ATLANTIC

A Thematic Long-term Approach to Networking for the Telematics and ITS Community

A Partnership of ITS Communities in Europe and North America

SYNOPSIS

And Highlights of

DISCUSSION PAPER

TRAFFIC AND TRAVEL INFORMATION SYSTEMS (TTIS)

Prepared by

Work Group 1.1

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In collaboration with Participating Partners and Sponsors

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PREFACE

ATLANTIC (A Thematic Long-term Approach to Networking for the Telematics and ITS Community) is an international cooperative undertaking that aims to foster information exchange and policy debate related to the application and development of intelligent transport systems (ITS). ATLANTIC originated as a project sponsored by the European Union under the 5th Research Framework with self-sustaining partners in Canada and the United States. ATLANTIC is organized into 8 work groups focused on different topics related to telematics and ITS. This document is the product of one of the Canadian work groups to benchmark and assess the state of ITS practice and research and development in Canada.

This Synopsis report is a summary of the discussion paper prepared by Work Group 1.1 on the topic of "Traffic and Travel Information Systems (TTIS)". It is intended to provide readers with a brief overview of the research results of Work Group 1.1. The Synopsis follows the same structure as the discussion paper so that one can easily find the more complete discussion and treatment of subtopics in the corresponding section of the discussion paper. This is particularly true of lists of references and descriptions of projects.

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The ATLANTIC Canada network acknowledges the leadership and contributions provided by its partners in Europe and the United States. The principal partners include Dr. John Miles (United Kingdom), Steve Morello (France), Ian Catling (United Kingdom), Isabelle Dussutour (POLIS), Siegried Rupprecht (Germany), Professor Chelsea White (USA) and Professor Kan Chen (USA).

The ATLANTIC Canada network node is sponsored by Transport Canada, Ministry of Transportation Ontario and Ministère des Transports du Québec and jointly managed by the ITS Centre and Testbed, University of Toronto and the Centre de recherché sur les transports, Université de Montréal. The core team providing overall leadership for ATLANTIC Canada includes Professor Baher Abdulhai (Toronto), Professor Teodor Gabriel Crainic (Montréal) and Dr. William Johnson (Ottawa).

The Canadian Work Group 1.1 Traffic and Travel Information Systems is jointly managed by a leader, Dr. Ata M. Khan, Carleton University, and a rapporteur, Mr. Paul Frigon, PSR Group. They provided the intellectual leadership and writing skills to assemble and document this discussion paper with inputs and contributions from a network of Work Group members. The names of Work Group 1.1 members and contributors appear in Annex A. Special recognition is extended to Ms. Sarah Taylor, Research Assistant, Carleton University, for her extensive contributions.

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1. EXECUTIVE SUMMARY

This discussion paper describes the mandate, activities and findings of the Work Group 1.1, Traffic and Travel Information Systems (TTIS) of the Canadian arm of the ATLANTIC project. This paper is intended to seek feedback from expert members of WG 1.1 and other readers on how to improve the information and ideas covered in the paper so as to enhance collaboration with ATLANTIC partners.

The WG 1.1 has covered, from a Canadian perspective, current practice and research needs in telematics-based traffic and travel information systems (TTIS). Also, comparisons are made with other ATLANTIC partners. Specifically, four inter-related TTIS services were studied. These are traffic information, public transit and multimodal traveller information, road condition information, and road weather information. Themes explored relate to information needs, consumer interest, business issues, reliability of information, adding value to real-time information by making predictions (e.g. predictive travel time) for origin to destination travel, and technological factors such as infostructure and wireless communications.

A survey of ITS Initiatives in Canada that relate to TTIS provided a base for further explorations of key service areas. Additionally, selected information was drawn from a recently released report, sponsored by ITS Canada, on an inventory of ITS projects in Canada (Fu, et.al., 2003).

Experts in the field were invited to join the work group. Annex A presents the names and affiliations of Expert members of WG 1.1. Their publications/reports/products served as sources of information. These experts as well a number of European ATLANTIC project participants were invited to review a draft of the paper. This final version of the paper reflects their comments as well as other latest information on TTIS developments.

The WG 1.1 participated in the development of the Orange Book on Predictive Travel Time. This activity was co-sponsored by ITS America's Special Interest Group on International Research & Learning (SIGIRL) and two private sector firms TrafficCast and PBS&J. In July 2003, the WG 1.1 played a role in organizing and participating in the Predictive Travel Time Workshop, held at Carleton University. Highlights of the conclusions reported in the draft Orange Book are noted in this discussion paper.

Findings of the work completed by WG 1.1 show that Canada has a wide variety of TTIS that are logically, to a high degree, interconnected with other ITS systems. In general, the TTIS implementations and research in Canada compare favourably with those in the U.S.A and Europe. Research needs in Canada reflect the special and unique Canadian conditions such as climate, socio-economic and demographic conditions. However, there is much common ground with other ATLANTIC partners both in terms of existing practice and research needs.

