Transit Signal Priority and Preemption

Overview

Traffic signal priority and preemption (TSP) allows for the modification of traffic signal timing and gives priority to specific vehicle types, such as buses, light rail, streetcars, trucks, emergency vehicles, or trains. The term "transit signal priority" only refers to the prioritization of transit vehicles. For this paper, TSP will refer to a broader category of traffic signal priority. The primary purpose of TSP is to reduce travel times, improve safety, and clear a path so that the priority vehicle can arrive at its next destination faster and safer.

There are two types of TSP: signal priority and signal preemption. Signal priority gives longer green light times at traffic signals on roads where transit vehicles are known to operate. It reduces congestion and delays on those routes. Signal preemption is an active measure, which reads a transponder in the emergency or transit vehicle and changes the signal timing to reduce the wait-time of the priority vehicle. Transponders can be prioritized so that an emergency vehicle can have a higher priority than a transit vehicle if they approach the same intersection from opposite directions.

Related to TSP is conditional signal priority (CSP). CSP-equipped buses only send priority requests when the requests improve reliability. For example, if the bus is ahead of schedule, it would not send the priority request. However, if the bus is behind or on schedule it would send the priority request. Researchers have reported that CSP is more effective at improving transit system reliability than traditional TSP.

Port Authority's Values

Reliable, Efficient, Growth-Oriented

Analysis

Researchers have reported mixed results about TSP's ability to affect transit system reliability. Empirical data from multiple studies suggest that most TSP phase adjustments did not current quick enough to reduce delay to transit vehicles. Systems that are most effective at reducing transit vehicle delays require higher degrees of sophistication and monitoring. However, manufactures of TSP systems report significant benefits. Depending on the length of the corridor, particular traffic conditions, bus operations, and TSP strategy implemented, transit travel times are typically reduced by 8% to 12%. Implementation of TSP has also proven to improve schedule adherence and transit travel time reliability. In Oregon, Portland's transportation service, TriMet, was able to avoid adding another bus to a corridor by implementing TSP, which resulted in a 10% decrease in travel time and up to a 19% reduction in travel time variability; in California, Santa Clara's EMTRAC reported that buses receiving signal priority traveled 18.4% faster than those without priority; and in Washington, D.C., WMATA bus travel times decreased by 20% on average.

Implementing traffic signal prioritization at multiple intersections has the potential to improve system reliability. Traffic signal prioritization (TSP) transponder costs are estimated at about $839 each, and complete intersection infrastructure costs up to about $50,380.

Another effective way to mitigate the impacts of delays caused by traffic signals is bottleneck bypass lanes. The lanes are a simple street engineering tool to let buses bypass the queue of private vehicles at signalized intersections and are often referred to as queue jumps. They're quicker to install than full bus lanes and mitigate delays by giving buses a way around the worst traffic bottlenecks on a route. According to the National Association of City Transportation Officials, "queue jump lanes combine short, dedicated transit facilities with either a leading bus interval or active signal priority to allow buses to easily enter traffic flow in a priority position. Applied thoughtfully, queue jump treatments can reduce delay considerably, resulting in run-time savings and increased reliability." In Denver, CO, transit queue jumps/bypass lanes reduced delays at bus intersections on two streets by 7 to 10 seconds.

Peer Examples

Los Angeles County's Metro

Metro's 400-mile network of rapid bus service has 2,600 buses in their entire fleet with 520 signalized intersections equipped with TSP. Since implementation, ridership has increased 40% and travel times have been reduced by 29%. The new technology gives priority to Metro rapid buses at traffic signals by having longer green lights and shorter red lights.

Pierce Transit, WA

Pierce Transit has 245 buses in its entire fleet. Using a combination of TSP and signal optimization they were able to reduce transit signal delay by about 40% in two out of seven bus corridors. Altogether they have seven bus corridors with 110 signalized intersections equipped with TSP.

Chicago's CTA & Pace

In 2016, the first phase of TSP installation, optimized signal timing, was implemented on certain corridors which both Chicago Transit Authority (CTA) and Pace buses service. Further installation of TSP will be an important component of the Bus Rapid Transit and Arterial Rapid Transit systems that are being developed for the Chicago region. Thirteen priority corridors that include 500 intersections have been chosen based on key factors such as bus ridership, geographic location, and network connectivity.

Level of Effort for Implementation: Moderate

- Requires coordination with other government agencies including SPC, City of Pittsburgh other municipalities, and Allegheny County. TSP would be best implemented at the county level.
- TSP costs could be spread over several agencies instead of just PAAC, including each municipalities' law enforcement and emergency service agencies.
- SPC has a regional signal program and could also be a potential resource for sharing costs and effort needed for implementation.

Resources

Pennsylvania Department of Transportation
Oregon Department of Transportation
Washington Department of Transportation
US Department of Transportation
EMTRAC Systems, STC, Inc.