Transit Signal Priority – A Hot Topic

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Starting in the 1990’s, Transit Signal Priority (TSP for Short) has gained significant momentum in recent years. Since I recently have asked a number of questions regarding TSP operation, TSP detection, and TSP Queue Jump, I thought a short introduction may be helpful to get started on this new avenue. Undoubtedly, you will be asked to help or participate in a transit initiative, so being somewhat prepared may be useful.

TSP is defined as “an operational strategy that facilitates the movement of in-service transit vehicles, either buses or streetcars, through traffic-signal controlled intersections.” Although Signal Priority and Signal Preemption are often used synonymously, they are quite different!

While Signal Preemption dramatically alters the signal timing at an intersection to provide a green signal display as quickly as possible and coordination is not a concern, Signal Priority, on the other hand, attempts to accommodate an approaching transit vehicle by either extending the green time to allow the vehicle to pass through the intersection, or by truncating the red time (reducing conflicting green times) so that a transit vehicle obtains a green signal sooner. The underlying principal during TSP is to make timing modifications that do not significantly affect signal coordination. In most instances, the signal is back in step within the next cycle.

The primary objectives of TSP are to:
- Reduce transit vehicle travel times – thereby reducing the fleet size and/or operating costs
- Reduce transit schedule variability – improve the service level to users

To accomplish these objectives, an efficient TSP system is needed. That is, a TSP system that maximizes the benefits for transit while keeping negative impacts to conventional traffic to a minimum. This operational goal is achieved by having:
- Accurate vehicle detection
- Sophisticated TSP control algorithm
- Effective monitoring, and reporting

A TSP system is comprised of vehicle detection, communications to the roadside equipment, and control algorithm to implement TSP. TSP must also interface with the on-board vehicle location (AVL) system as well as the traffic signal controller. These aspects can be challenging!

A couple of ‘unwritten rules’ are usually applied to TSP.
1. Do not break coordination
2. Do not skip phases
3. Do not violate minimums or clearances
4. Provide a ‘lock-out’ period between successive TSP requests

Figure 1 shows an overall view of the many subsystems at play and their interaction in a TSP implementation. Some or all of these subsystems may be deployed depending upon the need. For example, an unconditional TSP service request would not require the bus-to-TOC communications since schedule adherence monitoring would not be required.

Figure 1

Accurate vehicle detection
The ability of the TSP system to accurately detect the transit vehicle’s location and relay that information to the roadside equipment is a vital part of a TSP imple-
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In order for signal priority to be effective, the detection system must place a call at the appropriate time - repeatedly.

There are many ways of detecting a bus and relaying the TSP request to the roadside. We will not explore these options at this time (beyond the scope of this article); however it is suffice to note that GPS and wireless communications are becoming the new standard.

The following lists some characteristics needed for a transit signal priority detection system:

• Detect and distinguish transit and emergency vehicles from each other as well as the general motoring public
• Transmit information (i.e. bus ID, current location, speed, and heading) to the intersection
• Validate the data transmitted from the approaching vehicle and identify to determine whether the vehicle is authorized in the TSP system or not
• Be capable of interfacing and communicating with priority request generator and the traffic signal controller
• Be able to determine whether or not a detected vehicle has departed or cleared the priority intersection and prompt the intersection to return to normal operations once the vehicle has cleared
• Enable priority requests automatically. No driver actions should be required

Sophisticated TSP control algorithm

In most cases, the TSP algorithm resides in the traffic signal controller thus the choice of controller or firmware is important to providing the type of TSP operation desired. Controller manufacturers offer TSP as a standard feature or as an upgrade to the controller firmware. I think it is safe to declare that TSP algorithms will get more sophisticated as agencies demand increased TSP functionality.

There are still a few of the centralized control systems (UTCS-style systems by Computran, JHK, etc) operating. These systems have a different paradigm for TSP. To implement TSP in these systems may require the development of a new central TSP algorithm.

We are also bombarded with new terms that need to be understood. For example:

• TSD – Time Service Desired
• TED – Time Estimated Departure
• TTL – Time to Live
• PRED – Phase Reduction Time
• PEXT – Phase Extension Time
• Co-Phase – The priority phase

The interaction between TSD, TED, PRED, PEXT, detector location, signal operation and timings and the end result can become complex. A total understanding of these parameters is needed.

Effective monitoring and reporting

As with any system implementation, the more information – the better! Currently, most low priority algorithms provide very little information about their operation. You will need to work with your firmware supplier to insure that the required information is provided so that the effectiveness can be measured and fine-tuning can be accomplished to insure a first-class and long lasting implementation.

Transit departments will also be asking for these Measures of Effectiveness so that they can understand they are getting what was promised.

Summary

TSP is here to stay. With buses operating in mixed-traffic; or using exclusive curb-side lanes; or down the middle of the road, TSP requirements present a whole new set of operational challenges for traffic signal operations. I suggest that “An Overview of Transit Signal Priority” published by ITS America (which is available on-line) is an excellent starting point to get caught up with this new and exciting world of Transit Signal Priority.

Something to think about!

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