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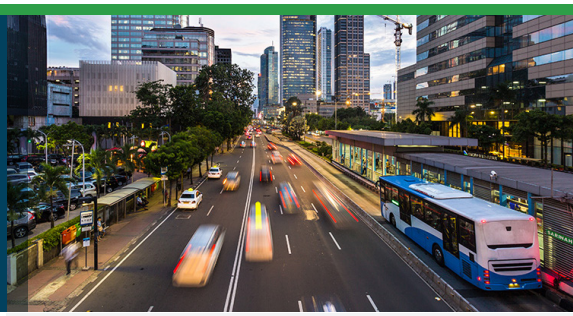
Building a better Bus Rapid Transit system with Transit Signal Priority



As urbanization and pressure on public transit systems in cities around the world intensifies, Bus Rapid Transit (BRT) is becoming an increasingly attractive answer to questions of smart passenger mobility.

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Combining the flexibility of buses with the efficiency of rail, BRT systems make smart use of technology, infrastructure and transit operations to create a faster, more reliable and more convenient public transport service for the most in-demand routes. These are regularly implemented in areas where congestion and other factors have led to bus services struggling to serve the needs of commuters and other riders. Because it is far less expensive to build and operate than rail, BRT works particularly well in growing mid-sized cities where standard bus services are struggling to meet demand, but there is still insufficient population density to justify the investment-levels required for light or heavy rail systems.

Core elements of BRT systems can include dedicated lanes or running ways, easily accessible 'stations' along the route, optimized ticketing and fare collection, service and operating plans, distinct and recognizable marketing and branding, and intelligent technology deployment[1].

A further key element of all BRT projects is intersection treatments: the way those intersections along the BRT corridor are optimized to benefit BRT vehicles while minimizing impact on other road users. This whitepaper looks at the way one of those intersection treatments, Transit Signal Priority technology, can play a significant role in enhancing the effectiveness of any BRT system when deployed alongside complementary strategies and technologies.

BRT INTERSECTION TREATMENTS

A number of approaches can be taken when it comes to intersection treatments as part of a BRT project. In many cases these elements are all used as complementary parts of the same system.

- Timing Signals for Buses – this is the process of optimizing and coordinating signals to create a 'green wave', offering a general improvement for all traffic. Here the onus is on traffic engineering departments to tweak their systems to create these efficiencies.
- Queue Jump – this is where an additional lane is provided at the approach to signalized intersections, often for buses only. For those areas of a route without a dedicated bus lane

CASE STUDY: ALBUQUERQUE, NM

This whitepaper examains how BRT systems often employ Transit Signal Priority solutions to reduce delays at intersections and maintain schedules.

It's this reliability which is the hallmark of successful BRT and BRT-lite systems, and reliable on-time performance which attracts riders. No place has done this better than Albuquerque, New Mexico where the new Albuquerque Rapid Transit (ART) route use TSP to make operations more efficient.

The final ART corridor design features 27 stations and incorporates two previous routes. The dedicated lanes run down the middle of the street at some points and next to the sidewalks along other portions of the route. Left-hand turns have been banned other than at signalized intersections. Buses run every seven and a half minutes – markedly more regularly than any previous service in Albuquerque.

it allows buses to move to the front of the queue of traffic, and is an effective way of gaining time on the course of a route. Queue jump is made possible through detection technology such as embedded loops or Transit Signal Priority (see below). A combination of queue jump and Transit Signal Priority is a particularly powerful strategy for moving transit vehicles efficiently.

- Prohibit Left Turns (right turns in countries where traffic drives on the left) – this can be a key component of a BRT system, as cross-traffic turns are one of the leading causes of slow-downs and delays, particularly during rush hour periods. Many consider this a vital element of BRT: in some cases left turns are prohibited along the full length of the BRT corridor, and in others they are restricted to signalized intersections.

