APPLICATION OF A MICRO-SIMULATION MODEL TO ESTIMATE THE EFFECTIVENESS OF TOLL PRICING ALTERNATIVES ON THE DIVERSION OF TRAFFIC TO TOLL FACILITIES

FINAL REPORT

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16. Abstract

The main objectives of this project were to evaluate the effectiveness of alternative toll reduction scenarios on diverting traffic to Turnpike facilities such as SR417. PARAMICS, a microscopic simulation software was validated using available data for a network of major highways and arterials in the surrounding Central Florida area to provide acceptable simulation accuracy based on pre-identified performance measures such as traffic volume and travel speed. The validated UCF-PARAMICS network model was used to test and evaluate the alternative toll reduction scenarios. The results from these scenarios demonstrated that under no change in the toll structure, the diversion of traffic volumes to SR417 was insignificant under all lane closure/incident scenarios. Moreover, the 50% toll reduction on SR417 and the 50% toll reduction for both SR417 and SR528 had a similar effect on the hourly traffic volume diverted to SR417. The same conclusion was applied for 100% toll reduction on SR417 only and toll reduction on both SR417 and SR528. As a result, there appears to be no added benefit due to toll reduction on SR528. Moreover, I-4 has the least travel time from the northern end to the southern end of the network when travel time includes the toll cost. So, usually no significant diversion happens off of I-4 to SR417 even under incident/lane closure and toll reduction scenarios. For people who value time significantly more than out of pocket toll cost, the toll roads are better alternatives when an incident/lane closure occurs on I-4. Finally, future research may use these and other scenarios to estimate the economic benefits of toll reduction in this well-defined real life network.

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EXECUTIVE SUMMARY

In this one-year study, the UCF research team defined, calibrated and validated a Central Florida road network that includes segments of the I-4, SR408, SR417, SR 528, Florida Turnpike (SR91), and major arterials in the Central Florida area. The validated UCF-PARAMICS Network was used to execute and evaluate the effectiveness of alternative toll pricing scenarios as traffic diversion strategies on toll and non-toll facilities in the network study area.

Twenty-four scenarios including various locations of the lane closures/incidents on I-4, and different toll reduction strategies were executed in addition to the base scenario. The performance of the simulated scenarios was evaluated using the traffic volumes and travel times measures of effectiveness on selected paths. The volume diversion analysis was performed at four screen lines to compare the changes in volume from the base scenario for trips originating from Lake Mary area (O1) to all destinations (O1Ds). In addition, Disney area (D1), UCF (D2) and Orlando International Airport (D3) were chosen as three specific destinations.

A number of observations were obtained during this study. The following is a summary of conclusions and recommendations in this study. It was found that diversion of traffic volumes to SR417 is insignificant under all lane closure/incident scenarios and the 50%-100% toll reduction on SR417 and the 50%-100% toll reduction for both SR417 and SR528 simultaneously have a similar effect on the hourly traffic volume diverted to SR417. As a result, there appears to be no added benefit due to toll reduction on SR528.

The results demonstrated that, for traffic originating at Lake Mary, the amount of diversion to SR417 ranged between 200 vph and 370 vph with 50% toll reduction on SR417 only, and 50% toll reduction for both SR417 and SR528 simultaneously For scenarios with 100% toll reduction on SR417 only and 100% toll reduction on both SR417 and SR528 simultaneously, the diverted traffic volumes to SR417 ranged between 460 vph and 620 vph.

Furthermore, the hourly traffic volumes on I-4 dropped at the location of lane closure/incident except at locations where off ramps were closed. The traffic volume diverted from I-4 under the recurring congestion with 50% or 100% toll reduction scenarios at the first screen line (Lake Mary blvd.) was between 170 vph to 360 vph. With lane closure between Lake Mary blvd. and SR436 this range became 260 vph to 360 vph. While, this range became 290 vph to 480 vph with lane closure between SR91 and Central Florida Parkway. And for lane closure between Lee Rd. and SR50, the maximum diversion occurred at the third screen line (SR50) and it ranged between 380 vph and 420 vph. Under incident scenarios (between Maitland blvd. and Lee Rd.) with 50% or 100% toll reduction, the highest traffic volume diversion from I-4 was observed at the second screen line (SR436) between 600 vph and 860 vph. However, the traffic diverted back to I-4 down stream of the lane closure/incident, thereby restoring the default conditions on I-4. As such, there are no such significant changes in the traffic conditions on I-4.

In terms of travel time savings, the results demonstrated that the travel time on I-4 had at least 20 minute advantage compared to other alternative routes (SR417, and SR417+SR528+I-4) under the existing conditions. However, simulated lane closure/incidents on I-4 added at most 20 minutes to the travel time on I-4. Hence, no significant diversion happens off of I-4 to SR417 for any of the lane closure/incident with and without toll reduction scenarios. Moreover, the results demonstrated that the toll roads are competitive alternatives to I-4 in terms of “time-on-route” or absolute travel times for those drivers who value time much more than out of pocket toll cost.

The major recommendation of this study appears to be that there is no added benefit due to toll reduction on SR528. There is no significant benefit of toll reduction to I-4 at the macroscopic network level unless some control mechanism (i.e., ramp metering) is implemented. Finally, there is some diversion to SR417 due to toll reduction though not totally from I-4.

ACRONYMS

ATIS	Advanced Traveler Information Systems
CFDW	Central Florida Data Warehouse
DBS	Database System
DMS	Dynamic Message Signs
DOT	Department of Transportation
ETC	Electronic Toll Collection
FDOT	Florida Department of Transportation
ITS	Intelligent Transportation Systems
OD	Origin-Destination
OIA	Orlando International Airport
OOCEA	Orlando-Orange County Expressway Authority
RTMC	Regional Traffic Management Center
SL	Screen Line
TAZ	Traffic Analysis Zone
TPK	Turnpike Enterprise
TSI	Transportation Systems Institute
UCF	University of Central Florida

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CHAPTER 1

INTRODUCTION

The Central Florida area is a growing destination center. Growth is anticipated to continue and the ability of the road network to service the growing traffic volumes will continue to decline. Improvements to the network are in progress and more significant construction is planned for the near future. One of the related issues affecting Florida's Turnpike Enterprise is how to evaluate the effectiveness of alternative toll plans on diverting traffic to Turnpike facilities such as the SR 417 to provide for mitigation of traffic and take advantage of their available capacity. An improved micro-simulation of network traffic flows is required to evaluate the effectiveness of such toll reduction plans. Also, the defined road network will be useful in examining traffic operations, incident management, future planning and can also be utilized with various Intelligent Transportation System (ITS) applications including Advanced Travel Information Systems (ATIS) and Dynamic Message Signs (DMS).

The **University of Central Florida-Transportation Systems Institute (UCF-TSI)** has extensive experience in studies of this type. The UCF-TSI research team led by Dr. Al-Deek and many of UCF students has worked on numerous network evaluations. The results of the studies have been published in international journals and had extensive wide scale exposure in the professional community world-wide (Emam and Al-Deek (2005), Klodzinski and Al-Deek (2004), Klodzinski and Al-Deek (2004), Klodzinski and Al-Deek (2003), Al-Deek et. al. (2002), Al-Deek et. al. (1998), Al-Deek and Kanafani (1993), Al-Deek et. al. (1989), Al-Deek et. al. (1990), Al-Deek (1992)). These UCF studies include Tampa and Cape

Canaveral area network simulations that were successfully modeled with the VISSIM and CORSIM micro simulation computer packages.

In this study a micro-simulation network model for the Central Florida area (UCF-PARAMICS Network) was developed "defined, validated and tested" to simulate and evaluate the effectiveness of alternative toll plans on diverting traffic to Turnpike facilities. The data was obtained from the Florida Turnpike Enterprise for construction, calibration, and validation of the network and results verified statistically. There were five major tasks in this project, see Figure 1 below for project schedule. These tasks have been described in detail in the contract.

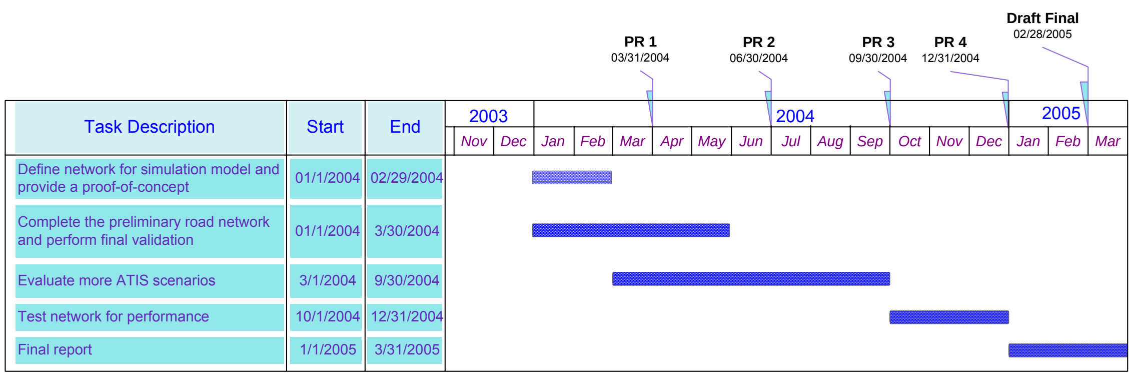


Figure 1: List of Project Tasks and Schedule

1.1 STUDY GOAL AND OBJECTIVES

The main goal of the project was to execute and evaluate the effectiveness of alternative toll reduction scenarios on diverting traffic to Turnpike facilities such as the SR417. Specific objectives of this project were:

1. Evaluation of diversion of vehicles from a non-toll road such as I-4 to toll facilities such as SR417.
2. Studying the impact of increased traffic on toll facility operations and travel times.
3. Evaluation of traffic volumes on selected non-toll road after diversion and their resulting operational speed and travel time.

The results from these scenarios were evaluated and invaluable information about the effectiveness of toll reductions alternatives as traffic redistribution strategies are provided in this report.

CHAPTER 2

LITERATURE REVIEW

Traffic simulation has been applied to study a variety of traffic problems and scenarios. Besides, simulation has also provided researchers, planners and engineers with a technique to evaluate a proposed set of alternatives for a specific traffic or transportation related problem. This section describes the advantages and disadvantages of using simulation, different traffic simulation software and instances in literature of successful application of traffic simulation.

2.1 STRENGTHS AND LIMITATIONS OF SIMULATION MODELING

May (1990) points out that it is important to keep simulation modeling in its context and view simulation modeling as one of several analytical techniques available to the traffic and transportation analyst. Also, he points out the following strengths of simulation modeling:

1. Other analytical approaches may not be appropriate.
2. Can experiment with new situations that do not exist today.
3. Time and space sequence information provided, in addition to mean and variances.
4. System can be studied in real time, compressed time, or expanded time.
5. Potentially unsafe simulation experiments can be conducted without risk to system users.
6. Can replicate base conditions for equitable comparison of improvement alternatives.

7. One can study the effects of changes on the operation of a system: "What if…happens?"
8. Can handle interacting queuing processes.
9. Demand can be varied over time and space.
10. Unusual arrival and service patterns can be modeled which do not follow more traditional mathematical distributions.

He emphasizes that potential reservations to simulation modeling including:

1. There may be easier ways to solve the problem.
2. Simulation can be time-consuming.
3. Simulation models require considerable input characteristics and data, which may be difficult or impossible to obtain.
4. Simulation models require verification, calibration and validation that if overlooked renders the model useless.
5. Some users may apply simulation models and treat them as black boxes and really do not understand what they represent or appreciate model limitations and assumptions.

With regard to traffic simulation within an ITS framework, some limitations have also been identified by The Smartest Project (1997) as follows:

- *Modeling congestion*. Most simulation models use simple car following and lane changing algorithms to determine vehicle movements. During congested conditions these do not realistically reflect driver behavior. The way congestion is modeled is often critical to the results obtained.

- *Integrated environments and common data*. Simulation models are often used with other models such as assignment models. There are common inputs required by all these models, such as origin-destination data, network topology, and bus route definitions. However, each model often requires the data in a different format so effort is wasted in re-entering data or writing conversion programs.
- *Safety evaluation*. Safety is a very complex issue. Simulation models completely ignore vulnerable road users such as cyclists or pedestrians.

2.2 TRAFFIC SIMULATION MODELS

Traditionally, traffic simulation models were developed independently for different facilities (e.g. freeways, urban streets, arterials, etc.). A wide variety of simulation models exist for various applications. Simulation models may be classified according to the level of detail with which they represent the system to be studied: Microscopic (high fidelity), Mesoscopic (mixed fidelity), and Macroscopic (low fidelity).

A microscopic model describes both the system entities and their interactions at a high level of detail. A mesoscopic model generally represents most entities at a high level of detail but describes their activities and interactions at a much lower level of detail than would a microscopic model. A macroscopic model describes entities and their activities and interactions at a low level of detail.

Another classification addresses the processes represented by the model: (i) Deterministic; and (ii) Stochastic. Deterministic models have no random variables; all entity interactions are defined by exact relationships (mathematical, statistical or logical). Stochastic models have processes, which include probability functions.

Traffic simulation models have taken many forms depending on their anticipated uses. While Federal Highway Administration (FHWA) funded the development of facility specific simulation softwares (NETSIM, ROADSIM, FRESIM, etc), these software have limited application when it comes to generalized networks with ATIS implementations. A new generation of traffic simulation models has been developed for ITS applications. Examples are AUTOS, METROPOLIS, **PARAMICS**, VISSIM, DYNASMART, DYNAMIT, INTEGRATION, THOREAU, and AIMSUN2.

2.3 APPLICATIONS OF SIMULATION

Applications like user's route choice dynamics in the case of lane closures was studied in a simulation environment by Mahmassani and Jayakrishnan (1991). The results showed that providing real time in-vehicle information to users could lead the network to reach a steady state at a faster rate than under the no-information case.

Modeling traffic flows in networks involving advanced traffic control and route guidance systems by Yang and Koutsopoulos (1996) using MITSIM (MIcroscopic Traffic SIMulator) on the A10 beltway in Amsterdam, the Netherlands network with non-recurrent congestion caused by a 20-minute incident, the case study demonstrated that on average 2-4% of travel time savings is achieved when real-time traffic information is provided to 30% of drivers. For drivers having viable alternative routes, real time route guidance is very effective, creating travel time saving of up to 18%.

Korve Engineers (1996) employed the WATSim simulation model to evaluate alternative scenarios for increasing capacity and improving traffic flow on a freeway connection, SR242 in California and ensuring a balanced design relative to freeway SR4 on the north and I-680 to the south. Design alternatives considered for three future periods (years 2000, 2010, 2020) included geometric changes, widening, HOV lanes and ramp metering. This study illustrated the use of simulation as an element of the design process with the capability of analyzing candidate designs of large-scale highway systems in a manner that lied beyond the capabilities of a straight-forward HCM analysis.

Al-Deek et al. (1988) discussed a study on the I-10 corridor project using FREQ8 model simulation to evaluate the benefits of In-vehicle Information Systems (IVIS). In this study the FREQ model was used to simulate a section of the Santa Monica I-10 freeway in California. The study estimated delays, queues and travel times on the freeway based on scenarios of recurring and incident congestion.

Gardes et al. (2002) calibrated PARAMICS and used it to evaluate Interstate 680 freeway improvement strategies in the San Francisco Bay Area. A major section of the study was devoted to describing a procedure that was developed to calibrate two critical driver behavior parameters: the mean target headway and the mean reaction time. A two-dimension process to calibrate these two parameters against target speeds and volumes was successfully applied.

John Shaw and Do Nam (2002) concluded that in an integrated project selection process, output data from micro simulation could serve as input for engineering economic analysis, which in turn provides an objective basis for selection of projects implementing the freeway reconstruction. The context was the Southeast Wisconsin Freeway System Operational Assessment (FSOA), a detailed examination of the safety and operational performance of the Metropolitan Milwaukee freeway system. As the project and software technology evolved, micro simulation emerged as the basis of an ongoing process for analyzing system wide freeway operations. The need to integrate FSOA with other studies and the District's project selection process became clear. Only the most advanced micro simulation software has the power necessary to accomplish a task of this complexity. PARAMICS and VISSIM packages were evaluated. Both offer significant advantages compared to CORSIM, and PARAMICS was recommended as the basis for further simulation work.

Liu et al. (2000) addressed the use of Application Programming Interface (API) to change the underlying simulation model used in PARAMICS. Authors explained how to override the simulator default models such as car following, lane changing, route choices, etc. The paper explained the procedure for coding the signalized intersections in PARAMICS. Complete details of coding Actuated signals, Signal Coordination and Ramp control using API were illustrated. Authors concluded that API allows researchers to override the simulator's default models such as car following, route choice models, lane changing, etc. and interface complementary modules (any ITS application) such as signal optimization, adaptive ramp metering, incident detection, etc.).

Lee et al. (2001) described the importance of calibrating the PARAMICS model for local traffic conditions. The authors simulated a one-mile segment of Interstate 5 in Orange County, California. Real-time loop detector data and two field data sets were collected and used in both calibration and validation processes. The authors stated that the two key parameters used in the study were mean target headway and mean reaction time. The authors found that these calibrated parameter values indicated differences between California drivers' behavior and the default values in PARAMICS.

Stewart (2001) developed a model using PARAMICS to study the effects of ramp metering on Motorway 8 (M8) and its neighboring surface streets in Scotland. A model was calibrated and validated with respect to the base model by comparing observed link count data, journey time data, automatic traffic count data and video count data over the sections of M8. The study revealed an acceptable correlation of the simulation results with observed statistics for ramp signal frequencies, cycle times and platoon sizes. The author was able to test different scenarios to illustrate the potential of ramp metering; based on his observations he concluded that PARAMICS can be used to replicate the traffic conditions and the driver behavior reasonably.

Abdulhai et al. (2001) used PARAMICS to study the impacts of the High Occupancy Vehicle (HOV) lane implementation for Highway 401 in Toronto, Canada. A model was developed to evaluate a set of various improvement options of Highway 401 by considering three different scenarios: converting one of the existing lanes into HOV lanes, addition of an HOV lane, and addition of a general purpose lane. All these scenarios were conducted under "All-or-nothing" traffic assignment option available in PARAMICS. The traffic parameters of flow, speed and delay for different sections of Highway 401 were used to compare the results from different scenarios. Application of PARAMICS to evaluate the various HOV lane improvement options for Highway 401 in Toronto was successful in meeting the primary research objectives, primarily to develop an HOV lane treatment plan. Also, visual inspection during micro-simulation runs identified potential problem areas with regards to ingress/egress locations. In addition, the sensitivity analysis provided valuable insight into the eventual success of the proposed HOV lane plan and any changes needed in it.

Chu et al. (2002) used PARAMICS to evaluate the effectiveness of the ramp metering technology on a section of I-405 using three ramp-metering algorithms ALINEA, BOTTLENECK and ZONE. This study revealed the use of calibration in simulation modeling. Some of the points that came into light during the study were:

- Accurate geometry of network and smooth coding of links, are important since drivers' behavior in PARAMICS is very sensitive to the network geometry.
- The signposting setting for links, which is used for defining locations of weaving area are crucial.
- Driver behavior factors in car-following and lane-changing models; including the mean target headway and mean driver's reaction time are important.

Based on the work conducted in this evaluation study, various other ATMS applications could be tested and evaluated by PARAMICS simulation laboratory.

Ramasamy (2002) developed a model to study the traffic characteristics on the University of Central Florida campus using PARAMICS. Maximum queue length and percentage time delay were used as measures of effectiveness.

Trapp (2002) demonstrated the integration of PARAMICS and Geographic Information Systems (Map Info) and a database using an interface in his paper regarding Microscopic Traffic Flow Modeling of Large Urban Networks.

Cheu et al. (2002) used PARAMICS to simulate different incident scenarios and used results from the simulation output to test the algorithms for incident detection.

Leftwich Consulting Engineers (2001) applied the PARAMICS software to assist with a program of revitalization and upgrading for Miami's downtown region for the Miami-Dade County Metropolitan Planning Organization.

Lee et al. (2003) applied PARAMICS to explore the potential employment of real-time information for the efficient management of city logistics operations. Simulation results suggested that the diversion strategies examined usually resulted in reduced travel times, which improved the efficiency of commercial vehicle operations (CVO).

Abou-Senna (2003) applied PARAMICS to analyze dynamic routing decisions in the Central Florida limited access network comprising the I-4 and the toll roads (SR417, SR408, SR528) in response to real time information through various stochastic assignment methodologies.

2.4 EVALUATION OF SIMULATION TOOLS

Boxill and Yu (2000) conducted a two-step evaluation study of simulation models: initial screening and in-depth evaluation. Criteria for initial screening were developed in order to eliminate models with no potential for use with ITS applications. In-depth evaluation attempts to identify more specific features and limitations of models selected from the initial screening process. Nine models were assessed in terms of ITS features modeled. These models were AIMSUN 2, CONTRAM, CORFLO, CORSIM, FLEXYT II, HUTSIM, INTEGRATION, PARAMICS and VISSIM. It was found that PARAMICS appears to be the leading model for real time simulation of hundreds of vehicles. It also appears to be the comprehensive visualization system and provides intelligent route guidance capabilities. Table 1 summarizes the in-depth evaluation.

Table 1: Summary of Models Based on In-Depth Criteria

	AIMSUN 2	CONTRAM	CORFLO	CORSIM	FLEXYT II	HUTSIM	INTEGRATION	PARAMICS	VISSIM
ITS Features Modeled									
Traffic devices	X						X	X	
Traffic device functions	X						X	X	
Traffic calming					X	X	X	X	X
Driver behavior	X			X	X		X	X	
Vehicle interaction	X			X	X		X	X	
Congestion pricing						X		X	
Incident	X		X	X	X	X	X	X	X
Queue spillback	X			X	X	X	X	X	X
Ramp metering	X			X	X	X	X	X	X
Coordinated traffic signals	X	X	X	X	X	X	X	X	X
Adaptive traffic signals	X	X	X	X	X	X	X	X	X
Interface w/other ITS algorithms	X								
Network conditions		X				X		X	
Network flow pattern predictions					X	X	X	X	X
Route guidance									
Integrated simulation	X	X		X	X	X	X	X	X
Other Properties									
Runs on a PC	X	X		X	X	X	X	X	X
Graphical Network Builder	X	X			X	X			X
Graphical Presentation of Results	X	X		X	X	X	X	X	X
Well Documented	X	X	X	X	X	X	X	X	X

(Source: Boxill and Yu (2000))

CHAPTER 3

METHODOLOGY

The methodology is an application of a micro simulation model (PARAMICS) to simulate a limited network of the Central Florida area on the macroscopic level. The developed methodology consists of the following steps:

1. *Network Coding.* Code and outline a preliminary network for the micro simulation model of the Central Florida area including major highways and primary arterials. The relevant geometric, traffic signal timing must also be included.
2. *Model Calibration.* Finalize the defined road network (UCF-PARAMICS Network) and conduct several runs. These runs are used to conclude the best Origin-Destination (O-D) that provides minimum error between the simulated output and the data provided by the Florida Turnpike, which includes traffic volumes. Traffic volumes are used to compare link counts between simulated and actual values by facility type and along selected screen lines. Screen lines are defined as the set of count sites, which interrupt traffic/passenger flows between sets of zones and share the same general corridors of movement. The procedure for calibration and validation of the UCF-PARAMICS Network includes five major steps. These include:
    1. Minimal zone selection adjustment to examine validity of shortest path
    2. Visual observations
    3. Adjustment of PARAMICS parameters
    4. Modeling Impedance factors on arterials

5. Comparisons to field data

3. *Model Validation.* The model must be validated in order to assure that it can replicate the actual system. This was accomplished by comparing the Central Florida Data Warehouse (CFDW) traffic speeds data, which was not used in the model development process, with the UCF-PARAMICS network model travel speeds output. This comparison was executed visually as well as statistically using a t-test.
4. *Evaluate ATIS scenarios.* Run model to simulate toll reduction scenarios such as lowering tolls on SR 417 only or on both SR417 and SR528 simultaneously during the morning peak travel period from 7:00 AM to 8:00 AM, diverting vehicles from a non-toll road such as I-4 to toll facilities due to different size and locations of construction on I-4, and finally simulating an incident on I-4.
5. *Conclusions.* Interpret the results to establish conclusions and make recommendations for future research and analysis.

CHAPTER 4

UCF-PARAMICS NETWORK

A complete network of the Central Florida area has been successfully defined to meet the objectives of the project. This includes complete coding of the network in the PARAMICS micro simulation-modeling package and construction of the origin-destination (OD) matrix from the defined zones. In order to eliminate confusion between different model and zonal references, the final defined network and traffic volume zones for this project will be referenced as the UCF-PARAMICS NETWORK or ZONES.

4.1 DEFINE THE CENTRAL FLORIDA ROAD NETWORK

There were three steps for defining the UCF-PARAMICS NETWORK. They included examination of which roads or road segments should be included in the network to meet the objectives but without over complicating the network with multiple travel routes that could provide more detail than necessary in order to complete the modeling and scenarios for this specific project.

4.1.1 Interstate Highways and Toll Roads

The first step was identifying all interstate highways and toll roads in the Central Florida area. Figure 2 displays these routes and the list included:

- Interstate 4 (I-4 or SR 400)-- from SR 417 (south/east-Disney Area) to CR 46 (Lake Mary Area)

- Greenway Expressway (SR 417)-- from I-4 (south/west) to I-4 (north/east)
- East/West Expressway (SR 408)-- from Kirkman Rd to SR 417
- Bee Line Expressway (SR 528)-- from I-4 to SR 417
- Turnpike (SR 91)-- from I-4 to SR 528

4.1.2 Major Arterials

The second step identified the arterials that had available data to be included in the UCF-PARAMICS NETWORK. This data (travel speed and distance) was provided by the Turnpike Enterprise and would be use in modeling the impedance factors on the network arterials. Figure 3 displays these selected arterial segments as highlighted portions of the network, which also displays the highways from Step 4.1.1. These arterials included:

- SR 434—US 17/92 to SR 436
- SR 50 (Colonial Dr.)—Kirkman Rd to SR 417
- US 441 (Orange Blossom Tr.)—Colonial Dr. to SR 417
- SR 482 (Sand Lake Rd.)—I-4 to SR 528 (boggy creek interchange)
- SR 435 (Kirkman Rd.)—Sand Lake Rd to Colonial Dr
- SR 436 (Semoran Blvd.)—SR 434 to SR 417
- US 17/92—SR 408 to SR 417 (Airport Blvd interchange)
- SR 426 (Aloma Ave.)—SR 417 (Aloma Ave interchange) to US 17/92

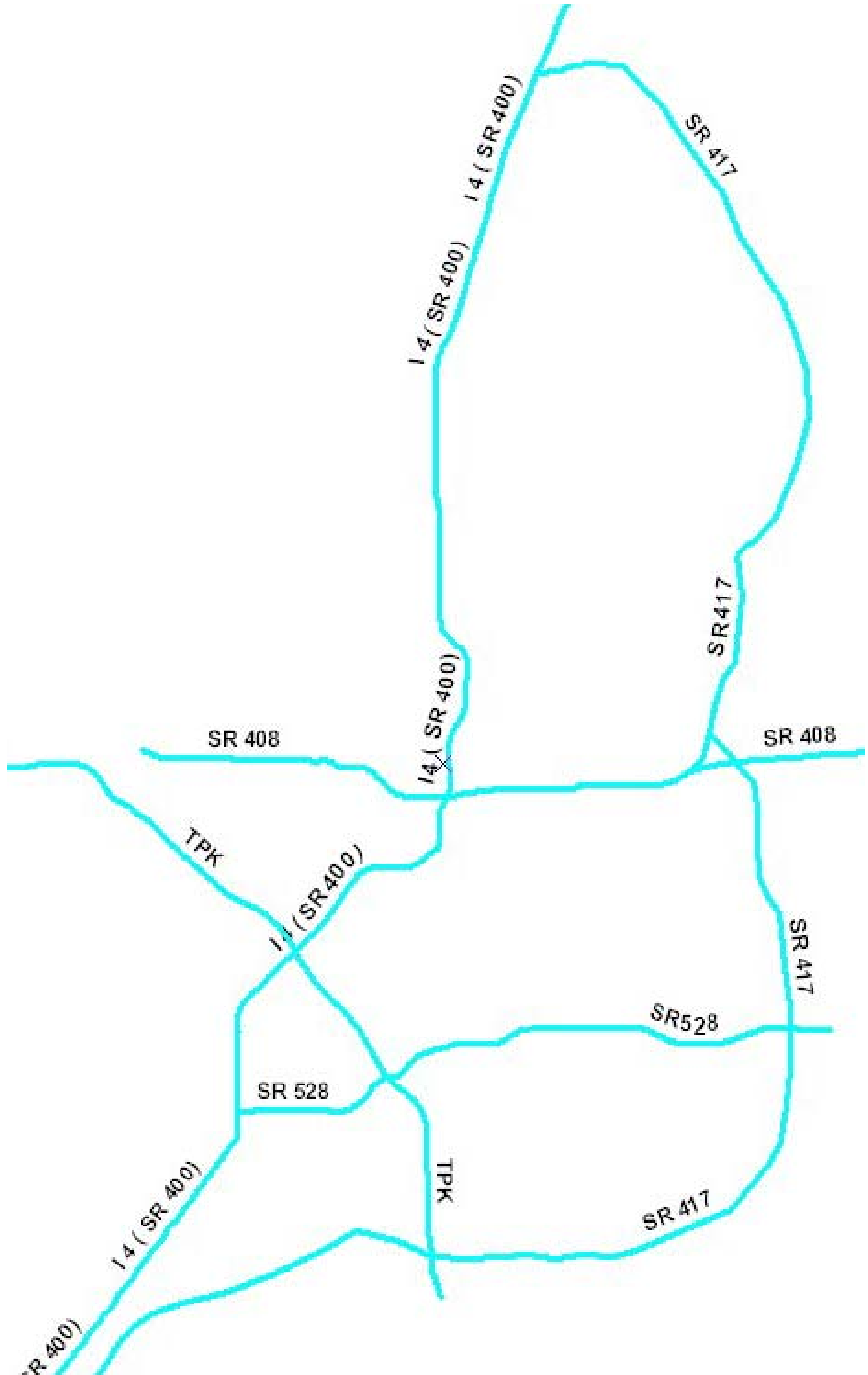


Figure 2: UCF-PARAMICS NETWORK Definition, (Step 4.1.1)

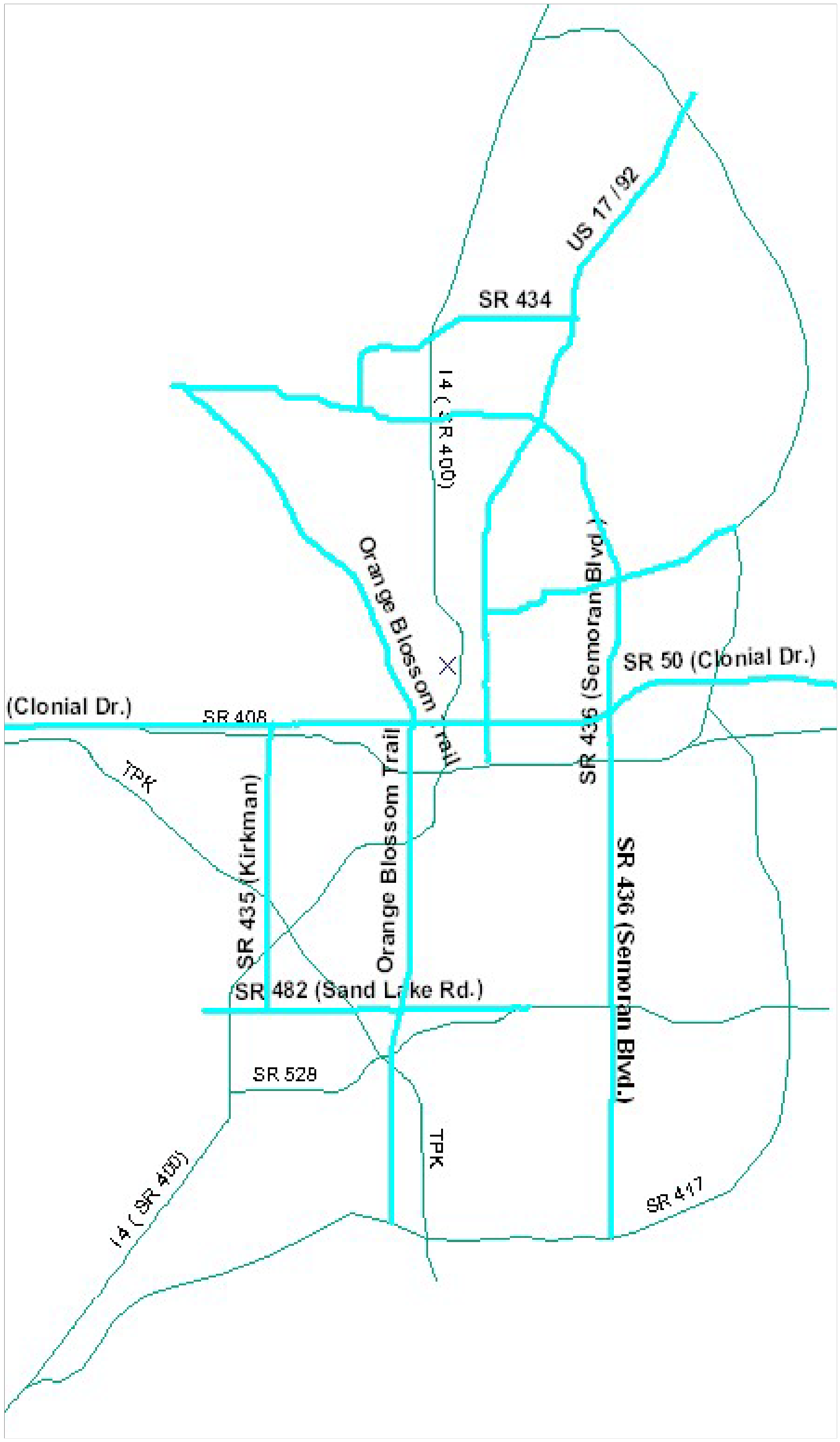


Figure 3: UCF-PARAMICS NETWORK Definition, (Step 4.1.2)

4.1.3 Alternative Arterials to I-4

This final step identified arterials that provide connections between the selected roads in Steps 4.1.1 and 4.1.2 as well as consideration of alternative routes in the Interstate 4 corridor. These roads do not have available travel time and speed data for calibration, however they are important for having a comprehensive network capable of meeting the project objectives. Figure 4 displays the network with the Step 4.1.3 roads highlighted. The final network is displayed in Figure 5. The roads selected for Step 4.1.3 included:

- SR 434 (Forest City Rd.)—SR 436 to Edgewater Dr.
- Red Bug Lake Road —SR 417 to SR 436
- SR 552 (Curry Ford Road)— SR 417 to SR 436
- Lake Mary Blvd.
- Princeton
- Lee Rd.
- SR 414 (Maitland Blvd.)
- Edge Water
- Central Florida Parkway (CFPW)
- SR 536 (Epcot Dr.)

Once the UCF-PARAMICS NETWORK was completed, the next step in the methodology was identification of UCF-PARAMICS traffic volume zones. This was also a three-step process.

