TRANSMIT: Travel-Time System for Border Crossings in Ontario's Niagara Region

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ABSTRACT

In recent years, increased border security measures and increased volumes of people and goods moving between Canada and the United States have lengthened border wait times. The Niagara Region of Ontario is host to a number of border crossings within a relatively small geographic area. This provides an opportunity to balance demand among the crossings if transportation agencies and travellers have adequate performance measures to make informed decisions.

The Niagara International Transportation Technology Coalition, of which the Ministry of Transportation of Ontario is a member, has implemented the TRANSMIT system on the United States approaches to the Niagara border crossings. TRANSMIT is a traffic management system developed by TRANSCOM, that uses vehicles equipped with E-ZPass electronic toll collection tags to generate travel time information. E-ZPass is the electronic tolling system used on the New York State Thruway and on the Peace Bridge.

The Ministry of Transportation is now working with NITTEC to expand this system to Ontario's Niagara Region. Travel time information from the system will be provided to the public through the Internet. Information from the system will also be provided to border agencies, including MTO, to assist in border area traffic management and travel time messaging on variable message signs. By providing motorists with advanced warning of border conditions, traffic can be effectively managed prior to the border approaches and travellers can make the best choice for their needs, ultimately improving safety, increasing service and reducing delays.

TRANSMIT: TRAVEL-TIME SYSTEM FOR BORDER CROSSINGS IN ONTARIO'S NIAGARA REGION

The Niagara Region is a bustling community, boasting major tourist attractions, industry, and a key national gateway between Canada and the United States. Not only is a large volume of traffic generated locally – with many day trips locally and back and forth across the border for shopping, working, and visiting – but people and goods come to or pass through the area from all corners of North America. Approximately 10 million trips are made over these crossings annually (1).

Managing this traffic and trying to ensure the optimum use of all road and bridge capacity, is a challenge requiring a detailed knowledge of current conditions. A challenge made more difficult given the number of kilometres of roadway within the area. One of the solutions chosen by the NITTEC – the Niagara International Transportation Technology Coalition, a coalition of local, state and provincial transportation agencies operating in the area – is the TRANSMIT (TRANSCOM's System for Managing Incidents and Traffic) system for collecting travel times using the E-ZPass electronic tolling tags.

The remainder of this paper will outline the relevant transportation organizations, facilities and issues in the Niagara Region; describe the TRANSMIT system and current work to expand it in Ontario; review the efforts to ensure the privacy of the toll tag users is protected; and discuss possible expansion of the system in future.

Ontario's Niagara Region Transportation

Within the region, two bridge authorities operate the four crossings over the Niagara River, which flows from Lake Erie to Lake Ontario and forms part of the Canada-United States border. The Buffalo and Fort Erie Public Bridge Authority operates the Peace Bridge, joining Fort Erie, Ontario and Buffalo, New York, serving both commercial and passenger vehicles.