- Transit Signal Priority – TSP systems allow buses to request an extended green signal or truncated red signal as part of the traffic light cycle, reducing travel time and improving reliability and rider experience. When a bus approaches a signalized intersection, equipment on-board allows it to request priority at the traffic lights – this can be granted or denied by traffic management departments depending on policies and conditions. TSP has been proven to reduce delays at intersections by up to 40 percent, minimize fuel costs by up to 19 percent, and cut greenhouse gas emissions by up to 30 percent[2].

TSP FOR BRT: ALBUQUERQUE ART CASE STUDY

Transit Signal Priority technology can play a crucial role in BRT systems, working in close conjunction with other strategies and technologies to ensure buses experience minimum delays due to waiting at red lights. With TSP, buses maintain correct headway and adhere to posted schedules. Additionally, significant savings can be made by avoiding the need to invest in more vehicles and their associated costs.

One way that TSP can be a key component of a BRT route is in the new Albuquerque Rapid Transit (ART) line in Albuquerque, New Mexico. ART is the first BRT system to be gold-rated for design by the Institute for Transportation & Development Policy (ITDP), a group that set the standard for BRT systems across the world. TSP plays a crucial role in ART's operation, for reasons both planned and somewhat unexpected.

The ART line is a nine-mile corridor along Central Avenue in Albuquerque, which forms part of historic Route 66. ABQ Ride, the public transit agency in Albuquerque, began planning for a potential BRT route more than half a decade ago.

Andrew de Garmo, principal planner at ABQ Ride, said the Central Avenue route had historically been the city's highest ridership corridor, carrying more than 40 percent of its daily passengers.

"There were bunching issues occurring along the route," de Garmo said. "And as ridership went up, we kept having to add more buses, so in a sense it was consuming more resources for slower service. BRT was an operational way to try and address those issues."

In addition, a forecast population boom meant that there was a further impetus to be able to move commuters from the predominantly residential west side of Albuquerque to the east, where most of the city's employment is located.

Stan Low, IT division manager for the transit department in the City of Albuquerque, said a major appeal of BRT was that the city could introduce dedicated lanes for the ART buses.

"In the past 10 or 15 years, each time we have introduced an additional service to Central Avenue, it immediately gets used, almost filled – so those routes are very, very popular no matter what we add," Low said. "We wanted to move a large number of people efficiently and avoid the growing congestion by adding dedicated lanes specifically for these mass people movers."

A third aspect driving the BRT project was Transit-Oriented Development (TOD), the associated economic development a Bus Rapid Transit route can bring. The effects of TOD are already evident as the ART route is finalized: renewed and refreshed street landscape, safe and welcoming stations, and a more inviting environment that encourages people to use the street. The result is often that BRT projects attract new businesses and residential developments thanks to the presence of a reliable public transit option.[4]

DESIGNING-IN TSP

The final ART corridor design features 27 stations and incorporates two previous routes. The dedicated lanes run down the middle of the street at some points and next to the sidewalks along other portions of the route. Left-hand turns have been banned other than at signalized intersections. Buses run every seven and a half minutes – markedly more regularly than any previous service in Albuquerque. The new stations feature off-board fare collection and automated ticketing, as well as level platforms for accessible boarding and convenience for cyclists.

From the outset, the system as designed to use Transit Signal Priority. Stan Low says the reasoning was clear.

"Other than, of course, moving people more effectively," Low said, "when they are planning how many buses it takes to move 'X' amount of people to maintain the required headway, if you have Traffic Signal Priority to maintain a constant distance between the buses and provide on-time performance, what you may find is that you don't need as many buses. You can provide the level of service that you want with fewer buses. That's a huge cost saving."

Some TSP systems, including that used for ART, are able to provide what's known as 'conditional priority': only granting priority at intersection when specific pre-agreed conditions are met. In Albuquerque, that means priority is only granted when the bus is behind schedule. Other systems may require buses to meet a minimum passenger count in order to make the request. These conditions can be applied during system configuration and tweaked for optimal performance.

Andrew de Gramo said ABQ Ride was very aware of public perception issues when the BRT system as being designed.

