U.S. Department of Transportation
Federal Highway Administration

ACS-Lite

The Next Generation of Traffic Signal Control

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HOTM / Resource Center
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Federal Highway Administration
RESOURCE CENTER

Outline

Background on adaptive traffic signal Systems

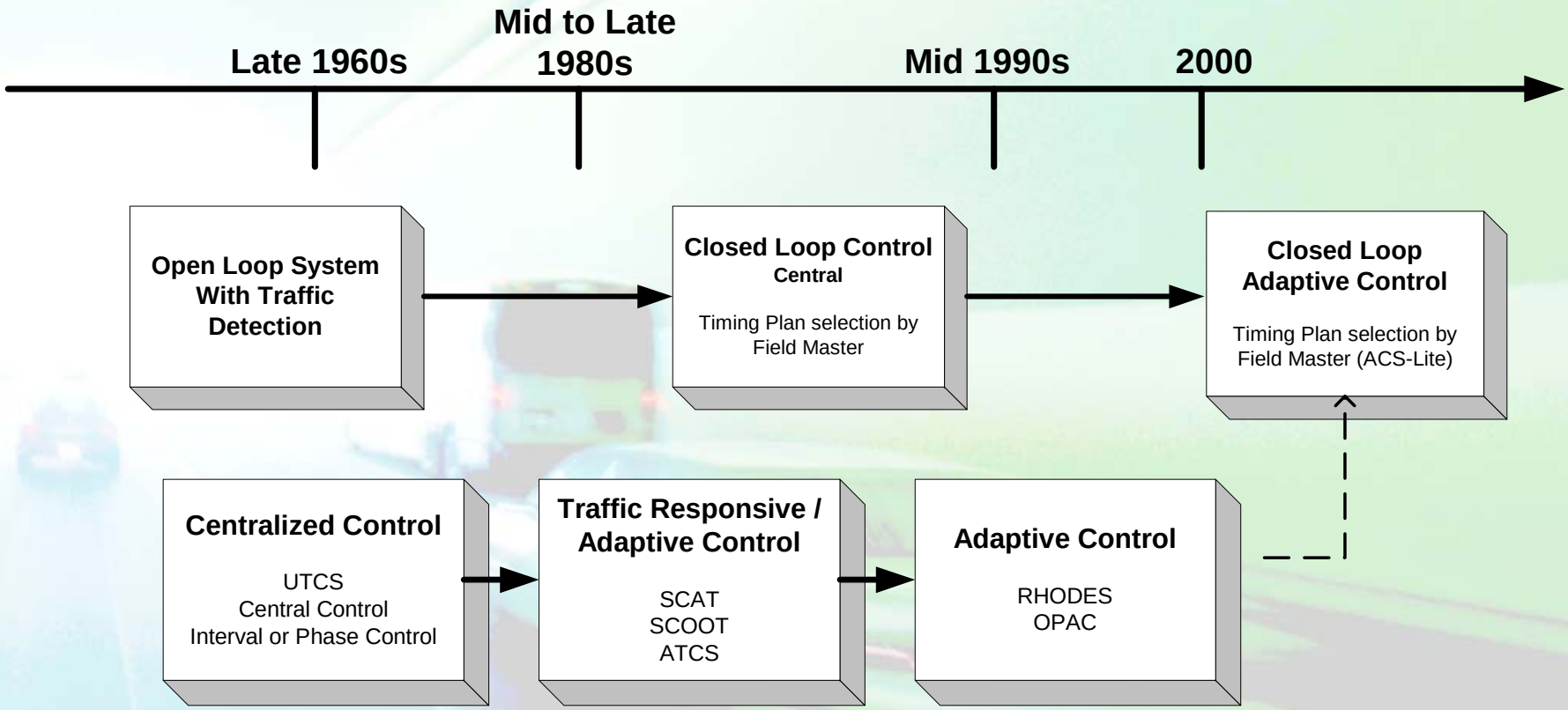
ACS-Lite

- Goals
- Development
- Functionality

Field Test

Next steps

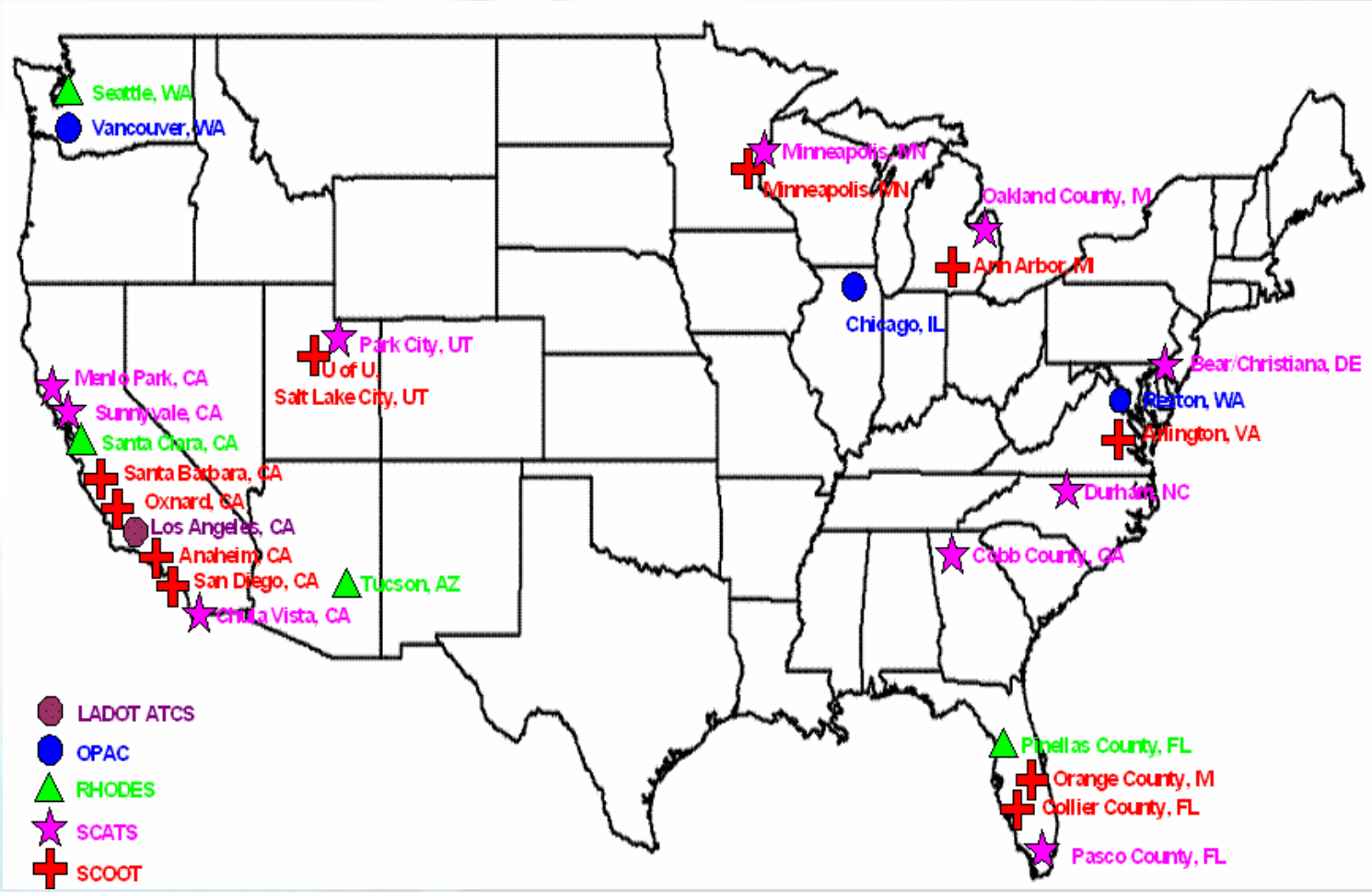
Traffic Signal Control Evolution



Benefits of Adaptive Signal Timing

- **Responsive to traffic conditions**
  - Reduce traffic delay
  - Delays onset of saturated conditions
- **Reduces or eliminates the need to retime traffic signals**
  - $1800 – $3500 / intersection
- **Improvements over Time Of Day plans**
  - Travel time
  - Delay
  - Stops
  - Fuel consumption
- **Data collection and archiving**

Adaptive Control Deployment



Adaptive Control Deployment

	SCATS	SCOOT	OPAC	RHODES	ATCS	OTHER
# of Systems	10	4	5	4	1	1
# of Signals	906	193	62	41	756	10

Disadvantages

- High capital cost $$$
- Requires extensive calibration & monitoring
- Requires active maintenance of traffic detectors
- Communications overhead
- More technical staffing

FHWA Goals for ACS-Lite

- **Low cost**
- **Leverage existing infrastructure**
  - Standard US-style actuated controllers and logic (rings, phases, splits, barriers, gap-out/extension, etc.)
  - Typical agency detector layouts
  - Typical communications
  - “Retro-fit” with major US signal system vendors
- **Reduce agency expenditure for adaptive control**
- **Operate without connectivity to a TMC**
- **Use NTCIP**

Project Team

U.S. Department of Transportation
Federal Highway Administration

SIEMENS

ECONOLITE
CONTROL PRODUCTS, INC.

PURDUE
UNIVERSITY

EAGLE Traffic Control Systems

THE UNIVERSITY OF
ARIZONA.
TUCSON ARIZONA

McCain

ITT Industries
Engineered for life

PEEK

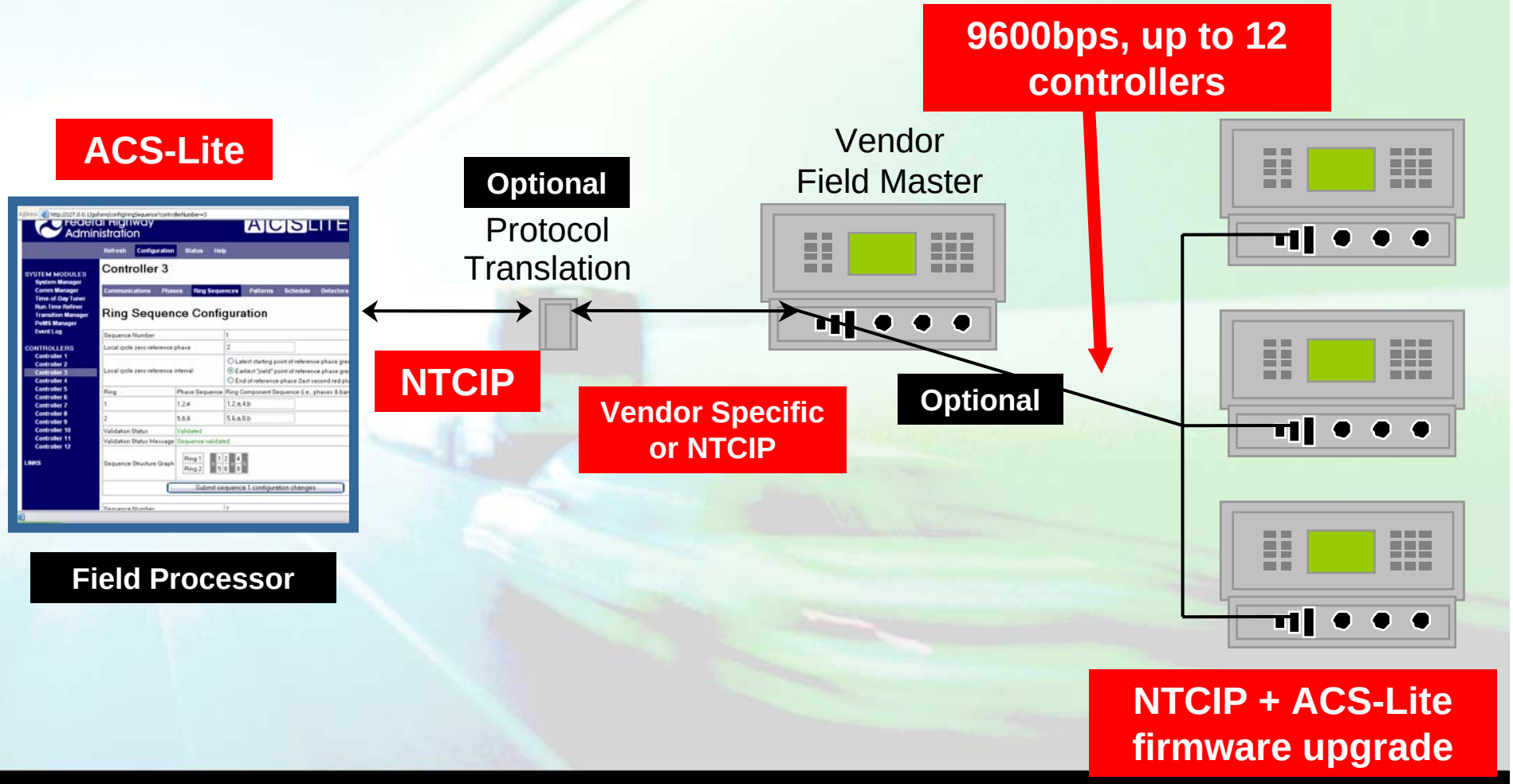
Adaptive Control Software – Lite (Outcome)

