).

This architecture provides standards that are applied to federally funded projects for integrated statewide and metropolitan deployment. This means federal funding is tied
to state based compliance of US ITS firms with USDOT ITS Standards and the National ITS Architecture (Miska, 2006).

**Figure 2-3: USA ITS Architecture**

![USA ITS Architecture Diagram]

*Based on: ITS US Department of Transportation, 2005*

The US Department of Transportation (DOT) is proactive and directive by providing dedicated ITS funding, promoting adopting and advancing technology penetration. Annually, the DOT funds $32 billion in grants and cooperative agreements. DOT operating administrations acquire equipment and services to fulfill mission objectives and disburse funds to the states and municipal authorities for transportation purposes. Regulations and directives governing DOT acquisitions are intended to assure impartial, equitable competition through the evaluation of proposals. Specific programs, such as the DOT Office of Small Business Utilization are proposed to maximize opportunities for US citizens. The DOT Small Business Innovation Research (SBIR) Program supports private sector initiatives, however funding is restricted to US-owned businesses (US DOT, 2006).
2.4.2 Europe

In Europe, ITS cooperation has been facilitated by the European Union and the ERTICO organization. The Keystone Architecture Required for European Networks (KAREN) and the ERTICO Strategy promotes an interoperable market for ITS applications and services in Europe. ERTICO partners include industry, public authorities, infrastructure operators, service providers and users. ERTICO builds consensus among partners and ensures representation within European Union institutions for Common Transport Policy. Standardisation is a critical factor for integration and market growth in Europe.

ERTICO is committed to ITS public-private partnerships to promote economic growth of the Trans European Network (TEN) and economy. ERTICO’s strategic goals are to create ITS awareness and acceptance by performing several key roles. ERTICO provides an advisory role to European governments at the national and regional levels for research policy, implementation, regulation, project procurement and operation. It provides a coordinating role in standards setting and a consulting role in the marketing objectives of its members (ERTICO, 2005).

ERTICO focuses on European ITS Architecture and standards, market and product development through public private partnerships. The organization has initiated significant international ITS cooperation activities. Cooperation with emerging markets contributes to the establishment of European ITS standards and provides early market access opportunities for ERTICO partners (ERTICO, 2005).
2.4.3 Japan

Japan leads globally in the commercialization of ITS-related technologies in the following specific market areas:

- Car navigation systems (12 million systems shipped);
- Vehicle information and communication system (VICS) (7 million systems sold);
- Electronic toll collection (ETC) systems (1.5 million ETC in-car units installed) (ITS Japan, 2003).

In Japan, the ITS platform combines the importance of providing communications and positioning functions. The Japan Urban ITS Committee identifies 55 services, including ITS user services and cargo transport services. The Committee organizes the functions and performance requirements into sub-platform, positioning sub-platform and various other sub-platforms.

ITS Japan has established an ITS Strategy Committee to make recommendations to government ministries and agencies. The ITS Strategy Committee has recommended the use of investment schemes that combine private and public sector funding, for example private finance initiatives (PFI). The committee has developed a service roadmap for the ITS platform with roles for ITS Japan, private and public sectors to make the ITS platform–based services available:

- Private-sector: technology component R&D for ITS platform construction;
- ITS Japan: the organizational framework required to launch the ITS platform and
2.4.4 International ITS Policy Summary

The international survey indicates that methods differ, however the following characteristics are key indicators of national ITS progress:

- There is national coordination to advance national interests both domestically and internationally. In some cases, this is a central government office such as the US DOT in the US, the Ministry of International Trade and Industry in Japan or the European Union in Europe.

- All sectors, public, private, and academia are involved. Cooperation between government and private sector is essential and is achieved through partnerships. Partnerships are vital to ITS development and deployment success. Financial benefits and risks are shared over the long term. Partnerships are achieved through an independent group such as ITS America (US), ERTICO (Europe) or ITS Japan (Japan).

- Demonstration projects provide proof of ITS benefits and an opportunity for domestic industries to demonstrate abilities to the international market. New market opportunities are generated through international cooperation and coordination. Participation in efforts such as standards setting activities promotes national interests and ensures integrated ITS market development globally.

- ITS initiatives for automated border crossings and electronic clearance require international standardization and cooperation of public and private entities. Specifically, partnerships and coalitions between Canada and the US aim to improve security while expediting trade (ITS International, 2004).
• Representation and reporting of national ITS standards and development activities to international standards setting organizations such as ISO/TC provides benchmarks for progress against other countries (ITS Canada, 2006).

• Funding from the government is available and essential for gaining partnership investment (Transport Canada, 1996a).

2.5 Summary

The international and domestic market analysis has provided strong indication of the ITS market potential. A competitive forces analysis has provided evidence of the power of the government as a force in the Canadian context for ITS industry growth and development with substantial capital investment leveraged through public-private partnerships. According to the international survey, other national governments are investing heavily in industry partnerships for major ITS technology development.

In summary, government policy is necessary to facilitate regional growth and development of wireless ITS firms. Next, analysis at the regional cluster level provides further evidence of the need for political strategy and policy making for the emerging ITS industry.
3 BC WIRELESS INTELLIGENT TRANSPORTATION SYSTEMS CLUSTER ANALYSIS

This chapter provides a review of current research on clusters as a basis for economic development. It examines the conceptual foundations of the cluster approach and evaluates the linkages between clusters and economic performance. Techniques for analysis are selected to identify and evaluate the wireless ITS cluster in BC. The wireless cluster is benchmarked against other clusters to determine its international importance and potential for global competition (Raines, 2002, p. 163). Sources of competitive advantage for wireless ITS firms are assessed, as well as weaknesses and areas in which policy could make a difference.

3.1 Cluster Concept

3.1.1 Definition of a Cluster

“Clusters are groups of companies and institutions co-located in a geographic region and linked by interdependencies in providing related products and services” according to Porter (2000, p. 16). By clustering, firms and institutions leverage assets, linkages and relationships. As a result, clusters may achieve efficiencies that enhance competitiveness. Due to proximity in geography and activities, clusters generate positive location-specific externalities such as specialized human resources, knowledge spillovers and higher performance from increased competition. For this reason, clustering affects government strategies to promoting economic development (Porter, 2000, p. 21).
3.1.2 Clusters and Economic Performance

Economic benefits accrue with cluster development. Companies in a cluster can operate more efficiently, achieve a higher level of innovation and stimulate new business formation (Ketels, 2003a). These benefits have significant implications for both clustering companies and for public policy. For companies, clustering adds greater value than the cost of competing in another specific location. For public policy, long term regional prosperity results from higher cluster productivity and innovation. However, the objectives of these groups are not necessary aligned. Public policy is not concerned with the distribution of benefits among cluster participants while private companies are concerned with profit maximizing decisions (Ketels, 2003a).

3.1.3 Components of a Cluster

Clusters encompass a concentration of similar firms and extend up and down the supply chain to suppliers and customers. A cluster includes: (1) similar and potentially competing firms (2) providers of specialized inputs and providers of specialized infrastructure, customers and manufacturers of complementary products, (3) interaction with research and educational organizations, trade associations, standards setting agencies funding and government institutions and (4) infrastructure that provides advantages to geographically co-located firms. Significant interaction between core firms and all other components is evident in a well functioning cluster (SQW Ltd, 2003a).

3.1.4 Clusters and Competitive Advantage

The major benefit of a cluster is that it creates “a system of interconnected firms and institutions whose whole is more than the sum of its parts” (Porter, 2000, p. 21).
Clustering affects competition by: (1) increasing productivity of firms and industries, (2) increasing innovative capacity of cluster participants; and (3) stimulating new business formation that extends the cluster (SQW Ltd, 2003a). Further, the positive externalities or spillover affects across firms, industries and institutions have potential to create sustainable competitive advantage.

### 3.1.5 Cluster Advantages to a Firm

Companies successful in developing sustainable competitive advantage have adopted actions to gain the full benefits of their presence in cluster:

**Innovation:** competitive advantage grows out of improvement, innovation and change. It includes new technologies, processes and can involve any activity in the value chain. To sustain competitive advantage, firms take advantage of the presence of a cluster to improve and innovate. Knowledge spillovers and interaction create more new ideas and provide pressure to innovate while the cluster environment lowers the cost of experimenting (Ketels, 2003a, p. 6).

**System view of the value chain:** Interaction with suppliers and channels is integral to the process of creating and sustaining advantage. Clustering manifests competitive advantage by engaging the entire value chain as a system. To sustain competitive advantage, firms must extend clusters by improving the conditions for suppliers, buyers and entry into related industries.

**Improving the source of competitive advantage:** Competitive advantage is sustained by continuous improvement within an overall strategic context. Since few competitive advantages cannot be imitated, a firm must continually search for different and better
ways of competing. For example, a firm competing with a differentiation strategy must find new ways to differentiate or improve its effectiveness.

Global approach: Sustaining competitive advantage in international competition requires extending local advantages with a global approach to strategy (Porter, 1998c, pp. 578-84).

3.2 Cluster Models for Analysis

3.2.1 Porter Cluster Diamond

A region may acquire high technology investment, however it will not develop a strong cluster without certain factors (Gollub & Egan, 2004b). Porter models the effect of geographical location on competition with forces graphically portrayed in diamond formation (Porter, 2000, p. 20).

Figure 3-1 Sources of Locational Competitive Advantage

Based on: Porter, 2000
Factor conditions are inputs that improve efficiency, quality and specialization for specific regions. Specialized factors are required to achieve higher productivity and are not as available in other locations. The context for firm strategy relates to the local rules and standards influencing rivalry. Demand conditions determine the potential for firms to move from imitative products to competing on differentiation. A well performing cluster creates significant benefits to productivity and innovative capacity that are difficult for firms in other locations to match (Porter, 2000, p. 21).

3.2.1.1 Strategic Choice

Choice of strategy can increase potential success of a firm when competing in industries where the government promotes an environment for competitive advantage. A cost-orientation strategy is susceptible to cost factors, demand and conditions that favour capital investment. A differentiation strategy depends on specialized human resources, expert buyers and leading suppliers. Focus strategies rely on strong demand in specific sectors (Porter, 1998c, p. 602). International market penetration should focus on segments with local advantages but which are emerging markets in foreign nations. Diversification has more potential to succeed when expanding clusters in which the firm currently competes with common buyers, channels, suppliers and technological connections (Porter, 1998c, p. 606). This connection exists between local wireless technology firms and the growing global ITS industry.

3.2.2 Cluster Initiative Performance Model

Cluster initiatives (CIs) are organized efforts to increase the growth and competitiveness of clusters within a region. Cluster initiatives are a central part of
industrial, regional and innovation policy making (Ketels, Solvell, Lindqvist, 2003b, p. 15).

The Cluster Initiative Performance Model (CIPM) is based on four components: three drivers 1) the social, political and economic setting within the nation; 2) the objectives of the cluster initiative; 3) the process by which the cluster initiative develops, which affect 4) the performance of the CI (Ketels, et al, 2003b, p. 25).

3.2.3 SQW Model

SQW Ltd, a consulting firm in the UK, proposed a framework for analysing clusters on the basis of critical mass, behaviour and entities (SQW Ltd, 2003b):

- Critical mass: is there a geographical concentration of firms?
- Cluster behaviours: are the firms linking or networking?
- Cluster entities: is infrastructure supporting optimal cluster behaviours within a regional concentration of firms?

