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# **A Portable Monitoring and Evaluation System for Traffic Signals**

**Texas Transportation Institute**  
**September 16, 2011**

# Project Overview

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- Identification of operational problems at signalized intersections
- Typically signal controller is programmed to operate in an optimum manner
  - *No information is available to evaluate operations (complaints)*
- AWECS, PIA, D-CS systems monitor, use, and document intersection operations
  - *Will serve as the frame work for the development of maintenance/monitoring tool*

# Project Objective

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- **Develop a tool to monitor, log, analyze traffic signal operations**
  - *TS2 Cabinet*
- **Portable and easy to install in a cabinet**
- **Configured using off the shelf hardware components**

# Architecture Components

- **Hardware**

- *Use of enhanced BIUs*
- *Field hardened computer (compact)*



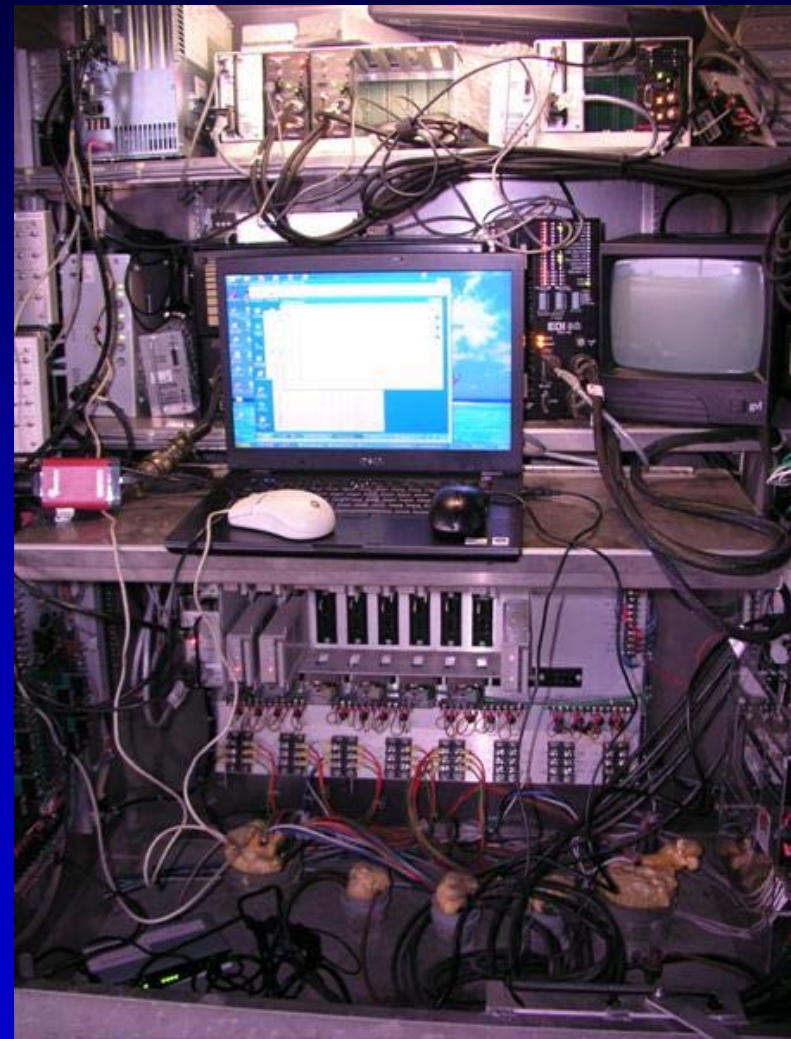
- **Software**

- *User friendly GUI*
- *Generate performance measures*
  - **Readily available results**
  - **Customizable results**



# Prototype Implementation

- Installed a prototype in the field
  - *SH 6 and SH 40*
  - *16 phases*
  - *Detectors up to 24*
  - *Four BIUs*



# Phase Settings

PTSMS - Phase Settings

## Phase Settings

Phase #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Active Phase	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Major Street Phase	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
MIN GRN	8	15	0	5	8	10	0	8	0	0	0	0	0	0	0	0
PASSAGE	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MAX 1	35	75	0	70	35	75	0	70	0	0	0	0	0	0	0	0
Yel	4.5	4	0	4.5	4.5	4.5	0	4.5	0	0	0	0	0	0	0	0
Red Clr	1.5	1.5	0	1.5	1.5	1.5	0	1.5	0	0	0	0	0	0	0	0

