**The Ohio State University**
**Discussion paper on traffic management and energy efficiency**
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## Number of signals:

City of Columbus (ca. March 2007):

- 1,016 signalized intersections (metro area has 400-500 additional signalized intersections)
- 75% are computer coordinated (either on the central network or closed loops)
- On average it has been over 10 years since a given intersection was retimed.
- In the Columbus metro area alone, the estimated cost to travelers due to congestion in 2003 were: 29 hrs lost to congestion per driver, 12,000,000 gal Excess fuel wasted, and an estimated total cost of $314,000,000

State of Ohio:

- There are around 17,000 signalized intersections in Ohio, roughly 1,400 of them belong to ODOT; the rest are local agency owned and operated.
- Could not find statewide statistics on numbers that are coordinated or how long it has been since they were retimed. Often, however, the signals are never retimed after instillation unless there are complaints from drivers.

## Lower energy bulbs:

- US Energy Policy Act of 2005 mandates that any traffic signal module or pedestrian module manufactured on or after January 1, 2006, shall meet the performance requirements used under the Energy Star program, (i.e., no new incandescent traffic signal heads can be sold but replacement bulbs can still be sold).
- Estimate that within ten years that most sizable municipalities will have converted to LED signal heads.
- LED signal manufacturers report that the payback time for converting to LEDs is on the order of 2.5 years
- LED signals consume roughly 10% of the energy used by incandescent traffic signals and can last up to 10 years, compared to less than two years for conventional traffic signals. (http://www.energystar.gov/index.cfm?c=traffic.pr_traffic_signals)
- The initial cost of an LED signal is roughly 5 times greater than incandescent ($75 vs. $14 per head) while the energy use is about 90% smaller ($33 vs. $274 over a 7 year period).

## Sensors at signalized intersections:

- Most commonly sensors are used in an attempt to minimize delay and fuel consumption through locally optimizing conditions in real time at a traffic signal. But without coordination such a local optimization simply moves the delay to the next intersection. The most important information about vehicle arrivals on a corridor can be calculated

ahead of time, without sensors. This calculation is possible because when an upstream signal turns green, the departing vehicles will arrive at the given signal a fixed time later (a free flow travel time). Signal coordination addresses this fact and is discussed below.

- There are some adaptive control strategies (ACS) that use an extensive network of sensors and a centralized computer to make network-wide decisions. Given the fact that most Ohio cities do not have the resources to maintain normal signal coordination, it may not be realistic to expect that these more complicated systems could be maintained.
- With regard to ACS, the FHWA noted in 2000, "The jury is still out on whether ACS works well. Benefits have been demonstrated in several areas where traditional adaptive control technologies (e.g., SCOOT, SCATS) have been deployed. However, some argue that the systems are no better than good fixed-time/time-of-day plans. This observation may be true, especially in areas where traffic is predictable or there is little traffic growth. Other issues with adaptive control include detector maintenance and communications problems."
- In personal conversations, a local FHWA representative said that "ACS Lite" does such optimization on a small network (2-10 intersections) and is promising. It requires effort to keep all detectors functioning, but it is not as labor intensive or expensive as ACS.

**Signal coordination and timing:**

- The biggest gains are not specifically technologically based, but rather, simply doing the necessary traffic studies to retime traffic signals to ensure traffic flows smoother. Like an oil change or a tune up for your car, signal retiming is an important part of keeping the system operating efficiently. Retiming is often neglected, while ITE proscribes it be done every 3-5 years, many operating agencies go 10 years or more.
- Based on the statistics at the end of this report there could be up to 40:1 payback for retiming. Even if the payback is closer to 20:1, it should be $60k per signalized intersection for about $3k investment. Prioritizing the selection will ensure a high payback rate. The statistics indicate at least 2%-10% reduction in fuel consumption.
- FHWA reports that staffing and then budget are the top two reasons given when operating agencies are asked why signals are not retimed more often.

**Signal coordination and timing recommendations:**

- Suggest having a program to submit proposals for supplemental funding to retime the 5 worst corridors in the state each year (e.g., based on discussions with city traffic engineers, $0.5M-$1M statewide, with $50k-$150k per corridor, though these numbers should be used as a starting point).
- Given the expressly urban nature of the problem, the MPOs in the state should be actively involved in the selection process, along with ODOT's Office of Roadway Safety and Mobility.
- The awarded funding should go to the maintaining agency to scope the work consistent with their existing expertise. Except for ensuring interjurisdictional coordination when a corridor includes more than one maintaining agency, the MPOs should not be involved in the implementation.

- The nomination criteria must be achievable without conducting a full timing study, otherwise it would defeat the purpose. Some metrics that should be achievable include: number of vehicles (AADT), years since retimed, evaluation as to the likelihood that retiming will help, and possibly limited field data collection such as two or three travel time runs.
- Specify that the plan must be implemented (not simply result in a report) and that part of any retiming budget should include subsequent fine-tuning after deployment (i.e., a follow up plan).

**Other points:**

- Increasing agency staffing for signal timing would likely be beneficial.
- Promote one way street systems.
- Fund intersection widening projects when needed, though they are much more expensive than simply retiming.
- Thought should also be given to land-use patterns to reduce commute distances.
- Access Management can help to improve arterial operation by reducing and controlling the points of access.

**More relevant statistics:**

National Transportation Operations Coalition (NTOC) Traffic Signal Operation National Report Card, http://www.ite.org/selfassessment/background.asp

- Gave a D- to the US, did not break scores by state but it would be safe to assume that Ohio is a typical state.
- "There is little doubt that signal timing has a greater impact on transportation system efficiency than any other operational measure in the traffic engineering toolkit."
- "[T]raffic signal timing is one of the most cost-effective actions that can be taken to improve surface transportation in urban areas."
- Numerous studies have shown that properly timed signals reduce congestion, accidents, fuel consumption, air pollution, and travel times.
- Cites one example in the state of Washington where they saw, "an annual fuel reduction of 295,500 gallons and annual reduction in vehicle delays of 145,000 vehicle hours."
- Cites another example where an agency found that "a program of regular signal timing updates has a benefit/cost ratio of 55:1, with an estimated annual user savings of $64 million."
- Notes the fact that "necessary staff and funding resources are scarce to adequately operate signals—despite the cost effectiveness and the interest from travelers."

The NTOC report card was conducted by: Federal Highway Administration (FHWA), American Association of Station Highway and Transportation Officials (AASHTO), Institute of Transportation Engineers (ITE), ITS America, et al. The 2006 report is due out by the end of the summer, and is not likely to show significant changes.

See also:

- http://www.ite.org/reportcard/ (a must read)
- http://ops.fhwa.dot.gov/arterial_mgmt/traffic_sig.htm

S. Sunkari, "The Benefits of Retiming Traffic Signals," *ITE Journal*, April 2004:

- Signal retiming should be done every 3-5 years (consistent with ITE guidelines)
- Retiming is often neglected
- Estimated to cost about $3000/signalized intersection
- Benefit/cost ratio from retiming can be up to 40:1, also cites two examples where it was over 55:1
- Cites three cases that included percent fuel consumption: 2%, 8.6%, 9.1% improvements, respectively.
- Cites three cases that included absolute fuel consumption: 400, 2400, 2600 gal/intersection saved, respectively.
- Other relevant statistics from citations: stops decreased by 10-16%, delays dropped by 13-40%.

Correspondence referred to a December 1981 *ITE Journal*:

- "every two-miles-per-hour improvement for vehicles in a traffic controlled area saves 10 percent in gasoline consumption"