SKINNY STREET BIG APPETITE: GEOMETRY DRIVEN BUS RAPID TRANSIT ALONG US 192

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ABSTRACT

Bus Rapid Transit (BRT) provides an innovative, cost-effective, and flexible way to improve transit as a viable mobility option. BRT is not a new concept and has been implemented in various forms throughout the United States and other parts of the world. BRT has many benefits; the primary typically being decreased transit travel time, increased reliability, and added transit capacity along corridors. However, the implementation of BRT often requires tradeoffs among various modes. While it is important to provide premium travel to transit and encourage ridership, too much of an impact on regular vehicular operations can result in a backlash against the transit mode and limit public support and future transit expansions.

Is it possible to take away roadway width to provide a transit guideway without negatively impacting traffic operations? Is it possible to have several different BRT service designs catering to various transit markets operating within the same exclusive guideway? Is it possible to develop a BRT operating system and geometry to safely operate a bi-directional BRT along a single lane transitway?

This presentation will look at the innovative geometry and operations of a median-running transit guideway developed to minimize footprint while still providing a safe and effective solution for both BRT service and the general purpose traffic. These solutions include contra-flow operations, unique transit, unconventional intersection queue jumps, general purpose traffic use of guideway, and priority detection between the different types of BRT service; highlighting the geometry driven solutions along the proposed 22-mile BRT corridor of US 192.

Keywords: Bus Rapid Transit, Innovative BRT Operations, Midblock Transit Station

INTRODUCTION

Bus Rapid Transit (BRT) provides an innovative, cost-effective, and flexible way to improve transit as a viable mobility option. BRT is not a new concept and has been implemented in various forms throughout the United States and in other parts of the world. BRT has many benefits; the primary typically being decreased transit travel time, increased reliability, and added transit capacity along corridors. However, the implementation BRT often requires tradeoffs among various modes. While it is important to provide premium travel to transit and encourage ridership, too much of an impact on regular vehicular operations can result in a backlash against the transit mode and limit general public support and future transit expansions.

US 192 is a heavily congested major arterial critical to the City of Kissimmee and Osceola County. The typical cross-section along the corridor varies. West of I-4, the cross-section is a high-speed six-lane divided highway with a wide grass median and at major intersections it is limited to a narrower median with long left turn lanes or a four to six-foot concrete separator with dual left turn lanes. East of I-4, the corridor is a six-lane divided roadway, with a raised grass median. There is little setback between the roadway and developed parcels, and dual left turn lanes and a four-foot concrete separator exist at major intersections. The furthest eastern portion of the corridor is a six-lane roadway with a center two-way left turn lane that becomes a left turn lane at intersections. This portion is mostly in the City of Kissimmee.

An Alternatives Analysis that identified BRT as the preferred alternative was previously prepared. The preferred alternative included a complex operating plan, which would allow for interlining several different routes serving various transit markets to operate within the same exclusive, center-running transit guideway. The operating plan in the Alternatives Analysis assumed traditional BRT on a mostly center-running exclusive guideway with station spacing of approximately one-mile. The service along the corridor was intended to interline express service that skips stops with service that includes every stop. The complexity of this BRT operating plan which would include dedicated lanes with passing opportunities typically requires either the reallocation of general purpose lanes to transit-only lanes or extensive roadway widening for the length of the BRT corridor.

The purpose of this concept design project was to take what was identified as the preferred alternative and develop BRT-specific guideway designs and operation protocols to ensure the BRT service will effectively and efficiently serve the corridor transit demand. These design and operation protocols included contra-flow operations, unique transit signaling at stations to allow for bi-directional operations along shared segments, unconventional intersection queue jumps, bus overtake zones to allow express bus priority passing, general purpose traffic use of busway at highly constrained intersections, and priority detection between the different types of BRT service. The result of the project was a conceptual plan of a 22-mile innovative corridor which balanced the operations and footprints of the BRT center-running transit guideway and the general purpose travel lanes. The conceptual plan will serve to further refine the placement and operation of individual stops and service as further analysis of transit service and ridership is developed in greater detail during the project development phase. This paper will describe the innovative geometry and transit operations developed to balance and achieve corridor mobility goals for all users of US 192.

MIDBLOCK TRANSIT STATION

The preferred alternative typically placed transit stations at major intersections with a conventional direction of travel for the BRT (right side operating). With this configuration, a minimum of one lane in each direction is required. Additionally, two transit stations would be required, one serving each direction of travel. The transit operations serving multiple lines within the same busway added to the complexity. This required an additional bypass lane at transit stops to accommodate the skip-stop BRT service. The required width for safe and accessible transit stations, the three bus lanes, and a physical separation between general purpose lanes and the busway pushes the limits of the busway beyond the available width within the existing median/left turn bays and require repurposing a general purpose lane in each direction. It is recognized that the placement of the transit stops will also consider transfers to other routes along perpendicular corridors and proximity to transit generating land uses along the corridor. This midblock configuration was developed in an effort to provide further flexibility and more options as the project is further developed.