3.2.4 Location Quotient Analysis

Location quotient analysis is a technique used to measure densities of firms and may be applied cluster analysis. The location quotient (LQ) identifies industries with employment in a region higher than the national average for that specific industry. It is determined by calculating the percentage of employment in the North American Industry Classification Systems (NAICS) to total regional employment. This ratio is divided by the percentage of total national employment in the specific industry over total national employment. If the LQ exceeds one then the region has a higher share of employment within the sector with some production exported. Therefore it is an indication of export
strength. However, with emerging industries such as ITS, it is difficult to apply NAICS codes that may not yet be established. Further, emerging clusters may have a lower economic concentration but have potential to become more economically significant. Emerging clusters may be measured by calculating the growth of industry employment, however this does not indicate productivity or efficiency of firms (Kargina, 2003, p. 14). The LQ is later applied in a comparison of wireless cluster strengths between competing regions.

### 3.2.5 Economic Input-Output Models

The input-output (I-O) model is used to determine relationships between the region’s industries (SANDAG, 1995, p. 4). The flow of goods and services between industries must be established in order to apply an I-O model. The cluster dependency factor (CDF) and the economic prosperity factor (EPF) can be evaluated from the I-O model:

**Cluster Dependency Factor:** is a set of ratios produced from the transaction table of the I-O model that determines the relative strength of the buyer and seller forces within a cluster.

**Economic Prosperity Factor:** is a measure of the industry’s economic significance by using the ratio of an industry’s annual payroll per employee divided by the region’s average payroll per employee.

Although the I-O model is useful for vertically integrated clusters, it does not address relationships between firms and does not account for other significant clustering behaviours.
3.2.6 Cluster Mapping for Evaluating Cluster Performance

A consistent definition of economic activities that belong to a cluster is necessary for systemic analysis. “Cluster Mapping” is considered an effort to develop cluster definitions from empirical analysis (Ketels, 2003a, p. 9).

Michael Porter of the Institute for Strategy and Competitiveness, Harvard Business School, has conducted the most extensive project for mapping clusters (Ketels, 2003a, p. 9). The study utilized regional employment data to identify industries that concentrate in geographical areas based on employment. Porter calculated the correlation of employment by industries across locations to identify cluster categories. Industries were primarily associated with one cluster, called a “narrow” cluster. Industries were also associated with other related clusters, called “broad” clusters. Broad clusters exhibit overlap between clusters and support the development of new clusters from existing ones (Ketels, 2003a, p. 9).

3.2.7 Framework for Evaluating Cluster Benefits

The impact of clusters on the growth performance of successful new technology-based firms has been analyzed in studies conducted by Maine, Shapiro and Vining (2006). The study proposes that the key dimensions of clustering benefits arise from chain benefits and spillover benefits. Spillover benefits arise from competing firms and from public infrastructure. Chain benefits are realized through market mechanisms such as procurement policy. It is argued that total benefits from both effects are strongest for firms located in proximity to a relevant cluster (Maine, et al, 2006, p. 4).

The empirical results imply distance from a relevant cluster is significant and substantial evidence indicates that clustering supports high growth rates. Cluster diversity
enhances performance and growth of firms that depend on supply chain effects such as ICT firms in the US (Maine, et al, 2006, p. 15).

Previous studies by Globerman, Shapiro and Vining (2005) on spillover benefits of clustering in Canadian ICT firms indicate that regional and metropolitan agglomeration does not influence growth rate. Moreover, the research indicates that the Canadian economy is not strong enough “to support many diversified clusters.” However, support of specialized clusters may be justified if located relatively close to large, diversified clusters, including those in other countries (Globerman, et al, 2005, p. 53).

3.3 BC Wireless ITS Cluster Analysis

By any definition, BC clearly has a wireless cluster and the ITS sub sector also meets the criteria of a cluster as defined in section 3.1.3. After a survey of techniques used to analyze clusters, Porter’s diamond framework will be applied to the BC wireless ITS cluster to analyse the clusters strengths and weaknesses. This analysis will build on the foundation of the previous competitive forces analysis of the ITS industry, since the competition is strongly influenced by the political and economic environment. The Porter framework necessitates the role for government and other institutions, such as WINBC, in enhancing competitive conditions. The Location Quotient and cluster mapping will also be applied to assess BC’s position relative to competing clusters.

3.3.1 BC Wireless Strengths

The 2006 WINBC Wireless Analysis reports that BC wireless companies exhibit strengths as indicated by the number of companies in each technical area as follows:
Table 3-1: Technical Strengths of BC Wireless Companies

<table>
<thead>
<tr>
<th>Technology</th>
<th>Number of BC Companies</th>
</tr>
</thead>
<tbody>
<tr>
<td>CDMA</td>
<td>39</td>
</tr>
<tr>
<td>Wifi</td>
<td>38</td>
</tr>
<tr>
<td>CDMA2000</td>
<td>30</td>
</tr>
<tr>
<td>GPS</td>
<td>25</td>
</tr>
<tr>
<td>VoIP</td>
<td>24</td>
</tr>
<tr>
<td>GSM/GPRS/EDGE</td>
<td>25</td>
</tr>
</tbody>
</table>

Data Source: WINBC (2006)

These technical strengths indicate that BC firms have the capability to participate in market opportunities for wireless ITS and compete internationally. A description of these wireless technologies is included in Appendix B.

3.3.2 Factor Conditions

The availability of factors is the most important consideration in co-location of wireless ITS companies. The most important attributes are:

Physical resources: Vancouver is a natural port and a transportation gateway to North America with Asia Pacific links. Hence transportation has become a priority for local, provincial and national governments, although it has been neglected for some time.

Human resources: BC has an expanding, economical workforce of qualified people. Linkages with local academia increase availability of potential knowledge capital.

Knowledge resources: Leading universities and associated academic research provide enterprise-academic cooperation to innovate and produce new technologies. The average number of degrees, diplomas and certificates awarded by BC’s public post-secondary institutions over the past three years was almost 48,000, an increase of 14.6 per cent over the previous time period (BC Ministry of Advanced Education, 2006). Specifically regarding ITS, the federal and provincial government have each provided $500,000 to
establish the Bureau of ITS and Freight Security at UBC. The bureau will establish R&D
for ITS and freight security (Transport Canada, 2005).

**Infrastructure:** BC provides information and transportation infrastructure to support
regional competitiveness. The province and the federal government have provided
funding for rapid transit projects and a dedicated provincial fuel tax of 6.75 cents per litre
has been allocated to the GVTA. However the GVRD is facing a transportation
infrastructure deficit estimated at $10.95 billion (Province of BC et al, 2006). The
opportunities section 2.2.5 provided details on the extent of planned spending by
government on transportation infrastructure.

**Proximity to US clusters:** GVRD is within proximity to clusters in Washington state and
in the same time zone as transforming clusters in California.

**Personal lifestyle:** Vancouver is a desirable place to live according to real estate demand
and economic indicators (VEDC, 2006). The city is ranked as having the best quality of
life in North America (Jacobsen, 2006).

However, BC exhibits deficiencies that inhibit industry expansion, most
significantly:

**Capital Resources:** The region has limited venture capital firms and investment funds
(WINBC, 2005). Ensuring availability of substantive and sustained financing is a major
challenge facing technology companies. Incentives are needed for entrepreneurs and
venture capital investment. Increased mobility of capital and increased size of available
capital pool is required (Graytek, 2004).
Local property taxes: Vancouver’s business and light industry property taxes are second highest in the region and higher than competing clusters in Alberta and Washington. (VEDC, 2006).

3.3.3 Related and Supporting Industries

The GVRD provides a diversified economic metropolisation area for cluster development. Industries that most directly support wireless ITS include:

Information, Computer and Telecommunications (ICT) industry: The presence of a strong ICT cluster allows local high technology companies greater flexibility, quality control and turnaround time for production. Vancouver’s ICT cluster is approximately 1,000 companies strong employing 30,000 people. However, it follows Toronto, Montreal and Ottawa in magnitude of size and critical mass (Graytek, 2004).

Software Industry: Wireless and ITS technology relies on software to ensure hardware platforms have flexibility, adaptability and versatility. A strong local software industry, including dominating multinational enterprises with a local presence, promotes the growth of wireless companies in product development.

New Media Industry: The presence of a new media cluster promotes synergies between industries for content provisioning in applications such as graphic optimization and animation. However, it is argued that the GVRD lacks the economic strength required to attract industry knowledge leaders needed to compete globally (Shapiro, 2006).

3.3.4 Demand Conditions

Expanding international trade and a growing population have increased the pressure on BC’s transportation infrastructure. The need for efficient transportation
systems to provide access to global markets and drive economic growth has intensified demand conditions. Specific demand conditions in the region include the following:

**Trade and Transportation Economy**: Employment in the GVRD is increasing by 21,000 jobs per year with one in five in trade and transportation. In 2005, $81 billion in goods and 22 million people traveled through the Vancouver gateway. Vancouver gateway transportation has become a major cluster with 50% of BC’s economic activity directly related to transportation (Province of BC et al, 2006).

**Competition with US West Coast Cities**: Substantial US federal investments in transportation infrastructure challenges Vancouver’s competitive position as a Pacific gateway. In response to competitive demands, the province, the region and gateway industries have developed a plan for transit infrastructure improvements.

**Gateway Program**: Gateway transportation projects, a $3 billion investment, are estimated to produce $24 billion in direct and indirect benefits over the next ten years. Economic activity and efficiency will improve as a result of stabilizing and reducing travel times. More competitive transportation of international goods and people will generate over 11,100 new jobs in BC (Province of BC et al, 2006).

### 3.3.5 Firm strategy, Structure and Rivalry

Firm strategy is affected by mechanisms for cooperation in the local region including industry associations and partnering networks.

**Entrepreneurship**: BC’s emerging wireless ITS industry exhibits new business formation that is critical to the success of new technology clusters. However, lack of venture capital does not allow BC firms to grow to maturity within the province (Gollub & Terplan, 2004a).
Industry Associations: Wireless Innovation Network of BC (WIN BC) was established in 2003 to promote collaboration between local wireless companies to leverage their collective resources and strengths. WINBC sponsors the annual Wireless Innovation Contest which focuses on showcasing wireless innovation and adoption. The Wireless Industry Partnership (WIP), launched in 2006, provides a portal to global networks and key resources to build and promote wireless development. WIP key resources include access to decision makers of leading companies, market data for competitive intelligence and visibility for potential investors, partners and customers.

ITS Society of Canada is a professional organization with the goals of facilitating the application of ITS, promoting cooperation between government and industry and advancing the ITS industry. The Society provides services to Transport Canada to further the development and implementation of the Canadian ITS Plan and Architecture.

Elements hindering the development of the cluster include:

Lack of Large Company Development: BC’s weaknesses in early stages of innovation, R&D funding and venture capital result in the development of fewer large companies than relative clusters in the US. But compared to other Canadian provinces, BC has developed some successful public companies (Gollub & Terplan, 2004a).