"We were fighting against a perception that we were putting in some high-speed system in the middle of the street that some people want to be able to walk across – so we didn't talk about speed a lot. But we were hoping to gain some travel time improvement from signal priority.

"We did publicly talk a lot more about on-time performance and reliability. So in retrospect, I think we may have had somewhat conflicting goals – we were hoping to improve our travel time, but to minimize impact on cross streets we were only planning to provide signal priority to buses which were behind schedule.

"It does come down in the end to attractiveness to the public: a faster service is going to be more convenient, and it reduces your operating cost and your capital cost if you don't need as many buses.

"We're actually running two routes that overlap each other for the entire nine miles, and then they diverge, and one goes north and one continues east. Between those two routes there'll be a bus coming every seven and a half minutes. For Albuquerque that's a pretty high frequency of service. It's a lot of buses and there's plenty of potential for bunching. So the reliability portion is important."

He added that TSP now has an even more important role to play than when the ART line was originally designed.

"We didn't realize in the planning stages how difficult it was going to be for our drivers to navigate the buses into the platforms we have built," de Gramo said. "The drivers have to be very precise. We're trying to pretend we're light rail, in a way, but we don't have the benefits of a track. As a result, the travel time is under even more pressure now because of the amount of time it takes them to approach the station and dock as close as we want them to without running into the platform. It's slower than we anticipated, which causes us to want even more benefit out of the TSP system."

Ultimately, the plan for ART relies on TSP to provide some critical aspects of the BRT system.

"From my perspective and from my understanding TSP is absolutely essential," Stan Low said. "There are a number of reasons. Number one is cost of the overall system. If TSP can help us to avoid putting just one additional bus on the road, because the system is operationally efficient, that bus is worth a million dollars. And that doesn't include the cost of the driver. So that's a big saving immediately.

"Then we also reap the benefits of pretty darn reliable service, because the bus isn't in traffic. The bus doesn't have to wait at most red lights if it's behind schedule. We are in effect bending the entire infrastructure to our schedule to ensure that the public has reliable service.

"That's the way I see it: the TSP system ensures our lowest cost in bringing the most reliable service, and if the traffic goes to hell, as is predicted based on our population growth, I don't have to be concerned with that, because my bus has not only its own lane, but effectively it has its own traffic signal lights."

THE INTERSECTION DILEMMA

Incorporating any intersection treatments, including TSP systems, into a BRT project will always involve balancing the different priorities of transit agencies and traffic engineering departments, Low continued.

"The goal of traffic engineers is to clear an intersection as best they know how, as quickly as possible," Low said. "And our goal, on the transit side, is to provide some priority to the mass transit vehicles, our buses. And those two goals are frequently at odds with one another."

This is exemplified by the City of Albuquerque's previous attempt to implement TSP on its 'BRT-lite' Rapid Ride bus routes. BRT-lite refers to transit routes which incorporate some elements of BRT, but not the full complement to qualify it with officially-designated BRT status. On the Rapid Ride route, traffic engineers would adjust the TSP system in response to pressure from driver complaints. The effect was that buses did not receive the priority benefits they should have.

In an attempt to align the traffic engineering and transit goals, Low is working to combine the software used by both traffic management and transit agencies. His goal is to provide the clearest possible information on when priority requests are made and when they are granted. The intention is to reassure traffic engineers that priority requests will only be made when a bus is behind schedule.

"Those two pieces of software will also be complemented by a third piece of software, and that is Traffic Signal Performance Measurement sensors," he explained. "These are sensors at the intersection that don't really tell you when the phases of that traffic light change, what they tell you is how effective, how clear is the intersection, how many cars are waiting at a red light, and how long have they been waiting, and when the light changes what percentage of those get through the light and what percentage do not.

"By tying these pieces of software together, we're aiming to calm traffic engineering so that they will see that our requests for TSP are not as frequent as they feared, and to offer performance monitoring of the intersection to be able to help them to set up whatever type of phase control they need to be able to clear that intersection effectively for their purposes."

