
Chris Vaughan
ITRE
What is ATSPM?

- Using UDOT SPMs
- In process of implementing UDOT SPMs
- Interested in SPMs
### What is ATSPM?

<table>
<thead>
<tr>
<th>Performance Metrics</th>
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<tbody>
<tr>
<td>Approach Delay</td>
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<tr>
<td>Approach Volume</td>
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<tr>
<td>Approach Speed</td>
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<tr>
<td>Arrivals on Red</td>
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<tr>
<td>Pedestrian Delay</td>
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<tr>
<td>Preemption Details</td>
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<tr>
<td>Purdue Link Pivot</td>
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</tbody>
</table>
High-resolution data is collected by a data logger at each signalized intersection. The unprocessed data is sent to a central location where it is stored. Database software is used to normalize the unprocessed data. ATSPM software is used to calculate ATSPMs and produce visual reports for staff and public consumption.

http://www.itre.ncsu.edu
Comparison of Reports and Features

<table>
<thead>
<tr>
<th>Report/Feature</th>
<th>Open Source</th>
<th>Econolite</th>
<th>Trafficware</th>
<th>Miovision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase Termination Metric(s)</td>
<td>(1)</td>
<td>(1)</td>
<td>(1)</td>
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<tr>
<td>Progression Quality Metric(s)</td>
<td>(2)</td>
<td>(2)</td>
<td>(2)</td>
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<tr>
<td>Split Failure Metric(s)</td>
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<tr>
<td>Delay Metric(s)</td>
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<tr>
<td>Volume Metric(s)</td>
<td>(2)</td>
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<tr>
<td>Yellow and Red Actuations Metric(s)</td>
<td>(2)</td>
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<tr>
<td>Pedestrian Metric(s)</td>
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<td>Preemption Metric(s)</td>
<td>(2)</td>
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<tr>
<td>Speed / Travel Time Metric(s)</td>
<td>(2)</td>
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<tr>
<td>Chart Customizations (e.g., Axis Min/Max, Data Filters)</td>
<td>(2)</td>
<td>(2)</td>
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<tr>
<td>Query Multiple Days on a Single Chart</td>
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<tr>
<td>Filter Data by Day of the Week</td>
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<tr>
<td>Historical Data Comparison</td>
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<tr>
<td>Query Multiple Intersections on a Single Chart</td>
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<tr>
<td>Dashboard Metric(s) for Multiple Intersections (Corridor / Network)</td>
<td>(1)</td>
<td>(1)</td>
<td>(1)</td>
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<tr>
<td>Summary Tables</td>
<td></td>
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<tr>
<td>Highlight &quot;Hot Spots&quot;</td>
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<td>(1)</td>
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<tr>
<td>Programmable Alerts</td>
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<tr>
<td>Optimization Features (e.g., Cycle Length, Split, Offset)</td>
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<tr>
<td>Process Data from Different Vendors</td>
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<td></td>
<td>(1)</td>
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<tr>
<td>No External Hardware Required</td>
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<td>(1)</td>
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<tr>
<td>Integrate with Non-Linux-Based Controllers (ATC or 2070 with 1C CPU)</td>
<td>(1)</td>
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<td>(1)</td>
<td></td>
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<tr>
<td>Access to Raw High-Resolution Data</td>
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<td>(1)</td>
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<tr>
<td>Guidance Documentation</td>
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</tbody>
</table>

*Note: Reports and features are under development for all ATSPM systems. Evaluation reflects available reports and features as of 5/16/18."
ATSPM Options

Data Logger Options:

• **Linux-Based Controller.** Linux-based traffic signal controllers are capable of logging 1/10-second-resolution data required for ATSPMs. Most controller vendors produce an ATC controller that is Linux-based. Alternatively, 2070 controllers can be converted to Linux-based by adding a 1C CPU module. This type of data logger requires the controller (or 1C CPU module) as well as staff time (or a consultant) to program the signal timing in the new firmware, bench test, and install the controller in the field.

