



National Intelligent Transportation Systems Training & Curriculum Initiative

February 2012

Acknowledgements

This report was produced under a contract to ITS Canada in a partnership with Transport Canada by the ONE-ITS Society. ITS Canada is grateful for the contributions made by both parties in bringing this to fruition and making the report a valuable step towards furthering the industry in Canada and abroad through education and training.

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Appendices (available upon request)

Executive Summary

This initiative addresses one of the strategic objectives of ITS Canada - to foster and facilitate training, education and professional development among all ITS stakeholders.

The project first collected an inventory of the required ITS subject matter including information on existing ITS training courses, curricula and professional development activities obtained through a search of online websites. This catalogue is a database of ITS training activities in Canada, the United States and overseas including Australia, South Africa, United Kingdom, Europe and Asia. This work also provided input for two documents used in the next phase of the inventory process - a matrix of stakeholders versus ITS architecture service bundles and a compilation of ITS training subject matter by ITS architecture service bundles.

Three focus groups were conducted in order to obtain input from members of the ITS community across Canada. The focus groups were convened in Calgary, Toronto and Montreal and participants were identified in eight employment categories including provincial, municipal, industry, operators, consultants, academics, and federal and national association members.

The focus group outcomes are presented in the body of the report following in Tables 1, 2 and 3, as a summary across all focus group sessions in Table 4, and as notes recorded at each session. The information from the catalogue of existing courses, the outcomes of the focus group sessions and the consultant's knowledge was brought together to propose a comprehensive framework for an ITS training curriculum and associated ITS courses. The framework has five layers that cover technical and non-technical orientations, and breadth and depth of material. The five layers are:

1. *Fundamentals and theory*
2. *Bridging courses and cross fertilization*
3. *Core ITS professional courses*
4. *Context and specialties, and*
5. *Awareness and promotion*

Within each of the five layers are proposed courses and associated modules that represent the most important ITS subject matter with an emphasis on the themes, ideas and suggestions that emerged from the focus group sessions.

The project developed a method for prioritizing the ITS courses to enable ITS Canada to identify the most important and urgent options for immediate development. The analysis categorized the 21 courses into three levels of priority – high, medium and low – based on three criteria (1) need as identified by focus groups (2) emerging trends and technologies, and (3) the anticipated role for ITS Canada. The resulting scores placed 8 of the 21 courses in the high priority category.

ITS Canada considers six of those to be top priority courses as the prime candidates for development in the next phase of ITS Canada's strategic plan. They are:

1. *Architecture Awareness and Education/Training*
2. *(ITS for) Advanced Traveller Information Systems*
3. *Connected Vehicle-Infrastructure Systems and Services*
4. *Introduction to ITS*
5. *Justifying Investments in ITS: The Business Case*
6. *(ITS for) Transportation Executives, decision and Policy Makers*

This report is a framework of associated courses for a professional ITS training curriculum that will position ITS Canada as a leader in the domain of ITS training and professional development. The proposed ITS training curriculum is comprehensive in scope, addresses the most important training needs of the ITS stakeholder communities, is open-ended for future growth and is adaptable to changing technology, economic conditions and social factors. It presents ITS Canada with a unique and valuable opportunity to manage and deliver ITS training and professional development that can be used to attract partners and supporters and provide leadership for a comprehensive national program.

Résumé directif

Cette initiative répond à l'un des objectifs stratégiques de STI Canada, soit de prendre en charge et de faciliter la formation, l'éducation et le perfectionnement professionnel pour toutes les parties prenantes dans le domaine des STI.

Le projet a débuté par une série de recherches sur la toile afin de créer un catalogue des sujets requis dans le domaine des STI, y compris des informations concernant les cours existants en STI, les programmes et les activités de perfectionnement professionnel. Ce catalogue est une base de données qui décrit les activités de formation en STI au Canada, aux États-Unis et à l'étranger, y compris en Australie, en Afrique du Sud, au Royaume-Uni, en Europe et en Asie. Ce travail de recherche a également fourni des données pour la création de deux documents qui ont été utilisés pour la prochaine phase du processus d'inventaire, soit une matrice des parties prenantes par rapport aux ensembles de services en architecture des STI ainsi qu'une compilation des différents sujets de formation en STI par ensemble de services en architecture des STI.

Trois groupes de discussion ont été mis en place afin d'obtenir des informations auprès des membres de la communauté des STI à travers le Canada. Les groupes de discussion ont tenu des rencontres à Calgary, à Toronto et à Montréal et des participants ont été identifiés dans huit catégories d'emploi, y compris des employés au niveau provincial, municipal, en provenance de l'industrie, du domaine de l'exploitation, des consultants, des institutions d'enseignement et des associations à l'échelle fédérale et nationale.

Les résultats des groupes de discussion sont présentés dans le corps du rapport dans le tableau n° 1, 2 et 3, sous la forme d'un résumé des résultats de tous les groupes de discussion dans le tableau n° 4 et en tant que notes qui ont été enregistrées lors de chaque rencontre. Les informations contenues dans le catalogue concernant les formations existantes, les résultats des rencontres des groupes de discussion et les connaissances du consultant ont été réunis afin de proposer un cadre intégral pour un programme de formation en STI et les cours respectifs en STI. Le cadre contient cinq niveaux qui recouvrent les orientations techniques et non techniques et il décrit la largeur et la profondeur de la matière. Les cinq niveaux sont les suivants:

1. *Les principes fondamentaux et la théorie*
2. *Les cours de rattrapage et la fertilisation croisée*
3. *Les cours principaux en STI de calibre professionnel*
4. *Le contexte et la spécialisation, et*
5. *La sensibilisation et la promotion*

Pour chaque niveau, on retrouve une proposition de cours et de modules pertinents qui représentent la matière en STI la plus importante en mettant l'accent sur les thèmes, les idées et les suggestions qui ont fait surface au cours des rencontres des groupes de discussion.

Le projet a permis de mettre en place une méthodologie de hiérarchisation des cours en STI afin de permettre à STI Canada de bien cibler les options les plus importantes et les plus urgentes afin de procéder au développement immédiat. L'analyse a classé les 21 formations selon trois niveaux de priorité – le niveau de priorité élevé, moyen et bas en raison de trois critères, soit (1) les besoins tels que déterminés par les groupes de discussion (2) les nouvelles tendances et les technologies émergentes et (3) le rôle anticipé de STI Canada. Les pointages obtenus ont permis de placer 8 des 21 formations dans la catégorie à priorité élevée. STI Canada considère cinq d'entre elles comme étant des formations prioritaires donc des candidats idéaux pour la mise en place dans l'exécution de la prochaine phase du plan stratégique de STI Canada. Ils sont présentés en ordre alphabétique ci-dessous:

1. *(Les STI pour) La diffusion avancée d'information aux voyageurs*
2. *Les systèmes et services en infrastructure STI pour le véhicule connecté*
3. *L'introduction aux STI*
4. *Comment justifier votre investissement dans les STI: L'étude de rentabilité*
5. *(Les STI pour) Les cadres, les décideurs et les responsables dans le domaine du transport*

Ce rapport est un cadre pour des cours associés à un programme professionnel de formation en STI qui permettra à STI Canada de devenir le chef de file dans le domaine de la formation en STI et le perfectionnement professionnel. La portée du programme proposé pour des formations en STI est très complète et traite des besoins en formation exprimés par les parties prenantes de la communauté des STI, il est conçu pour permettre une croissance et il pourra être adapté à l'évolution des technologies, aux conditions économiques et aux facteurs sociaux. Il offre à STI Canada l'occasion unique et précieuse pour gérer et fournir de la formation en STI et des activités de perfectionnement professionnel qui pourront être utilisées pour attirer des partenaires et des partisans en plus d'offrir la direction pour un programme national complet.

