Hitting all the greens

Signal systems that react in real time more of a reality

Unnecessary delays and congestion result in wasted fuel and needless creation of greenhouse gases.

The Federal Highway Administration (FHWA) estimates that more than 75% of the country’s 330,000 traffic signals are operating with outdated or uncoordinated signal-timing plans. Adaptive traffic-control technology holds great promise for reducing congestion on arterial roadways; however, there are only a handful of adaptive systems in operation in the U.S. Why is this? Why would a solution with great promise have such limited use? And why does the U.S. lag behind many other countries in the use of adaptive technologies?

Cause and effect

There are two underlying issues causing unnecessary delays at traffic signals. First, the majority of traffic signals in the U.S. do not receive regular timing updates. It is time-consuming to collect the necessary data, which means either dedicating staff to complete the work or hiring consultants. With dwindling budgets, these efforts usually fall to the bottom of agency to-do lists or are avoided to focus resources on more pressing needs.

Second, most traffic signals can’t adapt to changing conditions. The majority of signal systems operate with only a few outdated timing plans that do not adequately address the daily variations in traffic flow. Consider the number of times we have all waited through a red light while no opposing traffic was present, or the times we sat through multiple green lights just trying to work our way up to an intersection. The bottom line is that outdated timing plans are a primary cause of congestion on our roadways. One of the underlying reasons is that traffic-signal control technology is still operating based on strategies developed 30 or more years ago, making our signal systems ill-equipped to handle current traffic demands.

It is widely understood that adaptive traffic control is the pinnacle of arterial control and provides the best that traffic engineering has to offer for arterial mobility. A recent survey by HDR of 28 adaptive systems in the U.S. found that 13 of the 28 had been turned off...
or abandoned. The survey respondents noted their systems required too much ongoing maintenance and staff time or their system didn’t really provide much in the way of congestion relief.

The term “adaptive traffic control” has been used for decades. The common industry definition considers a system to be adaptive if it can adjust the signal timings within some period of time after traffic data is collected along a corridor. Historically, this time lag falls somewhere between 5 and 15 minutes before the signal timing is automatically adjusted. While the signals are adapting to serve demand, they do so through a responsive process rather than a real-time adjustment method. Based upon the operation of these systems, they would be more accurately titled “responsive-adaptive traffic-control systems.”

Under this definition, the majority of adaptive systems that exist in the U.S. would be categorized as responsive-adaptive systems. They provide improved corridor throughput and reduce congestion when compared with standard timing plans, but they still lag behind real-time traffic demand and, therefore, do not provide an optimal timing solution.

What if there was a shift in technology that allowed traffic signals to think and react like the traffic officers of the 1920s? These traffic officers would stand on a fixed platform in the street, and from this position they could view the traffic in each direction and make decisions on when to change the traffic light they were manually controlling. Their goal was simply to keep traffic moving, and they could react in real-time to make that happen.

Such technology could be referred to as “real-time adaptive traffic control” because it implements changes instantaneously based upon real-time demand. One example of this type of system is the InSync system developed by Rhythm Engineering. Installations of this real-time adaptive technology have improved traffic flow by 20-40% over conventionally timed signals.

Real-time work

The InSync adaptive traffic-control system utilizes robotics and artificial intelligence principles to detect vehicles...
and adjust signal timing and minimize stops along roadways. It includes a newly developed video detection/data collection system and optimizer unit that is installed at each intersection.

When deployed, the system “sees” real-time traffic, communicates with upstream and downstream intersections and automatically synchronizes the signals to optimize traffic flow along the designated arterials while simultaneously minimizing side-street delay.

The optimization unit utilizes two elements to determine signal changes. Inside the optimizer, a global timing routine focuses on minimizing stops along the main street. At the same time, a local optimizer program looks for opportunities to serve the side streets whenever there are openings in main street traffic. This optimization architecture results in significant reductions in stops along the main arterial and improved side-street service—two goals that are generally thought of as mutually exclusive by the traffic-engineering profession.

