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Supply Management of Auto Traffic to Address Starvation of Green in Multimodal Environments

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POLICY BRIEF

BACKGROUND AND OBJECTIVES

This research sought to address a condition where adjacent intersections are unable to service demand in part because an active rail line between the intersections disrupts traffic with frequent preemptions. The project used George Bush Dr, an arterial roadway along the south edge of the Texas A&M University campus in College Station, Texas, as a testbed for this research. Olsen Blvd and Wellborn Rd are main roadways around Texas A&M University that intersect George Bush Dr within a 1,000-foot stretch. This area suffers from traffic congestion and queue spillback during the PM peak period when classes are over and students and staff are going to their homes from the university campus. In addition, the rail that runs parallel to Wellborn Rd has between 20 and 30 trains traveling on this segment per day, which will lead to 1 or 2 trains disrupting traffic at this portion of the network during the PM peak period. The research team considered a variety of queue management options to address the starvation of green since the green time utilization is governed by the queue lengths backing up between the adjacent intersections. The team decided to use both field and simulation data to analyze the effectiveness of the changes in operations on the George Bush Dr corridor in College Station. The dual analysis enabled researchers to observe and note impacts of the system on the field operations and utilized the simulation to determine the effectiveness of alternative operations without risk of negative impacts on field performance and with the advantage of consistent conditions between alternative scenarios. The City of College Station determined that the preemptions at George Bush Dr and Wellborn Rd would keep the intersection on transition for long periods if the intersection operated in coordination mode. Therefore, the City found that the intersection would operate more consistently and service the traffic better if the intersections were in free, fully actuated control. The frequent special events near the intersections and the regularly saturated conditions in every direction of travel at the intersection of Wellborn Rd and George Bush Dr (referred to as WGB), led the City to use long maximum green times for the phases to service the high demands on normal operations and improve the process for special events. George Bush Dr and Olsen Blvd (GBO) operate in coordination during the PM peak period.

METHODOLOGY

The research team developed priority routines to accomplish two objectives: metering traffic entering the link between intersections and increasing green time for the eastbound approach. Metering the traffic describes a strategy where the green time for movements feeding the link between the intersections is limited to prevent additional traffic from entering the link. When the link is full, this method is essentially meant to stop allocating green time to movements that cannot use the green time due to a lack of storage. This takes the demand and causes these vehicles to wait on the links exterior to the intersection pair of GBO and WGB. Increasing the green time between the intersections is accomplished by instituting a flushing pattern with the priority routine. This combination of metering traffic and flushing the link between GBO and WGB is referred to as the *priority queue flush strategy* in this report. The research team added phases to WGB needed for the priority flushing pattern. To detect starvation of green at GBO, the Wavetronix radar at GBO used for detection of westbound traffic was reconfigured to detect the eastbound traffic between the two intersections. The metering strategy at GBO was deployed with internal peer-to-peer commands on the GBO signal controller such that when the detector was called, the controller would omit phases at GBO and peer-to-peer for the WGB intersection. The research team created and calibrated a baseline scenario of the model. They calibrated the model using the travel time and speed data obtained from INRIX. Alternative scenarios for simulation included the priority queue flush scenario, a retiming of the signals at GBO and WGB to have a shared cycle of 180 seconds, and a double cycle of GBO at a 90-second cycle length and a cycle length of 180 seconds at WGB. This revised strategy used information from the calibrated VISSIM model and utilized the PASSER V-09 (P5) computer program developed by Texas A&M Transportation Institute (TTI). The simulation experiment involved analyzing 10 simulation runs for the baseline, priority queue flush, revised timing with consistent cycle lengths, and the double cycle scenario. These simulations included two train preemptions.

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RESEARCH FINDINGS

The simulation results showed that the eastbound travel times and queue lengths improved by over 50 percent. In addition, the westbound left turn movement was adversely impacted because of this strategy. The retiming and double flushing scenario had simulation results that indicated unacceptable performance for the westbound left turn movement, so these strategies were not deployed.

The research team used several data sources from the INRIX platform to analyze field performance of the deployed system. The signal analytics and corridor analytics tool with INRIX indicated an immediate improvement in performance for the eastbound direction of travel after deployment in April 2023. The roadway analytics tool was used for a travel time analysis of George Bush Dr and Wellborn Rd to compare the first weeks of the fall semester in 2022 and 2023, the known worst period for this testbed. During the peak period, eastbound travel times were generally one to three minutes lower, 38 and 41 percent lower on average on Monday and Wednesday, respectively. The eastbound afternoon peak travel times were on average 41 percent lower on Tuesday and 44 percent lower on Thursday, with the peak time down 4.8 minutes. The westbound direction of travel experienced a 10 to 18 percent reduction in travel times on average. Northbound results were similar to westbound George Bush Dr. Travel time improvements were 1 to 10 percent and there were numerous times when travel times were worse following the signal timing changes. The westbound and northbound directions were not expected to experience any large improvement from the deployed strategy since the strategy was meant to assist the eastbound direction of travel. The southbound direction experienced a large improvement (30 and 34 percent), which is somewhat surprising given the long queues observed over the spring 2023 semester on Tuesday evenings and the priority given to George Bush Dr traffic. The 30 percent average reduction could be a result of driver frustration and students and the community finding alternative routes to Wellborn Rd.

POLICY AND PRACTICE RECOMMENDATIONS

This report discusses some challenges for the operations related to the deployment. Namely some additional configuration was needed to prevent redundant queue flushing given existing queue flush operations after a train preemption already deployed at the intersections. The key takeaway from this challenge was that the Siemens M60 controllers will remember calls placed for a priority routine during preemption. The team was able to deploy a resolution to this issue. Other challenges encountered during the research effort were more difficult to resolve. The metering strategy proved to be too aggressive and generated a no-service scenario for the southbound movement at George Bush and Olsen Blvd. Given the lack of tools to put restrictions around the phase omits, the metering strategy needed to be removed. This issue is likely related to the next unsolvable issue of too many priority requests. The research team found that calls would be placed for a priority check-in frequently by vehicles in motion, which the radar should not consider for the queue detection. The research team recommends identifying an alternative technology for monitoring the queue length driving the system, which should improve function from the no-service problem and the frequent priority check-ins.

Overall, this project found that the addition of a priority queue flush to the system improved performance. The eastbound direction of travel saw improved travel times and the greatest negative effect was on the westbound left turn, which saw an increase in average queue length of 90 feet (or about four vehicles) compared to the baseline. The simulation and field data both show that the eastbound direction of travel experienced improvements. Further research should consider shorter cycle lengths that better account for the westbound left turn. Shorter cycle lengths at WGB would be beneficial since long cycle lengths contribute to long queues. In addition, future research should search for a better detection unit to improve the ability to place priority requests only when queued traffic is present at the end of the link.

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