Exit

Update Phase Settings

# Detector Assignment

PTSMS - TS-2 Cabinet Detector Assignment

Select a Detector BIU: 1

**Detector to Phase Mapping**

Channel	Enabled	Phase	Type	Delay in Seconds	No Activity 0-255 Minutes	Max. Presence 0-255 Minutes	Erratic Count Count per Minute
1	<input checked="" type="checkbox"/>	2	Stopbar	0	60	60	100
2	<input checked="" type="checkbox"/>	6	Stopbar	0	60	60	100
3	<input checked="" type="checkbox"/>	1	Stopbar	0	60	60	100
4	<input checked="" type="checkbox"/>	5	Stopbar	0	60	60	100
5	<input checked="" type="checkbox"/>	4	Stopbar	0	60	60	100
6	<input checked="" type="checkbox"/>	8	Stopbar	0	60	60	100
7	<input checked="" type="checkbox"/>	3	Stopbar	0	60	60	100
8	<input checked="" type="checkbox"/>	7	Stopbar	0	60	60	100
9	<input type="checkbox"/>	0	None	0	255	255	255
10	<input type="checkbox"/>	0	None	0	255	255	255
11	<input type="checkbox"/>	0	None	0	255	255	255
12	<input type="checkbox"/>	0	None	0	255	255	255
13	<input type="checkbox"/>	0	None	0	255	255	255
14	<input type="checkbox"/>	0	None	0	255	255	255
15	<input type="checkbox"/>	0	None	0	255	255	255
16	<input type="checkbox"/>	0	None	0	255	255	255

Exit Update Detector Settings



# Coordination Settings

PTSMS - Time-Based Settings

Coordination Time - Based Settings

Prev Plan  Next Plan

Select a Plan Number

Hour Minute

Select start Hour and Minute

Exit Update Plan

PTSMS - Coordination Dial-Split Data

Coordination Plan Dial - Split Settings

Prev Plan  Next Plan

Select a Plan

Enter Plan Offset

Enter Plan Cycle Length

Enter Plan Phase Splits

1	2	3	4	5	6	7	8
16	58	0	46	20	50	0	50
9	10	11	12	13	14	15	16
0	0	0	0	0	0	0	0

Exit Update Plan



# Signal Operations

PTSMS - Phase Status

Duration of Last				#	Phase
Phase	GRN	YEL	RED	Greens	Detector
1	7.2	12.2	95.8	2	<input checked="" type="checkbox"/>
2	48.7	4.5	49.8	2	<input type="checkbox"/>
3					<input checked="" type="checkbox"/>
4	35.1	4.5	8.7	2	<input checked="" type="checkbox"/>
5	26.1	4.5	15.7	2	<input type="checkbox"/>
6	37.4	4.5	47.8	2	<input type="checkbox"/>
7					<input checked="" type="checkbox"/>
8	14.2	4.5	77.0	2	<input checked="" type="checkbox"/>
9					<input type="checkbox"/>
10					<input type="checkbox"/>
11					<input type="checkbox"/>
12					<input type="checkbox"/>
13					<input type="checkbox"/>
14					<input type="checkbox"/>
15					<input type="checkbox"/>
16					<input type="checkbox"/>

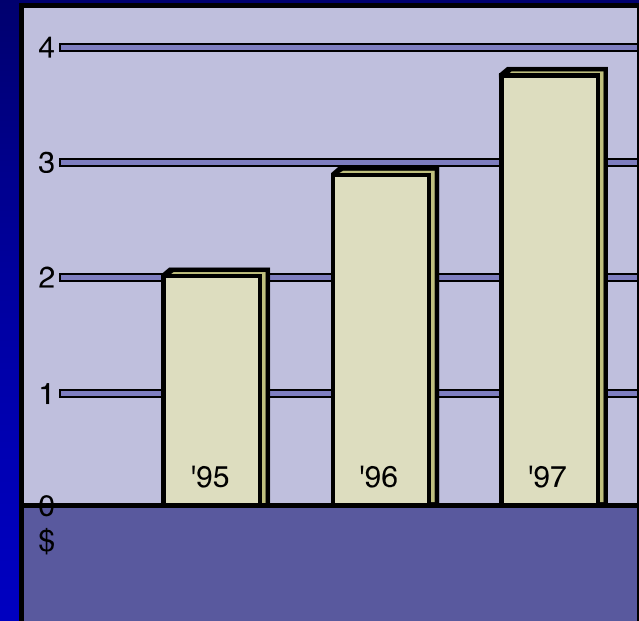
\*\*\* Number of Greens ==> Number of times Phase was serviced during the day.