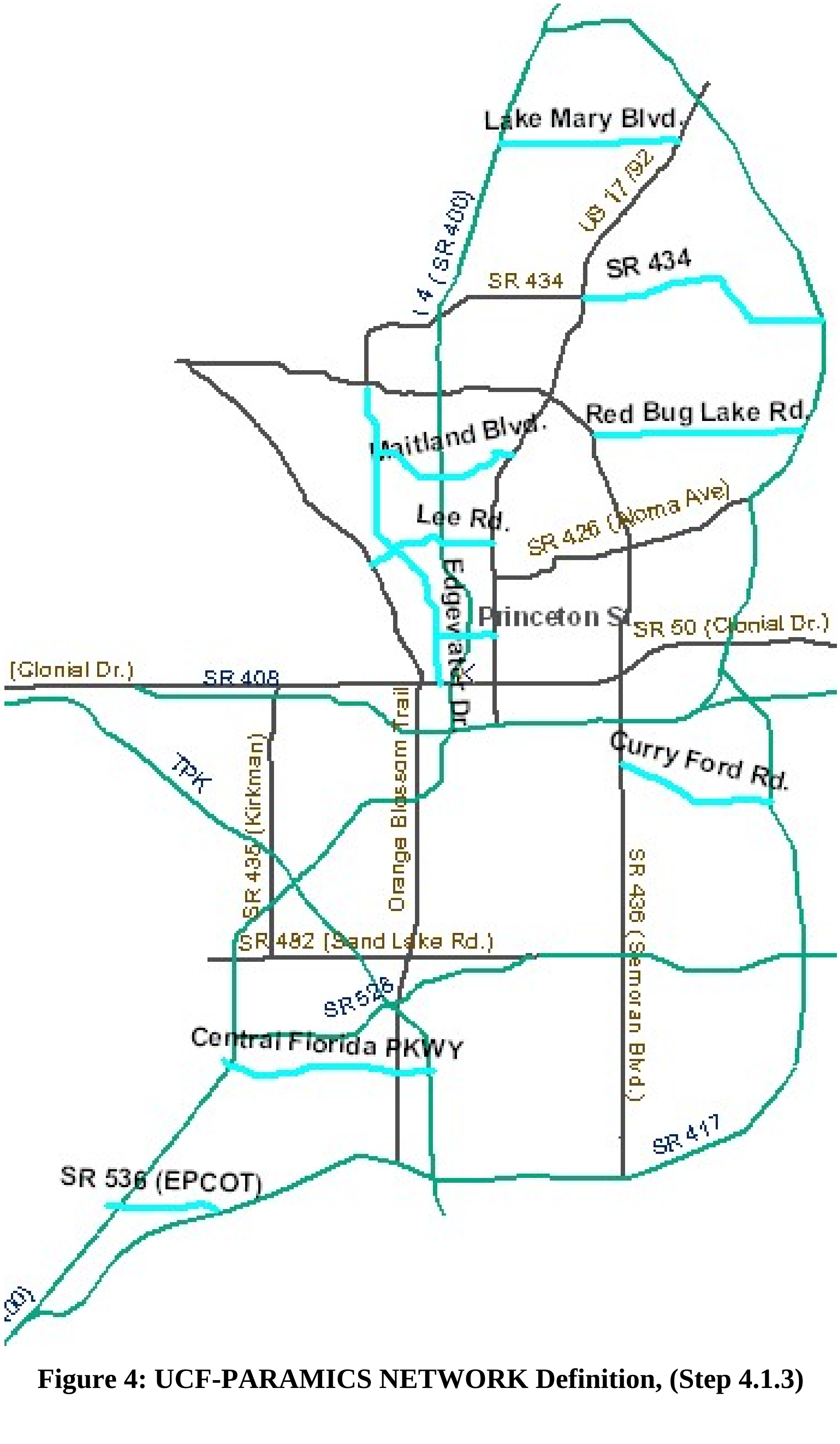


Figure 4: UCF-PARAMICS NETWORK Definition, (Step 4.1.3)

Figure 5: Final UCF-PARAMICS Network

4.2 IDENTIFY NETWORK TRAFFIC ANALYSIS ZONES

This procedure began with the Central Florida TAZs as defined for use in the FSUTMS simulation model. Figure 6 displays the TAZs for Central Florida with the UCF-PARAMICS NETWORK overlaid.

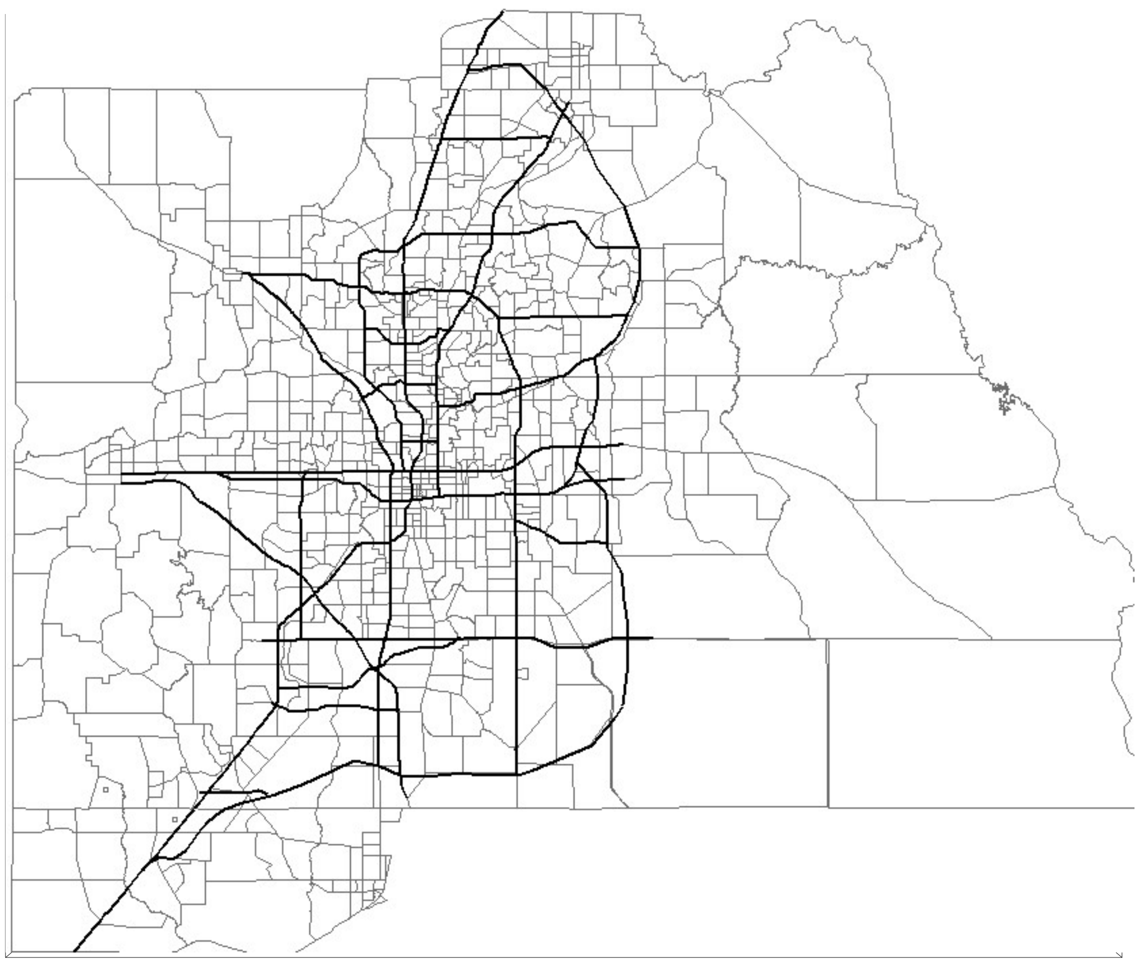


Figure 6: FSUTMS TAZs for Central Florida

4.2.1 Reduction of Exterior FSUTMS TAZs

Exterior TAZs were those on the outer area surrounding the UCF-PARAMICS Network that did not have any direct connections to the UCF-PARAMICS Network. FSUTMS was run for the Orlando Area Network only. This provided feedback that most of the exterior TAZs had zero volumes associated with the Orlando Area Network. Furthermore, travel time to access the network from these zones was estimated to be at least 50% of the total time a vehicle would occupy the UCF-PARAMICS Network, thus making their impact on the UCF-PARAMICS Network insignificant compared to the majority of traffic being considered for the network. As a result, this traffic will not be attracted to the UCF-PARAMICS Network since it is too costly to access the network and therefore these TAZs were excluded. Figure 7 displays the network and initial reduction of TAZs from 1816 to 743.

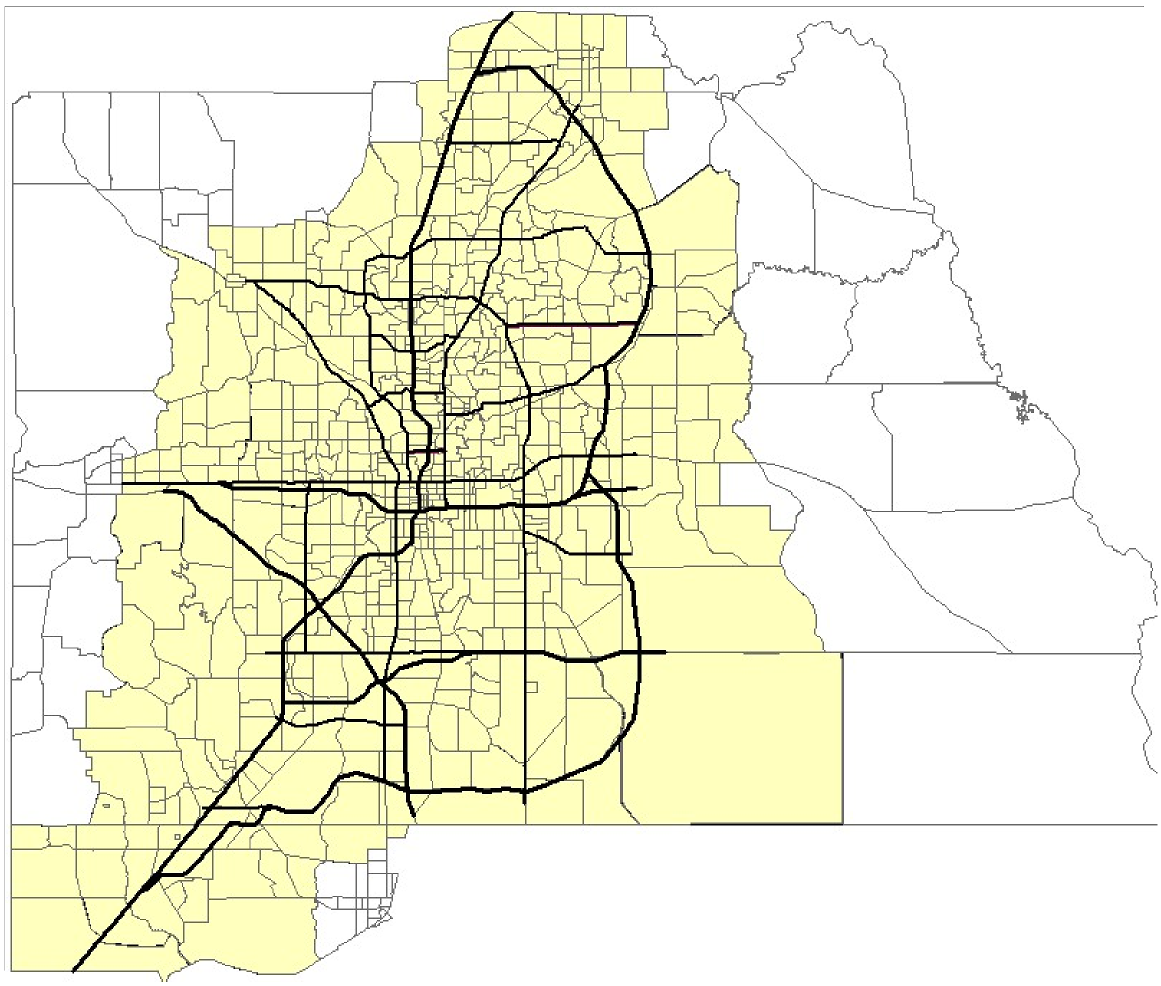


Figure 7: UCF-PARAMICS ZONE Identification, (Step 4.2.1)

4.2.2.1 TAZs with Existing Connections to the UCF-PARAMICS Network

TAZs with direct network access with a road segment that was included in the UCF-PARAMICS Network formed base UCF-PARAMICS Zones, which were then built upon for the remaining zone identification steps. Small TAZ groups bounded on all sides by UCF-PARAMICS Network were grouped and were set as one Zone. Also, consideration was given to the amount of distance/travel time to cross the entire defined UCF-PARAMICS Zone. If this value was small (i.e. less than 5 minutes during free-flow), the TAZs were grouped as one UCF-PARAMICS Zone. Some of these as examples include: Zone #s 28 to 31. Furthermore, other adjacent TAZs were grouped with these zones to define UCF-PARAMICS Zones for the UCF-PARAMICS Network. Figure 8 displays the UCF-PARAMICS network and zones with examples indicated for the Step 4.2.2.1 procedure.

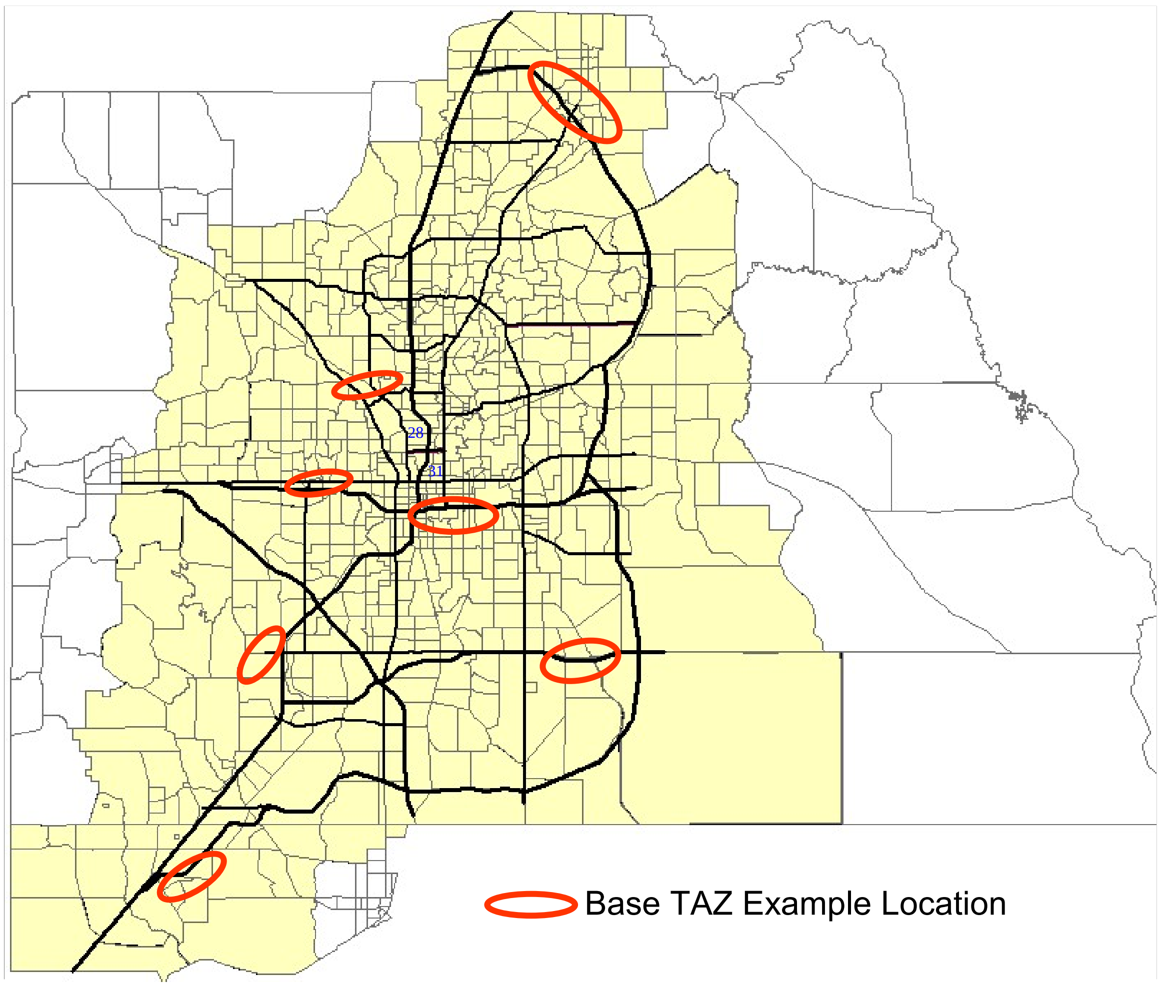


Figure 8: UCF-PARAMICS ZONE Identification, (Step 4.2.2.1)

4.2.2.2 TAZs Adjacent to "Base" TAZs

TAZs with connections to the selected "base" TAZs in Step 4.2.2.1 were combined to build the UCF-PARAMICS Zones. The traffic from these TAZs was considered to access the UCF-PARAMICS Network through the "base" TAZs. Those "cut" through by a UCF-PARAMICS Network link were considered on the side of the link where an existing TAZ connector would provide access for the TAZ traffic to the UCF-PARAMICS Network. These TAZs were then grouped with the "base" TAZ that had direct access to the UCF-PARAMICS Network. If this "cut" TAZ had an existing direct connector, then it was a "base" TAZ and located on the side of the existing connector. TAZs "cut" by a UCF-PARAMICS Network link were considered to be included in a UCF-PARAMICS Zone based on location of an existing TAZ connector. Figure 9 displays the preliminary selection of zones.

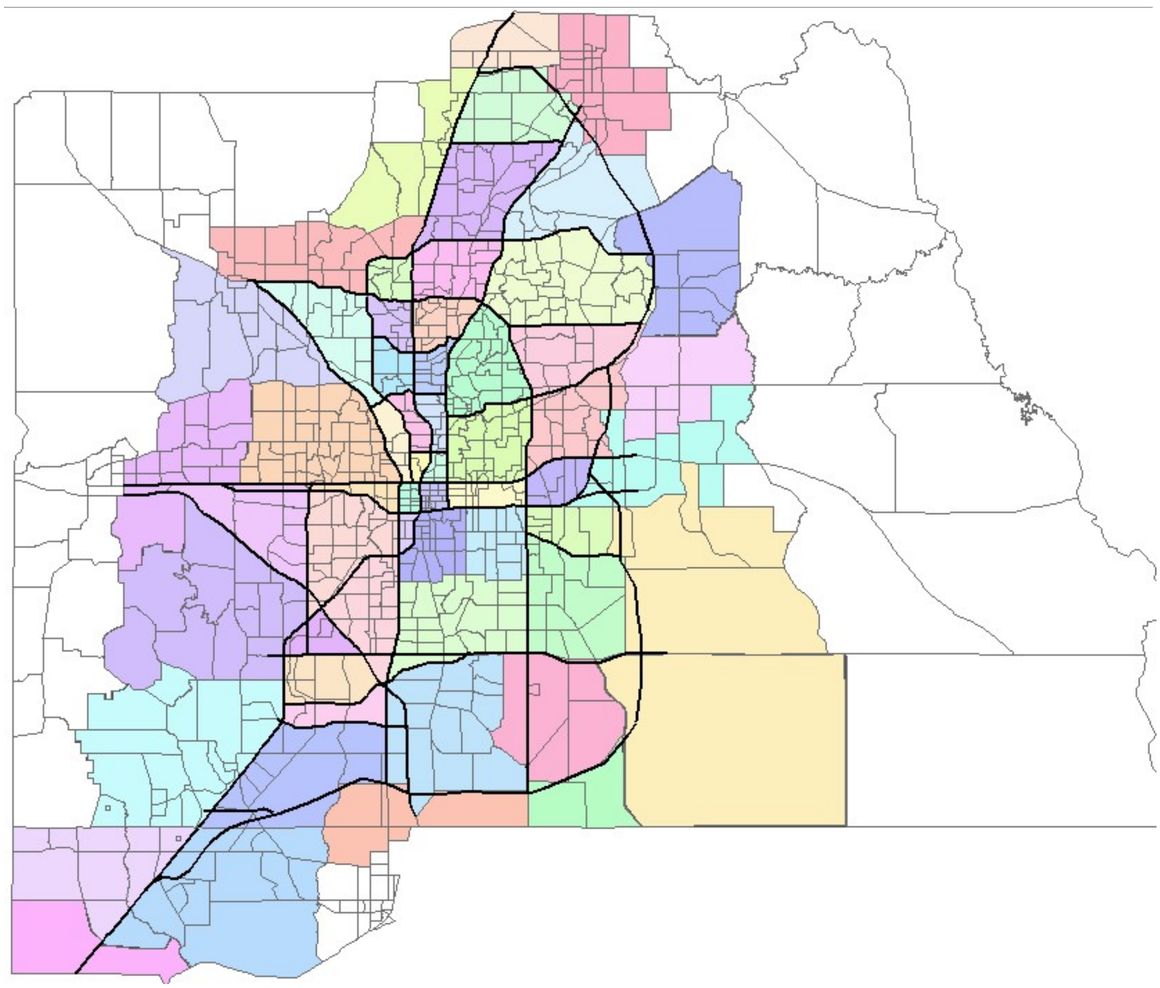


Figure 9: UCF-PARAMICS ZONE Identification, (Step 4.2.2.2)

4.2.2.3 Exterior UCF-PARAMICS Zones

This step was based on the location of UCF-PARAMICS Network access, alternate route availability, and uniformity in Zone identification along major route corridors.

For a UCF-PARAMICS Zone identification, a Zone was required to have at least one alternate route that a vehicle could select when entering or leaving the network. Whenever possible, an arterial or non-limited access facility was included in a defined UCF-PARAMICS Zone (For definition of the UCF-PARAMICS Network limited access facilities, see Network Definition Step 4.1.1). Some of these exterior zones already were constrained in definition based on the TAZs grouped with connections from Step 4.2.2.1 criteria (TAZ with existing connection to a "base" TAZ). UCF-PARAMICS Network access connections that were in close proximity to each other or NOT separated by an independent zone (zone separating two zones that had a connector that was identical to the UCF-PARAMICS Network access connection).

Uniformity is defined as distributing the TAZs in UCF-PARAMICS Zones based on previous definition of network connections and now considering the traffic volume distribution onto the network. No one UCF-PARAMICS Zone should have an unusually high volume or unusually high number of access points to the UCF-PARAMICS Network which would destabilize the network O/Ds by constraining (unusually low demand to the network) or "dumping" excess amounts of traffic onto the network at an unrealistically high rate of flow. This created a final reduction from 743 TAZs to 55 UCF- PARAMICS Zones. Figure 10 displays the continued zonal selection with indicated examples on the map.

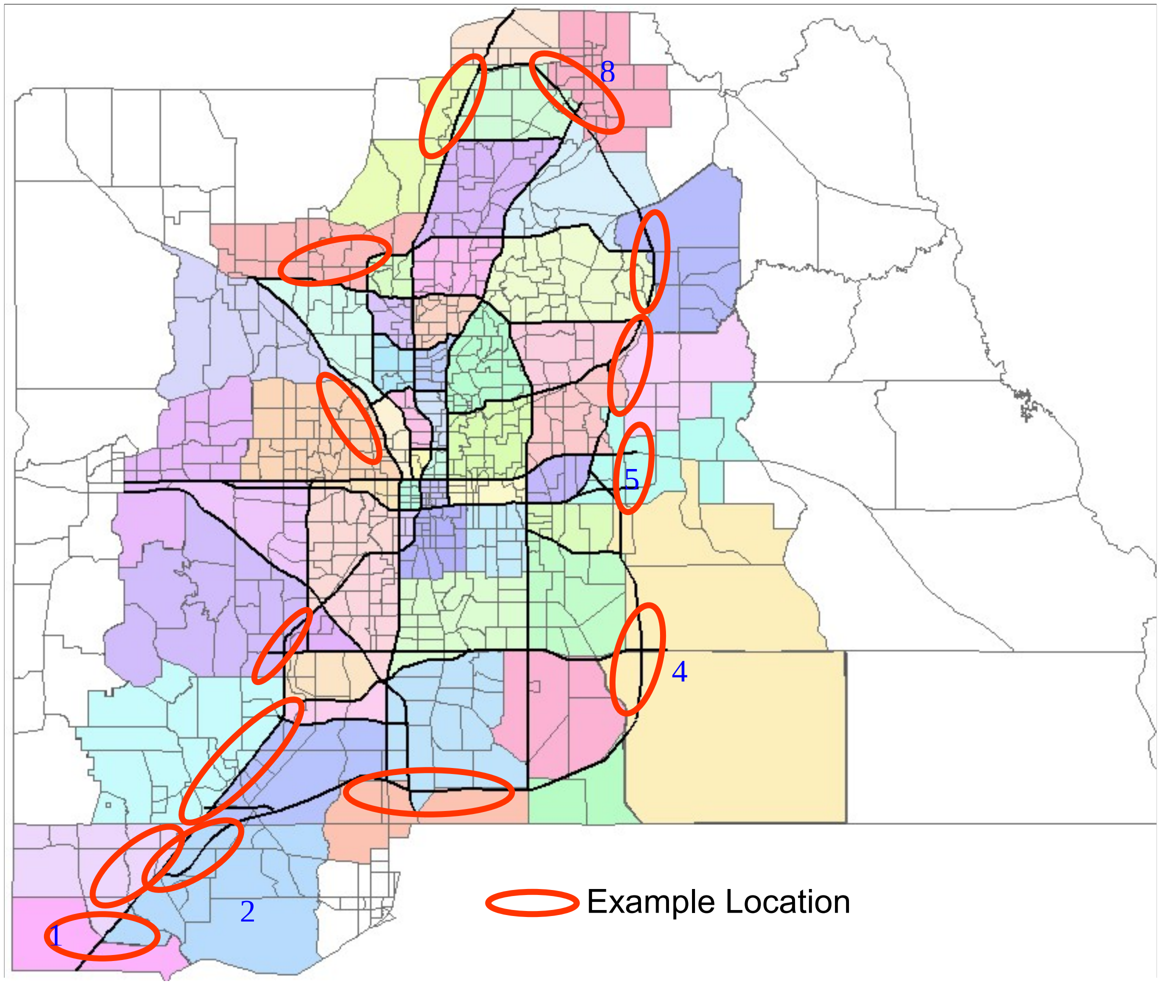


Figure 10: UCF-PARAMICS ZONE Identification, (Step 4.2.2.3)

4.2.3 Final UCF-PARAMICS Zones

TAZs with high volumes and multiple UCF-PARAMICS Network access points were re-examined for possible modifications. Adjacent high volume highways such as SR 408 were given special attention on both the east and west corridor ends and the zone area east and south of downtown (UCF-PARAMICS Zone #46). Furthermore, the UCF-PARAMICS Network boundaries were examined and given special consideration due to the high volumes entering and leaving from these N-E-S-W points (I-4/SR417 & SR 50/SR408).

The south area of Central Florida has significant interstate connections and these were examined closely to distribute the traffic on the dense interchange area in a realistic manner without creating an excess number of UCF-PARAMICS Zones here. The east side considered the East Orlando area and its contribution to the network in terms of traffic volumes and possible access from that area due to possible commuter travel from the East Coast of Central Florida which would use the UCF-PARAMICS Network daily. This was similar to the West side of Orange County and the Florida Turnpike, SR 50 (Colonial Dr.) and SR 408. The North I-4 corridor with the SR 417 interchange was also of consideration due to the commuter traffic from the Deland and Deltona area that would be contributing traffic volumes to the UCF-PARAMICS Network.

This changed the number of Zones from 55 UCF- PARAMICS Zones to 58 Zones. Figure 11 displays the final selection of zones for Step 4.2.3 and Figure 12 displays the final Zone definition for the UCF-PARAMICS Network.

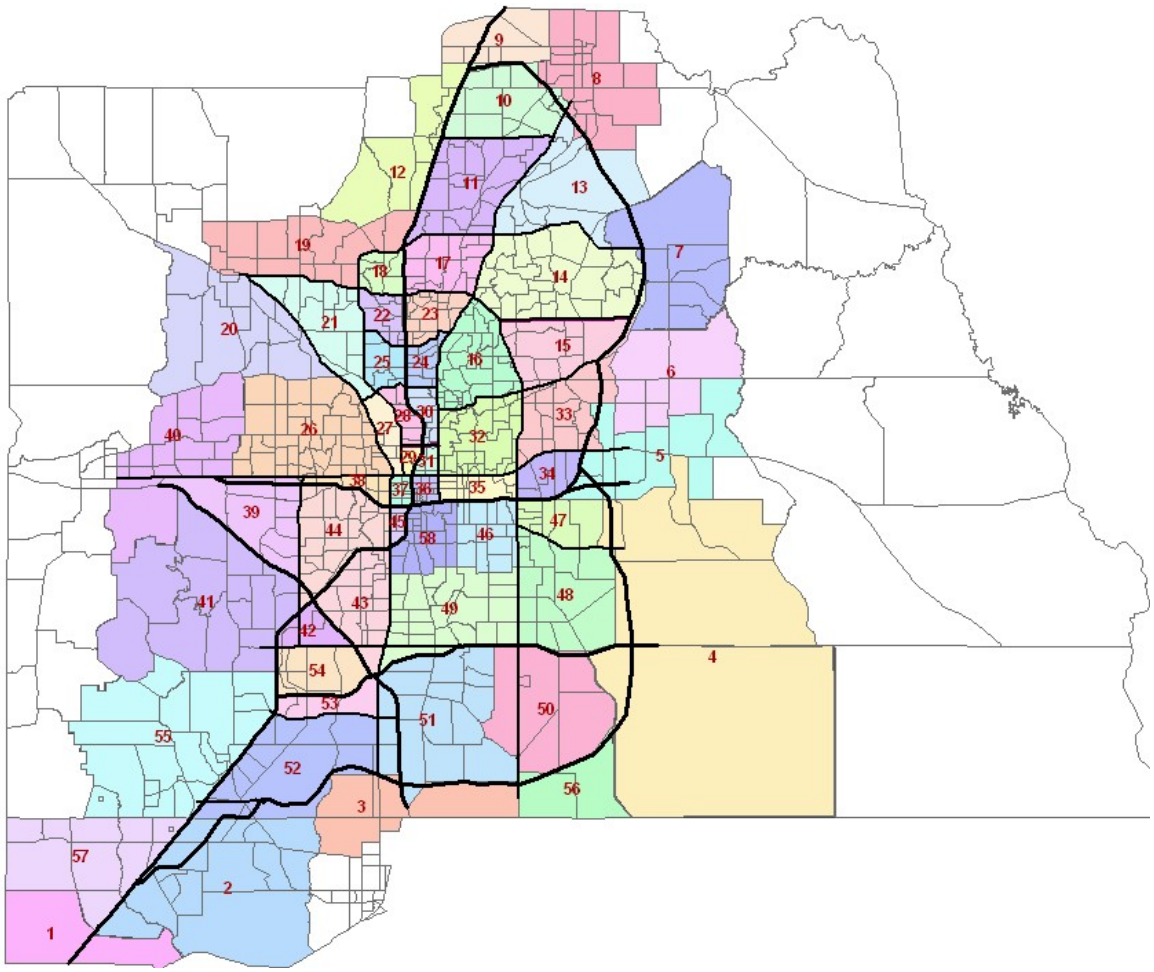


Figure 11: UCF-PARAMICS ZONE Identification, (Step 4.2.3)

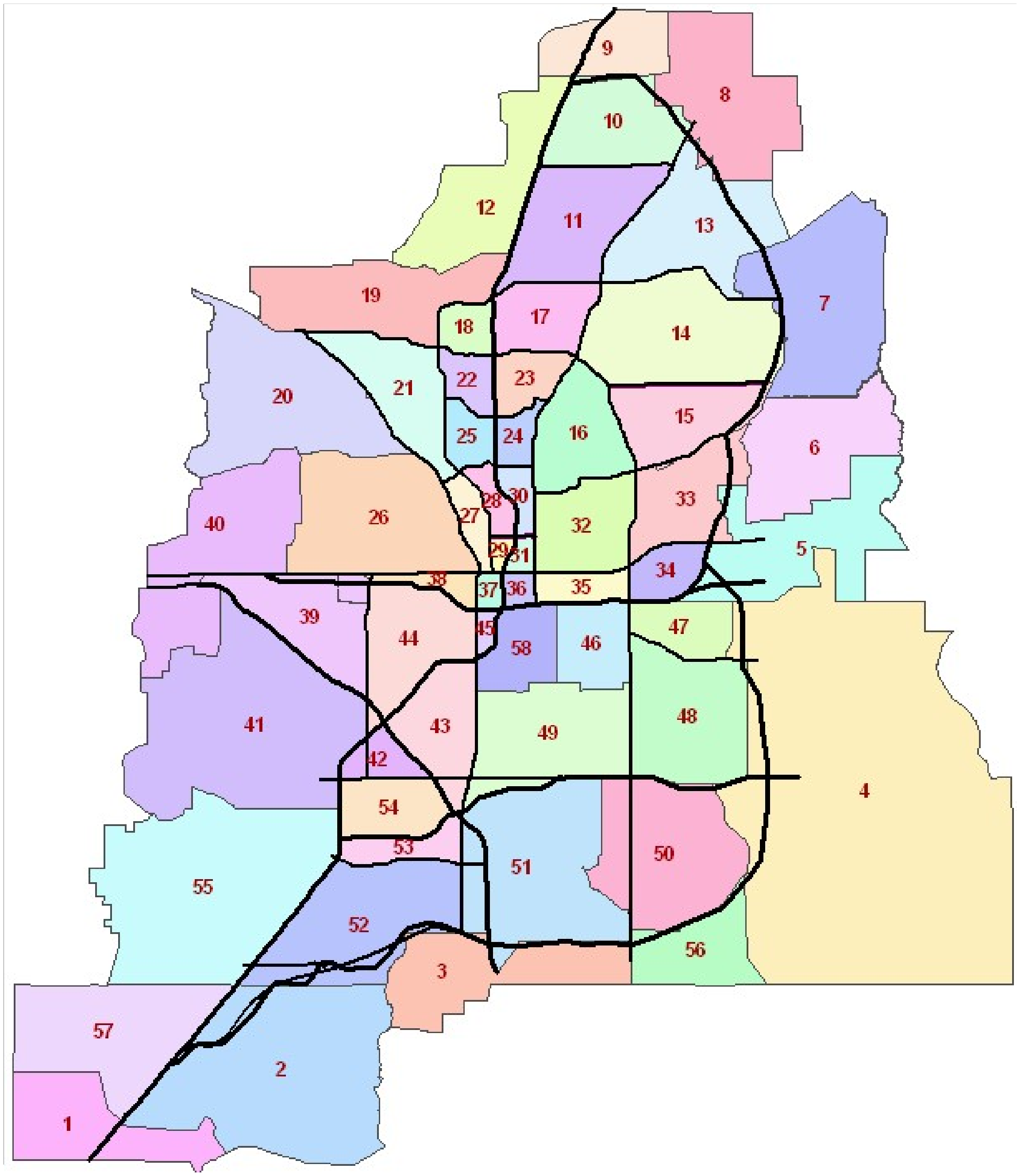


Figure 12: UCF-PARAMICS ZONE Identification, (Final)

CHAPTER 5

MODEL CALIBRATION AND VALIDATION

The UCF-PARAMICS Network was coded as defined in Chapter 4 and the zones designated in the model as well. Figure 13 displays the entire network and Figure 14 and Figure 15 show the north and south portions of the network in a zoomed view. Initially, the simulation was designed to run for 3 hours. The network was calibrated for the morning peak hour period from 7:00 to 8:00 AM. This additional simulation period (outside the peak hour) would allow the network to stabilize with the traffic volumes entering the network. It was anticipated that once preliminary adjustments were made to the OD matrix and UCF-PARAMICS zonal volumes, then this simulation approach would provide an accurate representation of the traffic patterns for the defined network.

