Applying Emerging Technologies for Smarter Traffic Signal Optimization Processes

ANNE ARUNDEL COUNTY MARYLAND

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Benefits Statement

This project in Anne Arundel County optimized traffic signals using innovative technologies, saving lives, time, and money. By relying on continuous data and remote processes, it reduced implementation time from months to weeks, improved traffic flow, and cut median travel times. The project saved $324,000 in user costs, $48,000 in fuel, and $7,000 in CO2 costs within a year. The approach allows for ongoing improvements, enhancing safety, efficiency, and cost-effectiveness, all while reducing the need for costly traditional methods.

In this case study you will learn:

1. About advanced technologies like ATSPMs and GcOST for remote, efficient traffic signal optimization.
2. About data-driven methods that led to better travel times, cost savings, and fewer complaints.
3. About the GcOST framework that ensured stakeholder satisfaction and accountability throughout the project.

Case Study #188

Version Number: 1

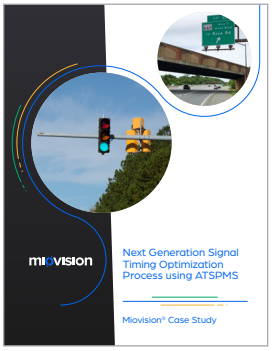
NOCoE

BACKGROUND

This project was unique because it used several new technologies and practices for traffic signal timing. First, it used Automated Traffic Signal Performance Measures (ATSPMs) for a complete corridor signal optimization without traditional traffic counts and models. Second, it used GcOST (Goals, Context, Objectives, Strategies and Tactics) to involve stakeholders and ensure their satisfaction. Third, it used clustering analysis and data fusion to filter out anomalies and identified the most common patterns for timing plans and incorporated different data sources. Lastly, it used all the ITS technologies including ATSPMs, object-based detection analytics, Bluetooth/Wi-Fi readers, communication via fiber, and CCTVs to do the project remotely. No field observations were needed! The signal optimization process was cheaper (lower consultant costs) compared to the traditional processes, more efficient, more successful, and it showed us that we can skip the desktop traffic signal timing software model.

The traditional traffic signal optimization process often relies on specific triggers, such as public complaints or the natural life cycle of traffic signal timings, which typically call for retiming every 3 to 5 years. This process includes data collection, model creation, and adjustments to cycles, splits, and offsets, culminating in the implementation and evaluation of new timings. However, this conventional method has its drawbacks: it requires a trigger, lacks an iterative process that incorporates performance measures, relies on data that may only represent a few days within a year, and often lacks clarity on the specific issues it aims to resolve. The evaluation phase may reveal problems, but by then, making changes can be costly.

In Anne Arundel County, Maryland, a project was undertaken to revamp this traditional process. The goal was to integrate multiple Intelligent Transportation Systems (ITS) technologies within Traffic Systems Management and Operations (TSMO) strategies, execute the process entirely remotely, adhere to a limited budget, and complete the optimization in a matter of weeks rather than months. This initiative aimed to enhance efficiencies, utilize a larger data set, and ultimately, develop enhanced traffic signal optimization plans.



The county contracted with Miovision Technologies and Mead & Hunt to re-time multiple corridors, with a particular focus on the complex Riva Road corridor in Annapolis, Maryland. This corridor, which includes eight intersections, presented unique challenges due to changes in the Annapolis High School bell schedule and the diverse land uses in the area, such as office complexes, hotels, shopping centers, a major freeway interchange, and a park and ride lot with transit service.

The analogy of extracting juice from an orange can be used to describe the conventional optimization process: if the signals haven't been retimed in a while, it's like starting with a ripe orange, and the initial retiming yields significant benefits. However, as retiming becomes more frequent, the benefits diminish. This project introduced a new approach, likened to having access to a fresh orange with abundant juice to extract. It's an adaptable process that, by integrating additional data sources and advanced computational techniques, allows for more frequent refreshment of strategies, ensuring a consistent stream of benefits.