Intelligent Transportation Systems Training Curriculum Development Project

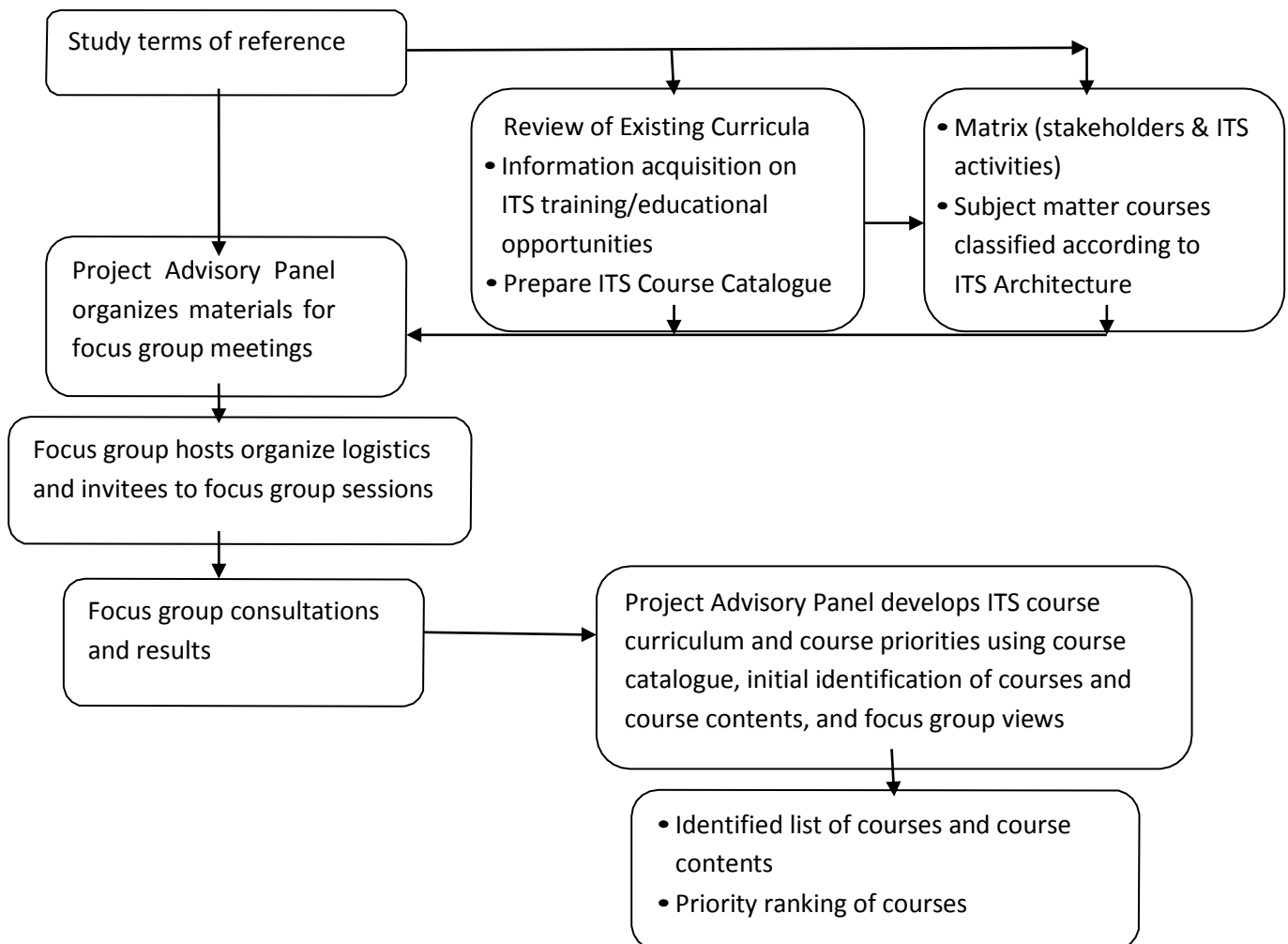
1. Introduction: Strategic Context

One of the strategic objectives of ITS Canada is to foster and facilitate training, education and professional development among all ITS stakeholders. To this end, the ITS Canada Strategic Plan has a new thrust to establish a relevant ITS professional training curriculum that will position ITS Canada as a leader in the ITS training domain. Trainees, engineers and other professionals are to be prepared to take positions as domain experts in the use and application of ITS technology throughout Canada. Ultimately, ITS Canada intends to make this training available for use outside Canada.

2. Project Methodology

The project methodology employed is outlined in **Figure 1**. This illustrates how the project team proceeded from the study terms of reference to the identification of the list of courses and the priority ranking of courses.

Figure 1 – Overview of Project Methodology



a. Review Existing Curricula:

A review and documentation of the existing ITS training courses, curricula and professional development activities was undertaken based on a search of relevant websites. This established an understanding of the scope and extent of ITS training activities in Canada, the United States and overseas with attention to Australia, South Africa, United Kingdom, Europe and Asia. (See Appendix B)

b. Inventory Required Subject Matter and Stakeholder Inputs

Subject Matter in Accordance with the ITS Architecture

The ITS training curriculum is derived from and consistent with the concepts of the “ITS Architecture for Canada Version 2.0”, published by Transport Canada. The project compiled a list of the known technical subject matter associated with each of the ITS service bundles in the ITS architecture. This provided a background document for all of the focus group sessions to illustrate the nature of the existing ITS training knowledge base and to serve as a starting point to explore the broader issues of ITS professional training and development.

Focus Groups

An important part of the project methodology was to consult with stakeholders in the ITS community through a series of focus groups. A list of stakeholder categories was developed that included provincial, municipal, industry, operators, consultants, academics, federal and association members. This provided an overview of the target groups to invite to the focus group sessions and a framework to assess the need for courses with different levels of instruction (for example, technical versus managerial).