2. WORK GROUP (WG) 1.1 OVERVIEW

ATLANTIC is an acronym for "**A** **T**hematic **L**ong-term **A**pproach to **N**etworking for the **T**elematics and the **I**TS **C**ommunity". It is an international forum linking ITS researchers in North America and Europe. The Canadian ATLANTIC project is a partnership to advance ITS research in Canada in association with international partners. It is expected that the Canadian node will result in an active ITS research community in Canada with cooperative links with international partners in Europe and the United States.

The Canadian node is organized into a network of academic, public sector and private sector researchers. Transport Canada, the Ministry of Transportation of Ontario, and Ministère des Transport du Québec provided a limited amount of financial support.

Theme areas are defined as (1) Integrated Transport, (2) Technologies and Services, and (3) Assessment and Evaluation of ITS. Eight separate work groups are assessing/advancing the state of knowledge and engaged in benchmarking exercises. The Work Group (WG) 1.1 is pursuing Traffic and Travel Information Systems (TTIS).

The Work Group 1.1, with the assistance of Sarah Taylor, a Ph.D. student at Carleton University, has developed a survey paper on TTIS and related ITS Initiatives across Canada. Due to very close linkages between TTIS and other types of ITS installations, the paper was designed to have a wide scope. Selected information from the paper is included in this document. Additionally, information was drawn from a recently released report sponsored by ITS Canada, on an inventory of ITS projects in Canada (Fu, et.al., 2003).

The WG 1.1 has identified experts who were invited to join the work group. Experts are affiliated with the following types of agencies.

- Universities, research institutes
- Consultants
- Government departments/agencies
- Technology firms (i.e. service and product providers)

Annex A provides the complete list of members and contributors/experts.

Another notable activity of the WG 1.1 is participation in the development of the Orange Book on "Predictive Travel Time". In addition to participation in teleconferences, the WG 1.1 played a role in the Orange Book Workshop held in July 2003 at Carleton University. The Orange Book project is co-sponsored by ITS America's Special Interest Group on International Research & Learning and two U.S. private sector firms, TrafficCast and PBS&J. Highlights of the findings reported in the draft Orange Book are noted in this discussion paper (PBS&J 2003).

3. WORK GROUP 1.1 SUBTOPICS AND THEME SUMMARY

The following four services, that use telematics-based traffic and travel information systems (TTI), are of interest to WG 1.1.

- Road Traffic Information (includes traffic condition & parking)
- Transit & Multimodal Travel & Parking Information
- Road Condition Information
- Road Weather Information

These services are intended for surface passenger as well as freight transportation systems. As for their significance, these can potentially affect travel decisions, including route choice.

The work group has identified the following major TTIS themes to be studied.

- The mission of TTIS, including addressing user requirements as well as meeting broader socio-economic goals (e.g., safety, economic efficiency)
- Components of TTIS
- TTIS as a self-sustaining business
- Technological advances (e.g., advances in telecommunications leading to advances in TTIS)
- Real time data collection networks
- Adding value to real time data by enhancing the reliability of fused data and to make predictions (e.g. of travel time) prior to distribution to travellers and other users.

These themes recognize the role, the market and technical aspects of TTIS that are to be studied for real world relevance. On the technical side, the major components of a TTIS can be conceptualized as shown in Figure 1. These are:

- Data acquisition
- Processing including data fusion
- Adding value to real time data in the form of predictions (e.g. predictive travel time)
- Delivery of travel information to all types of (passenger & freight transportation) users -- for their information and guidance.

Figure 2 presents details of data collection. The delivery means are shown in Figure 3.

On the business side, the TTIS - generated information is viewed as a commodity. Perceptions of travellers and other stakeholders with an interest in the information have to be understood in terms of reliability of information and their utility (i.e. value) for information. This would lead to an understanding of their willingness to pay for information. Next, suitable business models and charging mechanisms are to be defined. Clearly, a resolution of business issues is a pre-requisite for sustainable TTIS, unless the service is to be provided by public agencies owing to its importance to society. Figure 4 shows progression of knowledge required for resolving business issues.

This discussion paper describes Canadian TTIS developments and to the extent relevant, comparisons are made with the experiences of ATLANTIC partners. Also, Canadian research needs in the TTIS themes are defined at a macro level and comparisons are made with other Partners.