Smarter TSP is one way the balance between transit and traffic goals can be better achieved. This is driven through recent TSP advances in relative and conditional priority, including factors such as passenger loading (where vehicles must be carrying a set minimum number of passengers in order to reach the TSP threshold); route priority (where designated high priority routes receive TSP or are prioritized over other buses – for instance, a BRT route may be prioritized over a standard transit route); vehicle type; and schedule status.

BRT IN THE UNITED STATES

In the United States, Bus Rapid Transit is gaining popularity. But there are only six routes that currently meet the full BRT standards criteria as set out by the Institute for Transportation and Development Policy[3] (ITDP). Of those six full

BRT routes, three use Opticom TSP technology from Global Traffic Technologies (GTT):

- Albuquerque Rapid Transit (Albuquerque, NM)
- Cleveland Healthline (Cleveland, Ohio)
- Lane Transit District Emerald Express Green Line (Eugene, Ore./Springfield, Ore.)

The others are in Los Angeles, Calif., Hartford, Conn., and Pittsburgh, Penn. These six are the only routes that meet the ITDP BRT criteria, with points assigned for each BRT element they include. Those points equate to their overall rating of Gold, Silver or Bronze. At present, Albuquerque's ART line is the only one with a Gold rating.

But many others across the United States use just some of the BRT elements to create 'BRT-lite' systems. Albuquerque's Rapid Ride service is an example, and there's likely some form of express or priority bus service in operation in an urban hub near you.

For many of those BRT-lite systems, the reason that they are not full BRT systems usually comes down to cost. The investment required to provide dedicated lanes or alter infrastructure to build new stations or stops is hard to come by, or perhaps entirely prohibitive. And then there's the potential political cost, where dedicated BRT lanes can be perceived as 'taking road space' from cars.

In these cases, Transit Signal Priority can play a big role in helping to optimize a BRT-lite service. Giving the option to provide green lights to buses running behind schedule helps to ensure reliability, which is intrinsic to the positive perception of a public transportation. TSP can be utilized to manage headway through conditional priority such as that provided by GTT's Advanced Schedule Management module in its Connected Vehicle Platform. That way, riders feel that they can turn up to their stop and know that the interval between buses is not going to balloon into lateness.

One of the latest developments in signal priority systems makes it even more attractive to BRT-lite deployments where limited capital expenditure may be a consideration. GTT provides Opticom Priority Control as a Service (PCaaS)℠, a subscription-model service which enables all the benefits of the traditional Opticom system, without having to worry about buying equipment, installing it or undertaking ongoing maintenance. Agencies pay a fixed fee, and the equipment, software, services and details are managed by GTT's client services team.

SUMMARY

Bus Rapid Transit systems offer an appealing, rider-friendly means of moving large numbers of people through dense, congested city streets. There are a wide range of factors that contribute to their success, however agencies can find themselves constrained by limitations outside of their control.

Transit Signal Priority technology provides a means of moving buses through BRT corridor intersections swiftly, avoiding delays, maintaining correct headway and assuring riders of reliable on-time performance. It's this reliability that is the hallmark of successful BRT and BRT-lite systems, and reliable on-time performance attracts riders.

TSP works best as part of an integrated strategy for BRT, complementing other technologies and approaches, including signal timing optimization and modified turning conditions.

For agencies, the efficiency of operation which TSP offers can provide very real, very effective cost savings. Preventing the need to deploy additional vehicles is an immediate, large-scale financial benefit. Less fuel use provides both a cost savings and an environmental benefit.

TSP can also be extremely beneficial for BRT-lite systems, where intersection priority control is one of the simplest and most cost-effective methods of ensuring reliable service. By using smart deployment options like Opticom PCaaS, agencies can experience all the benefits which a TSP system offers without the associated capital outlay.

More information about how Opticom TSP can work as part of your BRT project can be found at www.gtt.com.

Sources

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