The project organized three focus groups in three cities across Canada – Calgary, Toronto and Montreal. A common agenda was used for all focus groups. The Project Leader attended and moderated each session to ensure a common format and continuity of the discussion.

A list of invitees to each event was developed for each city and nearby region by identifying two to four potential participants within in each category. These candidates were drawn mainly from the ITS Canada membership list. Invitations were sent by e-mail. Each session was scheduled for three hours with the start time in each city selected for the convenience of participants who wished to join that session by teleconference call. The moderator introduced the focus group subject matter with a presentation and two background documents. The first was a matrix of stakeholders versus ITS architecture service bundles that would interest them and the second was the ITS training subject matter by ITS architecture service bundle. The proceedings were recorded in notes taken by each host.

c. Organize Inventory into Logical Structure and Modules

The organization of the required subject matter into a proposed curriculum and associated courses synthesizes information from three sources including the catalogue of existing courses, the results of the stakeholder focus group sessions and the expert knowledge of the Project Advisory Panel. This process is illustrated in **Figure 2**.

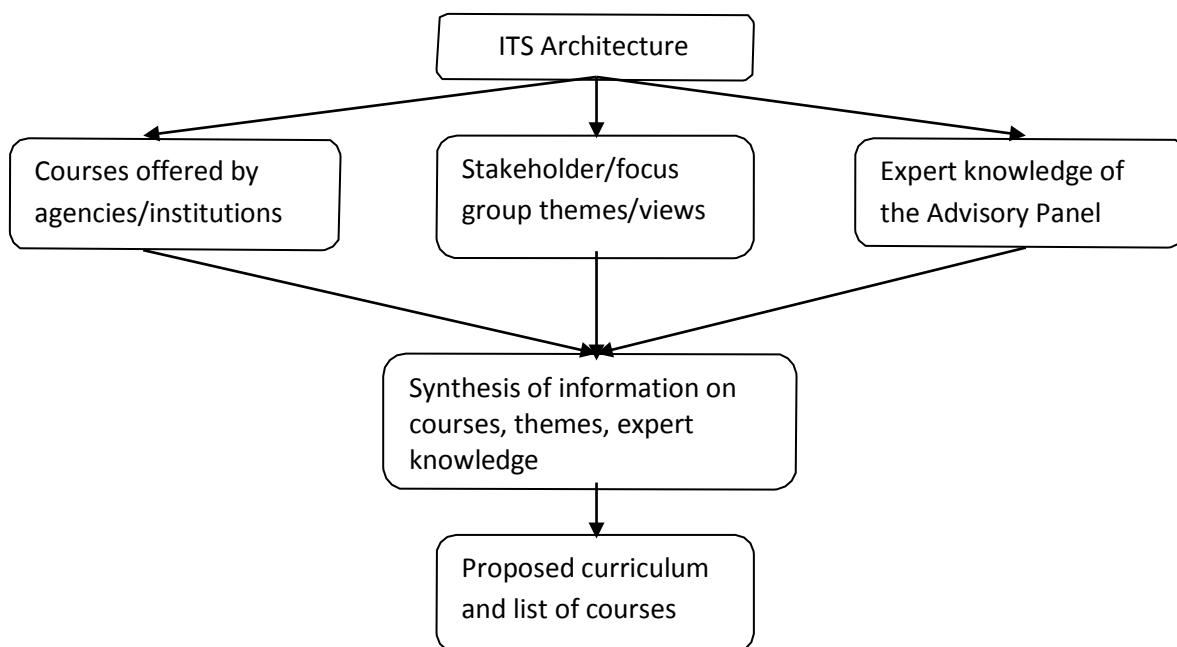
The synthesis process begins with the ITS architecture as a guide to the scope of the ITS domain. ITS Canada already has a program underway to organize workshops with appropriate course modules to deliver the content of the ITS architecture. It is not the intent of this project to duplicate the workshop courses for the ITS architecture. The intent here is to develop an ITS training curriculum

and associated courses that will produce professionals who are able to think creatively in a rapidly progressing field in order to identify, adapt and adopt the best technical solutions for the economic, social, and environmental conditions they encounter. This requires a depth and breadth of learning that goes beyond the static environment of the traditional classroom.

d. Prioritize the Modules

This task involved establishing the criteria for prioritizing the course modules and then assigning weights to each course based on their estimated contribution to each criterion. The total score gives the rank ordering.

Figure 2 – Synthesis of Information for the Proposed Curriculum



3. Inventory Results

Catalogue of ITS Courses and Research

The Catalogue of ITS Training Courses and Other Educational Material is presented in Appendix B. The catalogue contains three sections: (i) ITS courses corresponding to the contents of the ITS architecture, (ii) organizations and universities providing certificate programs, and (iii) universities and organizations conducting research on ITS and offering educational opportunities.

Observations

- > There already exist many ITS courses corresponding to the contents of the ITS architecture.
- > The U.S. Department of Transportation (USDOT) in the Research and Innovative Technology Administration (RITA) has an extensive program related to ITS professional capacity development that can provide much useful guidance for a similar program and activities in Canada.
- > The Consortium on ITS Education (CITE) has been active in ITS training for over a decade and it has a comprehensive set of offerings that can be used to contribute to guiding the Canadian initiative.
- > There are examples of certificate granting programs in a number of organizations and universities that could serve as models for similar initiatives in Canada.
- > Many Canadian universities are now offering ITS-related courses and transportation-related courses but there is no overall coordination of these offerings.
- > Many more U.S. universities are now offering ITS-related courses and transportation-related courses with significant oversight and funding from the U.S. Department of Transportation.
- > Some ITS research and educational activities are conducted in non-academic environments such as ITS conferences and government funded projects (e.g. ATLANTIC Network) that produce valuable training resources.
- > Note that the fees charged for certain ITS courses are included in the catalogue where they were posted.

Focus Group Outcomes: Themes, Ideas and Suggestions

Calgary

The Calgary focus group was convened on Friday September 30, 2011 at the premises of the Department of Civil Engineering, University of Calgary.. The focus group discussion at Calgary is summarized in **Table 1**.

Toronto

The Toronto focus group was convened on Tuesday October 4, 2011 at the ITS Centre at the Department of Civil Engineering, University of Toronto. The focus group discussion at Toronto is summarized in **Table 2**.

Montreal

The Montreal focus group was convened on Wednesday October 5, 2011 at the premises of the CIRRELT (Centre interuniversitaire de recherche sur les réseaux d'entreprise, la logistique et le transport or, in English, the Inter-university Research Centre on Enterprise Networks, Logistics and Transportation) at the Université de Montréal. The focus group discussion at Montreal is summarized in **Table 3**.