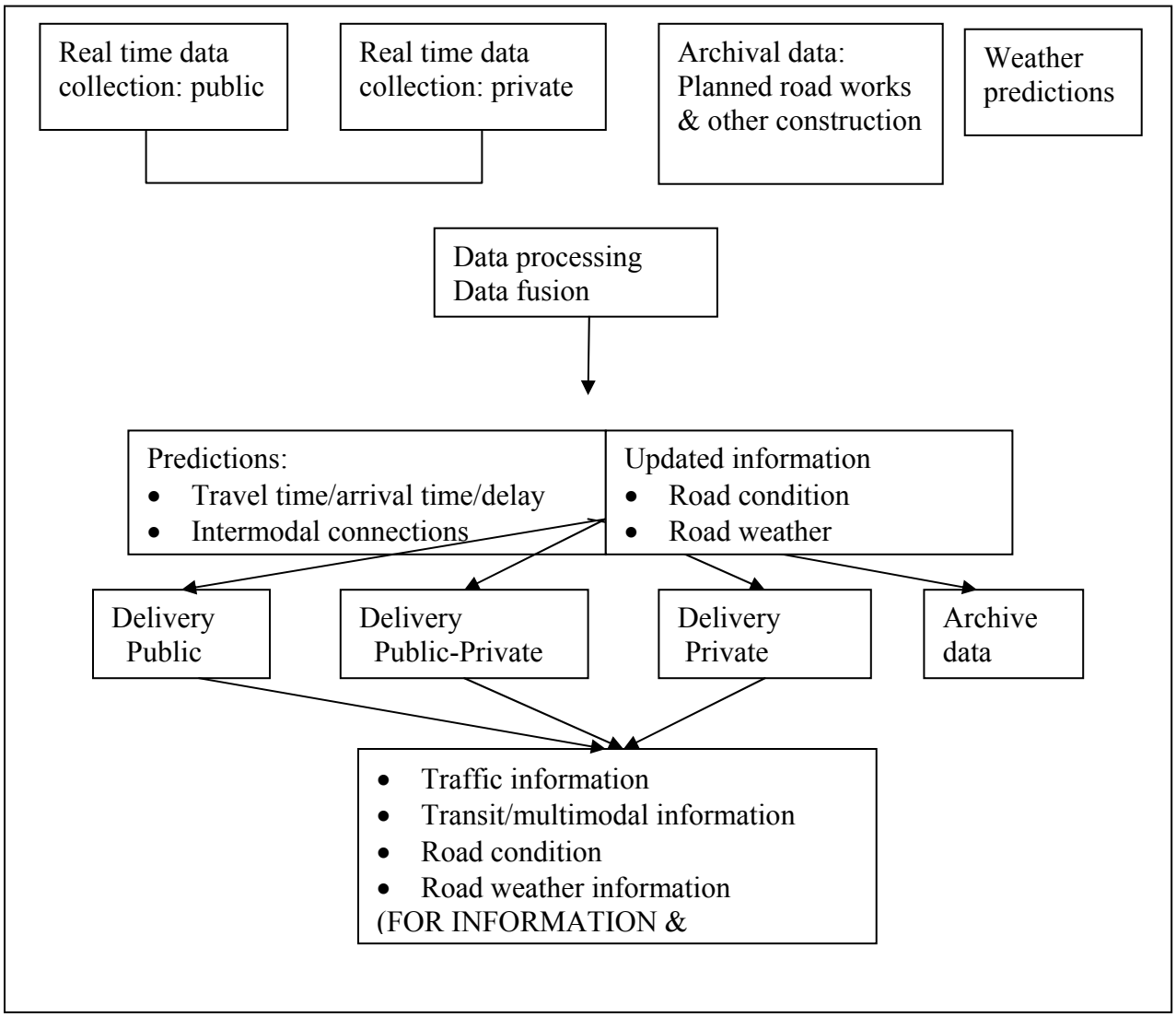

Figure 1: Technical Aspects of TTIS

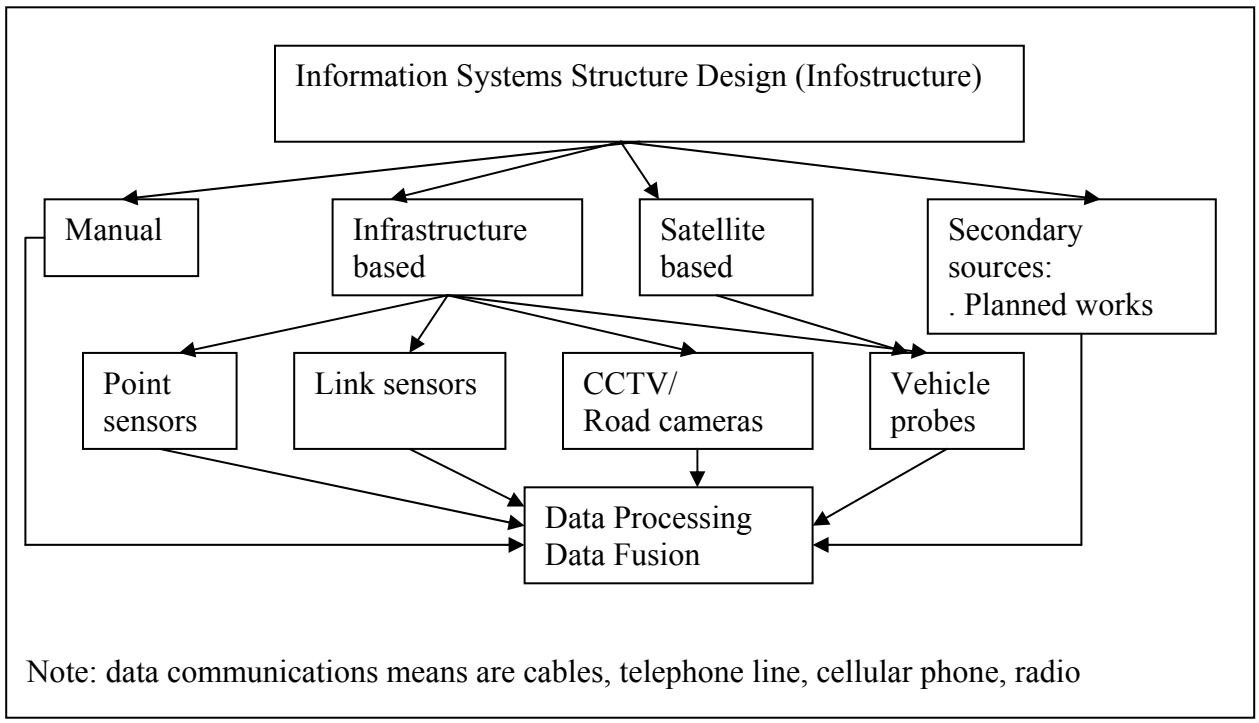

Figure 2: Data Collection

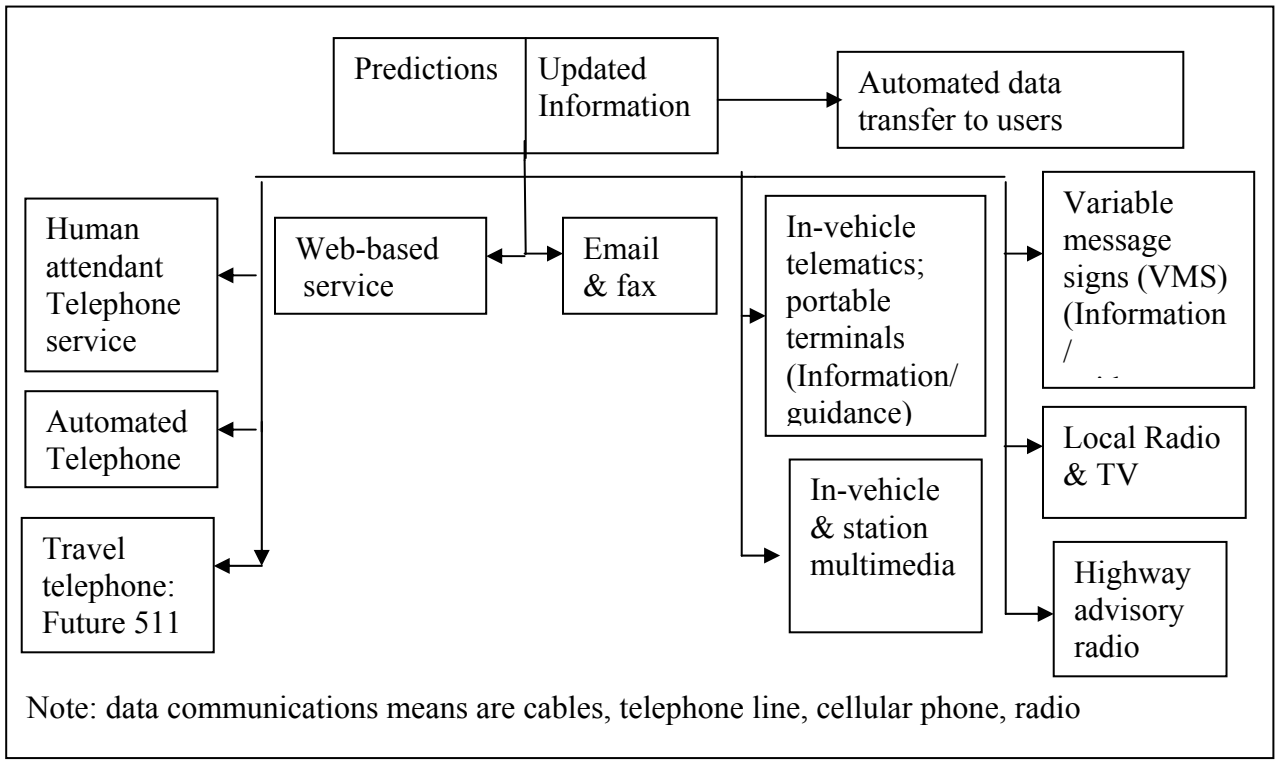

Figure 3: Delivery Methods

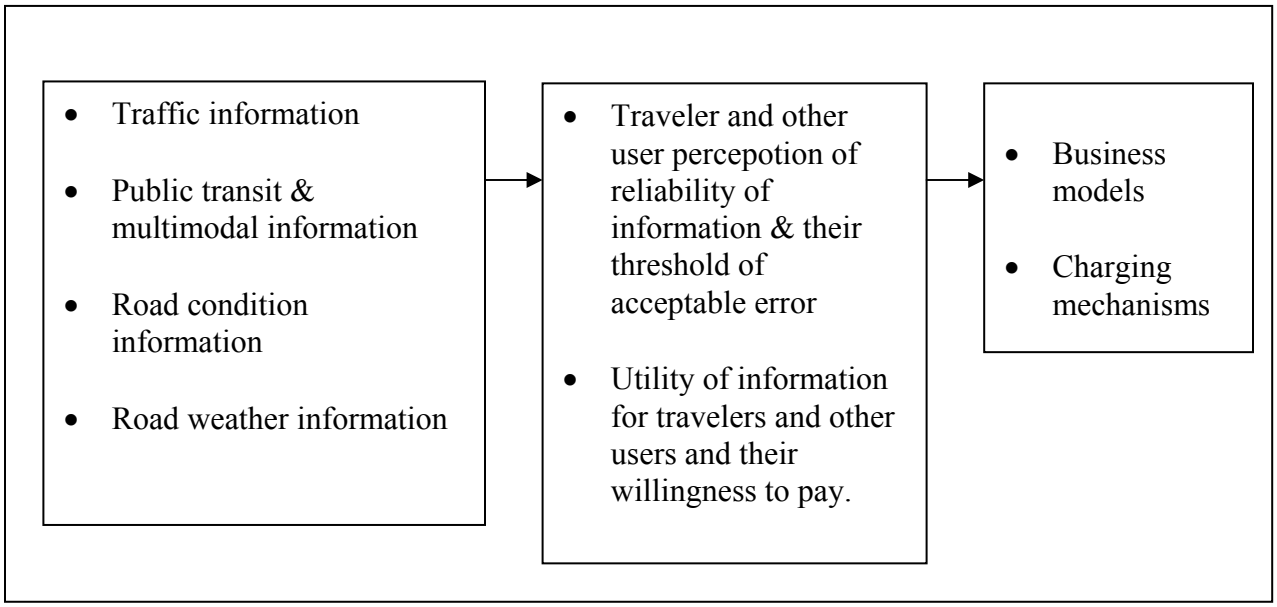

Figure 4: Business Issues

4. DISCUSSION OF SERVICE AREAS

See Discussion Paper for details.

5. TTIS & RELATED ITS INITIATIVES IN CANADA

5.1 Introduction

The majority of ITS initiatives are taking place in Ontario, Alberta, British Columbia, and Quebec (Figure 5). These provinces have developed and adopted ITS strategic plans, which provide a vision for the future of ITS as a part of their appropriate transportation systems, and outline strategies and action plans to explore ITS opportunities. Only recently have Saskatchewan and Manitoba taken their first steps to the development of an ITS strategic plan to serve as their road map for implementing ITS technologies throughout their provinces (MT&GS, 2002a; SDOT, 2002, Fu et al., 2003). The four provincial governments in Atlantic Canada are presently working together to develop a comprehensive plan to set the direction and pace of ITS for the next ten years (Landry, 2002). In doing so, they have developed an ITS Atlantic website.

