VDOT Virginia Department of Transportation
Virginia Center for Transportation INNOVATION & RESEARCH

Research Brief
VCTIR 15-R24RB August 2015

Evaluation of the Virginia Department of Transportation Adaptive Signal Control Technology Pilot Project

Perspective The Virginia Department of Transportation (VDOT) currently develops traffic signal timing plans that change by time of day using data from the recent past. While these plans often work well initially, they can become outdated as traffic patterns change over time, so engineers must repeatedly update them. Likewise, the plans are less effective if there are seasonal traffic changes caused by tourism or shopping or when special events or incidents occur. The Federal Highway Administration has estimated that 5 percent of all traffic delay nationally is caused by outdated signal-timing plans.

Adaptive signal control technology is an alternative approach to operating traffic signals. It uses a system of computer processors, traffic sensors and high-bandwidth communication to set traffic signal timings dynamically based on current traffic conditions. Since timing parameters are changed in real time, engineers do not need to regularly retime signals, reducing costs. These systems are also able to respond to changes in traffic caused by crashes, special events or unusual situations.

In this study, researchers at the Virginia Center for Transportation Innovation and Research (VCTIR), VDOT's research division, evaluated the impacts of Rhythm Engineering's InSync adaptive signal control technology on safety and traffic flow. They assessed the system's impact on 13 roadways included in a pilot project developed by VDOT's Traffic Engineering Division to determine whether the net benefit from the system justified the additional expense to install the technology. The study results showed that the system was a cost-effective solution that usually improved traffic conditions.

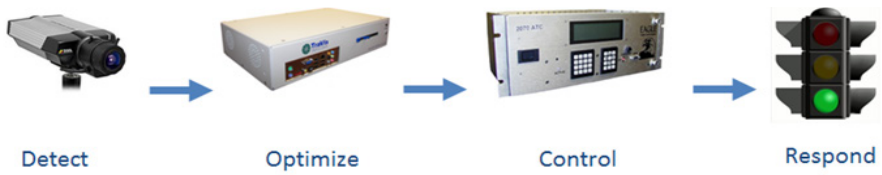
The researchers also defined situations where adaptive signal control technology should be considered. The Traffic Engineering Division is using this information and other lessons learned from the pilot to prepare a guidance document for VDOT's field traffic engineering staff to assess which roads will benefit from the future use of these systems.

Background Although adaptive signal control technology was initially developed in the 1970s, it has not been widely deployed. Until recently, the systems often were expensive and required a significant amount of in-house expertise to operate. This acted as a barrier to their use, even though they often reduced delays and improved efficiency versus traditional systems. Modern adaptive signal control technology systems have become much more user-friendly and cost-effective, which has increased interest in deploying them.

VDOT's Traffic Engineering Division wanted to determine whether the benefits of modern adaptive signal control technology systems justified the additional expense to purchase and maintain the equipment. Its staff decided to conduct a pilot project between 2011 and 2013 to test the InSync system on 13 roadways with different characteristics around the state. VCTIR worked with the division to design and carry out the pilot project evaluation.

VDOT's operations regions and Traffic Engineering Division selected study sites, focusing on locations expected to have highly variable traffic flow. The pilot sites were diverse, ranging from two-lane roads to six-lane divided highways. Speed limits ranged from 35 to 55 mph, and the annual average daily traffic varied between 13,000 and 44,000 vehicles per day.

Research and Recommendations The VCTIR researchers evaluated the impact of the adaptive signal control technology on major road travel time, travel-time reliability, side-street delays and stops on the main road using a "before" and "after" study at each of the 13 sites. To collect travel-time data, the researchers used a combination of GPS-equipped vehicles traveling the road length, Bluetooth readers installed at points along the way and estimates of speed and travel time from a private-sector vendor, INRIX.



Typical steps in adaptive control system technology processing

For the full report, search 15-R24 at vtrc.virginiadot.org. For more information about the study, contact Michael D. Fontaine, Ph.D., P.E., VCTIR associate principal research scientist, Michael.Fontaine@vdot.virginia.gov.

The analysis found that travel times on the major roads improved at 11 of 13 sites. At those sites, speeds typically increased by 3 to 5 mph with adaptive signal control technology. The number of times vehicles had to stop while traveling along the major road also declined significantly, often by between 20 and 40 percent. While traffic improved on the major road, it came at the cost of slight increases in delays on side streets. Delays increased by an average of 5 to 10 seconds per vehicle on side streets.

Benefits of Adaptive Signal Control Technology From the Pilot Project	
Travel times improved	At 11 of 13 roadways
Speed increase at roadways where travel time improved	3-5 mph
Average decrease in 95th percentile travel times	4.5 percent
Improvement in p.m. peak travel-time reliability	23 percent
Average reduction in number of stops	37 percent
Reduction in total intersection crashes	17 percent
Benefits accrued in one year outweighed cost of installation	At 10 of 13 roadways
Benefit-Cost ratio (average annual)	8.2-to-1

The researchers also examined whether the adaptive signal control technology system created any changes in safety. They analyzed crash data using five years of "before" data and one to two years of "after" data from 47 intersections. The results of that analysis showed that adaptive signal control technology produced a 17 percent reduction in total intersection crashes, although no significant change in fatal or injury crashes occurred.

The research team performed a benefit-cost analysis to determine whether the net changes in safety and delay on the major roads justified the additional costs to install adaptive signal control technology. At 10 of the 13 sites, the benefits accrued in a single year outweighed the cost of installation, and the average benefits were greater than costs by a ratio of 8-to-1 across all sites. Even though delays increased slightly on the side streets, they were outweighed by improvements in travel time on the major roads.

The researchers developed some guidance for where adaptive signal control technology should be used in the future. Some of the major issues that VDOT engineers should consider before applying these systems are:

1. Traffic considerations:

- Adaptive signal control technology is most likely to provide a benefit if the road experiences modest congestion for some portion of the day. It also provided benefits on roads that experience a lot of fluctuations in traffic demand due to school schedules, special events or shopping centers. It is unlikely to provide significant benefits at roads where the existing signals already keep traffic flowing well or that experience severe congestion for a large part of the day.
- Side-street delays may increase when adaptive signal control technology is used, so it should be used with caution if minor road approaches already experience excessive delays.

2. Site considerations:

- Adaptive signal control technology will lose some effectiveness if site characteristics — such as high-volume interchange ramps without signals or long distances between signals — prevent platoons of vehicles from making it through green signals together.
- The InSync adaptive signal control technology is particularly beneficial when installed on a road that includes both city and VDOT signal systems. InSync can be installed along with existing signal controllers, allowing different technologies in adjacent jurisdictions to communicate with one another to move traffic along a corridor.

3. Institutional considerations:

- In order to work properly, adaptive signal control technology must have well-functioning sensors and communications. This means VDOT may have more extensive maintenance responsibilities on these systems than traditional signal systems, requiring additional funds.

Based on the results of the pilot study, VDOT is continuing to deploy adaptive signal control technology on other roads around the state. These installations will contribute to VDOT's goal of reducing traffic delay and improving travel-time reliability.

The Virginia Center for Transportation Innovation and Research (VCTIR) is proud to contribute to VDOT's reputation as a national transportation leader. VCTIR greatly appreciates the cooperation and support of VDOT and the Federal Highway Administration.

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