Figure 1 from the original Alternatives Analysis Study shows a rendering of a proposed typical transit station located at a major intersection. The repurposing of the general purpose lanes, thus reducing capacity, would significantly impact the general roadway well beyond the point of failing traffic operations. While it is expected that traffic operations could be somewhat impacted through the implementation of premium transit service with transit as the priority, the impact of the service on traffic operations was determined to be far too great and would result in extreme congestion with the transit service possibly being blamed for the congestion. This situation could then impact the potential expansion of other premium transit service in the region. In an effort to identify other solutions, two concepts were developed that pulled transit stations away from major intersections.

FIGURE 1 Typical transit station at major intersection from previous study

The following sections show the concepts that provide safe and accessible transit stations that minimizes roadway widening. Pulling the transit stations away from the major intersections (midblock) also provides an opportunity for those intersections to be redesigned using innovative treatments to implement a center-running busway without degrading general purpose traffic operations. Additionally, midblock stations provide signalized and two-stage pedestrian crossings, improving accessibility and safety along the corridor.

Contraflow BRT Transit Station

Contraflow operations refer to bus vehicles operating on the left side of the road within the busway. One significant benefit of operating the busway contraflow is the allowance of a single transit station to be used for both directions of travel, significantly reducing the busway footprint at transit stops. To avoid the capital expenditure of procuring a new fleet of left side loading buses, right side loading was to be maintained. Buses can be specially ordered to provide left side loading. However, since transit agencies typically pool their buses, capital costs usually preclude having a mix of left- and right-side loading buses. Figure 2 below shows the midblock transit station concept for contraflow BRT operations.

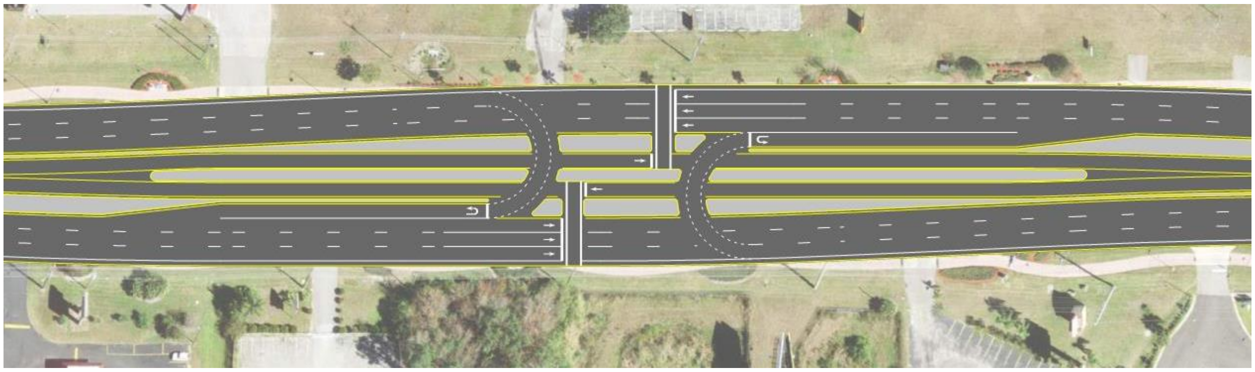

FIGURE 2 Midblock transit station with contraflow BRT

Conventional Flow BRT Transit Station

A second concept was developed that allowed for conventional flow of the busway, providing right-side loading of buses, and while still allowing for a single transit station to be placed in the middle of the busway. Figure 3 below shows an innovative treatment within the busway borrowed from a diverging diamond. As the bus approaches the transit station, it crosses over to the left side of the busway allowing the bus to serve travelers from the right side. Additionally, since the general purpose lanes and adjacent bus lane are travelling in the same direction, the busway allows general purpose traffic bound for the median U-turn to enter the busway and U-turn at the crossovers. Since the U-turn movement is completed from the busway, it is not necessary to bulb out US 192 at the midblock stations.

