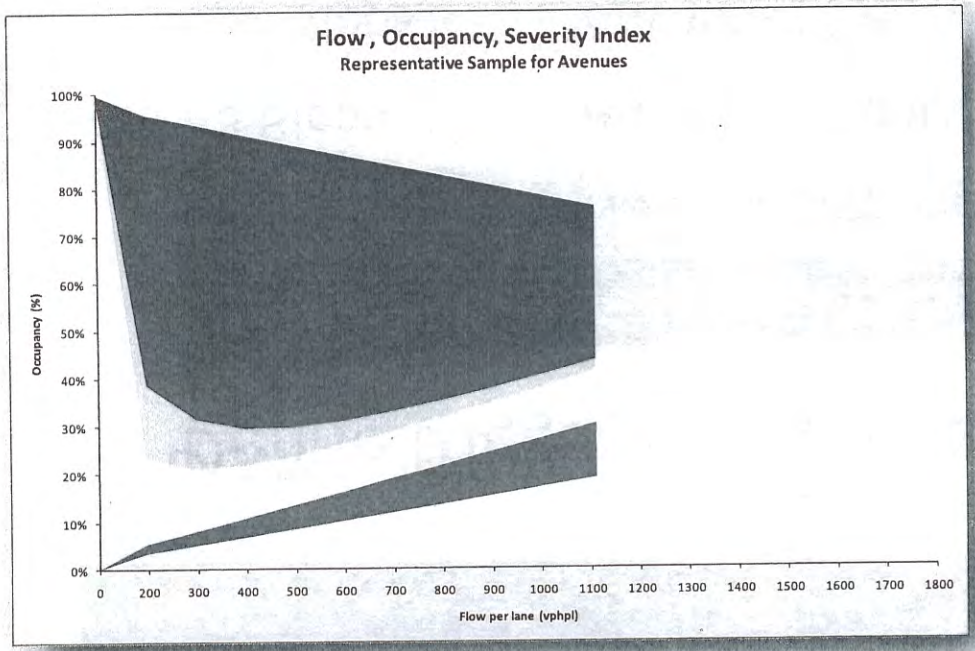
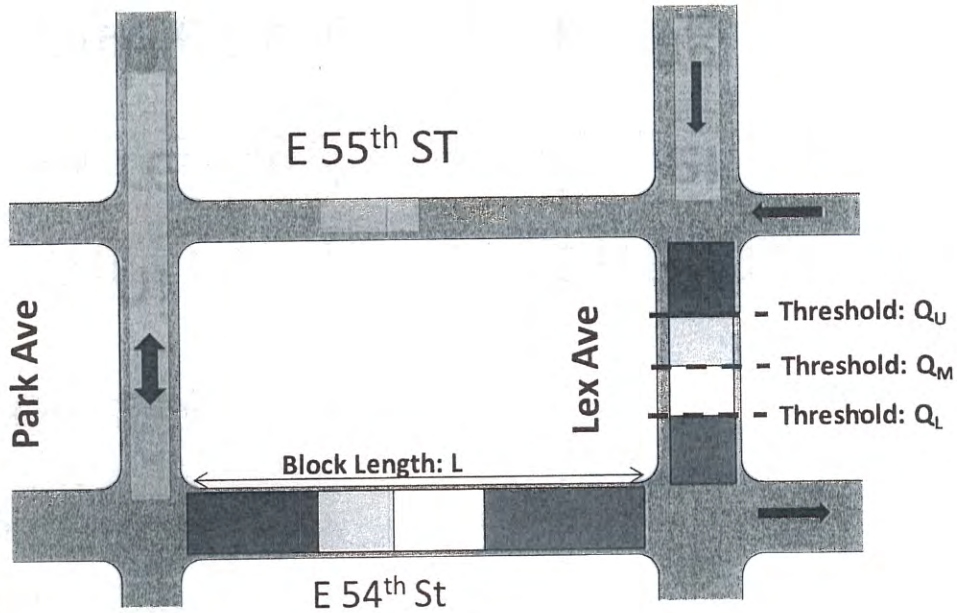
Level 2 Control

- Measure of queuing condition, relative to block length
- Estimate queue using flow/occupancy and then calculate Severity Index





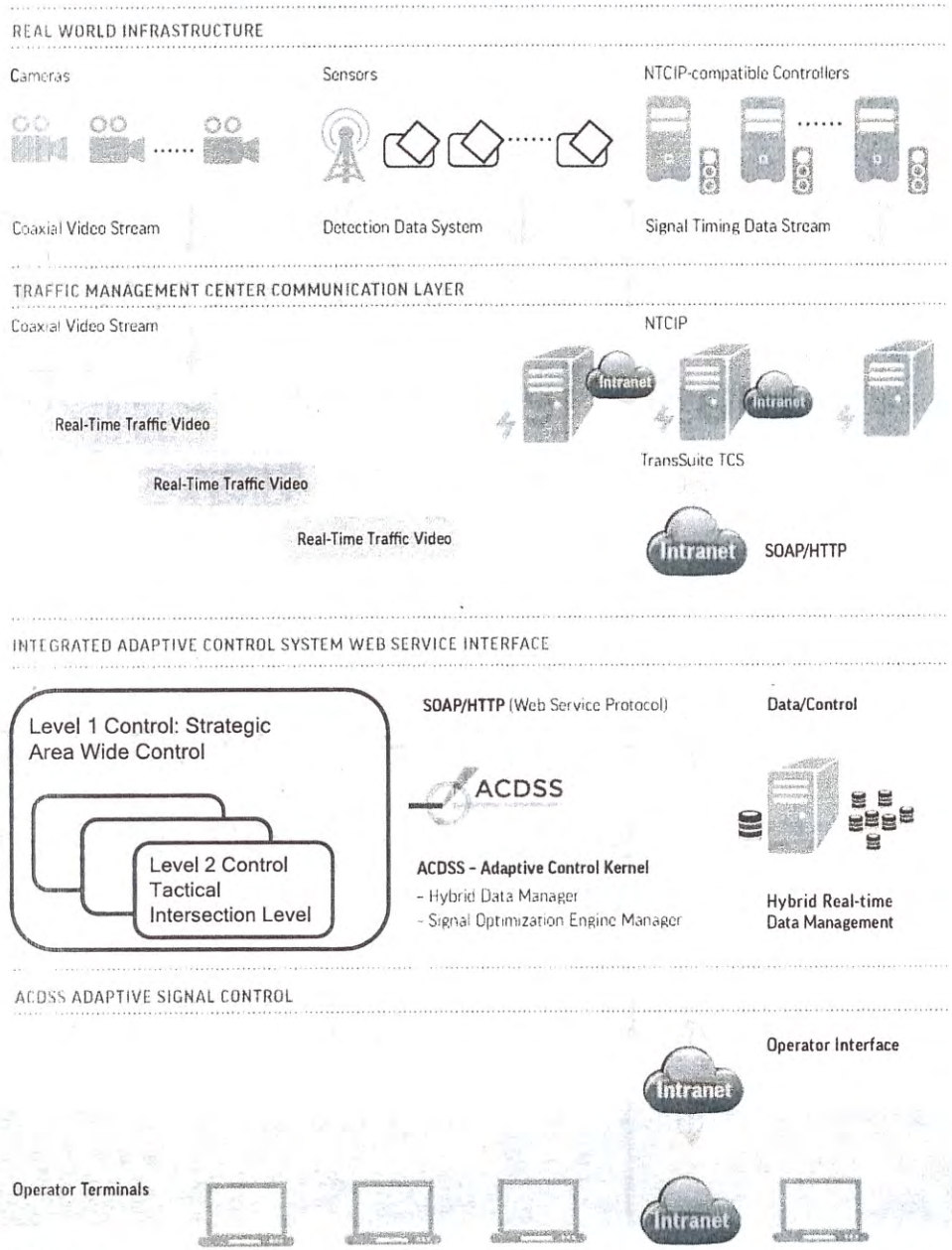
SI=1		Q < L/3
SI=2		L/3 < Q < 2L/3
SI=3		2L/3 < Q < 3L/4
SI=4		Q > 3L/4

Key Concepts

- Median travel time is a good and effective metric
- Travel time can be shown in 4 control zones based upon number of stops, as a basic user-perceived metric
- Hierarchical control on two levels, to respond in different time frames and different spatial extent
  - Level 1 recommends time plans to the operator, by street
  - Level 2 reallocates green at critical locations, opportunistically