- **Based on Rhodes**
- **TOD Plans for base signal timing**
- **Closed Loops Field Master Based Architecture**
  - Target Market
    - 20,000 Systems
    - 200,000 Intersections
- **Minimizes Traffic Detection needs**
- **Low bandwidth communications**

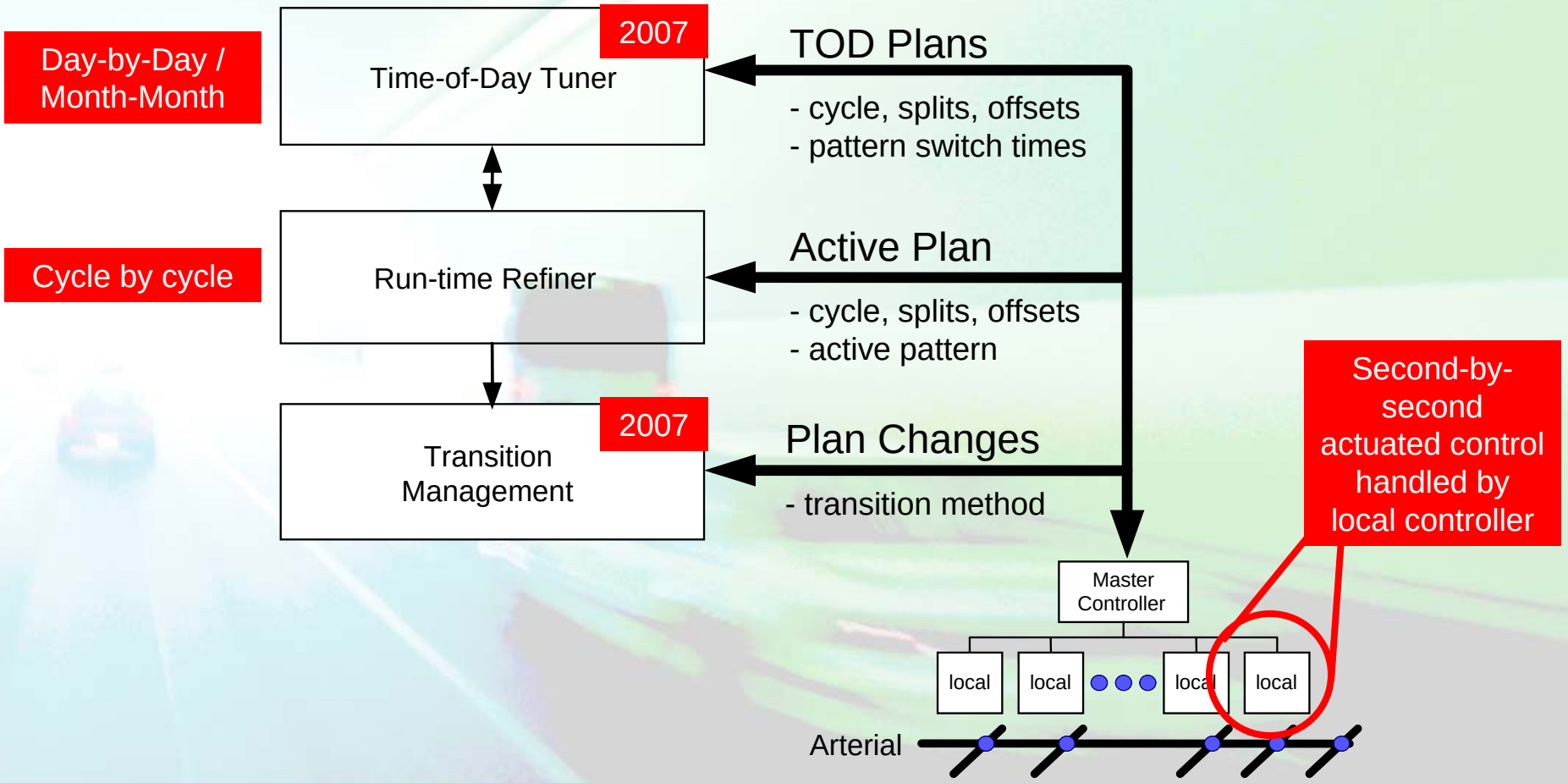
ACS-Lite Functionality

- Architecture
- Algorithms
- Detection layout
- Data acquisition
- Split tuning process
- Offset tuning process

ACS-Lite System Architecture



ACS-Lite Algorithms Architecture



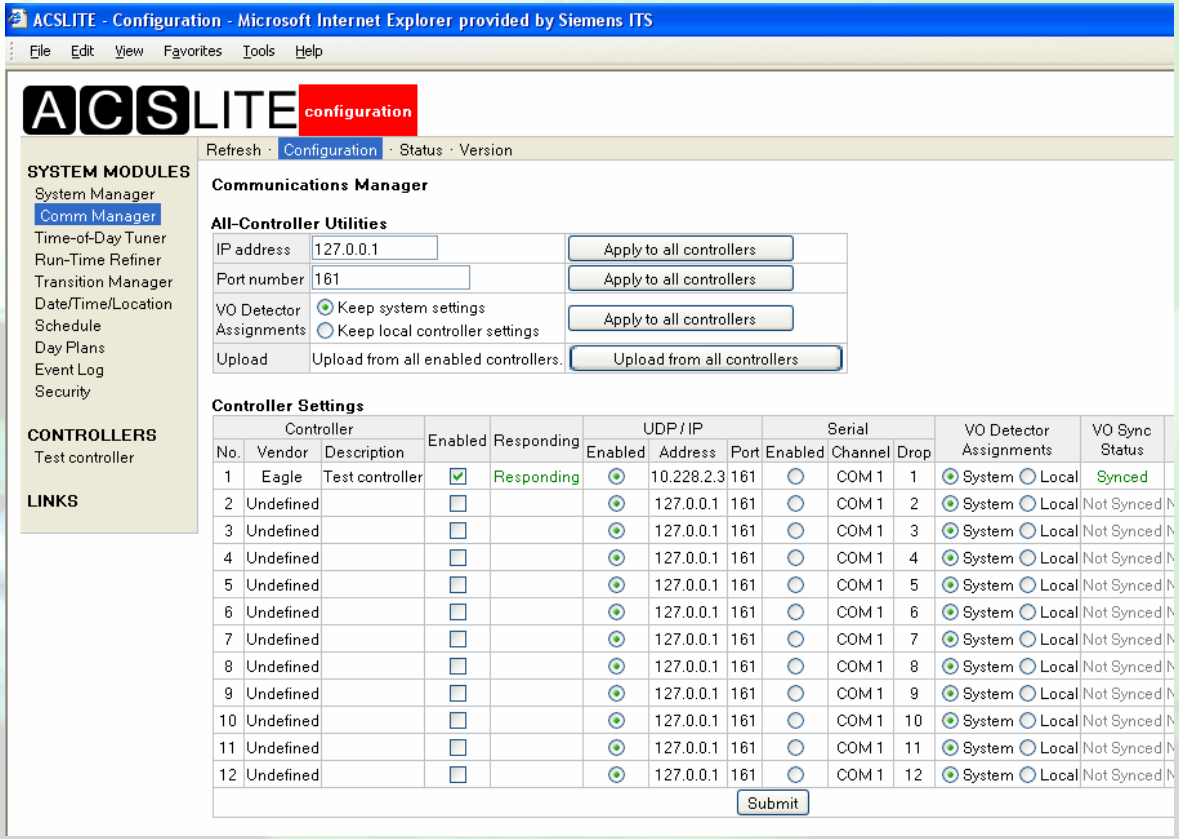
Web-based User Interface

Configuration / Setup

- **Communications**
- **Adaptive Settings**
- **Links**
- **Detectors**
- **TOD Schedule**
- **Archive data retrieval**

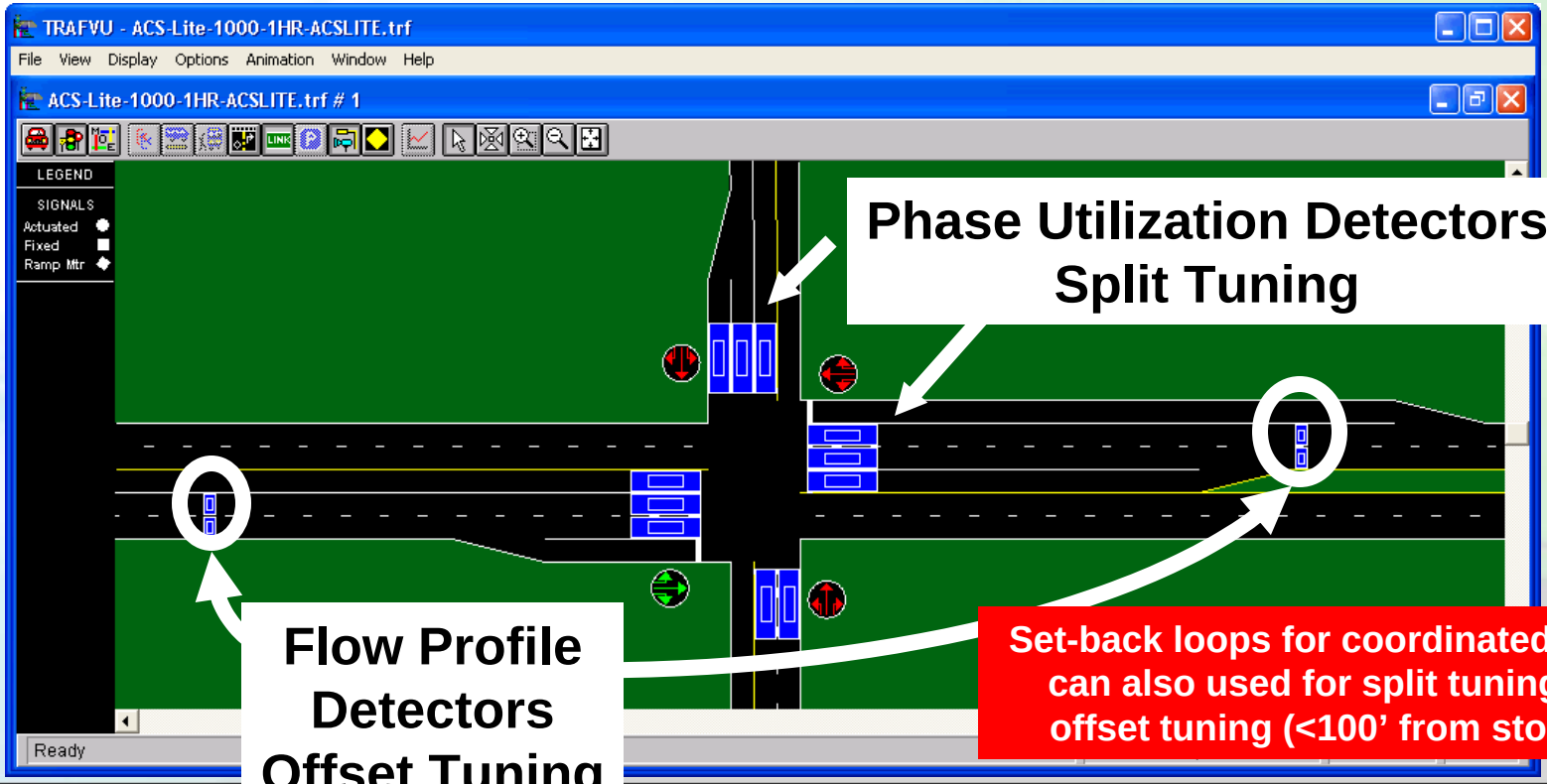
Status

- **Split tuning status**
- **Offset tuning status**
- **Pattern history**
- **Phase timing data**
- **Event log**
- **Detector status**