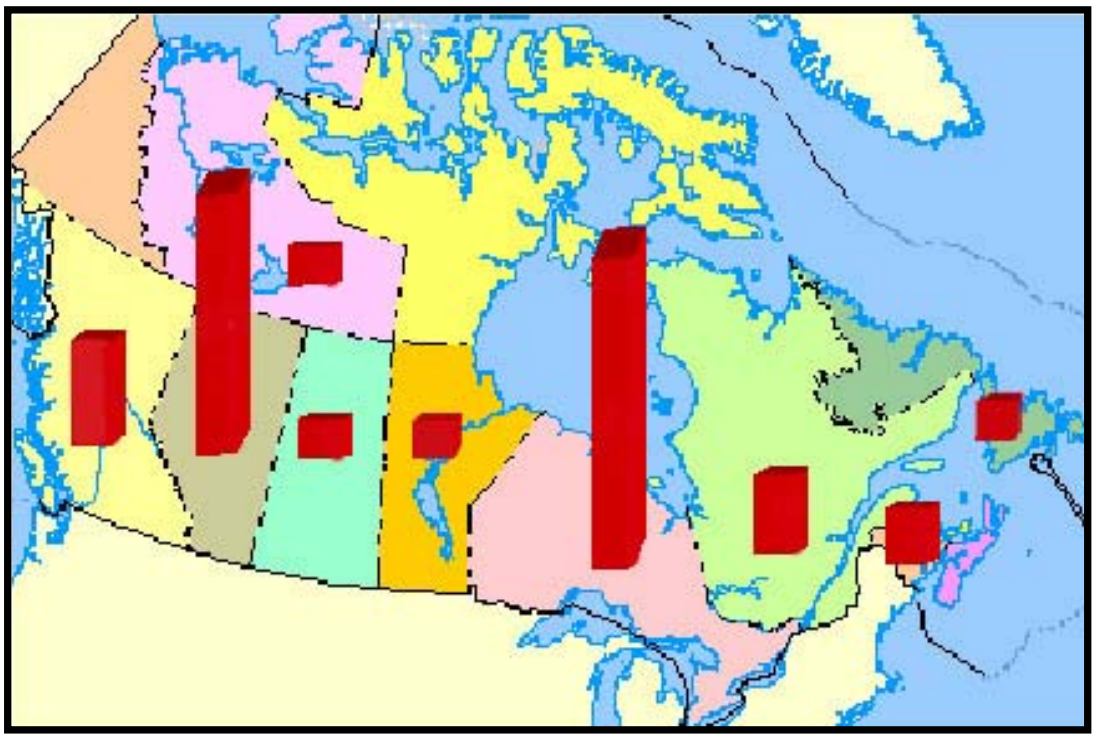

Figure 5: ITS Projects Across Canada (Adapted from Fu et al., 2003)

In formulating this chapter, the information obtained from across Canada suggests that the majority of the projects being developed and implemented are within the area of travel and transportation management, followed by public transportation operations and then by commercial vehicle operations (CVO). Through the review, it has been noted that the Prairie Provinces and Atlantic Canada are focusing primarily on rural highway safety and operations as well as CVO and cross border applications.

All provinces have deployed some aspects of the Road Weather Information Systems (RWIS). These provide timely information about local pavement conditions that is used to keep the highways and roadways operating safer in winter. Along with this, some provinces have integrated this system into an Internet and radio advisory to inform travellers of road conditions throughout their respective provinces. Most Canadian advanced traveller information systems (ATIS) are driven by the public road sector and in general, private initiatives can be found in large urban areas only.

This chapter in the Discussion Paper describes current practices as well as new initiatives in TTIS and related services in each province and territory. ITS interests of the Canadian university community are also reviewed. At the end of this chapter, recent developments of national interest are noted. Most services/projects cover more than one ITS activity (e.g., advanced traffic management plus advanced traveller information system). In some instances, ITS systems that do not fall in the TTIS area, but are believed to be of potential interest to the reader are described as well.

5.2 University Interests

The following universities in Canada were found to have research activities related to ITS. There is a brief description of their current activities in the Discussion Paper.

University of British Columbia

University of Calgary

University of Saskatchewan

University of Manitoba

Ryerson University

University of Toronto

McMaster University

University of Waterloo

Royal Military College

Carleton University

Concordia University

École Polytechnique de Montréal

Université de Montréal, Centre de recherche sur les transports

University of New Brunswick

5.3 Recent TTIS Developments of National Interest

A process is underway, in early 2004, for CRTC designation of the 3-digit code ***511 as a weather and traveller information service***. Seven organizations have agreed to participate in discussions for the establishment of a "511 Consortium" to co-ordinate this initiative on behalf of the transportation community in Canada: Transport Canada, Environment Canada, the Canadian Urban Transit Association, ITS Canada, the Ontario Ministry of Transportation, Ministère des Transports du Québec, and the Transportation Association of Canada. It is envisioned that the service would be developed by local, regional and provincial agencies with their private sector partners and would include traffic, transit and weather information as a minimum. As a first step, the 511 Consortium is preparing a "511 Development Plan" for Canada that will be available in 2004.

Additionally, in 2003, Transport Canada awarded a number of R&D contracts in four target areas of wide interest. These are noted below.

Traffic management and control and public transportation: projects include development of: intelligent sign management systems; a system for using cell phones as traffic probes; and a transit signal priority algorithm.

*Transportation safety, transportation security and commercial vehicle operations: p*rojects include development of: work zone traffic management systems on streets and highways; a commercial vehicle operations (CVO) data clearinghouse/brokerage facility; and a remote-controlled weigh station

*Reduction of greenhouse gases and Road Weather Information Systems: p*rojects include development of: a real-time communications system for "ride-matching" (i.e., matching drivers with riders) using an innovative point system to provide incentive to drivers to participate; and a sensor system to determine pavement load-bearing capability, which can vary in different weather conditions

ITS standards and methodological issues: projects include development of: a traffic system spatial infrastructure (i.e., the means by which geographic or locational information may be integrated with transportation management systems); and technical systems requirements for a national traveller information system that could be accessed by dialing "511".

