Texas Department of Transportation

THE UNIVERSITY OF TEXAS AT ARLINGTON

PROJECT SUMMARY REPORT

0-7160: Improving Traffic Signal System Planning, Design, and Management with Big-Data-Enhanced ATSPM System

Background

Automated Traffic Signal Performance Measures or ATSPM represent a state-of-the-art traffic signal management solution. After over 20 years of collaboration among federal agencies, state agencies, academia, and industry, the ATSPM system is increasingly being accepted and adopted by agencies. While the ATSPM deployment is scaling up, new challenges are surfacing. A main challenge is the increasing gap between traffic signal design and traffic signal operations. Traffic signal planning and design still follow the traditional approach instead of the new ATSPM approach due to a lack of the needed data. Once the new traffic signal timings are deployed in the field, they will receive much more extensive evaluation using the ATSPM method. Another challenge is that deploying the ATSPM system takes lots of resources even though the software may be free. This situation results in limited access to the ATSPM system among the stakeholders. Other challenges include the high demand for detectors, operational and maintenance complexities, etc. These issues will likely become hurdles for agencies to scale up their ATSPM deployment.

This research aims to address the above issues to facilitate TxDOT's stage-wide ATSPM deployment. It has achieved three goals:

- Provided a practical ATSPM-In-the-Loop simulation solution to introduce the ATSPM method into the traffic signal design stage. This solution will not significantly increase project costs.
- Provided a pre-deployment mechanism for stakeholders to evaluate unconventional traffic signal solutions using the ATSPM system, like adaptive, traffic signal preemptions etc.
- Provide a training platform for stakeholders to explore new ATSPM solutions.

What the Researchers Did

The research team from the U of Texas at Arlington conducted multiple tasks to fulfill the research goals.

A literature review and a best practice survey were first conducted. Among over 100 responses, most expressed an interest in ATSPM. Many agencies have either deployed or are considering deploying the ATSPM systems.

Second, a traffic simulation model was developed to generate the travel demand for future scenarios. A popular traffic simulation software, PTV VISSIM, was adopted to serve this goal. A TxDOT freight corridor, Cooper Street in Arlington (TX) was modeled including 14 intersections. Multiple sources of data were collected, including traffic signal timing data, turning counts, and connected vehicle trajectory data. All these data have been used for traffic modeling, calibration, and validation. The documented methods will also serve other stakeholders to fine-tune their current simulation models to integrate with the ATSPM-in-the-loop simulation platform.

The research team also improved and documented the installation process of two real-world ATSPM systems within a lab environment: the Utah-DOT open-source ATSPM and the "UTA-In-Motion" (an add-on ATSPM system databases are SQL Server (Express) and MySQL. These options ensure no software cost will be needed for stakeholders to adopt the ATSPM-In-the-

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Loop simulation solution in their projects.

The major effort is developing the software tools to transform the output of traffic simulation to the data format recognizable by the real-world ATSPM system(s). Three software tools were developed:

- Data Parser from narrative simulation output to the numbered ATSPM data format defined by Indiana DOT.
- Data parser from simulated vehicle trajectories (x, y) to the real-world WGS 84 trajectories (lat, lon) to emulate the real-world connected vehicle big data set. It serves as the data feed for the UTA-In-Motion ATSPM module.
- Data transferring from the Utah-DOT ATSPM database to the UTA-In-Motion ATSPM database.

All software tools will be published to the public for free soon.

Using the developed VISSIM models, installed ATSPM systems, and the developed software, the research team conducted two case studies to demonstrate how to use this new solution for traffic signal projects.

The first case study is like a standard traffic signal project. The travel demand is increased from the baseline traffic scenario. The traffic condition is evaluated using the ATSPM-In-the-Loop simulation to identify bottlenecks. Then the research team followed the standard method to optimize the traffic signal timings and then evaluate them again with the ATSPM-In-the-loop simulation method.

The second case study focuses on more complex traffic signal operations including traffic signal preemption and priority. The baseline model was first modified to increase traffic volumes as well as add a train track (for signal preemption) and buses/freight trucks for signal priority at multiple intersections. The traffic signal optimization follows a holistic method and was verified by the ATSPM performances.

While developing and maturing this new solution, the research team also performed technology transfer activities. A presentation was made first during the TexITE meeting in College Station in the spring of 2024. A more comprehensive presentation was made to introduce this new solution in the ATSPM's monthly webinar hosted by FHWA in June 2024. This new solution received broad interest from the audience.

Next Steps

The research team plans to further improve the documents on how to integrate traffic simulation with the ATSPM systems. They will also seek to integrate more ATSPM systems and support more controller emulators through collaboration with industrial partners. The research team will develop training materials and host more technology transfer activities to facilitate the stakeholders to adopt this new solution in their traffic signal projects. The vision is to improve the stakeholders' access to ATSPM and promote the adoption of ATSPM in the full spectrum of traffic signal operations, from design to operations.

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