Industry Fragmentation: The local wireless industry is fragmented and lacks specialization around the ITS supply chain. The local industry is dominated by Small and Medium sized Businesses (SMBs) that lack innovation networking and integration with larger international companies. Currently 64% of wireless companies in BC have less than 20 employees (WINBC, 2005).
Lack of Large Integrators: The regional area lacks large integrators that could provide opportunities for smaller companies developing enabling technologies and products (Chergui, 2002). Large integrators are needed to encourage procurement of locally developed products and to promote products in international markets.

3.3.6 Chance Events

Chance events played a major role in cluster development, most significantly:

Vancouver 2010 Winter Olympic Games: The Vancouver Organizing Committee for the 2010 Olympic and Paralympic Winter Games (VANOC) was established in 2003 to plan, organize, finance and stage the games. VANOC procurement activities are focused in areas where immediate requirements for goods and services arise. Significant requirements are expected in the area of transportation and communication.

Loss of Anchor Firms: The loss of MDI, MPR and Gleynare had negative effects on the wireless cluster. Although BC lost anchor firms, employees joined other companies, contributed to knowledge and experience spillovers and established start-ups.

3.3.7 Government

Various levels of government have a direct role in the provision of transportation and the implementation of ITS. Public policies favorable to the high technology sector in general, have benefited the local wireless industry. They include:

Academic Research and Education Support: The federal government, through various programs, has sponsored both fundamental and applied research in an effort to facilitate innovation.
R&D Taxation Benefits: Both the federal and provincial taxation systems have significant incentives to companies with R&D activities. This includes special treatment of R&D expenses, capitalization and tax credits. A 20% federal and 10% provincial tax credit reduces taxes payable and a 10 year carry forward of credits not used in the year they are earned provide significant incentives to firms. The 2004 provincial budget extended the International Financing Activities Act to initiate an intellectual property (IP) tax credit. However the IP tax credit is only available for the life sciences sector as pilot for generating business (BC Competition Council, 2006a). The current provincial and federal SR&ED credits provide a refundable tax credit for “Canadian-controlled private corporations”. However, it is not available to all companies in BC conducting significant R&D activities (BC Competition Council, 2006a).

Investment Capital Programs: The provincial government offers programs to assist small business in gaining access to capital. The Venture Capital Program provides BC investors with a 30% refundable tax credit. The Employee Share Ownership Program provides a 20% provincial income tax credit to employees that invest in their own company. The Labour-Sponsored Funds Program assists in investment fund creation for small business with high growth potential that require equity financing for sustainability (BC Ministry of Economic Development, 2006). However, in 2005 venture capitalists invested only $226 million of private equity in the BC technology sector. Ontario and Quebec far surpassed BC, resulting in BC companies being undercapitalized and having difficulty competing globally (BC Competition Council, 2006a). There is a need for early stage investment loans for companies in key stages of development that require a short term cash infusion for commercialization (BC Competition Council, 2006a).
3.4 BC Cluster Benchmarking

BC is facing regional, national and global challenges that impact the economic environment. By comparing cluster activity in neighbouring Alberta and Washington, specific factors may be identified that will improve BC’s productivity and competitive position. Gross Domestic Product per capita is a key indicator of economic growth. Evidence suggests that competitively priced, innovative and exportable products drive the increase in GDP per capita in BC (The Institute for Competitiveness and Prosperity, 2002). For background information, a statistical comparison of these regions is provided in the table below:

<table>
<thead>
<tr>
<th></th>
<th>BC</th>
<th>Alberta</th>
<th>Washington</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td>4.3 million</td>
<td>3.3 million</td>
<td>6.2 million</td>
</tr>
<tr>
<td>Labour Forces</td>
<td>2.3 million</td>
<td>1.8 million</td>
<td>3.2 million</td>
</tr>
<tr>
<td>GDP (US$)</td>
<td>138.3 billion</td>
<td>147 billion</td>
<td>238 billion</td>
</tr>
<tr>
<td>Venture Capital</td>
<td>226 million</td>
<td>640 million</td>
<td>64 million</td>
</tr>
</tbody>
</table>


The following diamond analysis provides an assessment of competing clusters.

3.4.1 Alberta

The Alberta Wireless and Telecommunications industry is well positioned for significant growth and makes a strong economic contribution to the provincial economy, according to results from a 2005 survey of Alberta’s Wireless and Telecommunication sector by KPMG. The survey estimates that the 300 companies within the Alberta Wireless and Telecommunications industry generate $3.5 billion in revenue and employ approximately 16,000 people. The industry is in a favorable position to grow substantially over the next few years. Key industry characteristics from the survey reveal:
59% of companies have been in operation for less than five years;
72% of the companies have annual sales approaching $5 million;
67% of the companies were cash flow positive, of those that are not, 93% believe they will be within two years;
84% anticipate their workforce will increase over the next two years;
46% expect their workforce to grow by at least 20% and 54% expect their workforce to grow by more than 20%;
97% plan to either grow or maintain current R&D spending (KPMG, 2005).

The industry has been successful in developing core technologies, executing sales and reaching target markets. In order to further grow, companies indicated that new products and technologies, new markets, and building effective industry collaborations and alliances were critical success factors. However, the industry faces some potential challenges including a lack of funding and the ability to attract highly skilled employees.

To raise capital, mergers and acquisitions, government funding, public equity and venture capital is required. The industry believes that business leaders, private-public partnerships and the provincial government should be responsible for enhancing the technology infrastructure in Alberta (KPMG, 2005).

3.4.1.1 Alberta Wireless Cluster Diamond Analysis

Factor Conditions

- Favorable Alberta business climate and tax structure. According to Statistics Canada, Alberta’s economy grew by a nation leading 4.5% in 2005 (Alberta Economic Development, 2006);
• Stable, low-cost operational environment. Edmonton is among Canada’s seven largest metropolitan areas and has the lowest business operating costs with a 6.7% lower cost advantage (KPMG, 2006);

• Skilled and educated work force, with 55% of the population having attained trade, college or university level of educational (Statistics Canada, 2001);

• High quality of life;

• Availability of R&D facilities and institutions.

Demand Conditions

• Majority of revenue generated within Alberta;

• Continued expansion and growth planned;

• Local communications, oil and gas industry demand.

Firm strategy, Structure and Rivalry

• Venture capital and private equity availability;

• Ability to acquire adequate growth capital;

• Investor confidence.

Related and Supporting Industries

• Network of technology business leaders and entrepreneurs;

• Large number of head offices in Alberta.

Government

• Lowest overall personal taxes in Canada (Alberta Economic Development, 2006);

• Access to grants and funding for R&D and commercialization;

• Availability of government incentives (CWTG, 2003);
Provincial operation of international trade and investment offices, including several in Asia that represent Alberta’s second largest export market (Alberta Economic Development, 2006)

3.4.2 Washington

Telecommunication and wireless is the fourth largest industry in Washington state and has demonstrated a 20% growth potential for wireless and RFID segments. Revenues for the wireless technologies and systems industry were $76 billion in 2002. The RFID market for firms in Washington is expected to grow from $1.3 billion to $7 billion by 2008 (Washington Technology Center, 2006).

Pioneering efforts in wireless have provided an innovative community that continues to create new business opportunities. However major companies have recently been acquired and moved out of state. Challenges facing the telecommunication and wireless industry in Washington are rapid consolidation and mergers, and the loss of small, innovative companies (Washington Technology Center, 2006).

3.4.2.1 Washington Wireless Cluster Diamond Analysis

Factor Conditions

- Nationally ranked first in exports per capita;
- Historically strong patent generation;
- Skilled workforce, Washington universities granted 3,9000 science and technology degrees in 2005;
- Higher cost of living compared to other states requires relatively higher wages.

Related and Supporting Industries
• Software industry: Microsoft is the strongest influence in the Washington software industry. Microsoft is known to work with and buy small development companies.

Demand Conditions

• Convergence: The Accenture & WSA Report on the convergence of wireless foresees WA poised for leadership in the convergence industry. According to the report, WA companies are active in the development of mobile content, digital media, digital home technology, embedded software operating systems and IP networking (Accenture, 2006).

Firm strategy, Structure and Rivalry

• High merger and acquisition activity;

• Venture capital placement expanded over the previous year, Washington firms received twice the aggregate amount of venture capital funding.

Government

• Municipal pilot projects: The Seattle Mayor launched free wireless internet access in the city’s business districts in May 2005. Seattle won the most “Unwired City” in Intel’s 2005 survey. The city also set up a task force on telecommunications innovation to compete globally by implementing the latest technologies in Seattle (WINBC, 2006).

• Federal funding (SBIR awards) is rising with a 24% increase during 2005;

• Tax burden is higher than average in US, public services need to be more substantial to offset higher business costs.
3.4.3 Comparative Summary

BC, Alberta and Washington can be comparatively benchmarked based on the strengths of conditions previously discussed and the quantitative data provided below:

Table 3-3: Cluster Quantitative Assessment

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Growth in R&amp;D</td>
<td>Average Annual Growth in Total R&amp;D 1993-2000. Source: Statistics Canada, National Science Foundation</td>
<td>8%</td>
<td>7%</td>
<td>10%</td>
</tr>
<tr>
<td>Licensing New Invention Disclosures</td>
<td>Executed Licenses per 100 Invention Disclosures, 2000. Source: Association of University Technology Managers</td>
<td>21</td>
<td>20</td>
<td>56</td>
</tr>
<tr>
<td>Start ups</td>
<td>Start-ups initiated per 100 licenses executed. Source: Association of University Technology Managers</td>
<td>50</td>
<td>39</td>
<td>21</td>
</tr>
<tr>
<td>Early Stage Venture Capital</td>
<td>Early stage venture capital per capita, All Industries, 2003 (CS). Source: MacDonald and Associates, PricewaterhouseCoopers</td>
<td>$13</td>
<td>$8</td>
<td>$24</td>
</tr>
<tr>
<td>Late Stage Venture Capital</td>
<td>Late Stage Venture Capital Per Capita, All Industries, 2003 (CS). Source: MacDonald and Associates; PricewaterhouseCoopers</td>
<td>$13</td>
<td>$6</td>
<td>$68</td>
</tr>
<tr>
<td>Taxation</td>
<td>Corporate Income Tax Rate (%). Source: Alberta Economic Development &amp; Federation of Tax Administrators</td>
<td>12%</td>
<td>10%</td>
<td>n/a*</td>
</tr>
</tbody>
</table>

* Washington has a business occupation tax in lieu of an income tax, which is based on gross revenue sales (0.471% to 1.5% according to the type of business)

Data source: Gollub, ICF Consulting, 2004

A cluster map for BC, Alberta and Washington shows the relative positioning of these regions based on the quantitative data provided. The conditions have been assessed on a scale of 1-10 by indicating each region as a percentage of the total:
This cluster mapping clearly indicates that BC lags behind Alberta and Washington in strength, however demonstrates considerable potential for growth and new business formation.

Charting the clusters on a growth share matrix shows the relative positioning of competing clusters by province/state and by metropolitan area. As described previously, the location quotient (LQ) is measured by calculating the percentage of employment in the North American Industry Classification Systems (NAICS) to total regional employment. This ratio is divided by the percentage of total national employment in the wireless industry over total national employment. If the LQ exceeds one then the region has a higher share of employment within the sector with export strength.