Table 1 – Focus Group Discussion Summary: Themes, Ideas and Suggestions

Calgary

Targeting Audiences

- 1) Two interpretations of the matrix of stakeholders emerged:
 - Training needs to implement/operate a new service/product (i.e. training) - example Road Weather Information Systems (RWIS) installation
 - How to design and implement the service/product (i.e. education) - example RWIS to educate decision makers and the public to accept and use the new service
- 2) Push often comes from provincial (province-wide) needs: to educate the public and decision makers
- 3) High level management
- 4) General public is driver of useful ITS change; needs to be part of the educating process

Training Content

- 1) Urgent request for training in business case development for new ITS projects
- 2) Emerging issue special sessions – examples congestion pricing, parking charges, gas tax: role of ITS for data collection
- 3) Traveler Information, Transit Information, **Safety**, Emerging Fields (connected vehicles, smart devices, traffic forecasting/prediction),
- 4) Benefit cost analysis, human factors, technical content, risk management; then later political aspects, finances, user acceptance, communication skills, etc.
- 5) Knowledge is needed from both pure IT people combined with knowledge from transit operators
- 6) Courses should be offered or focused on different levels of understanding
- 7) Management side (business side) can be combined with technical side (operations)
- 8) Need a high level business course: public engagement, performance indicators
- 9) Want to see continuous refreshment of material

Training Resources

- 1) See great value in person-to-person sharing of best practices
 - Example of meeting of professionals from all municipalities in Alberta once per year
- 2) Understanding the public and customers: market research

Collaborations, Integrations and Process

- 1) ITS training as an integrated approach in the whole country
- 2) Need to understand system knowledge: technology, resources (internal vs. external), staffing requirement
- 3) ITS World Congress: how to work together
- 4) General umbrella vs. specific subjects: e.g. evacuation of cities
- 5) Iterative approach between decision makers and technologies
- 6) Complex system: economics, government policy, legal aspects, **safety**, environmental, industry standard, security, reduce costs, etc.

Miscellaneous - Standardization

- 1) Standards should be flexible
- 2) Rigidity (safety) vs. flexibility (technology choice)
- 3) Even traditional safety standards should be challenged if ITS has a better way
- 4) ITS moves so fast: is it of value to try to standardize? Example Google maps, IBM data services
- 5) The role of the ITS community to ensure standards - example data warehousing

**Table 2 – Focus Group Discussion Summary: Themes, Ideas and Suggestions
Toronto**

Targeting Audiences

- 1) Interest expressed in mission-driven training: e.g. MTO is getting into connected vehicles. How can training serve this mission and how to monitor progress of the mission?
- 2) New breed of people with core competencies across the board has been identified as a possible long-term goal. A bold step is a new engineering bachelor in ITS covering all aspects of transportation- relevant technologies. Some European universities are already doing this. It may be of interest to ITS Canada to partner with selected universities to promote the concept and lead the effort.

Training Content

- 1) Request for training in business case development
- 2) Request for continuous refreshment of the training material to avoid “aging” of contents
- 3) Request for Connected Vehicles training
- 4) Identification of importance of training in ICT (information and communication technologies) and software engineering
- 5) ITS training is meant to improve someone's core skill set. ITS is multi-disciplinary in nature. Skill set includes the core skill set. The other skill set is how to talk to other experts (a civil engineer interfacing with a software engineer). Cross fertilization of background is therefore desired. Also, economics, financial aspects, business aspects complement the skill set. The end result is to improve the core skill set but also to learn enough to be well informed in other disciplines.
- 6) Courses should cut across theory, practice, management, and standards
- 7) Training programs should give young engineers the broad fundamentals of ITS
- 8) Discussion identified the potential for a layered training system. Near the base is university education, going near the top the focus shifts to short, quick professional training courses:
 - a. base: core science courses (fundamentals)
 - b. higher layer: bridging courses (cross fertilization courses)
 - c. higher: soft and grey material (procurement, privacy, environmental assessment etc)
 - d. very top: ITS awareness to attract newcomers, executive training for higher up executives (what they cannot afford not knowing).
- 9) Discussion identified the need for training in ITS policy, legal liability, privacy, impact of technology on social life, environmental issues etc.
- 10) Opinion was expressed to focus on short courses on topics that cannot be found elsewhere (niche areas): e.g. emergency evacuation planning and optimization and the role of ITS, connected vehicles, road pricing, integrated ITS and sharing of data, systems, resources and institutional expertise, green ITS, professional leadership, etc.
- 11) Discussion identified the value of one-on-one social interaction over traditional course delivery

Training Resources

- 1) Request for peer-to-peer interaction to share best practices
- 2) Request for using social networking, webinars and posting of video-based courses online

Collaborations, Integrations and Process

- 1) Discussion identified the importance of innovative training approaches and new media: e.g. social media (the you tube age). How to get people to voluntarily contribute to social media repositories, Webinars and content sharing.

Miscellaneous

- 1) Questions were raised on how ITS Canada can certify a curriculum. Should attendance be required to pass a test to receive credit hours for instance? Would several courses lead to a certificate?

**Table 3 – Focus Group Discussion Summary: Themes, Ideas and Suggestions
Montreal**

Targeting Audiences

- 1) Share perspectives from different fields and user needs together
- 2) Take into account all transportation modes, systems and services together
- 3) Take a multi-modal and multi-service and multi-disciplinary perspective
- 4) Training for people with different technical proficiency and different needs
- 5) Consider training at university level, college and continuing education for professionals
- 6) Make presentations to decision makers
- 7) Offer a la carte courses

Targeting Audiences – raising awareness

- 1) Promoting ITS Adoption by raising awareness, encouraging ITS adoption is role for education
- 2) Develop and promote good business case for ITS
- 3) Keynote speakers at ITS Canada conferences

Training Content

- 1) Real need of students is to have real world examples
- 2) Importance of data, interoperable data and systems
- 3) Basic ITS 101
- 4) Organization management with ITS
- 5) System engineering: breaking silos, synchronization across systems and operations
- 6) Focus on Transit: lagging behind private modes
- 7) Priority of telecommunication

Training Resources

- 1) Training students also requires training teachers
- 2) Budget must be available for course development

Collaborations, Integrations and Process

- 1) Can web-based ITS transportation courses (specifically by CITE) be used? (there are IP issues)
- 2) Traveling sessions are useful (example ITS architecture)

Miscellaneous

- 1) Certification
- 2) Role of regulation
- 3) French language
- 4) Difference between US and Canada (in terms of potential audience), and different priority in module development

Expert Knowledge: Emerging Trends and Technologies

Why Expert Knowledge is Important

The development of a new and useful ITS training curriculum requires a broad understanding of the past, present and future of the ITS training industry as it exists at the moment. The catalogue of current ITS training courses gives us a perspective on the accumulated knowledge and expertise that has established and nourished the ITS training field up to the present. The focus group discussions have helped to identify the weaknesses and strengths of the current state of the art and practice of ITS training activities. What is also needed is a perspective on the future and the most useful directions in which to channel the new ITS training curriculum. This understanding of the future comes from expert knowledge based on in-depth research, development and study related to the field of ITS and ITS training. The discussion in this section is intended to illustrate with three case examples related to ATIS, connected vehicles and large scale network enabled platforms, that the Project Team has that understanding of future needs and opportunities.