TSMO PLANNING, STRATEGIES AND DEPLOYMENT

Our team integrated various areas within the TSMO Strategy of Traffic Signal Coordination for Riva Road, including strategic planning, integration of new technologies and process modification. Cutting-edge technologies were implemented such as object-based traffic signal detection, continuous multi-modal traffic counts, and Automated Traffic Signal Performance Measures (ATSPMs) operational round-the-clock. Leveraging techniques from Federal Highway Administration (FHWA) publications, best practices were adopted, gaps were identified, and the processes were enhanced. The GcOST (Goals, Context, Objectives, Strategies, and Tactics) methodology was pivotal in our traffic signal optimization, focusing on an objectives and performance-based approach.

The data collection and field reviews deviated from traditional methods that often rely on limited datasets from short-term observations. Instead, extended data aggregation was used, spanning days to months, to compile a comprehensive dataset. This enriched data pool allowed us to assess traffic variability and how the system performs with different scenarios.

In modeling and simulation, we combined the rich dataset with historical data at intersections without the new ITS technology, applying normalization, cluster analysis, and data fusion techniques. The optimization strategies transcended platform constraints, employing refined techniques and an intuitive approach to tailor a network-specific strategy, ensuring our signal retiming met our objectives and surpassed expectations. The planned post-calibration period was unnecessary because the initial results already achieved the needed increase in efficiency. The innovative approach has set a new standard for traffic signal optimization.

COMMUNICATIONS PLANNING AND EXECUTION

The GcOST framework guided the communications planning and execution of the project. Recognizing that each stakeholder has distinct roles, responsibilities, interests, and expectations concerning traffic signal operations and performance, we ensured their collaboration and coordination to fulfill the needs and goals of the transportation network and its users. Stakeholder engagement was a crucial aspect of the GcOST process, guaranteeing that expectations were met at both an agency level and with the driving public.

The Riva Road corridor presented complexities, with numerous citizen concerns that varied in detail and often conflicted with traffic signal timing objectives. It was imperative for Anne Arundel County to address these concerns, prioritize feasible changes, and justify the modifications with data-driven conclusions. This approach not only addressed and reduced concerns but also set a precedent for transparency and accountability in traffic management. The project's success in reducing public complaints and enhancing traffic signal performance demonstrates the effectiveness of a methodical, data-oriented approach to traffic engineering challenges.

OUTCOME, BENEFITS AND LEARNINGS

The entire project, from ATSPM data analysis to re-timing, was executed remotely, eliminating the need for site visits. The project was completed in a matter of weeks compared to the traditional 2 to 4 months (or longer), showcasing the efficiency of staff time. There was a decrease in median travel time and an improvement in travel time reliability in both the AM and PM Peaks. Additionally, the project achieved a reduction in split failures at the three major intersections along the corridor, with the most notable reductions at Harry S Truman Parkway. The corridor savings for a one-year timeframe were substantial, with user cost savings of $324,000, fuel cost savings of $48,000, and CO2 cost savings of $7,000. Other over-arching benefits include:

- It allowed for a customized approach to consistently extract more benefits, akin to getting more juice from oranges.
- There was clear accountability, as the optimization was tied to specific goals and objectives, prompting a shift in approach if these were not met.
- When including the cost of ATSPMs into the project (platform and data storage), the benefit to cost ratio is still very favorable with the modified signal optimization process.
- The robust data set increased the quality of the optimization and provided more opportunities to correct any issues before implementation.
- It facilitates a shift towards active traffic management, laying the foundation for more frequent changes without having to start anew with each optimization project.

Link to the Webinar on this Project (FHWA-led Webinar): https://github.com/udotdevelopment/ATSPM/discussions/169

(Scroll down to February 26, 2024; Topic: Using ATSPMs in the Signal Optimization Process)