The LQ relative to the North American Average and annual average growth rate over the period 1993-2003 is used to determine the strength of the most relevant competitive wireless clusters. As a province, BC growth lags competing provinces and states in wireless/telecom with an LQ of less than one.
The wireless/telecom cluster growth rates for metropolitan regions are compared using the LQ vs 10 year average employment growth (%) relative to the North American Average (0.67% between 1990-2000). Again, Vancouver lags leading metropolitan areas with an LQ not exceeding one.
3.5 BC Companies Survey

Since cluster analysis based on quantitative criteria does not extend to concepts such as innovation and synergy, additional descriptors are required to evaluate clusters. Certain descriptors may only be identified through surveys, personal interviews or collective vision and associative behavior (Rosenfeld, 1997). For this reason, I conducted a survey of wireless ITS firms to assess current strategy, core competencies and competitive position for potential opportunities. By analyzing the firm’s strengths and weaknesses, better policy may be constructed to take advantage of these factors in a cluster. For specific examples of BC companies, see Appendix C.

3.6 Competitive Position of BC Companies

Wireless ITS firms must consider legal restrictions (patents), barriers to entry and first-mover advantages for competitive positioning within the global ITS industry. Competition reduces profits over time through imitation and substitution. Substitution arises as business models, technology and public policy change. Key success factors for the sustainable competitive advantage of BC companies are continuous upgrading and improvement.

Future applications of wireless intelligent infrastructure provides opportunities for competitive advantage. For example, by deploying emerging wireless mesh networking, both Streetlight Intelligence and Novax Industries are competitively positioned for viably deploying Municipal Wi-fi over greater outdoor areas. For more information on these companies see Appendix C.

Municipal Wi-fi involves establishing a common platform for government and public use. Municipal Wi-fi offers an affordable means of providing free, public internet
access to deliver what many view as an essential service. Wireless internet service has the potential to increase economic development and improve municipal operations. Markets include public safety, workforce mobility, ITS, digital video surveillance.

Market demand for this technology is high, with interest from prominent cities such as San Francisco and Philadelphia, which plan to deploy citywide public wireless mesh networks over the next two years. Many cities are already deploying mesh networks or have plans to do so within the year. Industry experts predict mesh networking will be a $2 billion market by 2007, according to the Dell'Oro Group (Cisco, 2005).

3.7 Summary

An analysis of the BC wireless ITS cluster based on the Porter diamond has identified strong forces in favour of development of the local environment. BC has supportive factor conditions including a local context that encourages investment as evidenced by the relatively high rate of new business formation; related and supporting firms that mean that firms are clustered and not isolated; local suppliers to ITS wireless; and positive current and future regional demand based on government transportation spending.

Benchmarking BC against neighbouring regions has identified areas of weakness in R&D and commercialization compared to competing clusters. These weaknesses include lack of government leadership and a regionally coordinated strategy, lack of early venture capital, lack of funding for public and private R&D, lack of incentives to attract capital, talent and companies to BC and limited recognition within and outside BC (PriceWaterhouseCoopers, 2003). BC companies face short-term and long-term
challenges in competition with other clusters. Short-term, lack of R&D investment is the biggest challenge. An increase in R&D would improve patenting, licensing, business formation, and venture capital investment. Long-term, BC must improve later stage financing to allow new businesses to develop into large, global companies in leading industry positions (Gollub & Terplan, 2004a). This situation indicates that more collective action is required.

Government policy impacts all elements of cluster specific development. It has responsibilities for infrastructure, standards, regulations and affects competition and demand (Ketels, et al, 2003b). A cluster analysis of wireless ITS has lead to the need for a political strategy and development framework to strengthen weaknesses. In summary, BC needs a strategy to create strong technology clusters for sustainable competitive advantage.
4 IMPLICATIONS

The purpose of this chapter is to assess the implications of the preceding industry and cluster analysis. The current situation of wireless ITS firms in BC has been assessed with the expected prognosis for the status quo, providing a rationale for action. Next, alternative courses of action are considered and the most appropriate strategic direction is determined.

The quantitative assessment and cluster mapping to benchmark BC provides evidence that the region lags behind other clusters. Further, research implies that the Canadian economy may not be strong enough to support many diversified clusters due to a high degree of political decentralization and a small domestic market (Vining, et al, 2005b). However, public policy in support of specialized clusters such as ITS may be warranted, particularly when located close to a larger, diversified cluster such as wireless telecommunication.

Regional scope represents an arena for public policy that focuses on the economies of clusters. A regional perspective may explore methods to build and strengthen links that allow clusters to operate more efficiently (Rosenfeld, 1997).

Generally, the public sector lacks incentives to strategically engage clusters. Firms may lack a common identity and awareness of related firms. As a result, elements of a coherent cluster are missing. Small firms face specific problems such as short-term financial pressures, limiting long-term collaborative activity and inhibiting the adoption of new technologies (Benneworth & Charles, 2001a, p. 391).
Evidence that local policies enhance the growth of a potential technology sector is required. Public policy may not be considered a substitute for inefficiently performing firms. A group of firms must first exhibit potential of becoming world leaders in specialized areas. The conditions for potential success of an industry need to be present before cluster development efforts are justified (Porter, 2000, p. 26).

The previous chapter demonstrates that BC wireless ITS firms have created the preconditions necessary for the formation of a successful cluster. However these firms must continue to develop the capacity for creating sustainable advantage, the potential to be world leaders and to attract the best knowledge resources to the region. In the USA, the top ICT clusters are embedded in diversified metropolitan areas. Similarly, the wireless ITS sector embedded in the larger and more successful wireless cluster has potential for growth and development.

Common strategic goals of wireless technology cluster as a whole and the emerging wireless ITS sector need defining. This requires linkages of smaller wireless ITS firms with larger partners to create a unified stance to advance common interests (Shapiro, 2006).

Cluster participants need to inform the government to contend with the weaknesses under its control. A cluster based approach may affect government priorities, policies, education, regulatory reform, export and foreign investment (Porter, 2000, p. 28).
4.1 Potential Alternatives

Strategic action is required for the BC wireless ITS cluster to compete nationally and internationally for capital, employees and customers, driving the economic potential for the entire province.

Strategic actions fall within three main categories at the firm, cluster and institutional level: (1) firm strategic decisions, (2) cluster management, and (3) public policy (Chergui, 2004, pp. 71-75). These levels provide potential alternative approaches for implementing strategic actions.

WINBC, as an industry association, is a potential cluster manager. As an organization, it is best positioned to implement strategic actions to benefit firms and influence public policy. Cluster development is a lengthy process that requires institutionalization of concepts, relationships and linkages (Porter, 2000, p. 29). Therefore it is the role of firms and cluster management to motivate policy makers and decision makers to promote sustainable economic growth in BC.

4.2 Strategic Direction and Intent

A strategic approach to emerging technology clusters is required from both the government and industry for economic development. Transportation in the Pacific gateway has emerged as a major economic cluster in western Canada. Thus, the benefits for wireless and transportation industries to collocate in the region are increasing.

Evidence supports the fact that most clusters do not form and develop through the actions of any government (Brown & McNaughton, 2003, p. 120). However, for companies that collocate in a particular region because of certain initial pre-conditions,
Cluster policy may leverage location advantages and originating firms into a dynamic economic force (Brown & McNaughton, 2003, p. 121).

Cluster policies may be considered a rational choice because of their capacity to boost economic performance. According to Porter (1998), clustering is the outcome of a set of strategic choices made by firms to generate competitive advantage. Therefore, cluster policy augments firm's strategies by supporting collective problem solving and collaboration (Benneworth & Charles, 2001a, p. 390).

4.3 Summary

The decision to use a clustering approach depends on the local, regional and national political context. The results of the preceding industry and cluster analysis imply that public policy in support of specialized clusters such as wireless ITS may be justified when embedded within a larger, diversified cluster such as wireless technology. Wireless and transportation have demonstrated the potential and pre conditions necessary for successful cluster development. Therefore, cluster policy in support of wireless, and procurement policy in support of ITS, will promote wireless ITS development in BC.
5 STRATEGIC POLITICAL FRAMEWORK FOR DEVELOPMENT

The preceding chapter has provided a rationale for action in support of a strategy to develop cluster policy for wireless and local procurement policy for ITS. The previous summary of government forces and international ITS policy will now be utilized in the development of political strategy for local ITS firms. This chapter will apply a framework for building an issue specific political strategy based on an efficiency argument and criteria for public ITS infrastructure investment.

5.1 Building a Political Strategy

Using a theoretical framework, critical elements of a political lobbying strategy would include: (1) level of inclusion of the strategy; (2) form of argument to persuade the relevant constituencies; (3) the choice of jurisdiction; (4) the choice of organizational target and (5) delivery mode (Vining, et al, 2005a).

5.1.1 Strategic Group Inclusiveness

The level of participation that firms choose in their political strategies determines their level of inclusiveness. The most limited form of a more inclusive strategy for wireless ITS is a strategic group strategy. Evidence that different groups within an industry are differentially affected by government actions supports organizing as a strategic group (Vining, et al, 2005a). In the case of the emerging wireless ITS cluster, a strategic group strategy with a coalition based on common locality and inputs would
unite firms. The collective goods characteristics of communication and transportation raises the net benefits of more inclusive strategies and lowers the individual firm’s cost (Vining, et al, 2005a). Specifically, the ITS Corporation represents various local transportation organizations responsible for the development of a regional ITS Plan. Industry organizations such as ITS Canada and WINBC represent private industry and individual firm’s interests.

5.1.2 Argument Form

Framing the policy argument is a critical political strategy choice based on fact/science, efficiency, or equity. An efficiency argument is proposed based on rising regional demand for cost effective transportation and communication infrastructure.

5.1.2.1 Efficiency Argument

Specifically, economic efficiency focuses on maximizing social surplus and the net benefits that accumulate to society (Vining, et al, 2005a). Wireless ITS firms are able to engage strategically in a rational efficiency argument and social cost benefit analysis. This requires combining science/fact research with an efficiency argument. Promoting the upgrading and development of public or quasi-public goods will positively affect related industries (Porter, 1998a, p. 89). Transportation and communication are public goods that justify efficient and cost effective public expenditures. With other governments investing heavily in transportation infrastructure, the challenge to remain competitive requires public investment in ITS. This argument will be presented in more detail in section 5.2.
5.1.3 Choice of Jurisdiction: Multiple Venues

Generic venues available to firms include supranational venues, capital national venues, regional venues, local venues, and multiple venues (Vining, et al, 2005a). The most important venue for a political ITS strategy is the capital-national level since the federal government leads the planning, development and implementation of a comprehensive ITS policy for Canada. Transport Canada’s national ITS Plan and ITS Architecture ensures integration of products and services nationally and provides a framework for coordinated ITS deployment in the public and private sectors. However, in Canada, provinces fund and regulate transportation, impose taxation, regulate businesses, and administer policies. As a result, multiple venues are necessary, whereby there is a development of separate strategies operating on both the capital-national level and the regional-provincial level. Investment is shared federally, provincially and municipally for specialized infrastructure such as port facilities, satellite communications, and testing laboratories. Therefore collaboration at multiple venue levels is required.