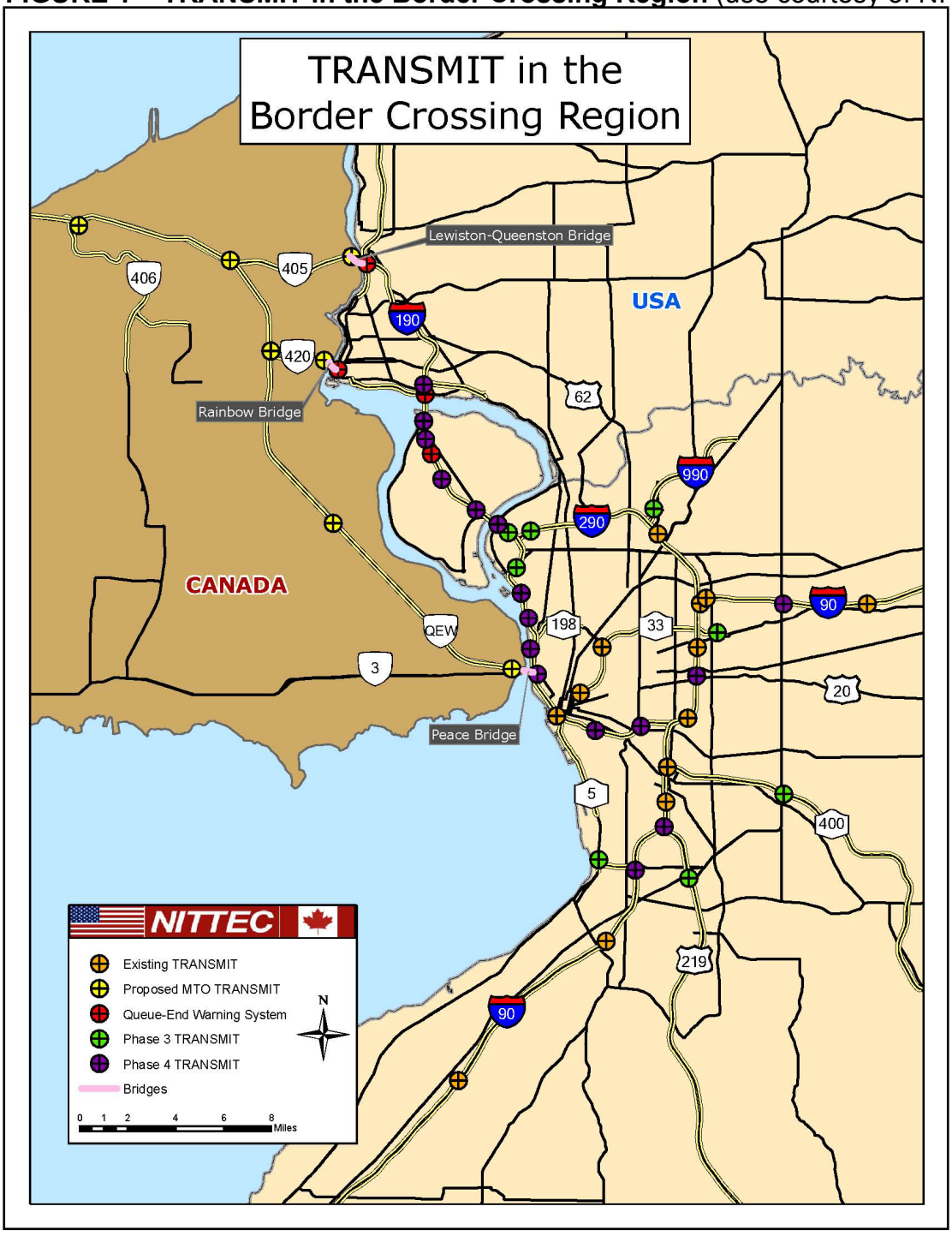
The remaining three bridges are operated by the Niagara Falls Bridge Commission. Two of these bridges join the two cities of Niagara Falls, Ontario and New York. The Rainbow Bridge, located in the tourist area of downtown Niagara Falls, allows passenger vehicles and tourist buses but prohibits commercial trucks. The Whirlpool Bridge, located further downstream, is further restricted to passenger vehicle based travellers subscribed to the NEXUS pre-approved clearance program.

The final bridge, appropriately named the Queenston-Lewiston Bridge, joins Queenston, Ontario with Lewiston, New York. It provides full services to commercial and passenger traffic, as well as train service between the two countries.

Figure 1 shows the complex network of highways in the region. Border routes on the Ontario side are dominated by the Queen Elizabeth Way (QEW) – a multi-lane freeway running from Toronto to Fort Erie – acting in some ways as a distributor of traffic across

the parallel crossings. The QEW connects directly to the Peace Bridge, and indirectly to the Queenston-Lewiston Bridge via Highway 405, and to the Rainbow Bridge via Highway 420.

FIGURE 1 – TRANSMIT in the Border Crossing Region (use courtesy of NITTEC)



On the US side, Interstate Routes I-90, I-190 and I-290; state routes 219, and 62; and local routes 5 and 198, distribute traffic among the crossings.