System Architecture

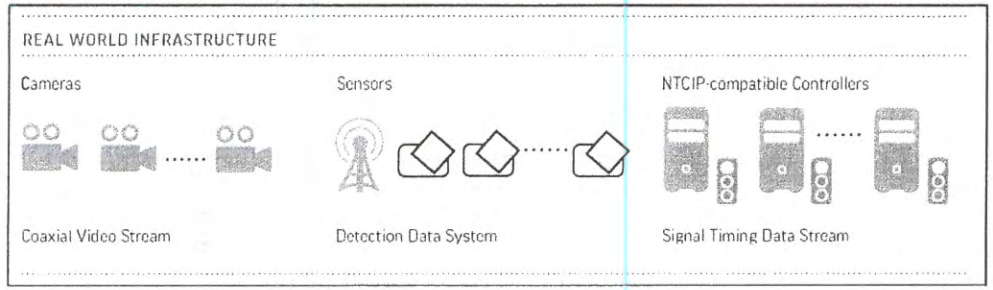
4 Components



Acknowledgements to TransCore ITS, with Ray Martinez here for the Q&A

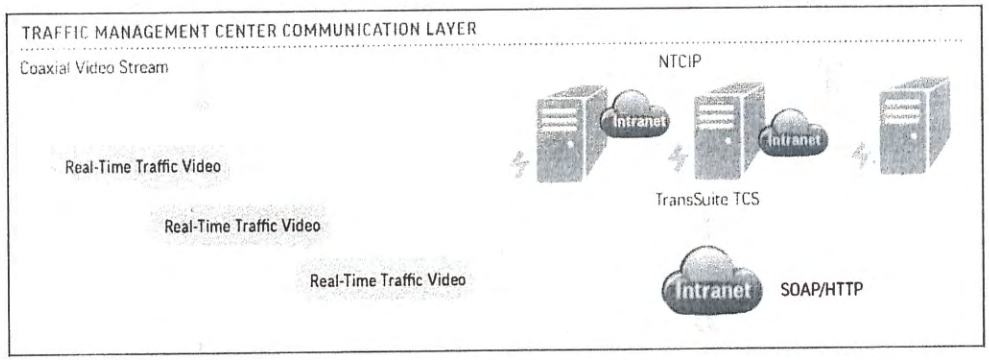
System Architecture

1. ITS in Field



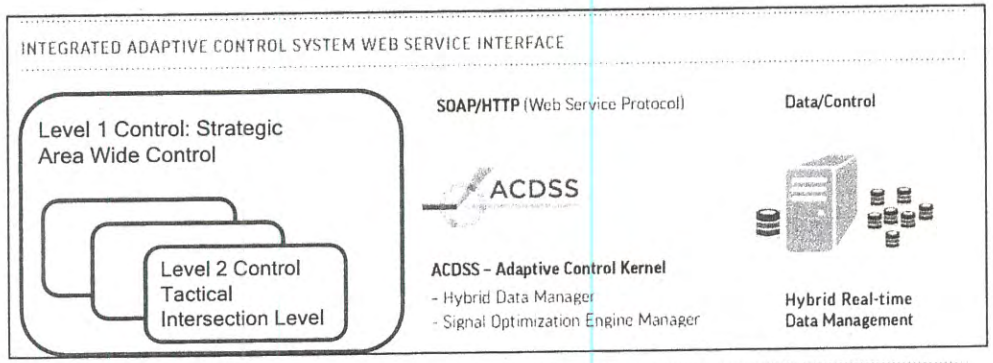
System Architecture

2. Communication Layer

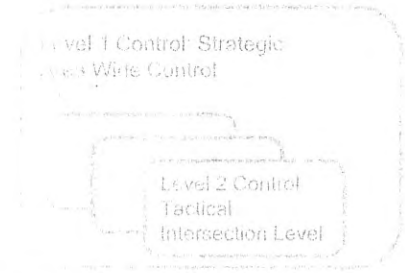


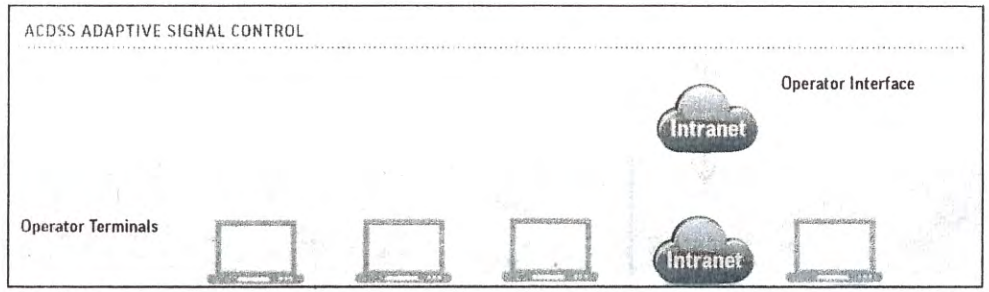
System Architecture

3. ATM Component



System Architecture





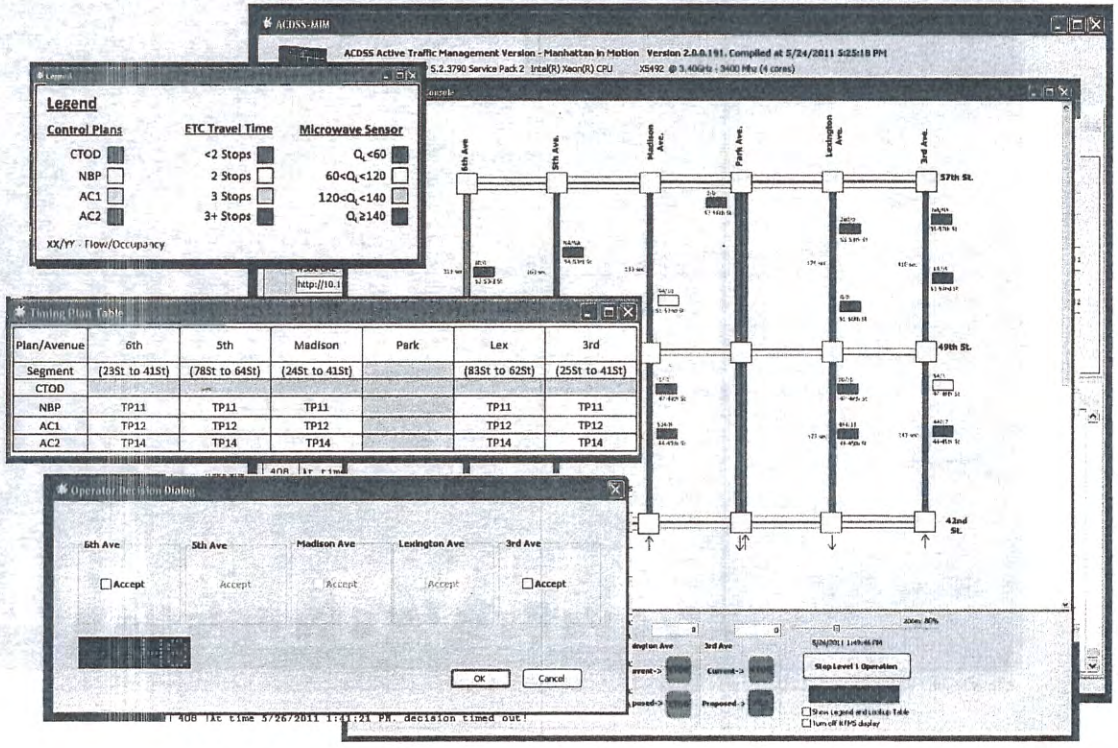
4. Operator and GUI

MIM ACTIVE TRAFFIC MANAGEMENT INITIATIVE AS IMPLEMENTED & USED

John Tipaldo, PhD P.E.
Director, NYCDOT ITS

Live @ TMC

- Real time data processed
- ATM system recommends changes to operator
- Operator reviews field video
- Action taken, if deemed necessary