• **External Hardware.** There are several vendors that produce hardware that can be used external to the traffic signal controller to log high-resolution data. Without a connection to the traffic signal controller, there are some events that will not be logged (e.g., termination types), but external hardware can record inputs (e.g., detector actuations) and outputs (e.g., displays) using other cabinet components. This type of data logger requires the cabinet hardware and typically time for the vendor to configure and install it in the field.
ATSPM Options

Data Storage Options:

- **Server.** This equipment can store the unprocessed high-resolution data, database software, and ATSPM software. This type of data storage requires a server with the appropriate processing power, memory, and disk configuration plus staff time (or a consultant) to install it at the central office. Coordination with IT staff will be critical for integration into the network.

- **Cloud.** If an agency does not want to maintain physical equipment at the central office, they can subscribe to a cloud-based solution where a private entity hosts the server(s). Vendors typically use a cloud-based solution to provide access to data. Cloud-based solutions require IT coordination for firewall access.
Database Software Options:

- **SQL Server.** There are several types of database software available. SQL Server is a popular option for use with the open source code. There is a free version of this database software, but it has limited applications because of size constraints (10 GB maximum). The professional versions of this database software vary in price based on the number of users who will access the program.
ATSPM Options

ATSPM Software Options:

• **Open Source Code.** This software is free through the web-based FHWA Open Source Application Data Portal (OSADP) and can process data from any Linux-based controller. It does require staff time (or a consultant) to install the software, configure intersections, verify that data is being collected and processed correctly, and troubleshoot issues.

• **Econolite Centracs® SPM.** This software is subscription-based (with an initial setup fee) and requires an Econolite Linux-based controller. The per-intersection cost decreases at 100 intersections.

• **Trafficware SPM Cloud.** This software is subscription-based (with an initial setup fee) and requires a Trafficware Linux-based controller. The per-intersection cost decreases at 101 intersections.

• **Miovision TrafficLink.** This software is subscription-based (with an initial setup fee) and can process data from any Linux-based controller. Alternatively, Miovision manufactures SmartLink, which is a piece of hardware external to the traffic signal controller (with built-in cellular communication). It can be used alongside non-Linux-based controllers, but will not record every event in that case (e.g., termination types).
Life Cycle Cost Estimate for 25 Intersections*

* Note: Cost estimates for all options assume NCDOT needs to procure data loggers. The open source code cost estimate assume NCDOT needs to procure data storage hardware and database software. Includes 20% contingency.
<table>
<thead>
<tr>
<th>Location</th>
<th>Controller Vendor</th>
<th>ATSPM System</th>
<th>Communication</th>
</tr>
</thead>
<tbody>
<tr>
<td>US401: Garner South</td>
<td>Econolite</td>
<td>Centracs® SPM</td>
<td>Yes</td>
</tr>
<tr>
<td>NC55: Broad Street</td>
<td>Trafficware</td>
<td>SPM Cloud</td>
<td>Yes</td>
</tr>
<tr>
<td>NC50: Benson Road</td>
<td>Econolite</td>
<td>Open Source Code</td>
<td>No (Raspberry Pi)</td>
</tr>
<tr>
<td>US17: Market Street</td>
<td>Econolite</td>
<td>Open Source Code</td>
<td>No (Raspberry Pi)</td>
</tr>
</tbody>
</table>
NCDOT ATSPM Pilot Findings

- ATSPM solutions with higher costs generally have additional reports and features available.
- The open source code is more expensive to deploy than the vendor options, assuming NCDOT needs to procure data storage hardware and database software. However, the vendor options have recurring annual subscription fees, so life cycle costs should be considered.
- The open source code provides flexibility to customize signal performance measures, but also requires NCDOT to maintain the system (typically necessitating close coordination with IT staff).
- The open source code and Miovision solutions can process data from any Linux-based controller, while the Econolite and Trafficware solutions require their own Linux-based controllers.
ATSPM can Support Both Traffic Signal Maintenance and Operations