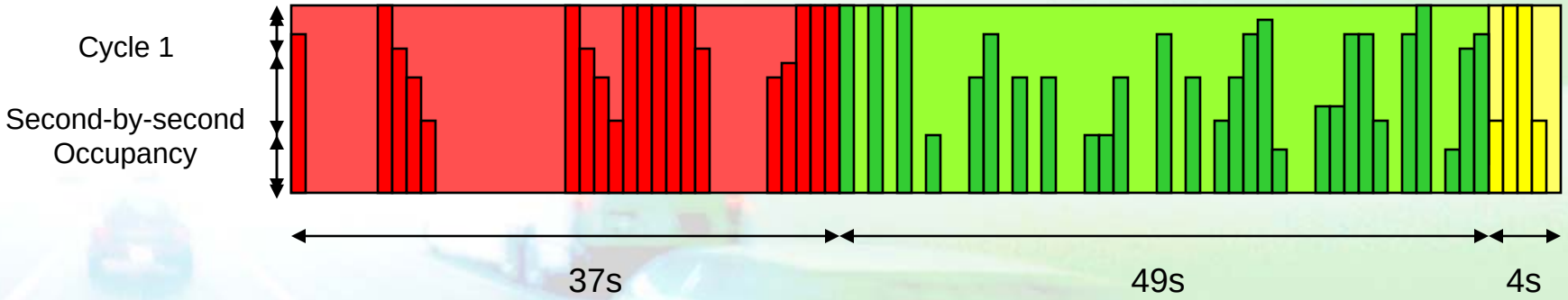
ACS-Lite Detection Layout

Need detectors at stop-bar of coordinated phases for split tuning

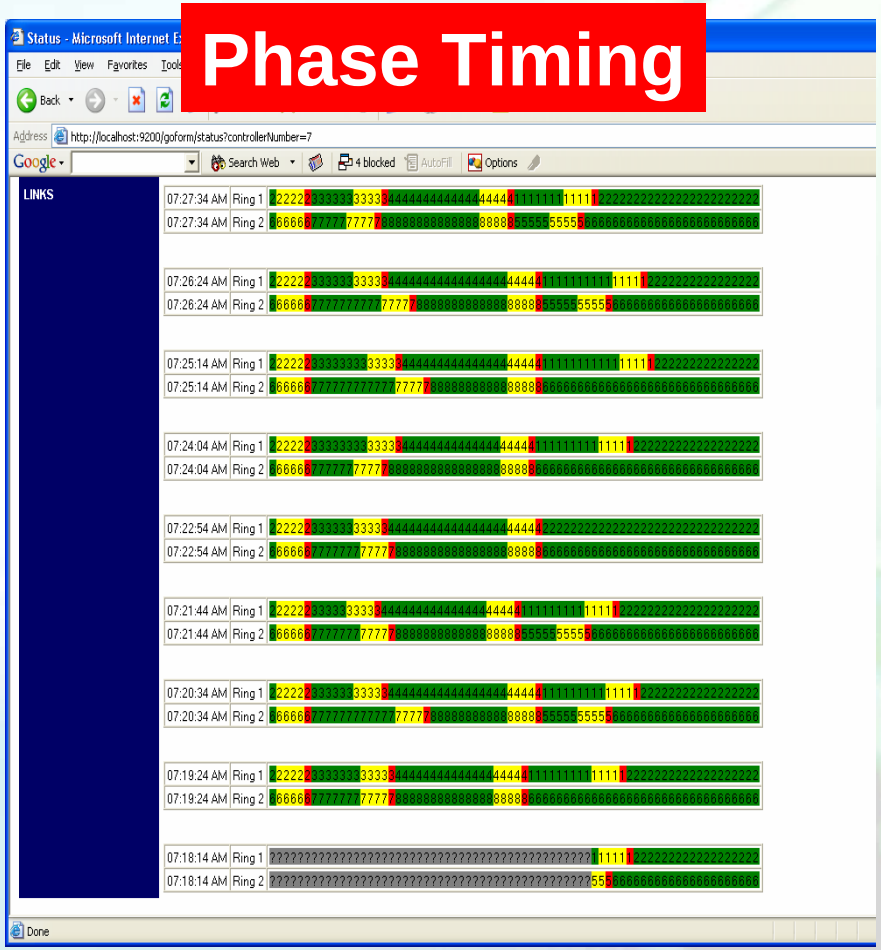


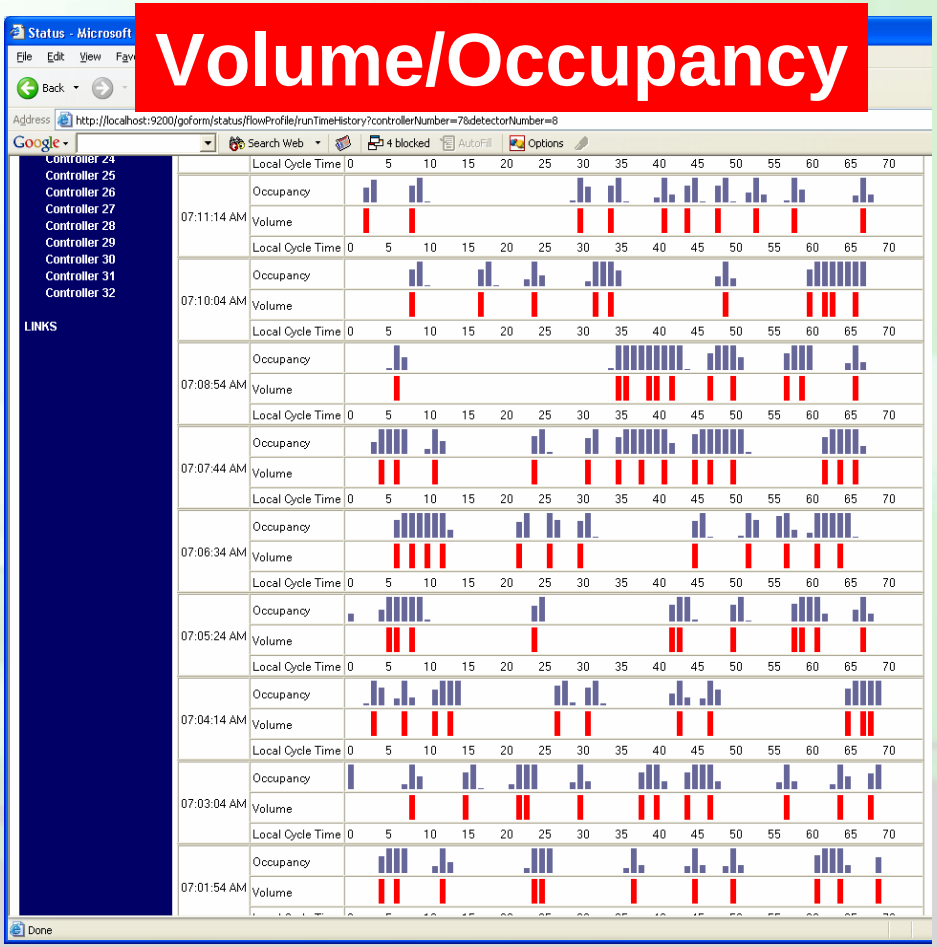
Data per phase interval

- **Occupancy values per second**
- **Correlated to Red/Green/Yellow**

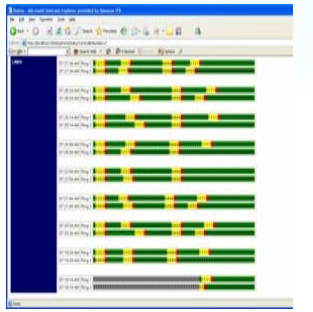


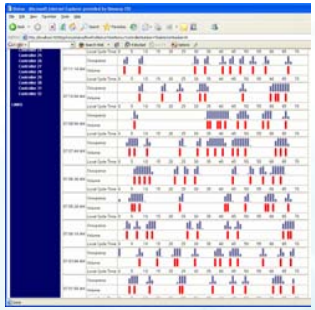
Cycle-by-cycle phase and detector data





Average occupancy over last few cycles





Cycle 1

Cycle 2

Cycle 3

Cycle 4

Averaging

Balance phase utilization on all splits

SYSTEM MODULES
System Manager
Comm Manager
Time-of-Day Tuner
Run-Time Refiner
Transition Manager
Date/Time/Location
Schedule
Day Plans
Event Log
Security

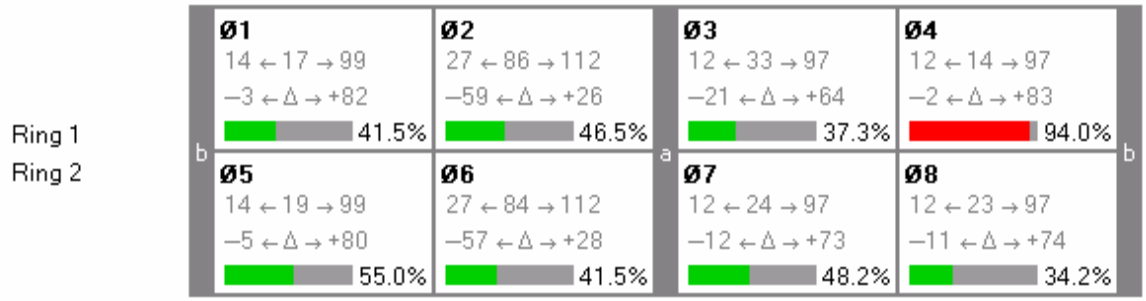
CONTROLLERS
US301 & 51st
SR70 & US301
SR70 & 30th
SR70 & 33rd
SR70 & 37th
SR70 & 39th
SR70 & 45th
SR70 & Natalie

LINKS

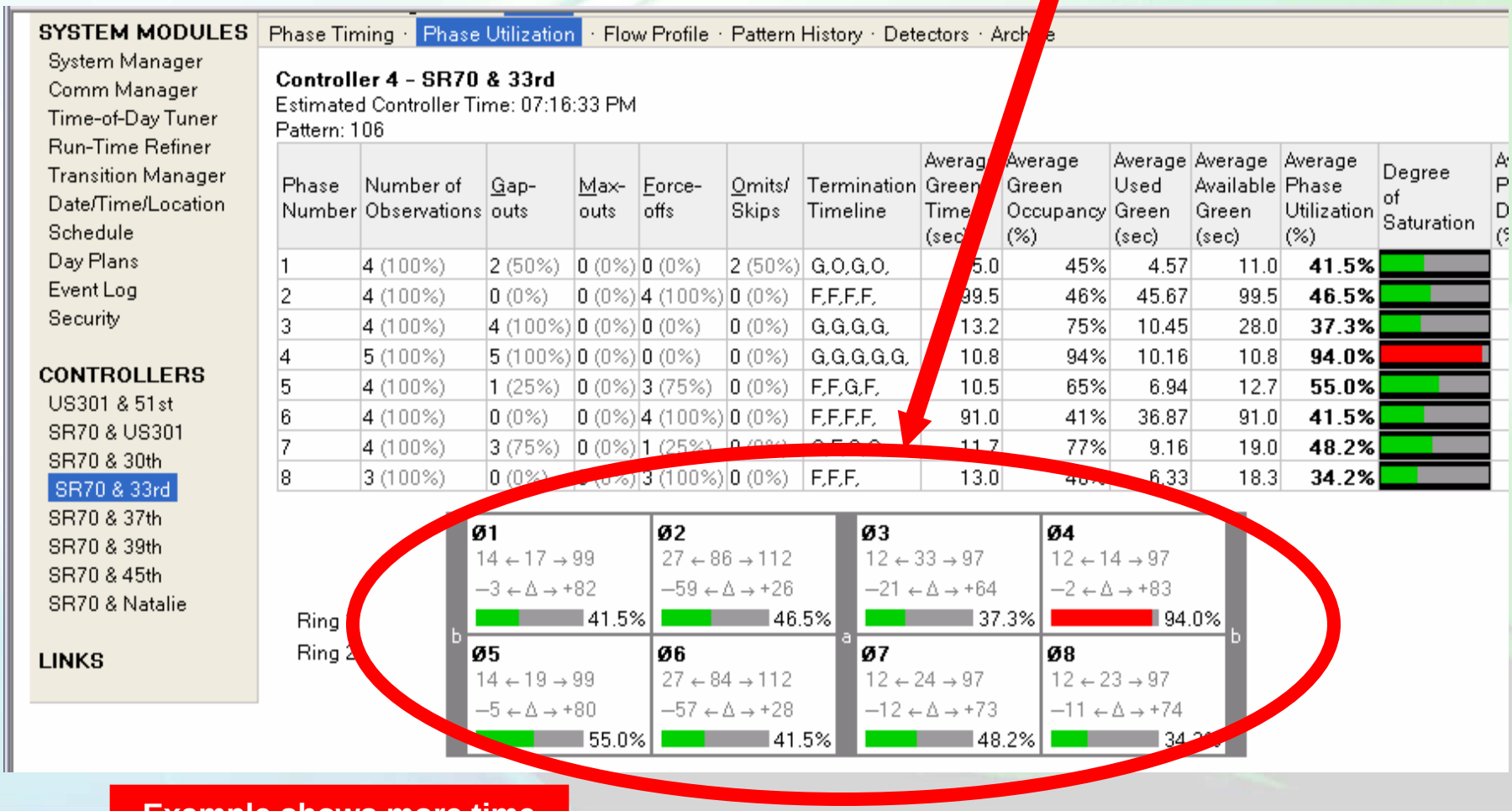
Phase Timing · Phase Utilization · Flow Profile · Pattern History · Detectors · Archive