Multimodal ATIS

Some of the key transportation challenges that Canadians face are congestion, long average commute times, high variability in travel times, adverse environmental impacts and rising levels of pollution, rising fuel prices, rising safety concerns, and adverse weather conditions.

One class of solutions to the above problems is to keep users 'informed' via the provision of Advanced Traveller Information Systems (ATIS). Advances in information technology and vehicle technologies help tremendously in this regard. ITS in general capitalizes on emerging Information and Communication Technologies (ICT) to better manage the increasingly congested and dynamic multimodal transportation networks of today. ITS involves the application of ICT and other advanced methods and techniques to improve the performance of transportation systems and to increase the contribution of these systems to our economic and social wellbeing.

The "heart" of ITS undoubtedly lies in gathering, using, and disseminating transportation system information (a subset of which is Traveller Information Services or "TIS") in real time in order to improve the performance and reliability of the transportation system, reduce congestion, as well as other unwanted system "externalities" such as accidents and pollution, and to improve the "user travel experience".

The Ministry of Transportation Ontario (MTO) for instance is in the process of initiating a major Traveller Information Services (TIS) program to give travellers choices between public transportation services, active transportation such as cycling and walking and driving, and to encourage more sustainable, healthier and more environmentally friendly travel and mode choice behaviour. The MTO's TIS initiative, and similar initiatives across Canada such as the Vancouver iMove system, aim to help travellers understand the travel options available to them and the current as well as expected performance conditions of those options for planning and undertaking their trips in the most efficient, healthy and environmentally friendly manner. The TIS will provide users (individuals and businesses) with accurate and timely information when and how they need it. TIS services may include information of transit services, ride sharing, active transportation, parking management, traffic conditions, road and weather conditions and pricing information where applicable.

The envisioned TIS system and framework is to be highly integrated (see following section about network enabled platforms), multimodal, multi-agency, multi-jurisdictional, single point of access by a variety of user groups, through a variety of channels, to information on transportation options and conditions.

Connected Vehicles and Aspiring toward the “Connected Traveler”

The ITS Canada training program must recognize and respond to the rapidly growing role of **connected vehicles**. Cars and transit vehicles are increasingly outgrowing their traditional role of being motorized cabins for transportation from A to B. We use the term “vehicles” because connectivity will not be limited to the private automobile only but will rather encompass all moving vehicles, including public transit buses, light rail and rail vehicles as well as commercial trucks. Vehicles are turning into social and technical hubs that connect themselves to other machines (other vehicles and components of the infrastructure) and connect their driver/passengers to his/her social and business world, in a productive but safe manner.

Ninety percent of cars today (2011) have Bluetooth, which is just the dawn of vehicular connectivity. Vehicles will be more and more connected via mobile devices, embedded telematics, dedicated communication channels and broadcast services. Connections can enhance emergency services, security features, traffic, weather and navigation information and services, Internet search and entertainment and of course business productivity. Equally importantly, connectivity can be capitalized upon to draw ridership to **public transit** where travel time can become **travel-time-well-spent** if put to good use.

Experts envision the vehicle as a mobile device that must safely connect drivers and passengers to the world around them, while being particularly cognizant and aware of the **context** in which the traveler exists. It is not just connected vehicles to which we aspire, but rather “connected travelers”. In such a rapidly changing world, Traveler Information becomes an essential service that must seamlessly stream into the vehicle (car, bus, train, truck and even planes), into mobile devices and ultimately into our daily activity chains and activity scheduling.

Large Scale Network Enabled Platforms for ITS

Network enabled platforms are internet based enterprise systems (middleware) that integrate massive amounts of data, software applications, communication resources and computing resources into a single point of access via a simple browser. Pervasive applications refer to, in the ITS context, applications that reach consumers at the individual level on their mobile smart phones and tablets while providing context aware information and services.

These are still emerging trends active in the research domains. For instance, several universities across Canada created the ONE-ITS (Online Network-Enabled ITS) platform (website at www.one-its.net) and its not-for-profit governing society to encourage integration of fragmented ITS efforts and create an environment for collaborative innovation in ITS. Also, the Ontario Research Fund (ORF) just awarded a large-scale project (2011) to the University of Toronto and York university to conduct the necessary research in matters related to pervasive applications in ITS, connected vehicles and smart infrastructure.

4. Proposed Organization of Required Subject Matter

The inventory of the required subject matter is described in Section 3 and the methodology for organizing the required subject matter is described in Section 2. In this Section 4, the information from the catalogue of existing courses, the outcomes of the focus group sessions and the Project Team's expert knowledge is brought together to propose an ITS training curriculum and associated ITS courses.

a. Key Themes

The Project Team proposed the following key themes to guide the structure and elaboration of the ITS training curriculum based on the insights from the literature results, the focus group inputs, and their personal knowledge of the education and training process. In **Table 4**, the themes from the focus group sessions are mapped against each of these key themes to illustrate how the inventory results influenced the organization of the required subject matter into the proposed ITS training curriculum.

Course Content Related

- > Focus on professional development
- > Comprehensive subject matter, from fundamentals to very practical on-the-job issues
- > Tuned to progressive, whole-life learning, with potential credits and certifications to encourage up take
- > Addressed to all stakeholder groups and supporting players (decision makers and general public)
- > Grounded in firm links to research and development
- > Continuous refreshment of materials
- > Content scope includes architecture, technology, business, economic and social factors
- > Addresses issues of safety, sustainability, user needs, efficiency, risk, regulations, databases, standards, strategic plans
- > Provide access to specialist knowledge (e.g. privacy laws and regulations)

Course Delivery Related

- > Easily accessible to students and working professionals
- > Provide access to practitioners' knowledge and best practices
- > Foster peer-to-peer interaction
- > Make use of the latest tools and new media (web tools, webinars, socio-technical networking) to make the learning process available ubiquitously