One of the key features of this innovative technology is its compatibility with almost all industry-standard controllers and cabinets. The system simply plugs into existing controllers as an overlay and provides inputs, or “calls,” to the controllers that are set to respond to InSync. It also is compatible with almost any central system software, so there is no need to discard existing hardware or software in order to implement adaptive traffic control.

Real-world results

How would you feel if you could reduce congestion, emissions, fuel consumption, travel times and the number of stops on your busiest arterial roadways? What if crashes were reduced and motorist frustration was lower in your community? Agencies are already seeing these kinds of sustainable returns on investment through real-time adaptive traffic-control installations in the Midwest.

The InSync system is estimated to reduce fuel consumption by 5,000 gal per year per intersection based upon intersections serving 25,000 vehicles per day. That equates to a decrease in CO₂ emissions of 97,000 lb per intersection annually and opens InSync projects to U.S. Department of Energy and FHWA funds aimed at lowering carbon emissions. The American Recovery and Reinvestment Act of 2009 includes $3.2 billion for the Energy Efficiency and Conservation Block Grant (EECBG) program, which provides federal assistance to agencies that reduce energy use and fossil-fuel emissions. FHWA’s Congestion Mitigation and Air Quality (CMAQ) program also provides funding for projects that improve air quality and even includes provisions for nonattainment and former nonattainment areas.

The Missouri Department of Transportation (MoDOT) deployed InSync at 12 signals along Rte. 291 in Lee’s Summit, a 2.5-mile problem corridor with unpredictable traffic flow variations. Before-and-after studies were conducted...
by the Midwest Research Institute (MRI) to determine if the system effectively improves corridor operations by reducing stops, delay, etc. The MRI study concluded, “The InSync system has reduced travel time, increased average speed through the corridor, reduced the number of stops expected for a through-vehicle on the corridor, and reduced fuel consumption and emissions, especially during the morning, off-peak and noon peak-time periods in the southbound direction.”

The southbound morning, off-peak and noon peak travel-time averages fell by 30% and speeds were increased by 50%. More importantly, the average number of times a vehicle had to stop was cut from four times to 0.2 times, meaning the system resulted in significantly less time spent at idle. Overall, the improved traffic flow is estimated to have reduced fuel consumption by an average of 25%.

The improvements to the southbound direction were not at the expense of northbound operations. The previous signal timing maintained progression in the northbound direction. InSync did not cause northbound operations to degrade and, with all the improvement to the mainline, side-street delay was not shown to increase.

Fewer stops also have shown a reduction in accidents. Initial police estimates put the reduction at 16%. Also, it was found that red-light violations had dropped on the corridor. In an interview with local news station KCTV, MoDOT Traffic Engineer Tom Evans commented that police were ending the current effort of red-light running enforcement because there was no longer anyone there to run the light when it goes red.

Opportunity knocking

The Texas Transportation Institute’s 2007 Urban Mobility Report showed that roadway congestion in the 437 largest U.S. cities leads to 4.2 billion hours of sitting in traffic and 2.9 billion gal of wasted fuel per year—the equivalent to the fuel produced from 48 fully loaded crude oil supertankers. That adds up to a total cost of $78 billion wasted annually.

The nation needs to turn a corner and invest more wisely to better serve traffic demands with the physical infrastructure we have in place. Real-time adaptive traffic control provides a quick and inexpensive solution that delivers immediate results.

Evans said the results in Lee’s Summit have been so positive that MoDOT is looking at opportunities to implement the InSync system along other corridors in the Kansas City area. Other agencies that are deploying InSync include the city of Lenexa, Kan.; Little Rock, Ark.; Joplin, Mo.; Rogers, Ark.; the Pennsylvania Department of Transportation; the Arkansas Highway Transportation Department; Overland Park, Kan.; and Leawood, Kan. R&B

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