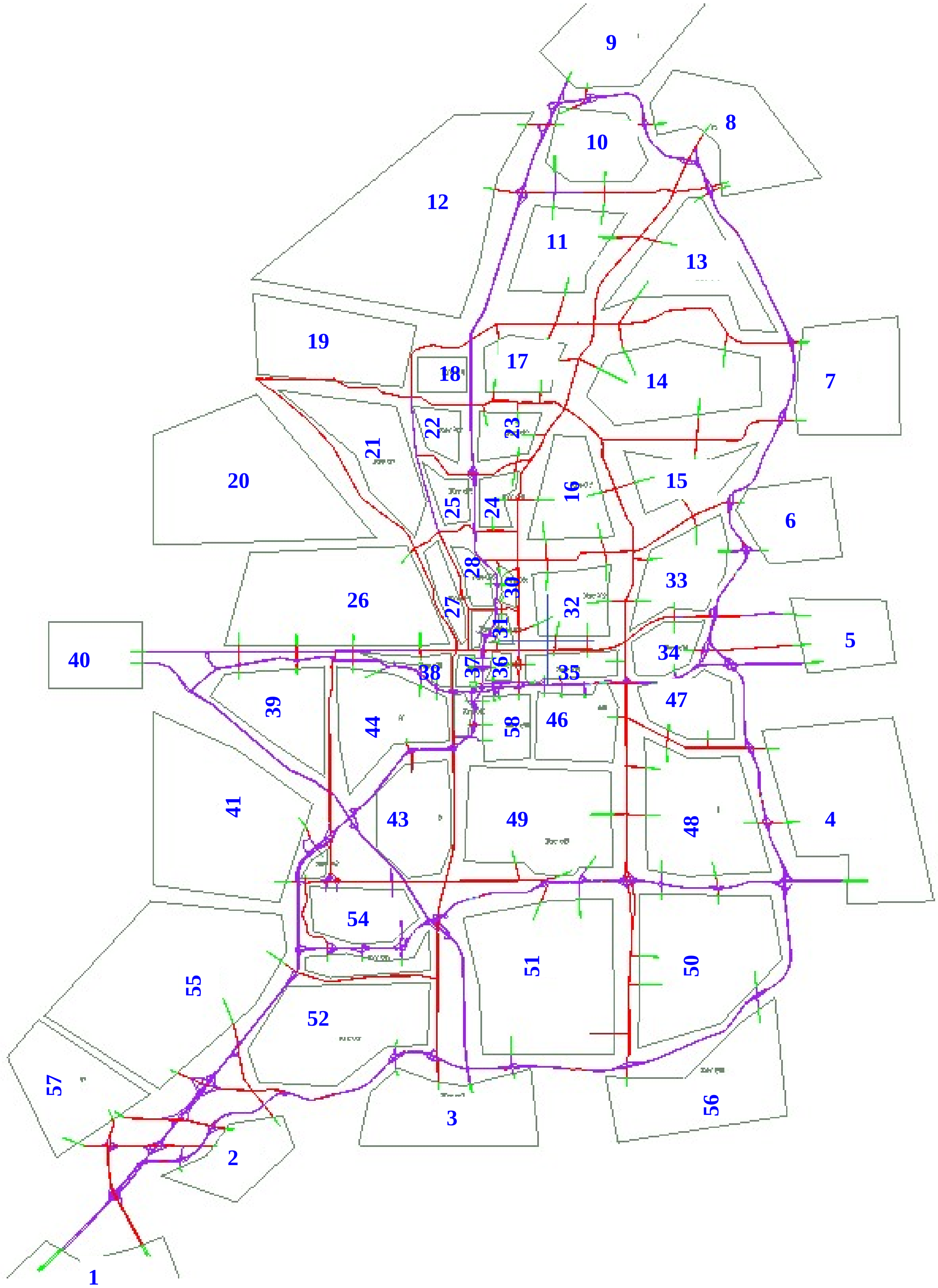


Figure 13: Coded Complete UCF-PARAMICS Network

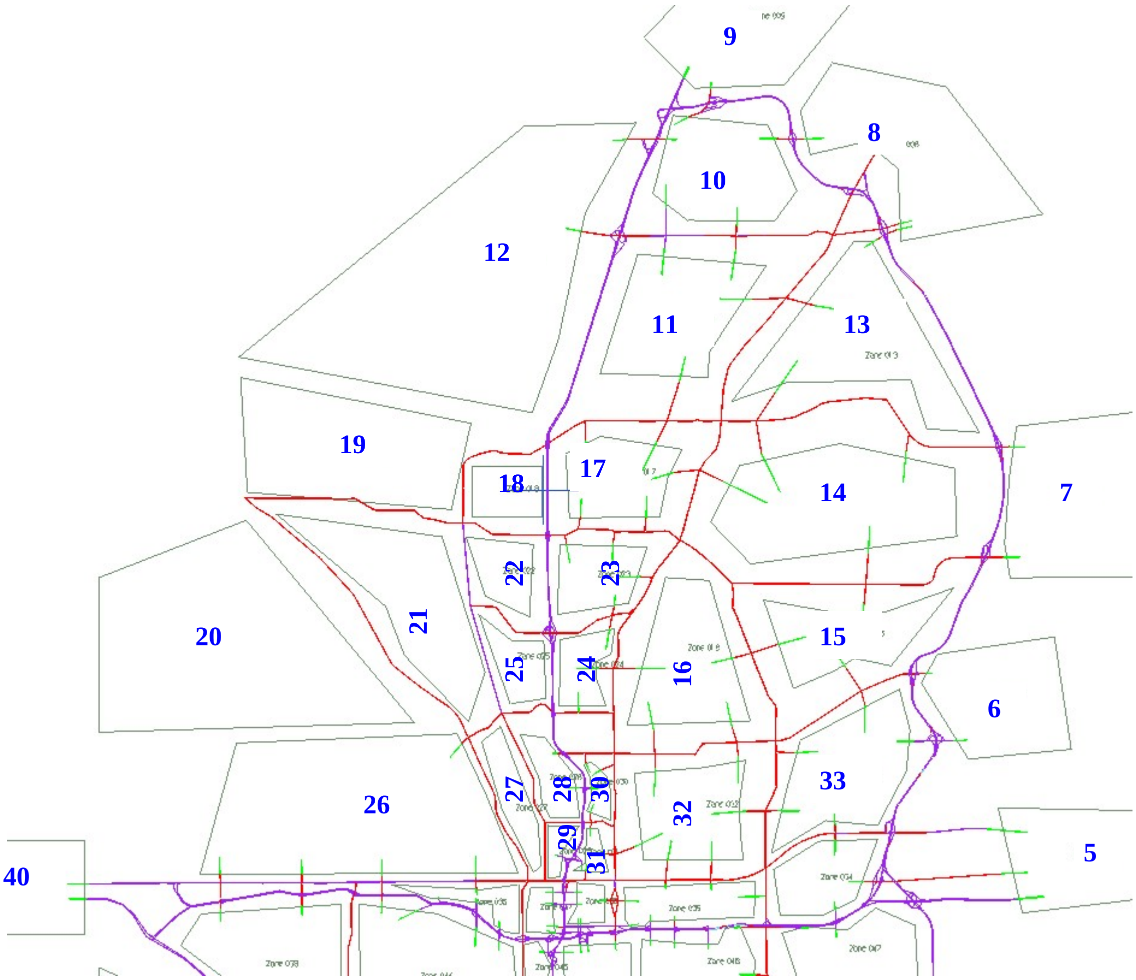


Figure 14: Coded UCF-PARAMICS Network (North of SR 50)

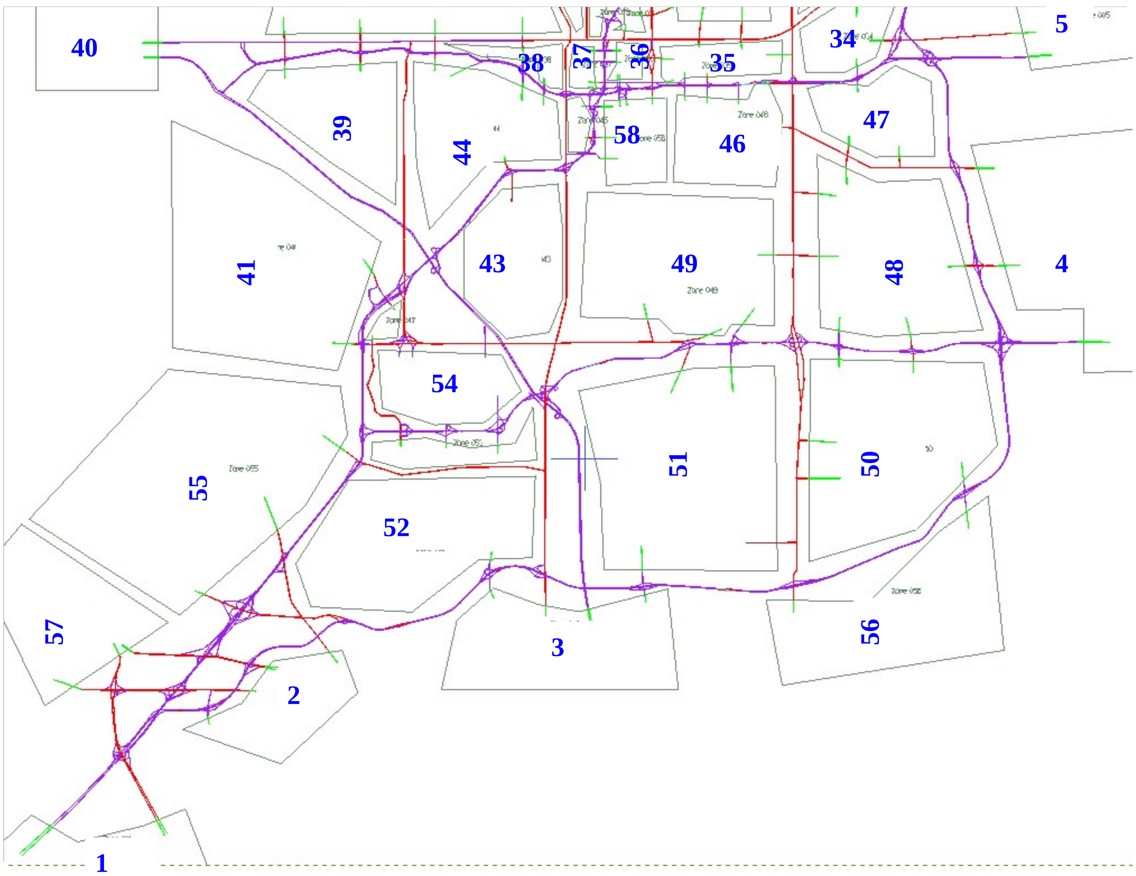


Figure 15: Coded UCF-PARAMICS Network (South of SR 50)

5.1 CALIBRATION DATA AVAILABILITY

The calibration process involved checking the UCF-PARAMICS Network model results against observed data and adjusting the parameters until the model results meet the evaluation criteria or the acceptable range of error. The locations for capturing the traffic volumes from the UCF-PARAMICS simulation were selected for the Interstate 4 and toll road corridors between interchanges to ensure that there were no effects from on or off ramp movements.

Table 2 represents an inventory of the available data by facility type that can be used in the calibration process. For the freeway volume data (Interstate 4), the field 2001-year traffic volumes were extracted from the UCF Data Warehouse project database (CFDW) in which the traffic volumes were directly downloaded from the FDOT's Regional Traffic Management Center (RTMC) through a high-speed Internet connection to UCF. However, some selected network links did not have sufficient loop detector data because the loops were considered too close to an interchange or some loops were inoperable during the selected time period. For these volumes, AADT with K and D factors applied were extracted from the 2001 and 2003 FDOT traffic data CDs.

For the toll roads (SR417, SR528, SR408, and SR91), the traffic volumes for Orange County were obtained from either the OOCEA website, or historical data from previous UCF projects (average hourly traffic volumes or plaza throughput by direction). Traffic volumes for the remaining toll road segments were provided by the Turnpike Enterprise. For the major arterials, traffic volumes were calculated from the Orange and Seminole County and FDOT 2001 and 2003 CDs AADT traffic data.

Initially, year 2001 was selected for the base of the field volumes. This decision was based on the field data provided by the Turnpike Enterprise for travel speed and distance on many of the major arterials, which was collected in year 2001.

Table 2: Summary of Network Roadways and Traffic Volumes Data Sources

Link Description	Data Sources					
	FDOT 2003 CD	FDOT 2001 CD	UCF-DW 2001	UCF-DW 2003	Turnpike Enterprise	Other
Interstate 4						
Eastbound (World Drive to Lake Mary Boulevard)	√	√	√	√	√	
Westbound (Lake Mary Boulevard to World Drive)	√	√	√	√	√	
SR-417						
Northbound (I-4 South, Southern Connector to North of International Drive)					√	
Northbound (North of International Drive to Rinehart road)	√	√				
Northbound (Rinehart Road to I4)					√	
Southbound (I-4 to Rinehart road)					√	
Southbound (Rinehart road to North of International Drive)	√	√				
Southbound (I-4 South Southern Connector to North of International Drive)					√	
SR-408						
Eastbound (SR-50 to SR-417)	√	√				
Westbound (SR-417 to SR-50)	√	√				
SR-528						
Eastbound (I-4 to SR-417)	√	√				
Westbound (SR-417 to I-4)	√	√				
Arterials						
SR-482	√	√				
US-441	√	√				
US-17/92						Seminole County
SR-436	√	√				
SR-50	√	√				

5.2 UCF-PARAMICS NETWORK CALIBRATION PROCEDURES

The procedure for calibration of the UCF-PARAMICS Network includes five major steps. These include:

1. Minimal zone selection adjustment to examine validity of shortest path
2. Visual observations
3. Adjustment of PARAMICS parameters
4. Modeling impedance factors on arterials
5. Comparisons to field data

The following calibration efforts were executed to calibrate the simulated network.

5.2.1 Preliminarily Calibration

The simulation period initially selected was 3 hours (6:00 AM to 9:00 AM). The network was calibrated for the morning peak 7-8 AM, a one-hour period. This was selected based on highest field traffic volumes for one hour from each of the 3 hours in the morning for I-4 and toll roads.

The preliminary OD matrix included all traffic volumes for the Central Florida area even though it was known that the limited defined UCF-PARAMICS network would not be able to accommodate all the traffic. As expected, the network performed poorly. It was found that due to the high volume of vehicles accessing the network, the network was significantly congested after the first hour of simulation. This was determined from observations of the animation, high number of “blocked” vehicles at some UCF-PARAMICS zones, and extremely low hourly volumes on Interstate 4. Blocked vehicles are those vehicles released in to the zones for loading on to the network but not able to access the network from the zones. This indicated that the ODs traffic volumes were too high for the network to accommodate and these volumes could not enter the network. Accordingly, significant adjustments and changes were made in the process of calibrating the UCF-PARAMICS network such as network geometry, demand matrix (O-D), PARAMICS parameters (i.e. driver behavior and the mean headway and reaction time…etc.) and the overall simulation configuration.

5.2.1.1 Simulation Duration Adjustment

From the initial simulation observations, the decision was made to specify the release of vehicles onto the network from the OD matrix for a defined set of time intervals to overcome the blocking problem. The distribution for the release of vehicles during the simulation for each time interval is a percentage of the total OD matrix volumes. The distribution for the initial simulation period (from 6:00 to 9:00 AM) for three 1-hour intervals was set at 25%-45%-30%.

To continue calibration and improve the network performance, adjustments to the simulation period were tested. The impact a different distribution may have on the network performance and length of the simulation period were tested independently and combined. Simulation periods between 1.5 and 3.5 hours were tested with 30 minutes increment period. Also, the distribution by decreasing the release (traffic volume) in the peak hour (7-8 AM) by 0.05 intervals and adding it to the warm up or dispersion periods was tested. These distributions were also applied to the tested simulation periods. It was concluded from the experimentation that a shorter simulation period of 2.0 hour simulation including the 7-8 AM hour with a 30-minute warm up and 30-minute dispersion period was good using the 5%-

10%-15%-20%-20%-15%-10%-5% distribution for release every 15 minutes. The OD matrix was adjusted to be compatible with the selected simulation period (volumes reduced to reflect the shorter simulation period).

5.2.1.2 Network Adjustment

From the initial simulation results, the decision was made to remove all adjacent volumes from the OD matrix due to the configuration of the UCF-PARAMICS network that had a limited number of arterials. Adjacent volumes were considered to be any vehicular movement (OD pair) originating from one zone that did not pass by another zone to reach the destination zone. These volumes represent the very short trips, and it was expected that these volumes were responsible for blocking the vehicles from the zones. Also, the UCF-PARAMICS network being a limited network with only a limited number of major arterials represented, it made sense to remove the volumes that were not expected to use the represented arterials. This was any one horizontal (i.e. Zone 49 to 48) or vertical movement (i.e. Zone 32 to 16) as shown in Figure 13. This reduced the OD matrix significantly and the network was expected to perform better from this revision.

The network performed better, but was still highly congested. Adjustments were made to the traffic signalization to reassign green times from the previous directions that were no longer required for some adjacent volume movements to the other directions. Each intersection had to be evaluated and adjusted independently. Most of the network signals were unique to the intersection based on lane configuration and vehicle movements on the network. Figure 16 and Figure 17 illustrate an example of the UCF-Network affected traffic signal before and after adjustment.

Furthermore, visualization and comparison of traffic volumes also pointed out that some vehicles were using the network for unusually long times. This was because the network geometry prevented the vehicles movement in certain directions. The alternate movements resulted in oversaturated signals in intersections and increased delays. This led to increase in congestion for vehicles stuck on the ramps and mainlines. In real life, vehicles would usually get onto the closest signal to change their direction. Since all arterials are not included, the simulated vehicles have restricted choice. To overcome this problem, the geometry, and signalization in the network at appropriate locations had been adjusted to allow these movements.

After all these adjustments, the iterative calibration process by comparing field volumes to simulation output began and more adjustment took place as described below.

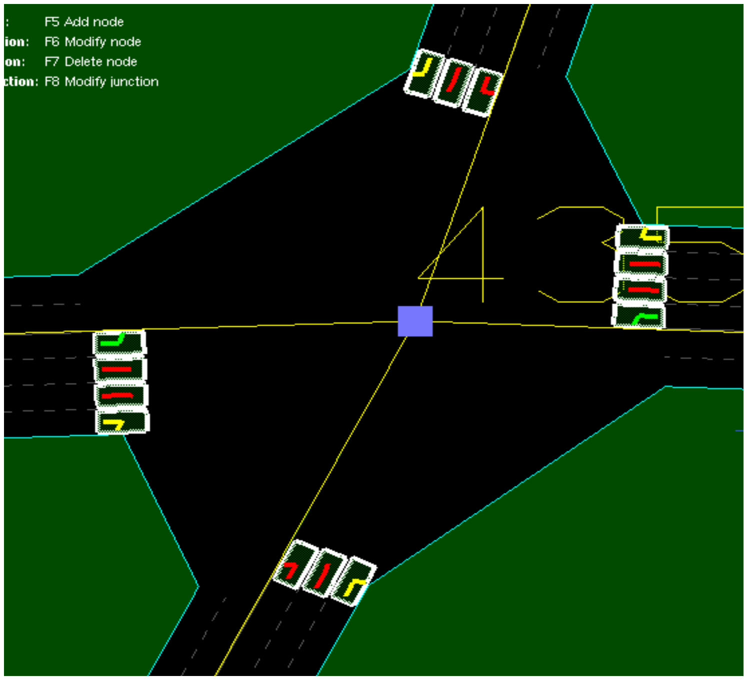


Figure 16: Snapshot of UCF PARAMICS Network Intersection Before Adjustment of Affected Traffic Signal

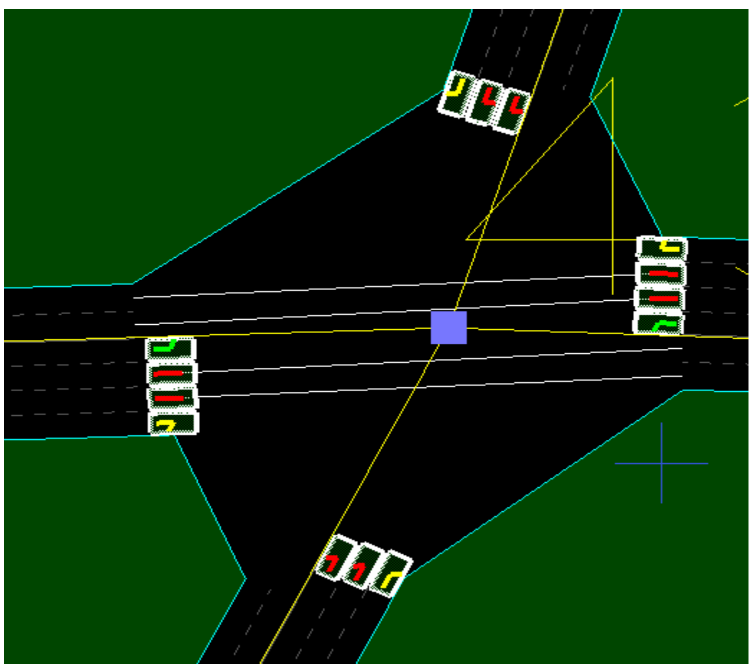


Figure 17: Snapshot of UCF PARAMICS Network Intersection After Adjustment of Affected Traffic Signal

5.2.1.3 Data Adjustment

Data from the UCF Data Warehouse database was initially intended to be used for calibration of the I-4 corridor. However, there were a limited number of isolated I-4 mainline segment (check locations) traffic count values available. An isolated segment was one confirmed not to have an influence from any on or off ramp on the mainline hourly volume. Also, more check locations were needed to examine the entire network and the consistency in the data source was crucial in the accomplishment of the network calibration process. Since, The UCF Data Warehouse database (CFDW) has only data for I-4, year 2001 was selected for the base of the field volumes because it covered the entire network roadways. This decision was made to be consistent with the field data provided by the Turnpike Enterprise for many of the major arterials which was collected in year 2001.

The UCF-PARAMICS Network still performed poorly during the initial calibration. As adjustments were made to calibrate the OD matrix, the performance of the network did not improve as expected. Both the animation and flow rates indicated that the network was overloaded with vehicles. During the peak period, most of the network roads were highly congested and the flows were significantly lower than the FDOT CD (year 2001) calibration data. A snapshot of the network congestion is shown in Figure 18 and a sample of the initial calibration results are provided in both Table 3 and Table 4. The yellow highlights in Figure 18 indicated the extensive queuing on the network during simulation.

To address this problem, the warm-up period was modified to provide more time for the vehicles to enter the network prior to the peak hour, but this also was not effective for improving the calibration error percentages. The field calibration data (FDOT CD) was questioned for validity. Three sources of data and five data sets were evaluated and compared. These are listed below.

- UCF Data Warehouse
    - Year 2001
    - Year 2003
- FDOT CD (AADT)
    - Year 2001
    - Year 2003
- Turnpike Enterprise
    - Year 2001

The data comparison demonstrated that the data from FDOT CD Year 2001 was consistently higher than the UCF Data Warehouse Year 2001 data on Interstate 4 for comparable locations. The same conclusion was obtained for the FDOT_CD of Year 2003 compared to the UCF data warehouse counts. It was found that the FDOT CD data was consistently higher than the UCF Data Warehouse data. The Turnpike Enterprise data was also consistently higher than the UCF Data Warehouse. This examination led to the resolution that the field data being used for calibration was excessive for the current network being modeled. This was attributed to the calculated FDOT volumes being more appropriate for roadways' design. Though the UCF Data Warehouse volumes would be more desirable for calibration of the Interstate 4 corridor, there were a very limited number of check locations traffic counts available. Therefore, a decision was made to use the FDOT CD (2003) most recent data, which was comprehensive in terms of covering all desired links (I-4, toll roads, and major arterials).

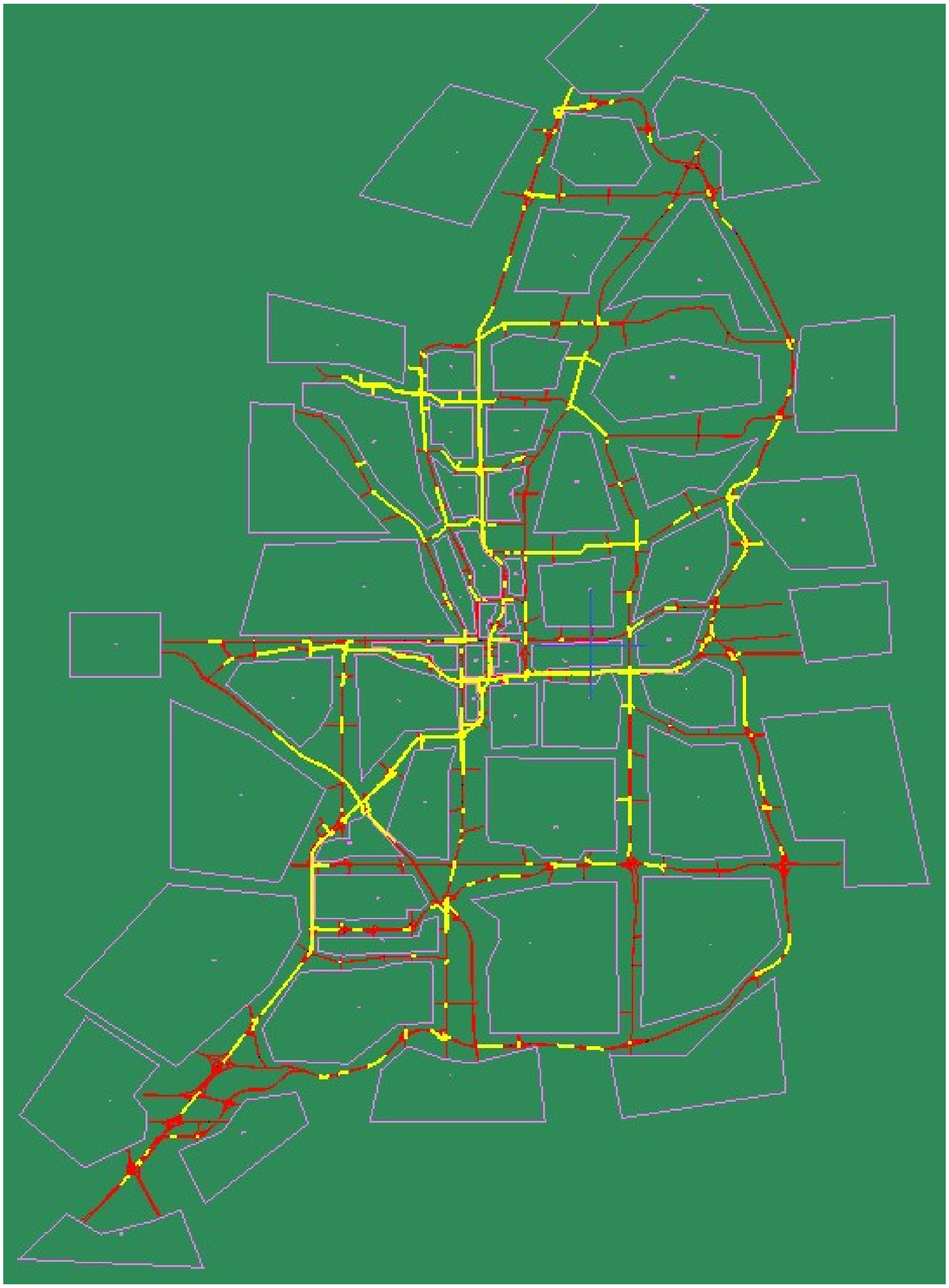


Figure 18: Snapshot of UCF PARAMICS Network During Simulation of the Morning Peak Hour

Table 3: Initial Calibration Results for I-4 Corridor (Eastbound)

Interstate 4 (Eastbound)

Node A	Node B	Description	FDOT_CD	PARAMICS	Error %
1484	1478	World Drive to SR417	2631	2181	17.10%
3	4	Central Florida Greenway to US-192	2955	2233	24.43%
1247	10	US-192 to Osceola Parkway	4130	3311	19.83%
4626	19	Osceola Parkway to SR-535	5528	3372	39.00%
4625	25	SR-535 to Central Florida Parkway	4460	4221	5.36%
34	35	Central Florida Parkway to Beeline EXPW	5952	3775	36.58%
52	37	Beeline Expressway to Sand lake road	6220	3761	39.53%
44	45	Sand lake road to Universal Drive	5356	4062	24.16%
54	55	Universal Drive to Kirkman Road	4573	2629	42.51%
60	63	Kirkman Road to Florida Turnpike	4750	3378	28.88%
73	77	Florida Turnpike to John young Parkway	4750	1849	61.07%
82	4570	John Young Parkway to Orange Blossom	5775	1982	65.68%
1288	87	Orange Blossom Trail to Michigan Street	7004	2002	71.42%
1302	1286	Michigan Street to Kaley Avenue	6741	2680	60.24%
92	93	Kaley Avenue to East West Expressway	7273	3414	53.06%
101	110	East West Expressway to Anderson Street	6988	3647	47.81%
102	103	Anderson Street to Robinson St (SR-408)	6760	3631	46.29%
240	235	South St(SR-408) to Amelia	6875	3951	42.53%
236	242	Amelia to Colonial Drive	6090	3056	49.82%
243	244	Colonial to Ivanhoe Blvd	5440	3467	36.27%
249	254	Ivanhoe Blvd to Princeton Street	6307	3227	48.83%
264	265	Princeton Street to Par Avenue	7601	3287	56.76%
267	271	Par Avenue to Fairbanks Avenue	6504	3052	53.08%
276	279	Fairbanks Avenue to Lee Road	6544	3544	45.84%
284	291	Lee Road to Maitland Blvd	5637	3620	35.78%
303	306	Maitland Blvd to SR-436	4060	3039	25.15%
310	318	SR-436 to SR-434	4967	2420	51.28%
329	334	SR-434 to Lake Mary Blvd	4854	2159	55.52%
344	350	Lake Mary Blvd to SR417	3745	1995	46.73%
Overall Average			5533	3607	42.43%

Table 4: Initial Calibration Results for I-4 Corridor (Westbound)

Interstate 4 (Westbound)

Node A	Node B	Description	FDOT_CD	PARAMICS	Error
367	372	SR417 to Lake Mary Blvd	3930	2380	39.44%
375	342	Lake Mary Blvd to SR-434	5094	3836	24.70%
318	310	SR-434 to SR-436	5213	3564	31.63%
308	307	SR-436 to Maitland Blvd	4621	3429	25.80%
291	284	Maitland Blvd to Lee Road	5917	4077	31.10%
280	279	Lee Road to Fairbanks Avenue	6868	3750	45.40%
272	271	Fairbanks Ave to Par Avenue	6827	2913	57.33%
265	264	Par Avenue to Princeton Street	7633	2928	61.64%
988	991	Princeton Street to Ivanhoe Blvd	6620	3036	54.14%
1011	1013	Ivanhoe Blvd to Colonial Drive	5710	1722	69.84%
1014	1019	Colonial Drive to Amelia	6392	2841	55.55%
103	102	East West Expressway to Anderson Street	7096	2936	58.62%
110	101	Anderson Street to East West Expressway	7423	1823	75.44%
93	92	East West Expressway to Kaley Avenue	7634	3843	49.66%
1286	1302	Kaley Avenue to Michigan Street	7075	3481	50.80%
87	1288	Michigan Street to Orange Blossom Trail	7375	3039	58.79%
83	4570	Orange Blossom Trail to John Young PKWY	6061	3695	39.04%
134	136	John Young Parkway to Conroy Road	4985	3408	31.63%
141	142	Conroy Road to Florida Turnpike	5242	3916	25.30%
148	152	Florida Turnpike to Kirkman Road	5722	3434	39.99%
158	160	Kirkman Road to Universal Drive	5016	2681	46.55%
170	173	Sand Lake Road to Beeline Expressway	7065	2993	57.64%
185	186	Beeline Expressway to Central Florida PKWY	6248	3462	44.59%
186	189	Central Florida Parkway to SR-535	4892	3716	24.04%
4595	195	SR-535 to Osceola Parkway	5098	2203	56.79%
207	208	Osceola Parkway to US-192	4736	2201	53.53%
1243	215	US-192 to World Drive	2836	1576	44.43%
Overall Average			5901	3070	46.42%

Since the peak hour volumes using the FDOT CD were calculated using the K and D factors from the 30^{th} highest hour, which is more appropriate for freeway design, a correction factor related to freeway design, was considered. The 85^{th} percent for freeway design values are typically utilized in application of the design such as for a posted speed limit (design speed = 65 mph, posted speed limit = 55 mph). This correction factor was applied to the peak hour volumes calculated from the FDOT CD Year 2003 and compared to the I-4 corridor links from the UCF Data Warehouse data. The data comparison is provided in Table 5. A paired T-test was performed on the data to test if there was a statistically significant difference between the data sets. It was found at the 95% confidence level that there was no significant difference between the two data sets for each direction. The P-value for the EB test was 0.78 and for the WB test was 0.46. This led to a reduction in the error percentages and improvement of the performance of the model.

Table 5: Calibration Data (Data Warehouse and 85th % FDOT CD)

UCF Data Warehouse	85% FDOT CD	I-4 Station #	Location
Interstate 4 (Eastbound)			
4006	4222	59	Semoran Blvd. (SR 436)
4667	4791	50	Lee Rd. (SR 423)
5139	5528	45	Par Ave.
5264	5361	42	Ivanhoe Rd.
5708	4909	31	John Young Pkwy
4113	4037	28	Conroy Rd.
3439	3791	12	E. SR 535
3291	3950	7	E. SR 536
3214	3510	6	Osceola Pkwy
2004	2102	2	World Drive
Interstate 4 (Westbound)			
4832	3623	54	Maitland Blvd. (SR 414)
5093	5029	50	Lee Rd. (SR 423)
5184	5838	47	Fairbanks Ave. (SR 426)
5647	5803	45	Par Ave.
5168	5627	43	Princeton St.
5021	4854	42	Ivanhoe Rd.
4797	5153	31	John Young Pkwy
4191	4238	28	Conroy Rd.
4464	4456	26	Florida Turnpike
3460	4264	22	Universal Blvd/International Dr
4147	5311	15	SR 528 (Bee Line EXPW)
4285	4159	12	E. SR 535
3231	4334	8	E. SR 536 (Epcot)

The adjusted FDOT CD Year 2003 data was then compared to the PARAMICS output. A relational database was constructed to cross reference UCF-PARAMICS network nodes with associated field and model output. The database had a number of input forms designed to make the management of data more efficient and make it easy to enter and edit the data. The database also had relationships that allow a cross-reference between selected roads, direction, field volumes, and model output data sets. Figure 19 is a snapshot of the database in use including the switchboard windows for the database that control the execution of important database actions.

