



# Smart Signals

SPOTS/Traffic Signals Subcommittee

December 7, 2017

# Smart Signals



- **\$50 Million for Smart Signals**
  - Adaptive Signal Control
  - Enhanced detection
  - Upgraded Communications
  - ATMS
  - Performance Monitoring

**WBAL** NEWS RADIO 1090

NOW STREAMING  
**WBAL News Now with Bryan Nehman**

Home Shows News Weather Traffic Sports Ravens Orioles

## Hogan Announces \$50M To Deploy Smart Traffic Signals

Wednesday, October 25 2017  
Associated Press

Maryland is getting smarter traffic signals.

Gov. Larry Hogan announced Wednesday a \$50 million plan to deploy a system that uses real-time traffic conditions and computer software to adjust the timing of traffic signals.

The Hogan administration says it will ease congestion for about 700,000 drivers a day on 14 major corridors. Three of them are in Anne Arundel County, two are in Baltimore County and three are in Charles County. Harford and Prince George's counties will each get smart signals in two corridors. Howard and Montgomery counties will get signals in one corridor each.

The governor says it's the second phase of his traffic-relief plan. Last month, he announced a \$9 billion plan to add four lanes to I-270, I-495 and the Baltimore-Washington Parkway.

# Outline



- Current and Upcoming Adaptive Deployments
- Design and Equipment
- Programming and Activation
- Before/After Studies
- Future

# Adaptive Deployments



## US 1/MD 175 Jessup

- Fall 2015
- 15 signals
- Centracs Adaptive

## MD 24/US 1 Bus Bel Air

- Spring 2016
- 13 Signals
- Centracs Adaptive

## MD 2 Brooklyn Park

- Spring 2017
- 4 Signals
- SynchroGreen

## MD 139 Towson

- Summer 2017
- 3 signals
- Centracs Adaptive

## US 301 Bowie

- Summer 2017
- 4 Signals
- Centracs Adaptive

# Upcoming Deployments



## **MD 2 Annapolis Harbor**

- 4 signals

## **MD 3 Crofton**

- 10 Signals

## **US 40 Catonsville**

- 11 signals

## **MD 202 Landover**

- 4 signals

## **MD 22 Aberdeen**

- 11 signals

## **US 301 Waldorf**

- 24 signals

**Target Late 2018**

# Adaptive Criteria

- Volume (20 pts)
- Capacity/LOS (15 pts)
- Weekend Shopping (10 pts)
- Incident Detour (5 pts)
- Seasonal (5 pts)
- Special Events (3 pts)
- Homeland Security (3 pts)
- Pedestrians (-12 pts)
- Volume and Capacity measured
- Qualitative analysis for other criteria
- Did not consider signal infrastructure

# Design

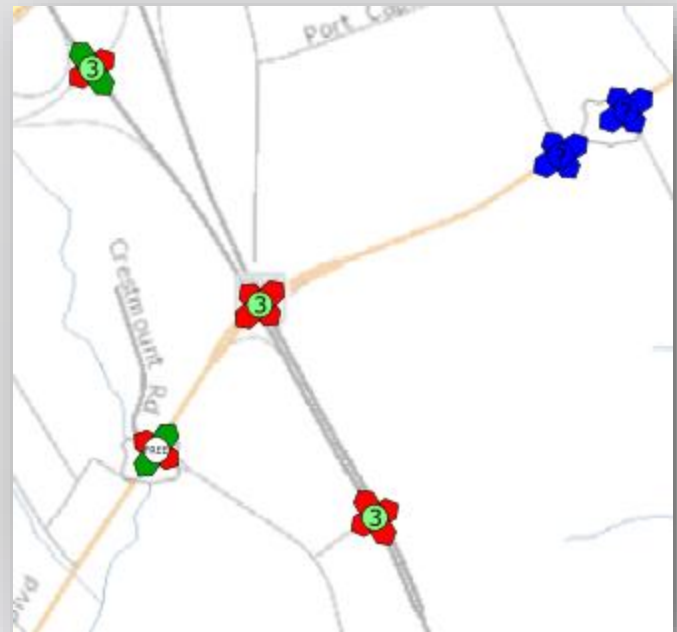
## Communication

- Sprint 3G/4G cellular
- Patton ethernet switches
- Use existing twisted pair copper

## ATMS

- Econolite Centracs
- Real time monitoring
- Split/cycle reports

**180 signals currently upgraded**



# Design



## Adaptive requires good detection!

- Survey existing detection

### Typical SHA Conditions:

- Video (multiple generations) for side streets and lefts
- Loops or micro-loops for mainline advance detection
- Mostly mast arm