**Table 4 - Key Themes for ITS Training Curriculum from Focus Groups
With Example Comments**

Key Themes	Calgary	Toronto	Montreal
Professional Development	√	√	√
Comprehensive Subject Matter	√	√ Core competence /Cross-fertilize/ Pyramid Model	√ Role for AQTR/ University/CEGEP /English & French /Synchronize /Council of Ministers
Progressive, Whole-life Learning, Certification	√	√ National ITS Inst/ Academy/Certify	√ CITE/AQTR /Certification
All Stakeholder Groups – Professionals (Road)	√	√	√
(Transit)	√	√	√
(Freight)	√	√	√
Decision Makers	√		√ Conference Presentations/ Champions or Ambassadors
General Public	√	√	√
Firm Link to R&D	√ Ex IBM-ATIS	√ Specialized Universities/ONE- ITS Network	
Continuous Refreshment of Materials	√ Ex Google Maps	√ Global Knowledge	√ Constant
Content Scope: Architecture, Technology, Business, Economics, Social Factors	√ ATIS/Maps/ Connected Veh/ DSRC/Business Case/Commun Skills/Telecom/ Tactical Planning	√ Theory/Practice /Management /Business Case /Fundamentals (Traffic-Transit- Freight Systems, GPS, GIS, Optim) /Connected Veh /ICT/communic /S-W/Architecture /System Design /Procurement/ B-C/Performance	√ Architecture/ Integration/ Interoperability/ Telecommunication/B- C/Business Case/Strategic Plans/Organization Management for ITS/ System Engineering
Address Issues of Safety, Sustainability, User Needs, Efficiency, Risk, Regulations, Data-bases, Standards, Databases, Strategic Plans	√ Safety/Security/ Environment/ Ind Standards/Risk	√ Mission Driven /Environment Assessment	√ Databases/ Strategic Plans

Provide Access to Specialist Knowledge (legal)	√ Privacy/Legal	√ Insurance/Road Pricing/Privacy /Legal Liability	
Accessible to Students & Working Professionals	√	√	√ Travelling Course Sessions
Provide Access to Practitioners & Best Practices	√	√	√
Foster Peer-to-Peer Interaction	√ Workshops/ World Congress	√ Talks by Vendors, Manufacturers	√
Make Use of Latest Tools and New Media to Deliver Courses	√	√ Social Media/ Webinars/u-tube	√

Notes: Tag identifies theme in Breakout Group Summaries – Details in Appendix C.3 and Section 4

√ denotes theme was mentioned in Focus Group Session (details in Appendix C.3)

b. Proposed Framework for a Comprehensive ITS Training Curriculum

The project team proposed a framework to organize the required subject matter into a comprehensive ITS training curriculum that encompasses the full spectrum of training needs for professional development. The framework is shown in **Annex A**.

This framework shows a continuum on the left hand side from ITS fundamentals near the bottom (with a heavier role for universities) to applied learning going towards the top (with a heavier role for ITS Canada),. It also shows a series of five layers on the right hand side that elaborates on the continuum in terms of progressive steps in the acquisition of professional knowledge. The layers, starting at the bottom (beginning of the learning process), are briefly described as follows.

>> Fundamentals and Theory – This layer includes core sciences (to understand transportation and technology fundamentals) and mathematics (algorithms, equations to model intelligence). It is best taught in a controlled environment such as universities and colleges where the results of recent research are easily available and constantly assimilated. Short courses of the same nature can be offered by ITS Canada, to be taught as short (several day) courses, perhaps offered at universities in a classroom environment.

>> Bridging Courses and Cross-Fertilization – For example, introduction to ICT for Civil Engineers, introduction to traffic fundamentals for ICT-oriented ITS professionals. These may be taught in universities to students or as short courses to working professionals.

>> Core ITS Professional Courses – This layer includes two tracks:

- (i) courses related to the ITS architecture (focus on technology and service bundles) and
- (ii) courses or workshops related to business case development of importance to professionals who must package and sell their ITS projects to decision makers, peers in parallel work functions and users

ITS architecture can be taught in classroom format, workshops and online while business case development is best taught in a short course with a workshop portion with opportunities for interaction with peers and mentors.

>> Context and Specialties – This layer includes issues such as procurement policies and practices, privacy, and access for the disabled (equity) which needs more specialized knowledge agents for authentic delivery. Best method of delivery is to offer very short courses during conferences and special events where a critical mass of students and professionals can be included.

>> Awareness and Promotion – There is a constant need to introduce ITS to novices (newcomers to the profession and senior management who are often drawn from outside the ITS domain) and to introduce new developments to the ITS community (e.g. connected vehicles). These activities are well suited to be carried out by ITS Canada whose capabilities and community outreach are well suited to the task. Introductory videos can be produced, displayed during events, and sold to parties wishing to retain copies.

c. Course Outlines for Logical Modules

The titles of the proposed courses are listed in **Table 5** and the proposed tables of contents for each course are presented below. The proposed courses are representative of the subject matter at each layer of the framework as it not inclusive of all possible courses. The framework is flexible and new courses can be added (or old ones deleted) depending on demand and market conditions. Note also that the proposed contents are ‘current best estimates’ and will likely be augmented or altered based on the instructor’s depth of knowledge of the subject matter who is assigned to develop individual courses.

Table 5 – Proposed ITS Courses

<i>Fundamentals and Theory</i>
Fundamentals of Advanced Traffic Management Systems
Fundamentals of Transit Systems Planning, Operations and Role of ITS
Fundamentals of Goods Movement, Freight, Logistics and Role of ITS
Fundamentals of ICT and Network Computing
<i>Bridging Courses and Cross Fertilization</i>
ITS, ICT and Network Programming for Non-ICT Professionals
Basics of Transportation Engineering: ITS for Non-transportation Engineers
ITS for Safer Transportation
ITS for Intermodal Transport
ITS for Emergency and Disaster Management
<i>Core ITS Professional Courses</i>
ITS Architecture Training
ITS for Advanced Traveller Information Services
ITS for Goods Movement, Freight, and Logistics
ITS Connected Vehicle-Infrastructure Systems and Services
How to Justify Your Investment in ITS : The Business Case
ITS Costs, Benefits, Evaluation and Performance Measures
ITS Deployment: Strategic Planning and Implementation
<i>Context and Specialties</i>
ITS, Sustainable Cities and the Environment
ITS and Privacy Concerns
Road Pricing: Economic, Social, Engineering and Technology Interplay
<i>Awareness and Promotion</i>
Introduction to ITS
ITS for Transportation Executives, Decision & Policy Makers

Fundamental Courses (3-Day Courses, video recorded)

Fundamentals of Advanced Traffic Management and Traveller Information Systems

- Introduction to ITS
- Traffic Flow Modeling for ITS
- Transportation Networks Modeling I: Static
- Traffic Control and Optimization: Theoretical Primer
- Transportation Networks Modeling II: Dynamic
- Origin-Destination Flow Estimation
- ITS-Capable Traffic Simulation
- Automated Incident Detection (AID)
- Traffic Control and Optimization: Freeways
- Traffic Control and Optimization: Surface Streets
- Introduction to Artificial Intelligence and Applications to ITS
- Traffic Data Collection and Dissemination as Traveller Information
- ITS Tools of the Trade (Detectors, Variable Message Signs, 511, Nomadic Devices, etc.)
- Integrated Traffic Management and Traveller Information

Fundamentals of Transit Systems Planning, Operations and Role of ITS

- History on the Role Of Urban Transit
- Transit Operations and Service Scheduling
- Transit Performance and Capacity Analysis
- Transit Lines and Networks
- Planning of Rail Transit Stations Locations
- Transit System Planning
- Transit Modes: Comparative Characteristics and Selection
- Traveler Information Systems for Transit