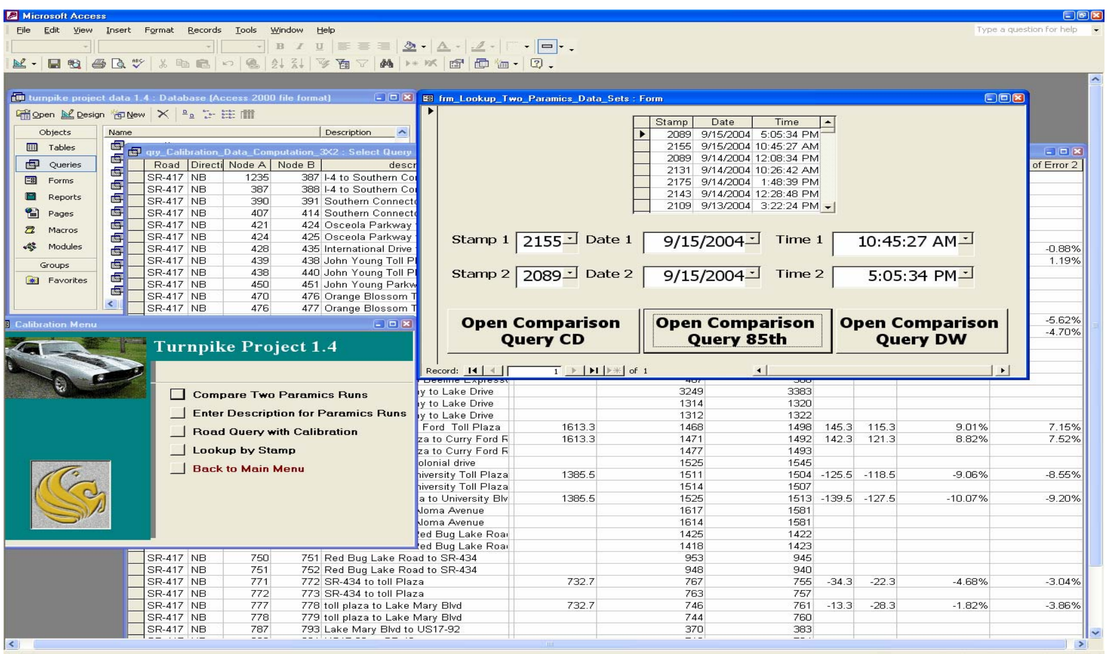


Figure 19: Selected Turnpike Project Database Windows

5.3 FINAL CALIBRATION AND VALIDATION

An incremental approach was used for calibration of the new simulation time period and reduced OD matrix to minimize the misfit between observed data from the adjusted FDOT CD (Year 2003) traffic volumes and the UCF-PARAMICS Network simulation results by fine-tuning the PARAMICS parameter values. This quantitative analysis was carried out in parallel with the visualization analysis through PARAMICS ANALYZER. When the comparison between the simulation and observed (field) data was not within an acceptable threshold, then some changes with selected PARAMICS model input parameter values were adjusted because the default values were calibrated against the United Kingdom (UK) traffic conditions.

PARAMICS has about ten main sensitive parameters that can be used in calibration. In some cases, these variables affect the entire network while others are specific to individual roadway segments or nodes (Quadstone Ltd., 2003). These parameters are summarized below:

- Mean Headway: the time between the leading edges of successive vehicles.
- Mean Reaction Time: the time taken to apply the brakes.
- Perturbation: a factor used to randomize the route cost perception to affect stochastic route choice.
- Dynamic Feedback: a loop mechanism used to update travel time costs in order to influence route choice.
- Familiarity: percentage of drivers that are familiar with the network.
- Simulation time step details: used to determine when calculations are carried out.
- Aggressiveness & awareness: distribution that affects the behavior of drivers.

- Sign posting: locations at which vehicles are aware of obstacles (hazards) ahead.
- Curve speed factor: amount of speed to which vehicles slow down due to curvatures.
- Seed value: a starting value for the random number generator.

In PARAMICS, the default parameter values are: mean headway = 1.0 sec, mean reaction time = 1.0 sec, perturbation = 5%, feedback = 5 minutes, and familiarity = 85%, time step = 2, driver's aggressiveness and awareness have normal distributions, sign posting = 2461.3 ft, and curve speed factor = 1. Several simulation runs were conducted in order to identify critical variables that may significantly influence the performance of the UCF-PARAMICS Network. In this procedure, the above parameters were examined one-by-one and the numerical outputs from the simulation runs were compared to the corresponding real data to achieve the 15% error accuracy goal.

Another issue in calibration was the interaction between errors of various runs. Since each simulation run improved errors in some links and adversely affected errors in other links, a way of checking the global performance of the run was required. Moreover, checking either the absolute error value (Field volume – Simulated volume) or the percentage error value ((Field volume – Simulated volume) / Field volume) could be misleading. For example, an error in volume of 300 vph results in a 30% error for a field volume of 1000 vph. On the other hand, 300 vph is 10% if the field volume is 3000 vph. Similarly, 20% of error has a significant meaning for different field volumes (20% of 1000 vph is 200 vph, 20% of 3000 vph is 600 vph).

A literature review presents another measure in calibration and validation of traffic simulation models. This measure is known as the GEH statistic, used by British engineers (Chu et al., 2004, UK Design Manual, 1996). GEH statistic is computed as

$$\text{GEH}(n) = \sqrt{\frac{\left(V(n)_{field} - V(n)_{simulated}\right)^2}{\left(\frac{V(n)_{field} + V(n)_{simulated}}{2}\right)}}$$

Where the subscript *'field'* denotes the field measurement, subscript *'simulated'* denotes measurement from simulation, *n* denotes the index of location of measurement (checkpoint). In our case, the measurement was Volumes (V). The criterion for acceptance was that the GEH statistic should be less than 10% for at least 85 % of the measurement locations (checkpoints). With the GEH statistic, the problem of scaling the volumes was minimized.

5.3.1 PARAMICS Parameters Adjustment

The travel cost on the links represents a combination of factors that drivers take into account when choosing routes. The most important of these factors are time, distance and tolls. Congestion will be priced according to the average cost per hour of 15 $/hr as used by Abou-Senna (2003). Based on the 2001 Texas Transportation Institute (TTI) congestion report, TTI has found that as average vehicle travel on freeways and arterial routes increases above congested levels, average speeds decrease, in proportion to the level of increased traffic. By comparing average vehicles speeds on congested routes to average speeds on non-congested routes, TTI estimated that the additional time spent in driving due to congestion for urban routes is $12/hr. This means that each 5 minutes delay costs one dollar. To be more conservative, toll price coefficient assumed 4 minutes delay to cost one dollar, which corresponds to $15/hr. The assignment method variable is the stochastic-dynamic feedback assignment with one-hour increment. The assignment model predicts the routes drivers will choose between an origin and a destination. The route chosen by the drivers would be the route with the least travel cost, considering the travel time as well as the toll cost. Dynamic Feedback Assignment (DFB) assumes that drivers who are familiar with the road will re-route if information is provided to them.

In addition, different seed values (such as 5, 111, 1234, 172 and 1111) were chosen randomly and were tested. It was found that seed value number 5 best fitted the observed field data. Also, based on the fact that high-density flows often require more time steps per second to operate in a free manner, time step 4 was used and it affected significantly the results in most of the check locations.

Furthermore, the mean headway and the mean reaction time, which control the vehicle following, gap acceptance and lane-changing models were tested. For the UCF-PARAMICS network, several combinations between Headway and Reaction times were conducted and the best results were obtained using 0.8 seconds values for both parameters respectively. It should be noted that the output average speeds and traffic flows are highly sensitive to these two parameters values.

With respect to the driver behavior, two parameters (aggressiveness and awareness) were examined due to their significant influence on the drivers choosing lanes. The two distributions levels across the population of drivers on the simulation network vary from 0 (no aggression or awareness) to 8 (high aggression and awareness). Various runs with different combinations of distributions were conducted until the outputs of lane usage were improved further. The selected distribution results are shown below in the final calibrated model.

Final calibrated model parameters are as follows:

- Mean Headway = 0.8 sec
- Mean Reaction Time = 0.8 sec
- Awareness = 1 2 3 4 80 4 3 2 1 (normal distribution)
- Aggressiveness = 1 2 3 4 80 4 3 2 1 (normal distribution)
- Perturbation = 5.0% (default)
- Curve speed Factor = 1.0 (default)
- Signposting = 2461.3 feet (default)
- Time step = 4
- Seed value = 5
- Familiarity of the road = 85% (default)
- Generalized cost coefficients = time (1.0), distance (0.0) and tolls (4.0)
- Simulation time = 2:00:00 where the first 30 minutes is a warm up period
- Dynamic Feedback = 1:00:00 period

Two consecutive snapshots of the network congestion are shown in Figure 20 and Figure 21 and close up consecutive snapshots of the current UCF-PARAMICS Network at I-4 and SR-408 interchange is shown in Figure 22. The yellow highlights in the snapshot indicate the extensive queuing on the network during simulation.

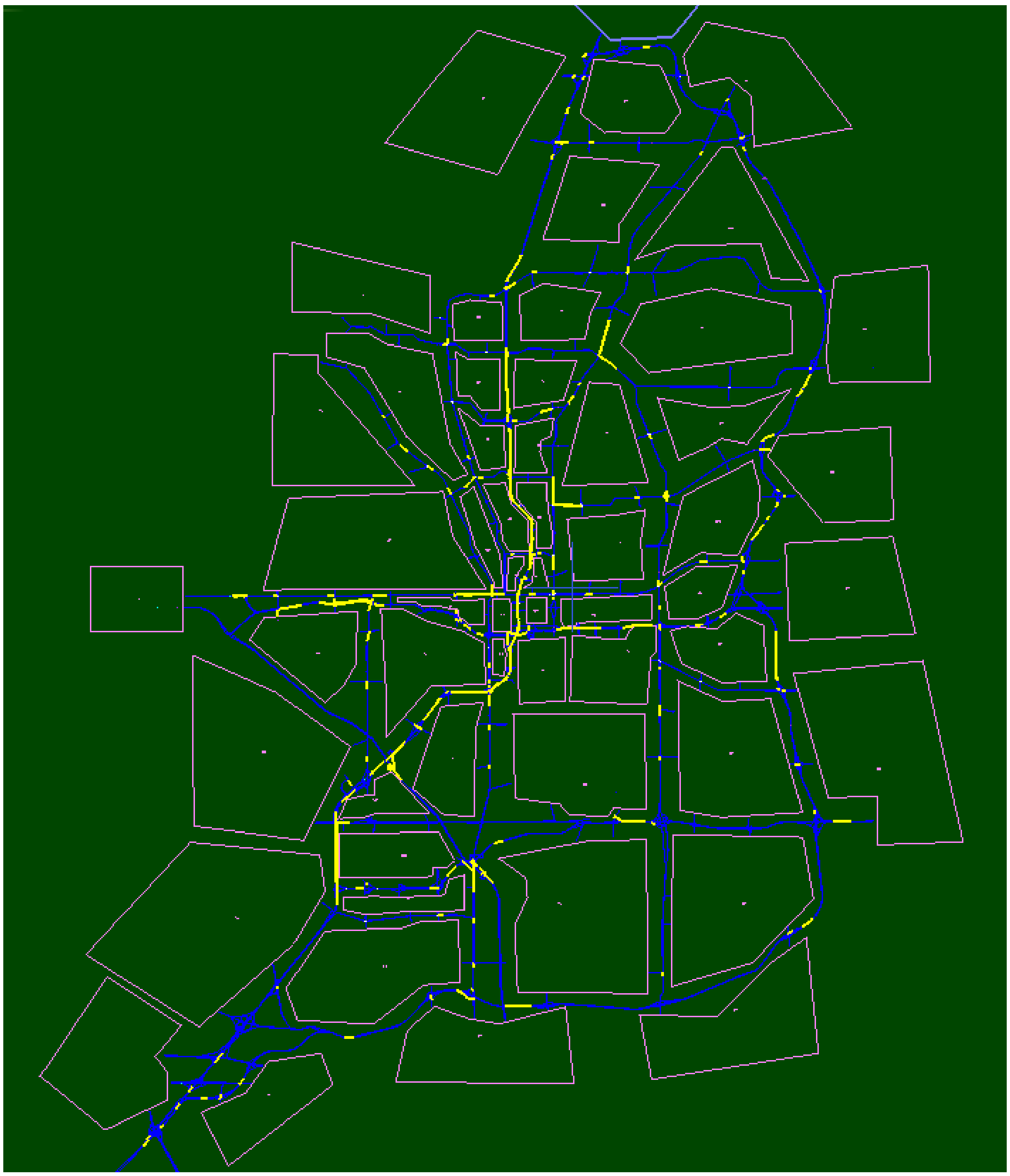


Figure 20: Snapshot of UCF PARAMICS Network of the Peak Hour (7:45 am)

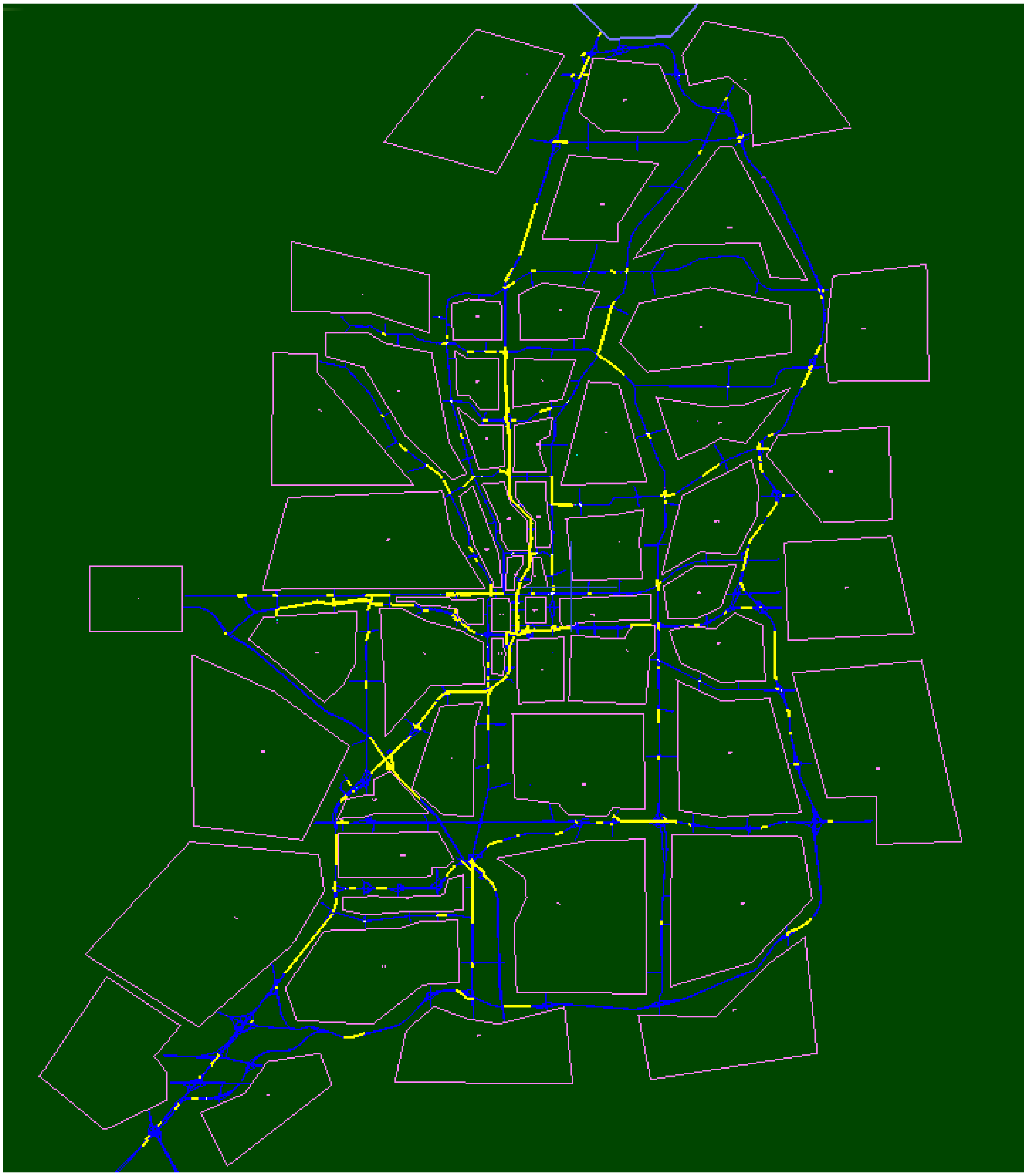


Figure 21: Snapshot of UCF PARAMICS Network of the Peak Hour (8:00 am)

Figure 22: Consecutive Snapshots of UCF-PARAMICS Network of the Morning Peak Hour (I-4/Sr 408 Interchange)

The UCF-PARAMICS Network performance calibration results are provided in Table 6 and Table 7 and Figure 23. Table 6 and Table 7 provide the GEH statistic and the error percentages at various locations (checkpoints) on SR528, SR417, SR408, and Interstate 4. Table 6 and Table 7 prove that the calibrations have achieved an error less than 15% at 90% of the checkpoints (45 out of 50), and a GEH statistic less than 10 for 90% of the checkpoints (45 out of 50). Errors that exceed these thresholds are shown in purple color. The two statistical evaluation criteria are computed as follow:

$$\text{Error } (n)\ \% = \frac{\left(V(n)_{field} - V(n)_{simulated}\right)}{V(n)_{field}} \quad \text{and} \quad \text{GEH } (n) = \sqrt{\frac{\left(V(n)_{field} - V(n)_{simulated}\right)^2}{\left(\frac{V(n)_{field} + V(n)_{simulated}}{2}\right)}}$$

Where the subscript *'field'* denotes the field measurement, subscript *'simulated'* denotes measurement from simulation, *n* denotes the index of location of measurement (checkpoint). In the present case, the measurement is Volumes (vehicle per hour).

In addition, Figure 23 shows a graphical representation for speed comparing the observed and simulated speed on the eastbound and westbound of Interstate 4. This visual inspection showed no significant differences between the simulated and the actual travel speeds on I-4. Also, a paired T-test was performed and it was found at the 95% confidence level that there was no significant difference between the two speed data sets for each direction. The P-value for the EB test was 0.905 and for the WB test was 0.114.

The calibration results for volumes and speeds for major arterials are shown in the tables and figures in Appendix A. The Turnpike enterprise had provided the UCF research team with field speed data for major arterials. With respect to volumes, because of absence of field volume data and due to limited nature of the UCF-PARAMICS network, the data could not be calibrated to the same level as the freeways and toll roads. With respect to the speed data, the performance of the network is reasonable.

It can be concluded after conducting this analysis that the UCF-PARAMICS network model replicated the existing conditions. As a result, this model was used to simulate and evaluate toll reduction scenarios.

Table 6: Final Calibration Results for UCF-PARAMICS Network (Toll Roads)

SR528

Direction	Description	Volume	Paramics	% Error	GEH
WB	Semoran Blvd to Airport Toll Plaza	2239	2274	-1.57%	0.7
WB	Sand Lake Road to Beeline West Main Toll plaza	1116	1151	-3.14%	1.0
EB	Orange Blossom Trail to Beeline West Main Toll plaza	737	746	-1.25%	0.3
EB	Conway Road to Airport Toll Plaza	1034	1034	0.04%	0.0

SR417

Direction	Description	Volume	Paramics	% Error	GEH
NB	I-4 to Celebration Toll Plaza	320	300	6.00%	1.1
NB	International Drive to John Young Parkway Toll Plaza	387	414	-7.07%	1.4
NB	Landstar Blvd to Boggy Creek Toll Plaza	648	641	1.01%	0.3
NB	Lake Drive to Curry Ford Toll Plaza	1613	1572	2.56%	1.0
NB	Colonial Drive to University Toll Plaza	1385	1473	-6.32%	2.3
NB	SR-434 to Lake Jesup Toll Plaza	732	759	-3.73%	1.0
SB	Lake Mary Blvd to Lake Jesup Toll Plaza	884	919	-3.96%	1.2
SB	University Blvd to University Toll Plaza	3115	3133	-0.58%	0.3
SB	Curry Ford Toll Plaza to Lake Drive	1878	1969	-4.82%	2.1
SB	Boggy Creek Road to Boggy Creek Toll Plaza	694	657	5.39%	1.4
SB	John Young Parkway to John Young Toll Plaza	1148	1181	-2.84%	1.0
SB	Celebration Toll Plaza to I-4	399	411	-3.13%	0.6

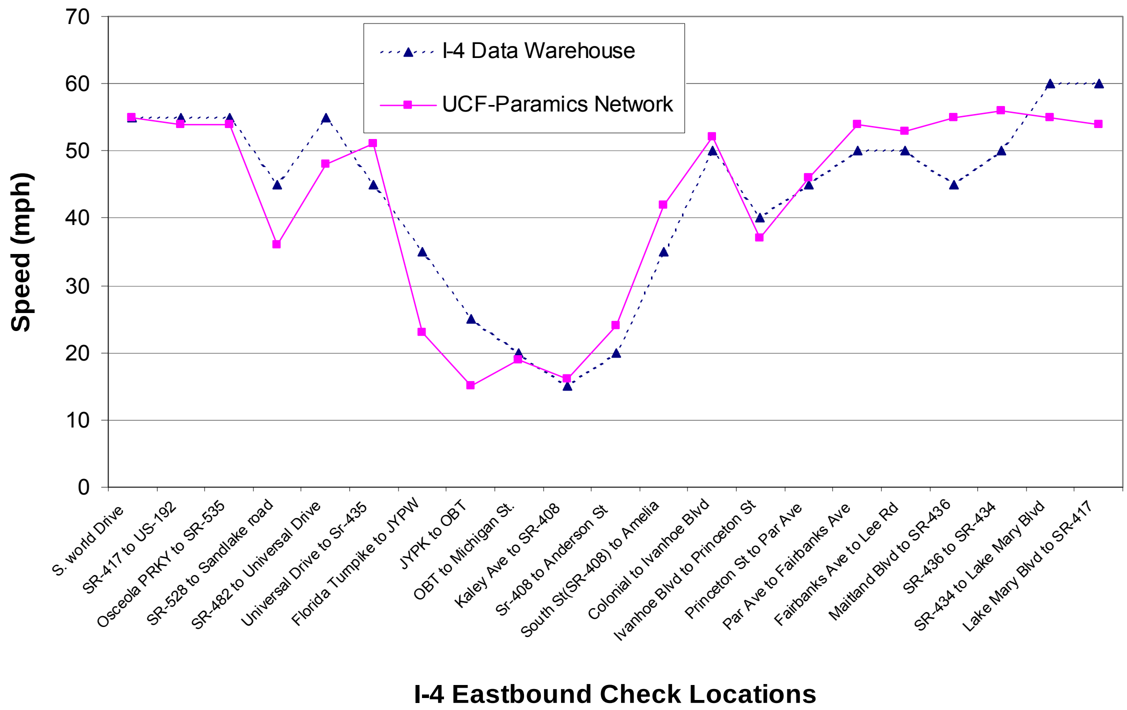
SR408

Direction	Description	Volume	Paramics	% Error	GEH
WB	Semoran Blvd to Holland East Plaza	5484	4005	26.76%	21.5
WB	Holland West Plaza to John Young Parkway	1885	1857	1.50%	0.7
WB	Hiawassee Plaza to Good Homes Road	1018	1026	-0.76%	0.2
EB	Good Homes Road to Hiawassee Plaza	2548	2297	9.86%	5.1
EB	John Young Parkway to Holland West Plaza	3122	2806	10.12%	5.8
EB	Conway to Holland East Plaza	2367	2330	1.57%	0.8

Table 7: Final Calibration Results for UCF-PARAMICS Network (I-4)

SR400 (I-4)

	Eastbound				Westbound			
Description	Volume	Paramics	%Error	GEH	Volume	Paramics	%Error	GEH
South of the world drive	2511	2673	-6.45%	3.2	2410	2423	-0.54%	0.3
Osceola Parkway to SR-536	4698	4702	-0.09%	0.1	4025	3609	10.34%	6.7
Central Florida Parkway to Beeline EXPW	5059	4386	13.30%	9.8	5310	5505	-3.67%	2.7
Sand Lake Road to Kirkman Road	4552	4503	1.08%	0.7	4263	3635	14.73%	10.0
Kirkman Road to Florida Turnpike	4037	3796	5.97%	3.9	4863	4265	12.30%	8.9
Florida Turnpike to Orange Blossom Trail	4037	3843	4.81%	3.1	4455	4265	4.26%	2.9
Orange Blossom Trail to East West EXPW	5729	4383	23.49%	18.9	6031	4917	18.47%	15.1
East West Expressway to Colonial Drive	5176	4587	11.38%	8.4	5433	4720	13.12%	10.0
Colonial Drive to Lee Road	4624	4345	6.03%	4.2	5627	4718	16.15%	12.6
Lee Road to Maitland Blvd	4791	4202	12.29%	8.8	5029	4236	15.77%	11.7
Maitland Blvd to Sr-436	4451	4106	7.75%	5.3	3927	4142	-5.47%	3.4
SR-436 to SR-434	4221	4095	2.99%	2.0	4431	4812	-8.60%	5.6
SR-434 to Lake Mary Blvd	4125	3918	5.02%	3.3	5023	5019	0.08%	0.1
Lake Mary Blvd to Central Florida Greenway	3183	3363	-5.66%	3.1	3825	3716	2.85%	1.8



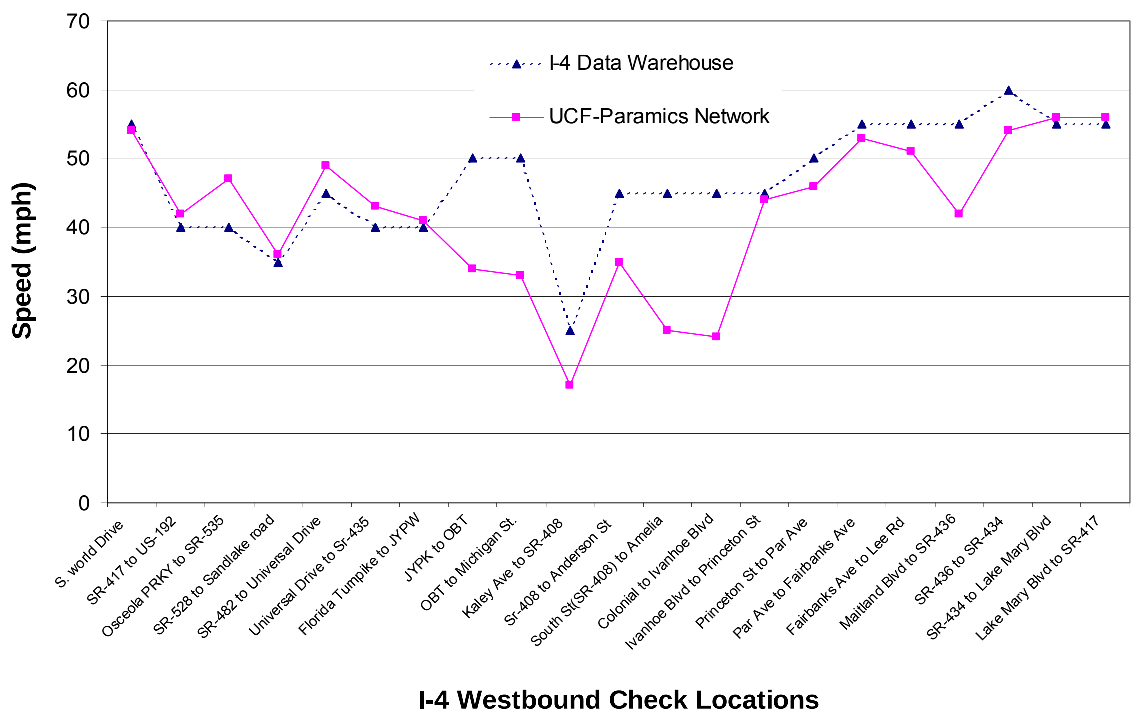


Figure 23: Validation of Travel Speeds on I-4

CHAPTER 6

EVALUATION OF ATIS SCENARIOS

6.1 EVALUATE ATIS SCENARIOS

The calibrated and validated UCF-PARAMICS network was used to execute alternative toll pricing scenarios as traffic diversion strategies on toll and non-toll facilities in the network study area. The results will be used to evaluate defined scenarios with the goal of determining the effectiveness of diverting traffic on Interstate 4. The overall intention is to test the possibility that by offering a lowered price structure on the alternative toll facilities it would make their use more attractive and alleviate congestion on Interstate 4. The scenarios categories included:

- Lowering tolls on SR 417 and SR 528 at the mainline plazas only, during the morning peak travel period,
- Simulating an incident on I-4,
- Closing one lane in each direction on I-4 at various locations,

These scenarios could cause the vehicles to divert off I-4. The tolls were removed off the mainline plazas, without affecting the tolls on the on/off ramps on the toll roads. This was done to provide the toll roads with an impedance to discourage the arterial commuters from using the toll roads. The results from these scenarios were evaluated and provided invaluable information about the effectiveness of toll reductions alternatives as traffic redistribution strategies. This application was conducted through 24 scenarios that are explained in the following section.

6.1.1 Experimental Design

The experiment focused only on the morning peak hour directions from 6:30 to 8:30 AM that includes a 30-minute warm up to load vehicles on the network and 30-minute dispersion period.

Vehicles in PARAMICS do not carry routing information with them beyond the next two links (other than knowing which destination they are headed for). The form of this information is a set of tables, which are stored at each node. The tables are constructed when the network is loaded (and are updated periodically if dynamic feedback is switched on). As a result, the vehicle traverses through the network always taking the nearest exits until reaching its destination. The decision of which exit to take is made two links ahead of time which is why we stated that a vehicle only holds routing information for up to two links.

The travel cost on the links represents a combination of factors that drivers take into account when choosing routes. The way PARAMICS assigns drivers to routes has already been dealt in the previous chapter. The route chosen by the drivers would be the route with the least travel cost, considering the travel time as well as the toll cost. Dynamic Feedback Assignment (DFB) assumes that drivers who are familiar with the road will re-route if information is provided to them. The tolls on the Central Florida area toll road network for 2003 are shown in Table 8.

Table 8: Existing Tolls on the Central Florida Expressways

East-West Expressway (SR 408)	
Holland East Main Plaza	$0.75
Holland West Main Plaza	$0.50
Hiawassee Main Plaza	$0.50
Bee line Expressway (SR 528)	
Bee Line West Main Plaza	$0.50
Airport Plaza	$0.75
Central Florida Greenway (SR 417)	
Celebration Main Plaza	$0.50
John Young Parkway Main Plaza	$1.00
Boggy Creek Main Plaza	$1.00
Curry Ford Main Plaza	$0.50
University Main Plaza	$0.50
Lake Jesup Main Plaza	$1.50

The ATIS scenarios had to be defined, evaluated and assessed. Since there were infinite scenarios possible, an experimental design was formulated to test a reasonable set of scenarios. The experiment included multi-level factorial design in which there were two qualitative variables: Toll cost and Traffic conditions, and two response quantitative variables: Traffic volumes and Travel times. The toll cost variable included five levels – no change in toll structure, 50% toll reduction on SR417, 100% toll reduction on SR 417, 50% toll reduction on both SR417 and SR528, 100% toll reduction on both SR 417 and SR528. The traffic conditions variable included five levels: one base scenario, three lane closure scenarios at different locations on I-4 and an incident on I-4. Because of the multi-level factorial design, there are a total of 25 scenarios, of which one is the calibrated scenario (base scenario with no change in toll structure). The base scenario was compared to the 24 scenarios to investigate the effect of the cost variable levels on the Central Florida area network (see Table 9). The locations and sizes of the constructions and the incident on I-4 are illustrated in Figure 24. For each of these scenarios, the following variables were chosen as measures of effectiveness:

- Hourly traffic volumes for a specific ATIS scenario compared to the hourly volumes of the base scenario and
- Average travel times.

Average travel time for a link/route in a road network is the average time used for all vehicles to drive on this link/route from its beginning/origin to its end/destination during a specific period of time (usually peak hour). Average travel time was chosen because it is the most commonly used measure of effectiveness for any transportation system (Emam and Al-Deek, 2004).

Table 9: UCF PARAMICS Network Scenarios

Location	Scenario	Description	Comments
N/A	**B**	**Base Scenario (Calibrated)**	**The Calibrated Network**
G1	S1	50% SR 417	Recurring congestion
	S2	100% SR 417	
	S3	50% SR 417 & SR 528	
	S4	100% SR 417 & SR 528	
G2	S5	Lane Closure on I-4 (LC)	One lane closure in each direction on Interstate 4 beginning **just east** of Lake Mary Blvd. to **west** of SR 436, which would include the Lake Mary Blvd., SR434, and SR436 interchanges. Alternative routes include SR417 and US17/92.
	S6	LC + 50% SR 417	
	S7	LC + 100% SR 417	
	S8	LC + 50% SR 417 & SR 528	
	S9	LC + 100% SR 417 & SR 528	
G3	S10	Lane Closure on I-4 (LC)	One lane closure in each direction on Interstate 4 beginning just west of Lee Rd. to **just east** of SR50, which would include the Princeton Interchange. Alternative routes include SR417, US17/92, or US441 (OBT). Note: Zone #21 may be significant on the west side of the network.
	S11	LC + 50% SR 417	
	S12	LC + 100% SR 417	
	S13	LC + 50% SR 417 & SR 528	
	S14	LC + 100% SR 417 & SR 528	
G4	S15	Lane Closure on I-4 (LC)	One lane closure in each direction on Interstate 4 beginning just west of SR91 (FTP) to **just east** of Central Florida Pkwy, which would include the SR528 and SR482 interchanges. Alternative routes include SR417, US441 (OBT), SR436 or SR91.
	S16	LC + 50% SR 417	
	S17	LC + 100% SR 417	
	S18	LC + 50% SR 417 & SR 528	
	S19	LC + 100% SR 417 & SR 528	
G5	S20	Incident on I-4	Incident on I-4 westbound **between** Maitland Blvd. and Lee Rd., alternative routes include SR417, US17-92, or US441 (Orange Blossom Trail).
	S21	Inc + 50% SR 417	
	S22	Inc + 100% SR 417	
	S23	Inc + 50% SR 417 & SR 528	
	S24	Inc + 100% SR 417 & SR 528	

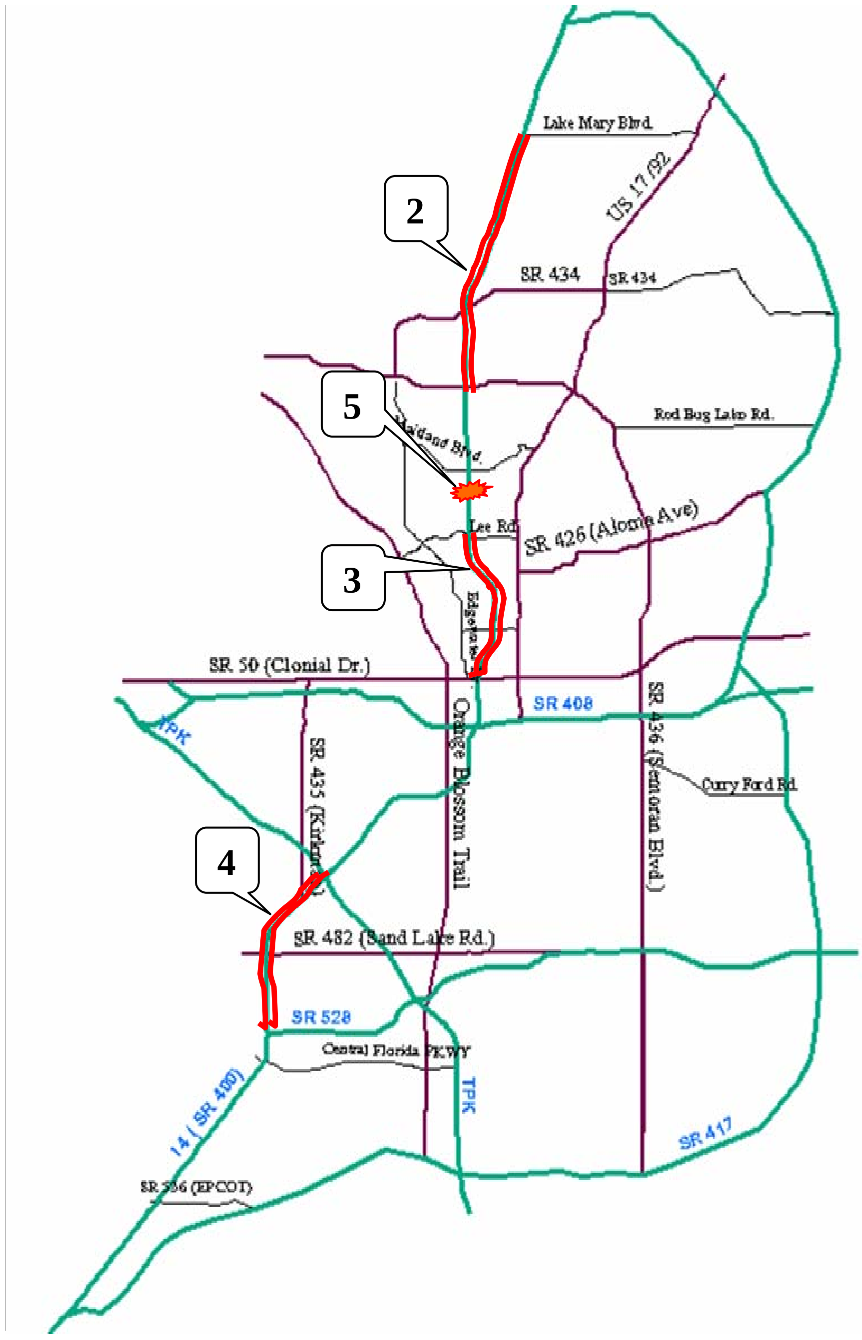


Figure 24: Locations of Lane Closures and Incident on I-4

6.2 PRELIMINARY SENSITIVITY ANALYSIS WITH TRAFFIC VOLUMES

A preliminary sensitivity analysis was performed by comparing the hourly volumes on individual links. This was done just to check if there was an increase in the volumes on the alternative routes to I-4 due to toll reduction, with specific emphasis on the volumes on toll roads. To find out if the source of increase in traffic volumes on toll roads was due to traffic diverting from I-4, traffic was compared across screen-lines as will be explained later in this report.

