GBNRTC

Greater Buffalo Niagara Regional Transportation Council

Buffalo-Niagara Integrated Corridor Management (BNICM)

nittec
Travel Smart.

CAMBRIDGE SYSTEMATICS

Buffalo-Niagara ICM AMS

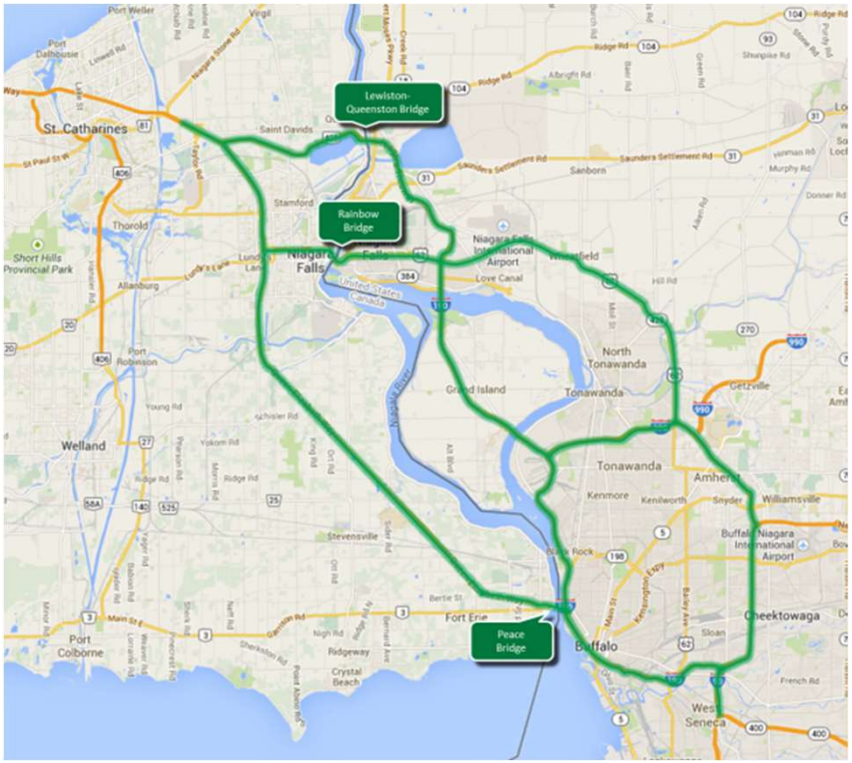
"Analysis Modeling and Simulation (AMS) helps agencies identify the optimum combinations of ICM strategies in their corridors. Conducting ICM AMS helps agencies confirm that the operations strategies they are considering will have the intended effects when implemented *before* they invest in them " - *(Integrated Corridor Management Analysis Modeling and Simulation, FHWA Workshop).*

Pioneer Sites Followed a Common Approach with the ICM AMS Methodology

Source: Research and Innovative Technology Administration

Visit the ICM Knowledgebase and Download the AMS Guide

Integrated Corridor Managed Initiative
ICM Partnership Team

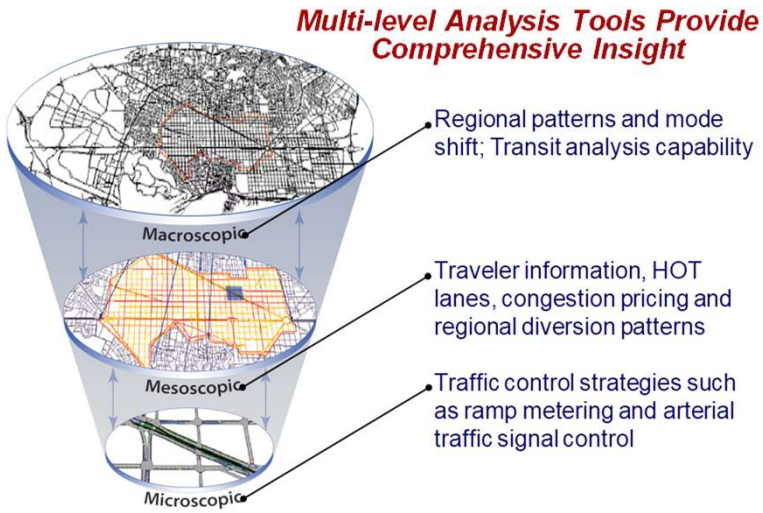


- Buffalo and Fort Erie Public Bridge Authority
- City of Buffalo
- Ministry of Transportation Ontario
- New York State Department of Transportation
- New York State Thruway Authority
- Niagara Frontier Transportation Authority

