NEVADA DEPRTMENT OF TRANSPORTATION

FFY 2015 RESEARCH PROBLEM STATEMENTS

I. PROBLEM TITLE: Improving Urban Signal System Corridor Operations by Minimizing Off-Peak and Side Street Delays.

II. PROBLEM DESCRIPTION: Traffic signal progression strategies for urban corridors are typically designed to accommodate the heavier peak travel periods. Such strategies significantly improve the capacity of major arterials and generally minimize overall system delay. However, these strategies are limited in time and location. During the off-peak periods, the traffic volumes are much less and often create excessive delays for the traffic using the side streets and the protected left turn movements on the arterial. Even during the Peak periods of travel, there are often locations on the arterials where the traffic volumes are much less than other locations. In addition to the significant financial burdens placed on the motorists and passengers caused by delays, there are several environmental costs due to an increase in vehicle emissions that idle during delays. In particular, such long side street delays during off-peak coordination frequently create numerous public complaints; consequently, there had been situations or public officials have notified traffic engineers to discontinue the operation of signal progression systems and negating the benefits of signal progression. It would be very beneficial if strategies can be developed that would significantly reduce the delay for motorists using side streets and protected left turn movements.

III. OBJECTIVE: The major objective of this research is to demonstrate through modeling signal progression strategies and exploring advanced signal control systems (e.g., adaptive signal control) that could minimize side street delays during off-peak periods while still maintaining main street progression.

IV. CUREENT PRACTICE and RELATED RESEARCH:

The current practice for signal timing and signal coordination is to develop and operate a limited number of predetermined time-of-day plans. For instance, coordination plans are commonly developed for and based on weekday morning, mid-day, evening, and weekend peak periods. Timing plans are developed in a way to fit specific traffic patterns. While coordination generally benefits main street traffic, minor street traffic may incur longer delays which indicates traffic coordination is not beneficial at all times. Due to this reason, agencies commonly encounter a dilemma on deciding whether signal coordination should run during off-peak periods or at intersections where traffic is light, and if coordination remains, what strategies can be implemented to minimize the side street and major street left-turn movement delays (Traffic Signal Timing Manual, FHWA, 2009).

While several agencies have used rule-of-thumb to determine if coordination should be on or not based on consideration of various factors such as traffic volume, distance, platoon dispersion, limited research has been conducted to provide quantitative recommendations based on sound modeling. In 2012,

researchers at the University of Nevada, Reno (Signal Timing and Coordination Strategies under Varying Traffic Volumes, R. Andalibian and Z. Tian, 2012) developed probability based on models to determine the conditions when coordination no longer brings benefits thus should be turned on. The modeling principle was based on consideration of the probability of going through a number of intersections when volume is low and green mostly remains on the main street. These research efforts do not address how side street delays can be minimized if coordination is on.

One of the strategies for reducing minor movement delays is operate at shorter cycles during the off-peak. However, the use of shorter cycles is limited by pedestrian crossings, where if not accommodated, would result in signals going into transition, which in turn disrupts coordination (Pedestrian Timing Treatment for Coordinated Signal Systems, Tian et al., 1998).

While modern signal controllers have the capability of reserving certain movements during coordination as a means of minimizing their delays, the options are still limited by the fundamental principles of signal coordination where a common background cycle length must maintain. One promising solution is to deploy an Adaptive Control System (ACS). ACS is not constrained by fixed cycle length and offset, thus can better handle intersections where volume is low while still maintaining main street coordination. Several such ACSs are available and being deployed in the U.S. urban areas, including SynchroGreen (Trafficware Inc.) and InSync (Rhythm Engineering, Inc.).

V. RESEARCH METHODOLOGY: The overall approach for this research would be to try 'just-in-time' or adaptive timing schemes. The detailed research plan includes the following: 1) The selection of appropriate signal progression software shall be done consultation with the Expert Task Group #4. Currently, Synchrogreen software is a good candidate. Additional exchange of ideas with the expert group will include dealing with pedestrians, shortening phase times, or skip phases. Various strategies shall be modeled later. 2) Necessary data collection efforts will include the timing programming for each local controller, sample field counts of vehicles and pedestrians at intersections during non-peak periods, and field measurements of local intersection signal timing of phases also during nonpeak periods. 3) In consultation with the Expert Task Group #4 the various strategies will be modeled the methodologies and the justification for the specific methodology selected. 4) The results from modeling the various strategies will be discussed and evaluated with the Expert Task Group #4. 5) Appropriate recommendations and discussion of implementation issues including the resolution will appear in the final report.

VI. IMPLEMENTATION POTENTIAL: This research falls under 'Laboratory Prototype Stage (II) and Controlled Field Demonstration Stage (III)'. There is already considerable work done nationally and international with signal progression. The model and associated analysis done within this research project would be similar to Laboratory prototype activity and the results

available from the modeling system will be analogous to a controlled field demonstration. The final report will recommend one or more strategies to be field tested under actual operating conditions. This testing would be analogous to the Field demonstration stage (IV). The major institutional Barrier would be the approval by the city of Sparks to implement one or more strategies recommended in the Executive Summary of the Final Report. There's also some political risk whether the public will complain about any implementing strategy. There should not be any implementation cost barriers because there would be very little construction cost required for implementing's any of the recommended strategies.

VII. URGENCY AND PAYOFF POTENTIAL: The urgency of this research lies with the user costs associated with the delays and pollution emitted while the vehicles are stopped and engines are idling. This will provide decision-makers with excellent information to decide whether the next stage (V) should be funded. The significant loss in monetary value of driver and passenger time, as well as continued pollution will continue. The major payoff associated with this research project will be a reduction in delay and pollution costs.

VIII. ESTIMATED BUDGET: Include an estimate of the budget for each phase proposed (if more than one). We propose a project duration of two years, including a simulation and field test of an adaptive signal control system. The estimated budget is $150,000 (modeling tasks) plus an additional $100,000 for field equipment at five signalized intersections.

IX. DATE AND SUBMITTED BY:

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X. NDOT CHAMPION, COORDINATION AND INVOLVEMENT We have worked with **Michael Fuess** of District 2 who will serve as the NDOT champion, develop this problem statement along with Hoang Hong at Headquarters. In addition, we have worked with **Jim Poston**, the traffic signal expert for the Washoe RTC. The stakeholders for this research include: NDOT District 2, Washoe RTC, City of Sparks and thousands of motorists using arterials.

From Mike Fuess NDOT District 2

Thank you Reed and Tian. Jim has some very good questions that will need to be addressed. I think this is a great opportunity for NDOT research.

Mike Fuess, PE, PTOE

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From Hoang Hong NDOT Headquarters

I've been long interested in this technology (from when I was working with Jeff Lerud). Please submit it and see if we get selected ☺

Thanks,
Hoang

From Jim Poston Washoe RTC

I would like to see a closer examination of how these "just-in-time" coordination schemes work. At least SynchroGreen is available to model.

What are the responsibilities of the project champion? I think I would be willing.

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