National Capital Region Transportation Planning Board
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TO: Transportation Planning Board **Technical Committee Item # 7**

FROM: Ling Li
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and Chair, Traffic Signals Subcommittee

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DATE: **DRAFT** of September 6, 2013 for TPB Technical Committee Review

SUBJECT: Status Report on Traffic Signal Timing/Optimization in the Washington Region

Background

At the February 20, 2013 meeting, the Transportation Planning Board requested a status report on traffic signal timing/optimization in the region, as well as a review of the TPB's discussions of the topic in conjunction with a 2002-2005 Transportation Emissions Reduction Measure (TERM) addressing optimization (as well as subsequent data updates). This memorandum will examine what it means for a signal to be optimized and what the current status is of maintaining traffic signal optimization in the region since the last report to the TPB in 2009.

What Are Signal Timing and Signal Optimization?

Signal timing (definition adapted from Wikipedia) is the traffic engineering technique to allot right-of-way at an intersection, involving the determination of how much green time the traffic lights shall provide at an intersection approach, how long the pedestrian "walk" signal should be, and numerous other factors. Signal timing strives for the dual goals of safety and efficiency. Signal timing may be achieved in advance studies and the uploading of "pre-planned" timings, and/or in "real-time" adjustments of signals (if so equipped – see below for more information on adaptive and active management of signals).

The concept of signal optimization generally falls into the "pre-planned" category. Signal optimization is a traffic engineering concept whereby traffic signals (often groups of signals in corridors and/or isolated systems) are (re-)timed to reduce delay for vehicles on the roadway system while ensuring safety. In optimization studies, engineers use a combination of traffic volume counts, in-car and in-field travel time observations, control center observations, and computer analysis to determine signal timings given the complex interactions of traffic flows. The results for any one driver on any one trip may not appear to be "optimal", due to high traffic loads, cross-traffic, pedestrian movements, and other factors, but overall system delay should be minimized. An engineering "rule-of-thumb" recommends checking signal timing at least every three years because traffic patterns evolve.

Traffic signals allot time at intersections for safety, traffic flow, pedestrians, and other factors; an individual signal's timing needs to be balanced for these factors. Multiple nearby signals can be analyzed as a system to coordinate timings. Under certain conditions, a corridor with a predominating flow and direction can be timed for "progression", reducing delays for traffic in that flow. Signals generally have three or more timing plans, usually including morning peak period, midday, and evening peak period, and frequently additional plans such as weekend or overnight plans.

"Optimized", however, does not mean "without delay". The motorist may still experience delays even after signal or corridor optimization, if, for example:

- There are high traffic volumes / left and right turns / high cross-traffic volumes
- The motorist is traveling in the opposite direction of predominant flow
- The safety of and sufficient crossing time for pedestrians necessitate extra time
- Signals are optimized for multi-modal travel

It is overall system delay, not necessarily the delay experienced by a given individual motorist, which is minimized in optimization.

Beyond Optimization: Traffic Signals in Real Time

Since the adoption of the TERM in 2002, there have been technology changes (improved signals timing analysis programs, traffic detection equipment, video surveillance, traffic management centers) which make it easier for traffic engineering staff to monitor traffic flow and provide adjustments to signal timings from remote locations to address congestion caused by incidents, special events, and diverted traffic from other roads. Real-time traffic management, which is adjusting signal timing based on current demand, provides congestion relief above and beyond those obtained from the timing plans created by computer programs such as Synchro™. As can be seen from the results of the survey a number of jurisdictions have adopted such a practice either on a daily basis or during special events. Agencies such as the Virginia Department of Transportation and Montgomery County Department of Transportation actively manage their signals using the traffic operations center in real time.

Adaptive Signal Control Technology (ASCT)

There are a number of situations when a computer-generated traffic signal timing plan may not produce the desired result as discussed above. To handle such a situation, implementation of ASCT which is performed by a computer program may offer an improvement over the existing operation. ASCT employs specialized detection equipment to adjust traffic signal timing based on real-time transportation demands – within an established set of parameters. The implementation of these systems requires the installation of specialized field equipment at the selected locations – representing additional costs to the implementing agency. The traffic signals subcommittee has

discussed this subject and a number of jurisdictions in the region are considering the use of ASCT for selected corridors.