Controller 4 – SR70 & 33rd
Estimated Controller Time: 07:16:33 PM
Pattern: 106

Phase Number	Number of Observations	Gap-outs	Max-outs	Force-offs	Omits/ Skips	Termination Timeline	Average Green Time (sec)	Average Green Occupancy (%)	Average Used Green (sec)	Average Available Green (sec)	Average Phase Utilization (%)	Degree of Saturation
1	4 (100%)	2 (50%)	0 (0%)	0 (0%)	2 (50%)	G,O,G,O,	5.0	45%	4.57	11.0	**41.5%**	
2	4 (100%)	0 (0%)	0 (0%)	4 (100%)	0 (0%)	F,F,F,F,	99.5	46%	45.67	99.5	**46.5%**	
3	4 (100%)	4 (100%)	0 (0%)	0 (0%)	0 (0%)	G,G,G,G,	13.2	75%	10.45	28.0	**37.3%**	
4	5 (100%)	5 (100%)	0 (0%)	0 (0%)	0 (0%)	G,G,G,G,G,	10.8	94%	10.16	10.8	**94.0%**	
5	4 (100%)	1 (25%)	0 (0%)	3 (75%)	0 (0%)	F,F,G,F,	10.5	65%	6.94	12.7	**55.0%**	
6	4 (100%)	0 (0%)	0 (0%)	4 (100%)	0 (0%)	F,F,F,F,	91.0	41%	36.87	91.0	**41.5%**	
7	4 (100%)	3 (75%)	0 (0%)	1 (25%)	0 (0%)	G,F,G,G,	11.7	77%	9.16	19.0	**48.2%**	
8	3 (100%)	0 (0%)	0 (0%)	3 (100%)	0 (0%)	F,F,F,	13.0	48%	6.33	18.3	**34.2%**	



Balance phase utilization on all splits



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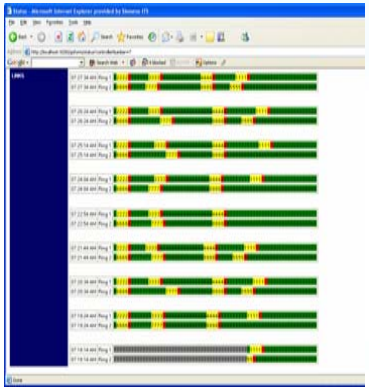
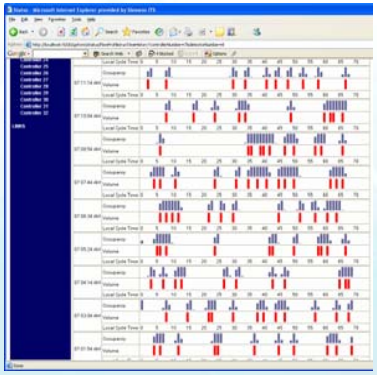
8	3 (100%)	0 (0%)		3 (100%)	0 (0%)	F,F,F,	13.0		6.33	18.3	**34.2%**	

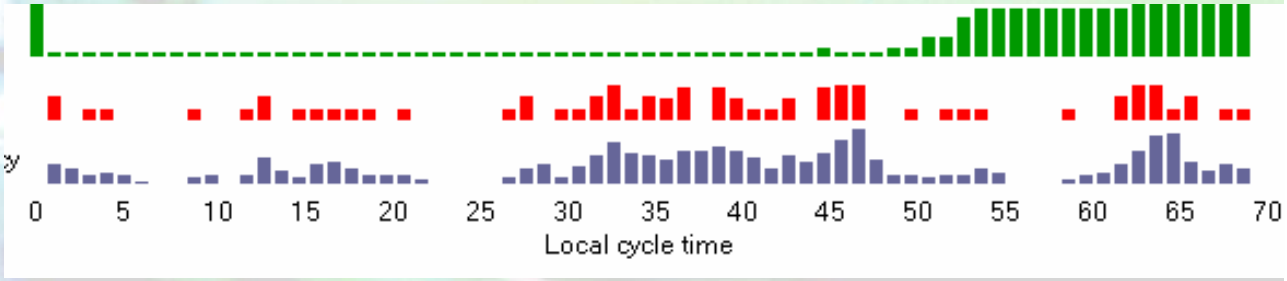
Example shows more time is necessary on phase 4

Offset Tuning
Average cyclic occupancy profiles



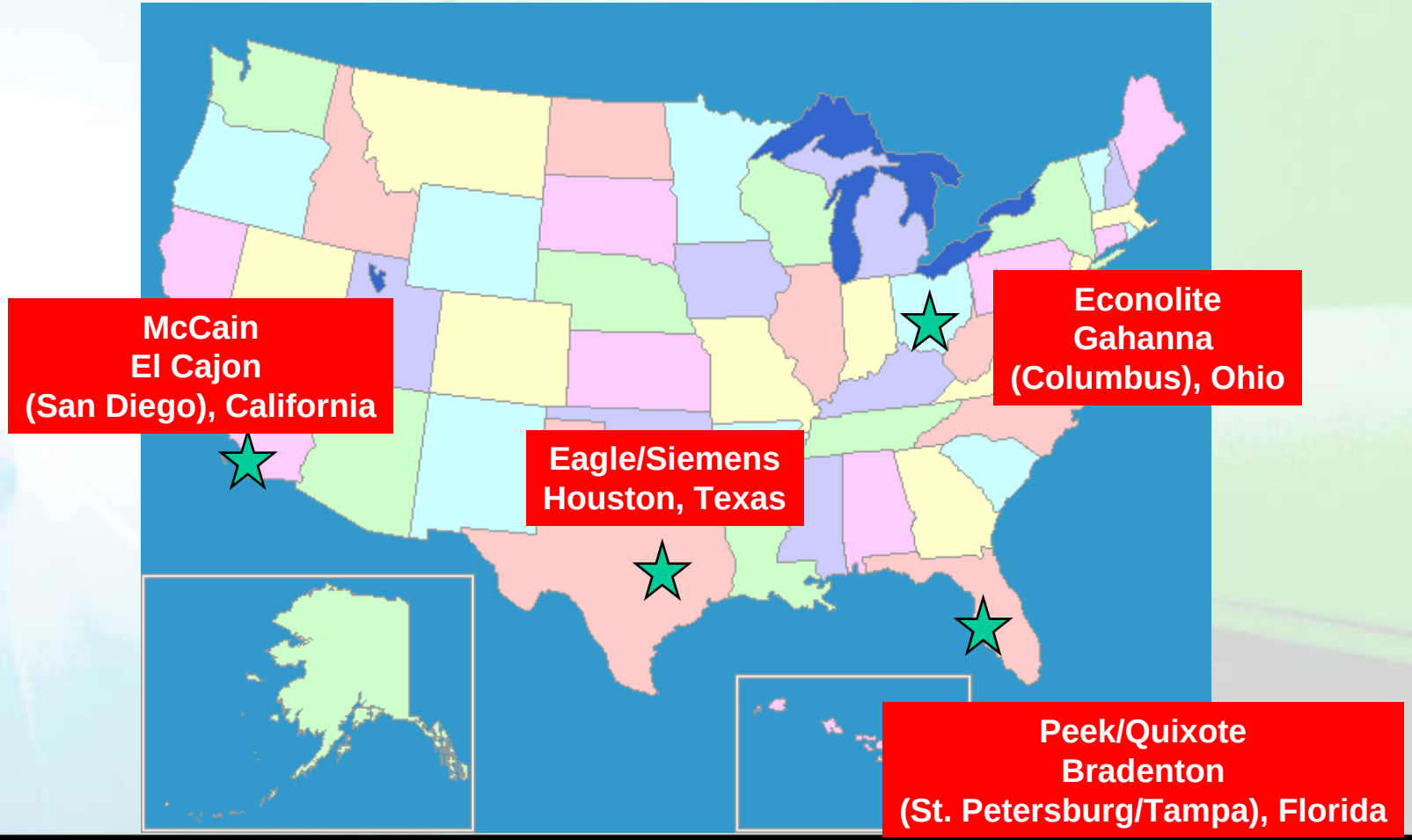


Example shows need to move offset so green corresponds with traffic earlier in cycle



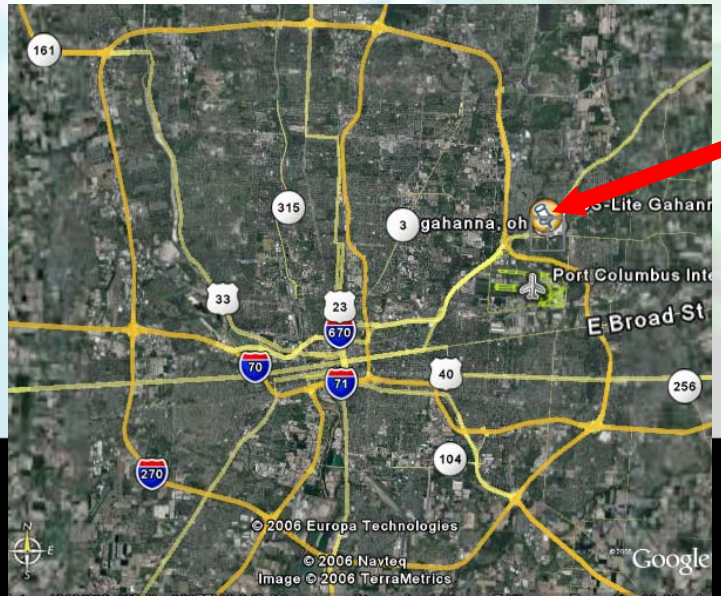
“statistical” flow profile

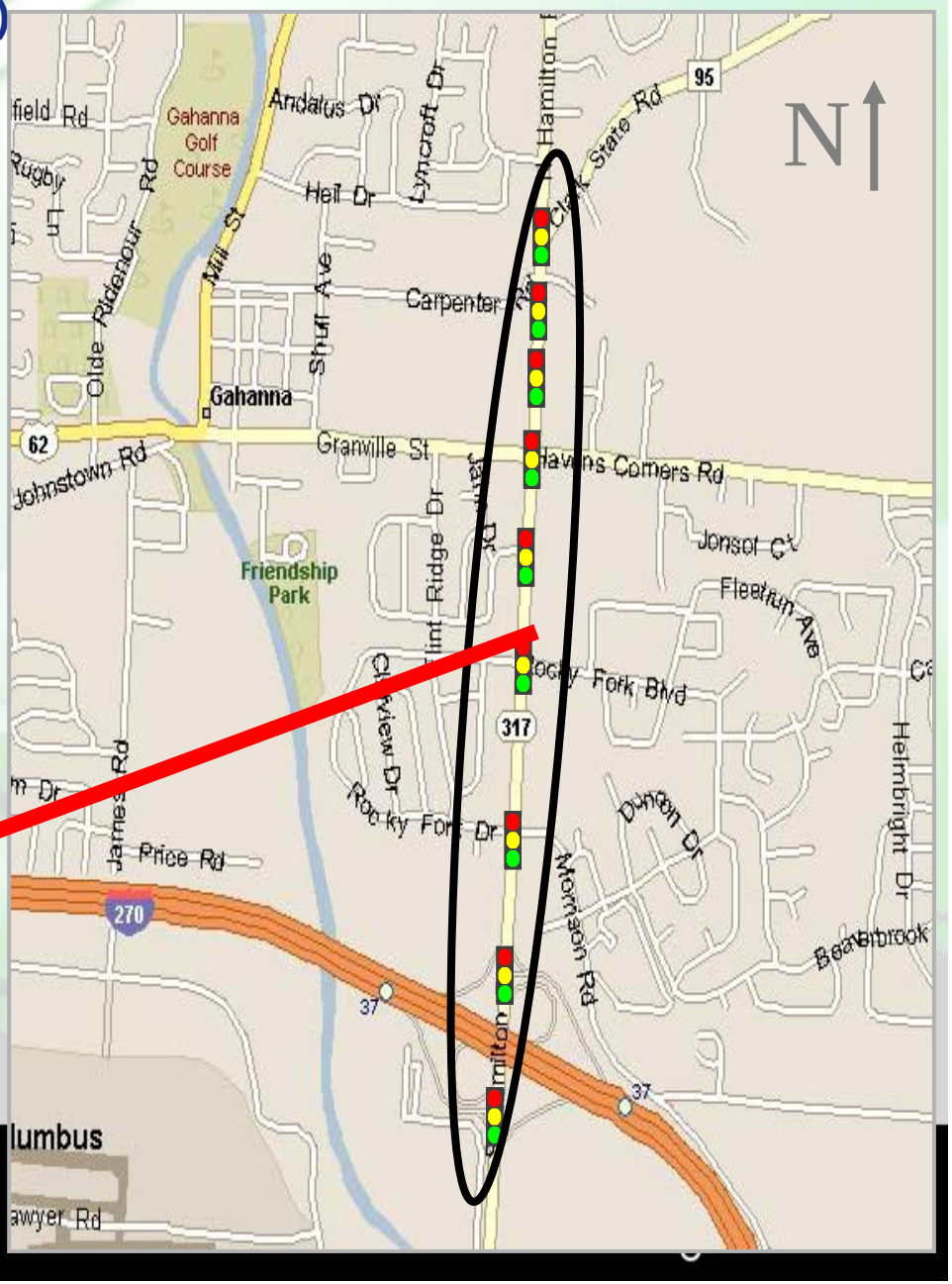
Field trials



Gahanna, OH field test location (Econolite)
Hamilton Rd

- I-270 SB Ramp
- I-270 NB Ramp
- Morrison Road
- Rocky Fork Drive
- Lincoln High School
- Granville Street
- Kroger Entrance
- Rocky Square Fork Shopping Center
- Clark State Road