5.1.4 Choice of Organizational Target

Choices of potential target audiences for political strategies can include any one or combination of: members of the cabinet, political appointees to bureaucracies, members of the bureaucracy, individual members of the legislature, members of independent regulatory bodies, the judiciary (Vining, et al, 2005a). Infrastructure projects such as transportation, communication, and ITS require combination targets because funding at all levels of government is needed. Furthermore, infrastructure crosses jurisdictions, so integration and cooperation is required. The initial targets of a regional
political strategy would be Transport Canada, BC Ministry of Transportation, and the GVRD.

5.1.5 Delivery Mode: Industry Association Provisioning

Individual firms must decide whether to engage directly in political action or to outsource it. Industry associations such as ITS Canada and WINBC are strategically positioned to argue political strategy on behalf of their members. A cooperative agreement or memorandum of understanding (MOU) should be proposed for these industry associations to collaborate on regional issues involving wireless ITS in BC.

5.2 Efficiency Argument for Cluster and Procurement Policy

Efficiency is the benchmark of a perfectly competitive economy (Wiemer, Vining, 1998, p. 58). The efficiency argument is based on agreement that the aim of economic policy is to sustain international competitiveness. Competitive advantage is built on the work force knowledge and technological infrastructure of a region. Therefore the objective of economic policy is to foster the development of knowledge based resources and infrastructure in order to achieve competitive performance (Maggioni, 2002, p. 207).

In the case of non-rivalrous ‘public goods’, such ITS, it is necessary to design and implement appropriate policy interventions to counter possible market failures. Inefficiencies may arise in the process of creating and developing innovative clusters. Policy intervention may be required for clusters to attain critical mass, to promote cooperative activities across firms and other institutions, and coordinate investment decisions (Maggioni, 2002, p. 207). To avoid potentially inefficient competition, demand
and supply of input factors must be evaluated to eliminate duplication of efforts across regions.

Governments must assess the effect of public policies on the future trajectories of clusters (Benneworth & Charles, 2001b, p. 341) and potential convergence. The expected degree of convergence of intra and inter industry technologies affects the projected development time of the cluster (Maggioni, 2002, p. 217). Therefore, cluster policy in support of wireless technology and general procurement policy in support of ITS would facilitate the emergence of wireless ITS.

Policy aimed at the development of the wireless ITS cluster should target public provisioning and regulating its use. In the case of transportation, the government plays a major role in local markets as purchasers of goods and services. Procurement policies are local policies performed by national authorities. These are a major element of cluster success in Sweden and the US, specifically Silicon Valley. Further, the practices of second sourcing, technology sharing and public dissemination required by such policies has led to rapid technology diffusion and a high rate of new business formation (Maggioni, 2002, p. 211).

Government and industry are responsible for the coordination of overall transportation and communication infrastructure to improve system efficiency and economic development. The growing inefficiencies in transportation will decrease BC’s economic growth. According to the OECD, every 1% increase in transportation costs reduces economic growth by 2-3% (BC Competition Council, 2006c). Improved consistency, predictability and reliability of transportation in BC is necessary and requires new policy which may include a governance model with an independent
planning and monitoring entity. Options are to expand the existing ITS Corporation, or to create a provincial or regional coordination entity (ITS Corporation, 2001).

5.3 Wireless Cluster Policy

Analysis of well performing regions has lead to the emergence of a new innovation and regional policy model. This model emphasizes the following elements:

- Focusing on high-tech, knowledge based industries;
- Developing research excellence;
- Attracting global companies; and
- Generating spin-offs (Todtling & Trippl, 2005, p. 1204).

Regional innovations systems involve several clusters and many industries with links to national and international innovation systems. These systems are subject to failure due to underdeveloped organizational and institutional infrastructure and missing interaction between the different organizations. Policy formulation and implementation should arise from communication, interaction and consensus building between regional stakeholders. Accordingly, the government’s role in innovation ranges from direct intervention to stimulation, mediation, brokering, promoting regional dialogue and building social capital (Todtling & Trippl, 2005, p. 1212).

Other metropolitan areas in Canada have attained some level of cluster diversity to enable the development of emerging markets and converging technology opportunities. In general, metropolitan regions benefit from knowledge externalities and agglomeration economies. Although technology companies, R&D activities and organizations exist, the metropolitan region may lack dynamic clusters of firms. Vancouver, BC, does not meet the conditions of a high-density diverse economic area according to some research.
(Globerman, et al, 2005, p. 53). In such a fragmented metropolitan region, it is necessary to overcome the lack of integration in order to compete in the global economy. In this context, adopting an explicit cluster strategy is crucial. Policy makers should encourage cluster diversity as an important element of cluster sustainability and support the development of integrated cluster strategies (Graytek, 2004). For this reason ITS should be promoted as an element to diversify the BC wireless cluster rather than focusing on specific industry sectors.

Regional, related industries such as wireless and ITS require collaboration and integration. Relevant policy should focus on closing gaps and improving institutional infrastructure. Policy is critical for promoting innovation networks between firms and facilitating university industry partnerships. This requires coordinated action around significant projects such as the regional Gateway Program. Policies should encourage local partnerships and supplier development through incentives for regional commercialization and production.

Finally, a provincial technology cluster strategy requires a clear set of objectives over a specified period of time with achievable goals such as doubling industry revenue and labour force levels between 2006 and 2010 (BC Competition Council, 2006a).

5.4 ITS Procurement Policy

Although the Greater Vancouver gateway is a major economic cluster in Western Canada, it competes directly with US West Coast cities such as Seattle, Tacoma, San Francisco and Los Angeles. Substantial US federal investment in transportation infrastructure also challenges Greater Vancouver’s competitive position. For this reason, the province, the region, and the transportation industry have developed a capital
expansion plan for an integrated transportation network. This will increase economic activity and create jobs regionally. Nonetheless, Greater Vancouver is facing a transportation deficit of $10.95 billion that must be addressed by the federal government in order to support future regional growth.

Industry associations such as WINBC, are concerned with the development and growth of local technology firms, specifically, wireless ITS. Therefore, promoting a domestic procurement policy for wireless ITS infrastructure would support the necessary conditions for local firms to grow into larger companies with world class potential. Since the public sector has an interest in getting the best value for the money, procurement policies should not deter small, specialized firms, from submitting proposals for public projects. The public may be served better by reforming procurement policies to encourage proposals from small firms with the right technical specialties for the region (Edgerton, 2000).

The government can stimulate innovative clustering by meeting specific societal needs through its role as a demanding customer. Industry is challenged to greater efficiency through the strategic coordination of government procurement and tendering policies, functional requirements and support of innovative alliances. As government is a major buyer, both innovative procurement and public/private partnerships are examples of policies that substantially increase innovation in the wireless and transportation industry (Hertog & Brouwer, 2001a, p. 216).

Public Private Partnerships (P3s) may be utilized by the government to reduce immediate expenditures and reduce the cost of major infrastructure projects. In order to ensure P3s provide efficient and effective service delivery for ITS, public sector
managers must design contracts that both compensate private sector partners for risk and ensure that the private sector partners bear it (Vining, et al, 2005b). To minimize problems that arise with ITS technology contractual agreements, Washington state Department of Transportation recommends creating reasonable negotiating benchmarks agreed upon by all parties, designing a partnership arrangement with shared risk and pooling of resources, and providing different procurement processes for separate technological components to allow project managers to communicate directly with suppliers of the technology (US Department of Transportation, 1999).

As the cluster grows, there is an opportunity to create a local supplier base so that fewer products and services need to be imported (Graytek, 2004). Industry associations such as WINBC, local, provincial and federal governments should explore ways of aggregating local demand in order to develop a local supplier base for ITS. Product and market development partnerships involving substantial R&D activities would strengthen demand.

Policy coordination is needed to guide multi-agencies in the deployment of regional ITS. The province of BC has a strong ITS Strategic Plan and capital projects underway. However, ITS elements required for proactive direction to agencies and management of ITS requirements are not present in the form of well documented policies (Kitasaka, 2006). Policy coordination is needed for telecommunications infrastructure, ITS technologies and standards and integration with municipal networks for interoperability.
Finally, a government procurement policy that requires a minimum percentage of company content from BC private sector technology companies would encourage partnerships between smaller companies and increase the profitability of larger ones.

5.5 Summary

Successful clusters are not necessarily supported by good cluster policy, but cases suggest that cluster policies that add value are the cluster policies most highly targeted to the needs of the specific groups. Therefore clustering is a market-induced process that should contribute to the profitability of the participating firms.

In wireless communication and transportation, there is a role for government in both innovative cluster policy measures and general public procurement policy (Hertog, Bergman, Charles, 2001b, p. 414). Innovation in wireless and ITS are complementary to one another due to knowledge spillovers and other interrelationships (Furman, Porter, Stern, 2002). In summary, a common strategic ground must be defined within the broader transportation and wireless industries in order to reach common goals.
6 RECOMMENDATIONS AND ACTION PLAN

The purpose of this section is to examine the necessary infrastructure conditions for growth of wireless ITS firms in BC. In the first section, policies to improve general framework conditions will be proposed. Then specific strategic action planning and organizing are recommended for WINBC to engage wireless ITS firms and the government in policy making.

The economic foundations of cluster policy for the wireless cluster and a procurement policy for the emerging wireless ITS industry require improving the following framework conditions:

Governance: enhancing competitiveness through tax, regulation and administration;
Innovation: generating knowledge and bringing it to market;
Finance: providing capital for research and commercialization;
Infrastructure: building research, development, production facilities and supporting resources;
Human Resources: developing and sustaining competitive skills; and
Marketing: Positioning, distributing and branding products (Gollub, 2004c).

The BC technology sector can remain competitive if it can excel at innovation in a defined global niche market such as ITS. An analysis of BC wireless ITS firms has demonstrated the potential and pre conditions necessary for economic growth. Without a political strategy for regional development, wireless and ITS firms will be challenged to attain critical mass and global reach.
6.1 Policies Improving Framework Conditions

6.1.1 Governance

Transport Canada needs to assert a more proactive position in international standardizing activities for ITS. Cooperation with US ITS agencies standardization efforts is critical for interoperability. National communications standards require close collaboration with Industry Canada.

Since standards are a key to ITS industry development, standards committees and processes allow countries to promote domestic technologies and influence the market. Canada’s lack of strength in some standards setting committees threatens the competitive position of Canadian industry. Active participation in various international standards committees by Transport Canada and Industry Canada would ensure the protection and promotion of national interests. Currently ITS Canada’s Architecture and Standards Committee is involved in the US based Standard Development Organizations (SDO) and ISO through the Standards Council of Canada (SCC). ISO/TC 204 conducts studies of ITS standards policy and development in countries worldwide. The Canadian delegation to the 2006 meeting of the ISO Technical Committee 204 on ITS Standards Best Practices included three members of the Canadian Advisory Committee for TC 204 (ITS Canada, 2005). Stronger Canadian representation in Working Groups (WG) would further protect and promote the interests of the Canadian ITS industry.

Moreover, the federal Canadian ITS Architecture version 1.1 released in 2001 requires updating to encompass US National ITS Architecture version 5.0 and new technologies and applications.
The regional institutional framework and governance model must assist agencies with cooperative planning and deployment. An efficient transportation system requires coordinated problem solving, data collection and performance measurement. This may be achieved by expanding the existing ITS Corporation or creating a provincial or regional coordination entity (ITS Corporation, 2001).

### 6.1.2 Innovation

Support for technology R&D is a major issue raised by Canadian ITS industry. Foreign governments in partnership with industry invest substantially in developing and demonstrating ITS technologies as shown in section 2.4. Canada must pursue the same objectives within its regional industry context.