### Adaptive Requirements:

- Stopbar detection on all approaches
- Advance detection on mainline



# Design



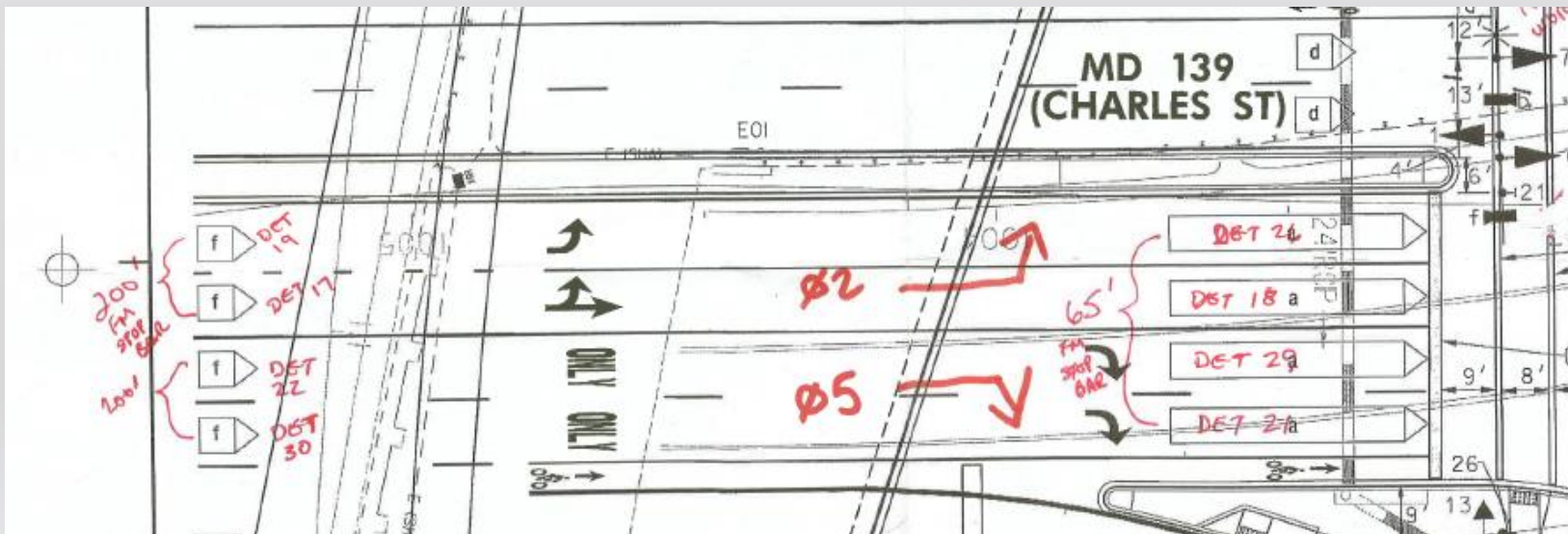
- Mast or Span?
- Can existing left turn cameras be used for mainline stopbar?
- Can cameras be added or do all need to be replaced?
- Are there sampling cameras?



# Programming

## Detailed Survey of Detection Zones

- Position and size of the zone
- Detector number, lane, phase



# Programming



1. Convert coordination patterns from percent to seconds
2. Create the algorithm

Algorithm Configuration

Specify a name and type for the algorithm, and select one or more entities to include in the calculations

Name

Type

Entities  ...

OK Cancel

# Programming

## Program Detectors

1. Name the Detector – ex. SB ADV M2 P2 D18
2. Offset or Split
3. Select the Upstream controller
4. Size and location of Detector
5. Free Flow speed

CentraCS Adaptive Controller Settings

Algorithm Name: Adaptive MD 139 Towson

Runtime Refiner... Links...