PTSMS - Detector Status (1 - 16)

Detector Actuations			Erratic Count		Count Per Day
Detector #	Last Pres Time (Secs)	Last Gap Time (Secs)	Status	Last Minute Count	
1	1.1	5.5	Good	1	11
2	0.0	346.2	Good	0	0
3	67.5	12.9	Good	0	4
4	21.8	0.9	Good	4	7
5	2.0	0.2	Good	9	36
6	0.0	346.2	Good	0	0
7	22.9	38.7	Good	1	4
8	64.6	15.8	Good	0	6
9	0.0	0.0	Good	0	0
10	0.0	0.0	Good	0	0
11	0.0	0.0	Good	0	0
12	0.0	0.0	Good	0	0
13	0.0	0.0	Good	0	0
14	0.0	0.0	Good	0	0
15	0.0	0.0	Good	0	0
16	0.0	0.0	Good	0	0

# Monitoring System

- **Signal Operations**
  - *Coordination Operations*
- **Preemption Activity**
- **Pedestrian Activity**
- **Average Hourly Report**
- **Cycle by Cycle Report**



# Data Analysis


The screenshot shows the PTSES software window with a title bar and a series of tabs. The first tab, 'Select Data Analysis Report Type', is active and displays five radio button options: 'Hourly-MOE Report', 'Time-Period Report' (which is selected), 'Preempt Report', 'Detector-Failure Report', and 'Ped-Detector Report'. The 'Detector Daily-Count Report' option is also present but not selected. A 'Generate Report' button is located at the bottom center of the window.

Portable Traffic Signal Evaluation System (PTSES)

Select Data Analysis Report Type | Load Data Files | Select an MOE | Select Days of Data | Select Phases | Select Time Interval | Generate Report

☐ Hourly-MOE Report    ☒ Time-Period Report    ☐ Preempt Report    ☐ Detector-Failure Report

☐ Ped-Detector Report    ☐ Detector Daily-Count Report



# Measures of Effectiveness

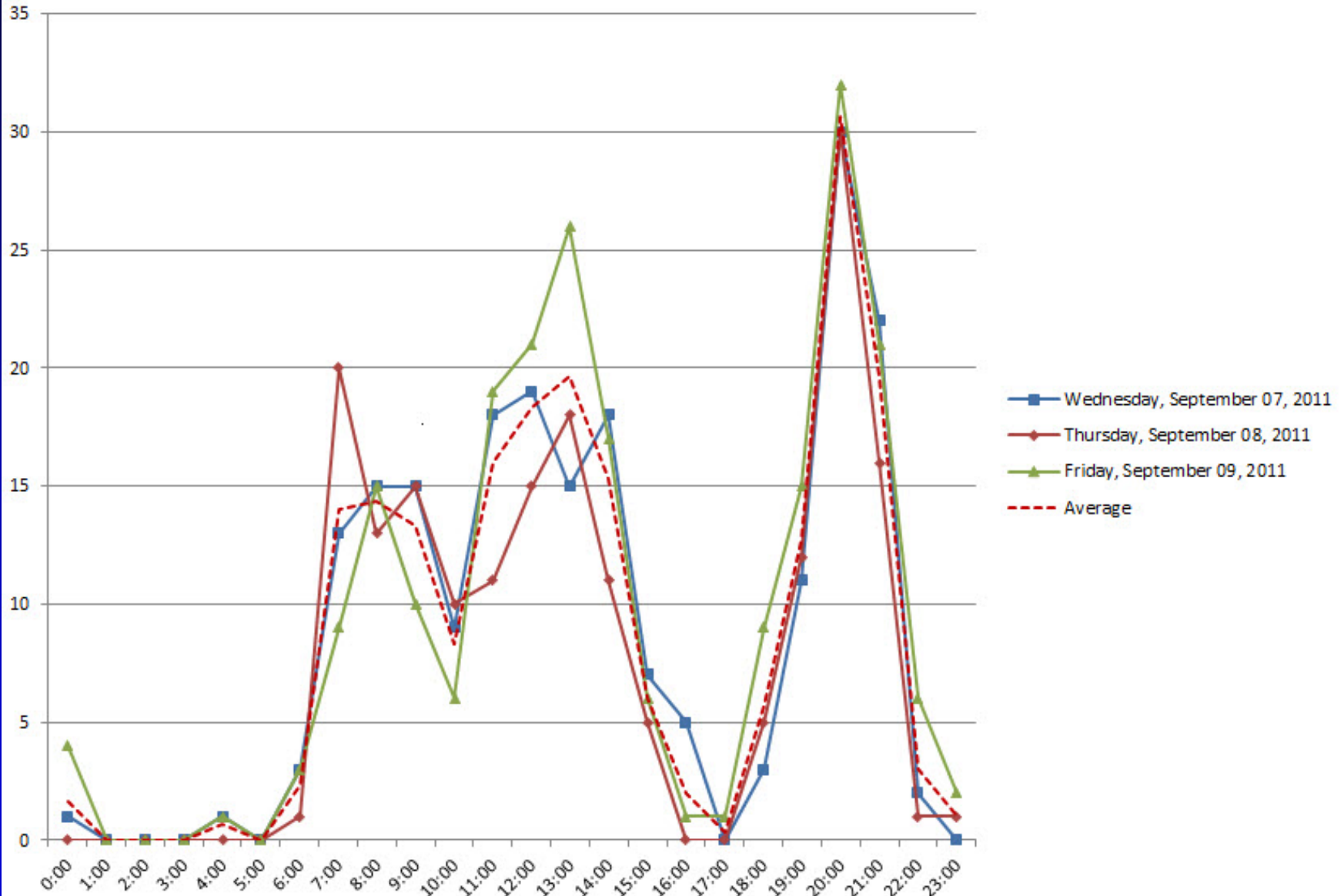
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- Number of Minimum Greens
- Number of Max-outs
- Average Phase Lengths
- Time to Service
- Queue Service Time
- Detector Occupancy
- Actuations