To stimulate R&D, in 2004 the provincial government extended the International Financing Activities Act to create an intellectual property (IP) tax credit for life sciences. This was intended as a pilot for the life sciences sector, which may later be extended to other sectors. This IP tax credit needs to cover the entire technology industry to generate business and drive export revenue (BC Competition Council, 2006a).

Existing sources of funding for ITS R&D, such as the NSERC research partnerships and SR&ED tax credit programs, must expand support of the Canadian ITS industry efforts within the current program scope. The provincial and federal SR&ED tax credit programs are available to “Canadian controlled private corporations”, however are not available to public companies. The provincial and federal government needs to cooperate to make the SR&ED refundable tax credit available to all companies conducting R&D, regardless of company structure (BC Competition Council, 2006).
ITS Canada in cooperation with federal agencies, should play an increasingly significant role in prioritizing R&D activities. Transport Canada has entered into a partnership agreement with ITS Canada as primary technical advisor to the department. ITS Canada should ensure that government R&D ITS priorities promote the interests of Canadian industry in growing domestic and global markets. Existing federal government laboratories, with technologies applicable to ITS, should apply their expertise to increasing domestic ITS industry capabilities. Transport Canada should continue to support, facilitate and fund ITS R&D through the TDC. Canadian ITS Centres of Expertise such as the UBC Bureau of ITS and Freight Security which received SHIP funding now require an extension for research programs. A new mandate should be pursued for funding ITS initiatives since SHIP funding expired on March 2006 (Spencer, 2006).

6.1.3 Finance

The emerging ITS cluster companies must raise sufficient capital for growth and expansion. The public sector should expand its role in providing incentives for private funding and should explicitly encourage companies to go public. BC lags behind Alberta and Washington in venture capital investments. As a result BC companies operate with significantly less equity funding and are unable to attract top talent, grow and market products internationally. The provincial government needs to inject funds to grow the local venture community through a fund-of-funds program modeled after programs which been successful in other regions (BC Competition Council, 2006a). Further, the government should support small business by creating a small business investment loans program. For example, the Precam Small Company Pilot Program funds ITS projects for
commercialization by Canadian companies. Precam Incorporated, a national industrial consortium, supports the development of ITS technologies by funding the R&D efforts of small businesses across Canada (ITS Canada, 2006).

BC companies need to forge partnerships with large, global companies for manufacturing, distribution and channel management. Methods of pooling resources to generate cross firm capital need to be investigated by local firms. Mergers of related firms may enable companies to attain the critical mass necessary to acquire capital investment. Further, cross-sector initiatives would support the development of partnerships for market development and substantial R&D activities. The federal government should mobilize coordinated action around significant projects such as the Gateway Program. This may take the form of a forum for decision-makers and project managers on projects involving multiple agencies. Such an approach has been successful with the Border Crossing Deployment Project. The International Mobility and Trade Corridor (IMTC) coalition, a group of US and Canadian business and government entities identified and pursued improvements to cross border mobility. This model involved the interaction with federal, provincial, state and local governments to obtain funding and deploy border ITS projects. With the support and coordination of this coalition, project time and costs were reduced (US DOT, 2003).

6.1.4 Infrastructure

Establishing a communications infrastructure policy will provide better management of existing infrastructure. There is potential to share existing infrastructure among transportation and communications entities for mutual public private benefits.
Major ITS considerations include interoperability, standards and future needs for capital projects such as the Gateway Program.

The goal of the proposed Regional Telecommunications Plan, introduced in Section 2.2.5, is to develop an integrated broadband network to support ITS initiatives. An inventory is under review regarding available public and private broadband infrastructure and regional ITS deployments bandwidth requirements. Responses to RFI from the private sector identified a range of available services including wired and wireless broadband connections. A gap analysis determined that the public sector has limited available infrastructure but private sector can bridge the gap (Livolsi & Shirra, 2006) to provision public needs.

6.1.5 Human resources

Emerging clusters require a constant infusion of new world-class researchers who can advance existing knowledge to levels essential for growth. Experienced, successful business managers who can bring innovation to market are also critical. The GVRD Livable Region Strategy must provide incentives required to attract top talent and leadership to the wireless ITS cluster in order to energize and motivate the entire industry. Such talent is in short supply and the global competition is high. This issue is common to the entire technology sector in BC. BCTIA and the BC Competition Council are participating in lobbying efforts to gain, train and retain better talent. These efforts require the support of government in providing tax incentives for industry to increase training programs and retain existing employees in technology. Further, although measures have been taken to expand capacity in undergraduate programs, there is still a shortage of graduates in the technology sector, specifically business graduates with the
skills necessary to lead companies (BC Competition Council, 2006a). Graduate level programs require expansion to parallel undergraduate capacity.

6.1.6 Marketing

Policies to support globalization should be examined to help companies achieve global scale operations. The federal and provincial government need to proactively support Canadian ITS industries to develop domestic and international alliances. It is important to develop international alliances as these alliances are essential for new technologies to penetrate local markets. Finally, government agencies responsible for international trade and export must assist Industry Canada and Transport Canada in ITS marketing and business intelligence initiatives.

The table below summarizes the recommendations for framework conditions:

<table>
<thead>
<tr>
<th>Framework Conditions</th>
<th>Recommendations</th>
</tr>
</thead>
</table>
| **Governance**       | • Stronger Canadian representation in international standards setting committees and work groups  
• Update Canadian ITS Architecture version 1.1 released in 2001 to encompass US National ITS Architecture version 5.0  
• Provide a governance model with an independent planning and monitoring entity by expanding the existing ITS Corporation, or creating a provincial or regional coordination |
| **Innovation**        | • Extend IP tax credit to cover the entire technology industry  
• Expand the SR&ED refundable tax credit so that it is available to all companies conducting R&D, regardless of company structure  
• Pursue a new mandate for funding ITS initiatives since SHIP funding expired on March 2006 |
| **Finance**           | • Inject funds to grow the local venture community through a fund-of-funds program, modeled after similar successful programs  
• Initiate a small business investment loans program |
| **Infrastructure**    | • Bridge gaps identified by the Regional Telecommunications Plan by sharing public private infrastructure to develop an integrated broadband network for ITS |
| **Human Resources**   | • Proactively support Canadian ITS industries to develop domestic and international alliances  
• Support Industry Canada and Transport Canada in ITS marketing and business intelligence initiatives through assistance from |
| **Marketing**         | |
Next, specific action planning and organizing for WINBC will be proposed.

6.2 Action Plan for WINBC

An action plan for WINBC to engage wireless ITS firms and the government in a political strategy addresses the previous framework conditions for development. Specifically, as an industry association for wireless in BC, WINBC could act as a facilitator for wireless ITS strategy building. WINBC could monitor the cluster (Hertog, Maltha, Brouwer, 2001c, p. 149) for the purpose of qualitative and quantitative data collection to support the identification and analysis of wireless sub clusters. As a result, WINBC may make specific recommendations related to innovation, cluster development and competitive positioning.

6.2.1 Governance

WINBC may lobby on common issues of concern to the cluster, could facilitate procurement from within the cluster and could provide information. Obtaining widespread concurrence for the priorities and findings of ITS research and development would promote knowledge spillovers. Consolidating and disseminating market, technical data, and standards through a centralized information system would promote participation and cooperation in the wireless ITS industry.

A proposal for the implementation of a public ITS technology and cost benefit database for evaluating ITS projects would engage local wireless ITS firms. This information will help increase ITS intelligence with evidence of successful applications and would promote international awareness of Canadian ITS capabilities. A cost benefits
database would be subject to public scrutiny and would provide a forum to emphasize benefits and strengthen analytical capacity. This database would lead to better decision making by providing common standards for estimating costs and benefits (Vining & Weimer, 2001, p. 159). Further, a technology and cost benefit database would support the establishment of technical standards for communications that can be produced efficiently at the lowest cost.

The implementation of an ITS cost benefits database has been very successful in the US. The USDOT ITS Joint Program office maintains a database on Cost Benefits of ITS deployments and Lessons Learned available via the internet. This has enabled stakeholders to capture experiences in planning, deployment, operations, maintenance and evaluation of ITS. ITS Canada contracted with Transport Canada to develop a technology database for new and emerging ITS products and services. The results are to be made available in both web-based and CD formats. Although ITS Canada has been licensed to continue database development past March 2006, it is still not available to the ITS industry. This is an opportunity for WINBC to support the further development of this database in order to achieve the proposed potential industry benefits.

6.2.2 Innovation

WINBC could facilitate the process of partnering emerging wireless firms with larger companies in order to improve business development and innovation. Promoting the local wireless cluster to multinationals will attract an anchor tenant for R&D infrastructure. Target companies attributes should include investing in substantial R&D, registering intellectual property in BC and creating new business. WINBC has identified companies with potential for this purpose such as Harmon International, Siemens ITS,
Motorola ITS, Microsoft Mobile for Automotive, Cisco and Navteq (WINBC, 2006b). Navteq has demonstrated the strongest potential as a wireless ITS anchor for BC and should be pursued further for this role. A strategy to attract anchor companies will also require support from the government to provide tax incentives to attract large companies to BC (BC Competition Council, 2005).

WINBC should collaborate with other industry associations such as BCTIA and the BC Competition Council to lobby the government for the development of the wireless cluster across a full range of industries. Further, WINBC should leverage existing wireless clusters in Canada to combine strengths for global competition by working with organizations such as WiTec Alberta and the Ottawa Wireless Cluster (OWC).

6.2.3 Finance

WINBC could aid in the development of innovative financing and public/private partnership solutions by participating in regional ITS infrastructure initiatives such as the Gateway Strategy. To ensure that BC wireless ITS companies receive opportunities in areas of government procurement, WINBC may lobby for a government procurement policy that requires a percentage of products and services from BC private sector companies. As an industry association, WINBC could support the aggregation of local demand and develop the local supplier base by enabling linkages between sectors. This would encourage partnerships between smaller companies and increase profitability of larger companies in wireless ITS.

Further, WINBC in collaboration with other associations, should lobby for a provincial technology cluster strategy with a clear set of objectives over a specified
period of time such as doubling industry revenue and labour force levels between 2006 and 2010 (BC Competition Council, 2006a).

6.2.4 Infrastructure

WINBC could act as a coordinator for private firm collaboration on the Regional ITS Strategic Plan and Telecom Plan. US national strategies to achieve stakeholder support of Regional ITS Strategic Plans ensure adequate time and resources are available for collaboration and ongoing outreach. This involves coordinating extensively with other stakeholder agencies and effective information delivery and sharing. WINBC should facilitate this process of collaboration.

Further, WINBC should become involved in the planning and development of transportation infrastructure by representing the interests of wireless ITS in the Gateway Program. The Gateway Program is committed to community and public consultation, ensuring that the project designs consider regional objectives. Preliminary design consultation is underway to gather community feedback on proposals for addressing congestion, moving goods and improving safety and reliability.