Signal Controller: MD 139 @ I-695 South Ramp - MD 139 @ I-695 South Ramp

Configuration Detectors

Detector Number	Description	Call Phase	Phase Utilization	Flow Profiling	Upstream Controller	Downstream Controller	Distance Upstream	Detector Length	FreeFlow Speed	Time To Flow	Effective Green Time Ext.	Second Shift To Brake Point
16		0	<input type="checkbox"/>	<input type="checkbox"/>	Not Specified.	MD 139 @ I-695 South Ramp	50 Feet	60 Feet	0 MilesPerHr	0	0.0	0.0
17		0	<input type="checkbox"/>	<input type="checkbox"/>	Not Specified.	MD 139 @ I-695 South Ramp	50 Feet	60 Feet	0 MilesPerHr	0	0.0	0.0
18	SB ADV M2 P2 D18	2	<input type="checkbox"/>	<input checked="" type="checkbox"/>	MD 139 @ MD 139A/MD 139B (Bellona)	MD 139 @ I-695 South Ramp	220 Feet	6 Feet	40 MilesPerHr	3	3.4	.4
19		0	<input type="checkbox"/>	<input type="checkbox"/>	Not Specified.	MD 139 @ I-695 South Ramp	50 Feet	60 Feet	0 MilesPerHr	0	0.0	0.0
20	EB STB M1 P4 D20	4	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Not Specified.	MD 139 @ I-695 South Ramp	0 Feet	59 Feet	30 MilesPerHr	0	0.0	0.0
21	SB STB L1 P5 D21	5	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Not Specified.	MD 139 @ I-695 South Ramp	0 Feet	60 Feet	23 MilesPerHr	0	0.0	0.0
22	NB STB M1 P6 D22	6	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Not Specified.	MD 139 @ I-695 South Ramp	0 Feet	30 Feet	40 MilesPerHr	0	0.0	0.0
23	NB STB M2 P6 D23	6	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Not Specified.	MD 139 @ I-695 South Ramp	0 Feet	30 Feet	40 MilesPerHr	0	0.0	0.0
24	NB STB M3 P6 D24	6	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Not Specified.	MD 139 @ I-695 South Ramp	0 Feet	30 Feet	40 MilesPerHr	0	0.0	0.0
25	SB STB M2 P2 D25	2	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Not Specified.	MD 139 @ I-695 South Ramp	0 Feet	30 Feet	40 MilesPerHr	0	0.0	0.0
26	SB STB M1 P2 D26	2	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Not Specified.	MD 139 @ I-695 South Ramp	0 Feet	30 Feet	40 MilesPerHr	0	0.0	0.0

# Programming



## Add Links

1. Select controllers and enter associated phases
2. Enter length and speed

The screenshot displays the 'Centraflex Adaptive Links' software interface. At the top, the 'Algorithm Name' is set to 'Adaptive MD 139 Towson'. Below this, there are three buttons: 'Add...', 'Edit...', and 'Delete', which are highlighted with a yellow box. A 'Filter by Signal' dropdown menu is set to '-- unfiltered --'. The main area shows a list of links with columns for 'Enabled', 'Upstream', and 'Downstream'. A blue arrow points from the 'Upstream' link 'MD 139 @ Bellona/Kenilworth' to the 'Downstream' link 'MD 139 @ I-695 South Ramp'. A 'Link Detail' window is open, showing the configuration for the selected link. The 'Upstream' section has a controller dropdown set to 'MD 139 @ Bellona/Kenilworth' and a phase dropdown set to '6'. The 'Downstream' section has a controller dropdown set to 'MD 139 @ I-695 South Ramp' and a phase dropdown set to '6'. A yellow box highlights the 'Length: 1000 ft' and 'Travel Speed: 40 mph' fields. Below these, the 'Travel Time' is calculated as '17 secs'. At the bottom of the window, there is a checkbox for 'Configure opposite direction' and 'OK' and 'Cancel' buttons.

# Programming – Intersection Settings



Centraics Adaptive Controller Settings Control

Algorithm Name: Adaptive MD 139 Towson

[Runtime Refiner...](#) [Links...](#)

Signal Controller: MD 139 @ I-695 South Ramp - MD 139 @ I-695 South Ramp

Configuration **Detectors**

**Options**

Controller Enabled  Adjust Offset  Oversized Peds Allowed

**Split Adjustment**

Phase	2	4	5	6
Timing	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Biasing	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

**Upload**

[Upload](#) [Cancel](#)