Management through Engineering Judgment/Troubleshooting

The third technique used by a number of jurisdictions is managing good efficient operation of signals through engineering judgment and troubleshooting. Whenever complaints are received traffic engineers visit the signalized intersection and using their experience and judgment adjusts the signal timing to reduce delay and improve operations.

The techniques continue to provide improvements over a stand-alone optimized timing plan operation which otherwise may deteriorate over time.

Sustainment of Benefits

Benefits from retiming/optimization are, of course, limited if the corridor in question was already reasonably well-timed. Once a corridor is well-timed, benefits can only be maintained, not improved upon.

Changes since 2002 in the Air Quality Analysis Context of the Signal Optimization TERM

In 2002, the region committed to an increased level of signal optimization at a level of 2,946 signals over a three year period for air quality credits as a "TERM". At that time, this commitment helped the region achieve a finding of conformity with air quality standards. However, a number of changes have occurred in the years since that alter the air quality context of such a program. The former TERM level of optimization achieved is now assumed in the "base case" for regional air quality, and cannot be repeated. Also, the new Environmental Protection Agency-sanctioned "MOVES" model, in contrast to the old "Mobile" model, no longer readily accommodates analysis of TERMs of this type. Today's cleaner vehicle fleets also mean less impact for any optimization effort compared to 2002. Nevertheless, though the air quality conformity motivation for optimization may have been reduced, there are still congestion management and other reasons to continue optimization efforts.

Results of the Latest Signal Timing/Optimization Survey

According to regional records, a total of 21 different agencies have ownership and/or maintenance responsibility for traffic signals in the Washington region (this number excludes military bases/facilities which may have signals on their non-public roads). Thirteen of those agencies, covering an estimated 97% of the signals in the region, completed the recent TPB staff survey. The

overall results of the survey show a slight decline in the percentage of traffic signals regionally which had been retimed within the 3-year "rule of thumb" window for the period ending December 31, 2012. An estimated 76% of the region's eligible traffic signals had been retimed or checked within the three-year window, in contrast to an estimated 80% as of the last report in 2009. This result, however, should be interpreted within the context of the comments below.

Summary Table of Regional Signal Timing/Optimization Results of 2009 and 2013 Surveys (Original TERM commitment = 2946 signals)

Survey Year	Total Signalized Intersections	Total Retimed		Retiming Method			Not Checked		No Report	
				Computer Optimized	Engineering Judgment	Active Management				
2013	**5500**	**4200**	**76%**	**47%**	**7%**	**22%**	**1200**	**22%**	**100**	**2%**
2009	5400	4300	80%	56%	24%	*	1000	18%	100	2%

* Combined with engineering judgement in the 2009 survey

Additional information/comments provided by respondents of the survey:

- Regional results overall held to a similar albeit lower level to that of three years ago, in the context of widespread budgetary belt-tightening by involved transportation agencies; it is hoped that some upcoming anticipated investments will improve the regional picture.
- DDOT currently has a five-year signal re-timing project. This includes a phased approach, with the intent to touch all signals based on areas of concern. DDOT has also identified three corridors for possible deployment of an adaptive system.
- Signal optimization can get an arterial up to its design capacity but cannot increase capacity.
- Techniques are often combined; signals can be optimized using computer software followed by active field management for validation purposes.
- Active management is particularly useful to address non-recurring congestion caused by incidents and special events.
- Signal equipment must be properly maintained for signal timing to be effective.

Outlook

There is ongoing awareness and commitment to safe and effective signals operations among the transportation agencies of the region. There is continuing interagency coordination through the Traffic Signals Subcommittee and other forums. There are benefits of providing sufficient resources to ensure good signals operations, and it is hoped that these resources can continue to be devoted. As of now, the majority (76%) of the region's traffic signals are being re-timed/optimized or checked on a frequent basis.