6.2.5 Human Resources

Factors that influence an individual's decision to relocate to a new city involve a complex combination of business opportunity, infrastructure requirements, individual compensation, job security and quality of life (PriceWaterhouseCoopers, 2003). In order to attract high technology industry leaders, WINBC should implement and maintain a web portal to disseminate opportunities and information to potential recruits.
6.2.6 Marketing

WINBC must work collaboratively to execute a coordinated and focused market plan for BC wireless ITS in order to attract resources and investment capital. In order to achieve this, WINBC should form a special interest group (SIG) in ITS to focus attention on wireless ITS and potential local opportunities. An ITS SIG would help facilitate the development of a coalition that requires interaction between private industry and federal, provincial, state and local governments to develop policy, obtain funding and deploy regional ITS projects.

The table below summarizes the action plan recommended for WINBC:

<table>
<thead>
<tr>
<th>Framework/Conditions</th>
<th>WINBC Action Plan</th>
</tr>
</thead>
</table>
| Governance           | • Consolidate and disseminate market, technical data, and standards through a centralized information system to promote participation and cooperation in the wireless ITS industry  
• Support ITS Canada in the implementation of a public ITS technology and cost benefit database for evaluating ITS projects |
| Innovation           | • Assist in partnering emerging wireless firms with larger companies in order to improve business development and innovation.  
• Promote the local wireless cluster to multinationals to attract an anchor tenant for R&D  
• Collaborate with other industry associations such as BCTIA and the BC Competition Council to lobby the government  
• Leverage existing wireless clusters in Canada to combine strengths for global competition |
| Finance              | • Lobby for a government procurement policy that requires a percentage of products and services from BC private sector companies  
• Lobby for a provincial technology cluster strategy with a clear set of achievable objectives |
| Infrastructure        | • Coordinate private firm collaboration on the Regional ITS Strategic Plan and Telecom Plan  
• Participate in the regional Pacific Gateway strategy for ITS transportation infrastructure |
| Human Resources       | • Disseminate information to attract potential recruits via a portal maintained by WINBC |
| Marketing             | • Form a special interest group (SIG) to focus attention on wireless ITS and potential local opportunities |

Source: author
These action steps are recommendations for the emergence, growth and implementation of the wireless ITS technologies within the BC infrastructure. WINBC could undertake these action steps at a regional level.

6.3 Conclusion

BC wireless ITS firms have the potential to cluster and achieve clustering benefits. Local companies have proven capabilities to compete globally in the ITS industry. The political strategy recommendations in this chapter will help strengthen the BC wireless ITS cluster and enhance its ability to grow and develop. Ultimately, these actions will improve the competitive position of BC wireless ITS companies internationally and extend their global reach.
Appendix A: BC Emerging Wireless Technologies

IEEE 802.16 WiMAX Wireless Broadband

Worldwide Interoperability for Microwave Access (WiMAX) is the IEEE.802.16 standard defined by the WiMAX Forum organized to promote standardization and interoperability. The IEEE.802.16 has a scheduling media access controller (MAC) that allows the subscriber station to only complete once. The algorithm for scheduling is stable under over subscription, overload and is more bandwidth efficient. The largest segment of spectrum for WiMAX is available around 2.5 GHz, although there is no uniform global licensed spectrum.

802.16-2004, Fixed WiMAX, supports only fixed access while 802.16e, Mobile WiMAX, supports both mobile and fixed access. The WiMAX mobility standard has improved modulation schemes. Enhanced OFDMA supports fixed wireless and mobile Non Line of Sight (NLOS) applications.

WiMAX is designated as a metropolitan area network (MAN) technology that connects Wi-Fi hot spots together and to the internet, providing a wireless alternative for last mile broadband access.

IEEE 802.11 Wi-Fi

Wireless Fidelity (Wi-Fi), IEEE 802.11 specifies wireless local area networks (WLAN) technology. Wi-Fi uses both multi carrier OFDM radio technology and single carrier direct-sequence spread spectrum radio technology. The standardized and
unlicensed spectrum near 2.4 GHz is used for Wi-Fi by international agreement. The table below provides details on Wi-Fi standard protocols:

Table: Wi-Fi Protocols

<table>
<thead>
<tr>
<th>Protocol</th>
<th>Release date</th>
<th>Frequency</th>
<th>Bandwidth</th>
</tr>
</thead>
<tbody>
<tr>
<td>IEEE 802.11</td>
<td>1997</td>
<td>2.4 GHz</td>
<td>1.2 Mbps</td>
</tr>
<tr>
<td>IEEE 802.11a</td>
<td>1999</td>
<td>5 GHz</td>
<td>6,9,12,13,24,36,46,54 Mbps</td>
</tr>
<tr>
<td>IEEE 802.11b</td>
<td>1999</td>
<td>2.4 GHz</td>
<td>5.5, 11 Mbps</td>
</tr>
<tr>
<td>IEEE 802.11g</td>
<td>2003</td>
<td>2.4 GHz</td>
<td>6,9,12,13,24,36,46,54 Mbps</td>
</tr>
<tr>
<td>IEEE 802.11n</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IEEE 802.11s</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: author

IEEE 802.11s Wi-Fi Mesh Networks

802.11s is the unapproved IEEE802.11 ESS Mesh Networking standard targeted for approval by 2008. To solve the IEEE802.11 MAC interoperability problem, 802.11s specifies a protocol that supports both broadcast, multicast and unicast delivery over self configuring multi-hop topologies.

The Wi-Mesh Alliance (WiMA) has a proposal that will enable seamless communications for wireless applications including consumer, business and government. Another consortium SEEMesh, introduced Mesh Portals that offer interoperability to mesh networks by allowing other wireless standard technology to be identified and integrated into the network.

UltraWideBand IEEE 802.15.3a

Ultra Wide Band (UWB) is a technology for transmitting information spread over a large bandwidth that should be able to share spectrum with other users. The FCC authorized the unlicensed use of UWB in 3.1–10.6 GHz. UWB is defined as transmission for which the signal bandwidth exceeds either 500 MHz or 20% bandwidth. Due to the
low emission levels, UWB systems tend to be short range but support extremely high
data rates. High data rate UWB can enable wireless monitors and the transfer of data
from digital camcorders.

**RFID**

Radio Frequency Identification (RFID) is an automatic identification technology
used to store and retrieve data using RFID transponders. An RFID transponder or tag is
attached to a device for identification using radio waves.

Passive RFID tags do not have an internal power supply. Incoming radio
frequency signals induce an electrical current in the antenna to power the CMOS
integrated circuit (IC) for transmitting a response. Semi passive RFID tags have a small
battery that constantly powers the IC, enabling it to respond faster. Active RFID tags
have an internal power source that generate an outgoing signal. Active tags are most
reliable and able to conduct a session with a remote reader.

An RFID tag contains a digital memory chip with a unique electronic product
code. The antenna emits a signal, activating the RFID tag to read and write data. RFID
microchips can be read-write, read-only or write once, read many (WORM). Read-write
tags have a read-only serial number with additional blocks of data to add information or
write over existing information. Read-only microchips have information that cannot be
changed stored on them during the manufacturing process. WORM tags can have a
written serial number that cannot be overwritten.

Low frequency (120-134.2 KHz and 140-148.5 KHz) and high-frequency (13.56
MHz) RFID tags can be used without a license globally. Ultra-high-frequency (868 MHz-
928 MHz) tags do not have a single global standard.
RFID technology standards include:

- ISO 14443 specifies a proximity card used for identification that uses the form of a standard credit card (SmartCard) denoted by ISO 7810 ID-1.

- ISO 15693 is an ISO standard for vicinity cards which can be read from a greater distance. ISO 15693 systems operate at the 13.56 MHz frequency, and offer maximum distance of 1-1.5 meters. This standard is used in ITS for electronic toll collection.

- EPCglobal is the framework that is expected to go through International Standardization pursuant to ISO rules. Currently, distributors and governments are promoting EPC as a standard for adoption.

RFID is a technology that revolutionizes the supply chain, providing benefits to distributors, manufacturers, suppliers, shippers, consumers and carriers. The implementation of RFID produces increased efficiencies and effective distribution for applications such as inventory control, asset tracking and asset utilization, transportation and logistics.
Appendix B: BC Wireless Industry Technologies

CDMA (IS-95X) and variants

Code division multiple access (CDMA) is a method of multiplexing and multiple access that divides the channel by special codes. The constructive interference properties of the codes are used to perform multiplexing. The original standard, IS-95 is considered 2G cellular.

IEEE 802.11 – Wi-Fi

IEEE 802.11, the Wi-Fi standard, consists of a group of wireless LAN standards. Wi-Fi uses both multi carrier Orthogonal Frequency Division Multiplexing (OFDM) and radio technology single carrier direct sequence spread spectrum radio technology. The Federal Communications Commission (FCC) authorized unlicensed spread spectrum in 1985. 802.11 includes six modulation techniques, the most prevalent are defined by the a, b, and g standards. IEEE standard 802.11p, Wireless Access for Vehicular Environment (WAVE), defines revisions required to support ITS applications.

CDMA2000 and variants

CDMA2000 is a group of 3G wireless standards that use CDMA. It is considered the next generation of CDMA digital cellular. CDMA is digital radio technology used to transmit voice and data between mobile devices and cell locations. CDMA sends bit streams with code divided channels. It allows several radios to use the same frequency, providing a significant economic advantage. CDMA2000 is incompatible with other major, competing 3G standards.

There are many variants of CDMA2000. Listed in increasing complexity, they include CDMA200 1x, 3x, 1xEV-DO and 1xEV-DV. One times Radio Transmission
Technology (1xRTT) operates in a pair of 1.25-MHz radio channels. Over IS-95 networks, 1xRTT doubles voice capacity. It qualifies as 3G technology but may be deployed in the 2G spectrum.

GPS

The Global Positioning System (GPS) is a satellite navigation system. A cluster of GPS satellites broadcast precise timing signals by radio to GPS receivers. Longitude, latitude and altitude accurately determine their location in any weather, at any time, anywhere on the globe.

Voice over IP

Voice over Internet Protocol (VoIP) is the routing of voice over any IP-based network. The voice data is transmitted over a packet-switched network, rather than circuit-switched telephone lines. VoIP can be deployed over any IP network, such as the private building-wide LANs or the internet.

GSM/GPRS/EDGE and variants

The Global System for Mobile Communications (GSM) is the most common mobile phone standard worldwide. GSM is a 2G mobile phone system employed by more than 1.5 billion people over 210 countries. The GSM standard allows international roaming between mobile phone operators and enables subscribers to use their mobile devices internationally. GSM is an open standard developed by the 3G Partnership Project.

General Packet Radio Service (GPRS) is a mobile data service accessible by GSM mobile devices. It is a 2.5G technology providing moderate speed data transfer by utilizing available TDMA channels in the GSM network.
Enhanced Data rates for GSM Evolution (EDGE) is a digital mobile device technology which enhances 2G and 2.5G GPRS networks. EDGE is a superset of GPRS which operates on any GPRS network with the necessary upgrades deployed. EDGE provides Enhanced GPRS (EGPRS) for packet switched systems such as the internet.
Appendix C: BC Companies Survey

Analysis of the Strategy of Sample BC Companies

According to Porter, firms compete on either cost-based, differentiation or focus strategies. The firms surveyed represent all of these strategies.

Cost-based competition

Firms within the wireless ITS cluster require cost drivers for competitive advantage. Research and development of innovative products, continuous process improvement and concurrent engineering add value by reducing costs. Due to the emerging state of the wireless ITS industry, economies of scale and scope will take time to develop. Benefits from the experience curve will also accrue with cumulative production.