A number of agencies are involved in managing this complex highway and road network. In Ontario, the QEW, Hwy 405 and Hwy 420 are operated by the provincial Ministry of Transportation. Major local roads are operated by the Regional Municipality of Niagara, and minor local roads by the Town of Fort Erie, City of Niagara Falls, and the Niagara Parks Commission.

On the New York State side, the thruway is operated by the New York State Thruway Authority; major highways are operated by the New York State Department of Transportation; and local roads are operated by the City of Buffalo, City of Niagara Falls, and Niagara County.

With this many agencies operating in a relatively small geographic area managing this volume of local and cross-border traffic, coordination is critical to ensure travellers receive the best information and service possible. NITTEC provides the forum to help ensure this coordination.

Formed from 14 agencies on both sides of the border, NITTEC's mission is to improve mobility, reliability and safety on the regional, bi-national multi-modal transportation network through information sharing and coordinated management of operations. While each agency retains authority for their own roads, NITTEC facilitates linking activities, sharing opportunities, and provides a hub for joint operations.

TRANSMIT

One such joint operation is the TRANSMIT system. TRANSMIT is a system that takes advantage of the Interagency Group's E-ZPass electronic tolling transponders to measure travel times between selected points on the road network.

TRANSMIT was developed by the Transportation Operations Coordinating Committee (TRANSCOM), a coalition of 16 transportation and public safety agencies in the New York-New Jersey-Connecticut metropolitan region. Many of these same agencies are members of the Interagency Group and use E-ZPass for their electronic tolling needs on thruways, bridges and tunnels.

The principles of how TRANSMIT works are pretty simple. Devices capable of reading the E-ZPass transponder are installed at strategic points in the road network. As a transponder equipped vehicle passes the reader the tag ID and the time of passing are read and sent to a server. As the transponder passes another reader at a different point on the road network, the IDs are matched and the difference in time is determined. This provides the travel time information between the two points.

By averaging the measures from numerous vehicles a representative travel time for the road segment is developed. This process works on a continuous basis – providing a near real time measure of travel times. The travel times can also be converted into

average link speeds by dividing the link length by the travel time and converting into either miles per hour, or kilometres per hour.

If these measures accurately reflect actual conditions on the road, then they have obvious value to both road authorities and to travellers directly. Road authorities are able to infer a variety of road conditions and implement appropriate traffic control measures. Possible incidents and bottlenecks can be identified and responded to. Guidance to drivers can be provided via variable message signs or through changes to other traffic control devices such as traffic signals. By storing the travel time or speed data agencies are also able to create historical patterns to be used for advanced planning and operations management.

Travellers, on the other hand, also gain increased control of their journey by having access to both historical and current information. Improved planning of routes within the region, or across the border can be done with knowledge of typical conditions. While en-route, or immediately prior to taking a trip, travellers can make changes based on current conditions.

By providing accurate information to travellers, and supplementing it with specific guidance, agencies are able to work with travellers to balance demand across various routes and crossings – ensuring we are able to maximize our overall network capacity.

NITTEC acts as the hub for the information being collected in the Niagara gateway area. As can be seen from Figure 1, there are 48 existing or planned sites for the TRANSMIT system. Seven of these sites are being constructed in Ontario this year.