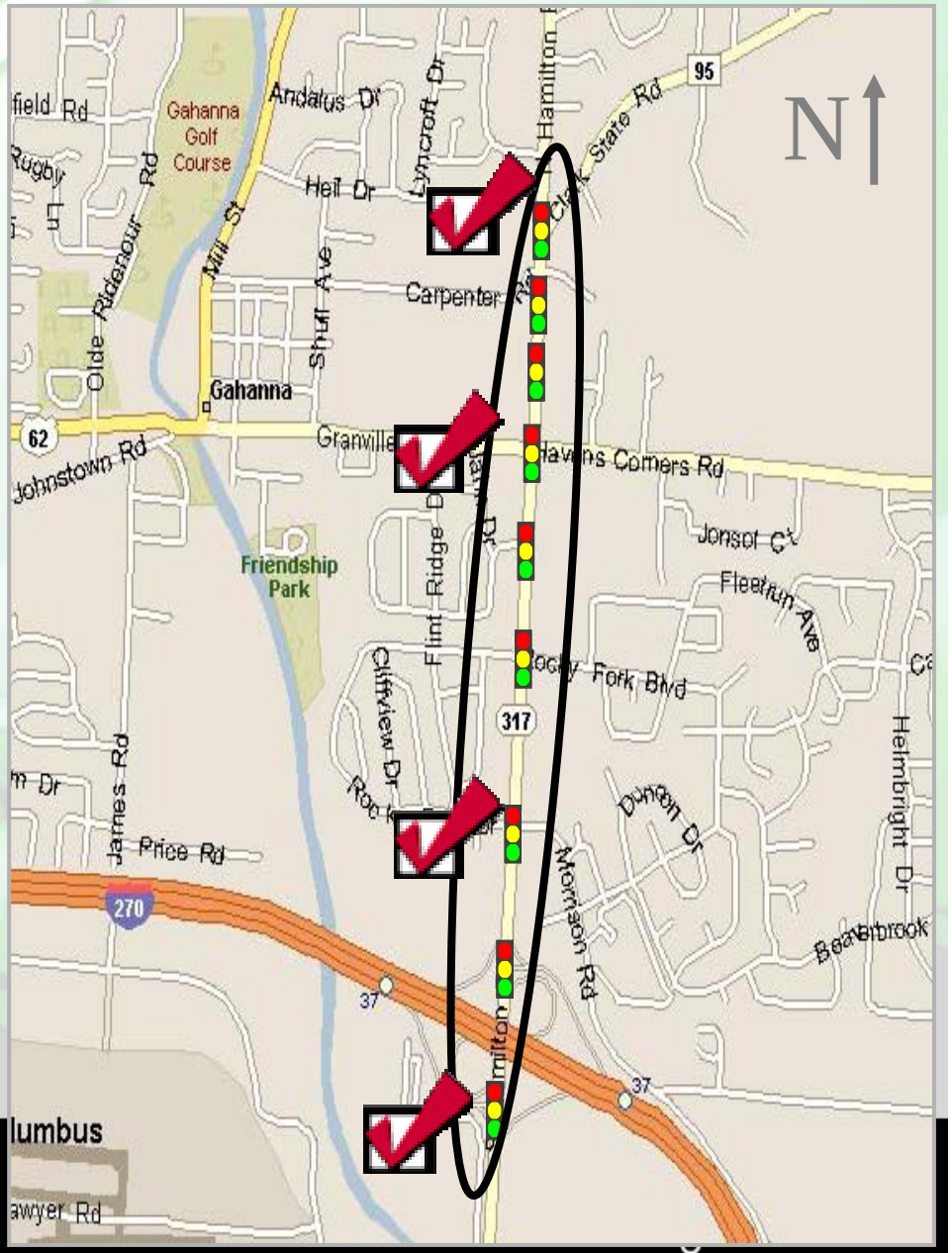
Split tuning locations

I-270 SB Ramp
- **Loops**

Morrison Road
- **Video/loops**

Granville Street
- **Loops**

Clark State Road
- Loops/video



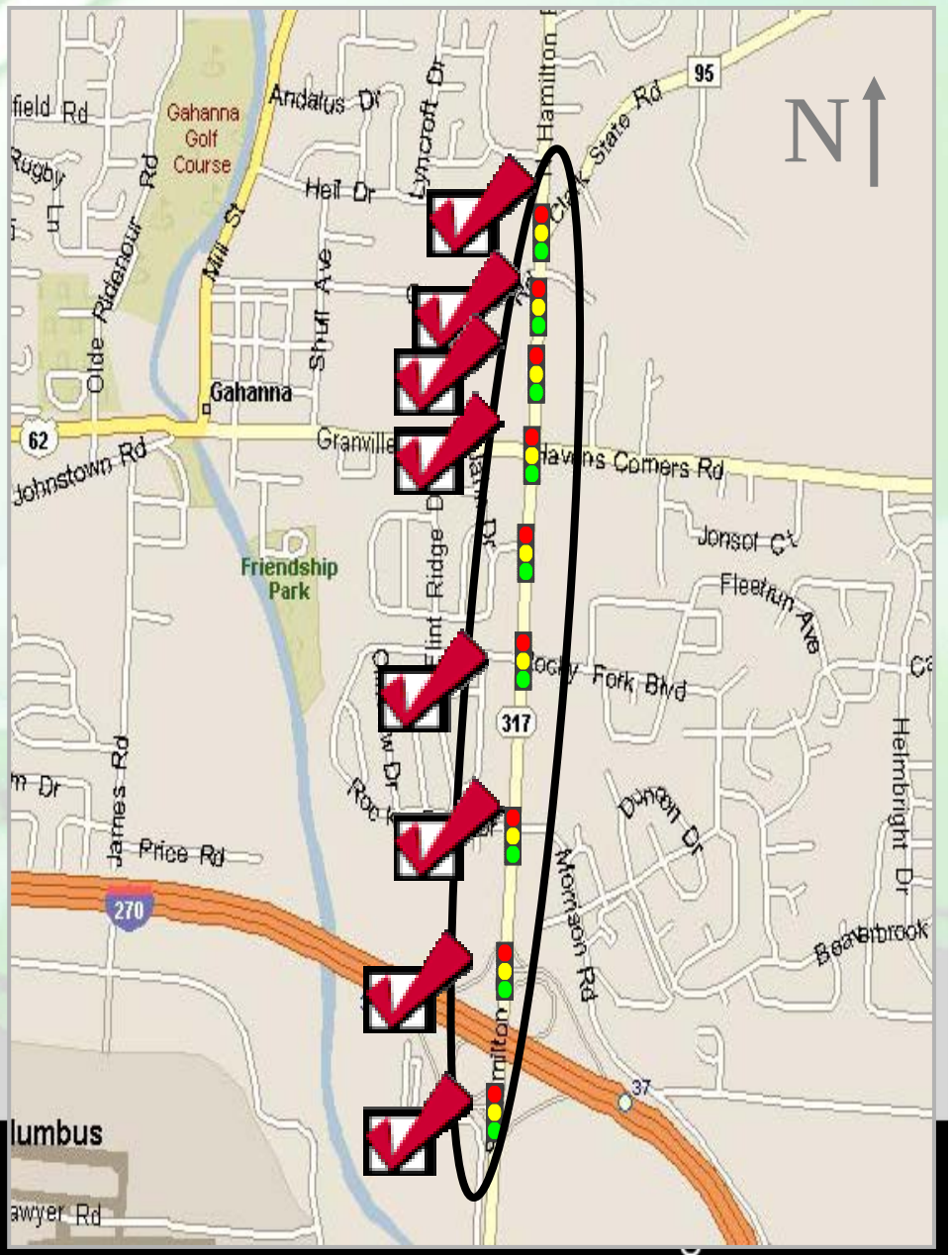
Offset selection locations

All intersections

- **Video/loops**

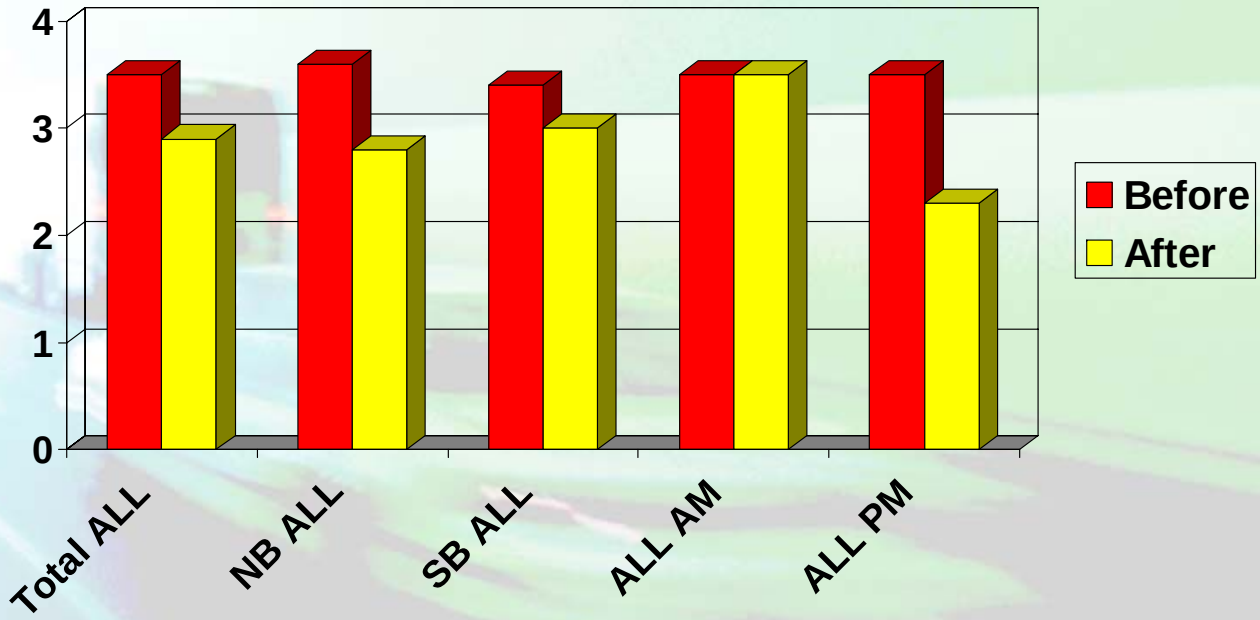
Selection of an offset progression pattern, rather than tuning

Limitation of advanced loop stations



Gahanna, OH field test results

Results - Number of Stops



Gahanna, OH field test results

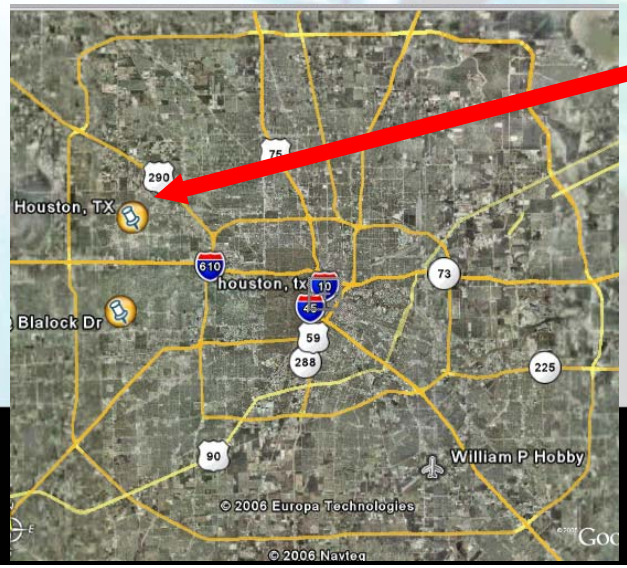
	Before (per veh)	After (per veh)	Savings (per veh)	Peak Hours (all vehs)	Peak Hours Savings
Total Delay (hour)	0.03761	0.03758	0.00003	0.15588	**$1.89**
Total Stops	3.5	2.9	0.6	3117.6	**$43.65**
Fuel (Liters)	0.390	0.373	0.017	89.287	**$53.08**
Peak Hours Benefit	**$98.61**				
Daily Benefit	**$340.03**				
Annual Benefit	**$88,500.00**				