Descriptions of checkpoint locations of the UCF-PARAMICS Network are provided in Table 10 and Table 11. Table 10 shows the locations (checkpoints) on Toll Roads (SR417 and SR528). Table 11 shows locations (checkpoints) on I-4 and three major arterials.

Table 10: Description of the Checkpoint Locations on Toll Roads

SR417 (South Direction)	
Location	Description
1	I-4 to Reinhart Road
2	Reinhart Road to SR-46
4	SR-46 to US17-92
6	US17-92 to Lake Mary Blvd
8	Lake Mary Blvd to Lake Jesup toll plaza
10	Lake Jesup toll plaza to SR-434
12	SR-434 to Red bug Lake road
14	Red bug Lake road to Aloma Avenue
16	Aloma Avenue to University Blvd
18	University Toll Plaza to Colonial Drive
19	Colonial drive to Curry Ford road
20	Curry Ford Toll Plaza to Lake Drive
22	Lake Drive to Beeline Expressway
24	Beeline Expressway to Narcossee road
26	Narcossee road to Boggy creek road
28	Boggy Creek Toll Plaza to Landstar Blvd
30	Landstar Blvd to Orange Blossom Trail
31	Orange Blossom Trail to John Young Parkway
33	John Young Parkway to John Young Toll Plaza
34	John Young Toll Plaza to International Drive
36	International Drive to Osceola Parkway
37	Osceola Parkway to Celebration Main Toll Plaza
39	Celebration Main toll Plaza to I-4

SR528 (West Direction)	
Location	Description
1	East of Sr-417 Interchange
3	SR-417 Interchange to CR-15
4	CR-15 to Golden Rod Road
6	Golden Rod Road to Semoran Blvd
8	Semoran Blvd to Airport Toll Plaza
9	Airport Plaza to Conway Road
10	Conway road to Sand Lake Road
12	Sand Lake Road to Beeline West Main Toll Plaza
14	Beeline West Main Toll Plaza to Orange Blossom Trail
15	Orange Blossom Trail to John Young Parkway
16	John Young Parkway to Orange Wood Road
17	Orange Wood Road to International Drive
18	International Drive to I-4

Table 11: Description of the Checkpoint Locations on I-4 and Major Arterials

I-4 (West Direction)		Major Arterials (South Direction)	
Location	Description	Location	Description
1	SR-46 to Central Florida Greenway	US17/92 (South Direction)	
2	Central Florida Greenway to Lake Mary Blvd	1	North of SR 417 from Sanford
3	Lake Mary Blvd to SR-434	2	SR 417 to Lake Mary Blvd
4	SR-434 to SR-436	3	Lake Mary Blvd to SR 434
5	SR-436 to Maitland Blvd	4	SR 434 to SR 436
6	Maitland Blvd to Lee Road	5	SR 436 to Maitland Blvd
7	Lee Road to Fairbanks Avenue	6	Maitland Blvd to Fairbanks Avenue / Aloma Avenue (SR 426)
8	Fairbanks Ave to Par Avenue	7	Fairbanks Avenue / Aloma (SR 426) to SR 50
9	Par Avenue to Princeton Street	8	South of SR 408
10	Princeton Street to Ivanhoe Blvd	Semoran Blvd. (South Direction)	
11	Ivanhoe Blvd to Colonial Drive	1	OBT to SR 434
12	Colonial Drive to Amelia	2	SR 434 to I-4
13	Amelia to East West Expressway	3	I-4 to US 17-92
14	East West Expressway to Anderson Street	4	US 17-92 to Red Bug Lake Rd
15	Kaley Avenue to Michigan Street	5	Red Bug Lake Rd to Fairbanks Avenue / Aloma Avenue(SR 426)
16	Michigan Street to Orange Blossom Trail	6	Fairbanks Avenue / Aloma (SR 426) to SR 50
17	Orange Blossom Trail to John Young Parkway	7	SR 50 to SR 408
18	John Young Parkway to Conroy Road	8	SR 408 to Curry Ford Rd
19	Conroy Road to Florida Turnpike	9	Curry Ford Rd to SR 528
20	Florida Turnpike to Kirkman Road	10	SR 528 to SR 417
21	Kirkman Road to Universal Drive	11	SR 417 south
22	Beeline Expressway to Central Florida Parkway	Orange Blossom Trail (South Direction)	
23	Central Florida Parkway to SR-535	1	SR 436 to SR 50
24	SR-535 to Osceola Parkway	2	SR 50 to SR 408
25	Osceola Parkway to US-192	3	SR 528 to SR 417
26	US-192 to World Drive	4	SR 417 south
27	World Drive to Western Beltway		

6.2.1 Analysis of Scenarios Group1 - G1

For these scenarios, the alternative toll reduction plans for mitigating recurring congestion on I-4 were evaluated. The Base scenario itself represented the volumes under recurring congestion. The difference in volumes between the specific scenarios and the base (Si – B, where "i" is the scenario number and B is the base scenario volume) will be the measure of performance. Hence forth, the difference in volumes will refer to (Si – B). From the graphical representation of Group1 (or G1) scenarios, the following observations were reported:

<u>SR417 (South Direction)</u>

- It can be seen from Figure 25 that SR417 traffic volumes for all alternative toll scenarios "S1, S2, S3, & S4" are higher than the Base scenario "B". On a closer look at the difference in volumes between the individual scenarios and the base scenario (Si – B) at each location on SR417 Southbound (see Figure 26), we find that in almost all the locations, the differences are positive. This means that there is an increase in the number of vehicles using SR417 under all "toll reduction" scenarios. It is not counterintuitive to see from Figure 26 that there is a larger increase in SR417 usage under Scenario S2 (100% reduction) compared to Scenario S1 (50% reduction).
- It can be seen from Figure 26 that Scenarios S1 (50% reduction on SR417) and S3 (50% toll reduction on SR417 & SR528) are almost identical from SR46 (West of US17/92) to Colonial Drive (location 4 to location 19 in Table 10 for SR417 south). It means that no additional volumes are on SR417 due to inclusion of toll reduction on

SR528. The differences in traffic volumes compared to the base scenario range from 50 veh/hr to 500 veh/hr. From Colonial Drive to SR528 (location 19 to location 22 in Table 10 for SR417 south), S3 has higher increase in volumes (for about 125 to 150 veh/hr) than S1 due to the additional toll reduction in SR528. South of SR528 (location 22 to location 39 in Table 10 for SR417 south), there is a drop of vehicles on SR417 in S3 (for about 100 veh/hr). This is expected since a majority of vehicles will use SR528 rather than SR417 to reach their destinations (Zones 49, 51 …etc). As we move away from these zones, the differences in volumes between volumes between S1 and S3 become lesser.

- It can be seen from Figure 26 that Scenarios S2 (100% reduction on SR417) and S4 (100% toll reduction on SR417 & SR528) have similar performance to the differences in volumes between scenarios S1 and S3 respectively. From US17/92 to Colonial Drive (location 6 to location 19 in Table 10 for SR417 south), the differences compared to the base scenario range from 200 veh/hr to 800 veh/hr. Also, there is a drop in vehicles south of Colonial Drive till SR528 (location 19 to location 22 in Table 10 for SR417 south). The reason for this high drop in the number of vehicles diverted to SR417 in S4 is the removal of SR528 tolls.

Based on the above observations, it can be concluded that: North of SR528 (locations 1 to location 22 in Table 10 for SR417 south), both 50% and 100% toll reduction will promote drivers to use SR417. As a result, if we are willing to increase the number of vehicles diverting to SR417 only, then it is recommended to reduce the tolls on SR417 only. It is not clear how much toll reduction should be introduced at this stage (50% or 100%). This is a topic of a future research project that is a natural continuation of this project. Also, we did not differentiate between vehicle types in this analysis as all vehicles were grouped together as one population (SunPASS – includes AVI/ETC, Manual, and Exact Coin).

SR528 (West Direction)

- It can be seen from Figure 27 and Figure 28 that scenarios S1 and S2 have volumes less than the Base Scenario. Reducing tolls only for SR417 makes SR528 westbound a more expensive alternative to SR417 (for the southern part of SR417 where it runs parallel to SR528). Therefore, we find that the difference in volumes increases as the commuters move farther westwards on SR528 westbound for scenarios S1 and S2. These differences range from 30 veh/hr to 200 veh/hr for S1 (50% toll reduction on SR417) and from 30 to 400 veh/hr for S2 (100% toll reduction for SR417).
- On the other hand, when SR528 is a part of the toll reduction as in scenarios S3 and S4, there is an increased surge of vehicles on SR528 westbound, which shows that SR528 westbound is the preferred route to SR417. The difference in volumes for S3 ranges from about 300 to 600 veh/hr for most of the locations on SR528 westbound. For S4 (100% toll reduction on SR417 and 528), the difference in volumes ranges from 600 to 800 veh/hr. This could mean that reducing tolls on SR528 might be detrimental to projecting SR417 as a viable alternative to I-4, as SR528 westbound feeds into I-4.

I-4 (West Direction)

It can be seen from Figure 30 and Figure 30 that traffic volumes on I-4 westbound dropped by almost 400 veh/hr at the I-4 and SR417 interchange (location 2 in Table 11 for I-

4 west). Also, the 100% toll reduction on SR417 has a noticeable impact of the traffic volumes on I-4 (S2 – B). However, the toll reduction on SR528 balanced the reduction on SR417 tolls and maintained the vehicles on I-4 (S4 – B).

Major Arterials (South Direction)

It can be seen from that the difference in base scenario volumes and S1 for US17/92 and OBT are not significant. Due to the recurring congestion, some traffic volumes consistently diverted from SR436. Some volumes diverted from US17/92 and SR436 to SR417 under the toll reduction scenarios. Also, it can be seen from Figure 31 and Figure 32 that there is a consistent drop in the traffic volumes on SR436 (Semoran Blvd.) and OBT because a significant amount of volumes are diverted to SR417 and SR528 due to the toll reduction. The amount of toll reduction does not impact the number of vehicles diverting.

The tables for the hourly traffic volumes for I-4, SR417, SR528 and major arterials for G1 are included in Appendix B.

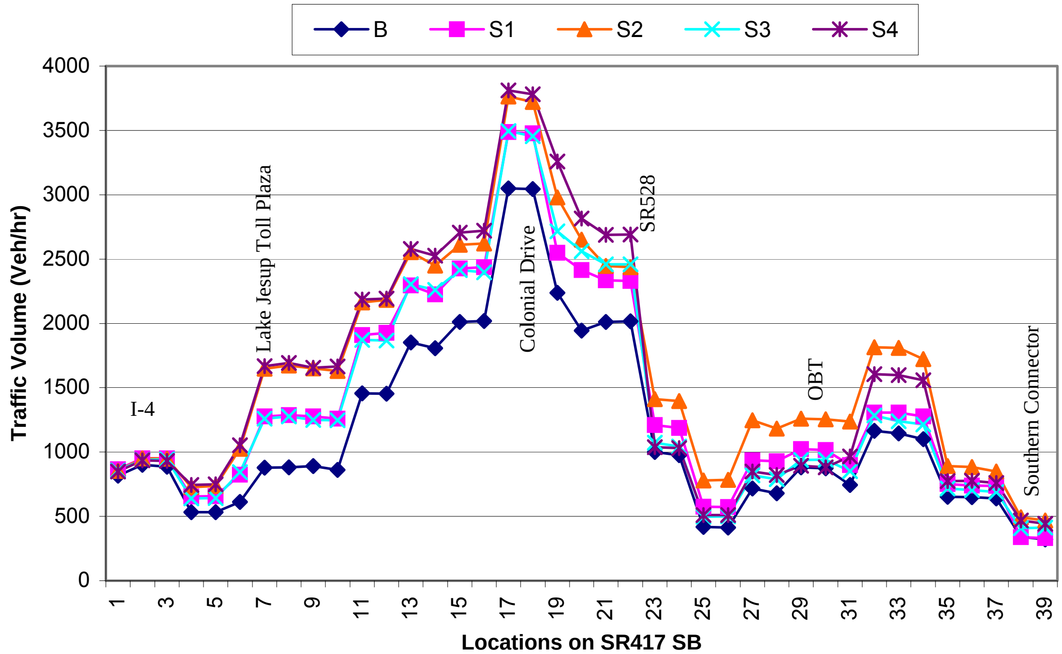


Figure 25: Traffic Volumes on SR417 Southbound Under Various Toll Reduction Scenarios and Recurring Congestion on I-4 "Scenarios Group1-G1"

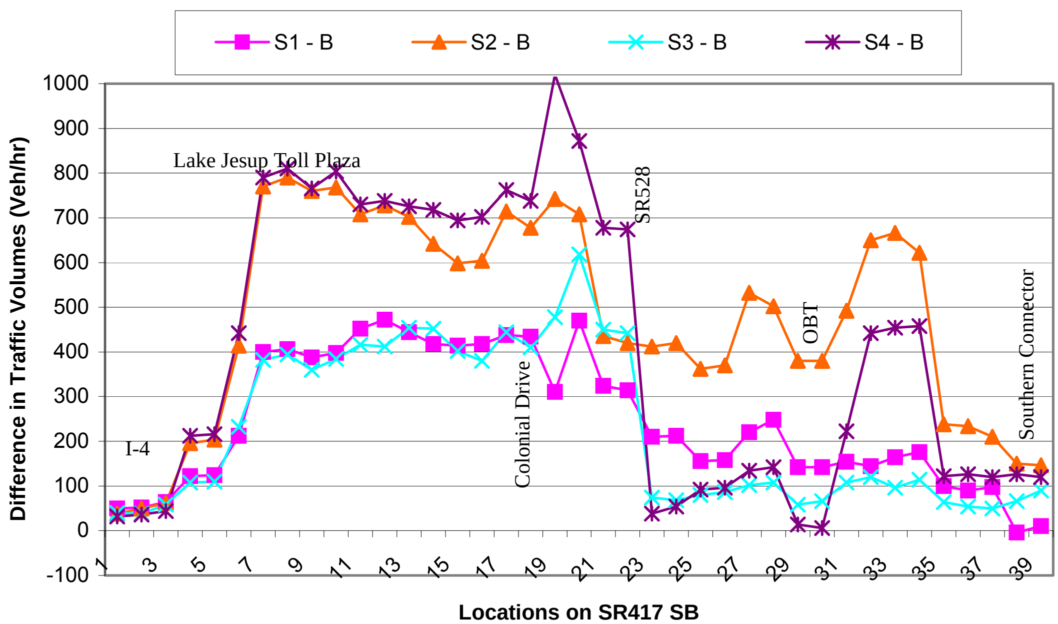


Figure 26: Difference in Traffic Volumes on SR417 Southbound Under Various Toll Reduction Scenarios and Recurring Congestion on I-4 "Scenarios Group1-G1"

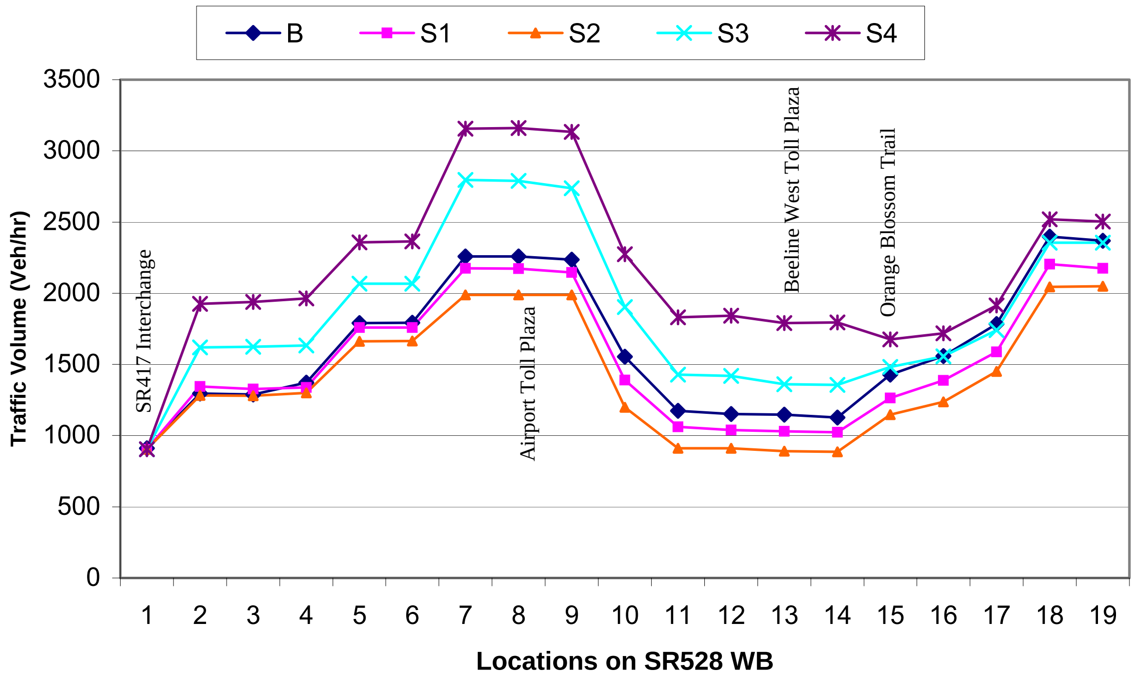


Figure 27: Traffic Volumes on SR528 Westbound Under Various Toll Reduction Scenarios and Recurring Congestion on I-4 "Scenarios Group1-G1"

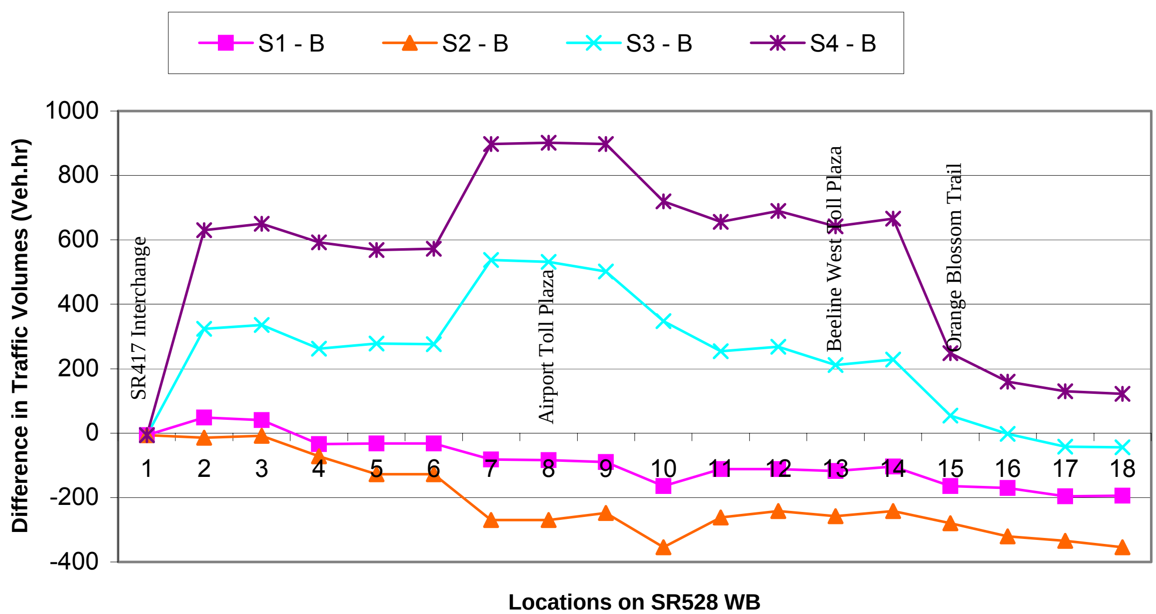


Figure 28: Difference in Traffic Volumes on SR528 Westbound Under Various Toll Reduction Scenarios and Recurring Congestion on I-4 "Scenarios Group1-G1"

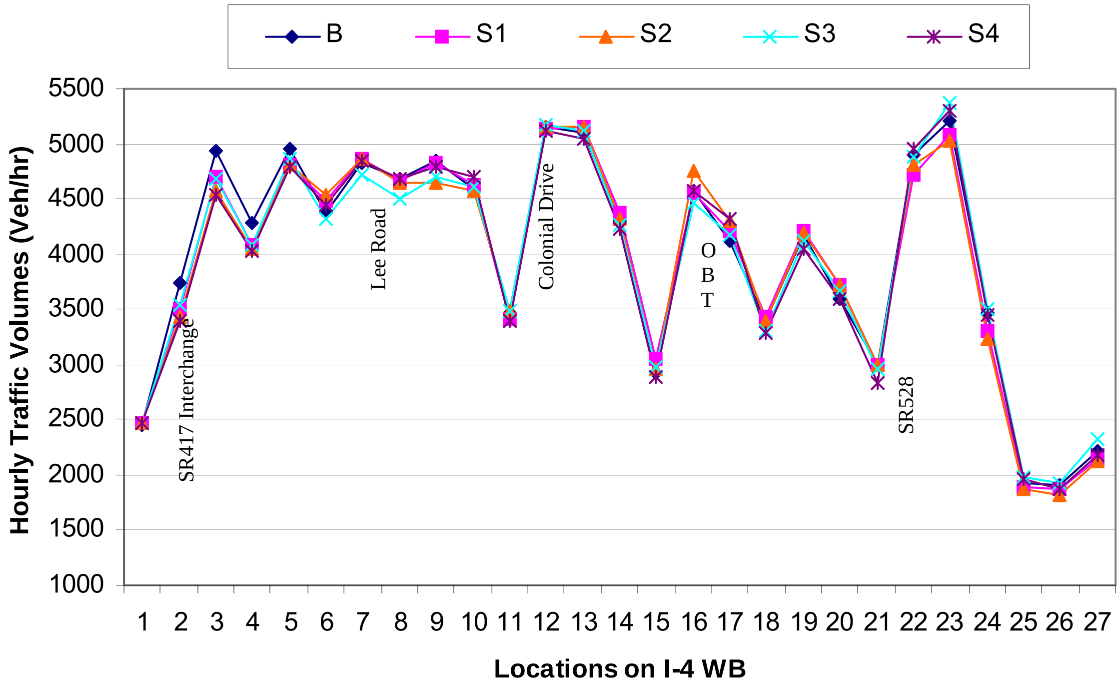


Figure 29: Traffic Volumes on I-4 Westbound Under Various Toll Reduction Scenarios and Recurring Congestion on I-4 "Scenarios Group1-G1"

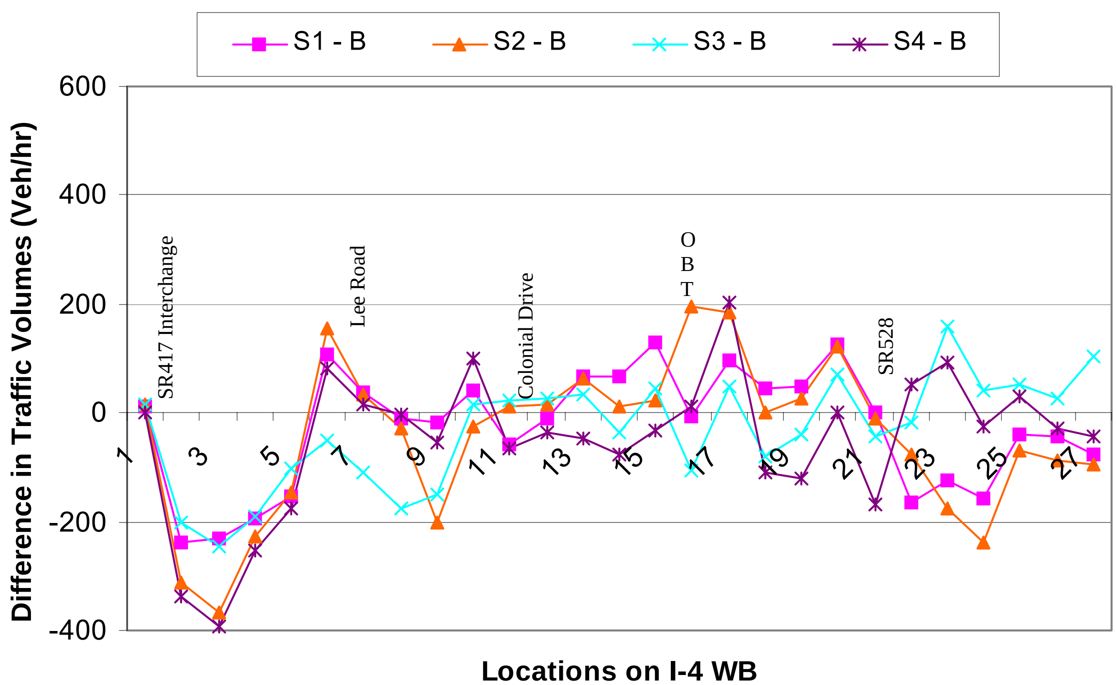


Figure 30: Difference in Traffic Volumes on I-4 Westbound Under Various Toll Reduction Scenarios and Recurring Congestion on I-4 "Scenarios Group1-G1"

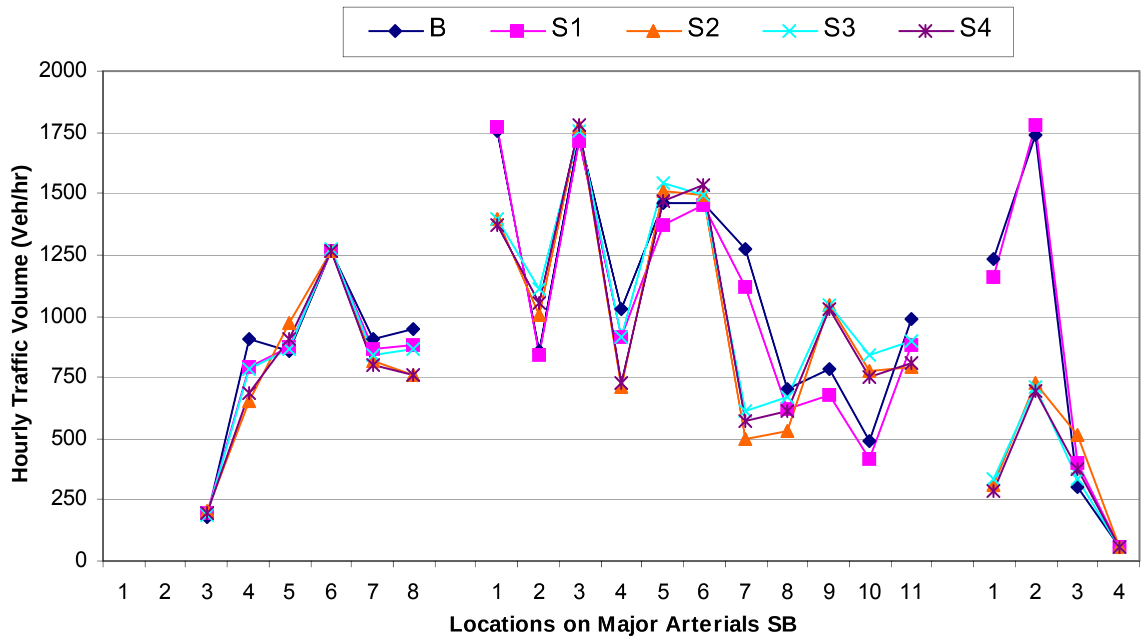


Figure 31: Traffic Volumes on Major Arterials Southbound Under Various Toll Reduction Scenarios and Recurring Congestion "Scenarios Group1-G1"

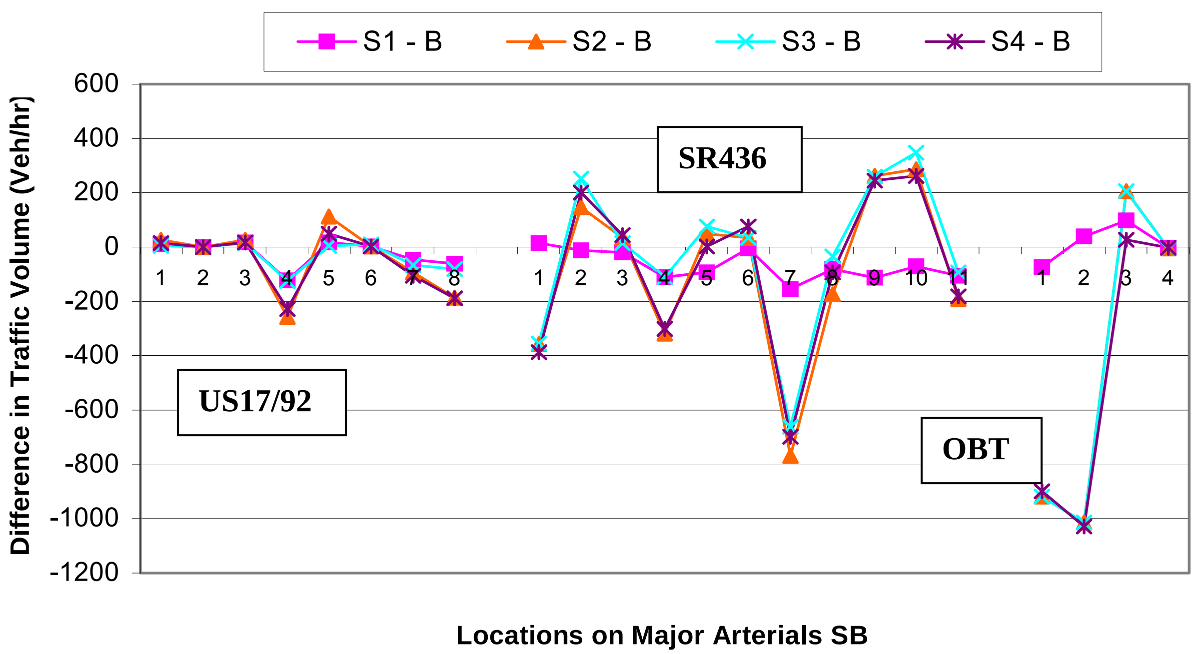


Figure 32: Difference in Traffic Volumes on Major Arterials Southbound Under Various Toll Reduction Scenarios and Recurring Congestion "Scenarios Group1-G1"

6.2.2 Analysis of Scenarios Group 2 - G2

For these scenarios, the alternative toll reduction plans with one lane closure in each direction on Interstate 4 beginning **just east** of Lake Mary Blvd to **west** of SR436 (location 3 to location 5 in Table 11 for I-4 west), which included the Lake Mary Blvd, SR434, and SR436 interchanges were evaluated. The Base scenario represented the volumes under recurring congestion, while scenario S5 represented the volumes under lane closure and without toll reduction. The off ramps on I-4 were closed at the locations of the lane closure as a worst-case scenario, thus prohibiting vehicles to get off I-4 at the locations of the lane closure. From the graphical representation of Group2 (or G2) scenarios, the following observations were reported:

SR417 (South Direction)

- It can be seen from Figure 34 and Figure 34 that the base scenario and scenario S5 (one lane closure in each direction on I-4) are almost identical except for the peak in the beginning of the curve (138 vehicles). This is observed west of US17/92. It was concluded that the diverted vehicles are going to use the arterials (US17/92) not SR417 with the existing mainline tolls.
- It can be seen from Figure 34 that scenarios S6 (lane closure on I-4 & 50% reduction on SR417) and S8 (lane closure on I-4 & 50% toll reduction on SR417 & SR528) are identical from Rinehart Road to Colonial Drive interchange (location 1 to location 19 in Table 10 for SR417 south). The differences in traffic volumes compared to the base scenario range from 300 to 500 veh/hr. Therefore some diversion was observed to SR417 due to toll reduction. South of Colonial Drive interchange to Beeline

Expressway interchange (location 19 to location 23 in Table 10 for SR417 south), S8 has higher volumes compared to S6, because of the added incentive on SR528 toll reduction. South of Beeline Expressway interchange (location 23 in Table 10 for SR417 south), the volumes on SR417 drop in both S6 and S8. Also South of Beeline Expressway interchange to the Southern Connector (location 23 to location 39 in Table 10 for SR417 south), reducing the tolls on SR528 along with SR417 will decrease the number of diverted vehicles to SR417, because the drivers will have two alternatives: Use SR417 or use SR528, and then use I-4. As a result, the differences in traffic volumes compared to the base scenario were around 200 veh/hr and 100 veh/hr for scenarios S6 and S8 respectively.