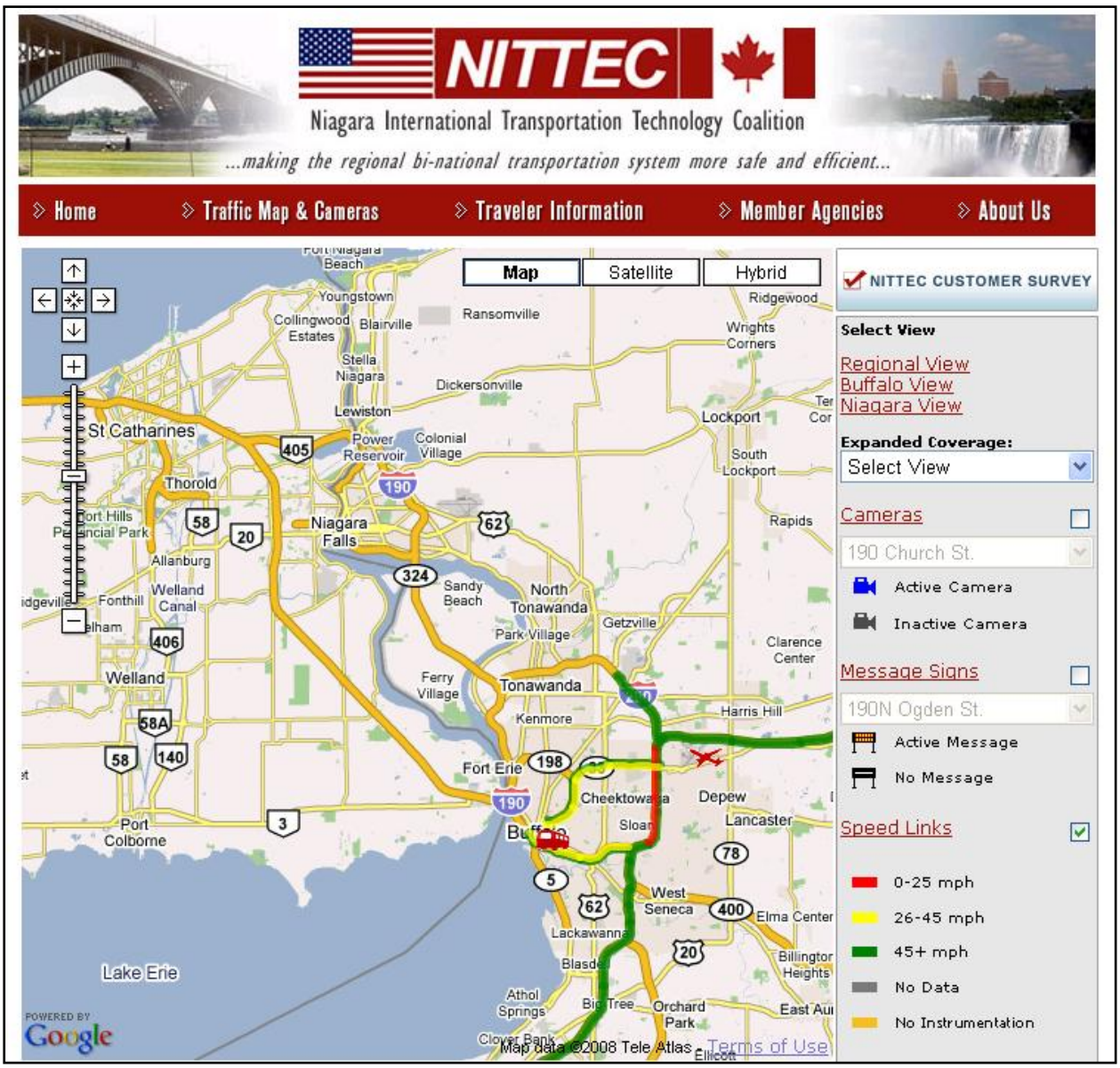
Information from each of these sites is sent to the NITTEC TRANSMIT server in Buffalo, where it is matched with data from other sites, shared with the individual agencies, and posted to the NITTEC web site as average speed data as shown in Figure 2.

Representing Actual Conditions

To meet the needs of both agencies and travellers the data needs to closely reflect real conditions on the road. Two factors have a major impact on this.

The first factor is data latency – or the time that passes from when someone begins to travel on a road section until the travel time for the full section is reported. Part of this reflects the actual travel time from the start to the end of the road section. In Ontario, most of the TRANSMIT sites have been stationed to measure travel time to each of the border crossings from key decisions points facing drivers. For the approach to the Peace Bridge this could leave a highway leg almost 30 km long. When the highway is operating well, this would produce travel times in the 15 minute range – an acceptable latency for this application. However, during times of congestion when speeds drop this may extend to 30-45 minutes of travel time – a latency felt to be unacceptable. To reduce this latency, an intermediate site is being installed that will divide the section in half.