Fundamentals of Goods Movement, Freight, Logistics and Role of ITS

- Introduction: Significance of Freight Transportation, Industry Structure, Key Issues and Trends
- Supply of Freight Services: Short Path, Travelling Salesman, Vehicle Routing Problems, Transportation, Transshipment, Assignment Problems
- Basics of Logistics and Supply Chain: Strategic Network Design, Inventory and Transportation, Relation between Shippers and Service Providers
- Demand Models: International Freight Transport, Intercity Freight Transport, Urban Freight Transport
- Shipper Behaviour: Carrier Selection, Role of Third Party Logistics, Information Technology Adoption
- Role of Advanced Technologies: Freight and Fleet Management, International Border Crossings, Intermodal Operations, Advanced Logistics
- Implications of E-Commerce
- Data Sources and Needs

Fundamentals of ICT and Network Computing

- Networked Systems Fundamentals
- Network Architectures, Client-Server, Multi-Tier
- Layered Systems, Middleware, Service Orientation
- Networking Protocols
- TCP/IP
- Network Operating Systems
- Wired/Wireless LAN/WAN and Remote Access
- Client Server Programming, Web Programming
- Network Security and Troubleshooting
- Internet Connectivity

Bridging Courses and Cross Fertilization (1-Day Courses, video recorded):

ITS, ICT and Network Programming for Non-ICT Professionals

- Basic Concepts of Information and Communication Technology
- Information and Communication Technology and Development
- ICT and Economic Growth
- Introduction to Computers
- Computer Communication Networks
- The Internet
- Global System for Mobile Communications
- Database Management System (DBMS)
- Operating Systems
- Information and Communication Technology and Society
- ITS Field Applications

Basics of Transportation Engineering: ITS for Non-transportation Engineers

- Road Vehicle Performance, Human Factors
- Highway Design Principles
- Traffic Stream Flow Models
- Traffic Analysis: Flow, Speed & Density and Queuing Principals
- Introduction to Traffic Control: Signalized vs. Non-Signalized, Signal Timing, HCM
- Introduction to System Control
- Signalized Intersection & Arterial Operations
- Freeway Operations
- Role of ITS in Traffic Management, Transit Management and Freight Management

ITS for Safer Transportation

- Introduction and overview of Transportation Planning, Design and Operations
- Fundamental Safety Consideration in the Design and Layout of: Roadway Segments, Intersections and Interchanges
- Highway Safety Challenges
- Potential of ITS to Improve Safety
- Understanding Human Factors
- Understanding Human Skills and Capabilities and Reaction to Transportation Systems
- Safety Principles of Human Factors: Hazard Elimination, Proper Design, Barriers, Warning, Information
- Why Do Driving Errors Occur? Driver vs Information, Decision/Understanding, Action
- ICT Role in Improving Information Perception
- Connected Vehicles and Smart Transportation Systems

ITS for Intermodal Transport

- The Need for a Seamless Intermodal Transportation System
- Barriers To Intermodal Integration: Institutional, System Integration, Funding, and Low Market Demand
- Policy Measures
- Improving Transit and Intermodal Services
- Deployment of Intelligent Transportation
- Systems in Public Transit
- Cases Studies and Lessons Learned

ITS for Emergency and Disaster Management

- Basic Concepts and Introduction to Emergency Evacuation: Definitions and Dimensions, Stakeholders, Modes, Behaviour
- Recent Emergency Evacuations and Lessons Learnt
- Spatial and Temporal Constraints in Emergency Evacuation
- Estimation of Evacuation Demand
- Strategies for Vehicular Emergency Evacuation: Contraflow, Staging, Traffic Routing, Traffic Control, Flexible Destination
- Strategies for Transit Emergency Evacuation: Optimal Location of Passenger Pickup and Drop off, Bus Shuttling and Routing, Flexible Routes
- Role of ITS and ICT in Emergency Evacuation
- Channels of Communication in Emergency Evacuation
- User Equity and Compliance Issues
- Advanced Optimization of Transportation Networks for Emergency Evacuation
- Network Vulnerability and Reserve Capacity
- Autonomic Network Control Concept: Self-healing Transportation Networks

Core ITS Professional Courses (1-Day Courses, video recorded):

(highlighted courses are now complete and ready to deliver)

ITS Architecture Training

- Canadian ITS Architecture Training Workshop
Course outlined as part of ITS Canada fall 2011 workshop series

ITS for Advanced Traveller Information Services

- Defining User Needs – Market Research
- Technologies for Data Collection
- Data Fusion and Quality Control
- Technologies for Information Dissemination (wireless, maps, Google, etc.)
- Advanced Value-added Services (travel time prediction, etc.)
- Business Case Analysis and Development
- Driver Distraction and Overload Issues
- Legal and Privacy Issues

ITS for Goods Movement, Freight, and Logistics

- Introduction to Communication Technology in Freight Industry
 - Dedicated Short Range Communications
 - Wide Area Wireless Communication
 - Vehicle-Vehicle Communication
- ITS Applications for Freight Industry
 - Commercial Vehicle Electronic Clearance
 - On board Safety Monitoring
 - Hazard Material Incident Response
- Potential Benefits of ITS for Goods Movements
 - Reduction in Overweight Loads
 - Decrease Operating Cost
 - Avoid Accidents and Crash Rates
 - Travel Delay Savings
- Advanced Intelligent Freight Technologies:
 - Asset Tracking
 - On-Board Status Monitoring
 - Gateway Facilitation
 - Network Status Information
- Barriers to Adoption of Intelligent Freight Technology
 - Standards
 - Operational Impacts and Costs
 - Exposure to Government Actions
 - Proprietary Information
 - Resistance to Change

ITS Connected Vehicle-Infrastructure Systems and Services

- Overview of Connected Vehicle Systems and Services
- Current and Projected State of the Art of Technology for Connected Vehicles
- Intelligent Systems for Vehicles: collision avoidance, lateral and longitudinal warning, electronic braking
- Telematics, Navigation, Finding Services (example electric vehicle recharge station)
- Safety Systems: crash detection, emergency support, advanced driving concepts, cooperative driving, intersection collision avoidance, adaptive speed control

How to Justify Your Investment in ITS : The Business Case

- Identify and Quantify Elusive Business Benefits
- Build Step-by-Step Action Plan: Identify business goals, Assess project risk, Determine value-based success metrics, Communicate IT's value to management
- Quantify Risk Factors and Develop Contingency Plans
- Communicate Business Value Impact, Impact on Society, Impact on Environment
- Impact on Mobility

ITS Costs, Benefits, Evaluation and Performance Measures

- Identification of Performance Measures and Criteria
- Create and Develop Performance Measures Matrices
- Comparative Performance Measures
- Cost Benefit Analysis
- Current State of Practice Measures
- Case Studies