ICM Goals

Goal Category	Goal Objective
Agency Coordination	Improve center-to-center communications
Traveler Information	Improve accuracy of congestion (travel time) information reliability
	Enable intermodal choices through improved traveler information
	Improve integration of weather information/data for traveler information, and for maintenance operations
	Improve integrated operations based on real-time data
Mobility (Arterial, Border, Freeway, Transit)	Maximize the free flow of traffic and reduce congestion
	Provide transit alternative and park-and-ride facilities
	Enhance border crossing clearance
	Facilitate ITS and operational improvements that will facilitate ICM mobility
	Enhance alternative route management capabilities
Incident Management	Establish incident classifications and severity guidelines
	Improve and coordinate incident management

Modeling Methodology



Selected Platform:

TransCAD

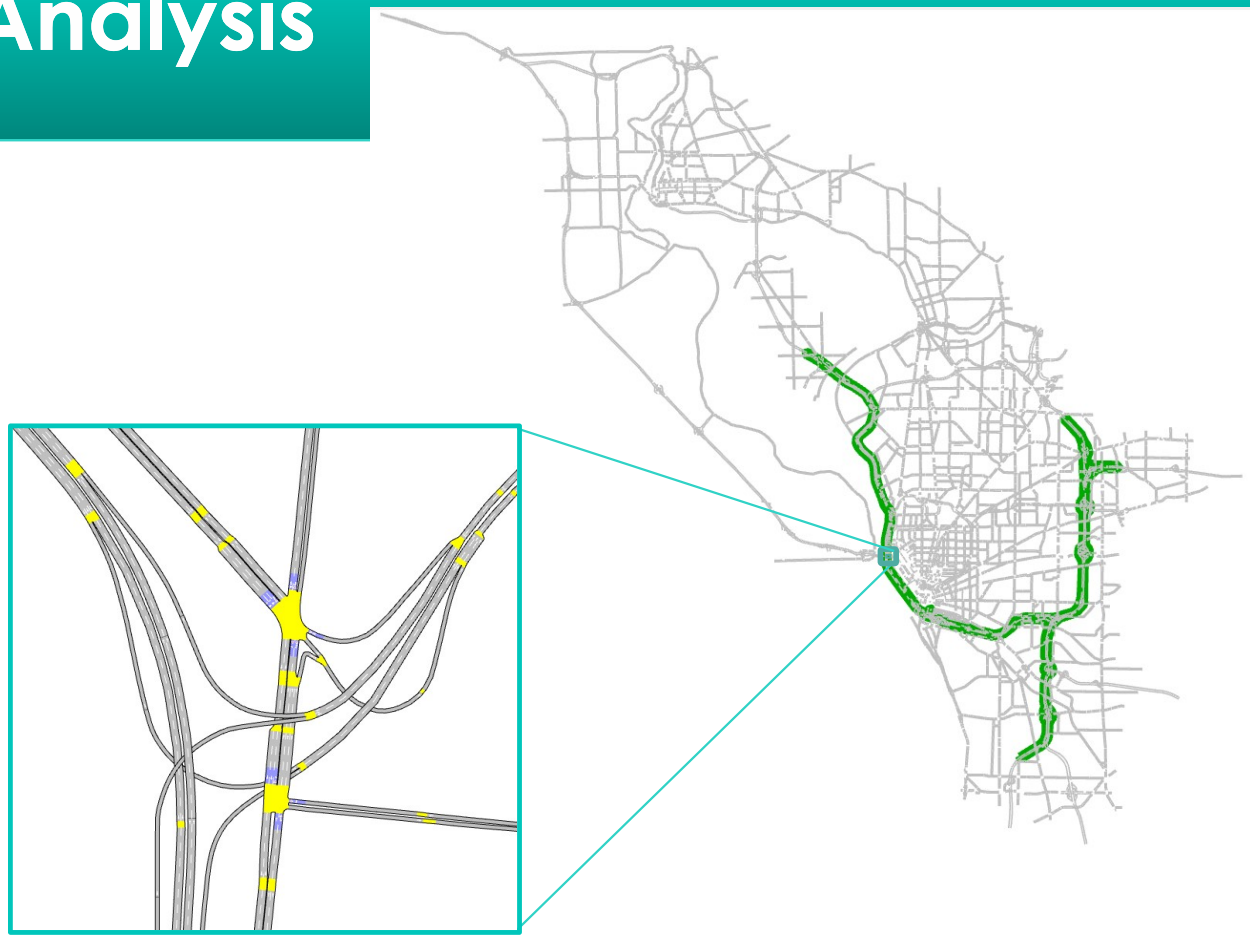
Aimsun Meso

Hybrid

Aimsun Micro

Integrated Corridor Management Benefits Analysis

- Mesoscopic
- Microscopic



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Collaboration of Data Sources