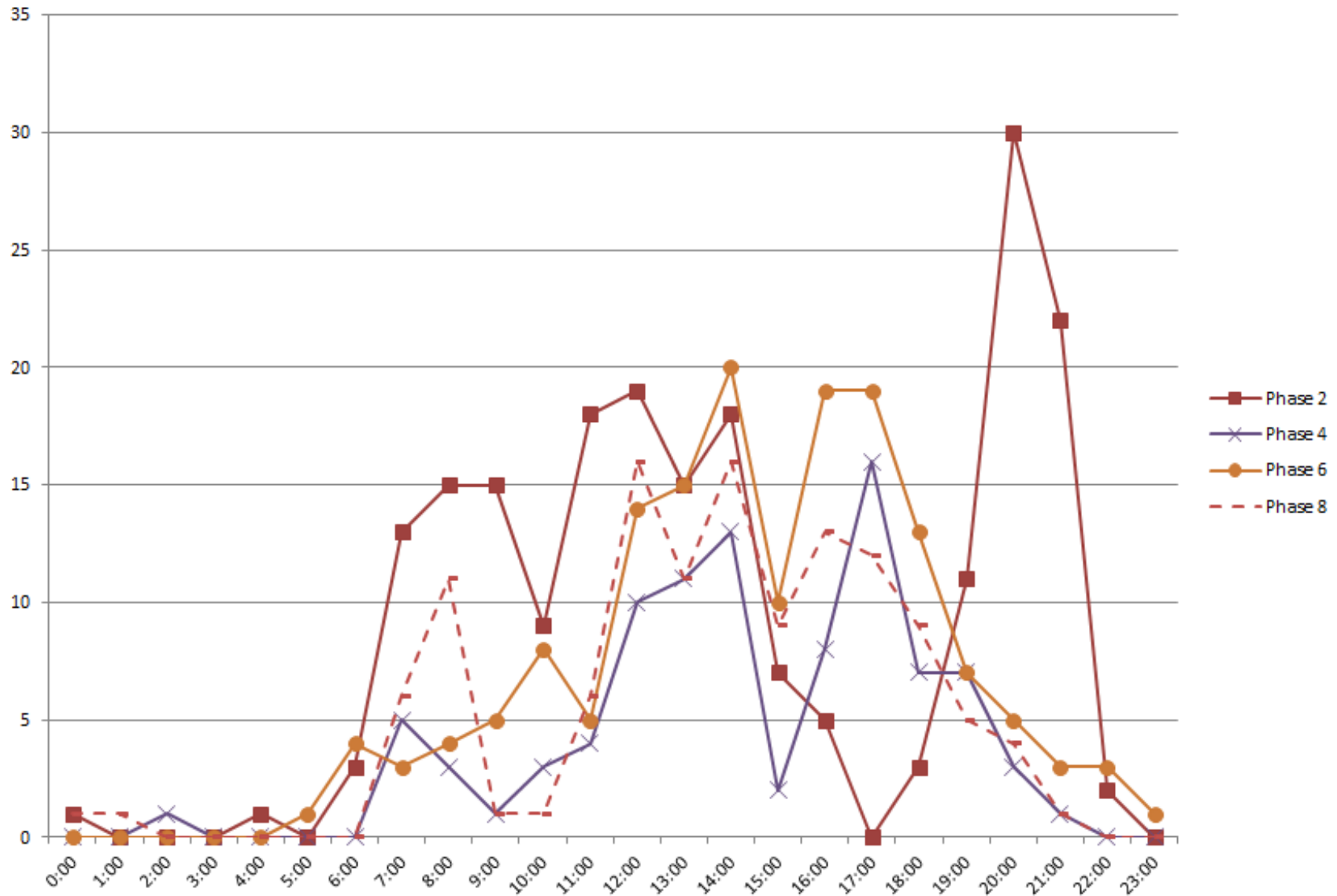
# Max-Outs Phase 2

Phase 2 Number of MaxOuts per Hour Summary



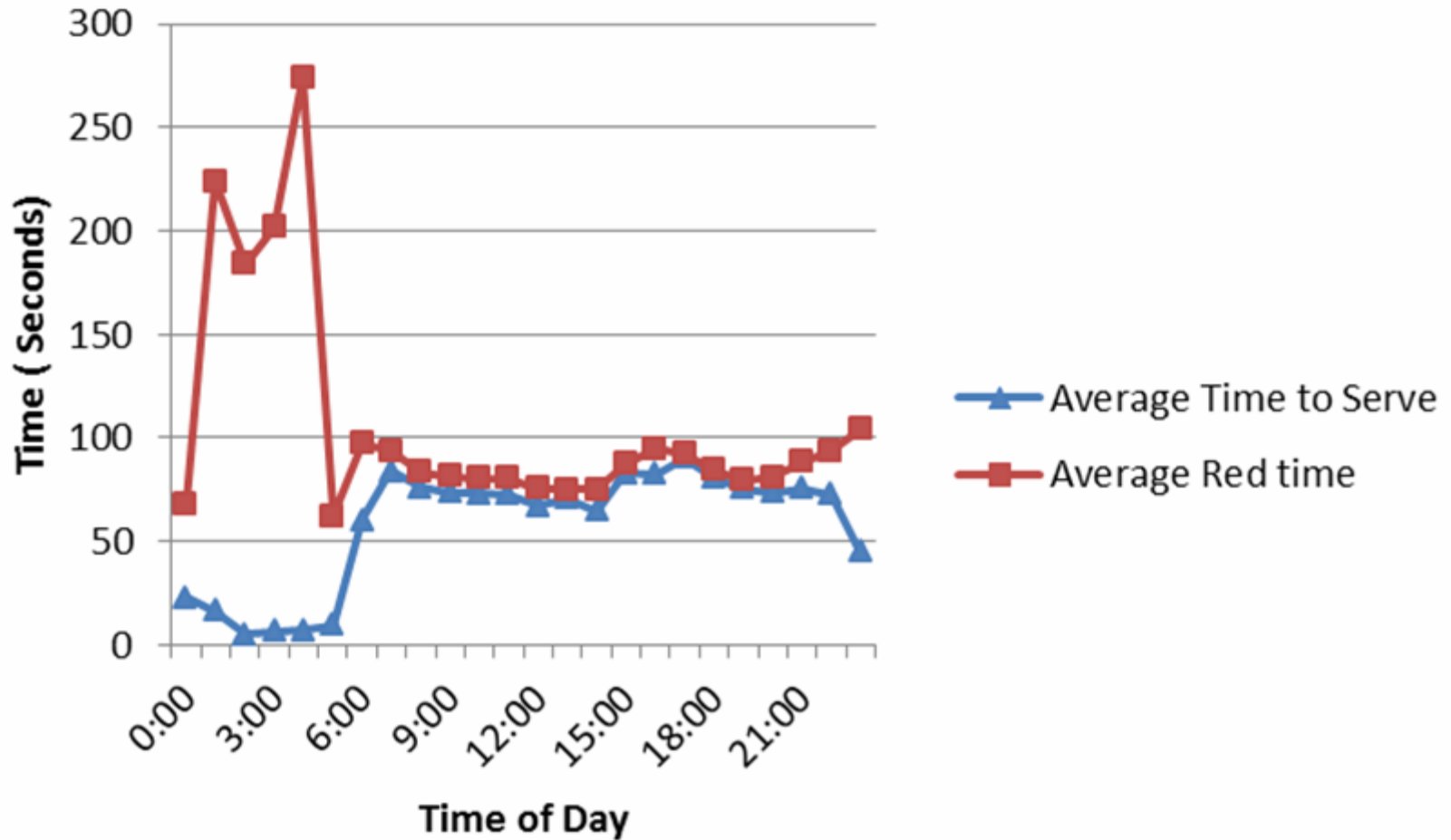
# Max-out Behavior

Number of Maxouts per Hour Summary for 09/07/2011





# Delay Experienced (Phase 4)



# Cycle by Cycle Data (Phase 4)

			Phase	CycleNo	Green Start	Green	MinGrn	Max1	Coordination Status						
Phase	CycleNo	Green Start								Occupancy on Red	Time to Service	Count on Green	Count on Yellow	Count on Red	
4	179	07	4	179	07:01:03	00:17	00:05	01:10	Coord	1:21	00:01:09	00:01:09	0	0	1
4	180	07								1:12	00:01:12	00:01:12	0	1	0
4	181	07								1:36	00:01:27	00:01:27	0	0	1
4	182	07								1:38	00:01:37	00:01:37	0	0	1
4	183	07	4	181	07:04:25	00:18	00:05	01:10	Coord	1:33	00:01:17	00:01:17	0	0	1
4	184	07								1:45	00:01:14	00:01:14	0	0	1
4	185	07								1:15	00:01:15	00:01:15	0	0	0
4	186	07								1:15	00:01:15	00:01:15	0	0	0
4	187	07	4	183	07:08:23	00:23	00:05	01:10	Coord	1:15	00:01:15	00:01:15	0	0	0
4	188	07								1:15	00:01:15	00:01:15	0	0	0
4	189	07								1:15	00:01:15	00:01:15	0	0	0
4	190	07								1:15	00:01:15	00:01:15	0	0	0