ITS Deployment: Strategic Planning and Implementation

- Strategic Planning for ITS
- Why Strategic Planning is Essential
- Issues and Challenges Associated with Strategic Planning
- Strategic Planning Steps and Development
- Implementation Considerations
- Lessons Learnt from ITS Deployments

Context and Specialties (Half-Day Courses, video recorded):

ITS, Sustainable Cities and the Environment

- Climate Change and Sustainability Challenges
- Transportation Role in Shaping Sustainable Cities
- ITS and GHG Emissions
- Successful Cases: Curitiba, The Green Capital

ITS and Privacy Concerns

- Challenges of ITS for the Law of Privacy
- Constitutional Privacy Protections
- Evolving Surveillance Technologies in Defining Privacy Rights
- Privacy-Aware ITS Platform

Road Pricing: Economic, Social, Engineering and Technology Interplay

- What is Congestion Pricing?
- Why Now?
- Microeconomic Foundations of Congestion Pricing
- Static vs. Dynamic Pricing
- Profit-Maximizing vs. Social-Welfare Maximizing Pricing
- Lessons Learnt From Mega Cities

Introduction to ITS (2-hour Courses, video recorded, + 15–30 minute videos)

- What is ITS?: Introduction to the Goals of ITS
- Why ITS?: Enhancing Safety, Reducing Congestion, Improving Mobility
- How to ITS?
- Potential Benefits of ITS
- Stakeholders and Partnerships
- ITS Case Studies

ITS for Transportation Executives, Decision and Policy Makers (Half-Day Course, video recorded)

- Introduction to ITS
- ITS Benefits and Potential
- ITS Costs and Barriers
- ITS Impacts on Environment and Society
- ITS Showcases

5. **Proposed Priorities for Module Development**

a. Criteria for Setting Priorities

A simple model is proposed to set relative priorities among the proposed course modules. Using the following three criteria, a value of 'one' or 'zero' is assigned to each course for each criterion based on whether or not the course satisfies the criterion. The sum of the three scores then assigns each course to one of four categories with a score of 0, 1, 2 or 3. The results are presented in **Table 6**. Courses with the score of 3 have the highest priority and those that have the same score have the same relative priority. As there are many other factors to consider in making a decision to develop a course, this result provides some degree of latitude in choosing the actual order for course development.

i. **Need as Identified by the Focus Groups**

Focus group participants identified unique needs that are currently not addressed or are difficult to access in the present state of ITS training. These needs deserve urgent and priority attention.

ii. **Emerging Trends and Technologies**

Training courses must also consider emerging ITS trends, technologies and user needs. In particular, we draw ITS Canada's attention to three areas: (1) Multi-modal ATIS, (2) Connected Vehicles, and (3) Integrative Platforms for pervasive applications.

iii. **Anticipated Unique Role of ITS Canada**

There are many organizations working in the space of ITS Training and Education, ranging from research-intensive large universities, to smaller universities and colleges, to for-profit organizations and consortiums. For ITS Canada to penetrate this market successfully, it needs to seek opportunities that make it unique. For instance, starting with "cross fertilization" courses, and business matters and executive orientation courses in the Canadian context provides this edge, relative to other organizations in this space. Also, the unique nature of the ITS Canada membership and market opportunity in Canada is a consideration.

ITS Canada is relatively new to the ITS training and education business. Therefore, it needs to start gradually, carve a niche and do it well to build a name as a credible player in the ITS training and education domain. Also, in the longer term, it is advisable that ITS Canada provide certification of some sort to give credit to trainees for taking courses. Credibility in this case is paramount for the certificates to carry weight.

Demand for ITS Canada training courses will depend not only on need but also on the time constraints of the target audience. Lighter, shorter and less expensive courses are likely to draw a wider audience. Therefore, it might be beneficial for ITS Canada to start with half-day and one-day courses first.

b. Recommended Modules for Early Development

Based on the list of courses, the criteria for setting priorities and the assigned scores, it is recommended that ITS Canada consider the courses with a score of 3 in **Table 6** for earliest development.

Table 6 – Priority Ranking for ITS Courses

<u>Fundamentals and Theory</u>	<u>Score</u>
Fundamentals of Advanced Traffic Management Systems	1
Fundamentals of Transit Systems Planning, Operations and Role of ITS	1
Fundamentals of Goods Movement, Freight, Logistics and Role of ITS	1
Fundamentals of ICT and Network Computing	1
<u>Bridging Courses and Cross Fertilization</u>	
ITS, ICT and Network Programming for Non-ICT Professionals	2
Basics of Transportation Engineering: ITS for Non-transportation Engineers	2
ITS for Safer Transportation	Hi-priority 3
ITS for Intermodal Transport	2
ITS for Emergency and Disaster Management	Hi-priority 3
<u>Core ITS Professional Courses</u>	
ITS Architecture Training	Hi-priority 3
ITS for Advanced Traveller Information Services	Hi-priority 3
ITS for Goods Movement, Freight, and Logistics	2
ITS Connected Vehicle-Infrastructure Systems and Services	Hi-priority 3
How to Justify Your Investment in ITS : The Business Case	Hi-priority 3
ITS Costs, Benefits, Evaluation and Performance Measures	2
ITS Deployment: Strategic Planning and Implementation	2
<u>Context and Specialties</u>	
ITS, Sustainable Cities and the Environment	1
ITS and Privacy Concerns	2
Road Pricing: Economic, Social, Engineering and Technology Interplay	2
Introduction to ITS	Hi-priority 3
ITS for Executives, Decision- and Policy-Makers	Hi-priority 3

c. ITS Canada Role

ITS Canada sees its role as procuring and funding the preparation and delivery of the modules, providing back office management, and potentially partnering with other organizations to reduce cost, maximize benefits and identify clients for courses.

d. Potential partners to deliver courses in conjunction with ITS Canada include:

- TAC – Transportation Association of Canada
- CUTA – Canadian Urban Transit Association
- AQTR – Association québécoise du transport et des routes
- CIRRELT – Centre interuniversitaire de recherche sur les réseaux d'entreprise, la logistique et le transport
- CITE – Canadian Institute of Traffic Engineers
- IMSA – International Municipal Signal Association
- OTC – Ontario Traffic Conference (and other provincial equivalents)
- IBEC – International Benefit Evaluation and Cost Working Group
- ITS America
- ITS United Kingdom
- Other National ITS Societies.

e. Course Delivery Options by Course Module

The options for delivery of course modules must be adapted to the circumstances of the students and the delivery capabilities. Possible options are noted in presenting the proposed courses in Section 5. This is a large topic and solutions are specific to the course being offered. The options that will be considered are:

- *Traditional Classroom*
- *Online Webinars*
- *Individual Study Online*
- *Workshops/Seminars*
- *Recorded Video and Other Means*

Annex A