Count Data

- Traffic Counts : Multiple Agencies
- NYSTA Continuous Count Stations
- NYSDOT Permanent Counter Data
- PBOA Bridge Crossing Data

Speed Data

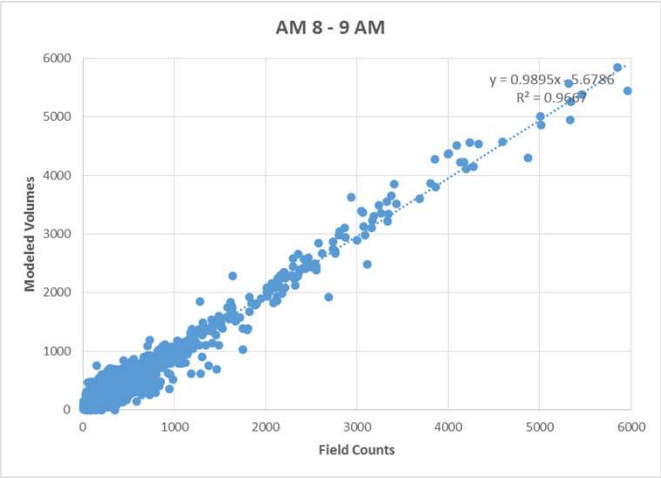
- NPMRDS Travel Time/ Speed Data
- TRANSMIT Speed Data

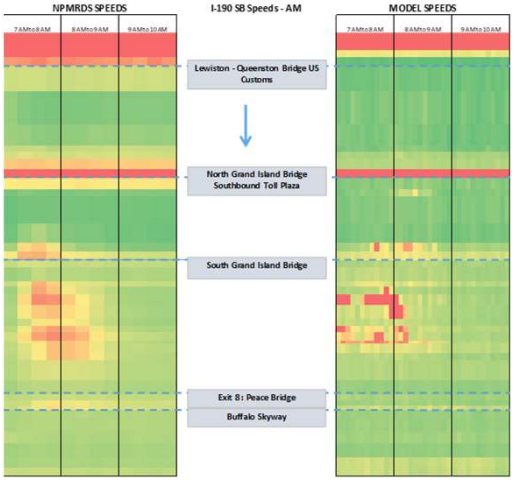
Delay Data

- Border Crossing Bluetooth Delay Data

Model Calibration

- Each Base Condition model calibrated against available field conditions
  - Link Volumes
  - Speed Contours





ICM Potential Strategy Summary

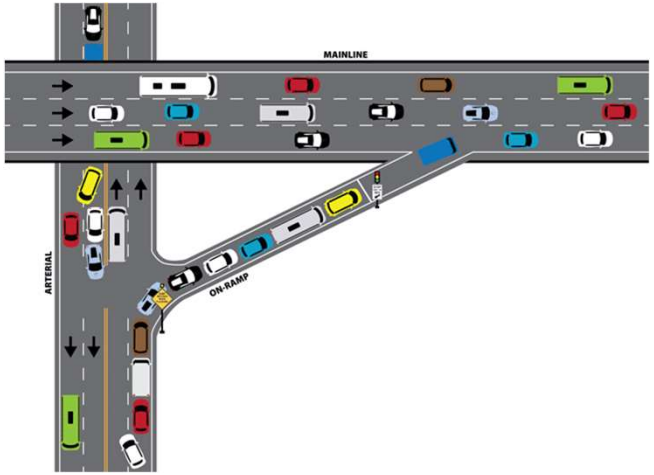
	AM/PM Typical Commute	Vehicle Crash	Sabres Home Game	July 4th / Canada Day Weekend	Snow Event
Variable Speed Limits (VSL)	X	X			X
Queue Warning	X	X			X
Ramp Metering	X	X			
Dynamic Routing & Enroute Information	X	X	X	X	X
Pre-Trip Information	X	X	X	X	X
Highway/Arterial Demand Balancing	X	X			
Corridor Signal Coordination	X	X	X		X
Transit Signal Priority	X	X			
Incident Detection		X			
Freeway Service Patrol	X	X			
Parking ITS			X		
Variable Tolls	X			X	
Dynamic Lane Controls		X			X
RWIS & Plow Management System					X