4	191	07	4	185	07:12:23	00:40	00:05	01:10	Coord	1:15	00:01:15	00:01:15	0	0	0
4	192	07								1:40	00:01:40	00:01:40	0	1	0
4	193	07								1:31	00:01:24	00:01:24	0	0	1
4	194	07								1:39	00:01:39	00:01:39	0	1	0
4	195	07	4	187	07:16:23	00:40	00:05	01:10	Coord	1:38	00:01:30	00:01:30	0	0	1
4	196	07								1:31	00:01:26	00:01:26	0	1	1
4	197	07								1:38	00:01:30	00:01:30	0	0	1
4	198	07								1:37	00:01:19	00:01:19	0	0	1
4	199	07	4	188	07:18:23	00:40	00:05	01:10	Coord	1:40	00:01:12	00:01:12	0	0	1
4	200	07								1:39	00:01:33	00:01:33	0	0	1
4	201	07								1:33	00:01:28	00:01:28	0	0	1
4	202	07								1:29	00:01:01	00:01:01	1	1	1
4	203	07	4	190	07:22:23	00:40	00:05	01:10	Coord	1:45	00:01:29	00:01:29	0	0	1
4	204	07								1:21	00:01:20	00:01:20	2	0	1
			4	192	07:26:23	00:15	00:05	01:10	Coord						

# Diagnostics

	Indicators	Possible Causes	Potential Actions
Number of Minimum Greens	<ul style="list-style-type: none"> <li>High number of minimum greens.</li> <li>Relative low occupancy on green at the same time.</li> </ul>	<ul style="list-style-type: none"> <li>The phase may be on min recall.</li> <li>The demand on the phase is light but fairly uniform.</li> </ul>	<ul style="list-style-type: none"> <li>Check if the minimum green is too long.</li> <li>Check if the right-turn-on-red vehicles can be sufficiently serviced with detector delay.</li> </ul>
	<ul style="list-style-type: none"> <li>Low number of minimum greens.</li> </ul>	<ul style="list-style-type: none"> <li>Moderate to heavy traffic demand on that phase.</li> <li>The arrival pattern is consistent.</li> </ul>	<ul style="list-style-type: none"> <li>No action required.</li> </ul>
Occupancy on Green	<ul style="list-style-type: none"> <li>High occupancy on green (near 100%) only at a certain time of day.</li> </ul>	<ul style="list-style-type: none"> <li>Heavy traffic demand on that phase.</li> </ul>	<ul style="list-style-type: none"> <li>If the occupancy on green on the conflict phase is below 100%, max time for this phase may be increased.</li> </ul>
	<ul style="list-style-type: none"> <li>High occupancy on green (near 100%) constantly throughout the day.</li> </ul>	<ul style="list-style-type: none"> <li>Malfunctioned detector is placing a constant call.</li> </ul>	<ul style="list-style-type: none"> <li>Check the phase detector.</li> </ul>

