Buffalo-Niagara Integrated Corridor Management

executive summary

prepared for
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Executive Summary

Many transportation agencies across the country are realizing that continued expansion of their region's roadways to alleviate congestion is becoming more difficult. Often faced with reduce budgets and increased project development costs, as an alternative to expanding the roadway's physical capacity more agencies are turning to leveraging technology to better manage the operations of their roadways to reduce congestion levels, improve the reliability of travel times, and prevent crashes. The concepts of Integrated Corridor Management (ICM) fundamentally strive for these operational improvements through improved coordination between varying agencies operating transportation systems within the region, improved incident or event response strategies during congestion or non-recurring events, and improved use of Integrated Transportation Systems (ITS) technologies to improve the operations in the corridor. These concepts are also best applied not to a specific facility, but the larger corridor of alternative parallel or nearby roadways or alternative travel models.

The Buffalo-Niagara region is well positioned for the consideration of an ICM deployment. Numerous agencies are involved in operating roadways on both sides of the border, and the long history of development in the region has created roadways which can be difficult and exceedingly expensive to physically expand. This Buffalo-Niagara ICM (BNICM) project built upon previous ICM planning efforts completed for the region and aimed to develop decision support tools needed to complete the required Analysis, Modeling, and Simulation (AMS) assessments of potential ICM deployments in the region and to conduct those AMS assessments and to prove the feasibility of an ICM deployment to provide the overall benefits to improve operational and environmental conditions on the region's transportation network. Throughout this planning level BNICM project, the previously established goals for a successful ICM deployment were kept in mind for the ICM system to improve agency coordination, improve traveler information, improve mobility for all transportation network elements, and to improve incident management capabilities.

This project was completed for the Niagara Frontier Transportation Authority (NFTA), the Greater Buffalo-Niagara Regional Transportation Council (GBNRTC), and the Niagara International Transportation Technology Coalition (NITTEC) and made possible through grant funding of both the United States Department of Transportation (USDOT) and from the New York State Energy Research and Development Authority (NYSERDA).

For further details beyond those presented within this executive summary, please refer to full final report for the Buffalo-Niagara Integrated Corridor Management Final Report (March 2020).

Model Development

At the onset of the BNICM project, it was evident that a robust analysis tool would be needed to simulate the various conditions under which ICM response plans could be deployed, as well as to simulate the various potential ICM strategies that would need to be tested and analyzed. While GBNRTC had various existing simulation models already developed, none of them were ideal for the combined need of both regionwide analysis and local operations details that would be needed for analysis of the BNICM project.

To fill this gap, the BNICM project's first charge was to develop an Aimsun hybrid microscopic – mesoscopic simulation model that could simulate traffic conditions at the regional level with a mesoscopic simulation framework while simultaneously simulating localized details and technologies needed to evaluate key freeway corridors and certain ITS strategies. The framework for the BNICM analysis tool was also selected.
to potentially be expanded into use as a near real-time predictive element of a future ICM decision support system (DSS) tool for real-world ICM deployments, as has been done in previous ICM deployments in the U.S. and in other countries.

The BNICM model covers the entirety of the I-190 corridor from I-90, through downtown Buffalo, across Grand Island, through the Niagara region, and terminating at the Lewiston-Queenston Bridge crossing between United States and Canada. The model includes all parallel freeway and arterials, and the larger bi-national corridor comprised of the three major bridge crossings between Canada and the United States in the Buffalo-Niagara region and all connecting roadways between those crossings on both sides of the border.

The model was first constructed and calibrated to represent existing conditions. This involved an exhaustive effort to compile all available traffic counts for the region. In addition to the traffic count database maintained by GBNTRC, additional counts were compiled from the New York State Department of Transportation (NYSDOT), the New York State Thruway Authority (NYSTA), the Ministry of Transportation of Ontario (MTO), the Buffalo and Fort Erie Public Bridge Authority, and the Niagara Falls Bridge Commission. After review of those collected traffic counts, as part of this study additional field counts were collected to fill in identified key gaps in the available traffic count data.

The traffic counts were then used to revise and improve upon the regional travel demand estimates from the GBNRTC regional travel demand model through an Origin-Destination adjustment process. These demands were then simulated in the BNICM model for the typical weekday AM peak period (7-10 AM) and the PM peak period (3-6 PM) and compared to the observed count data as well as against historic roadway speeds as extracted from the National Performance Measurement Research Data Set (NPMRDS). Further changes and improvements to the roadway representation in the model, the regional travel demands, and the models representations of route choices made by drivers were iteratively improved upon through the calibration phase of the project until the resulting simulations well represented the existing typical weekday peak period conditions.