MIM In Action

REAL TIME DATA

Sensors

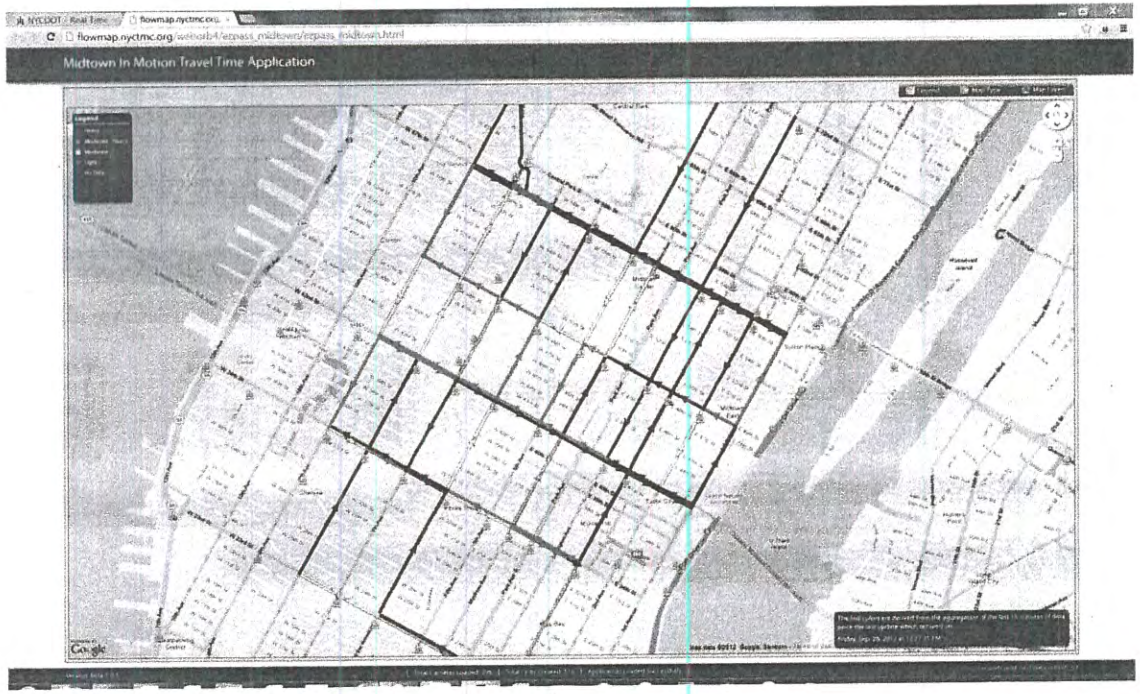
Travel Time

Flow, Occupancy

ANALYSIS + RECOMMENDATIONS

REVIEW FIELD CONDITIONS

TAKE ACTIONS BASED ON REVIEW



MIM In Action

REAL TIME DATA

↓

ANALYSIS + RECOMMENDATIONS

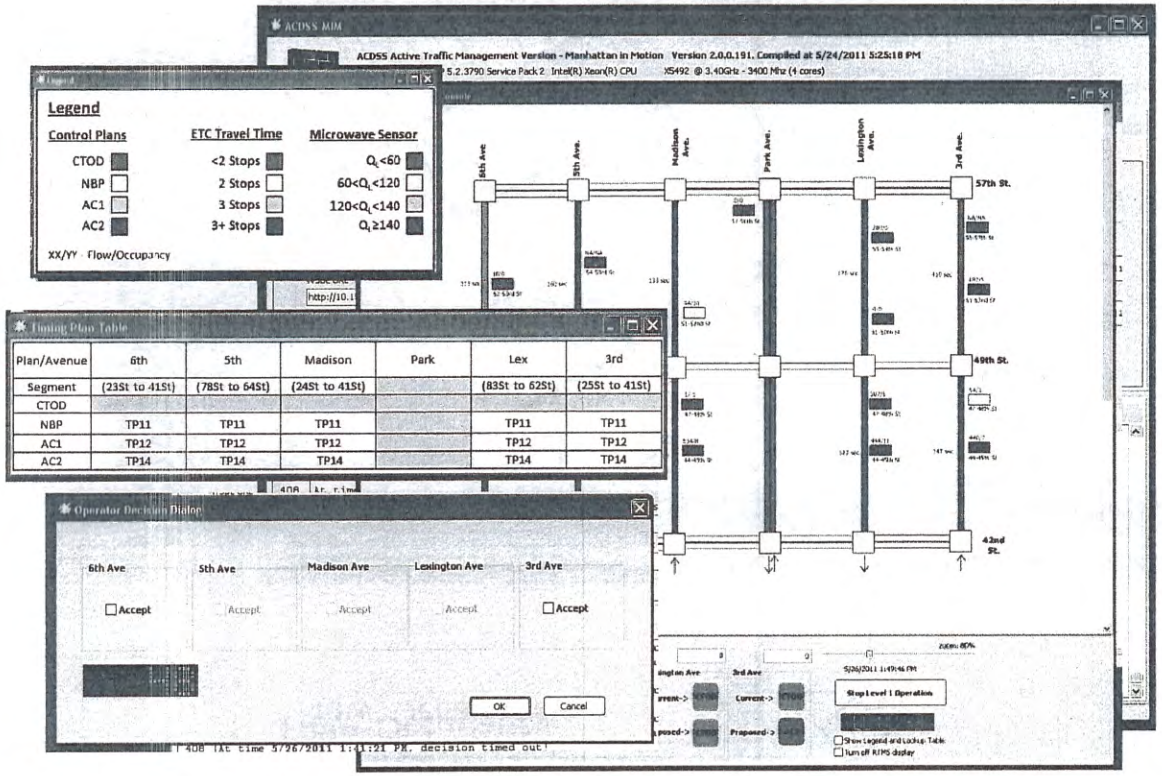
↓

REVIEW FIELD CONDITIONS

↓

TAKE ACTIONS BASED ON REVIEW

Recommend New Signal Timing Plans



MIM In Action

REAL TIME DATA

↓

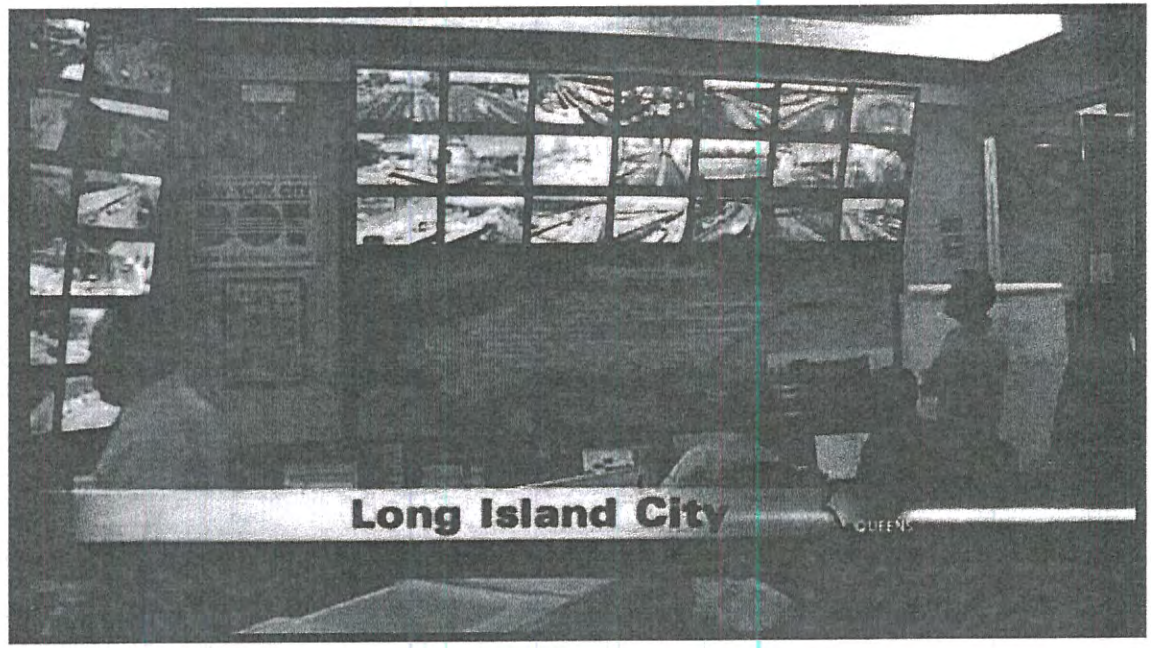
ANALYSIS + RECOMMENDATIONS

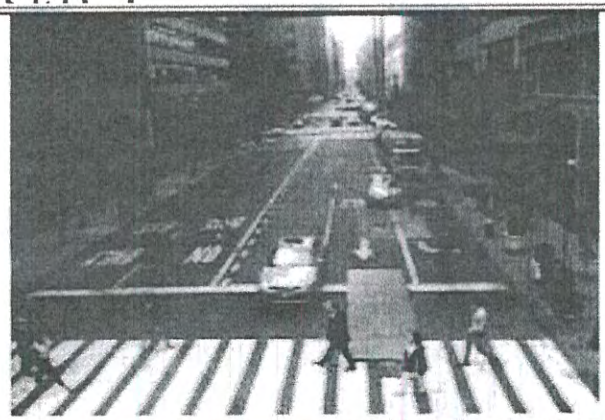
↓

REVIEW FIELD CONDITIONS

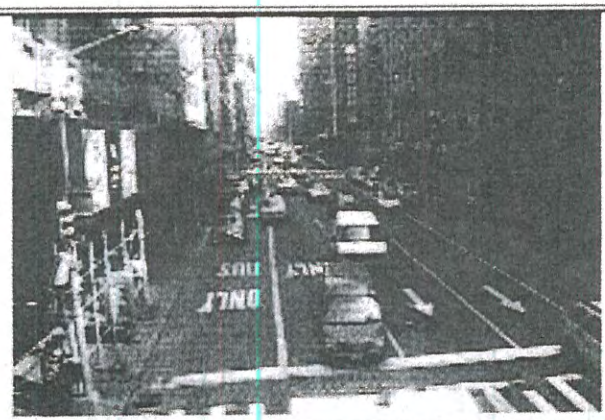
↓

TAKE ACTIONS BASED ON REVIEW





Madison Avenue and 49St



Lexington Avenue and 49St

MIM In Action

REAL TIME DATA

↓

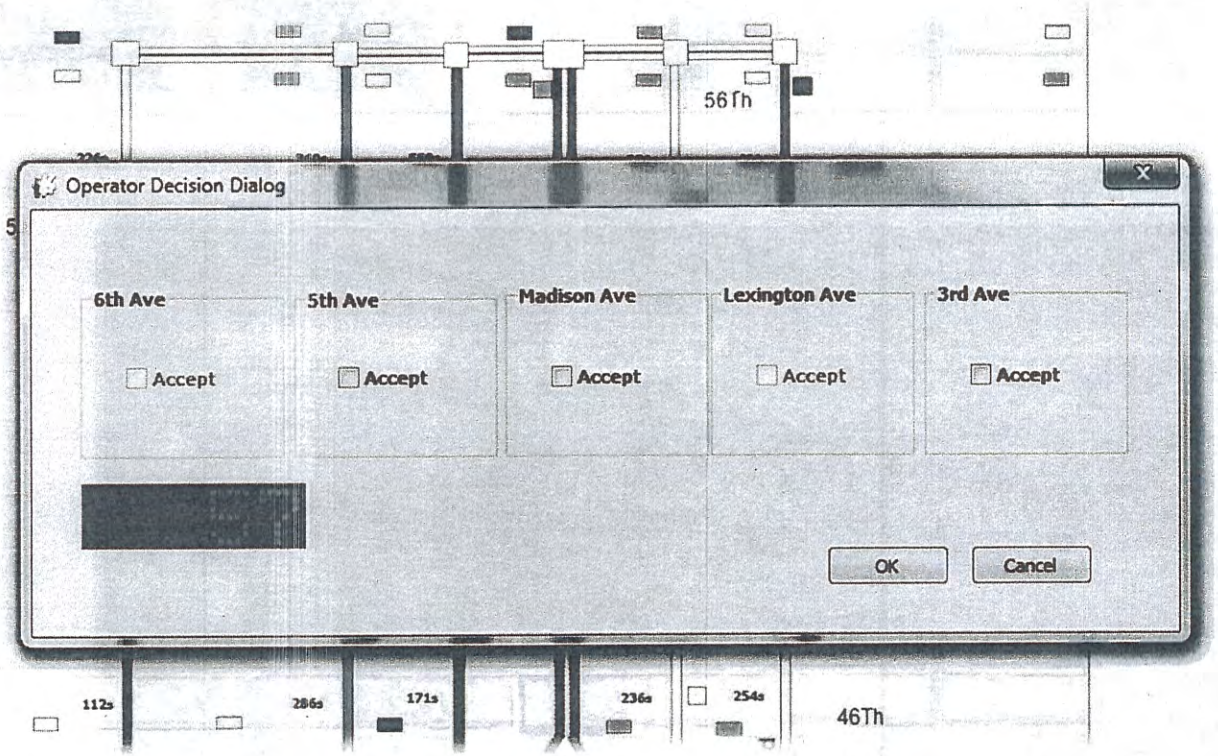
ANALYSIS + RECOMMENDATIONS

↓

REVIEW FIELD CONDITIONS

↓

TAKE ACTIONS BASED ON REVIEW



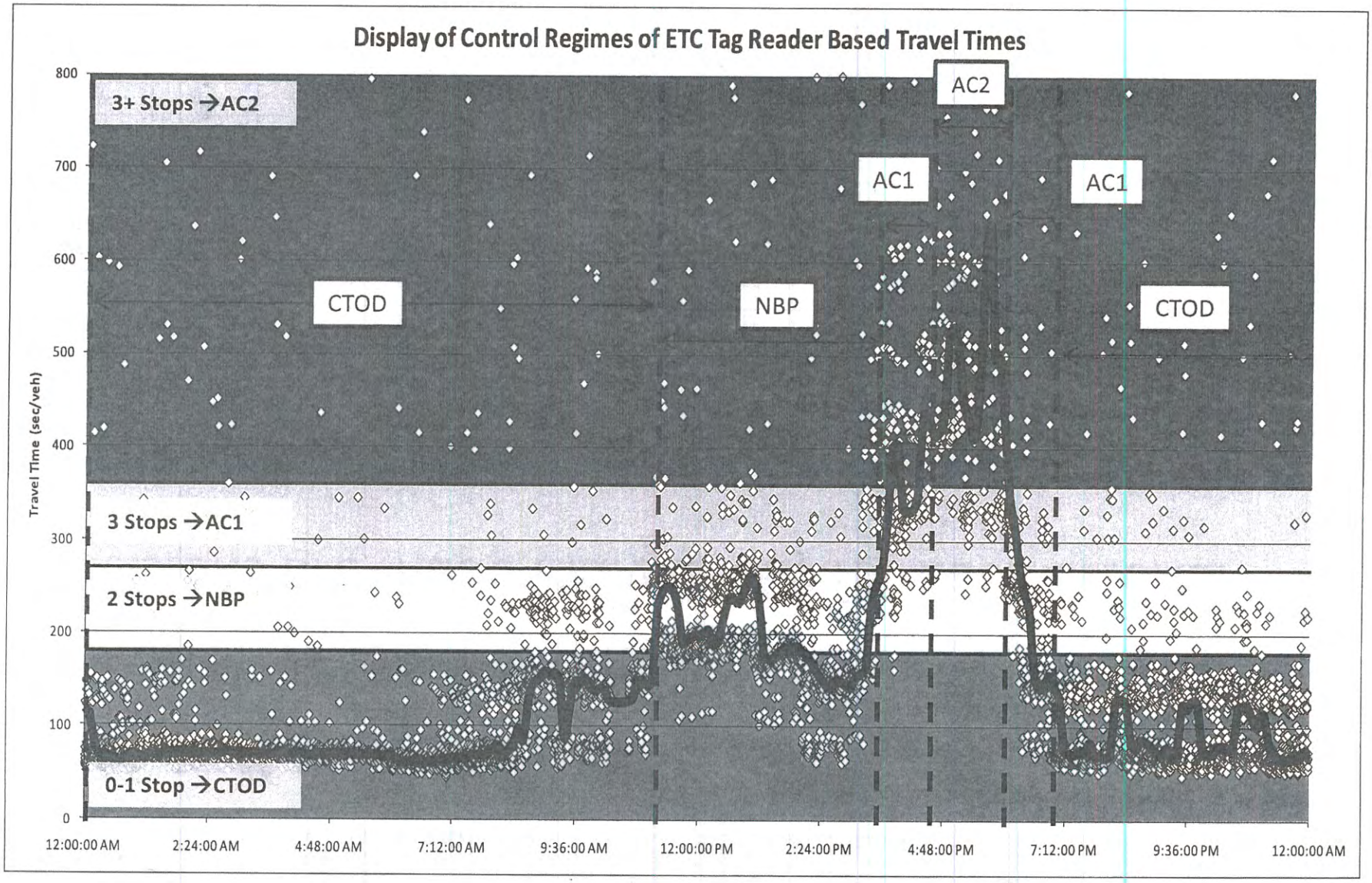
ALGORITHMS AND METRICS OF THE MIM ACTIVE TRAFFIC MANAGEMENT INITIATIVE

Satya Muthuswamy, P.E. PTOE
President, KLD

Metrics

- Level of System Usage
- Travel Time
  - Calendar Format
  - "Coffee Spill" plot
- Queue length and Severity Index
  - Relative Distribution
  - Average SI
  - Equity Ratio

Level of Activity



Level of Activity

- TMC staff using the tool
- Acting on recommendations
- Decisions are made individually for each arterial

Average no. of plan changes per day

year	Month	6 Ave	5 Ave	Madison Ave	Lexington Ave	3 Ave