BNICM Simulated ICM Strategies

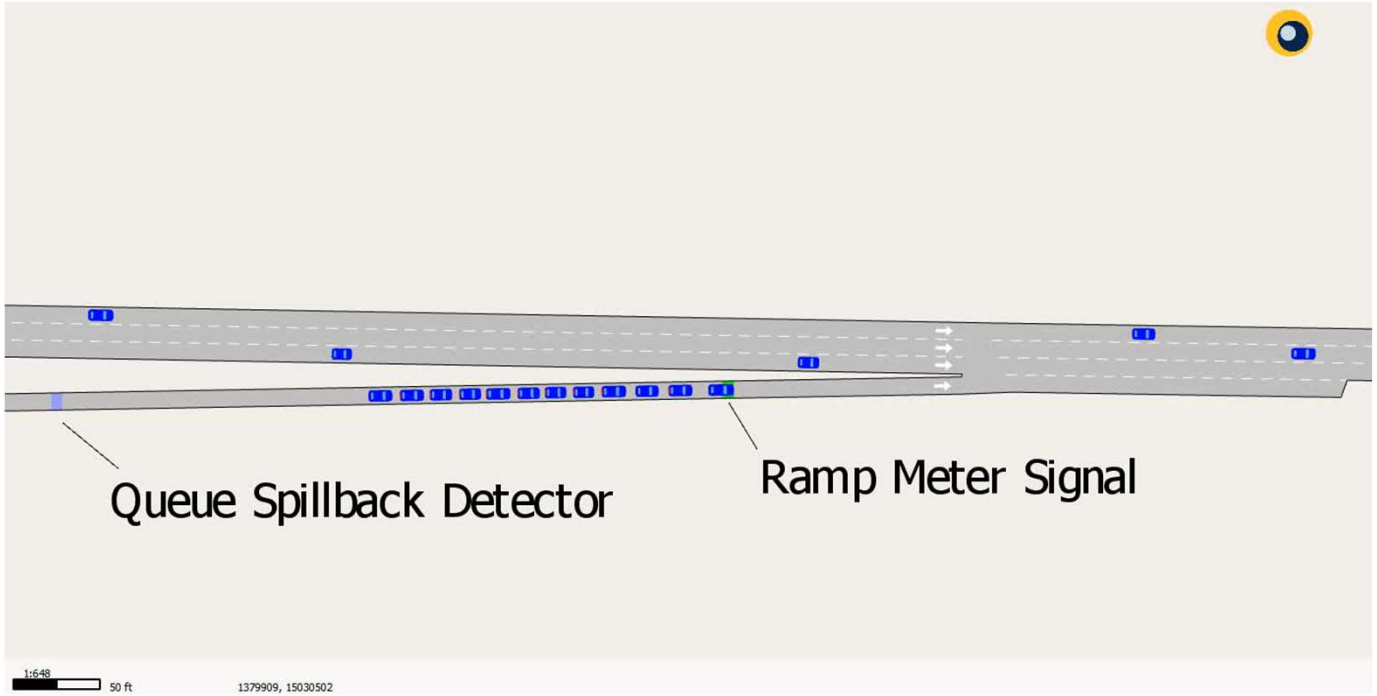
- ICM Strategies Tested:
  - Dynamic Routing Traveler Info & Highway Balancing
  - Incident Detection Systems & Freeway Patrol
  - Ramp Metering
  - Variable Speed Limits and Queue Warning
  - Variable Tolls (Peak Surcharge)
- Various combinations of these strategies in each of the seven base conditions
  - 75 scenarios of combinations of ICM Strategies simulated

Ramp Metering
Overview

- Ramp Metering
  - Signals on ramps to control the traffic flow entering the freeway
  - Metering rates can configurable based on freeway/ramp traffic conditions
- Benefits
  - Reduce mainline delay
  - Reduce crashes
- Queue detection to prevent arterial blocking



Ramp Metering
Example



Ramp Metering
BNICM Implementation

- I-190 between I-90 & I-290
- Period specific operations by direction
- End of ramp queue overrides
- Sensor monitor mainline lanes, only activate meters when mainline density is high (LOS D or worse)

Variable Speed Limits & Queue Warning
Overview

- Variable Speed Limits (VSL)
  - Dynamically adjust speed limits (regulatory or advisory) in response to
    - Congestion – *Typical AM/PM Peaks*
    - Incidents – *Incident Scenarios*
    - Road weather conditions – *Snow Event*
  - Provide downstream speed forecast/alert
  - Attempt to reduce speed variability