FIGURE 2 – NITTEC Web Site with Travel Speeds (use courtesy of NITTEC)



The other aspect of latency deals with system induced delays. When designing the communications system one option is to collect and aggregate data in the field and only report it back to the server on a 5, 10 or 15-minute interval. This can significantly reduce communications needs and costs. The downside is that it introduces a delay in the reporting of travel times. For this reason it was decided to transmit data from the field immediately to the central server.

The second factor is the number and distribution of vehicles being measured. There needs to be enough traffic throughout the day in order to have a statistically significant measure of traffic conditions on a continuous basis. This needs to be reflected in two aspects. The first is to have a continuous flow of traffic throughout the day such that

measures can be collected continuously. If the time between vehicles passing a site begins to approach or exceed the data latency measure, the system may be unable to determine whether traffic has stopped moving or become congested – or that transponder based vehicles just haven't passed the site. Logic within the system can help address these situations; nevertheless, it can erode confidence in the results.

The second aspect is to have a large enough percentage of the vehicle fleet equipped with transponders in order to develop a statistically valid sampling of traffic movements. There isn't a consensus on what this penetration needs to be. Previous studies (2,3) have suggested that penetrations ranging from as low as 5% to as high as 30% are necessary, depending on the level of statistical significance required for the specific application.

E-ZPass has more than 17-million vehicles enrolled in their system. Within the region, the New York State Thruway (I-90) and the Peace Bridge both use the E-ZPass system to provide electronic tolling – generating a large source of transponder equipped vehicles. Nonetheless, as the reader sites get deployed further away from these sources of vehicles the lower the likelihood that equipped vehicles will be found travelling. With the QEW providing a key freeway link between New York State and the Greater Toronto Area, it is expected that the necessary penetration should be achievable.

As a pilot system for Ontario, this volume and penetration rate will be one aspect of the system that the Ministry of Transportation will be assessing in order to determine the effectiveness of the system – and the potential for future expansion.

Privacy

Threats to personal privacy can take a number of forms – from inappropriate access to personal information through to tracking of individual movements and activities. To protect against these, a number of safeguards have been built into the TRANSMIT system.

The E-ZPass system doesn't store personal information on the transponders. Personal information required for E-ZPass billing is stored on the E-ZPass server. To ensure that this information is protected as confidential the E-ZPass and TRANSMIT systems are isolated from each other – using separate readers, communications and servers.

The communications network used on the Ontario site will be a combination of agency owned infrastructure and public infrastructure. To protect the information collected at the Ontario sites it will be encrypted prior to transmission.

Finally, transponder information is stored on the TRANSMIT server only long enough to match it between reader sites. Once a match is made the original data is erased from the system and only a travel time is retained for averaging with other travel times. If no match is made within a predetermined time period, then the data is also erased.

Future of TRANSMIT in Ontario

The initial NITTEC TRANSMIT service is operational on the New York side of the border. The web service can be viewed at http://maps.nittec.org/mappage.aspx. Work is underway with the US agencies to expand the density of the network, and to expand the geographic coverage.

Work is also underway installing the first seven sites in Ontario with plans for them to become operational during the fall of 2008. This is being considered an operational pilot for Ontario, so it is a little difficult to determine the future of TRANSMIT. Expectations are that this pilot will prove successful, and the Ministry of Transportation will put in place the communications infrastructure to bring the core data back to its Burlington Compass Traffic Operations Centre, where it will become one more input into our traffic management system. Information from this system will help us determine what messages to put on our variable message signs, and will be posted to the ministry web site.

Finally, it is possible that the ministry may also expand our use of TRANSMIT data. Areas of expansion could include further inland along the QEW to Toronto, as well as in the Thousand Island region of the province where we have additional links to New York State and may be able to take further advantage of E-ZPass equipped vehicles.

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