# Limitations and Future Work

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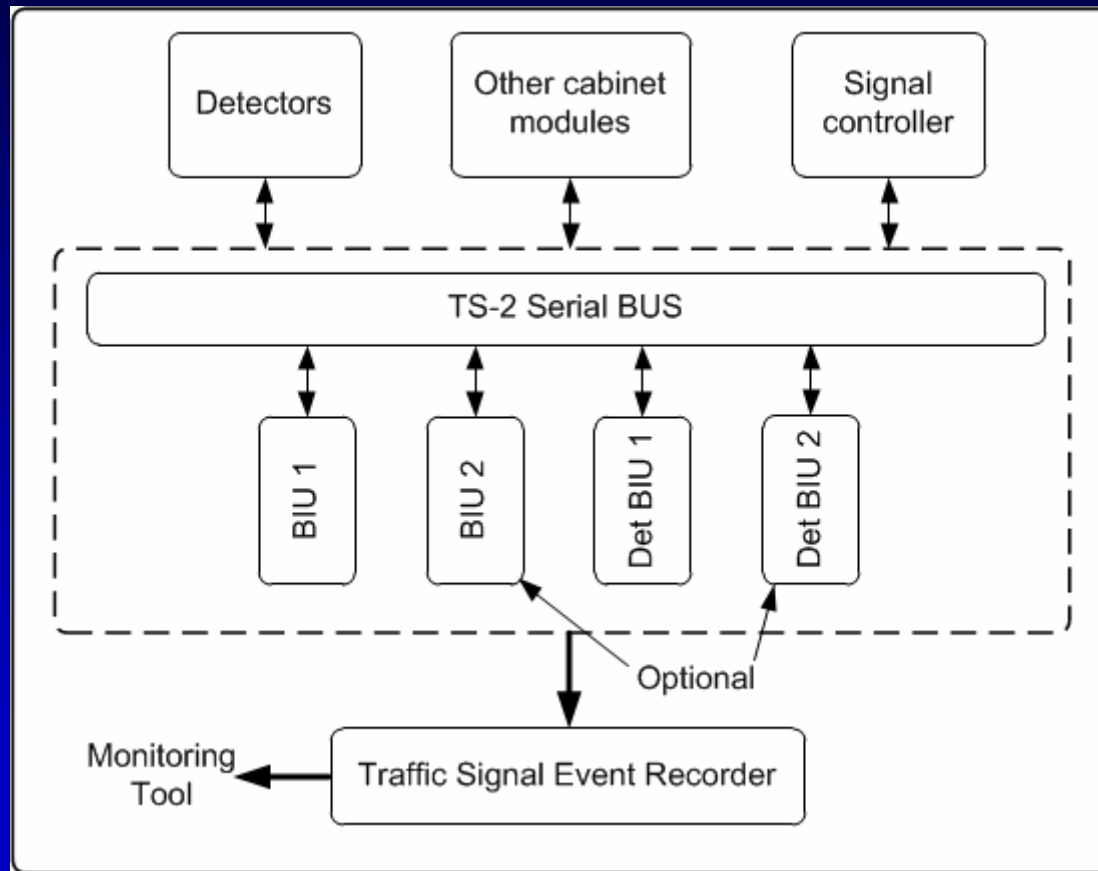
- Use of detector BIUs that do not have a serial port
- Requires data to be input
- Modify it for NTCIP controllers

# Questions

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# System Architecture





# Prototype Development

- Implemented the prototype system in TransLink laboratory
  - *Eight phases*
  - *Eight detectors*
  - *Two BIUs*



# Pedestrian Operations

PTSMS - Ped Detector Status

<input checked="" type="checkbox"/> Ped Detector - 2	<input type="checkbox"/> Ped Walk-1
<input type="checkbox"/> Ped Detector - 4	<input type="checkbox"/> Ped Walk-2
<input type="checkbox"/> Ped Detector - 6	<input type="checkbox"/> Ped Walk-3
<input type="checkbox"/> Ped Detector - 8	<input type="checkbox"/> Ped Walk-4