- Also, it can be seen from Figure 34 that scenarios S7 (lane closure on I-4 & 100% reduction on SR417) and S9 (lane closure on I-4 & 100% toll reduction on SR417 & SR528) have differences in traffic volume similar to the differences described above between scenarios S6 and S8. From Rinehart to Red Bug Lake Road (location 1 to location 13 in Table 10 for SR417 south), the differences compared to the base scenario range from 350 to 850 veh/hr. From Red Bug Lake Road to the Beeline Expressway Interchange (location 13 to location 22 in Table 10 for SR417 south), the differences compared to the base scenario were around 700 to 1000 veh/hr for S9 and 500 -700 veh/hr for scenario S7. The reason for this high increase in the number of vehicles diverted to SR417 in S9 in this section is the removal of SR528 tolls that encourage drivers to use SR528 from SR417. South of Beeline Expressway to OBT (location 23 to location 31 in Table 10 for SR417 south), there’s a decrease for S9.

This is because SR528 encourages vehicles to get off SR417. There is a surge of vehicles near OBT (location 31 in Table 10 for SR417 south)

Based on the above observations, we conclude that North of Boggy Greek (location 1 to location 26 in Table 10 for SR417 south), both 50% and 100% toll reduction will promote drivers to use SR417. As a result, if we are willing to increase the number of vehicles diverting to SR417 only, then it is recommended to reduce the tolls on SR417 only. It is not clear how much toll reduction should be introduced at this stage (50% or 100%). This is a topic of a future research project that is a natural continuation of this project. Also, we did not differentiate between vehicle types in this analysis as all vehicles were grouped together as one population (SunPASS, Manual, and Exact Coin).

SR528 (West Direction)

- It can be seen from Figure 35 and Figure 36 that the base scenario and scenario S5 are almost identical which means closing a lane in the northern section of I-4 will have insignificant impact on the volume changes on SR528.
- As expected, it can be seen from Figure 36 that traffic volumes on SR528 under scenarios S6 and S7 are less than they are under the Base scenario. Reducing tolls only for SR417 makes SR528 westbound a more expensive alternative to SR417 and promotes vehicles to use SR 417. As a result, the traffic volumes decreased on SR528 by 100 and 200 veh/hr for scenarios S6 and S7 respectively.
- Also, it can be seen from Figure 36 that scenarios S8 and S9 are showing an increase in the traffic volumes on SR528, which shows that SR528 westbound is the preferred route to SR417. The increase in volumes for S8 (50% toll reduction on SR417 &

SR528) ranges from about 300 to 500 veh/hr for most of the locations on SR528 westbound. For S9 (100% toll reduction on SR417 and 528), the increase in volumes ranges from 500 to 900 veh/hr. Clearly, 100% toll reductions promoted more drivers to divert to SR528 than 50% toll reduction.

I-4 (West Direction)

It can be seen from Figure 37 and Figure 38 that the traffic volumes on I-4 westbound dropped significantly by almost 1200 veh/hr at the lane closure location (represented by the two vertical lines). Also, the toll reduction on SR417 has random variation on the traffic volumes of I-4.

Major Arterials (South Direction)

It can be seen from Figure 39 and Figure 40 that vehicles diverted to US17/92 due to the lane closure on I-4. The traffic volumes increased on US17/92 from SR417 (Sanford Area) to Maitland Blvd (SR414), then the traffic volumes dropped because the diverted vehicles off of I-4 to US17/92 have diverted back to I-4 once they passed the construction or lane closure site. Also, it can be seen from Figure 40 that there is a consistent drop in the traffic volumes on SR436 (Semoran Blvd) because a significant amount of traffic volumes have diverted to SR417 due to the toll reduction. It can be concluded that the more toll reduction on SR417 and SR528 the higher the number of arterial vehicles diverted to SR417. On the other hand, there is random and insignificant variation in traffic volume on OBT.

The tables for the hourly traffic volumes for I-4, SR417, SR528 and major arterials for G2 are included in Appendix B.

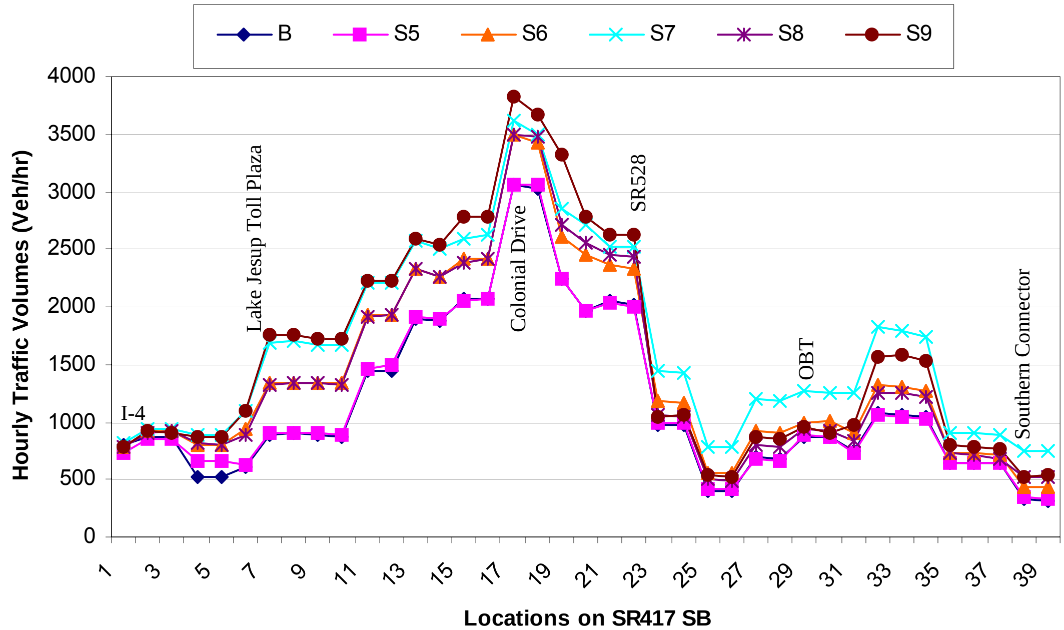


Figure 33: Hourly Traffic Volumes on SR417 Southbound Under Various Toll Reduction Scenarios with Lane Closure on I-4 "Scenarios Group2-G2"

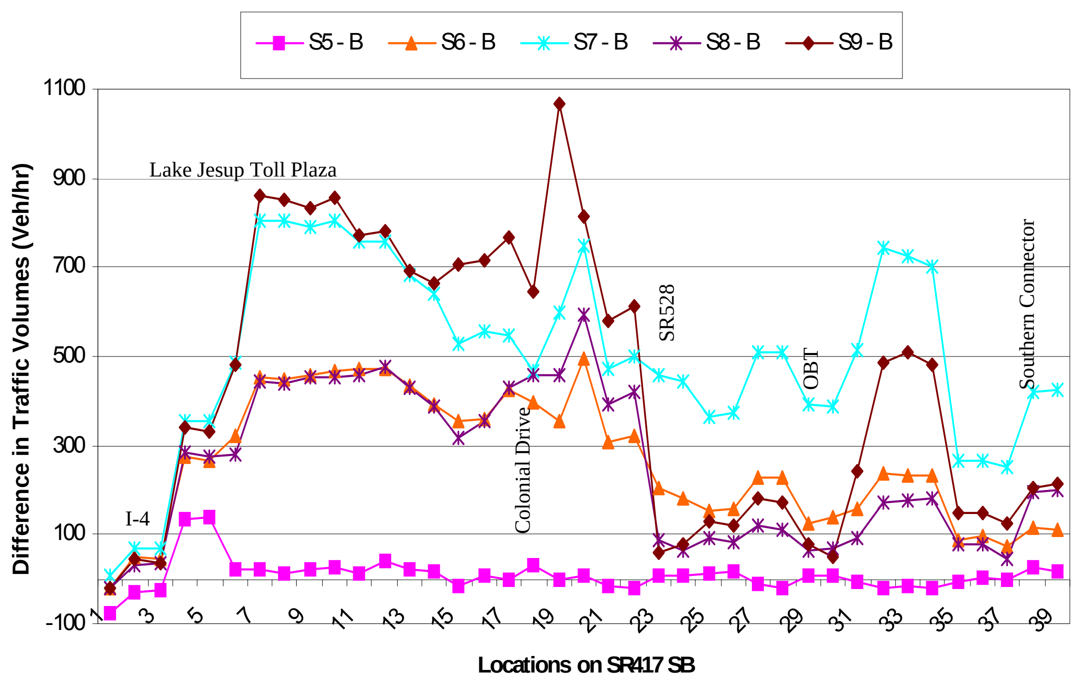


Figure 34: Difference in Traffic Volumes on SR417 Southbound Under Various Toll Reduction Scenarios with Lane Closure on I-4 "Scenarios Group2-G2"

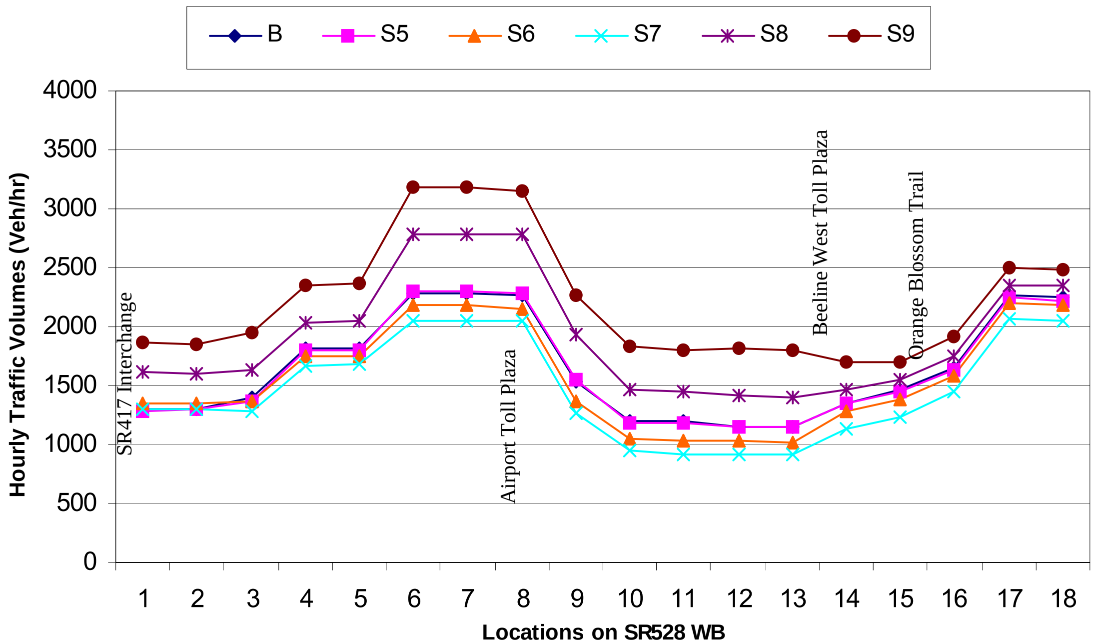


Figure 35: Hourly Traffic Volumes on SR528 Westbound Under Various Toll Reduction Scenarios with Lane Closure on I-4 "Scenarios Group2-G2"

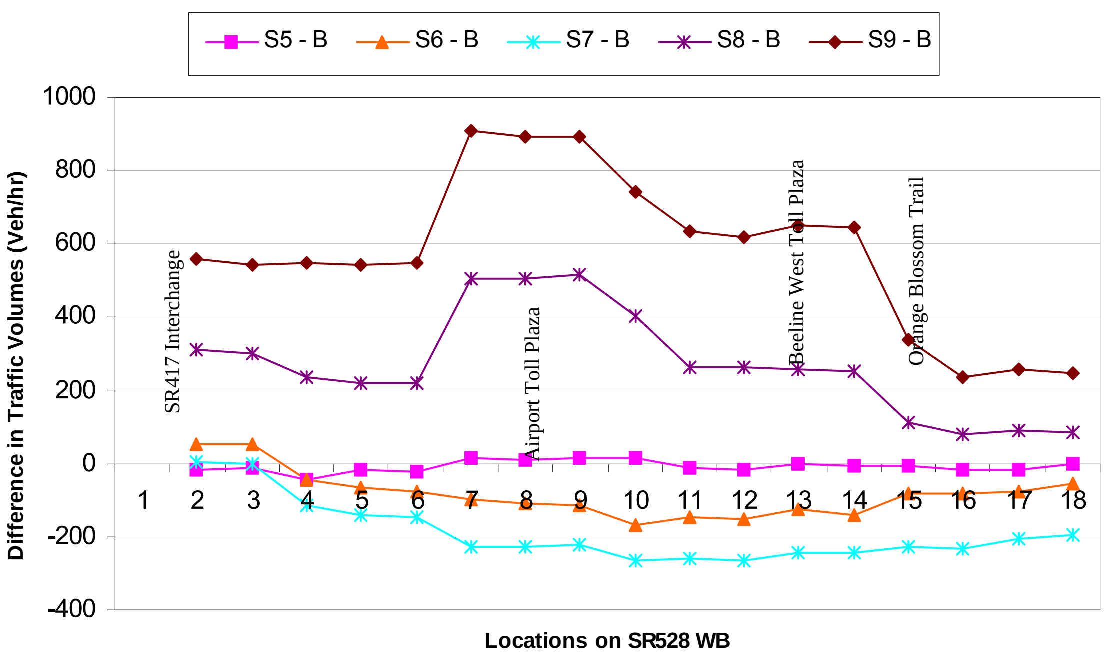


Figure 36: Difference in Traffic Volumes on SR528 Westbound Under Various Toll Reduction Scenarios with Lane Closure on I-4 "Scenarios Group2-G2"

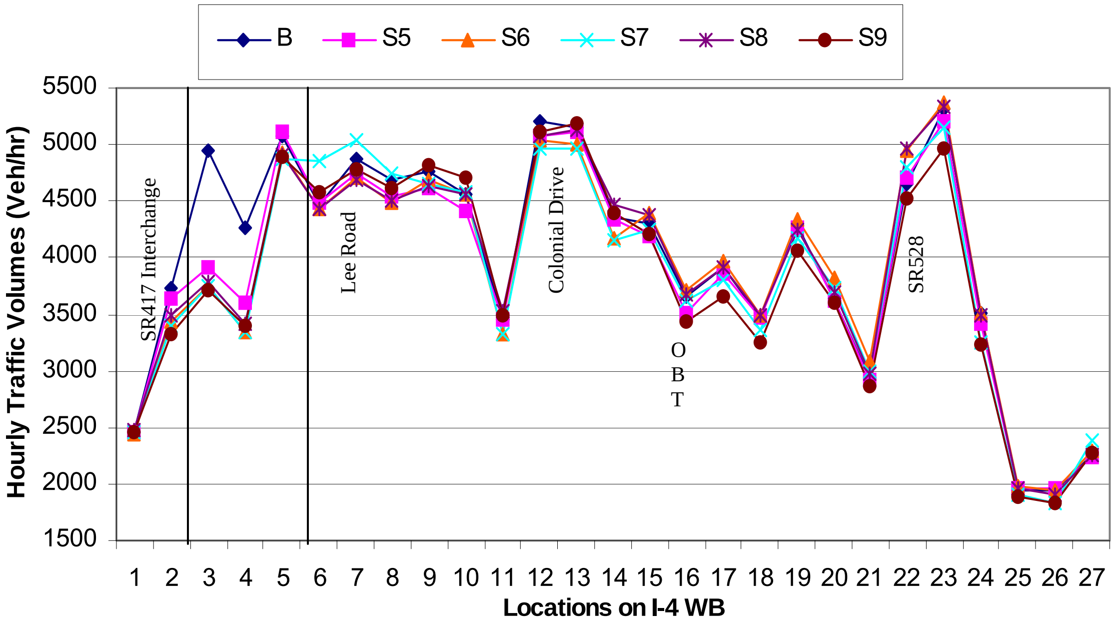


Figure 37: Hourly Traffic Volumes on I-4 Westbound Under Various Toll Reduction Scenarios with Lane Closure on I-4 "Scenarios Group2-G2"

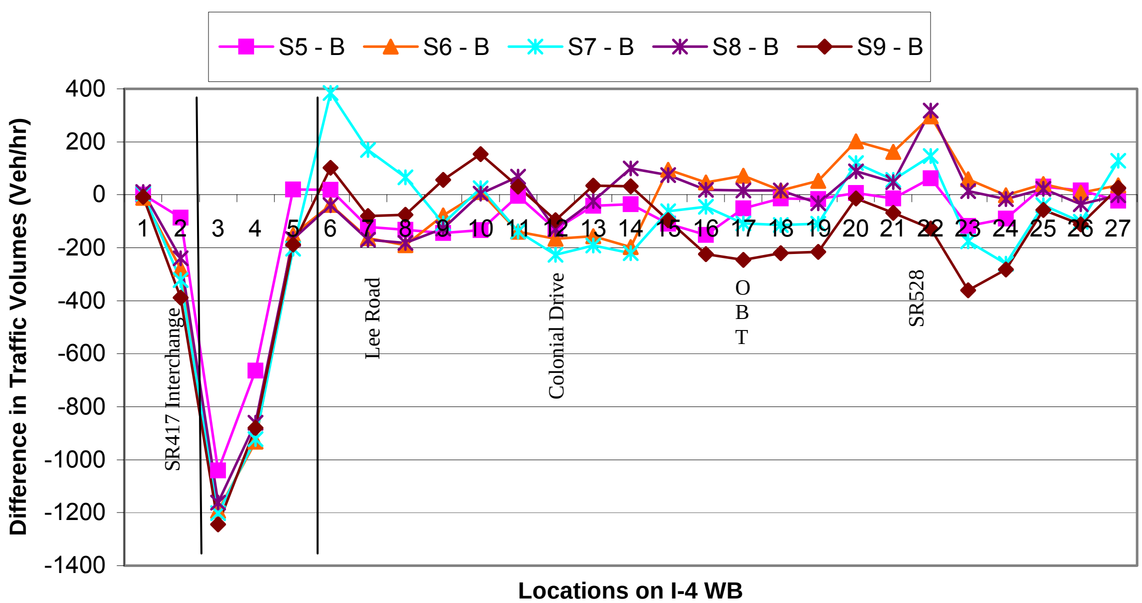


Figure 38: Difference in Traffic Volumes on I-4 Westbound Under Various Toll Reduction Scenarios with Lane Closure on I-4 "Scenarios Group2-G2"

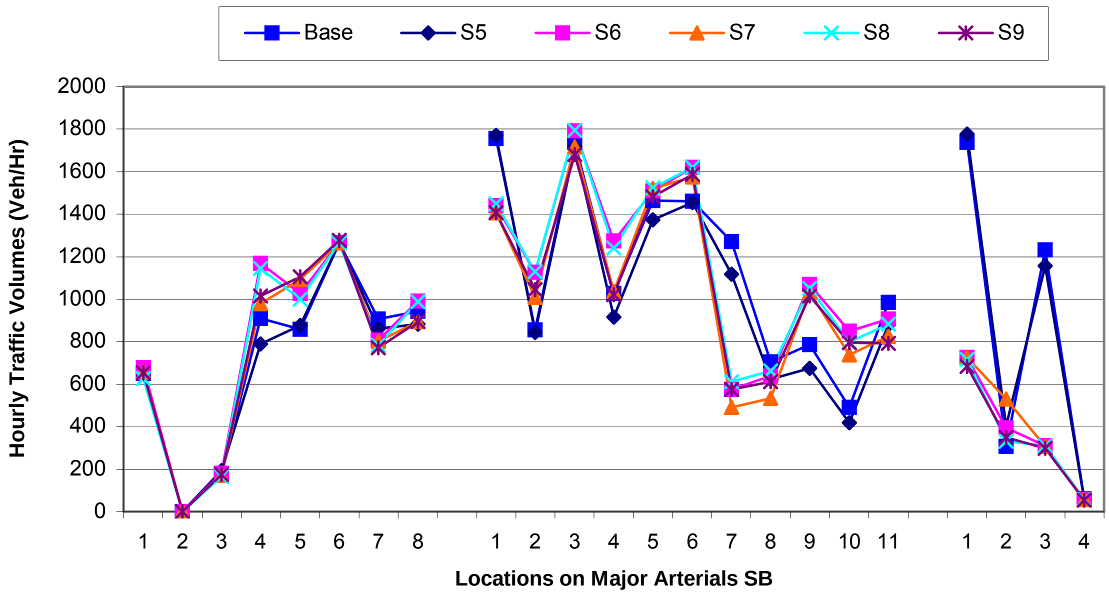


Figure 39: Hourly Traffic Volumes on Major Arterials Southbound Under Various Toll Reduction Scenarios with Lane Closure on I-4 "Scenarios Group2-G2"

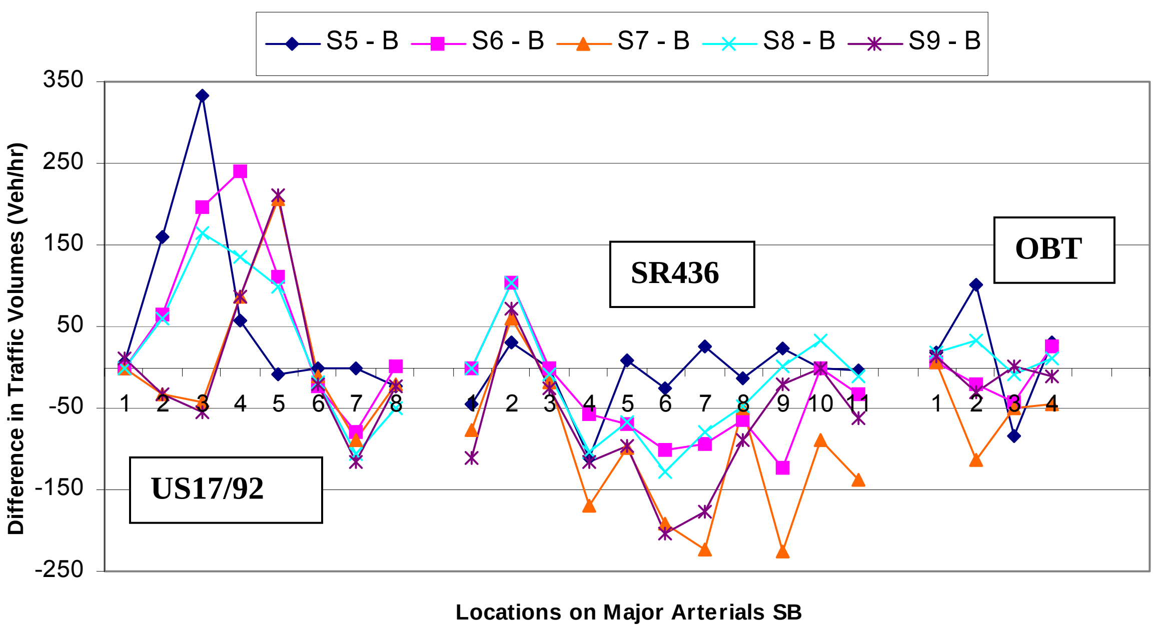


Figure 40: Difference in Traffic Volumes on Major Arterials Southbound Under Various Toll Reduction Scenarios with Lane Closure on I-4 "Scenarios Group2-G2"

6.2.3 Analysis of Scenarios Group 3 - G3

For these scenarios, the alternative toll plans for Lane Closure (LC) on I-4 beginning **just west** of Lee Road (location 6 from Table 11 for I-4 West) to **just east** of SR50 (location 11 from Table 11 for I-4 West) that included Princeton Street were evaluated. The Base scenario represented the hourly volumes under recurring congestion, while S10 represented the hourly volumes under this lane closure and without toll reduction. From the graphical representation of Group1 (G1) scenarios, the following observations are reported:

<u>SR417 (South Direction)</u>

Note that all scenarios have similar trends but they exhibit different magnitudes in the differences in traffic volumes as compared to the base scenario. Details are explained below:

- It can be seen from Figure 41 and Figure 42 that the base scenario and scenario S10 (one lane closure on I-4 in each direction) are almost identical. This is because there was no diversion to SR417 in spite of a lane closure on I-4, when the toll structure did not change.
- It can be seen from Figure 42 that scenarios S11 (lane closure on I-4 & 50% reduction on SR417) and S13 (lane closure on I-4 & 50% toll reduction on SR417 & SR528) are almost identical from Lake Mary (location 1 to location 18 in Table 10 for SR417 South) to University Plaza. The differences in traffic volumes compared to the base scenario range from 200 to 400 veh/hr. These vehicles may have destinations around Colonial drive exits on I-4 (and are affected by the lane closure on I-4). They use SR417 as alternative to I-4 and take the SR-50 exit (location 19 in Table 10) to reach their destinations. Therefore there is a drop in the number of vehicles for all

scenarios near Colonial drive exit on SR417. South of University Plaza (location 19 to location 24 in Table 10) to the Beeline Expressway, reducing the tolls on SR528 along with SR417 will increase the number of diverted vehicles to SR417, because the drivers will have two alternatives: Use SR417 or use SR528 and then use I-4. As a result, the differences compared to the base scenario were found to be about 400 and 600 veh/hr for scenarios S11 and S13 respectively. South of the Beeline Expressway interchange (locations higher than 24 in Table 10), there is a drop on the volume on SR417 under S11 compared to S13 as the drivers diverted to SR528. Also, there is a sudden spike near OBT (location 31 in Table 10) for scenarios S11 and S13 (up to 700 veh/hr) as the number of vehicles with origins just east of Colonial drive and destinations towards Disney area would use OBT, SR528 and SR417 as their alternatives to I-4.

Also, it can be seen from Figure 42 that scenarios S12 (lane closure on I-4 & 100% reduction on SR417) and S14 (lane closure on I-4 & 100% toll reduction on SR417 & SR528) have a similar performance for the differences in traffic volumes between scenarios S11 and S13 respectively. From US17/92 to University Plaza, the differences compared to the base scenario range from 200 to 800 veh/hr. Between University Plaza and Beeline Expressway, the differences compared to the base scenario were found to be on average about 650 and 850 veh/hr for scenarios S12 and S14 respectively. The reason of the high drop in the number of vehicles diverted to SR417 in scenario S14 is the removal of SR528 tolls. As for scenarios S11 and S13, we find a spike near OBT for scenarios S12 and S14, for the same reason as was with

S11 and S13. In this case, the differences in volumes compared to the base scenario are 900 and 1200 veh/hr for scenarios S12 and S14 respectively.

Based on the above observations, we conclude that: North of University Toll Plaza, both 50% and 100% toll reduction will promote drivers to use SR417. As a result, if we are willing to increase the number of vehicles diverting to SR417 only, then it is recommended to reduce the tolls on SR417 only. It is not clear how much toll reduction should be introduced at this stage (50% or 100%). This is a topic of a future research project that is a natural continuation of this project. Also, we did not differentiate between vehicle types in this analysis as all vehicles were grouped together as one population (SunPASS, Manual, and Exact Coin).

SR528 (West Direction)

- It can be seen from Figure 43 and Figure 44 that the base scenario and scenario S10 are almost identical which means closing a lane on I-4 westbound east of SR50 will have insignificant impact of the volume differences on SR528. This is because SR528 is not perceived as an alternative route to I-4, and closing a lane on I-4 does not encourage any of those users to use SR528 as a potential alternative.
- As expected, it can be seen from Figure 44 that scenarios S11 and S12 promoted vehicles to continue to SR417. This is because there is a reduction of volumes on SR528 for S11 and S12. For these drivers, SR417 south was a more beneficial alternative when compared to SR528 west due to reduction of tolls on SR417. Therefore, the traffic volumes decreased on SR528 by 200 and 300 veh/hr for scenarios S11 and S12 respectively. The traffic increases as long as we got closer to

I-4. Figure 44 shows positive values west of Orange Blossom Trail (location 15 in Table 10 for SR528 west) on SR528, because it is used as a transition segment to I-4.

- Also, it can be seen from Figure 44 that scenarios S13 and S14 are showing an increase in the traffic volumes on SR528. The difference in volumes compared to the base scenario for scenario S13 (50% toll reduction on SR417 & SR528) ranges from about 200 to 600 veh/hr for most of the locations on SR528 westbound. For S14 (100% toll reduction on SR417 and 528), the difference in volumes ranges from 500 to 800 veh/hr. Clearly, 100% toll reductions promoted the drivers more to divert to SR528 than 50% toll reduction.

I-4 (West Direction)

It can be seen from Figure 45 and Figure 46 that the traffic volumes on I-4 dropped significantly by almost 1500 veh/hr at the location of lane closure, which is represented by the two vertical lines. Under all scenarios, there is a reduction in traffic volumes on I-4 westbound from Lake Mary to Orange Blossom Trail – OBT, (location 16 from Table 11 for I-4 West), which is passing the location of the lane closure. This is because the drivers use OBT as an alternative to I-4 near the lane closure location and get back on to I-4 using the OBT interchange with I-4 after passing the location of lane closure. We also have seen that SR417 gained about 400 to 800 veh/hr under these scenarios. After passing the location of the construction, the drivers have high propensity towards using I-4. Therefore, the differences in traffic volumes compared to the base scenario were found to be less than 200 veh/hr.

Major Arterials (South Direction)

It can be seen from Figure 47 and Figure 48 that the difference in traffic volumes for scenario S10 compared to the base scenario for US17/92 and OBT are insignificant except at Maitland Blvd. intersection with US17/92 (location 7 Table 11 for US17/92). Due to the lane closure on I-4 near this location, significant volumes diverted from US17/92 to SR417 SB. The reduction in volume on US17/92 is not very sensitive to the amount of toll reduction at this location. OBT and SR436 have no differences in volumes due to lane closure. There is a consistent drop in the traffic volumes on SR436 and OBT due to toll reduction because a significant amount of volumes are diverted to SR417 and SR528 due to the toll reduction. The amount of toll reduction does not impact the number of vehicles diverting.

The tables for the hourly traffic volumes for I-4, SR417, SR528 and major arterials for G3 are included in Appendix B.

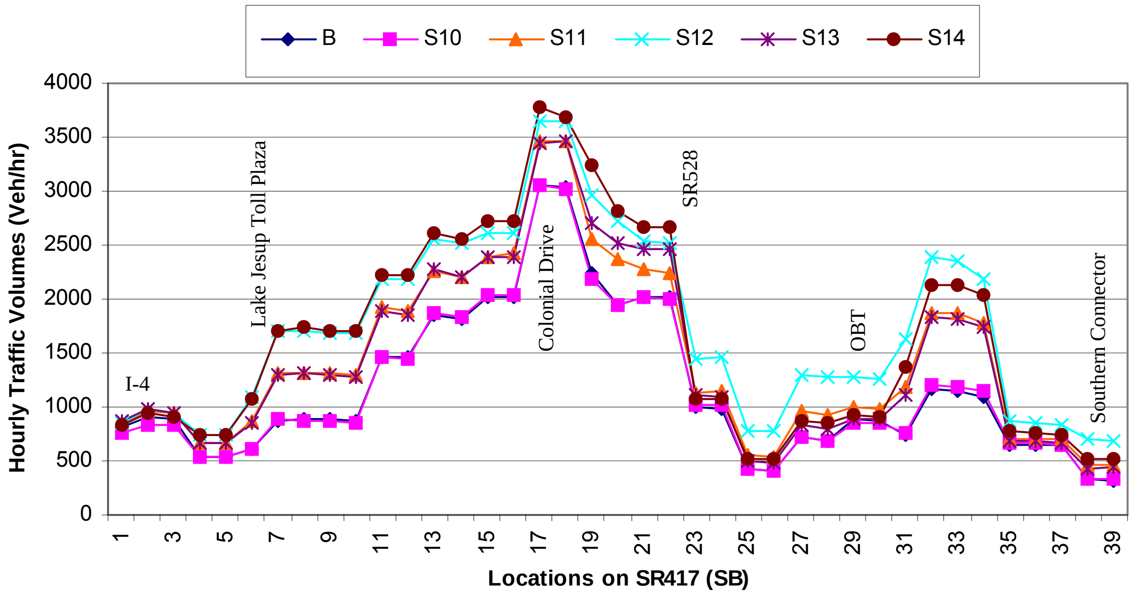


Figure 41: Hourly Traffic Volumes on SR417 Southbound Under Various Toll Reduction Scenarios with Lane Closure on I-4 "Scenarios Group 3-G3"

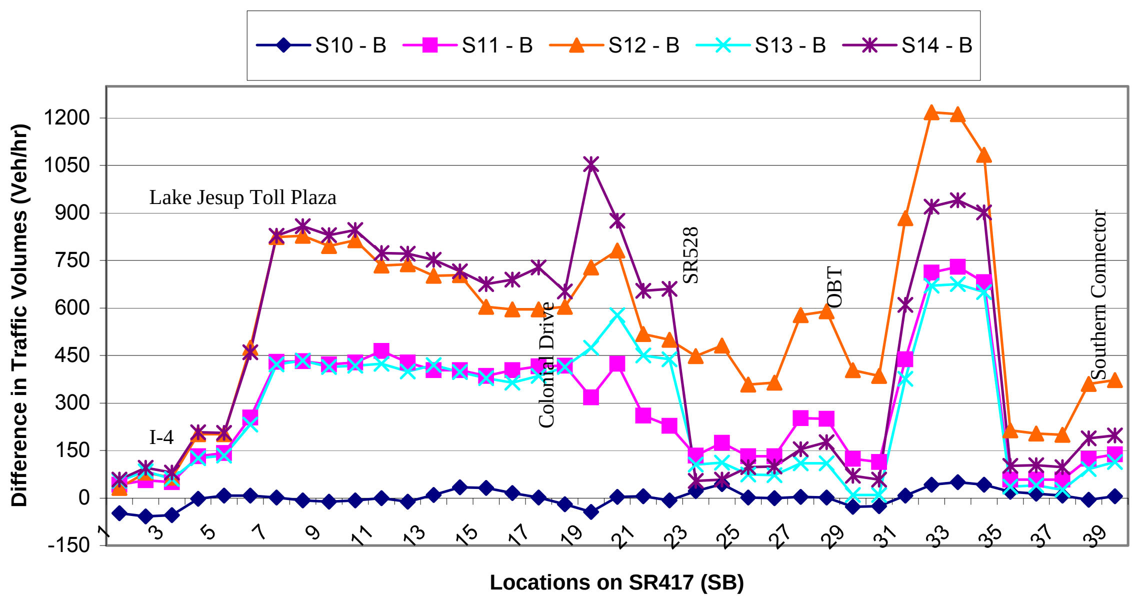


Figure 42: Difference in Traffic Volumes on SR417 Southbound Under Various Toll Reduction Scenarios with Lane Closure on I-4 "Scenarios Group 3-G3"

