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DEPARTMENT OF TRANSPORTATION

OFFICE OF RESEARCH & INNOVATION

TECHNICAL SUMMARY

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PROJECT COST:
$57,486

Most of Minnesota's traffic signals use complex controllers to manage traffic, responding to information gathered from multiple sources, such as loop detectors and other sensors.

Evaluating the Use of Central Traffic Signal Control Systems

What Was the Need?

Traffic signal control has evolved since the 1950s from simple time-based signal protocols to current dynamic systems that allow adjustment of signals to traffic conditions. Intersection control information (ICI) is increasingly important to transportation agencies, researchers and private companies involved in developing traffic models and technologies.

Historically, the availability of traffic signal control information in Minnesota and traffic data formats have varied across jurisdictions. Nationally, increased use of central traffic signal control systems (CTSCS) has supported recent trends toward more dynamic traffic models and control, as well as toward advances in automated intelligent vehicles. This quickly evolving environment makes the creation of a unified, standardized system of ICI in Minnesota both feasible and necessary.

Researchers gathered intersection control information (ICI) from traffic signal control professionals throughout Minnesota. This information will be used to create a unified code of ICI for developing future traffic models and technology systems.

MnDOT sought to examine the use of CTSCS to manage all aspects of traffic near construction zones more strategically and effectively in order to mitigate the frequent and often severe disruption of traffic these zones can cause. This project was initiated to determine the state of Minnesota's ICI systems and to develop guidance for reaching MnDOT's goal of a unified ICI and better statewide traffic management through CTSCS.

What Was Our Goal?

This project had three objectives:

- Deliver guidance and tools to collect ICI from all Twin Cities metro area jurisdictions and automate the importation of this information into each jurisdiction's CTSCS and signal performance measure (SPM) applications. A stated priority was the ability to import this data into MnDOT's digital products used in construction design.
- With the help of all stakeholders, define the most inclusive format to represent all required information.
- Design a Regional Database of Unified Intersection Control Information (RDUICI), and propose methods and tools for importing and exporting data between the RDUICI and all CTSCS and SPM applications by local jurisdictions.

What Did We Do?

Researchers distributed surveys to signal operators and transportation model builders to identify the contents and develop the format of the unified ICI.

A survey sent to 153 signal professionals sought to learn how operators in diverse jurisdictions store and distribute ICI. Responses from 42 participants helped researchers assess the availability of ICI and the degree of effort a regional unified ICI would require.

A second survey was sent to 58 designers, modelers and planners who have experience working with MnDOT signal information to learn about ICI's various uses; 25 people responded. Researchers also interviewed a selected group of signal operators and modelers to gain more detailed information.

continued

"A unified set of intersection control information is valuable for developing a regional signal timing database to model construction project impacts and provide standardized information for use with connected vehicle technologies."

—Kevin Schwartz,
Signal Optimization Engineer,
MnDOT Metro Traffic Engineering

"Identifying the needs of different stakeholder groups allowed us to produce an organized, comprehensive format for intersection control information."

—John Hourdos,
Research Associate Professor,
Minnesota Traffic Observatory, University of Minnesota

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Unified ICI can identify all the parameters traffic signal controllers need to effectively manage challenging highway configurations like this diverging diamond interchange in Bloomington.

These surveys and in-depth interviews allowed researchers to create intersection models of varying complexity to drive the identification and categorization parameters of the proposed unified ICI. Researchers developed a complete unified ICI for a diverging diamond interchange, a complex interchange that is difficult to represent with traditional intersection models. Researchers also developed a relational database schema for containing the data set in a machine-readable format. This schema is a starting point for developing a system for standardizing the management and availability of ICI across jurisdictions.

What Did We Learn?

Researchers documented all intersection signal control codes in use. They showed the feasibility of a unified ICI and demonstrated it through the example of a fully coded diverging diamond interchange. They learned that some data in older formats would need to be digitized to be included.

Further investigation and communications with the software developers of MaxView, MnDOT's CTSCS, showed researchers that current systems could not be used to store the entire unified ICI. While the systems contain much of the unified ICI data set, some detailed geometric information is missing that is critical to understanding the intersection control. MaxView also contains information that is not readable by other systems.

Because of these challenges, researchers suggested managing unified ICI through a custom-built, centralized cloud repository. This solution would only require that vendors develop tools for exporting the information they have in a unified ICI format. The cloud repository would then be accessible to signal control vendors and to MnDOT, and security would remain intact.

What's Next?

MnDOT now has the full range of intersection signal control data used across the state. Researchers have determined it can be imported, stored and delivered through a cloud-based method. With these findings, the agency can begin to consider projects that use CTSCS for construction zone disruption mitigation and intelligent vehicle technologies.

This Technical Summary pertains to Report 2019-14, "Evaluation of a Central Traffic Signal System and Best Practices for Implementation," published March 2019. The full report can be accessed at mndot.gov/research/reports/2019/201914.pdf.