Title
US 192: A Different Take on BRT – A Case Study of Improving Operations for All Users

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Abstract

Bus rapid transit (BRT) projects are often implemented at the expense of other modes, particularly when BRT will be running in a dedicated busway. Implementations have included removing an existing through lane on the outside in each direction, to median running busways that restrict adding left turn lanes. In the case of US 192 in Central Florida, a study was directed to improve the capacity along the corridor while allowing for median running BRT. The existing corridor is a highly congested 22-mile arterial with over 40 signals that is part high speed divided highway with signals, and part signalized undivided urban arterial. Current bus stops along the route are on the outside of the roadway with limited accommodations for pedestrian crossing from one side to the other of US 192.

The proposed improvements to the corridor include reducing the speed limit, providing signal-protected pedestrian crossings, implementation of U-turns in place of left turns (in multiple ways), implementation of a median busway for the length of the corridor, implementation of median bus stops, implementation of an innovative approach for operating a two-lane busway with multiple tiers of service (express and non-express), displaced left turns, an at-grade diverging diamond interchange, hook turns, jughandles, quadrant road intersections, and transit transfer stations. The combination of innovative designs along the corridor result in better operation in 2043 than current conditions, a dedicated busway, and improved pedestrian safety and access while minimizing the need for right-of-way acquisition.

Overview

Previously, an Alternatives Analysis Transit Study was conducted on US 192 that identified a preferred alternative with a center median dedicated busway. However, the preferred alternative did not address existing and future traffic congestion that would be present with or without the dedicated busway. Therefore, a traffic and bus operations study of the corridor was completed in order to develop a corridor-wide solution that includes the implementation of a median dedicated busway capable of serving multiple tiers of bus service, improved and signal-protected pedestrian crossings throughout the length of the corridor, and vehicle capacity-related improvements. The result included traffic operations in 2043 with better operational conditions than today all while limiting the need for right-of-way acquisition and avoiding grade separated solutions. Utilizing a blend of various elements from known and implemented innovative design concepts, site-specific, one-of-a-kind concepts were developed at several critical intersections to go along with the conversion of 22 miles of arterial into a superstreet corridor. Unique bus operational concepts were developed to minimize the cross section of the median busway while providing safe and efficient mobility for all users. So how did we do it? Let's start with some context.

Background

Central Florida is one of the world's top tourist destinations, attracting more than 62 million annual visitors. Visitors congregate around the many theme parks on the south side of Metropolitan Orlando and mix with the many employees that work to provide a world class experience to them. Lack of early land use planning and the presence of many environmentally sensitive lands has resulted in the development of large principle arterials to serve these transportation needs and a limited collector grid network. As the capacity of these facilities fills up and it is no longer practical to continue widening, the area has increasing looked to multimodal solutions to offer a variety of trip choices to employees and visitors alike. US 192, a principal arterial serves as the east-west spine of Osceola County and connects employees living in Kissimmee and St. Cloud to Walt Disney World. The corridor also has minor tourist attractions and smaller hotels. Through an Alternatives Analysis Transit Study, Bus Rapid Transit (BRT) was selected as a corridor improvement.

The project presented some unique challenges. Adding BRT could potentially be achieved from reducing number of lanes of travel. The capacity lost from the removal of the lane was not going to be returned based on the ridership results, therefore innovative intersection improvements were desired to be included as a way to enhance person throughput. Enhancing person throughput though might induce additional demand or lessen demand on an adjacent toll facility. The key performance indicators needed to include not only intersection and corridor throughput and delay, but also the effect on the surrounding network.

To understand the effect on traffic operations and to consider network effects, multilevel modeling was performed in Aimsun. Aimsun allowed for microscopic simulation of intersection movements replicating the effects of innovative intersection improvements and the mesoscopic analysis of regional network flow which predicts how movement on adjacent roadways would be affected. The combination ensures both the macro level effects could be answered, while also providing the detail required to verify the proposed improvements were being adequately replicated.

Existing conditions

The existing corridor is a highly congested 22-mile arterial with over 40 signals that is part high speed divided highway with signals, and part signalized undivided urban arterial. Current bus stops along the

route are on the outside of the roadway with limited accommodations for pedestrian crossing from one side to the other of US 192.

The existing cross section leaves little room for the more traditional median BRT treatment envisioned in the Alternatives Analysis Transit Study. This study had called for separate bus stops for each direction and three total bus lanes at each bus stop to allow buses to pass stopped buses. Such an approach would have necessitated the removal of an existing lane in each direction to fit the BRT-related improvements in the median.