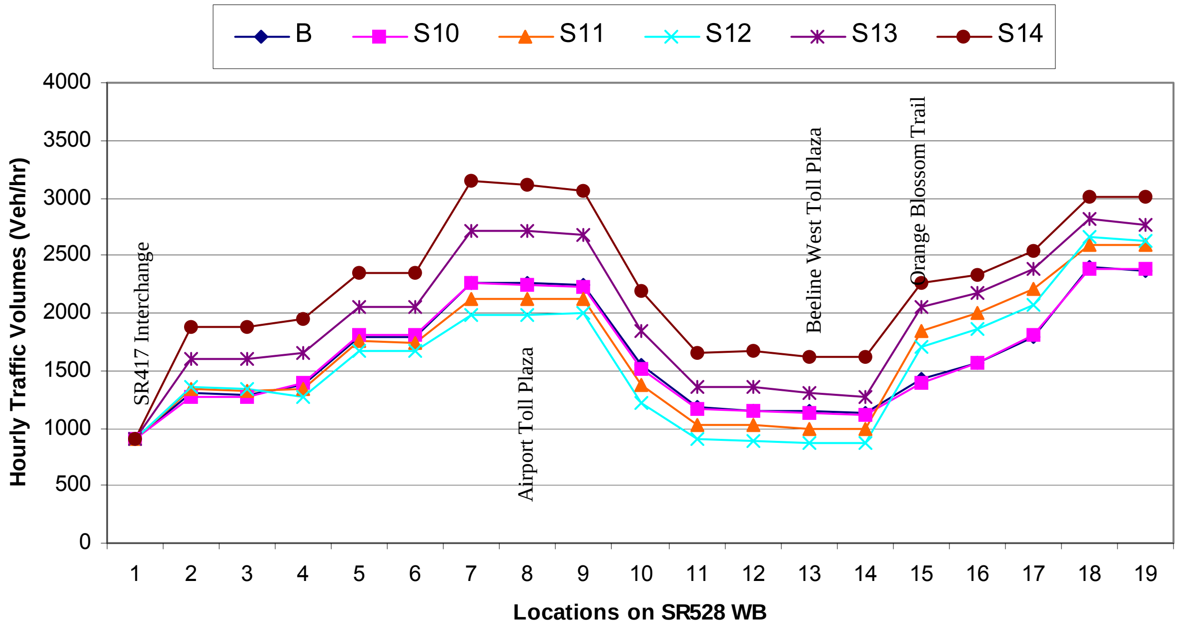


Figure 43: Hourly Traffic Volumes on SR528 Westbound Under Various Toll Reduction Scenarios with Lane Closure on I-4 "Scenarios Group 3-G3"

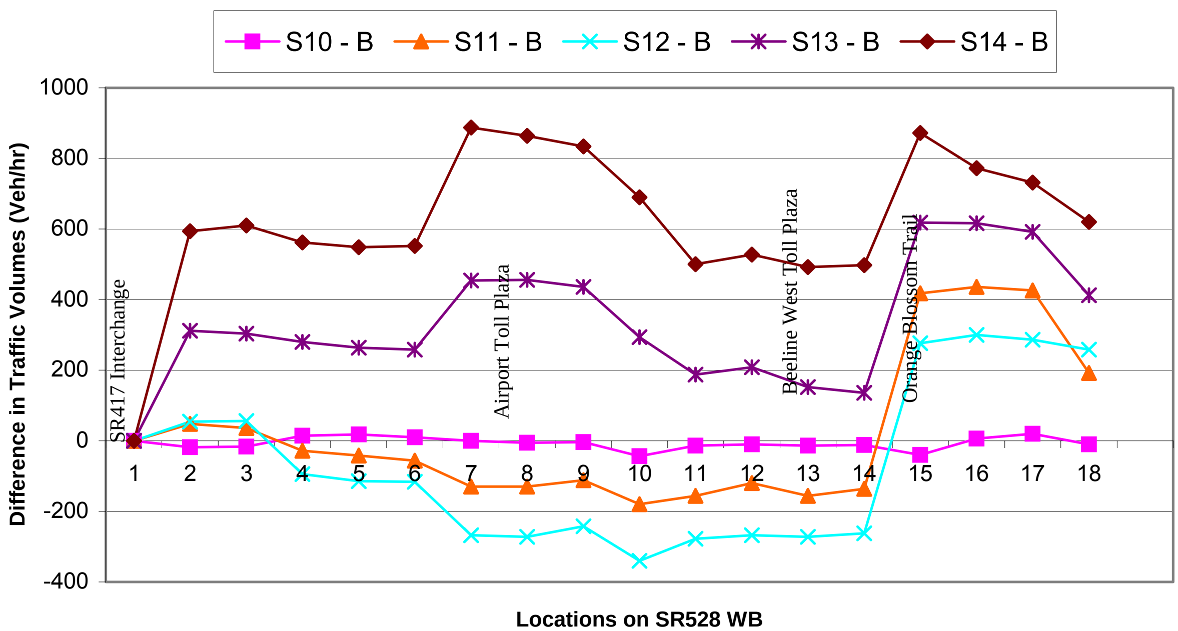


Figure 44: Difference in Traffic Volumes on SR528 Westbound Under Various Toll Reduction Scenarios with Lane Closure on I-4 "Scenarios Group 3-G3"

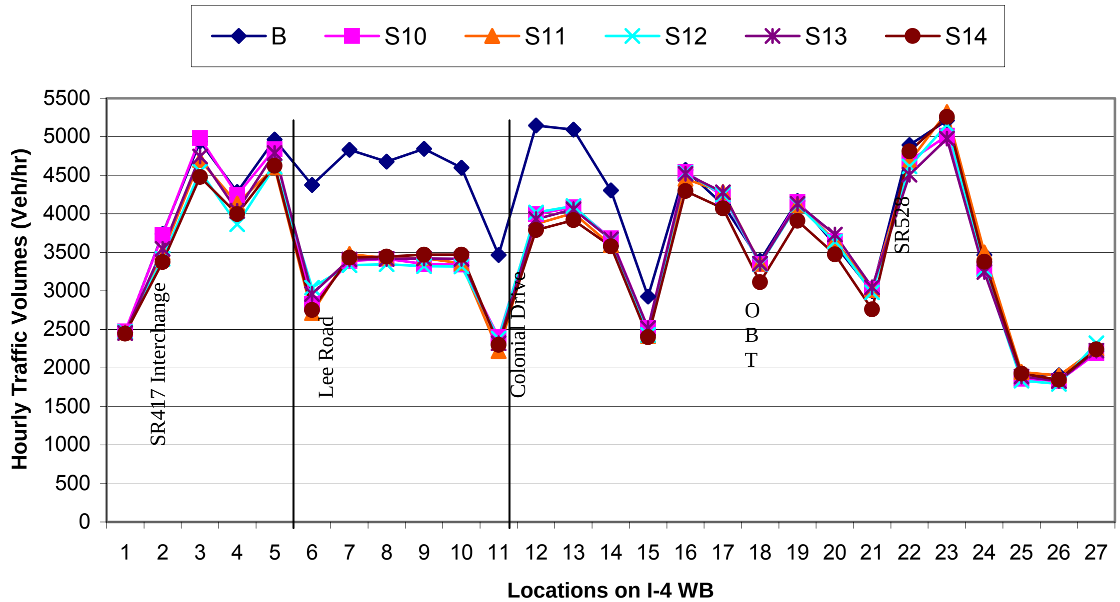


Figure 45: Hourly Traffic Volumes on I-4 Westbound Under Various Toll Reduction Scenarios with Lane Closure on I-4 "Scenarios Group 3-G3"

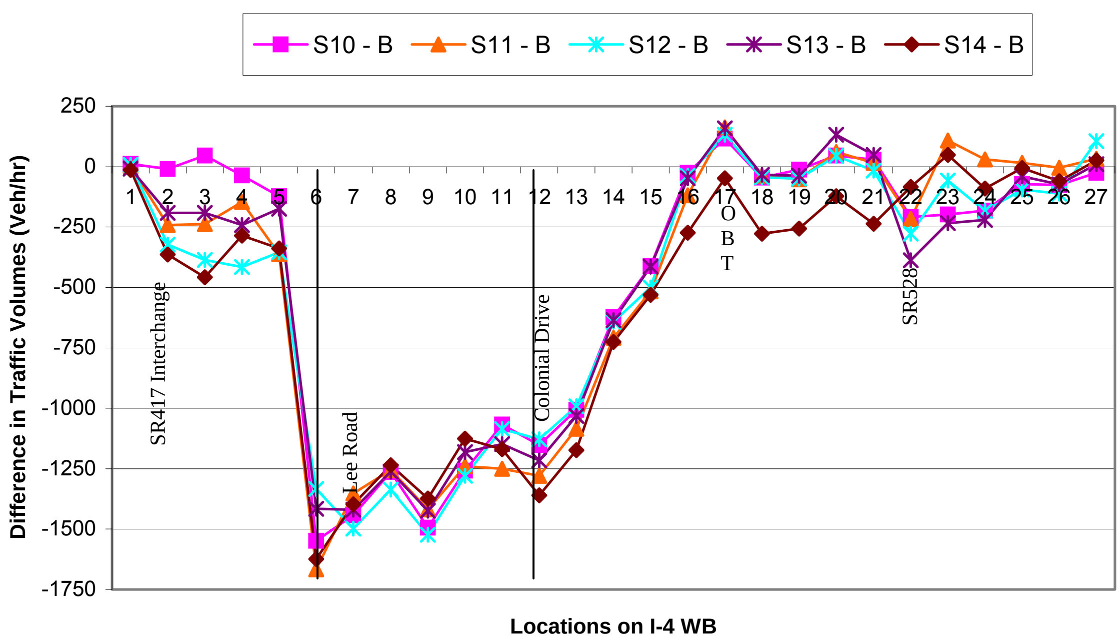


Figure 46: Difference in Traffic Volumes on I-4 Westbound Under Various Toll Reduction Scenarios with Lane Closure on I-4 "Scenarios Group 3-G3"

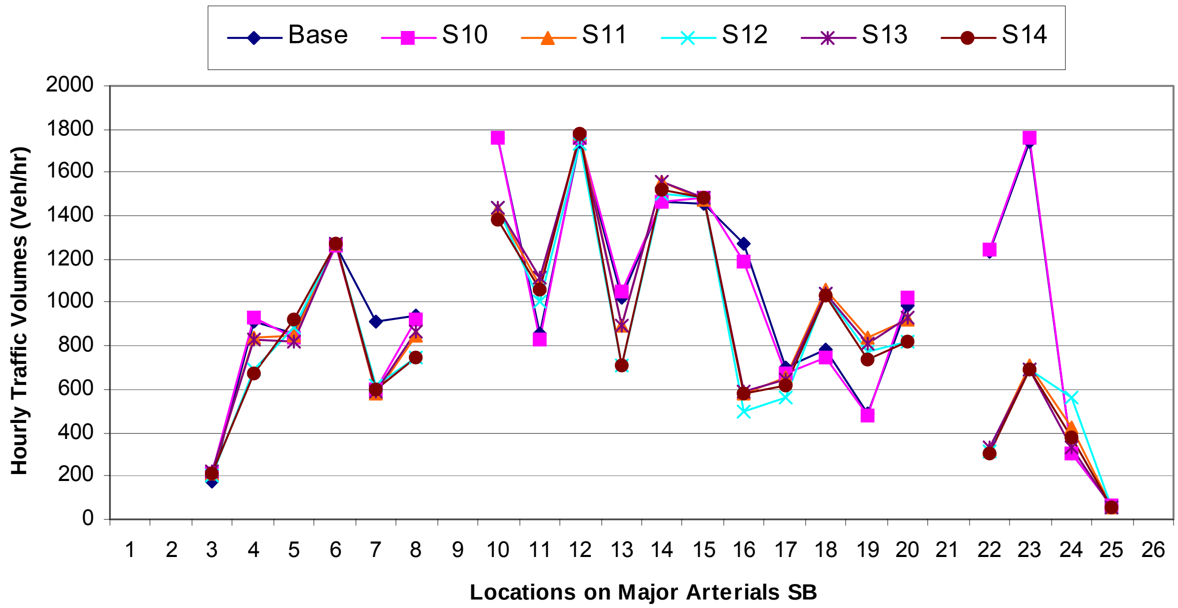


Figure 47: Hourly Traffic Volumes on Major Arterials Southbound Under Various Toll Reduction Scenarios with Lane Closure on I-4 "Scenarios Group 3-G3"

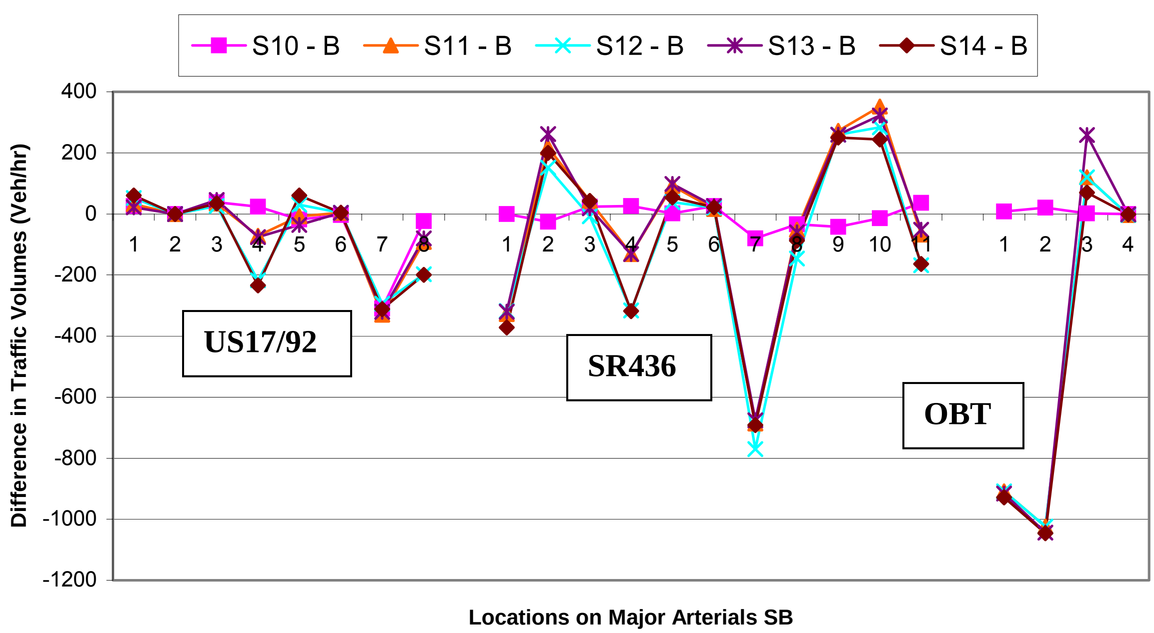


Figure 48: Difference in Traffic Volumes on Major Arterials Southbound Under Various Toll Reduction Scenarios with Lane Closure on I-4 "Scenarios Group 3-G3"

6.2.4 Analysis of Scenarios Group 4 - G4

For these scenarios, the alternative toll plans for Lane Closure (LC) on I-4 beginning **just west** of Florida Turnpike (SR91) (location 20 in Table 11 for I-4 west) to **just east** of Central Florida Parkway (location 22 in Table 11 for I-4 west) including SR528 and SR482 intersections were evaluated. The Base scenario represented the volumes under recurring congestion, while S15 represents the volumes under this lane closure and without toll reduction. S16-S19 represented volumes under lane closure with the toll reduction alternatives. From the graphical representation of Group4 (or G4) scenarios, the following observations were reported:

<u>SR417 (South Direction)</u>

- It can be seen from Figure 49 and Figure 50 that the base scenario and scenario S15 (one lane closure in each direction on I-4) are almost identical. This is because the vehicles do not divert to SR417 in the absence of toll reduction, in spite of the lane closure.
- It can be seen from Figure 50 that scenarios S16 (lane closure on I-4 & 50% reduction on SR417) and S18 (lane closure on I-4 & 50% toll reduction on SR417 & SR528) are almost identical from Lake Mary to University Plaza (location 6 to location 18 in Table 10 for SR417 south). The differences in traffic volumes compared to the base scenario range from 200 to 400 veh/hr. These vehicles may have their destinations east of Central Florida Parkway on I-4. Therefore there is a drop in the number of vehicles for scenarios S16 and S18 near University toll plaza on SR417 (location 19

in Table 10 for SR417 south) as vehicles use the colonial drive exit to reach their destinations. South of University Plaza to the Beeline Expressway (location 19 – location 22 in Table 10 for SR417 south), reducing the tolls on SR528 along with SR417 will increase the number of diverted vehicles to SR417, because the drivers will have two alternatives: Use SR417 or use SR528 and then use I-4. The difference between the two scenarios is not as marked, due to a lane closure on I-4 at the SR528 interchange. South of the Beeline Expressway interchange (location higher than 22 in Table 10 for SR417 south), there is a drop on the volume on SR417 under scenario S16 when compared to scenario S18 as the drivers diverted to SR528. There is a sudden spike near OBT (location 30 in Table 10 for SR417 south) for scenarios S16 and S18 (up to 700 veh/hr) as the number of vehicles with destinations towards Disney area would use OBT, SR528 and SR417 as their alternatives to I-4.

- Also, it can be seen from Figure 50 that scenarios S17 (lane closure on I-4 & 100% reduction on SR417) and S19 (lane closure on I-4 & 100% toll reduction on SR417 & SR528) have the same performance to the differences in traffic volume between scenarios S6 and S8 respectively. From US17/92 to University Plaza (location 6 to location 18 in Table 10 for SR417 south), the difference from the base scenario ranges from 200 to 800 veh/hr. Between University Plaza and Beeline Expressway, (location 19 –location 22 in Table 10 for SR417 south) the differences compared to the base scenario were found approximately on average 650 and 850 veh/hr for scenarios S17 and S19 respectively. The reason of the high drop in the number of vehicles diverted to SR417 in scenario S19 south of SR528 is the removal of the SR528 tolls. Between scenarios S17 and S19, the differences of volumes compared to the base scenario for locations between the Beeline Expressway and OBT (location 22 to location 29 in Table 10 for SR417 south) are 400 and 100 veh/hr respectively. As for scenarios S16 and S18, we find a spike in near OBT (location 30 in Table 10 for SR417 south) for scenarios S17 and S19. In this case, the differences in volumes compared to the base scenario are found to be about 800 veh/hr for both S17 and S19 scenarios.

Based on the above observations, we conclude that: North of University Toll Plaza, both 50% and 100% toll reduction will promote drivers to use SR417. The reduction in volumes due to 50% reduction of tolls on SR528 has a marginal affect on the volumes on SR417 though complete removal of toll on SR528 produces a significant drop in SR417's usage. As a result, if we are willing to increase the number of vehicles diverting to SR417 only, then it is recommended to reduce the tolls on SR417 only. It is not clear how much toll reduction should be introduced at this stage (50% or 100%). This is a topic of a future research project that is a natural continuation of this project. Also, we did not differentiate between vehicle types in this analysis as all vehicles were grouped together as one population (SunPASS, Manual, and Exact Coin).

SR528 (West Direction)

- It can be seen from Figure 51 and Figure 52 that as we move westwards on SR528, the volumes on SR528 are reduced between 100 veh/hr to 500 veh/hr till OBT (location 14 in Table 10 for SR528 west) for scenarios S15 – S17 compared to the base scenario. For lane closure on I-4, the volumes on SR528 are reduced by about

100 veh/hr (S15) upto Orange Blossom Trail (location 14 in Table 10 for SR528 west). These vehicles could be using alternate routes to I-4.

- Also, it can be seen from Figure 52 that there is no significant differences in traffic volumes between scenarios S15 and S16. This means that the number of vehicles diverting to SR528 from SR417 has not changed significantly due to reduction of toll on SR417. On the other hand, it can also be seen from Figure 52 that removal of tolls on SR417 only (S17) encourages about 200 veh/hr to be off SR528 and use SR417 or arterials as an alternative. Also, most of the vehicles on SR528 west bound exit near OBT (location 14 in Table 10 for SR528 west) due to the construction on I-4.
- It can be seen from Figure 52 that scenarios S18 and S19 introduce SR528 into the toll plans, and there is a significant increase in volumes on SR528 till OBT. Most of the vehicles then exit on OBT to avoid the lane closure on I-4. Only complete removal of tolls on SR528 can retain some vehicles to continue on SR528 onto I-4.

I-4 (West Direction)

- It can be seen from Figure 53 and Figure 54 that the difference between the Base and scenario S15 is close to zero until Turnpike (location 20 in Table 11 for I-4 west) on westbound on I-4. This means that for a lane closure (represented by the two vertical lines in the above two figures), the vehicles do not divert until they reach the location of the lane closure. Then, drivers got on to either OBT or Turnpike to reach their destinations.
- It can be seen from Figure 54 that when the toll is reduced, we find that there is a difference of about 300 – 500 veh/hr on I-4 near Lake Mary area (location 1 to

location 8 in Table 11 for I-4 west). This difference in traffic volume compared to the base scenario exists up to Fairbanks (location 8 in Table 11 for I-4 west). This is when vehicles are diverting probably to the "reduced" toll facilities (SR417 in this case). On the other hand, reducing tolls on SR528 does not seem to have a significant impact on the mitigation of traffic on I-4.

Major Arterials (South Direction)

- It can be seen from Figure 55 and Figure 56 that the difference in base scenario volumes and scenario S15 for US17/92 and SR436 are insignificant. Some volumes diverted from US17/92 to SR417 for toll reduction scenarios. OBT has high differences due to diversion of volumes at the location of the lane closure.
- Also, there is a consistent drop in the traffic volumes on SR436 (Semoran Blvd) and OBT because a significant amount of volumes are diverted to SR417 and SR438 due to the toll reduction. It can be concluded that the more toll reduction on SR417 and SR528 the higher the number of vehicles diverted to SR417 as expected.

The tables for the hourly traffic volumes for I-4, SR417, SR528 and major arterials for G4 are included in Appendix B.

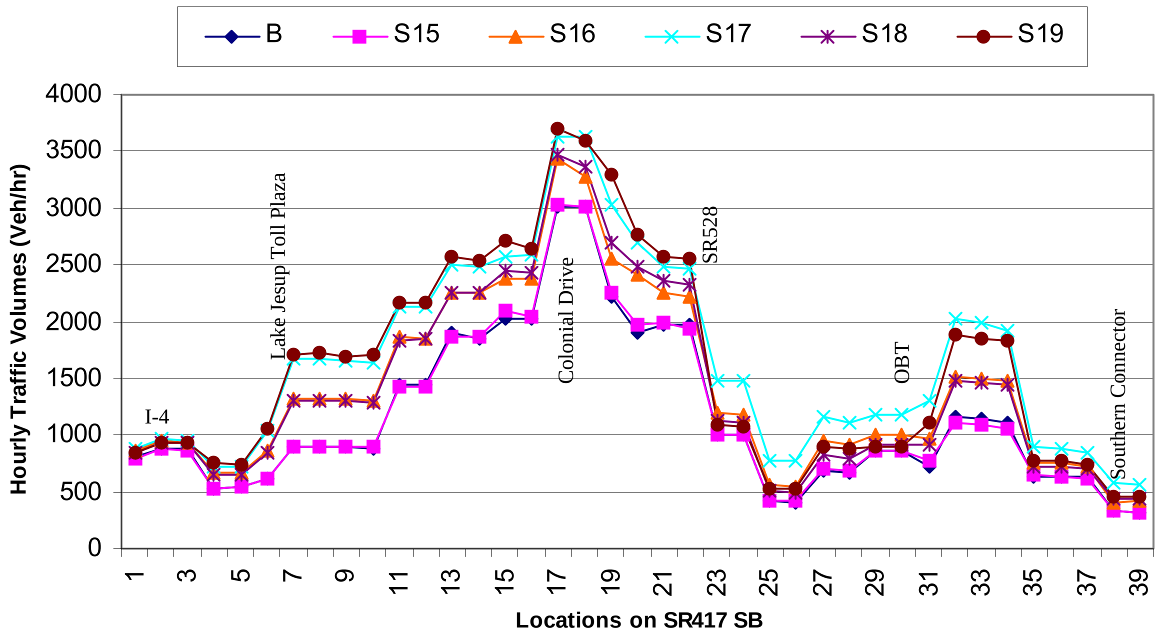


Figure 49: Hourly Traffic Volumes on SR417 Southbound Under Various Toll Reduction Scenarios with Lane Closure on I-4 "Scenarios Group4-G4"

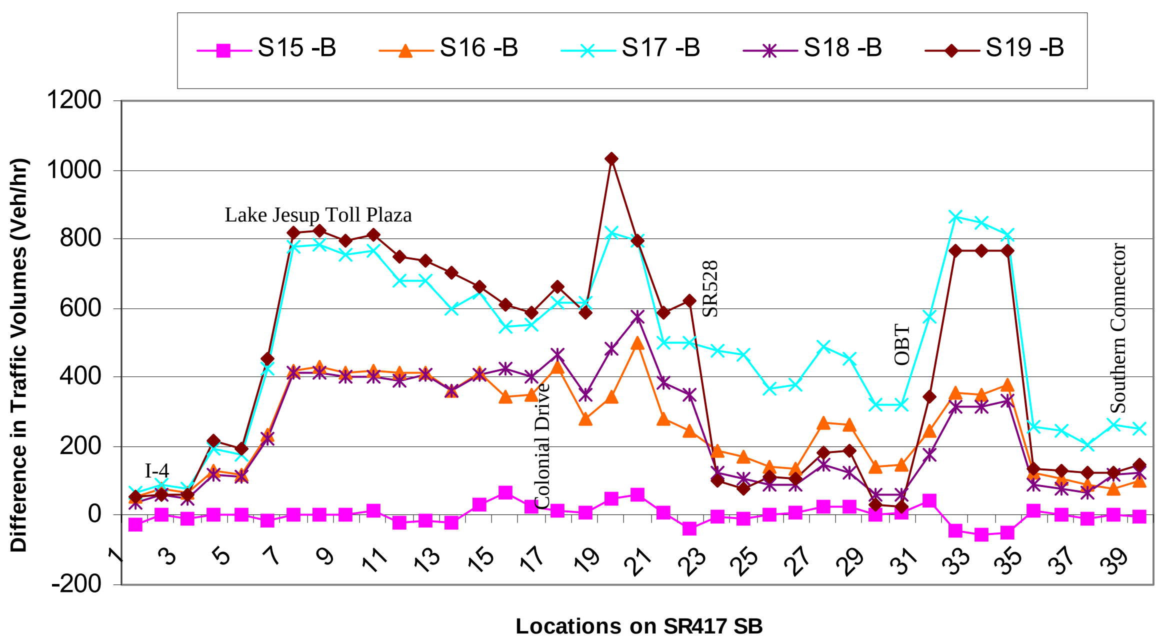


Figure 50: Difference in Traffic Volumes on SR417 Southbound Under Various Toll Reduction Scenarios with Lane Closure on I-4 "Scenarios Group4-G4"

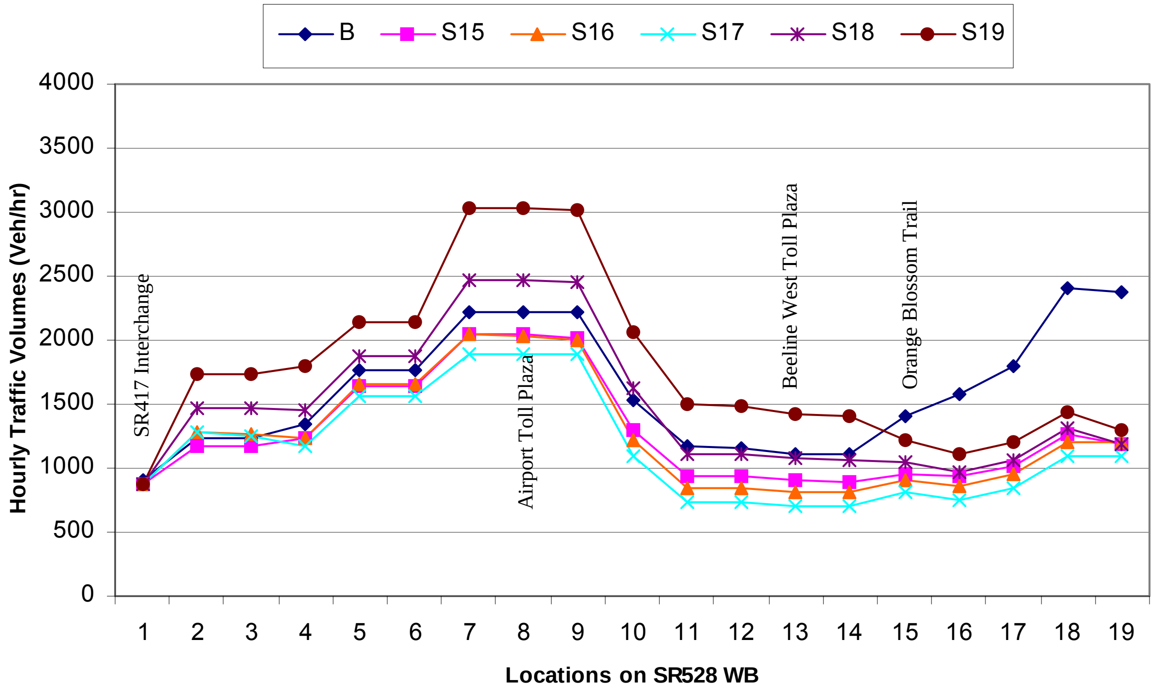


Figure 51: Hourly Traffic Volumes on SR528 Westbound Under Various Toll Reduction Scenarios with Lane Closure on I-4 "Scenarios Group4-G4"

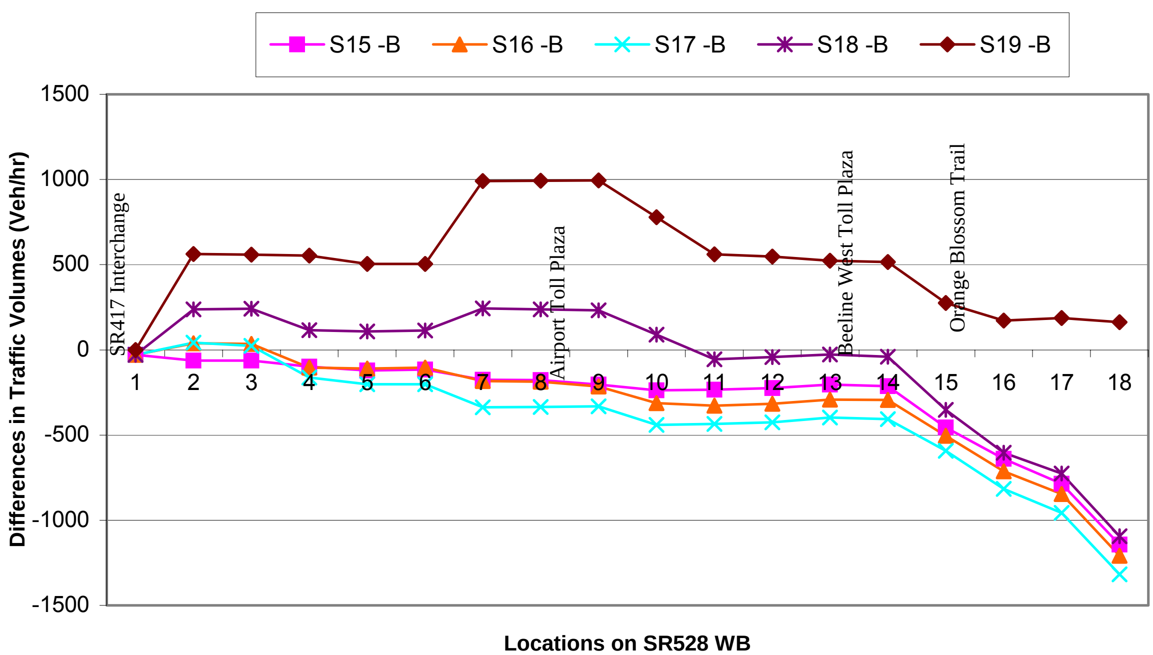


Figure 52: Difference in Traffic Volumes on SR528 Westbound Under Various Toll Reduction Scenarios with Lane Closure on I-4 "Scenarios Group4-G4"

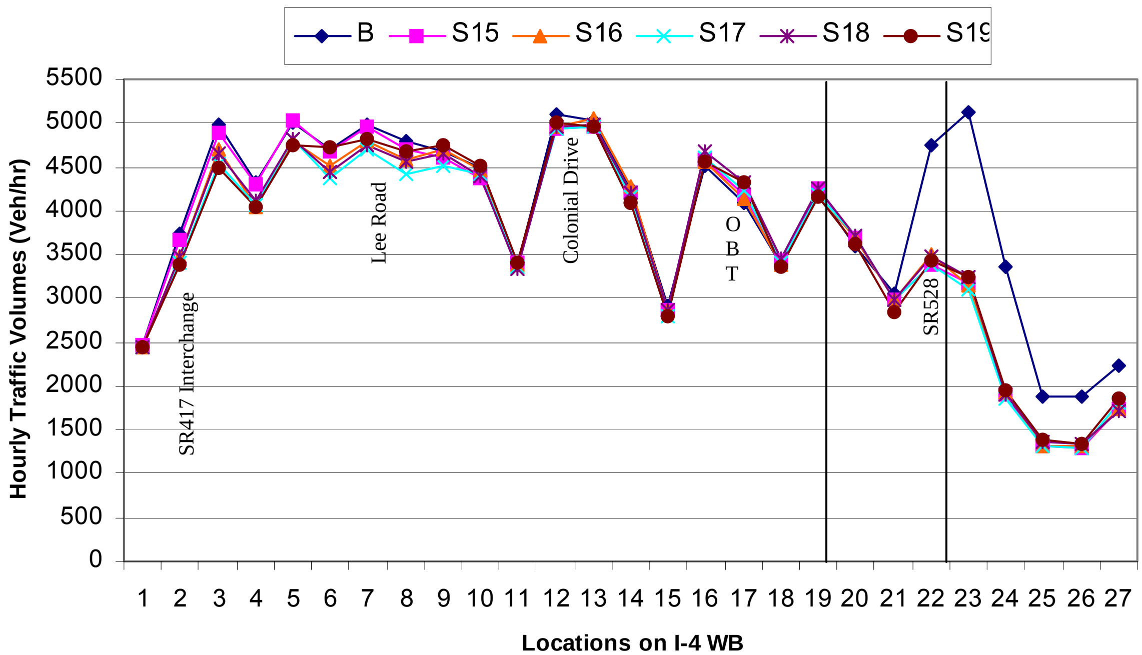


Figure 53: Hourly Traffic Volumes on I-4 Westbound Under Various Toll Reduction Scenarios with Lane Closure on I-4 "Scenarios Group4-G4"

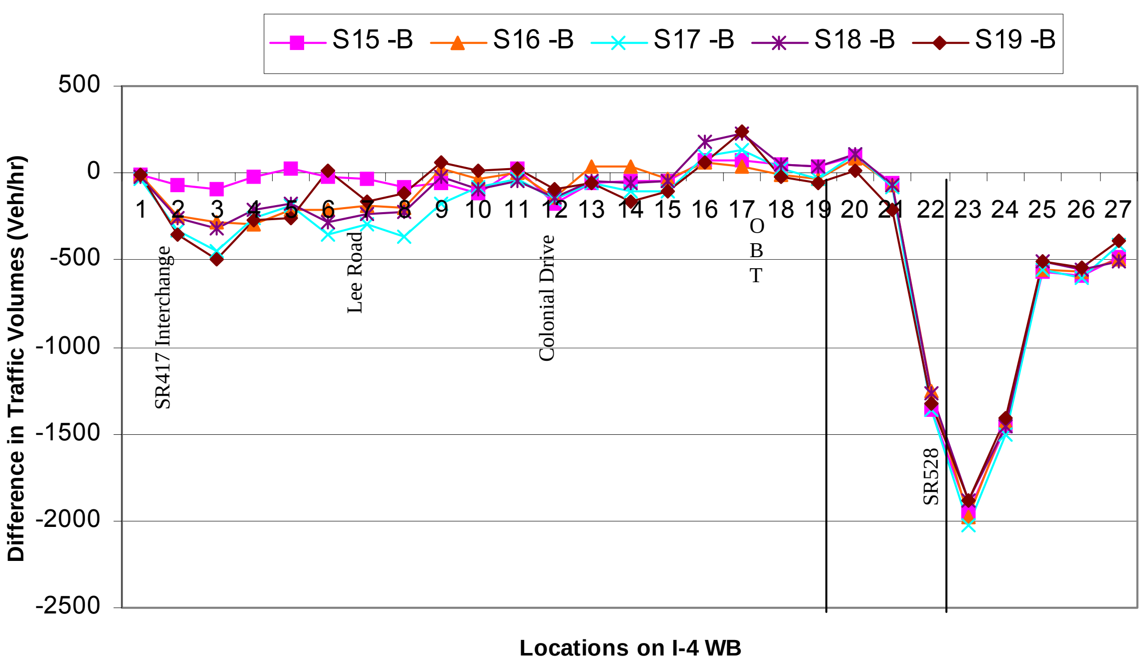


Figure 54: Difference in Traffic Volumes on I-4 Westbound Under Various Toll Reduction Scenarios with Lane Closure on I-4 "Scenarios Group4-G4"