6. COMPARISONS OF CURRENT PRACTICE WITH ATLANTIC PARTNERS

This section is an abbreviated version of the Discussion Paper analysis. The focus here is on travel information for road users. The Discussion Paper also includes a discussion of Public Transit and Multimodal services together with Table 2 (omitted from this Synopsis Paper).

6.1 Comparisons on the Basis of Service Attributes

A comparison of current practice in Canada, U.S.A. and Europe is made for each TTIS service category on the basis of the following attributes (if applicable):

- Real time information capability
- Integration of real time user information systems with other ITS systems (applicable to public transit)
- Predictive travel time capability (on an origin-destination basis)
- Use of reliability criterion
- Integrated information covering all types of road facilities and covering public and private modes
- Mature market

For ease of reference, the comparative information is presented in Tables 1, 3 and 4. The contents of these tables reflect a review of information referenced in this report and other observations of WG 1.1 members.

6.2 Observations on Factors Affecting Development of TTIS Services

See Discussion Paper for details.

Table 1: Comparisons of Current Practice: Highlights of Traffic Information Service

Service Attribute	Canada	U.S.A.	Europe
Real time information capability	Only in major metropolitan centers	Most major urban areas	Only at major metropolitan centers
Predictive travel time capability	No	Limited capability	Limited capability
Reliability criteria used	No check is made	At some locations	At some locations
Integrated information covering all types of road facilities	Only in major metropolitan centers	Most major metropolitan areas	Only at major metropolitan areas
Mature market	No	Growing market	No

Note: The contents of the above table reflect a review of information referenced in this report and other observations of WG 1.1 members.

Table 3: Comparisons of Current Practice: Highlights of Road Condition Information Service

Service Attribute	Canada	U.S.A.	Europe
Real time information capability	Only at some location	Only at some locations	Only at some locations
Prediction of road conditions	No	Limited capability	No
Reliability criteria used	No check is made	At some locations	At some locations
Integrated information covering all types of road facilities	Only at a limited number of locations	Only at a limited number of locations	Only at a limited number of locations
Mature market	No	Growing market	No

Note: The contents of the above table reflect a review of information referenced in this report and other observations of WG 1.1 members.

Table 4: Comparisons of Current Practice: Highlights of Road Weather Information System Service

Service Attribute	Canada	U.S.A.	Europe
Real time information provided to travelers	Only at some location	Only at some locations	Only at some locations
Prediction of road weather conditions	Some locations	Some locations	Some locations
Reliability criteria used	At some locations	At some locations	At some locations
Integrated information covering all types of road facilities	Only at a limited number of locations	Only at a limited number of locations	Only at a limited number of locations
Mature market	No	Growing market	No

Note: The contents of the above table reflect a review of information referenced in this report and other observations of WG 1.1 members.

7. RESEARCH NEEDS & COMPARISON WITH ATLANTIC PARTNERS

7.1 Traffic Information

A number of facets of traffic information systems in Canada require further research. Table 5 presents a comparison of research interests in Canada, U.S.A. and Europe. These are inferred from literature sources shown in the Discussion Paper (e.g., Transport Canada 2004, Frigon and Johnson 2002, Frigon 2003, TAC 2004, ITS America 2001, Chen 2002, Al-Deek 2003, Miles 2003, Miles, et al 2003, Pretorius 2001)

7.2 Public Transit and Multimodal Information

See Discussion Paper for details and Table 6..

7.3 Road Condition Information

Given the nature of road condition information, it generally has a rural orientation. Table 7 presents Canadian research needs as well as comparison with other ATLANTIC partners. These include real time information, dial-in number such as 511 services, role and effectiveness of highway advisory radio, information requirements for different market segments, utility to users of TTIS-generated information, acceptable levels of reliable forecasting, infostructure, and business models.

7.4 Road Weather Information

An RWIS working group consisting of representatives from provinces and territories, Environment Canada, Transport Canada and the Insurance Corporation of British Columbia are studying the development of a Canadian RWIS network. This project has much scope for enhancing road weather technology. Also, it could serve as a model for the adoption of large-scale integrated systems (MTO 2003). Recently, RWIS specifications became available on the website of the Transportation Association of Canada (TAC 2004). It is anticipated that follow-up research work would be required in the following areas: sensors and accuracy, exposure, site, maintenance, data and telecommunications.

Given the nature of road weather information, it has both urban and rural orientation. Table 8 presents research needs in Canada. Also, comparisons with other ATLANTIC partners are made. Please see the following references for supporting information (Pisano, Hicks, Persaud, Goodwin and Stern 2003, Nelson and Persaud 2002, Karlsson 2003). As expected, research interests in this service are similar to those in road condition information. However, the challenges of a seamless road weather information service are higher than for other services.