Today, US 192's unique role as the only non-tolled route between Kissimmee and Walt Disney World along with the heavy commercial and hospitality-oriented development and its function as a commuter route results in significant congestion throughout the day, often extending well outside of traditional commuting peak periods. Removal of a through lane in each direction was deemed as not a practical option. More than half of the 40 signals along the corridor are currently nearing or over capacity. A median busway would also preclude additional turn lanes and impact signal timing and phasing further degrading the operations of this important corridor. There is extensive existing development along the roadway, particularly along the urbanized sections of the corridor. The desire to keep costs low and avoid impacts to the economic viability of along the corridor precluded right-of-way acquisition and grade separations. To further complicate the study, the frequency and type of bus service had not yet been determined.

Approach

This study is unique in that it sought to identify improvements along the entire length of the corridor while attempting to improve conditions for all users where a more typical approach for most projects (not BRT specifically) is geared toward making an improvement for one use while trying not to degrade other uses. At the onset of the study, the details of BRT implementation were only vaguely defined. This study assumed a median busway. Locations of stops and the busway cross section, for example, were still undefined. For the purposes of this study, improvement options would need to be identified that allowed for median-running BRT, but the width, the operations, and the design of the BRT facilities could be defined by the alternatives developed by this study as opposed to being a constraint that would define the alternatives considered.

Typically, median-running BRT implementations find ways to fit the necessary facilities within an existing corridor. Where space is limited, vehicular operations are usually compromised to fit transit service with the spoken or unspoken justification that degradation in traffic operations would help facilitate a faster adjustment of mode choice toward heavier transit use.

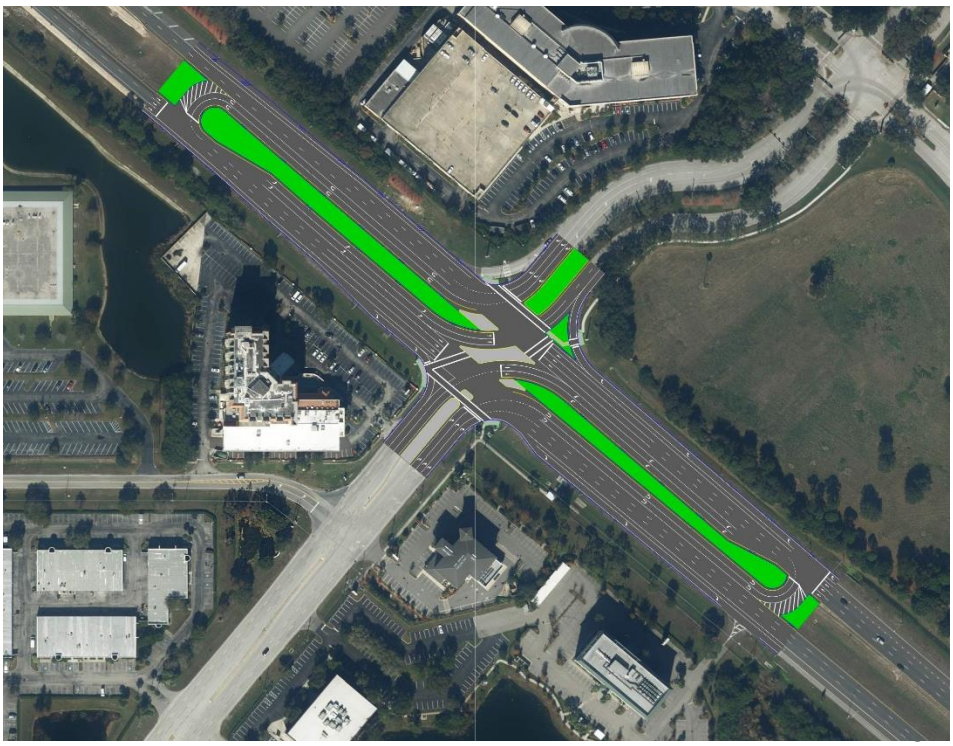
This study sought to improve vehicular capacity such that implementation of median-running BRT would not significantly degrade traffic operations for vehicular traffic though the goal was to prevent the public from associating BRT with creating traffic problems and thus creating potential issues with subsequent BRT deployments in the region. The conceptual development would need to seek to keep costs low by minimizing right-of-way acquisition and keeping everything at-grade.