Training is needed to know **what to look for** and **where to find it**

Examples of UDOT Operations Use Cases:

<table>
<thead>
<tr>
<th>Focus</th>
<th>Metric</th>
<th>Detection Requirements</th>
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</thead>
<tbody>
<tr>
<td>Progression Quality</td>
<td>Purdue Coord. Diagram</td>
<td>Advance Count Detection</td>
</tr>
<tr>
<td>Approach Speeds</td>
<td>Approach Speeds</td>
<td>Advance Radar/Speed Trap</td>
</tr>
<tr>
<td>Approach Volumes</td>
<td>Approach Volumes</td>
<td>Advance Count Detection</td>
</tr>
<tr>
<td>Lane-by-Lane Volume/Lane Util.</td>
<td>Turning Movement Counts</td>
<td>Stop Bar Count Detection</td>
</tr>
<tr>
<td>Red Light Monitoring</td>
<td>Yellow and Red Activations</td>
<td>Stop Bar Count w/ speed filter</td>
</tr>
<tr>
<td>Corridor Offset Optimization</td>
<td>Purdue Link Pivot</td>
<td>Advance Count Detection</td>
</tr>
</tbody>
</table>
Use Cases

Coordination Optimization Example: Progression Quality

One approach shown

Vehicles arrive on green
Vehicles arrive on yellow
Vehicles arrive on red

Source: UDOT

http://www.itre.ncsu.edu
Use Cases

Source: INDOT

http://www.itre.ncsu.edu
Use Cases

Broad Street & Judd Parkway Signal 1816
Tuesday, September 5, 2017 12:00 AM - Tuesday, September 5, 2017 11:59 PM

Currently showing Force-Offs, Max-Outs and Gap-Outs with a consecutive occurrence of 1 or more. Pedestrian events are never filtered.

Legend
- Gap Out
- Max Out
- Force Off
- Ped Begin Walk
- Ped Begin Clearance
- Unknown Termination Cause

Time (Hour of Day)

http://www.itre.ncsu.edu
Detection Alert
Phase 4 at 400 E & 800 N, 4/8 & 9/2014

Phase 4 starts constant call

SPMs evaluated for % max outs

Alert email sent

4/8/2014

4/9/2014

Gap out
Max out
Force off

Pedestrian activation (shown above phase line)

Skip

Metric: Purdue Phase Termination
Detection Requirements: None

Source: UDOT

http://www.itre.ncsu.edu
Limitations

Source: Darcy Bullock

Efficient Coordination

Efficient Local Control

Detector Health

Working Communications

http://www.itre.ncsu.edu
Limitations

Source: Alison Tanaka, KAI

http://www.itre.ncsu.edu
Limitations

Detector Configuration E:
Minor Stop Bar & Major Advance (Lane-By-Lane)

Available ATSPM Reports
1. Purdue Phase Termination
2. Split Monitor
3. Pedestrian Delay
4. Preemption Details
5. Turning Movement Counts
6. Purdue Coordination Diagram
7. Approach Volume
8. Approach Delay
9. Arrivals on Red
10. Approach Speed
11. Yellow and Red Actuations
12. Purdue Split Failure *

NOTE
Minor street and left-turn stop bar detection allows Purdue Split Failure to be reported for those movements.
Without major street stop bar detection, available green time on the major street will be unknown. A practitioner can supplement with other reports, such as Purdue Phase Termination.

Detector Configuration F:
Minor Stop Bar & Major Advance (Lane Groups)

Available ATSPM Reports
1. Purdue Phase Termination
2. Split Monitor
3. Pedestrian Delay
4. Preemption Details
5. Turning Movement Counts
6. Purdue Coordination Diagram
7. Approach Volume
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