Base Conditions

While typical weekday peak period conditions do often occur, a number of other non-typical conditions are also frequently seen on the region’s roadways. These conditions needed to be included in the evaluation of the future ICM deployment as ICM strategies can often provide greater benefits when conditions are not typical but include non-recurring events such as disruptions from crashes, unusual demand conditions, or from adverse weather conditions. To serve in the evaluation of the potential benefits from an ICM deployment, five additional observed or base conditions were selected, and the AM and PM peak period models were adapted and further calibrated to represent these non-typical conditions. The final set of base conditions included the following:

- Typical AM and PM peak period conditions
- Major crashes in each of the AM and PM peak periods
- Snow conditions in the AM peak period
- High cross-border demand Canada Day & Independence Day holiday traffic during a PM peak
- High demand for a Sabres hockey game in Downtown Buffalo during a PM peak

For each of these conditions, an actual representative day from recent years was selected, and any date specific count and speed data for that day were compiled. These additional non-typical base condition models were developed by altering the typical peak period condition models to include the non-typical
conditions. These base conditions models were similarly calibrated to represent the available speed and count data for those representative non-typical conditions.

ICM Strategies Benefits

To select which specific ICM strategies should be considered for inclusion in a future ICM deployment, a review of the larger universe of potential ITS deployments was reviewed and a candidate list of ICM strategies was developed that were best suited to the Buffalo-Niagara region considering its roadway network, the goals of the ICM deployment, and the base conditions under which the ICM deployment would be evaluated. The following ICM strategies were advanced for further consideration and evaluation:

- Improved Dynamic Traveler Information
- Freeway Incident Detection and Service Patrol
- Ramp Metering
- Variable Speed Limits and Queue Warnings
- Variable Toll Pricing
- Signal Coordination
- Parking Intelligent Transportation Systems (ITS)
- Dynamic Lane Controls
- Road Weather Information System (RWIS) and Plow Management

For each of the strategies, a plan for what a deployment of each of those systems within the I-190 and the cross-border corridors would consist of was developed. Given this expected deployment of each of these systems, estimated initial deployment costs as well as the annual operating and maintenance costs were used to create annualized life-cycle costs for each of the ICM strategy deployments.

To evaluate the impacts of the ICM strategy deployment under the different base conditions, methods were developed to include these ICM strategies implicitly within the BNICM simulations so that the impacts on operations could be estimated. By comparing the results of two simulations with and without the ICM strategies active, the differences in the performance metrics could be taken as the impacts of the ICM strategy deployment. The primary metric used to evaluate the operational impacts was the change in the total vehicle hours traveled (VHT). This provided a good overall metric to evaluate the impacts on all relevant regional roadways, including both freeways and arterials. The changes in VHT were then converted into monetary values using assumed driver’s value of time estimates.

Where the simulation tool could not feasibly estimate impacts, off-model estimates of the benefits of ICM strategy deployments were developed. These benefits were generally in the form of savings from improved safety conditions and resulting prevented crashes. Previous studies presenting the observed impacts of the similar ICM strategy deployments on reducing crash rates were leveraged along with existing crash statistics for the study corridors to estimate the number of prevented crashes that could be expected. These values were then converted into a dollar values using crash cost estimation methods.

Benefit-Cost Analysis Results

As the permutations of the number of ICM strategies and the base conditions would result in a significantly large number of scenarios, two key sets of packages of strategies were developed to streamline the evaluation process. The first ‘Package A’ set of strategies focused on improving freeway conditions and included the first five strategies in the above list. The second ‘Package B’ included those same strategies,
but also added real-time signal coordination to better include the arterials in the ICM deployment. The final three strategies were not included in the ICM deployment evaluations at this stage of the ICM planning.

Under the Package A ICM deployment, an annual savings of over half a million VHT could be expected, or when converted into dollars a savings of over $7.5 million. The deployment could also be expected to prevent approximately 5 medium to major peak period crashes per year and 22 minor peak period crashes per year. The estimated mobility benefits of the additional VHT savings from those prevented crashes added another three quarters of a million dollars in benefits, and the societal savings of those prevented crash costs was estimated at over $2.7 million per year. Collectively, a Package A ICM deployment was estimated to produce benefits of over $11 million per year. Compared to the estimated annualized costs of the Package A deployment of $4.9 million per year, the benefit to cost ratio is estimated to be 2.25.

Under the Package B ICM deployment, the annual savings in VHT were estimated to increase to over 617,000 hours per year, equivalent to over $9.2 million in user time savings. As the Package B deployment was not predicted to further improve safety benefits over the Package A ICM deployment, the Package B safety benefits remained unchanged from Package A. The total benefits of the Package B ICM deployment was then estimated at over $12.7 million per year. When compared to the estimated $5.1 million annualized costs of a Package B deployment, the benefit to cost ratio improved to 2.49.

