Over the last few years, public transportation has become more desirable as capacity of existing roadways failed to keep up with rapidly increasing traffic demand. Buses are one of the most common modes of public transportation with low impact on network capacity, especially in small and congested urban areas. However, the use of regularly scheduled buses as the main public transport mode can become useless with the presence of traffic congestion and dense construction areas. In cases like these, innovative solutions, such as bus rapid transit (BRT), can provide an increased level of service without having to resort to other, more expensive modes, such as light rail transit (LRT) and metro systems (subways). Transit signal priority (TSP), which provides priority to approaching buses at signalized intersections by extending the green or truncating the red, can also increase the performance of the bus service.

The objective of this research is to evaluate the effectiveness of BRT with and without TSP (conditional and unconditional) strategies. The microsimulation software VISSIM was used to compare different scenarios. The VISSIM simulation model was developed, calibrated, and validated using a variety of data that was collected in the field. From this model, the main performance parameters along the corridor were analyzed. These parameters included average travel times, average speed profiles, average delays, and average number of stops. As part of a holistic approach, the effects of BRT with TSP on crossing street delay were also evaluated. Simulation results showed that TSP and BRT scenarios were effective in reducing travel times (up to 26%) and delays (up to 64%), as well as increasing the speed (up to 47%), compared to the base scenario. The most effective scenarios were achieved by combining BRT and TSP.

This research provides an innovative approach by using nested sets (hierarchical design) of TSP and BRT combination scenarios. Coupled with microscopic simulation, nested sets are used to evaluate the effectiveness of BRT without TSP, then with conditional or unconditional TSP strategies. The robust methodology developed in this research can be applied to any corridor to understand the combined TSP and BRT effects on traffic performance. Presenting the results in an organized fashion like this can be helpful in decision making. This research also used regression analysis to observe the effect of the tested scenarios analyzed in VISSIM software compared to the No TSP- No BRT base model for all vehicles and for buses only. The developed regression model can predict the effect of each scenario on each studied Measures of Performance (MOE). The developed models with real life data input are able to predict how proposed enhancements change the studied MOEs. The novel approach developed in this dissertation can be expanded to other transit systems.

To demonstrate the methodology developed in this research, it is applied to a test corridor along International Drive (I-Drive) in Orlando, Florida. This corridor is key for regional economic prosperity of Central Florida.