2011	Aug	0	4	2	3	3
2011	Sep	2	4	4	6	6
2011	Oct	3	4	4	3	4
2011	Nov	2	4	2	4	4
2011	Dec	3	5	2	5	6
2012	Jan	2	3	3	3	4
2012	Feb	1	3	3	3	2
2012	Mar	2	3	5	2	3
2012	Apr	0	3	1	2	3
2012	May	4	5	5	5	4
2012	Jun	3	4	4	4	4

Max no. of plan changes per day

year	Month	6 Ave	5 Ave	Madison Ave	Lexington Ave	3 Ave
2011	Aug	2	10	7	7	6
2011	Sep	7	11	14	16	10
2011	Oct	9	8	8	7	9
2011	Nov	6	9	7	8	10
2011	Dec	9	10	10	10	14
2012	Jan	6	8	9	5	10
2012	Feb	6	9	10	8	8
2012	Mar	9	7	9	4	9
2012	Apr	1	4	2	3	4
2012	May	7	8	10	10	6
2012	Jun	7	8	6	8	6

Level of Activity

- TMC staff using the tool
- Acting on recommendations
- Decisions are made individually for each arterial

Average no. of plan changes per day

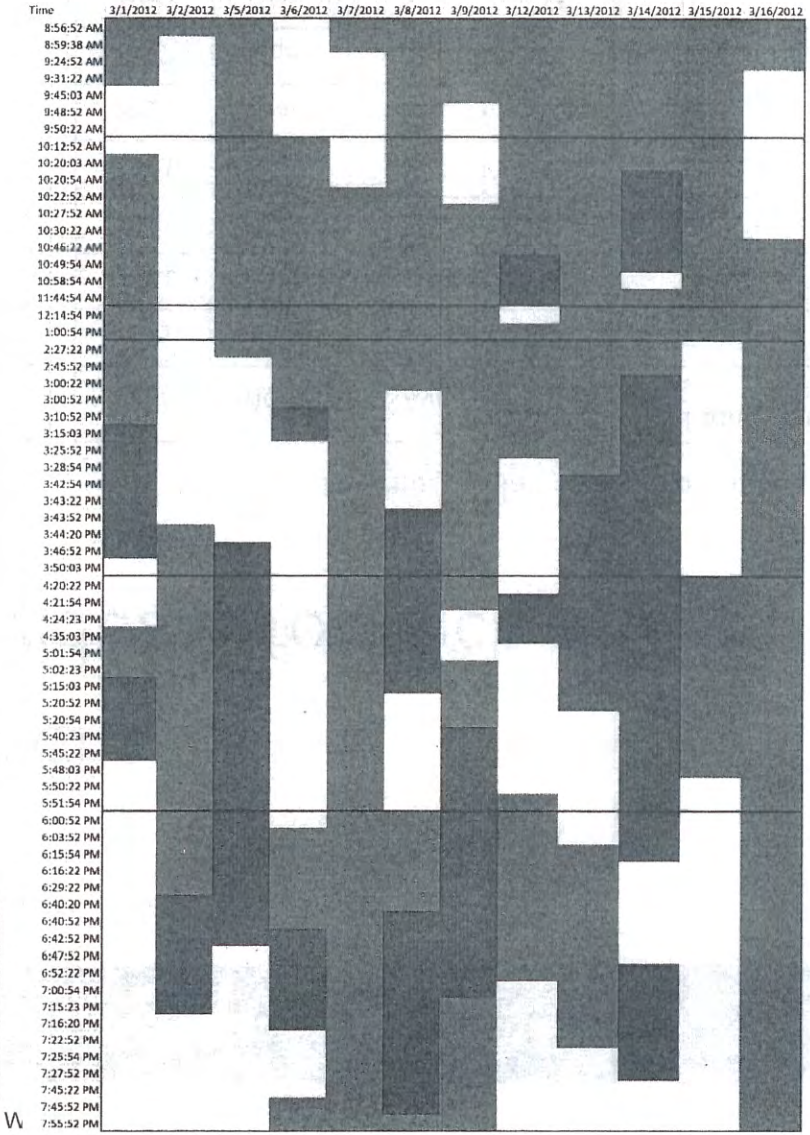
year	Month	6 Ave	**5 Ave**	Madison Ave	Lexington Ave	3 Ave
2011	Aug	0	**4**	2	3	3
2011	Sep	2	**4**	4	6	6
2011	Oct	3	**4**	4	3	4
2011	Nov	2	**4**	2	4	4
2011	Dec	3	**5**	2	5	6
2012	Jan	2	**3**	3	3	4
2012	Feb	1	**3**	3	3	2
2012	Mar	2	**3**	5	2	3
2012	Apr	0	**3**	1	2	3
2012	May	4	**5**	5	5	4
2012	Jun	3	**4**	4	4	4

Max no. of plan changes per day

year	Month	6 Ave	**5 Ave**	Madison Ave	Lexington Ave	3 Ave
2011	Aug	2	**10**	7	7	6
2011	Sep	7	**11**	14	16	10
2011	Oct	9	**8**	8	7	9
2011	Nov	6	**9**	7	8	10
2011	Dec	9	**10**	10	10	14
2012	Jan	6	**8**	9	5	10
2012	Feb	6	**9**	10	8	8
2012	Mar	9	**7**	9	4	9
2012	Apr	1	**4**	2	3	4
2012	May	7	**8**	10	10	6
2012	Jun	7	**8**	6	8	6