Table 5: Comparisons of State of the Art & Research Directions: Traffic Information

Research Subject	Interest in Canada	Interest in the U.S.A.	Interest in Europe
General: Development of dynamic, real time TTIS. Examples: . Border crossings . Construction zones	Yes	Yes	Yes
Add predictive travel time capability to real time TTIS services.	Yes	Yes	Not known
Dial-in number for traffic and related information (e.g., 511 services in the U.S.A.).	Yes	Further improvements to the 511 services	Yes -- e2000
Requirements for different market segments (e.g., study of requirements for pre-trip and during trip information).	Yes	Yes	Yes
Utility of travellers and other users for TTIS-generated information; acceptable levels of reliable forecasting.	Yes	Yes	Yes
Infostructure: study of densities of data collection networks.	Yes	Yes	Unknown
Portable devices for receiving personalized advanced ATIS services.	Interest in cell phone and other multi-use devices.	Yes	Interest in the demonstration of a Personal Advisor Terminal for TTIS for pre-trip and on-trip travel needs.
Business models and ad-hoc brokers of TTIS services; factors that affect the formation and success of a TTIS business.	Yes	Yes	Yes
Architecture and standards development; potential risks/benefits associated with maturing standards.	Yes	Yes	Yes

Table 7: Comparisons of State of the Art & Research Directions: Road Condition Information

Research Interest	Activity in Canada	Activity in U.S.A	Activity in Europe
General: Development of dynamic, real-time TTIS (e.g., for road construction zones).	Yes	Yes	Yes
Dial-in number for information (e.g., 511 services in the U.S.A.).	Yes	Further improvements to the 511 services	Yes -- e2000
Role & effectiveness of highway advisory radio (HAR).	Yes	Yes	Unknown
Requirements for different market segments (e.g., study of requirements for pre-trip and during trip information).	Yes	Yes	Yes
Utility to travelers and other users of TTIS-generated information; acceptable levels of reliable forecasting.	Yes	Yes	Yes
Infostructure: study of densities of data collection networks.	Yes	Yes	Unknown
Business models and ad-hoc brokers of TTIS services; factors that affect the formation and success of a TTIS business.	Yes	Yes	Yes

Table 8: Comparisons of State of the Art & Research Directions: Road Weather Information

Research Interest	Activity in Canada	Activity in U.S.A.	Activity in Europe
Large scale integrated system for providing seamless service	Yes	Yes	Yes
Dial-in number for traffic, road condition, road weather and related information (e.g., 511 services in the U.S.A.)	Yes	Further improvements to the 511 services	Yes -- e2000
Role and effectiveness of highway advisory radio (HAR); Tying-in of variable message signs to HAR to the RWS	Yes	Yes	Not known
Requirements for different market segments (e.g., study of requirements for pre-trip and during trip information)	Yes	Yes	Yes
Utility to travelers and other users of TTIS-generated information; acceptable levels of reliable forecasting	Yes	Yes	Yes
Infostructure: study of densities of data collection networks.	Yes	Yes	Unknown
Business models and ad-hoc brokers of TTIS services; factors that affect the formation and success of a TTIS business.	Yes	Yes	Yes
Architecture and standards development; potential risks and benefits associated with maturing standards.	Yes	Yes	Yes

8. CONCLUSIONS

Canada has a good base of ITS implementations in TTIS service areas. As a result of strategic plans developed by governments at all levels and by the private sector, priorities are being defined for further applications.

Most Canadian TTIS services are driven by the public road sector. However, private initiatives can be found in large urban areas.

In a number of ITS initiatives reviewed, some TTIS services are logically interconnected with other ITS systems.

Canadian applications of TTIS are shaped by the socio-economic, demographic, and environmental characteristics of Canada. However, there are similarities with ATLANTIC partners in terms of existing practices (see Tables 1 to 4).

A number of research areas have been defined in this report, covering all facets of TTIS. As in the case of existing practice, these reflect Canadian needs. Also, there is much common ground with other ATLANTIC partners (Tables 5 to 8).

On the basis of the above noted conclusions, the following recommendations are made:

(1) Research is recommended in subjects noted in Tables 5 to 8 for overcoming information gaps in order that road transportation systems in Canada can fully capture the benefits that ITS and related information technologies can provide.

(2) Further integration of TTIS with other ITS components is highly desirable for enhancing user and broader societal benefits.

(3) Given that in Canada there is much research interest as well as expertise in the TTIS areas and that other than financial constraints, there are no inherent hurdles to developing and adopting innovations, it is in the best interest of all stakeholders if research in TTIS services is enhanced.

(4) Since financing of R&D in TTIS is a substantial hurdle in the current financial environment characterized by reduced availability of venture capital and reduced government budgets, special efforts should be made by the private as well as the public sector to address this issue.

REFERENCES

See Discussion Paper for details.

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