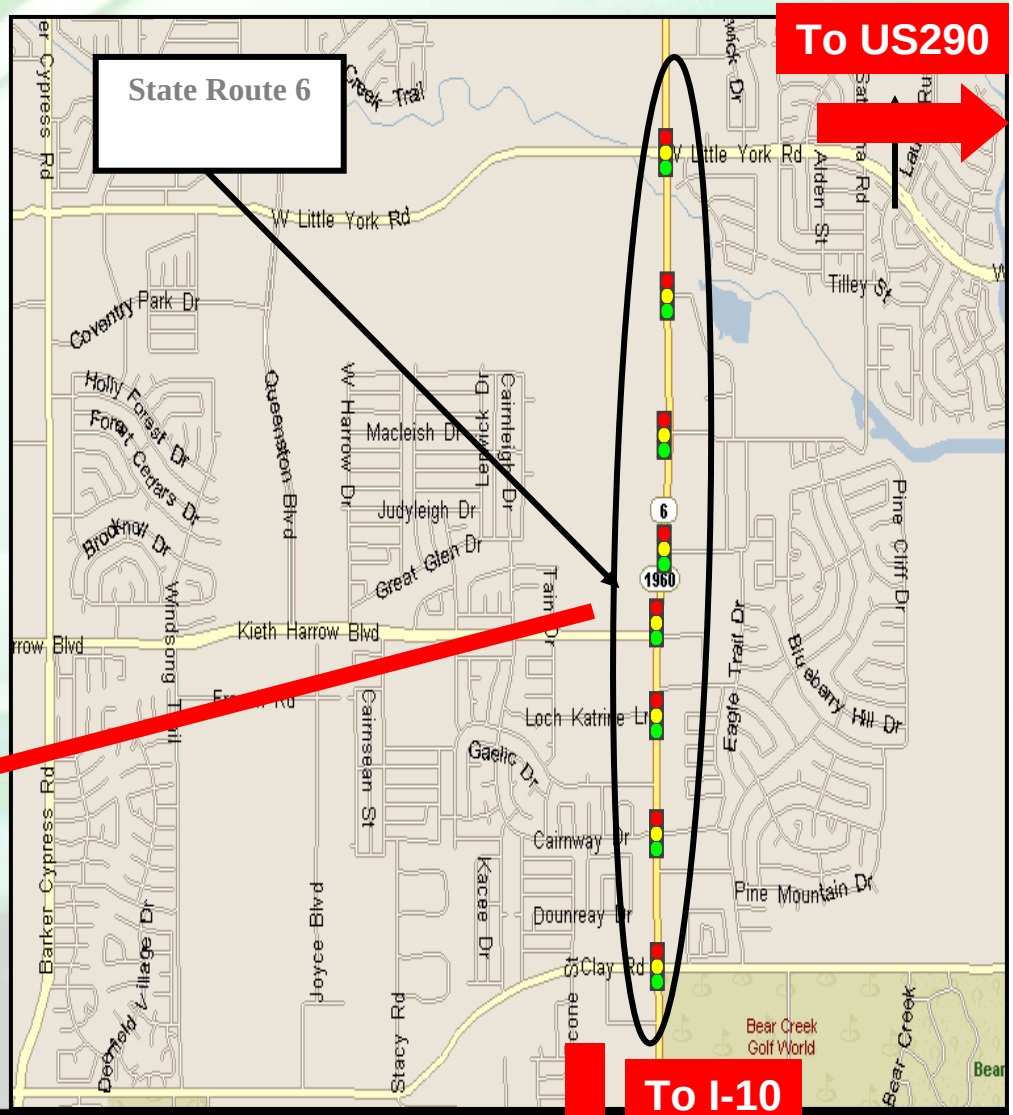
[1]*Peak hours = Average savings*(Average Corridor Peak Hour Volume*4 peak hours)*

Unit Costs:
Total Delay – $12.10 per hour
Stops – $0.014 per stop
Fuel Consumed – $0.59 per liter ($2.25 per gallon)

Houston, TX field test location (Eagle)

- West Little York Road
- Yorktown Crossing Parkway
- Timber Creek Place Lane
- Addicks Satsuma Road
- Keith-Harrow Boulevard
- Loch Katrine Lane
- Cairnway Drive
- Clay Road





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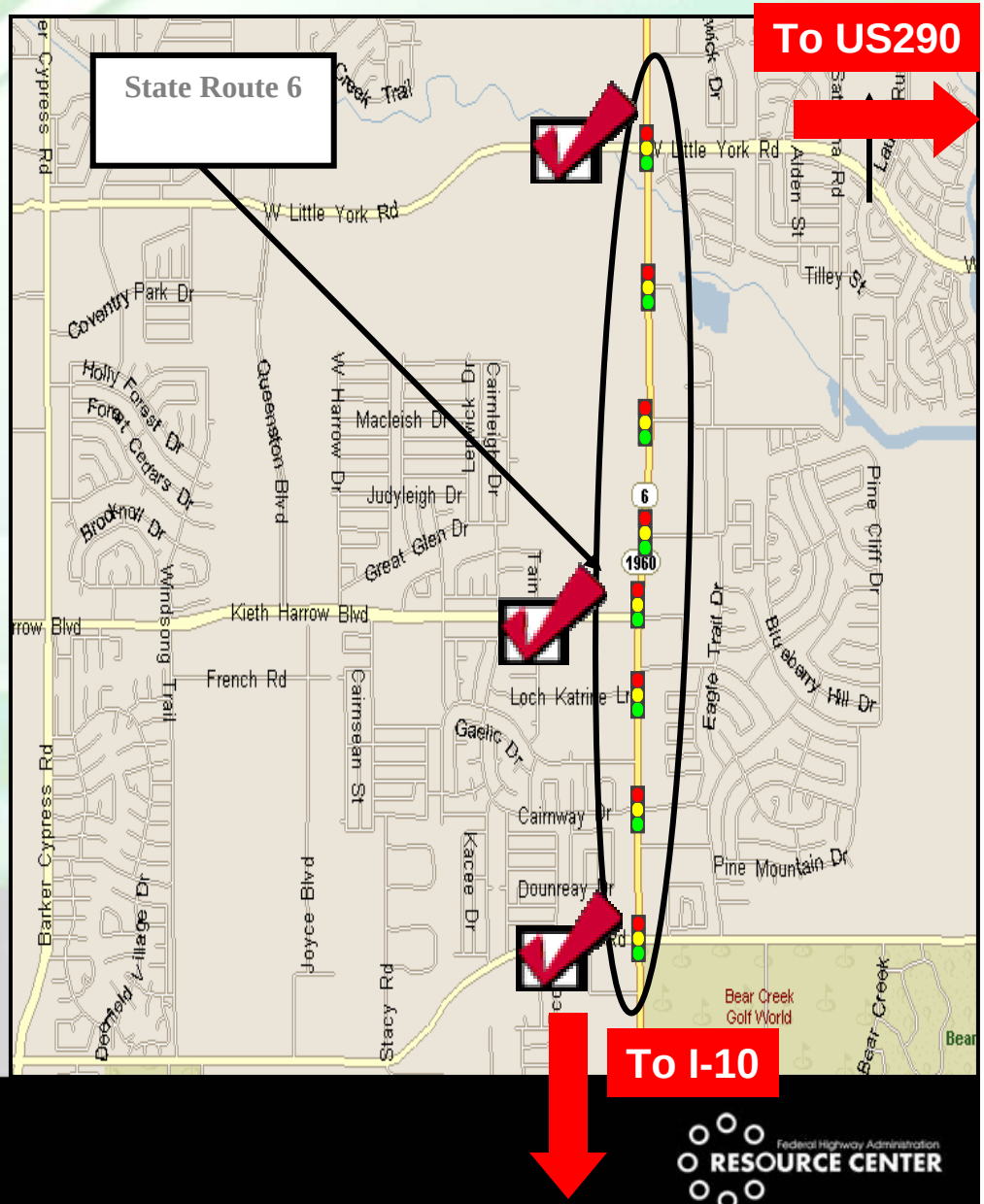
Houston Split tuning locations

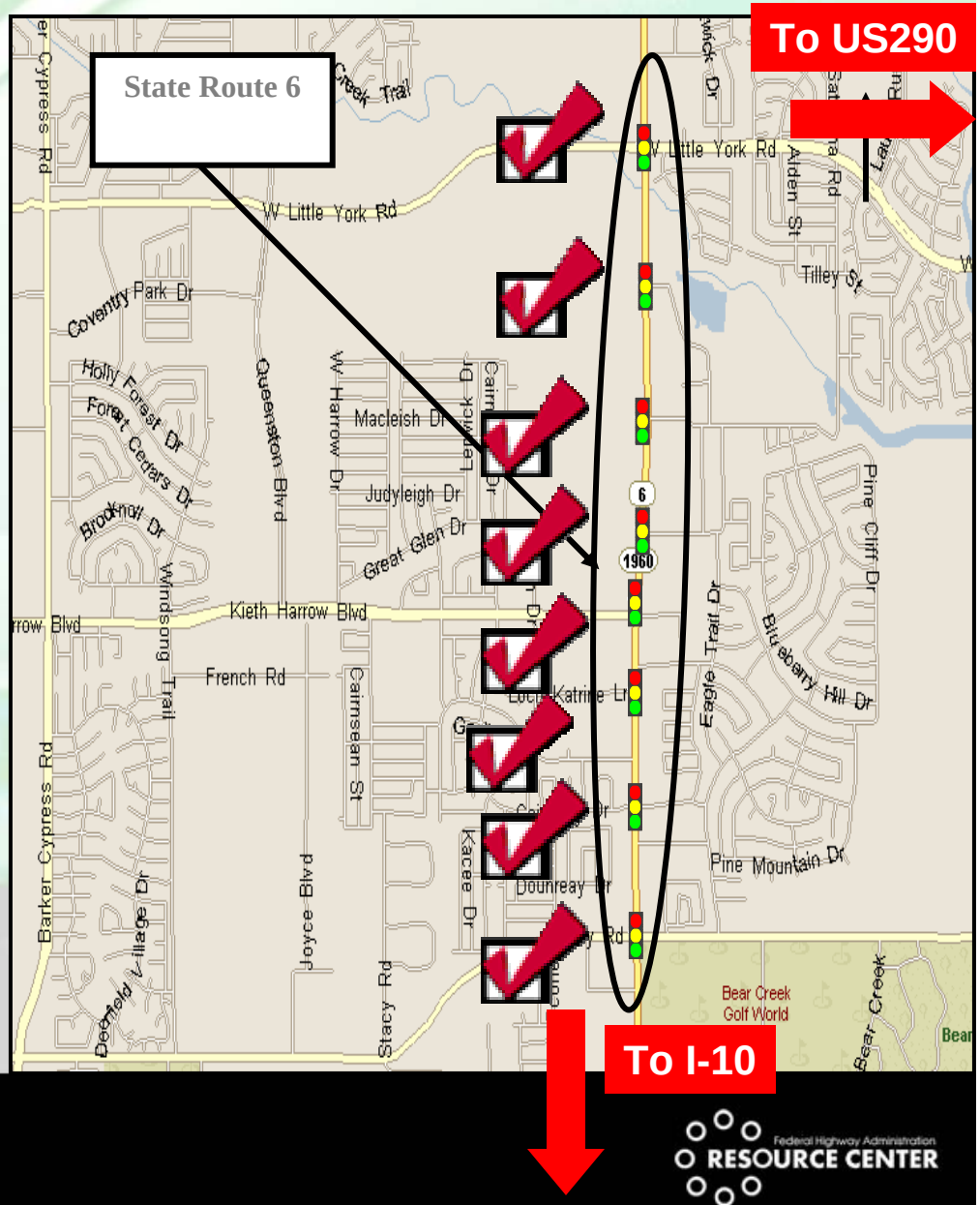
- **Clay Road**
  - **–Video**
- **Kieth-Harrow Boulevard**
  - **–Loops**
- **West Little York Road**
  - –Video/loops