Variable Speed Limits & Queue Warning

BNICM Implementation

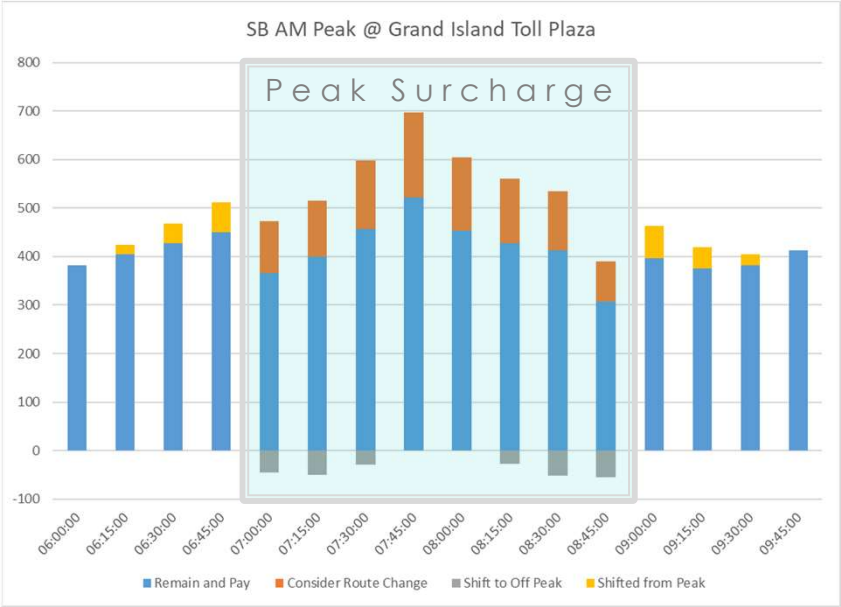
- All of I-190
  - NB and SB (I-90 to LQB)
- Designate sections approximate 1 mile in length
  - Speeds evaluated every 60 seconds
  - If speed on next downstream section drops below a 5 mph speed threshold, set speed limit to +5 mph above that
  - Minimum 35 mph speed limit
- Speeds similarly increased as downstream conditions improve

Variable Tolls
Overview

- Variable tolls
  - Demand management strategy
  - Improves peak period mobility
  - Improves peak period reliability
- Potential Implementation
  - Location
    - I-190 through Grand Island
    - Border crossings (potentially)
  - Time-of-Day Toll to influence traffic travel outside of core peak hours

Variable Tolls
BNICM Implementation

- Grand Island Bridge Tolls
  - Peak period toll increase of $1.00 above off peak conditions
  - 7-9am & 4-6pm
- Assumed diversion in time, potentially in route



Dynamic Routing, En Route & Pre-Trip Info
Overview

- Dynamic Routing & Enroute Driver Information
  - Disseminate roadway info to travelers during the trip
  - Allow vehicles to less congested/faster facilities to make better use of the roadway capacity
  - But do not dictate those routes
- Pre-Trip Info
  - Influence departure time and route choice decision
- Methods
  - Via DMS boards
  - Globally via NITTEC app, 511, Waze, etc.

Dynamic Routing, Info, and Balancing
BNICM Implementation

- Increased DMS signage of travel times on roadways
  - Six new DMS signs
- Assumed 10% increase in population with information dissemination
  - Both pre-trip and enroute
  - Increased likelihood a driver will find a route with a better travel time
- No predefined or suggested detour routes provided

Automated Incident Detection & Freeway Service Patrol

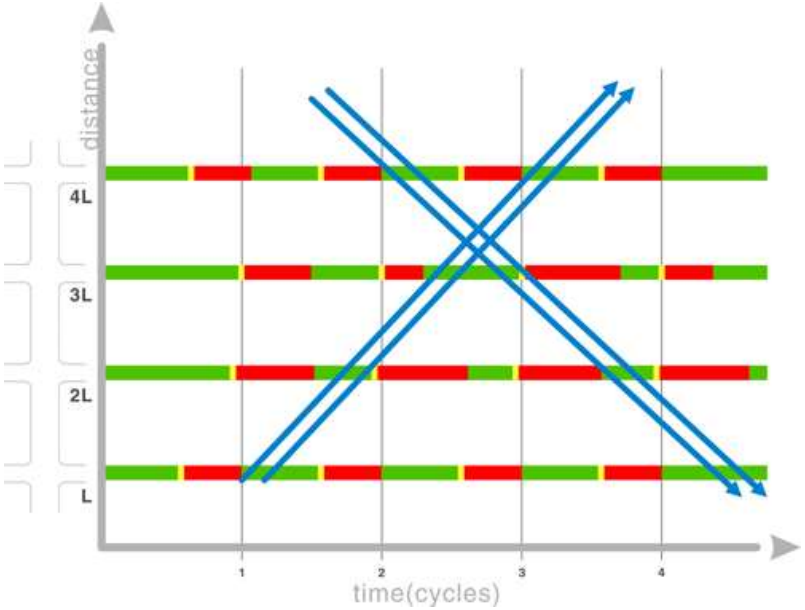
Overview & BNICM Implementation

- Improve Incident Detection
  - Contribute to clearing incidents faster
  - Reduce the time required for traffic to return to normal conditions
  - Reduce secondary crashes