Level of Activity

- Madison Avenue – Sample of control decisions



- Varying levels of activity

March 2012

NBP

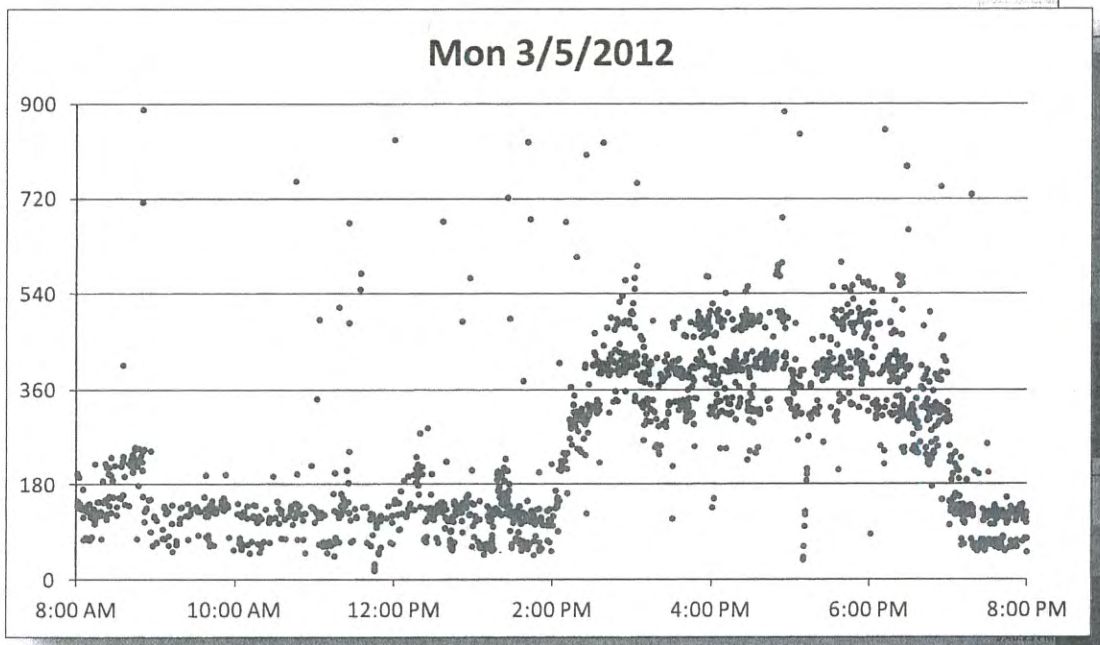
AC1

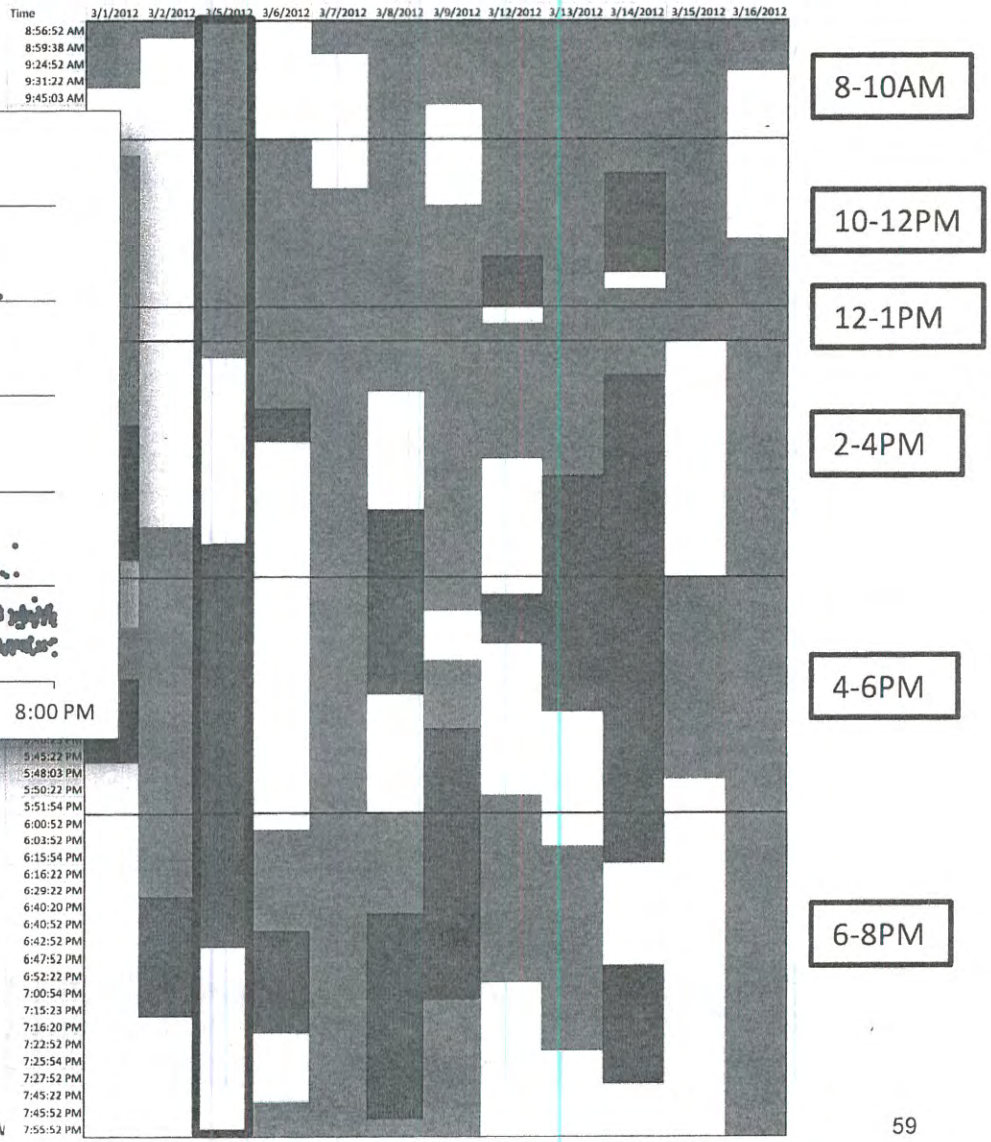
AC2

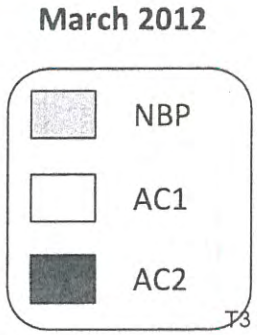
T3 W

Level of Activity

- Madison Avenue – Sample of control decisions







T3 W

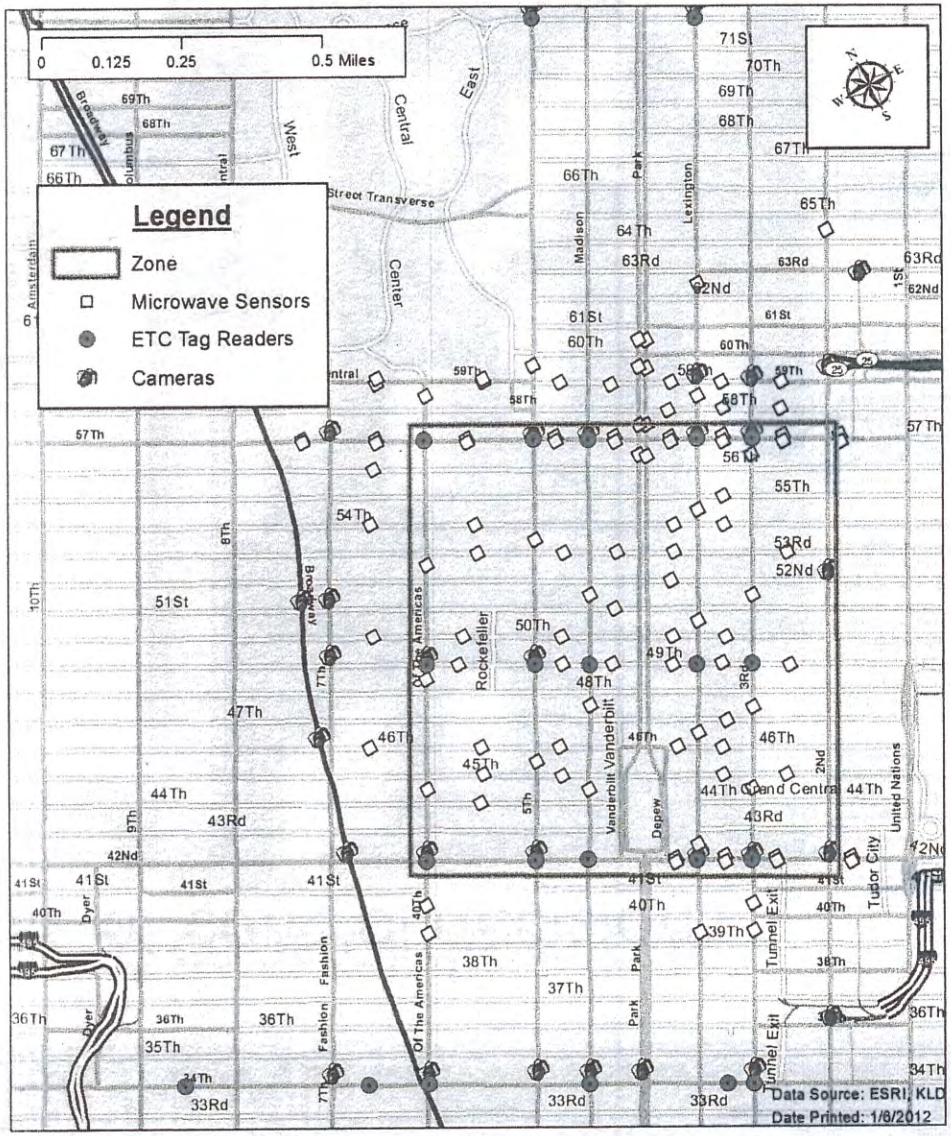
NEW YORK CITY DOT
U.S Department of Transportation
Federal Highway Administration