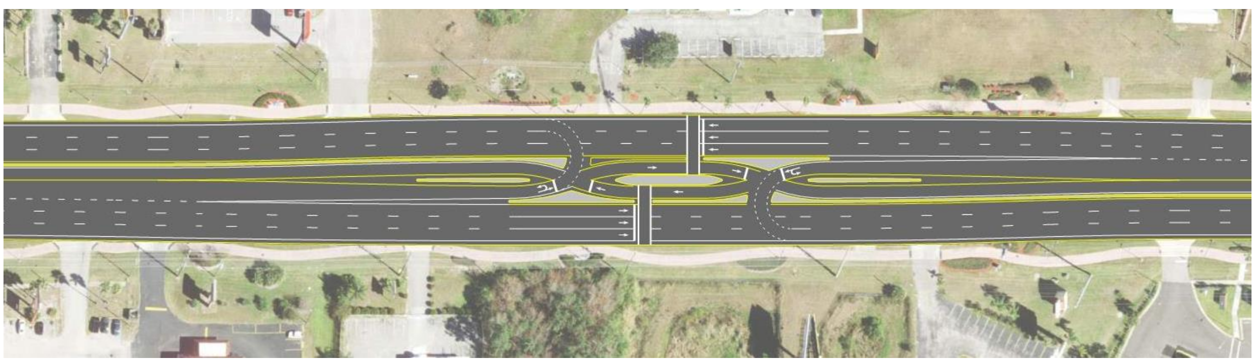

FIGURE 3 Midblock transit station with conventional flow BRT

BUS OVERTAKE ZONES

One factor that allows for BRT to increase the reliability for the transit user is by reducing the number of transit stops, thus reducing the opportunities for delay commonly experienced at transit stations. As previously mentioned, it was proposed to interline several bus routes and service types within the same busway. Although not uncommon for bus routes to share portions of a common route, what complicates the preferred alternative is having more traditional (all-stop) service sharing with express (skip-stop) transit operations in the same busway. Essentially, even with accurate headways, eventually the express BRT route will catch the all-stop BRT route, degrading the travel time of the express route.

To provide opportunities for the express BRT to jump the all-stop BRT without adding an additional third bus lane at the transit stops, a bus overtake zone was developed for the contraflow and conventional flow operations busway concept.

Figure 4 and Figure 5 below show the bus overtake zone for the contraflow and conventional flow operations respectively. Both concepts effectively operate the same. Equidistant between proposed midblock stations, transit signals will be placed and effectively rest on green. In the event the express BRT will queue behind the all-stop BRT, the transit signal will stop buses going in both directions. This will allow the express BRT to go into the opposing bus lane, pass the all-stop BRT and reenter the correct bus lane safely.

FIGURE 4 Bus overtake zone with contraflow operations

FIGURE 5 Bus overtake zone with conventional flow operations

The difference between the contraflow overtake zone and the conventional overtake zone is the minimum distance required between midblock transit stops. The minimum midblock transit station is 2,400 feet and 3,150 feet for the contraflow and the conventional flow operations, respectively. As previously described, the conventional flow operations allow the general purpose traffic making a U-turn to enter the busway. This requires the busway to provide enough weaving distance for the general purpose traffic to merge and decelerate to a stop once they enter the busway. The linear distance provided for this merging maneuver precludes the express BRT to enter the opposing bus lane to complete overtaking the all-stop

BRT within the weaving section; essentially moving the bus overtake zone further away from the midblock transit stop.

TRANSIT SIGNAL OPERATIONS

Unique transit signal technology is essential to the efficient and effective operations of the corridor BRT service. Advanced signaling technology is essential to ensure the varying types of BRT (all-stop versus skip-stop) can integrate and function effectively within a limited amount of dedicated transit right-of-way. Since some vehicles will be stopping at stations more than others, the signaling technology will be put in place to avoid any potential delays and collisions brought upon by BRT vehicles traversing the corridor. The operations rely on transit signal priority (TSP) using a host of different equipment, operations protocols, technology parameters, and signage to facilitate the complex BRT operations along the corridor. TSP will include the following features and conditions:

- The corridor will be equipped with state-of-the-art transit signal priority using a combination of GPS location and vehicle detection via in-ground loops or video
- TSP will be triggered and will allow more transit green time depending on the side street volumes
- Vehicles will be equipped with technology to differentiate skip-stop (express) from all-stop BRT vehicles to trigger different priority levels at signals
- Priority can also be dependent upon schedule adherence (I.e. – priority will be increased for buses behind schedule and not given to buses that are ahead of schedule)
- Signals will be programed to provide higher priority to express BRT vehicles, including at locations that hold back all-stop vehicles at bus over take zones to prioritize express service
- Dynamic and static messaging will be placed throughout the corridor to communicate directional movement to the bus operator, particularly along bi-directional segments
- Preemption will only be allowed for emergency vehicles and not for BRT vehicles
- Signals may operate with "predictive" priority, which will limit vehicle delay at signals as it relies on corridor travel time predictions to prepare for an approaching transit vehicle

CONCLUSION

The BRT-specific guideway designs and operation protocols will accommodate a median running busway for the entire 22-mile long corridor. Critical elements, such as how an express BRT bus will safely overtake a non-express bus and transit stations requiring a smaller footprint, were identified and resolved using a combination of innovative geometry and transit signal operations. The result provides an opportunity to reliably run several BRT lines serving different travel markets within the same median running busway without significant Right-of-way or negative traffic impacts to the general purpose lanes.