- Assumed automated incident detection system and increase freeway service patrols
- Assumed 3 minute faster incident detection
- Assumed 5 minute faster clearance times
- Overall 8 minutes faster crash to clearance intervals

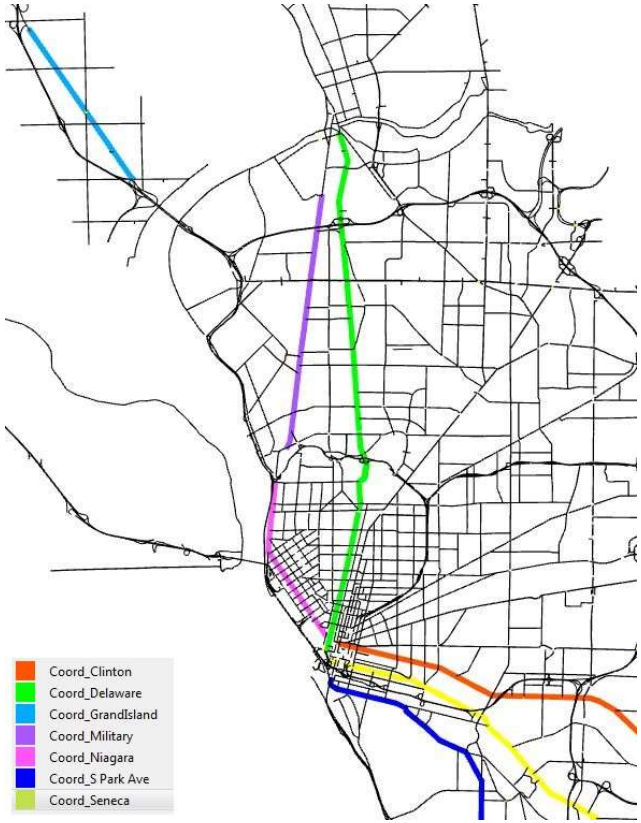
Corridor Signal Coordination
Overview

- Improve corridor performance through signal coordination
- Identify candidate corridors
  - Performance-based:
    - Based on the significant delays w/ and w/o ICM
  - Key corridors to consider:
    - Niagara St
    - Delaware St
    - South Park Ave
    - Seneca St
    - Clinton St
    - Military Rd
    - Grand Island Blvd