Offset tuning locations

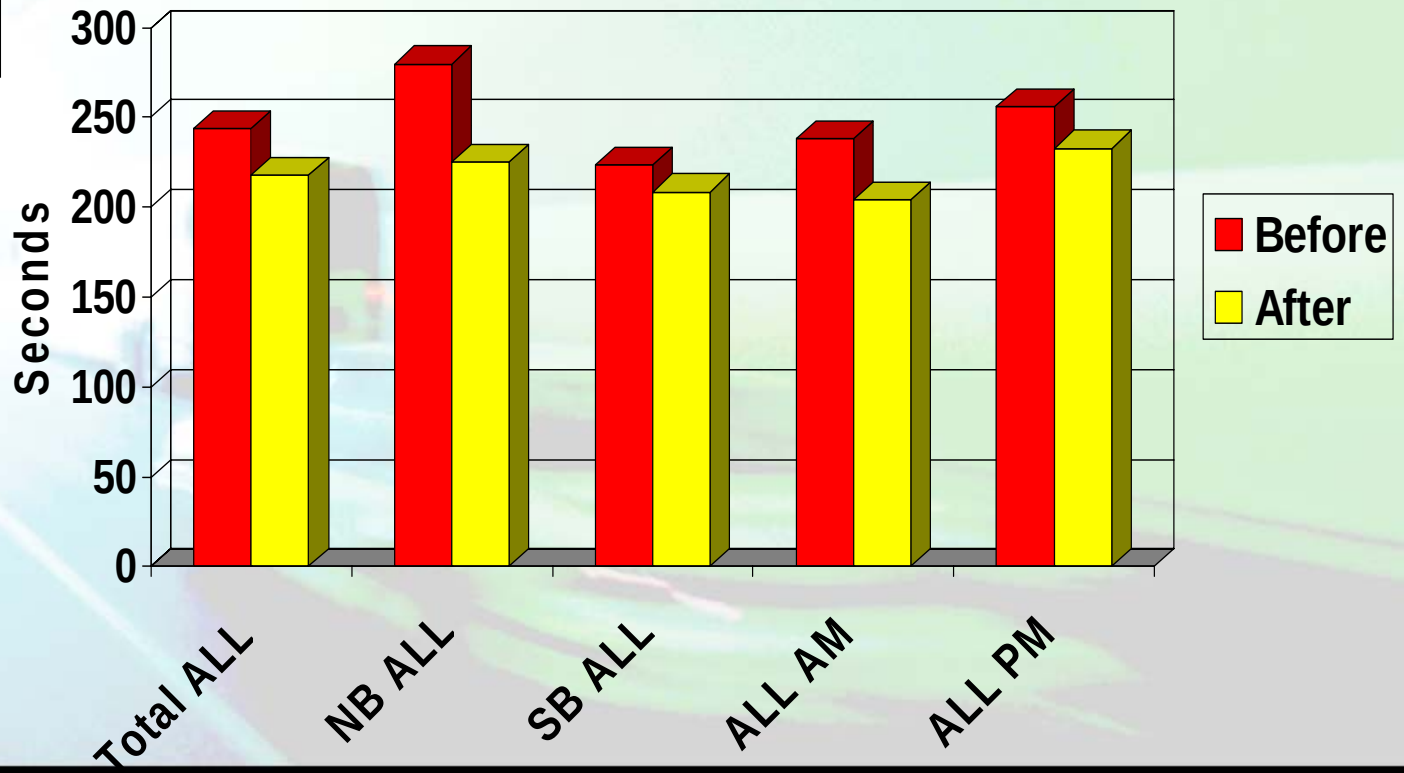
All intersections

- Mix of video/loops



Houston, TX field test results

Results - Travel Time



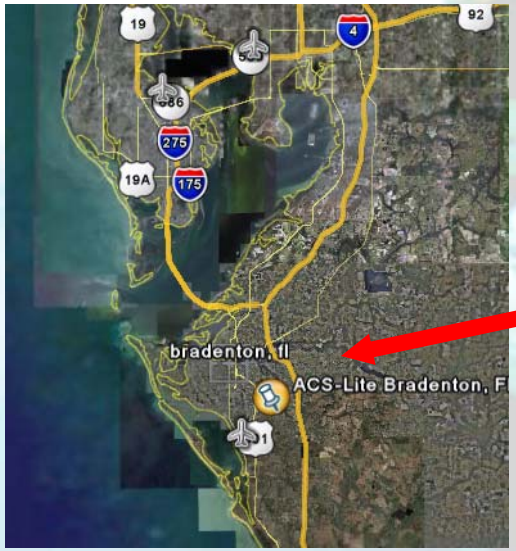
Houston, TX field test results

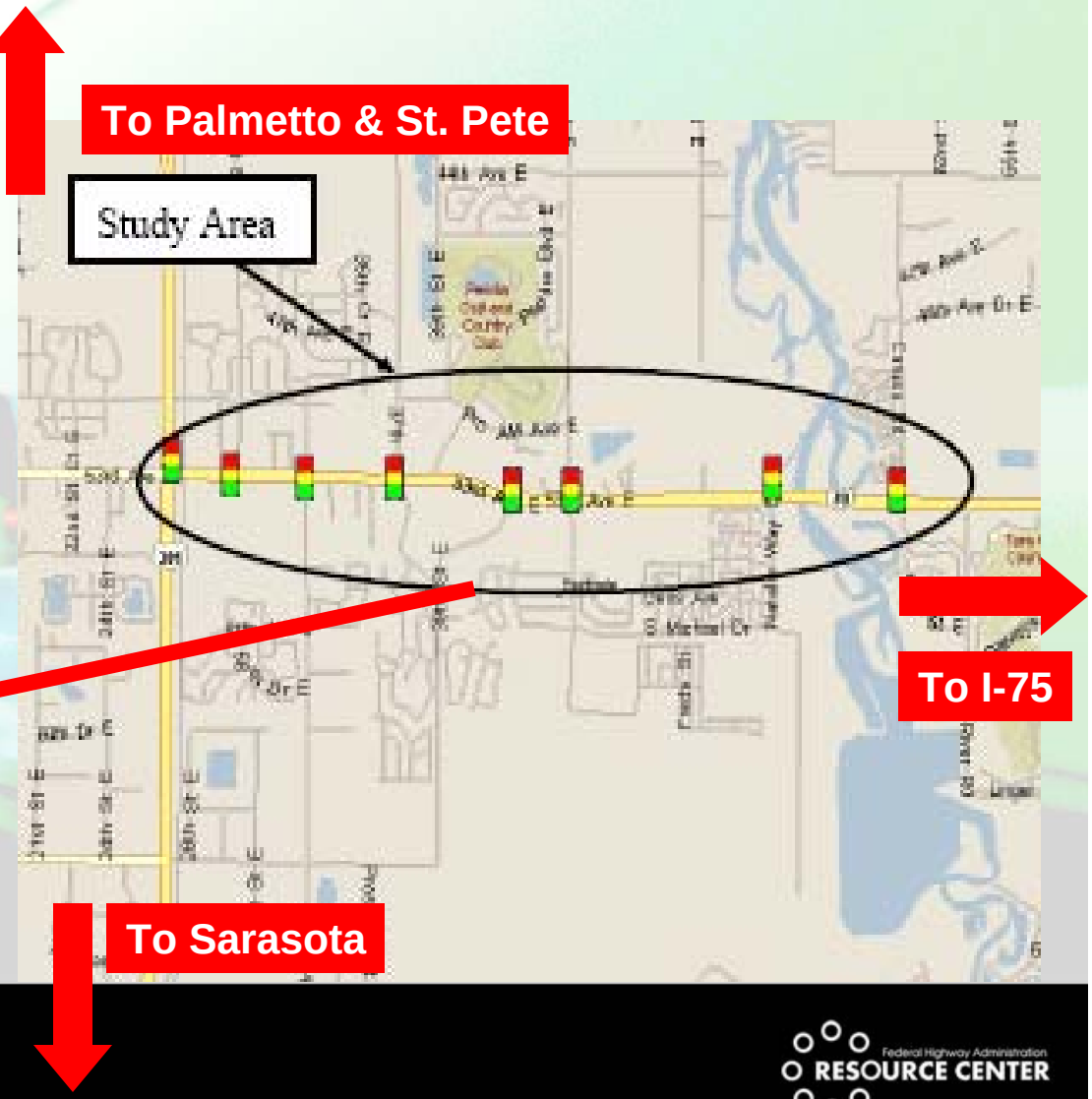
	Before (per veh)	After (per veh)	Savings (per veh)	Peak Hours (all vehs)	Peak Hours Savings
Total Delay (hour)	0.01856	0.01214	0.00642	39.16252	**$473.87**
Total Stops	1.7	1.2	0.5	3051.6	**$42.72**
Fuel (Liters)	0.490	0.455	0.035	214.837	**$127.71**
Peak Hours Benefit	**$644.30**				
Daily Benefit	**$2,221.72**				
Annual Benefit	**$577,648.12**				

Unit Costs:
Total Delay – $12.10 per hour
Stops – $0.014 per stop
Fuel Consumed – $0.59 per liter ($2.25 per gallon)

Bradenton, FL field test location – SR 70 (PEEK)

Caruso Road
Natalie Way
45th Street
39th Street
37th Street
33rd Street
31st Street
US301
US301 & 51st (to north, not shown)