Real-Time Data Sources

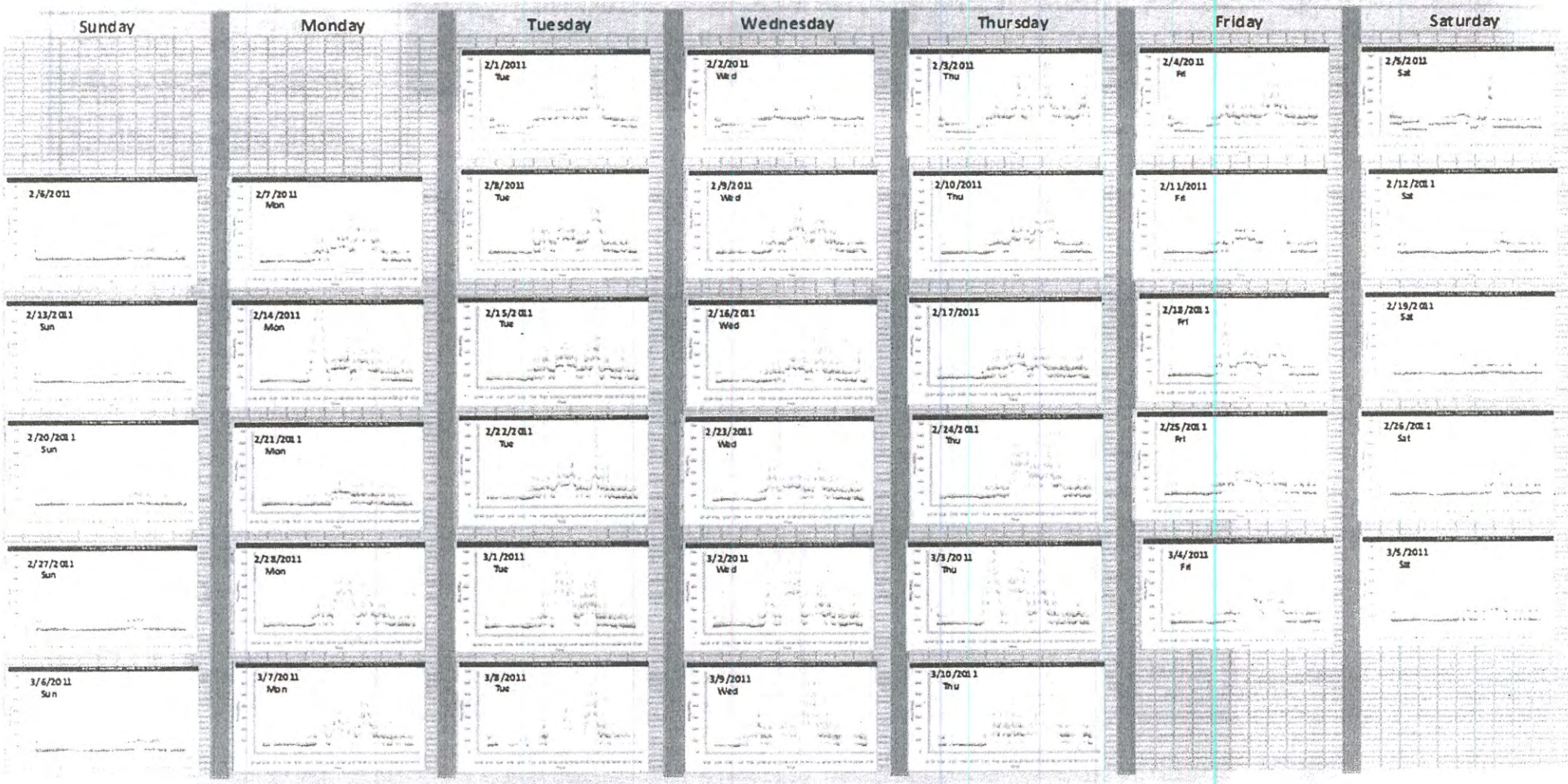
- ETC Tag Readers
  - Travel Time
  - 23 readers
  - 43 segments
  - **24,000 records per day**

- Microwave Sensors
  - Flow and Occupancy
  - 100 sensors
  - Up to 4 lanes per location
  - **743,000 records per day**

Midtown in Motion
Sensors, Readers, Cameras



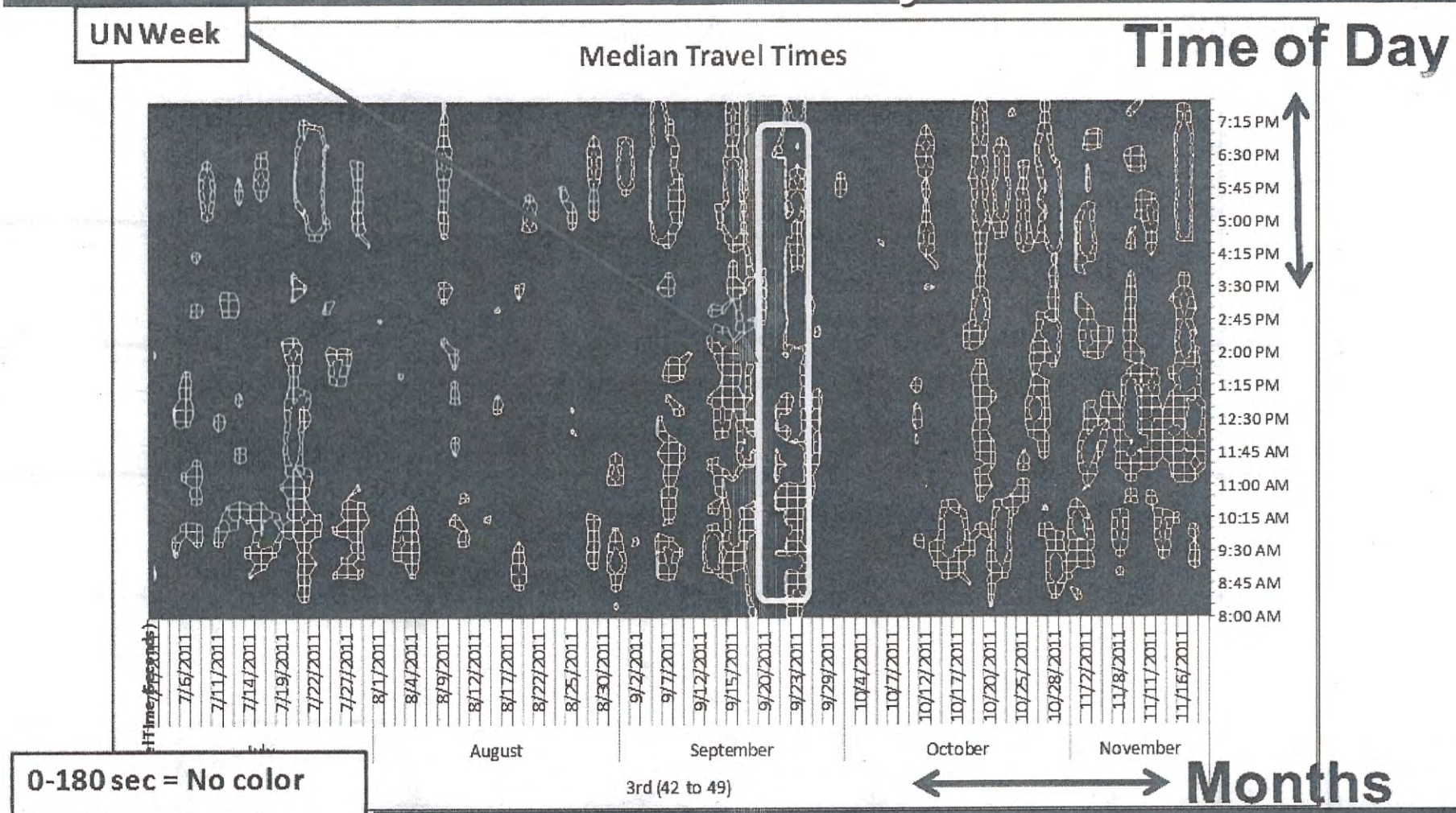
Travel Time: Variability is the Norm



One Month data (Feb 1 to March 10, 2011) for one segment

Variability, is the norm

Travel Time – History over Time



0-180 sec = No color
180-270 sec = Yellow
270-360 sec = Orange
> 360 sec = Red

Median travel time across months, shown above

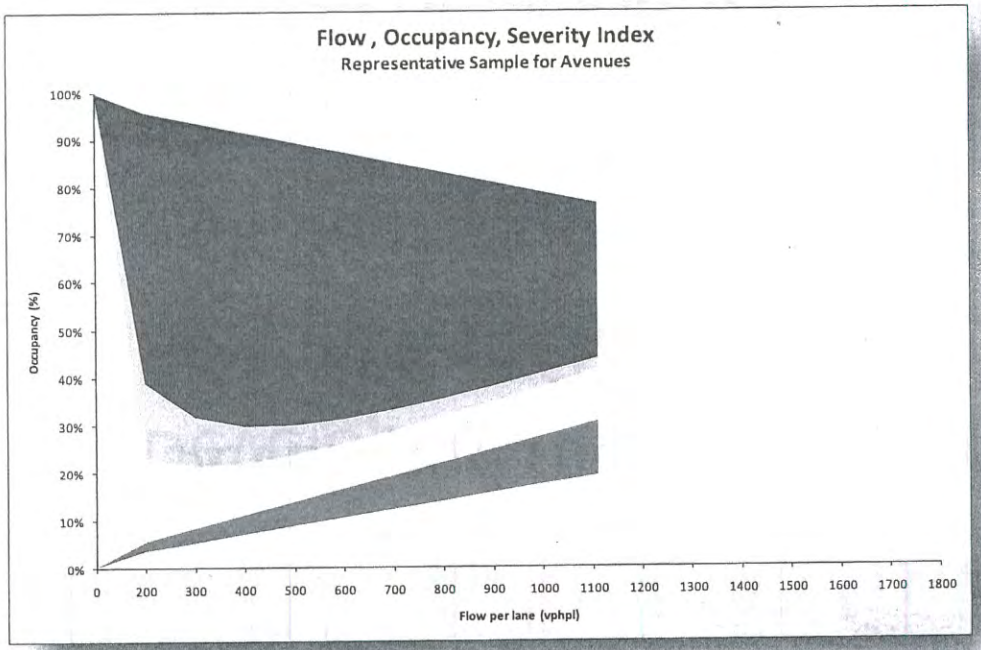
Seasonal demand, Special events, incidents, etc. trigger some congestion despite ATM