Streetlight Intelligence

Streetlight Intelligence (STI) designs, manufactures and markets products targeted for the street light industry. STI is a publicly held company which trades on the TSX Venture Exchange. The company has not generated revenues from operations and is considered to be in the development stage. STI is in the process of completing its first full product to market, the Lumen SIMS system, an integrated streetlight management system that provides energy and maintenance savings using mesh technology to extend wifi.

STI has developed strategic capabilities to deliver energy, environmental and maintenance efficiency through technological cost advantage and capacity utilization. The customer segment focus is on streetlight owners such as municipalities and highways seeking reduced operating costs. STI provides an absolute technological cost advantage
through a patented “anti cycling” technology prevents lamps from cycling near the end of life.

STI strategy focuses on four areas: 1) refining the product design to meet market demand, 2) refining production and manufacturing capabilities, 3) strengthening the company’s relationships with key industry participants, such as roadway lighting authorities, roadway lighting consulting engineers, and power companies, and 4) coordinating private and public sector initiatives with the goal of implementing large scale revenue-producing installations of the company’s Lumen IQ technology (Streetlight Intelligence, 2006).

**Differentiation-based competition**

Sources of differentiation arise from technological and process advantage in wireless ITS firms. Dynamic aspects of differentiation based competition in the ITS industry include first mover advantage, strategic flexibility and continuous experimentation.

**Novax Industries Corporation**

Novax Industries Corporation (Novax) is a private company that designs and manufactures wireless products to improve vehicular flow and user safety. Novax has developed a Transit Signal Priority (TSP) solution that expedites transit vehicle flow through traffic. The company is pursuing a leadership position in traffic management and pedestrian access solutions.

Novax differentiation-based competitive strategy focuses on specialized product improvement on dimensions most valued by buyers. Tangible differentiation through
R&D provides an absolute technology quality advantage, customizable and flexible manufacturing and complementary goods and services.

The major technology advantages of 802.11p 802.11 over cellular is the provision of a virtual network, bandwidth controls, municipal network with multi SSID and symmetrical high speed. In contrast, cellular incurs high latency, high operating costs, is optimized for voice and has no control over subscription ratio (Daluz, 2006). These key features provide technological differentiation and product quality advantage to buyers. Spillover benefits result from producing similar product lines and synergy benefits provide intangible differentiation.

**WebTech Wireless**

WebTech Wireless (WebTech) is a wireless service provider that develops and manufactures a wireless vehicle service solution for commercial vehicle operations (CVO). WebTech is publicly listed on the junior Toronto Stock Exchange with total assets of $6.9 million Cdn and net income of $0.4 million Cdn at year end 2005. WebTech Wireless is a global corporation with customers in 41 countries.

WebTech differentiates products by delivering technological advantages and performing demand increasing activities. Differentiation is offered by providing a customizable mix of tracking and location services. WebTech's absolute technological advantage arises from the use of GPRS to support internet protocol (IP) that enables internet and intranet content access.

WebTech anticipates strong growth due to increased market penetration and increased demand for wireless vehicle services. As a result, WebTech Wireless expects revenue growth from hardware sales and subscribers. Focus-based competition
The wireless ITS segment provides opportunities for focus-based competition to serve the needs of specialized segments of the ITS market.

**In Motion Technology Inc**

In Motion Technology Inc (In Motion) is private company that designs and develops mobile area networks. In Motion integrates WiFi and 3G network technology, providing professionals and mobile critical workgroups access to applications over corporate virtual private networks (VPNs) while in transit.

In Motion focuses on the communications challenges of the emergency response industry segment. Delivering mission-critical data to first responders is burdened with security concerns, total cost of ownership issues and reliability problems. In Motion’s mobile gateway technology addresses these challenges with a secure and reliable mobile local area network for the connection of multiple devices in the field. “Ultimately, our objective is to extend mission-critical data to the mobile workers without disrupting their normal work practices.” says Kirk Moir, CEO. Larry LeBlanc, CTO says the company plans to target utility companies and government fleets next, in order to promote adoption of Wi-Fi among fleet operators (In Motion Technology Inc, 2006).

**Core Competencies of BC Companies**

Core competencies meet critical success factors for wireless ITS companies, providing the basis for outperforming the competition. Core competencies provide the basis for launching strategies to create or exploit opportunities in other markets or new arenas. Core technical strengths emerging in BC wireless ITS companies have potential for leadership in the global market. These ITS technology capabilities and applications are:
- Wi-Fi applications for traffic signal priority (TSP);
- Wi-Fi applications for adaptive lighting;
- Wi-Fi vehicle area networks for wireless access for the vehicular environment (WAVE);
- GPS/GPRS Telematics for location based services (LBS);

**Novax Industries Corporation**

Novax has developed a leadership position in traffic management and pedestrian access with cost effective and innovation wireless technology solutions. Novax core capabilities in traffic signal priority products have proven ability to meet critical success factors better than the competition. Profile deployments include transit priority (TransLink, TTC); traffic signal control (Vancouver, Halifax, Caracas); accessible pedestrian system (30,000 worldwide).

Novax provides a communication portal and platform that enables transit productivity, security and communication requirement. The solution supports conditional and adaptive priority, AVL, APC, electronic fare collection, location based advertising, passenger information, email and internet access, VOIP, automated bus stop information, data/video recording and emergency video (Novax, 2006).

Novax competence raising measures to promote international awareness of Canadian ITS capabilities is critical to government agencies. Novax is capable of meeting public policy objectives to reduce congestion and increase safety and efficiency. Public-private partnerships with such capable private sector suppliers may provide solutions for service provisioning.
Streetlight Intelligence

STI’s adaptive lighting performance has been verified through laboratory and field testing. Significant benefits accrue for owners and society such as: power consumption reducing operating costs, obtrusive lighting reduction, asset management and energy management consumption tracking for un-metered installations.

The preliminary findings of pilot projects and the results of laboratory testing were submitted to the Roadway Lighting Committee (RLC) of the IES in August, 2005. This report was well received by the RLC, which establishes lighting design guidelines for North America (STI, 2006).

STI is strengthening core competencies and linkages with public sector regulators in order to achieve its goal of implementing large scale installations.

In Motion Technology Inc

In Motion provides a patent pending wireless communications gateway for use in challenging environments such as public safety vehicles. The gateway combines in vehicle WiFi and 3G cellular data using wireless LAN and WAN technologies for mobile communications.

In Motion has targeted the EMS field which is under constant pressure to improve performance and reduce operating costs. In Motion’s technology and partnerships offers the EMS market a unique product that creates a mobile broadband network for public safety users. These core competencies have met critical success factors for the target market significantly better than the competition.

WebTech Wireless
WebTech’s core capabilities combine GPS-based location on GPRS and EDGE networks for vehicle focused location based services to meet the needs of the transportation market. WebTech Wireless service offering targets the high growth in long haul trucking, representing $98 billion in revenue, and has commenced trials with 10 Fortune 500 companies to prove its capabilities.

"The marketplace is undergoing significant restructuring with a recent trend of consolidation, which indicates the industry is forcing weaker competitors out while stronger ones are continuing to grow," said Anwar Sukkarié, CEO, "Our proven ability to manage growth, maintain a solid level of customer service, while remaining profitable strengthens our position for continued growth." R&D investment has increased for building product enhancements for new products. WebTech also increased its marketing and support service activities to penetrate target markets (WebTech Wireless, 2006).

**Competitive Position of BC Companies**

**Novax Industries Corporation**

Transit Signal Priority (TSP) is provided by competing technology solutions such as loop detectors, proximity zone based and GPS. Novax has established partnerships and launched pilot projects to prove the advantages of its wireless TSP solution.

The evaluation project for the 98BLine was formed from key funding partners Transport Canada, TransLink, and IBI Group with a total value of $175,000. Novax supplied and installed the TSP capability of the 98 B-Line BRT system. The evaluation of the 98 B-Line BRT demonstrated that wireless ITS technologies provide significant benefits in all of the areas targeted by the Regional ITS Plan. This will help TransLink build on the success of the 98 B-Line to implement additional BRT services and provide
other regions in Canada with supporting information to implement ITS solutions. Thus, the pilot project contributed to meeting regional transportation goals and to the implementation of Canada’s ITS Architecture (Transport Canada, 2003).

Novax competes in the TSP market with large global players such as 3M. 3M developed the Opticom GPS Priority Control System that uses future-forward global positioning system technology. Recently the City of Kelowna selected 3M Opticom for their pilot project to integrate traffic signal systems and incorporate TSP. Partners included BC MoT, Translink and IBI Group with funding awarded in the amount of $250,000 for a total cost of $515,000.

Since public sector owners have an interest in getting the best value for their money, procurement policies may deter small, specialized firms such as Novax, from submitting proposals for public projects. The public may be better served by reforming procurement policies to encourage proposals from small firms with the right technical specialties (Edgerton, 2000).

**Streetlight Intelligence**

STI competes directly with similar technologies offered by major competitors such as GE and Telemics for the city public works departments, utilities, industrial areas and military bases that operate the majority of the installed streetlight base.

Many new competitors have entered the adaptive lighting marketplace in both North America and Europe during 2005. These competitors have largely focused their products on asset management and maintenance savings features by offering wireless networks of remote sensors. However STI is the only company that offers streetlight
operators the ability to granularly dim street lights and save energy as well as achieve maintenance savings.

STI currently has a BC Hydro-sponsored pilot project in progress with the City of Prince George, BC. An additional project is also underway on a community college campus in Victoria, BC. In 2005, the Company initiated pilots with the City of Oakland, California, and FortisAlberta, an Alberta utility company (McLean, 2006). Experience and accumulation of procurement expertise by the public sector will improve the long term competitive position of STI.

**In Motion Technology Inc**

In Motion faces competition from mid-sized vendors and large companies such as Cisco, which offers a mobile access router for vehicle deployment.

Specific legislation for emergency services has provided public motivation for deploying wireless technologies. Mandated emergency services led by Enhanced 911 in North America and Europe will enhance driver safety by enabling users to send emergency information to dispatch centres quickly and accurately. Initiatives address upgrades to national 911 systems to handle new wireless and networked technologies. This increases the demand for development and deployment of the many ITS-related technologies, such as integration of public safety communication systems with ITS systems.

Public market forces are predictors of revenue growth for In Motion to capitalize on. Appropriate public private partnering is essential to deliver mission critical services to public safety providers.

**WebTech Wireless**
The AVL and telematics industry is very competitive and offers many technological choices to the local market. Location based services (LBS) are poised for rapid growth in commercial vehicle services. LBS are ramping up due to higher data rates, next generation converged networks and improved handset capabilities. Neil Chan of WebTech believes that eventually every vehicle will be a wireless gateway.

WebTech competes for resources, recognition and relationships with target customers. Competitors may adopt more aggressive pricing policies, increasing price pressure. In addition, competitors may establish cooperative relationships to compete more effectively. Innovative new technologies may provide increased performance over WebTech's current products. Thus, a cluster initiative would promote common interests and collaboration in support of market expansion.

WebTech is globally pursuing transportation, government, waste management, construction and utility service verticals. Public sector purchasing is vital to long term competitive sustainable advantage.
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