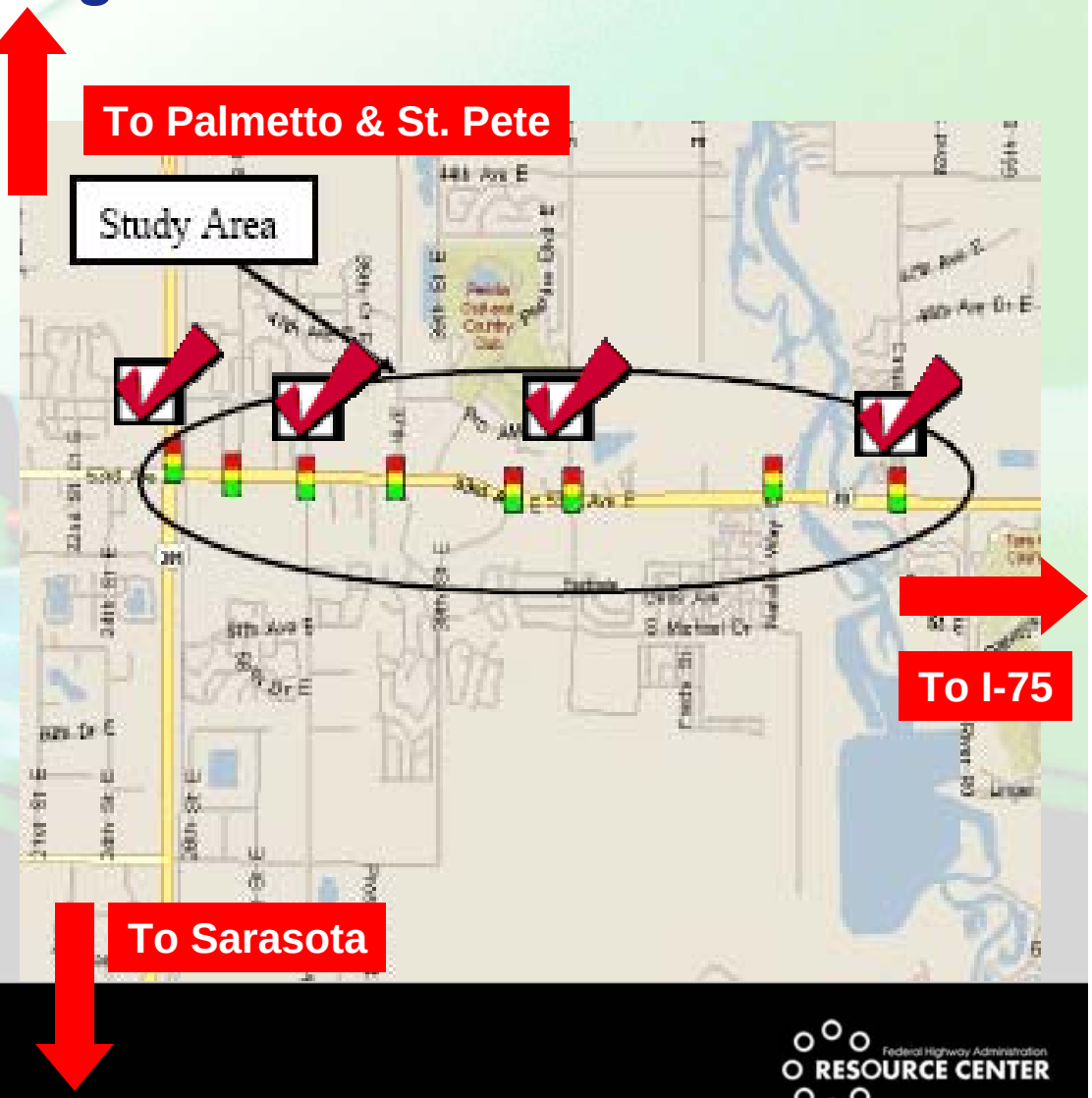
Bradenton, FL split tuning locations

Caruso Road
- **Loops/video**

45th Street
- **loops**

33rd Street
- **loops**

US301
- loops



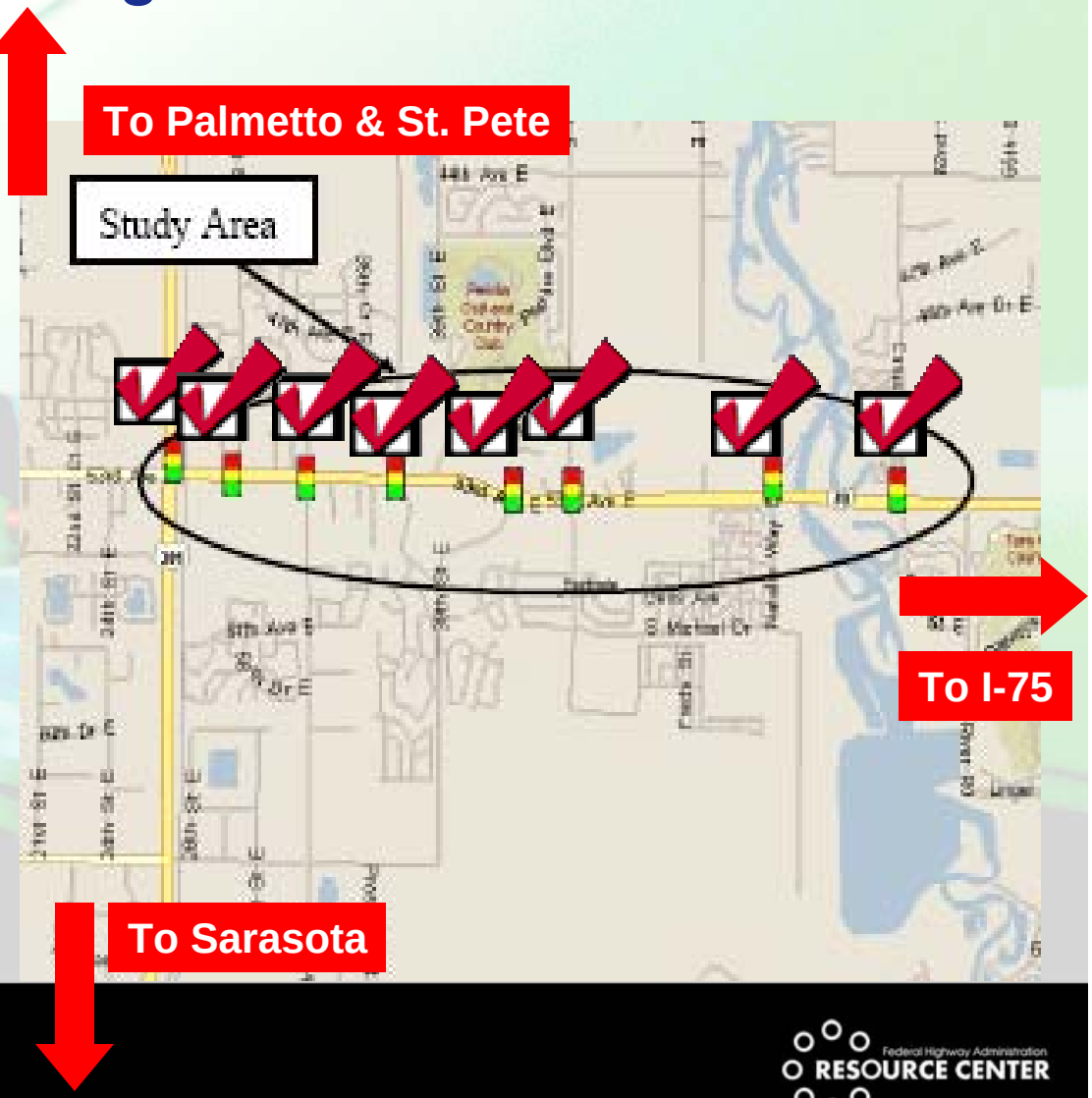
Bradenton, FL offset tuning locations

All intersections

- **Mostly loops (video at Caruso)**

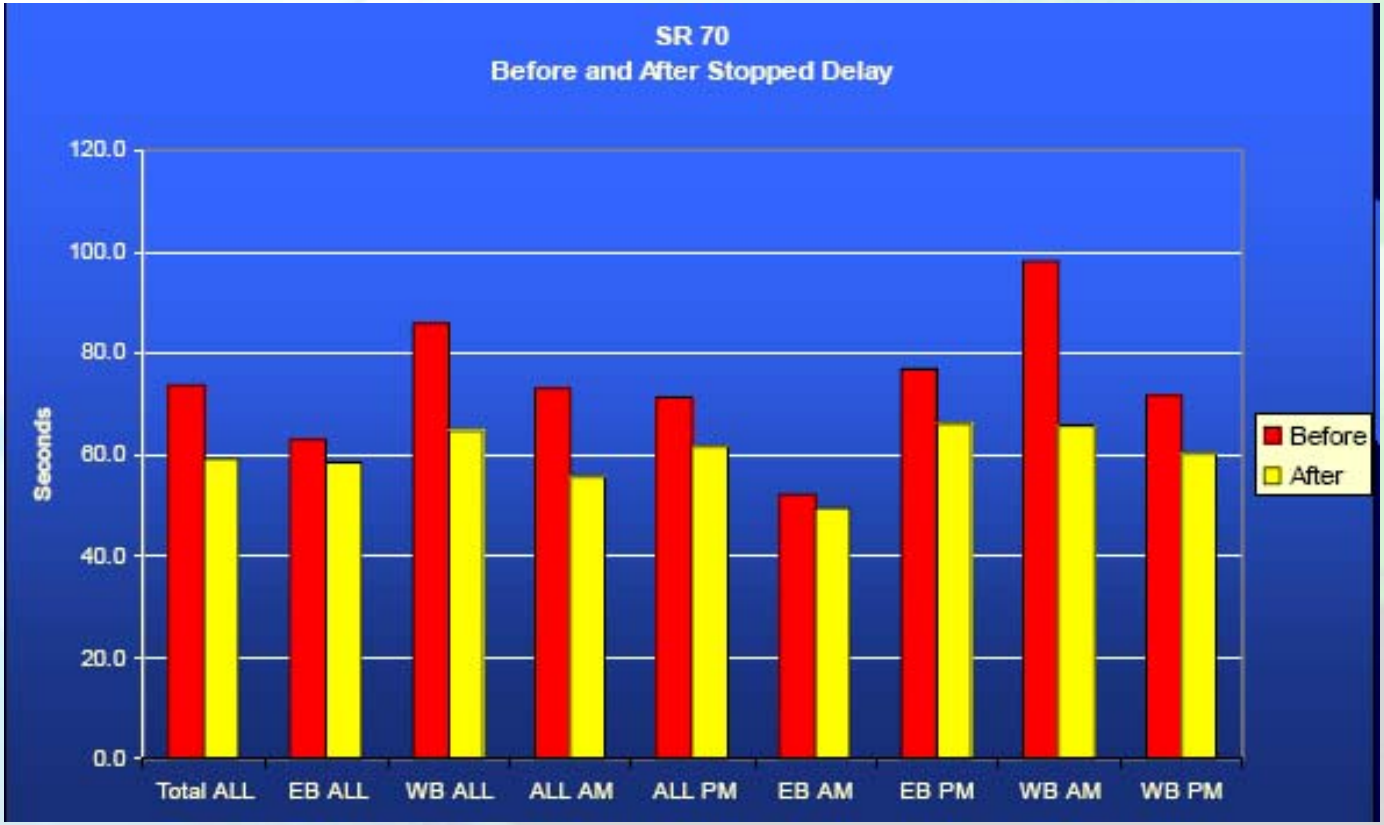
Considered fixing offset at 31st between US301 and 33rd

- **Critical short link**
- **Tuning improved performance**



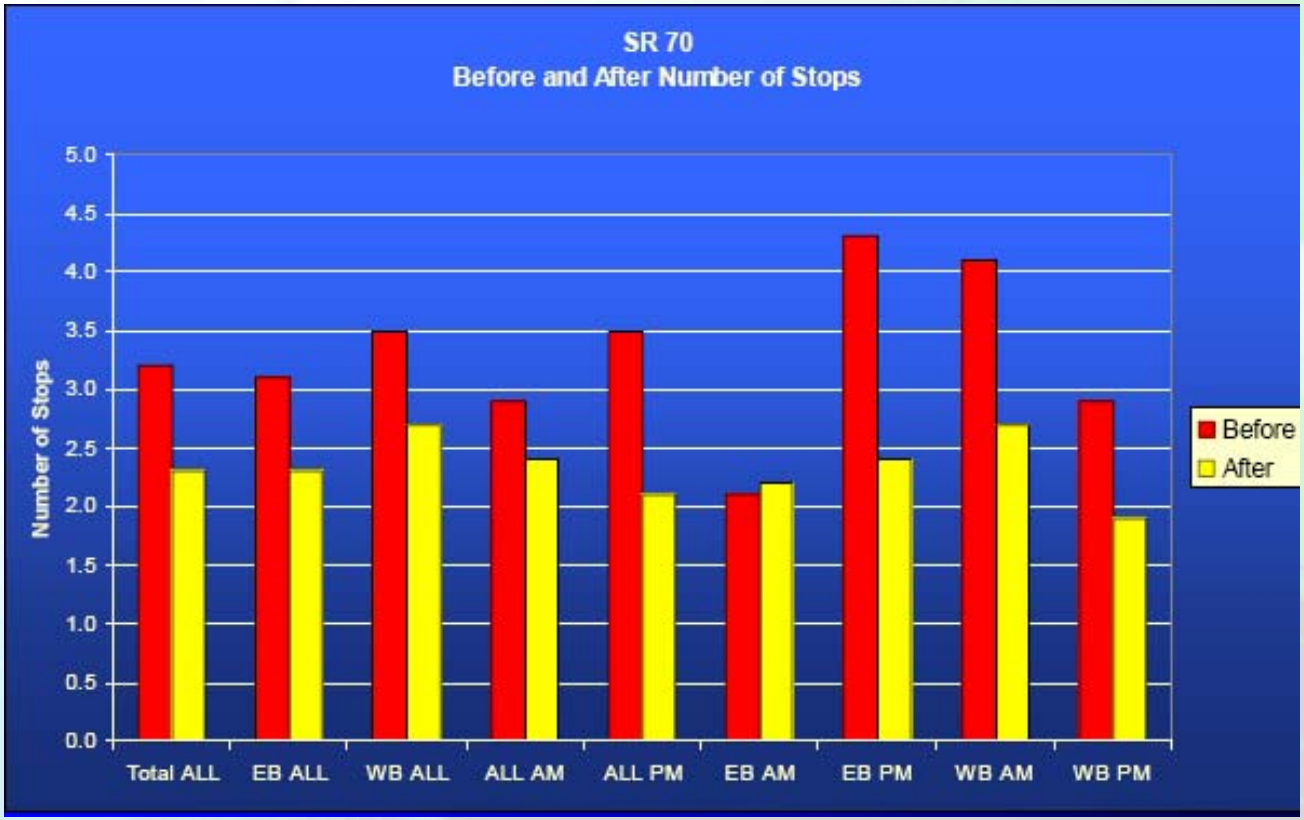
Bradenton, FL field test results

Results – Stopped Delay



Bradenton, FL field test results

Results – Number of Stops



Benefits

- **Reduces the need for traffic signal retiming**
- **Reduces**
  - Delay/Travel Time
  - Stops
  - Fuel consumption
- **Low Cost**
- **Low Bandwidth communications**
- **Functions with existing controllers**

Future Enhancements FY 2007

- **Time of Day Tuner**
  - Long Term Timing Plan Maintenance
  - Time of Day Schedule Switch Points
- **Run Time Refiner**
  - Cycle length tuning
- **Transition Manager**
  - “Best Way”

NEXT Steps

- **5 Early Adopters**
- **Workshop for evaluating Adaptive Traffic Signal Control Needs**
- **Support Deployments**
- **Contact Vendor or FHWA for more information**

QUESTIONS???

http://www.ops.fhwa.dot.gov/arterial_mgmt/index.htm

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Federal Highway Administration

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