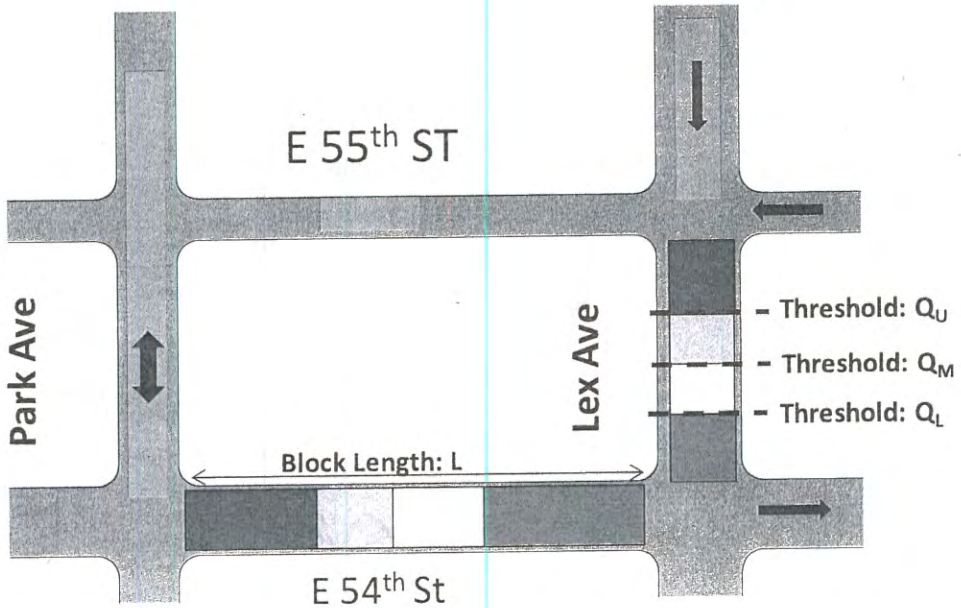
Care must be exercised in before/after evaluation

NEW YORK CITY DOT | U.S Department of Transportation Federal Highway Administratio

Severity Index (SI)

- Measure of queuing condition, relative to block length
- Estimate queue using flow/occupancy and then calculate SI

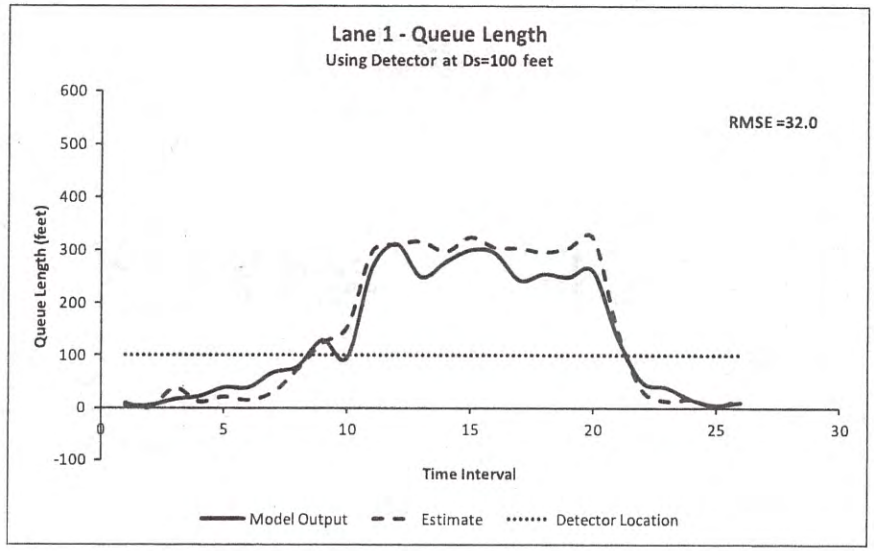


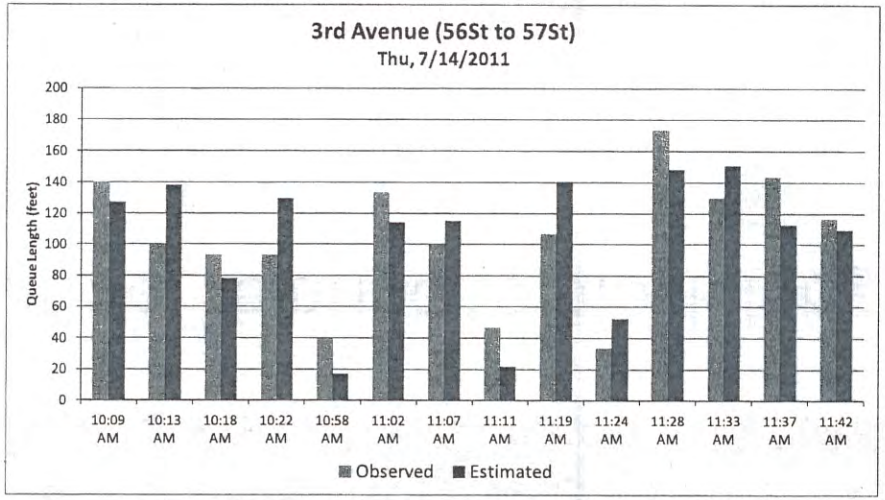


SI=1		Q < L/3
SI=2		L/3 < Q < 2L/3
SI=3		2L/3 < Q < 3L/4
SI=4		Q > 3L/4

Queue Estimation Algorithm

- Developed methodology to estimate queue using flow and occupancy
- Minimal set of inputs
- Robust queue estimates for real time control
- Tested using simulated and real world data
- 2013 TRB paper





Severity Index (SI) and Control Policy

Travel Time <= 1 stop

		Cross Street SI			
		1	2	3	4
Avenue SI	1	Do Nothing	Street + Δ_1	Street + Δ_2	Street + Δ_2
	2	Ave + Δ_1	Do Nothing	Street + Δ_1	Street + Δ_1
	3	Ave + Δ_2	Ave + Δ_1	Reset to Default	Reset to Default
	4	Ave + Δ_2	Ave + Δ_1	Reset to Default	Reset to Default

Travel Time > 1 stop

		Cross Street SI			
		1	2	3	4
Avenue SI	1	Reset to Default	Reset to Default	Reset to Default	Reset to Default
	2	Ave + Δ_1	Reset to Default	Reset to Default	Reset to Default
	3	Ave + Δ_2	Ave + Δ_1	Reset to Default	Reset to Default
	4	Ave + Δ_2	Ave + Δ_1	Reset to Default	Reset to Default

- Use travel time and Severity Index
- Adjust signal splits – user defined
- Four policy actions
  1. Do Nothing
  2. Change by Δ_1
  3. Change by Δ_2
  4. Reset to default

SI and Control Policy

Travel Time <= 1 stop

Avenue SI	Cross Street SI: 1	2	3	4
1	Do Nothing	Street + Δ_1	Street + Δ_2	Street + Δ_2
2	Ave + Δ_1	Do Nothing	Street + Δ_1	Street + Δ_1
3	Ave + Δ_2	Ave + Δ_1	Reset to Default	Reset to Default
4	Ave + Δ_2	Ave + Δ_1	Reset to Default	Reset to Default

Travel Time > 1 stop

Avenue SI	Cross Street SI: 1	2	3	4
1	Reset to Default	Reset to Default	Reset to Default	Reset to Default
2	Ave + Δ_1	Reset to Default	Reset to Default	Reset to Default
3	Ave + Δ_2	Ave + Δ_1	Reset to Default	Reset to Default
4	Ave + Δ_2	Ave + Δ_1	Reset to Default	Reset to Default

- Use travel time and SI
- Adjust signal splits – user defined
- Four policy actions
  1. Do Nothing
  2. Change by Δ_1
  3. Change by Δ_2
  4. Reset to default

SI and Control Policy

Travel Time <= 1 stop

		Cross Street SI			
		1	2	3	4
Avenue SI	1	Do Nothing	Street + Δ_1	Street + Δ_2	Street + Δ_2
	2	Ave + Δ_1	Do Nothing	Street + Δ_1	Street + Δ_1
	3	Ave + Δ_2	Ave + Δ_1	Reset to Default	Reset to Default
	4	Ave + Δ_2	Ave + Δ_1	Reset to Default	Reset to Default

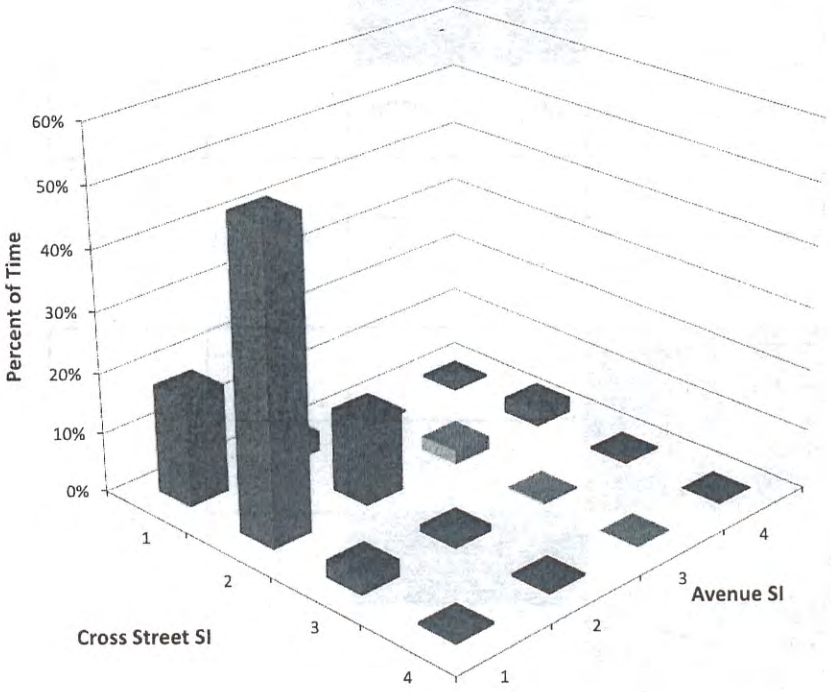
Travel Time > 1 stop

		Cross Street SI			
		1	2	3	4
Avenue SI	1	Reset to Default	Reset to Default	Reset to Default	Reset to Default
	2	Ave + Δ_1	Reset to Default	Reset to Default	Reset to Default
	3	Ave + Δ_2	Ave + Δ_1	Reset to Default	Reset to Default
	4	Ave + Δ_2	Ave + Δ_1	Reset to Default	Reset to Default

- Use travel time and SI
- Adjust signal splits – user defined
- Four policy actions
  1. Do Nothing
  2. Change by Δ_1
  3. Change by Δ_2
  4. Reset to default