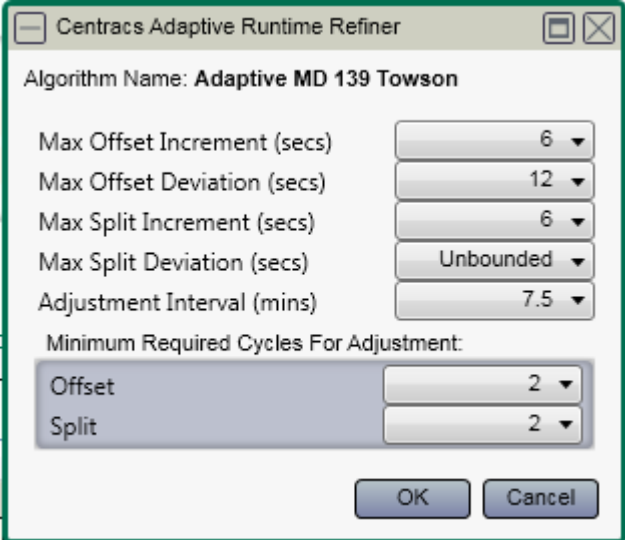
Last Sync Time 10/12/2017 3:18:11 PM

DB Sync Status Synced

Auto DB Resync

# Programming – System Settings

- Set incremental adaptive changes
- Set maximum adaptive changes
- Number of cycles for adjustment must fit into the adjustment interval
- Run the system in Analysis mode



The screenshot shows a dialog box titled "Centraacs Adaptive Runtime Refiner". The "Algorithm Name" is set to "Adaptive MD 139 Towson". The settings are as follows:

Parameter	Value
Max Offset Increment (secs)	6
Max Offset Deviation (secs)	12
Max Split Increment (secs)	6
Max Split Deviation (secs)	Unbounded
Adjustment Interval (mins)	7.5
Minimum Required Cycles For Adjustment:	
Offset	2
Split	2

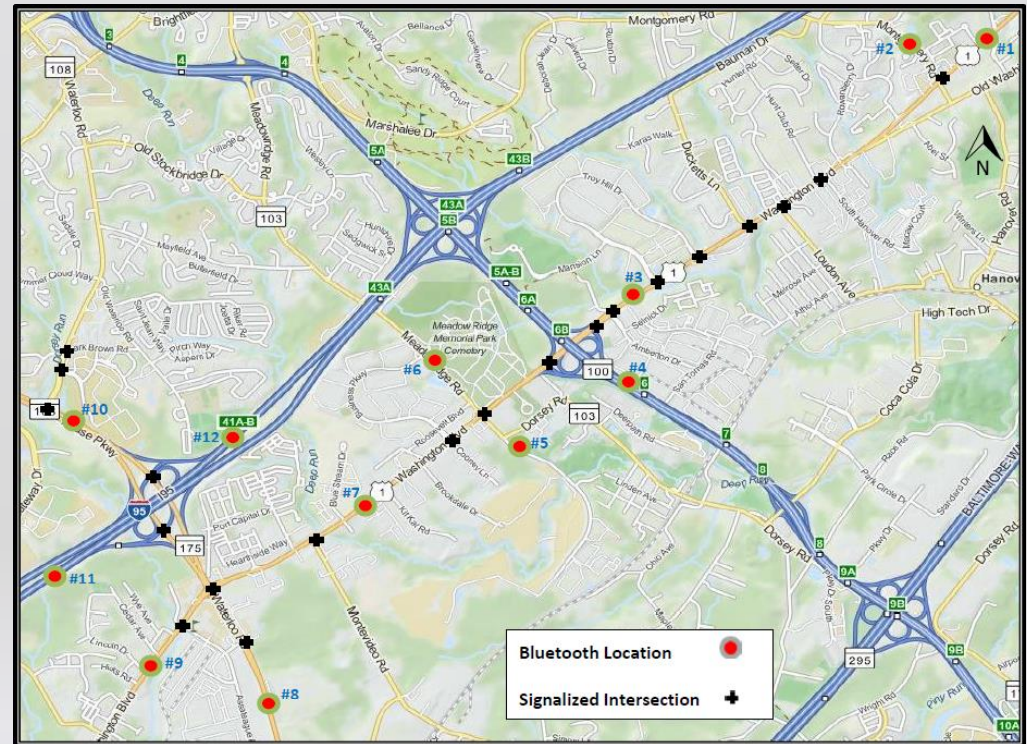
Buttons for "OK" and "Cancel" are located at the bottom right of the dialog.