Implementations Plans

Both evaluated ICM deployment plans showed a positive return on investment and should be considered feasible for deployment within the region. The next step towards an ICM deployment within the region would consist of a more detailed design and a more robust analysis of the costs to deploy, operated, and maintain the ICM system components within the region. In particular, attention should be made to the addition of real-time volume sensors. While real-time speed data is generally available, a future ICM system will need to use the detection of both the speeds and volumes of both freeway and arterial facilities as inputs into the ICM system decisions.

A further review of the deployment assumptions for the ICM strategies made as part of this project should also be revisited in more detail. While overall the analyses of the ICM deployments showed that they would produce benefits, the analysis of events under which an ICM system would be deployed showed varying degrees of benefits. Further review, investigation, and analysis of those conditions and strategy deployments returning lower than average benefits should be re-examined to determine the potential for improved response plan performance under those conditions to improve benefits.

An additional next step would be to consider the potential for ICM benefits outside of the weekday peak period conditions. While higher levels of benefits should be expected during the peak period when congestion is higher, potential for additional benefits outside of the peak periods is very much present, especially for safety benefits and travel time benefits during crash conditions. Operating an ICM system during off-peak weekday and weekend conditions should have minimal impacts on the deployment costs but could yield further benefits and improved benefit to cost ratios.

The next stages of analysis should also consider the potential benefits and costs of a staged deployment. Deploying the entire ICM system as analyzed under this project may be prohibitively expensive in terms of initial deployment costs. A staged deployment approach would allow those high initial capital costs to be distributed over years. However, further analysis should be completed on the potential staged deployments...
to ensure that the different stages operate effectively without the inclusion of potential future later stage
deployment components of the ICM system.

Specific to the I-190 corridor, the next steps towards implementation should include more robust design
considerations for the ICM strategy deployments. For the ramp metering, the design of a ramp metering
timing algorithm should be developed and evaluated versus the more generalized algorithm applied under
this project, both for normal operating conditions and as part of a response plan where ramps may see
significantly different volumes. Further attention should also be made to the variable speed and queue
warning system as tested in this project. The high costs associated with deployment may suggest a staged
deployment design, with the first stage of deployment focusing on those areas with more frequent crashes
and slow congested operations.

Specific to the cross-border corridor, next steps towards implementation should include a more detailed
examination of the possibility of trucks changing their crossing locations on short notice to improve travel
times from an incident on either side of the border. Further communication and coordination are also
recommended between NITTEC and MTO on an international approach to ICM to coordinate actions taken
during an ICM event, and to ensure that the events are designed to complement each other, and not conflict
each other. Further coordination with U.S. Customs and Border Protection (CBP) and the Canada Border
Services Agency (CBSA) so that the operations of the border crossings are included in the determination of
an appropriate response plan. While these lines of communication are already established, further
agreements and cooperation in the automated sharing of data and potentially jointly developed ICM
response plans for both countries could further improve the ICM system performance.

Performance Monitoring

While the previous simulation and benefit-cost analysis demonstrates the feasibility and viability of an ICM
deployment within the region, any potential deployment should also include a data driven process to
continually monitor the performance of the ICM system and its response plans that are implemented in the
field. The results of that performance monitoring should also carry forward into a continuous improvement
framework to ensure that the ICM response plans implemented in the field are as beneficial as they can be
for the given conditions as an ICM system operates over time.

Once the ICM system is deployed, a detailed reporting of the performance of the system under the ICM
response plan should be developed and tracked over time. While it is impossible to truly know how the
roadway system would have performed if a different response plan was undertaken, the comparison of the
different performances of different response plans under similar conditions should provide meaningful
insights into the relative performance of the response plans. Given these reviews and comparisons, efforts
should be made under an ICM deployment to routinely revisit the components of the response plans with the
goal for continuous improvement of their benefits.

The use of the BNICM simulation tool can also be leveraged for this performance reporting in a future ICM
system. The model was developed with a framework that allowed the possibility of a future expansion and
conversion into a real time prediction simulation engine that could be used in real-time to help evaluate
different response plans' effectiveness under any given situation. Even if in the ICM system detailed design
the decision is made not to include a real-time simulation based predictive input to the DSS, an off-line
simulation tool can still be leveraged to evaluate different response plans in a post-implementation manner to
estimate if further enhancements could have been made to the response plan implemented to maximize
benefits. In either real-time or off line use, the reporting of the performance of the simulation models and
their accuracy as a predictive tool in estimating the real world system performance should be included as part of an ICM system deployment. This performance reporting provides the data needed to enhance and improve the simulation model over time, which should in turn lead to more accurate predictions of the impacts of an ICM response plan under varying conditions and improved response plan performance in the real-world.