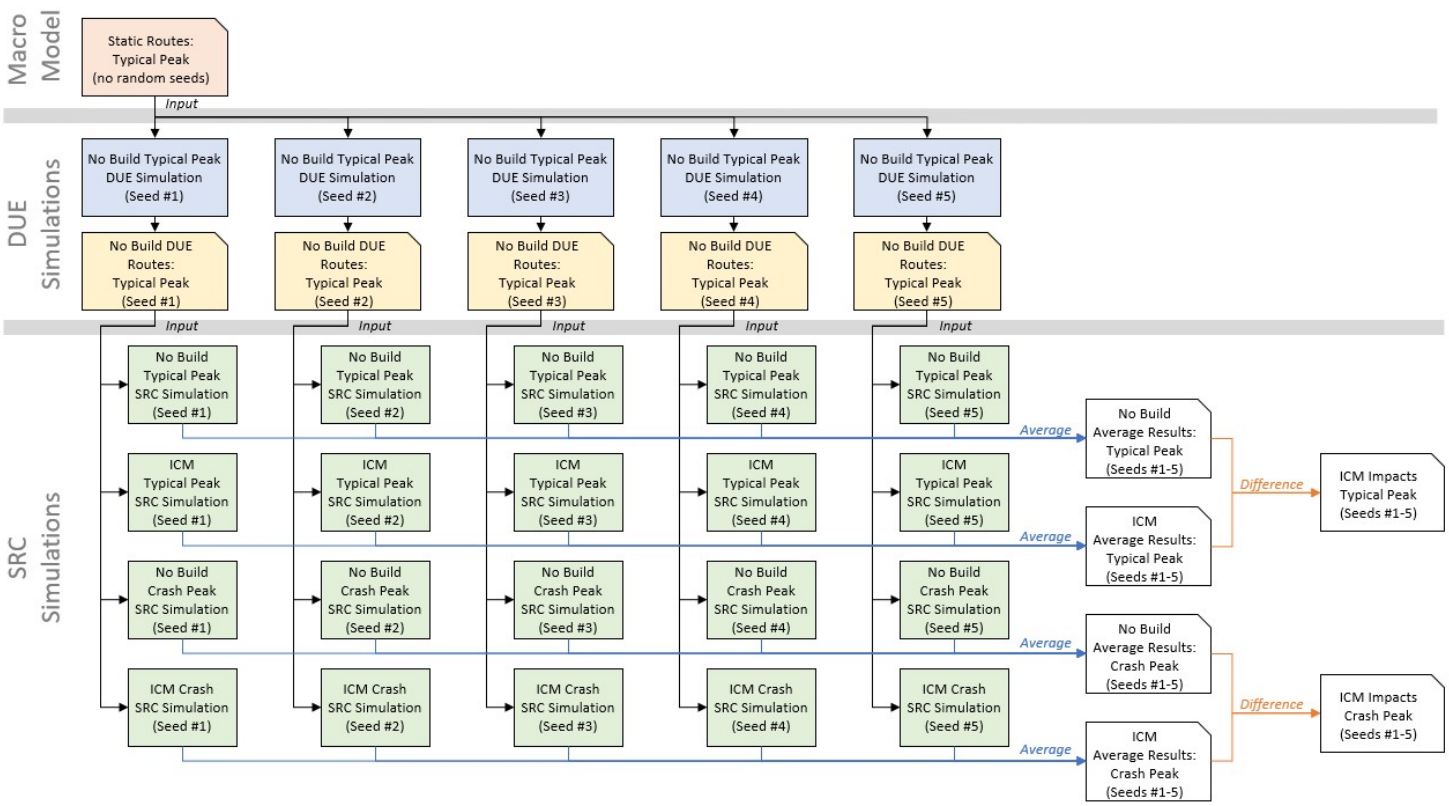


Corridor Signal Coordination
BNICM Implementation

- Key corridors:
  - Niagara St
  - Delaware St
  - South Park Ave
  - Seneca St
  - Clinton St
  - Military Rd
  - Grand Island Blvd



Robust Model Scenario Testing



Assumed ICM Impacts on Crash Rates

- Literature on Safety Impacts

Strategy	Crash Type	Typical Crash Reduction	Range of Reductions
Queue Warning	Primary Secondary	-20% -45%	-4 to -42% -40 to -50%
Variable Speed Limits	Primary Secondary	-20% -67%	-11 to -37% -67% (1 ref.)
Ramp Metering	Primary Secondary	-26% n/a	-26 to -39% n/a

- Assumed crash prevention rate of 20%

Prevented Crashes with ICM Deployment

	NITTEC Reported 2018 Crashes			Predicted Annual Crashes Prevented from ICM Deployment (20% of 2018 Crashes)		
Number of Crashes Per Year	AM Peak Period	PM Peak Period	Both Peak Periods	AM Peak Period	PM Peak Period	Both Peak Periods
Minor Crashes (Severity 1)	47	63	110	9.4	12.6	22.0
Medium & Major Crashes (Severity 2-3)	9	16	25	1.8	3.2	5.0
Total Crashes (Any Severity)	56	79	135	11.2	15.8	27.0

- AM Peak Crashes Prevented: 11.2 per year
- PM Peak Crashes Prevented: 15.8 per year

Monetizing Performance Metrics

- User's Value of Travel Time
  - Assumed hourly rate of $14.92 / hour of travel
  - Based on national averages
- Safety Cost per Crash
  - Medical costs, vehicle and property damages, legal costs, lost productivity, lost wages, etc.
- User Time from Prevented Crashes
  - Prevention of additional user travel costs from prevented crashes

Travel Time Benefits from Prevented Crashes

	AM			PM			Total Annual Benefits ($)
	Costs Per Crash		# of Prevented Crashes	Costs Per Crash		# of Prevented Crashes	
	veh-hrs	$		veh-hrs	$		
NB Minor Crash	1,148	$ 17,130	9.4	1,709	$ 25,503	12.6	$ 505,023
SB Minor Crash	1,259	$ 18,784		1,868	$ 27,867		
NB Medium/Major Crash	n/a	n/a	1.8	4,259	$ 63,541	3.2	$ 259,998
SB Medium/Major Crash	2,110	$ 31,482		n/a	n/a		
Total							$ 765,021

- Travel Time Savings in Vehicle Hours and associated Monetary Savings

Monetized Crash Prevention Benefits

- Costs per crash:

Severity	Severity	National	New York (US x 1.22116)	2014 Data*	Per Crash Costs
K	Fatality	$ 11,295,400	$ 13,793,500	0.4%	$ 13,793,500
A	Serious Injury	$ 655,000	$ 799,900	3.6%	
B	Minor Injury	$ 198,500	$ 242,400	6.3%	$ 224,000
C	Possible Injury	$ 125,600	$ 153,400	31.0%	
U	Unknown Severity	n/a	n/a	1.8%	n/a
O	No Injury	$ 11,900	$ 14,500	56.9%	$ 14,500

Sources: Crash Costs for Highway Safety Analysis, Jan 2018; 2014 NYS DMV 2014 Statewide Crash Statistical Summary

- NY Rates for Non-Fatal Crash (ABCO):
  - Average $ 102,119 per prevented crash

ICM Package A Strategy Costs

- Assumed National Average Cost Experience
- Estimate levelized annual cost of equipment lifecycle capital and O&M costs

System	Annualized Costs	Description
En Route Information	$ 144,978	Six new DMS Signs
Ramp Metering	$ 356,791	Software & 28 Meter Installations with mainline and queue detection
Variable Speed Limits & Queue Warnings	$ 4,137,343	Software & Installation of VSL components (1 full gantry per mile)
Package Costs:	**$ 4,639,112**	All Components

Sources: Unit costs from FHWA's TOPS-BC Tool, v4.0

ICM Package A Benefit Cost Ratio

Travel Time Benefits:	$7,572,628
Prevented Crash Costs	$2,757,205
Prevented Crash Time	$765,021
Total Annualized Benefits	$11,094,854
Total Annualized Costs	$4,639,112
Benefit / Cost Ratio	**2.25**

ICM Package B Strategy Costs

- Assumed National Average Cost Experience
- Estimate levelized annual cost of equipment lifecycle capital and O&M cost

System	Annualized Costs	Description
En Route Information	$ 144,978	Six new DMS Signs
Ramp Metering	$ 356,791	Software & 28 Meter Installations with mainline and queue detection
Variable Speed Limits & Queue Warnings	$ 4,137,343	Software & Installation of VSL components (1 full gantry per mile)
Signal Controller Upgrades	$ 173,306	ICM Coordination on Niagara St (26 Signals – Elmwood to Ontario)
Package Costs:	**$ 5,109,416**	All Components

ICM Package B Benefit Cost Ratio

Travel Time Benefits:	$9,210,516
Prevented Crash Costs	$2,757,205
Prevented Crash Time	$765,021
Total Annualized Benefits	$12,732,742
Total Annualized Costs	$5,109,416
Benefit / Cost Ratio	**2.50**

- Approximately 10% increase in efficiency over Package A

Benefits More Than Double Costs

- Evaluation of ICM deployments showed expected benefits in excess of expected costs
  - Benefits estimates are thought to be conservative
    - Only included benefit estimates for weekday peak periods. While expected to be less significant than peak period benefits, additional benefits in weekend and weekday off peak periods can still be expected. These benefits will only improve to the benefit cost ratio, as implementation costs will not increase
    - Crash cost benefits excluded the potential for reducing any fatal accidents
  - All analyzed strategies show potential net positive benefits, at least when considering both mobility and safety benefits

I-190 Corridor ICM Implementation

- I-190 corridor ICM implementation plan
  - Pursue implementation of all analyze strategies, while still considering prioritization and follow up studies mentioned above
  - Evaluations presented should be studied further as future efforts move towards system design and deployment; including:
    - Refinement of deployment costs should be undertaken with initial designs for implementation
    - Refined ramp meter algorithms may yield further benefits then those estimated here
- Refined evaluations and testing of projected benefits for partial I-190 deployments should be tested.

Border Crossing ICM Implementation

- Cross border corridor ICM implementation plan
  - Large improvements to cross border operations have already been undertaken since this effort was initiated. Includes:
    - expansion of the border crossing travel time monitoring systems to all major crossings
    - refinement and more detailed sharing of delay information of border crossing delays via the Internet and DMS
- Continued efforts to coordinate with MTO on an international ICM approach should be undertaken.

Implementation Monitoring Plan

- ATCMTD potential implementations
  - DSS Deployment incorporating ICM strategies
  - Real-time system monitoring and management of operations
- Any future ICM deployment considerations should ensure a constant monitoring and evaluation process is included. A performance evaluation program that evaluates the effectiveness of ICM response plans as they are implemented in the field is needed. This will require additional efforts to better tune the BNICM simulation model to better predict real-world responses to the implemented ICM strategies. This is useful to better design ICM responses to given events, to better prepare for additional future ICM events. This is true regardless of a future ICM effort includes the BNICM model in a real-time support role or in an off-line planning role.