# Studies

## US 1/MD 175 Jessup (Centracs Adaptive)

- 12 Bluetooth Readers
- Mainline and major side-street movements
- Inrix
- 3 percent reduction in system travel times
- 4 percent reduction in mainline travel time





# Studies

## MD 24/US 1 Bus Bel Air (Centracs Adaptive)

- 3 Bluetooth Readers
- >10% reduction in travel time for several segments
- Strong results in midday and on weekends

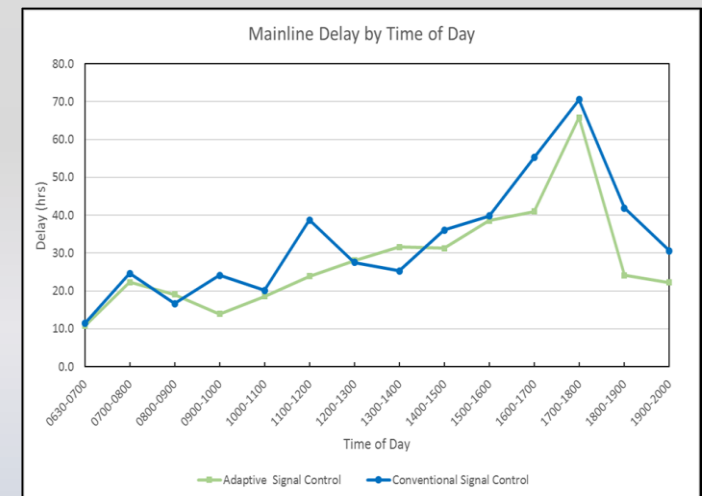
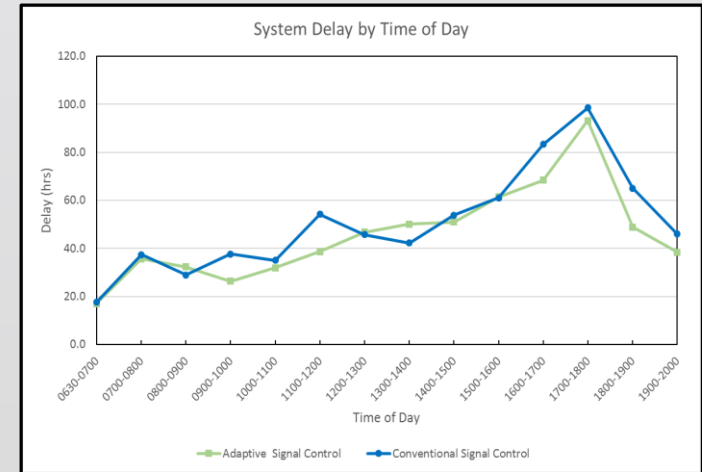
MD 24 Average Travel Time between MD 924 and Boulton Street

Peak Period		MD 24 Northbound									MD 24 Southbound								
		MD 924 to Ring Factory Rd			Ring Factory Rd to Boulton St			Overall MD 924 to Boulton St			Boulton St to Ring Factory Rd			Ring Factory Rd to MD 924			Overall Boulton St to MD 924		
		Travel Time (minutes)		%	Travel Time (minutes)		%	Travel Time (minutes)		%	Travel Time (minutes)		%	Travel Time (minutes)		%	Travel Time (minutes)		%
Weekdays		Before	After		Before	After		Before	After		Before	After		Before	After		Before	After	
		AM Peak	4.5		4.3	4.7%		5.3	4.8		10.3%	10.3		9.5	8.2%		4.2	4.1	
Midday Peak	4.7	4.4	6.1%	5.2	4.6	13.2%	10.2	9.1	12.2%	5.0	5.1	-1.8%	4.8	4.4	8.6%	9.9	9.7	1.8%	
PM Peak	6.6	5.9	11.8%	6.0	5.7	6.1%	12.5	11.6	8.1%	6.2	6.1	0.4%	5.1	4.6	11.8%	11.8	11.2	5.3%	
Weekend Peak	5.8	5.1	11.9%	5.0	4.7	6.1%	10.8	10.4	3.5%	5.8	5.4	6.4%	4.7	4.3	9.0%	11.3	10.1	11.3%	

# Studies

## MD 2 Brooklyn Park (SynchroGreen)

- Combined GPS Travel Time runs, controller split/cycle reports and TM counts
- 9.5 % reduction in system delay
- 15.5 % reduction in mainline delay



# Studies



## Conclusions

- No study is perfect
- Match the study to the corridor
- Try to capture side street performance
- Prefer delay, try to capture weekends, smaller time intervals

## Studies show adaptive is working

- Centrac Adaptive – simple, inexpensive, limited by cycle
- SynchroGreen – effective, more expensive, more complex

# Future



## Performance Monitoring

- How do we know the adaptive is working?
- When do we need to change base timings?
- Travel time, arrivals, etc.

## Adaptive on most SHA corridors

## Adaptive Changes

- Eos Adaptive – cycle and improved split calculations
- Multimodal
- Update existing adaptive systems