The existing median is just wide enough to accommodate two lanes that would be used for BRT. Maintaining the median space for BRT at the intersections meant either removal of all of the left turn lanes along the corridor, many of which are dual left turn lanes that are currently well over capacity, or making the BRT discontinuous at major intersections. The tightest of the right-of-way constraints were invariably at the main intersections themselves, where the most space would be needed from a traffic operations standpoint. The easier and safer of the two options would be the elimination of the left turn lanes and the concept development turned to some innovative concepts to allow this to happen while also improving operations.

Turning things around

Improving capacity at an intersection can be simplified into two basic approaches: increasing flow in the same amount of time (this typically involves adding lanes, which was not an option) or increasing the amount of time available by reducing the number of ways time must be divided (reducing phases at the signal). One way to reduce the number of phases at a signal is to remove left turns from the main intersection by diverting them into a U-turn and thus replacing a left turn with a combination of a right turn, U-turn, and a through movement. There are multiple ways to accomplish this that have a variety of different names. Examples of three of them can be found in the Figures 1-3.

Figure 1 - Restricted Crossing U-Turn Intersection



The restricted crossing U-turn (RCUT) shown in Figure 1 prohibits the minor crossroad through movement and forces all traffic from the minor street to turn right. Through or left turn traffic would use the median U-turn provided to return to the main intersection and complete their movement. The right turn out of the minor street is protected by the signal phase that allows the left turn into the cross street. The result is the conversion of a single signal into two signalized U-turns and two signals at the main intersection that can operate independently.

The median U-turn (MUT) intersection shown in Figure 2 goes by a number of different names, most notably the Michigan Left Turn Intersection and much like the RCUT, left turns can be handled via U-turns on the main road (usually the facility with the larger median or more available space). As opposed to the RCUT, the MUT allows the minor street through movement to take place at the main intersection.

Figure 2 - Median U-turn Intersection

Another variant of the MUT utilizes roundabouts, typical on the minor cross street, to handle the U-turns that accommodate the diverted left turning traffic. This variant is sometimes referred to as a bowtie intersection and is more applicable with lower turning movement volumes.

Two different corridor alternatives were developed during the study. The first "minor build" included RCUTs, MUTs, and bowties throughout the length of the corridor. The resulting corridor analysis showed that this alternative would perform better in 2040 than the existing configuration does with today's traffic though it would leave a handful of problem intersections. This first alternative focused on making as much improvement to the operations along the corridor as possible while maintaining consistency throughout the corridor and without the introduction of more intimidating geometric design elements. Another, more robust corridor alternative was also developed that combined elements of RCUTs, MUTs, and bowties with elements of continuous flow intersections, diverging diamond interchanges, quadrant roads and hook turns to address the remaining problem locations. The resulting "full build" improved operations significantly, eliminating all the bottlenecks that remained in the "minor build" alternative. See

Table 1 below for a comparison of analysis results. The no build reflects the existing conditions and lane configurations; Traditional BRT reflects removal of a through lane in each direction; RCUT/MUT/Bowtie is the “minor build” alternative; and the Full Build option includes the remaining bottleneck fixes.

Table 1 - Comparison of Operations of Improvement Alternatives

Volume to Capacity ratio	No build	Traditional BRT	RCUT/MUT/Bowtie only	Full Build
Below 0.9	9 (5)	1 (0)	28 (29)	37 (36)
0.9 to 1.0	7 (8)	1 (1)	8 (5)	0 (1)
1.0 to 1.1	8 (7)	1 (0)	1 (2)	0 (0)
1.1 to 1.5	12 (15)	26 (28)	0 (1)	0 (0)
Over 1.5	1 (2)	8 (8)	0 (0)	0 (0)

Summary

The innovative approach to this study, the idea of fixing vehicular operations while allowing for BRT implementation is a reversal of the typical approach to BRT implementation. The median busway considered required the removal of a through lane in each direction in order to avoid a widening of the roadway which would incur significant right-of-way costs. The implementation of innovative intersection treatments along the corridor focused on concepts that preclude left turns from the main roadway as the space for left turn lanes would be absorbed by the median busway. The inclusion of innovative intersection concepts allowed the study to develop alternatives that significantly improves operations for vehicles, increases pedestrian crossing opportunities and crosswalk safety, while also providing for a median busway that will yield significant improvements to the efficiency of transit operations along this critical corridor.