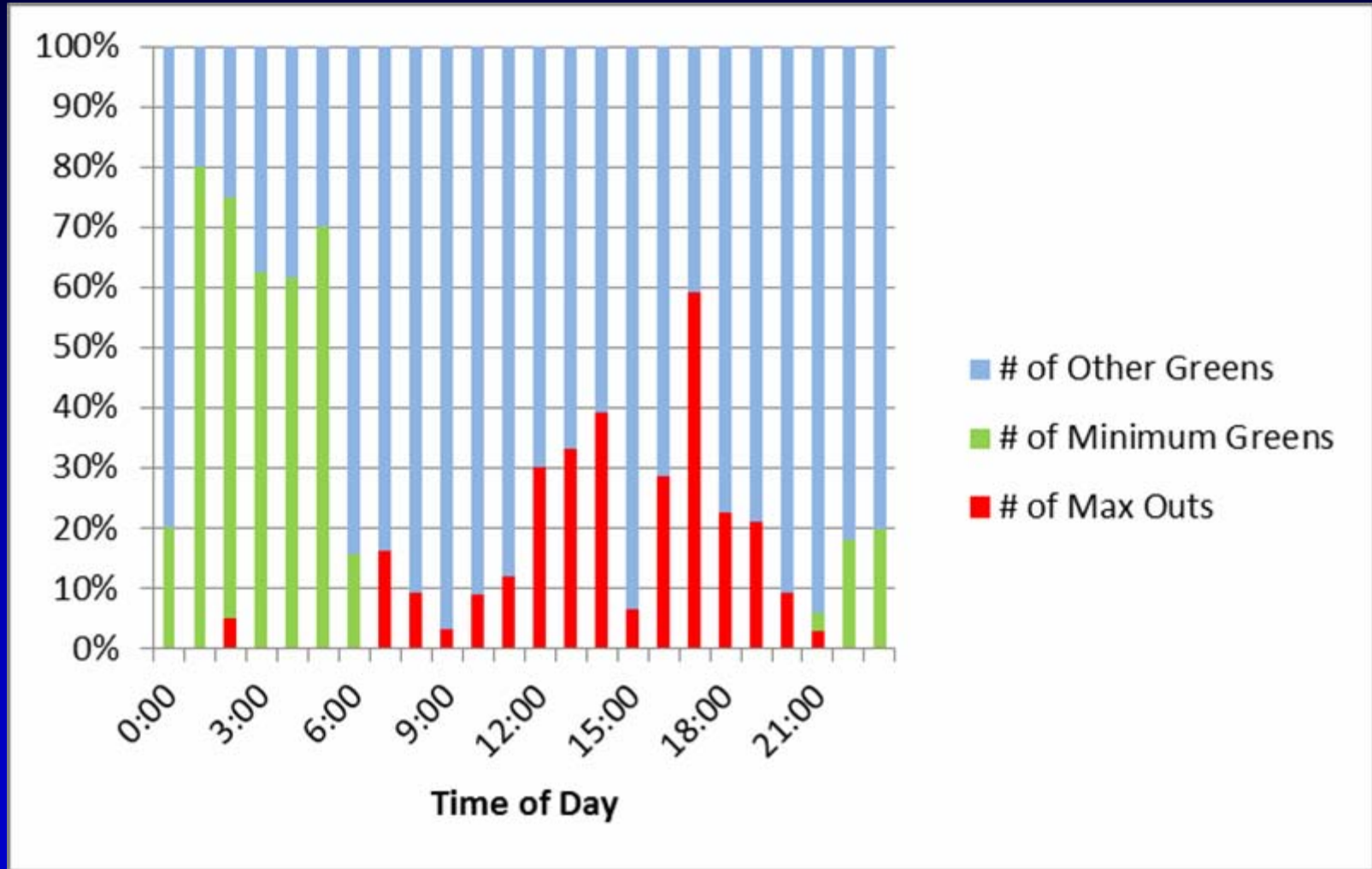
Exit

PTSMS - Ped Detector Status

<input type="checkbox"/> Ped Detector - 2	<input checked="" type="checkbox"/> Ped Walk-1
<input type="checkbox"/> Ped Detector - 4	<input type="checkbox"/> Ped Walk-2
<input type="checkbox"/> Ped Detector - 6	<input type="checkbox"/> Ped Walk-3
<input type="checkbox"/> Ped Detector - 8	<input type="checkbox"/> Ped Walk-4

Exit

# Phase Utilization – Phase 4



# Max-Outs Phase 4

Phase 4 Number of MaxOuts per Hour Summary