New Metrics

- Relative Distribution of SI



		Crosstown St			
		1	2	3	4
Avenue	1	15%	15%		
	2	13%	21%		
	3	2%	1%%		
	4	8%	25%		

Lower SI, Shorter Queues on Crosstown Street

Same SI on Ave and Crosstown Street => Balanced Operations

Lower SI, Shorter Queues on Avenue

- Average SI – Avg. of SI by approach by interval
- Equity Ratio – Avg. SI (Cross St) / Avg. SI (Ave)

RESULTS & CONCLUDING REMARKS

Mohamad Talas, PhD P.E. PTOE
Deputy Director, NYCDOT ITS

Results to date

- Phase A
  - Initial results show an improvement of speeds around 10% within the study area
  - The overall speeds considering both inside study area and approaching study area were comparable
  - Level 2 control, has been helping to reduce queuing (and in turn gridlock) while achieving equity

Results to Date

- Comparison of average speed
- AM = 8AM to 10AM, MD = 11AM to 1PM, PM = 4PM to 6PM
- Highlighted cells for improved speed

		6th Avenue		5th Avenue		Madison Avenue		Lexington Avenue		3rd Avenue	
		Before	After	Before	After	Before	After	Before	After	Before	After
AM	Zone	7.4	8.5	6.9	7.1	6.9	7.8	5.3	5.3	5.6	6.5
	Outside	7.7	7.2	8.1	7.9	5.8	5.3	7.9	7.7	5.3	5.9
	Overall	7.5	8	7.5	7.5	6.5	6.7	6.3	6.2	5.5	6.3
MD	Zone	7.3	8	7.6	7.8	6.3	10.6	6.7	9.2	5.7	7.9
	Outside	9.2	7.7	5.3	5.6	5.6	7.7	6.7	6.1	5.7	6.3
	Overall	7.9	7.9	6.3	6.6	6	9.4	6.7	7.3	5.7	7.3
PM	Zone	6.6	7	5.2	6	7.6	8.2	8.6	8.8	5.1	5.3
	Outside	8.8	7.4	7	6.3	8.6	7.3	5.9	5.6	7.7	7
	Overall	7.2	7.1	5.9	6.1	7.9	7.8	7	6.8	5.8	5.8

Project Accolades

- Awards
  - IRF, ACEC, ITS America
- Public Profile
  - Favorable media coverage

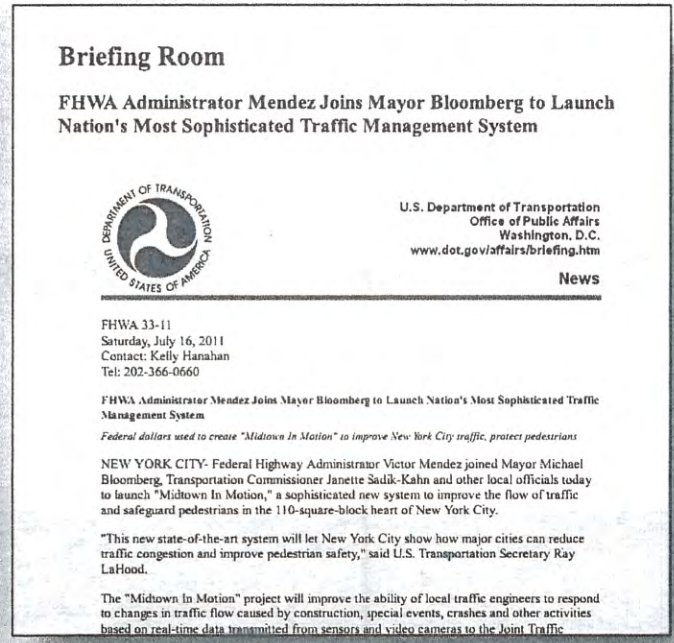
IRF GRAA

ITS AMERICA

Smart Solution Spotlight Award

ACEC
American Council of Engineering Companies
100 Years of Excellence

Diamond Award for Engineering Excellence



Briefing Room

FHWA Administrator Mendez Joins Mayor Bloomberg to Launch Nation's Most Sophisticated Traffic Management System

U.S. Department of Transportation
Office of Public Affairs
Washington, D.C.
www.dot.gov/affairs/briefing.htm

News

FHWA 33-11
Saturday, July 16, 2011
Contact: Kelly Hanahan
Tel: 202-366-0660

FHWA Administrator Mendez Joins Mayor Bloomberg to Launch Nation's Most Sophisticated Traffic Management System

Federal dollars used to create "Midtown In Motion" to improve New York City traffic, protect pedestrians

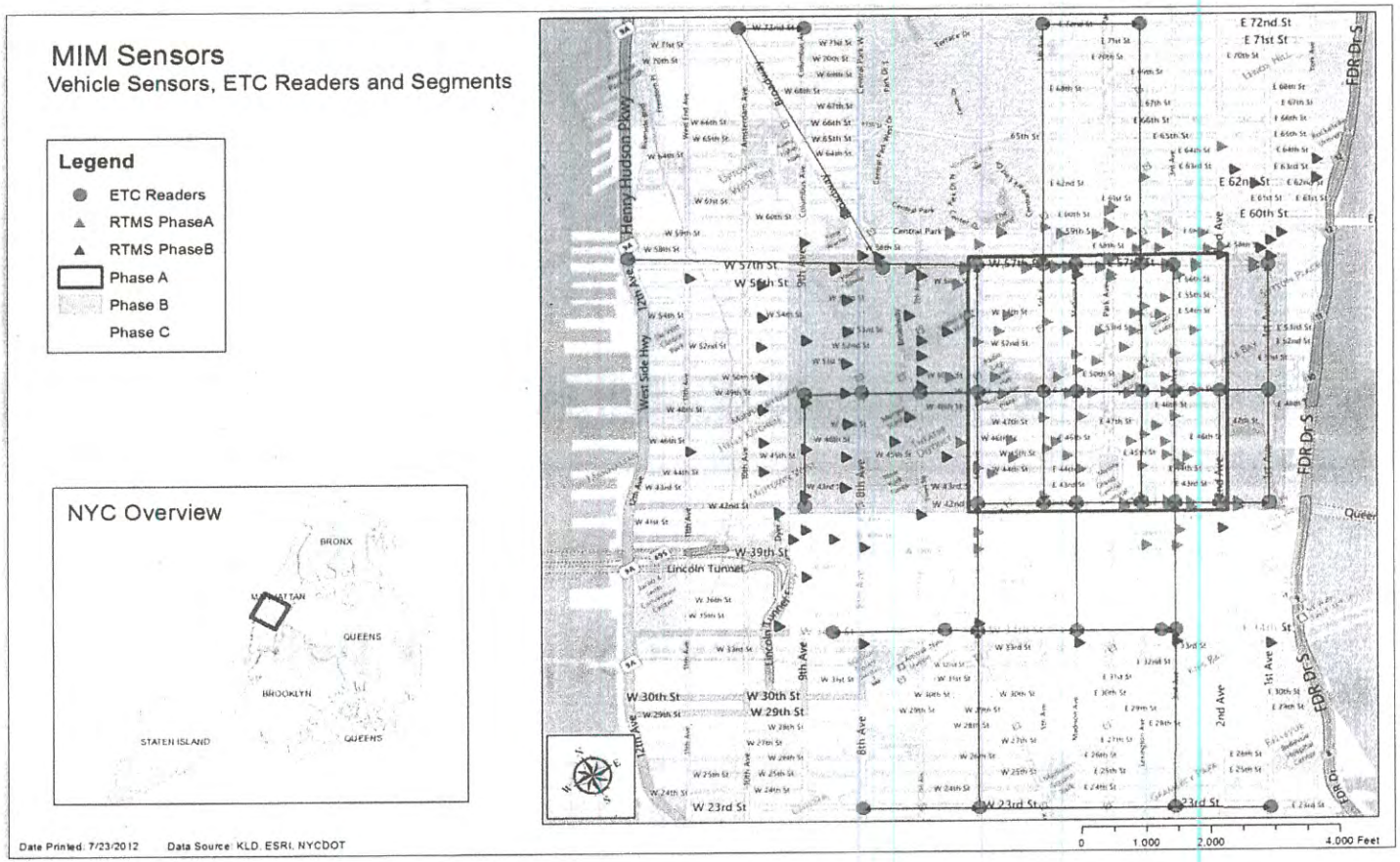
NEW YORK CITY- Federal Highway Administrator Victor Mendez joined Mayor Michael Bloomberg, Transportation Commissioner Janette Sadik-Kahn and other local officials today to launch "Midtown In Motion," a sophisticated new system to improve the flow of traffic and safeguard pedestrians in the 110-square-block heart of New York City.

"This new state-of-the-art system will let New York City show how major cities can reduce traffic congestion and improve pedestrian safety," said U.S. Transportation Secretary Ray LaHood.

The "Midtown In Motion" project will improve the ability of local traffic engineers to respond to changes in traffic flow caused by construction, special events, crashes and other activities based on real-time data transmitted from sensors and video cameras to the Joint Traffic

Next Steps

- Planned Expansion
  - Phase B will be live shortly
  - Phase C underway



Data Sharing

- NYCDOT developed a tool to view travel time data
- NYCDOT will share information with app developers

Lessons Learned

- Cost effective solution, built on existing ITS
- Rapid deployment of ITS in record time
- ITS design adapted to conditions
  - Mid block vehicle sensors
  - Optimized ETC tag readers locations
- Centralized control and monitoring
  - Integrate technologies in operations
  - ATM makes recommendations
  - Operator review using cameras
  - Decision making and action

Lessons Learned

- Reliable data source for real time control
  - Travel time data using ETC tag readers
  - Flow and occupancy from microwave sensors
- Robust metrics for real time control
  - Median travel time for control decisions
  - Severity Index
- Hierarchical control is very effective to minimize gridlock and congestion
  - Strategic – Level 1
  - Tactical – Level 2

Acknowledgements

We wish to thank all team members of this project:

- FHWA
- New York City DOT
- TransCore
- KLD
- Peek Traffic
- ISS/EIS

Participant Q&A