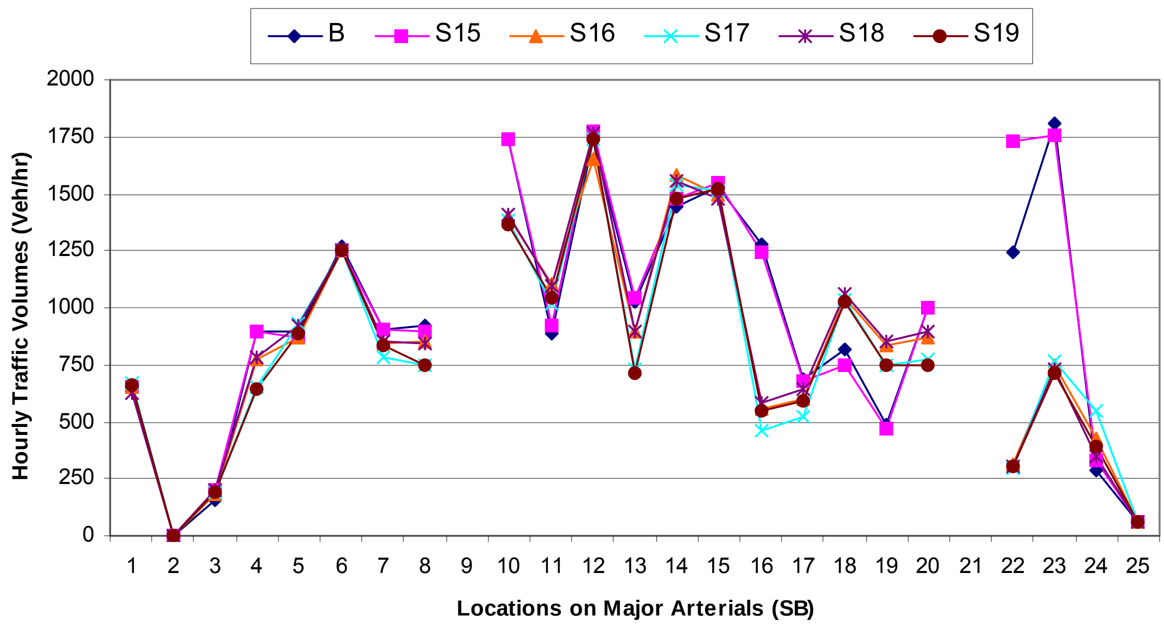


Figure 55: Hourly Traffic Volumes on Major Arterials Southbound Under Various Toll Reduction Scenarios with Lane Closure on I-4 "Scenarios Group4-G4"

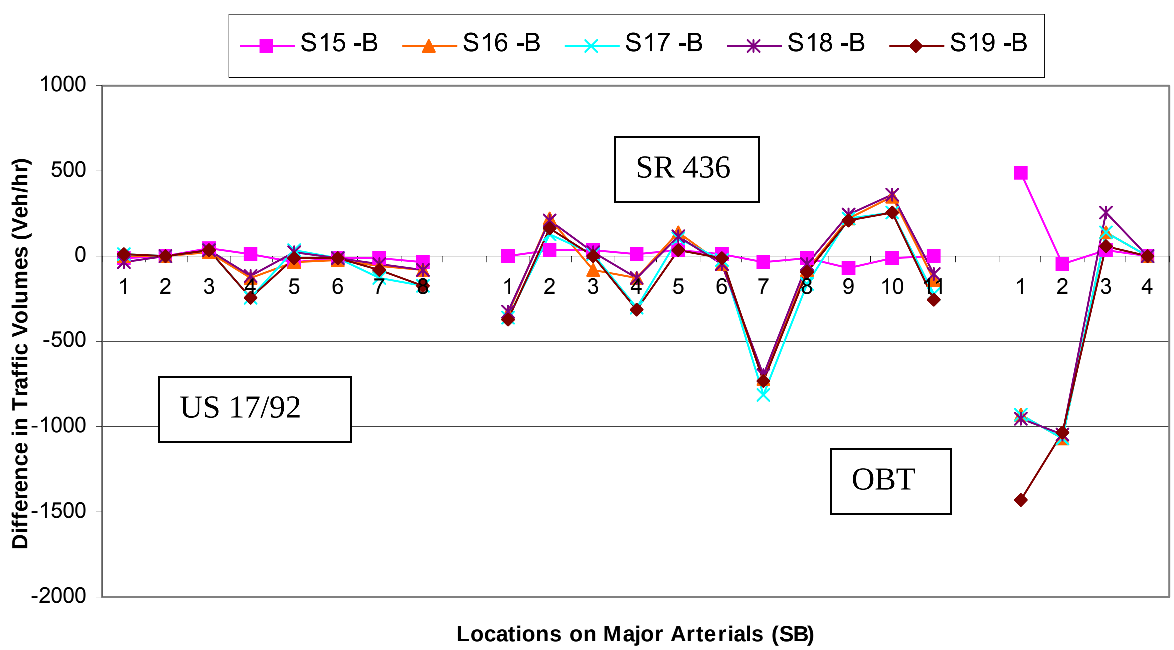


Figure 56: Difference in Traffic Volumes on Major Arterials Southbound Under Various Toll Reduction Scenarios with Lane Closure on I-4 "Scenarios Group4-G4"

6.2.5 Analysis of Scenarios Group 5 - G5

For these scenarios, the alternative toll plans for incident on I-4 westbound between Maitland Blvd and Lee Road were evaluated (location 6 in Table 11 for I-4 west). An incident was simulated at location 6 on I-4 west that occurred half an hour after the start of the simulation. The incident resulted in closure of two out of three lanes from 7:00 – 7:30 AM, and one out of three from 7:30-8:00 AM. The behavior of drivers for incident scenario is different from the lane closure scenarios because the drivers can have only en-route information for the incident. While for the lane closures, they have pre-trip information. The Base scenario represented the volumes under recurring congestion, while S20 represented the volumes under this incident and without toll reduction. S21-S24 represented volumes under incident conditions with toll alternative reduction. From the graphical representation of Group5 (or G5) scenarios, the following observations were reported:

<u>SR-417 (South Direction)</u>

- It can be seen from Figure 57 and Figure 58 that the base scenario and scenario S20 (incident on I-4 in west direction) are almost identical except from SR434 to University Blvd (location 10 to location 16 in Table 10 for SR417 south). This means that about 200 veh/hr have diverted to SR417 under the existing mainline toll plan to avoid the incident on I-4.
- It can be seen from Figure 58 that scenarios S21 (incident on I-4 & 50% reduction on SR417) and S23 (incident on I-4 & 50% toll reduction on SR417 & SR528) are almost identical from I-4 interchange to University Plaza (location 1 to location 16 in

Table 10 for SR417 south). The differences in traffic volumes compared to the base scenario range from 100 to 600 veh/hr. These vehicles may have their destinations west of Lee Road (location 6 on I-4 west from Table 10, which is passing the location of the incident). Therefore there is a drop in the number of vehicles for scenarios S21 and S23 south of Colonial drive on SR417 (location 19 in Table 10 for SR417 south). South of the Beeline Expressway interchange (location 24 in Table 10 for SR417 south), there is a drop on the volume in SR417 volume under scenarios S21 and S23 as the drivers divert to SR528 to get on I-4. Also, there is a sudden spike near OBT (location 31 in Table 10 for SR417 south) for scenarios S21 and S23 (up to 400 veh/hr) as the number of vehicles with destinations towards Disney area would use OBT, then SR417 as an alternative to I-4.

- Also, it can be seen from Figure 58 that scenarios S22 (lane closure on I-4 & 100% reduction on SR417) and S24 (lane closure on I-4 & 100% toll reduction on SR417 & SR528) have the same performance in terms of the differences in traffic volume between scenarios S21 and S23 respectively. From US17/92 to Colonial Drive (location 6 to location 19 in Table 10 for SR417 south), the differences compared to the base scenario range from 600 to 800 veh/hr. Between Colonial Drive and Beeline Expressway (location 19 to location 24 in Table 10 for SR417 south), the differences compared to the base scenario were about 500 and 700 veh/hr for scenarios S22 and S24 respectively. The reason of this high drop in the number of vehicles diverted to SR417 in scenario S24 south of SR528 is the removal of SR528 tolls. For scenarios S22 and S24, the differences in volumes compared to the base scenario for the locations between the Beeline Expressway and OBT (location 24 to location 30 in

Table 10 for SR417 south) are about 400 and 100 veh/hr respectively. Also, there is a spike near OBT (location 31 in Table 10 for SR417 south) with about 800 veh/hr difference in traffic volume.

Based on the above observations, we conclude that: North of University Toll Plaza, both 50% and 100% toll reduction will promote drivers to use SR417. The reduction in volumes due to reduction of tolls on SR528 has a marginal affect on the volumes on SR417 though complete removal of SR528 tolls produces a significant drop in SR417's usage. As a result, if we are willing to increase the number of vehicles diverting to SR417 only, then it is recommended to reduce the tolls on SR417 only. It is not clear how much toll reduction should be introduced at this stage (50% or 100%). This is a topic of a future research project that is a natural continuation of this project. Also, we did not differentiate between vehicle types in this analysis as all vehicles were grouped together as one population (SunPASS, Manual, and Exact Coin).

SR-528 (West Direction)

- It can be seen from Figure 59 and Figure 60 that as we move westwards on SR528, the volumes on SR528 are reduced between 100 to 400 veh/hr till OBT (location 15 in Table 10 for SR528 west) for scenarios S20 – S22 compared to the base scenario. For the occurrence of an incident on I-4 between Maitland Blvd and Lee Road, the volumes on SR528 are reduced by about 150 veh/hr for scenario S20. These vehicles could be using alternate routes to I-4 such as SR417. Also, there is a consistent difference of about 80 veh/hr between scenarios S20 and S21 compared to the base scenario and a difference of about 120 veh/hr between scenarios S21 and S22 as compared to the base scenario, which means that removal tolls of SR417 encourages about 120 veh/hr to be off SR528 and use SR417 or arterials as an alternative.

- It can be seen from Figure 60 that scenarios S23 and S24 introduce SR528 into the toll plans, and there is a significant increase in traffic volumes on SR528 till OBT (location 15 in in Table 10 for SR528 west). The volumes on SR528 are increased on average about 100 veh/hr and 600 veh/hr for scenarios S23 and S24 respectively compared to the base scenario. Most of the vehicles then exit on OBT and use SR417 to avoid the congestion on I-4. Only complete removal of tolls on SR528 can retain some vehicles to continue on SR528 on to I-4.

I-4 (West Direction)

- It can be seen from Figure 61 and Figure 62 that the difference between the Base and S20-S24 are almost identical from SR434 interchange to Universal Dr. interchange (location 4 to location 21 in Table 11 for I-4 west) then there is about 300 veh/hr difference in the traffic volumes due to removal of tolls on the mainline toll plazas as in scenarios S22 and S24.
- The traffic volumes on I-4 dropped significantly by 1600 veh/hr at the incident location between Maitland Blvd and Lee Road (location 6 in Table 11 for I-4 west) on I-4 westbound. These differences in traffic volumes exist up to OBT on I-4 (location 16 in Table 11 for I-4 west). On the other hand, after passing the location of the incident, the drivers have high propensity towards using I-4. Therefore, the differences in traffic volumes compared to the base scenario were found to be about 200 veh/hr on average.

Major Arterials (South Direction)

- It can be seen from Figure 63 and Figure 64 that due to the incident, the difference in base scenario volumes and S20-S24 for US17/92 are insignificant.
- There is a consistent drop in the traffic volumes on SR436 (Semoran Blvd) and OBT because a significant amount of volumes are diverted to SR417 and SR528 due to the toll reduction.

The tables for the hourly traffic volumes for I-4, SR417, SR528 and major arterials for G5 are included in Appendix B.

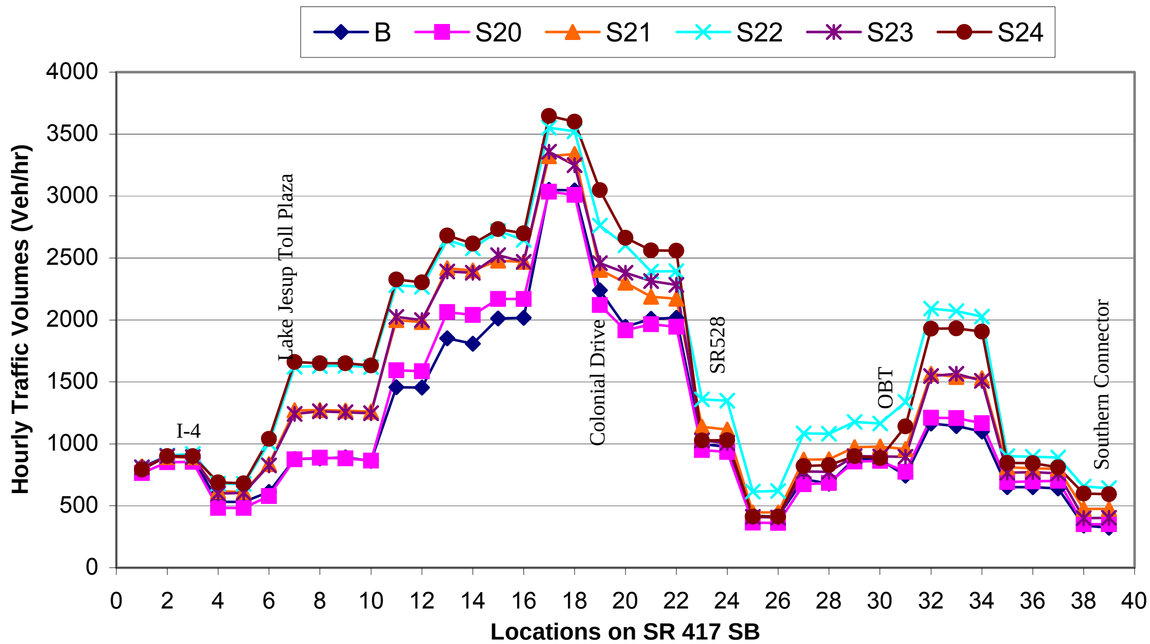


Figure 57: Hourly Traffic Volumes on SR417 Southbound Under Various Toll Reduction Scenarios with an Incident on I-4 "Scenarios Group5-G5"

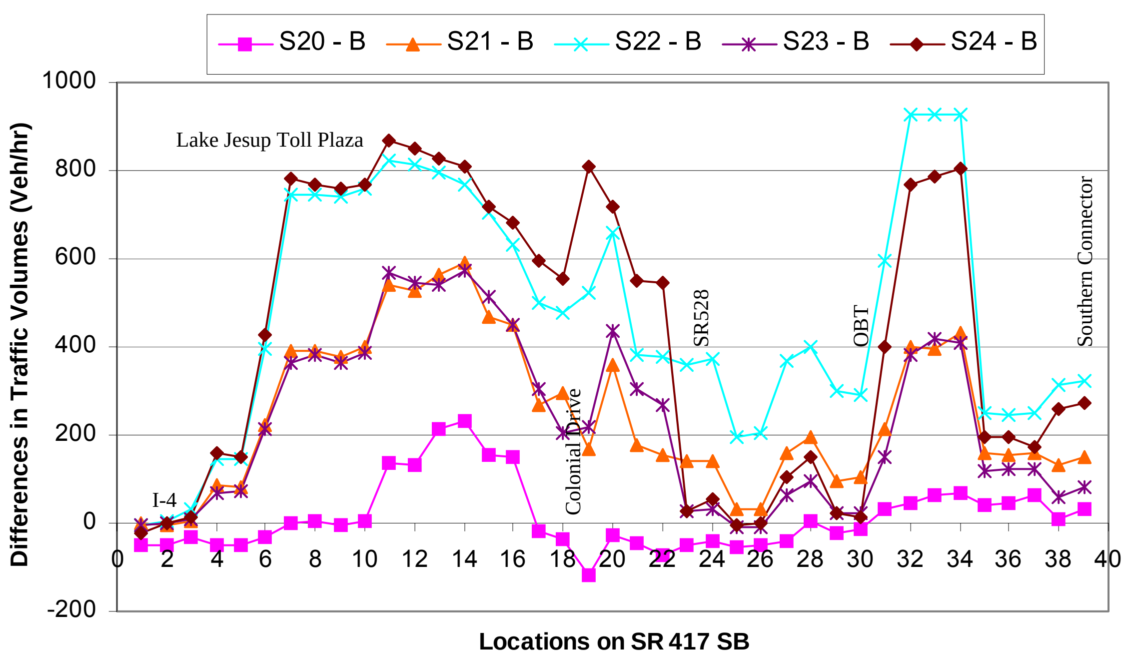


Figure 58: Difference in Traffic Volumes on SR417 Southbound Under Various Toll Reduction Scenarios with an Incident on I-4 "Scenarios Group5-G5"

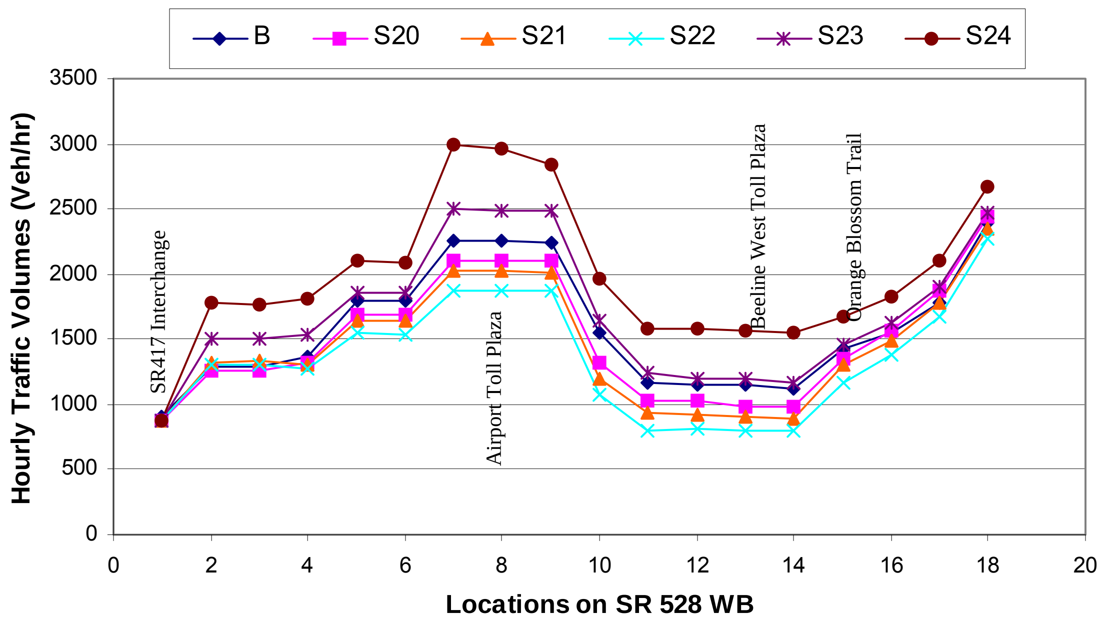


Figure 59: Hourly Traffic Volumes on SR528 Westbound Under Various Toll Reduction Scenarios with an Incident on I-4 "Scenarios Group5-G5"

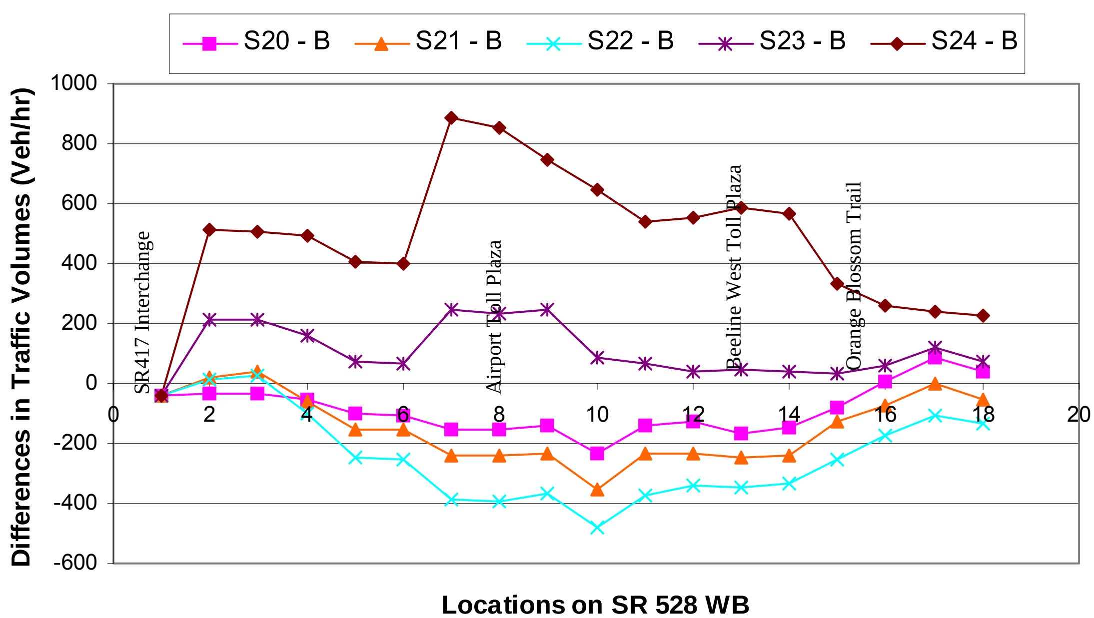


Figure 60: Difference in Traffic Volumes on SR528 Westbound Under Various Toll Reduction Scenarios with an Incident on I-4 "Scenarios Group5-G5"

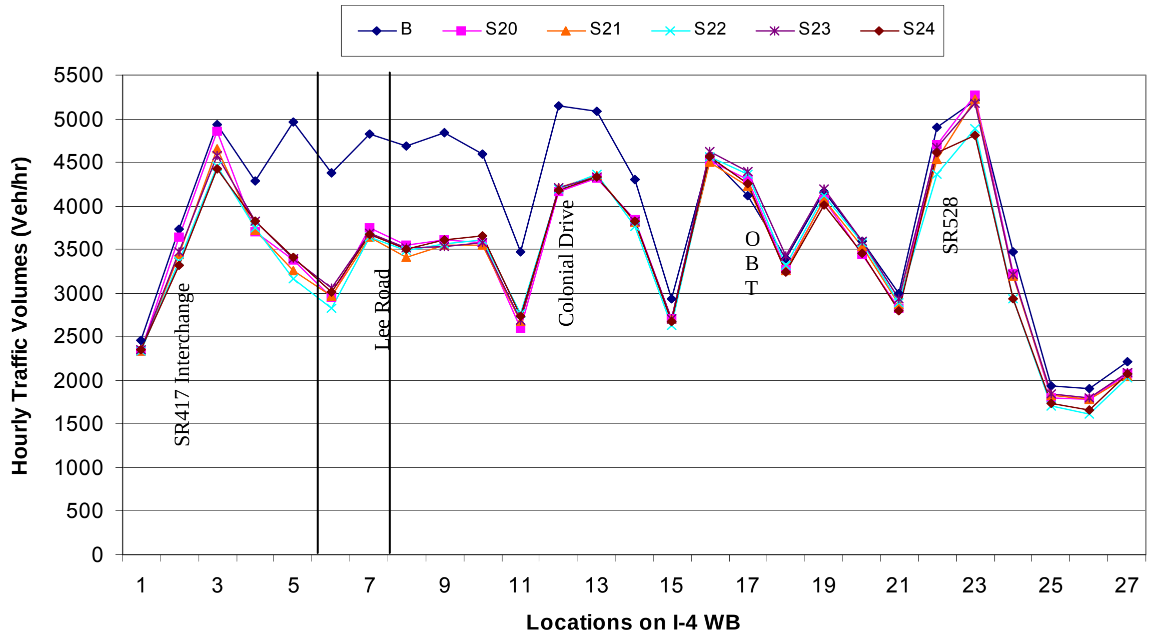


Figure 61: Hourly Traffic Volumes on I-4 Westbound Under Various Toll Reduction Scenarios with an Incident on I-4 "Scenarios Group5-G5"

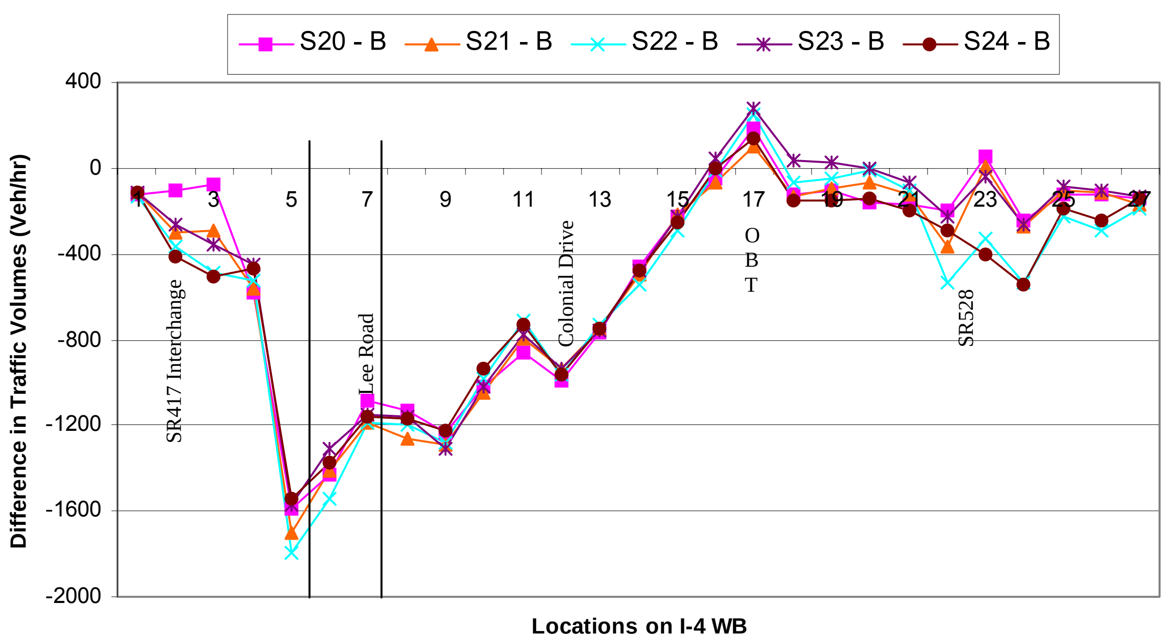


Figure 62: Difference in Traffic Volumes on I-4 Westbound Under Various Toll Reduction Scenarios with an Incident on I-4 "Scenarios Group5-G5"

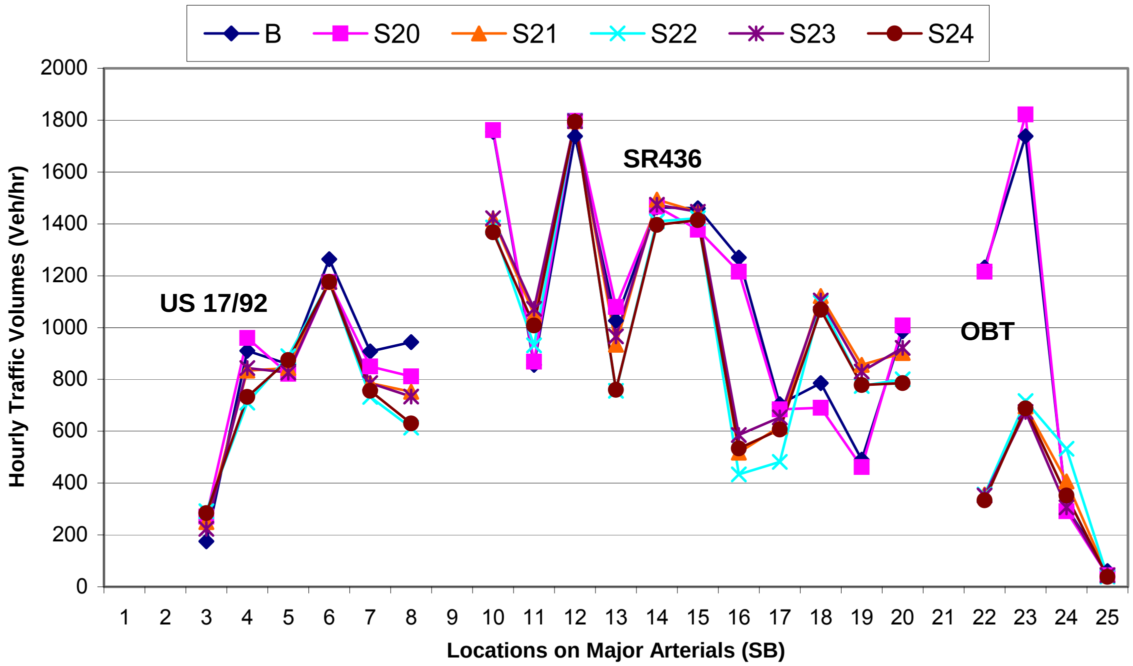


Figure 63: Hourly Traffic Volumes on Major Arterials Southbound Under Various Toll Reduction Scenarios with an Incident on I-4 "Scenarios Group5-G5"

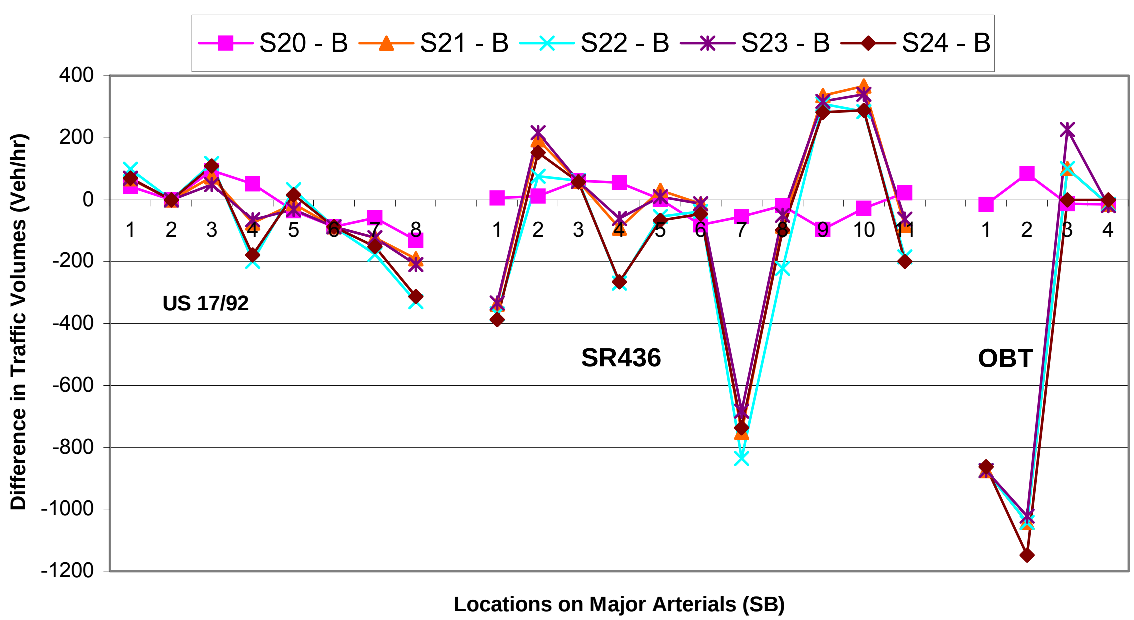


Figure 64: Difference in Traffic Volumes on Major Arterials Southbound Under Various Toll Reduction Scenarios with an Incident on I-4 "Scenarios Group5-G5"

6.3 ROUTE DIVERSION ANALYSIS BETWEEN SPECIFIC O-D PAIRS

Several simulation scenarios were conducted to investigate the impact of varying tolls on the Central Florida network during the peak hour. In this analysis, the percentage of route diversion and the average travel time were analyzed between specific O-D pairs as measures of performance and effectiveness. The three O-D pairs used in this analysis as shown in Figure 65 were as follows:

- O1D1 is from Lake Mary to Disney Area.
- O1D2 is from Lake Mary to University of Central Florida (UCF).
- O1D3 is from Lake Mary to Orlando International Airport (OIA).
- O1Ds is from Lake Mary to all destinations

Figure 65 shows the zones associated with these OD pairs. Lake Mary Area comprises of zones 8, 9, 10 and 12. UCF area comprises of zones 5 and 6. OIA area comprises of zones 50 and 51. Disney Area comprises of zones 1, 2, 55 and 57. These specific O/D pairs were chosen because they represent the Westbound/Southbound morning peak travel directions and at the same time travelers have access to alternative routes between their origins and destinations. These alternatives were "I-4", "US17/92", and "SR417".

From Lake Mary to Disney Area (O1D1)

The results showed that I-4 was the only route chosen in most of the scenarios, even when tolls on SR417 and/or SR528 were reduced or eliminated. A possible reason for this result was because I-4 represented the physical shortest path (42 miles) compared to the other alternatives (SR417 – 58 miles, SR417+SR528+I-4 route – 58 miles). In addition, it was the only alternative that directly connects between this origin and destination. Figure 66 demonstrates the chosen alternatives in each scenario. The graphical representation helps in the visual inspection to identify where the diversion occurs, and at the same time compares each scenario to the base scenario. Figure 66 shows that a minor diversion from I-4 occurred only in the case of complete removal of tolls on SR417and SR528 (S4, S9, S14, S19, S24).

From Lake Mary to University of Central Florida Area (O1D2)

The results showed that SR417 was the only route that was chosen in most of the scenarios. The possible reason for this result was because SR417 represented the physical shortest path compared to the other alternatives. In addition, it was the only alternative that directly connected this origin and destination. Figure 67 reveals the chosen alternatives and shows that a diversion from SR417 rarely occurs.

From Lake Mary to Orlando International Airport Area (O1D3)

The results showed that the majority of drivers preferred SR417 than I-4 in most of the scenarios. Figure 68 reveals that a diversion to SR417 occurred in the case of reducing or removing tolls on SR417 only or both SR528 and SR417. Also, when I-4 lane closure scenarios (S5, S10, S15 and S20) were compared to the base scenario, it was noticed that closing one lane on I-4 was not enough to cause drivers to divert to SR417.

From Lake Mary to All Destinations (O1Ds)

The results shown in Figure 69 indicate that I-4 was chosen in most of the scenarios (over 60% of the productions from this origin chose I-4), then SR417 (approximately 20%) and finally US17/92 (usually less than 10%). As a result, only 10% of the total production from this chosen origin might have used either I-4 or SR417 based on the existing construction and toll reduction scenarios. Figure 69 demonstrates the chosen three alternatives in each scenario and shows that a diversion from I-4 occurred in the case of removing or reducing tolls on SR417 only or both SR417 and SR528. It was also found that all drivers have high propensity towards using I-4, even when tolls on the toll roads were reduced or eliminated.

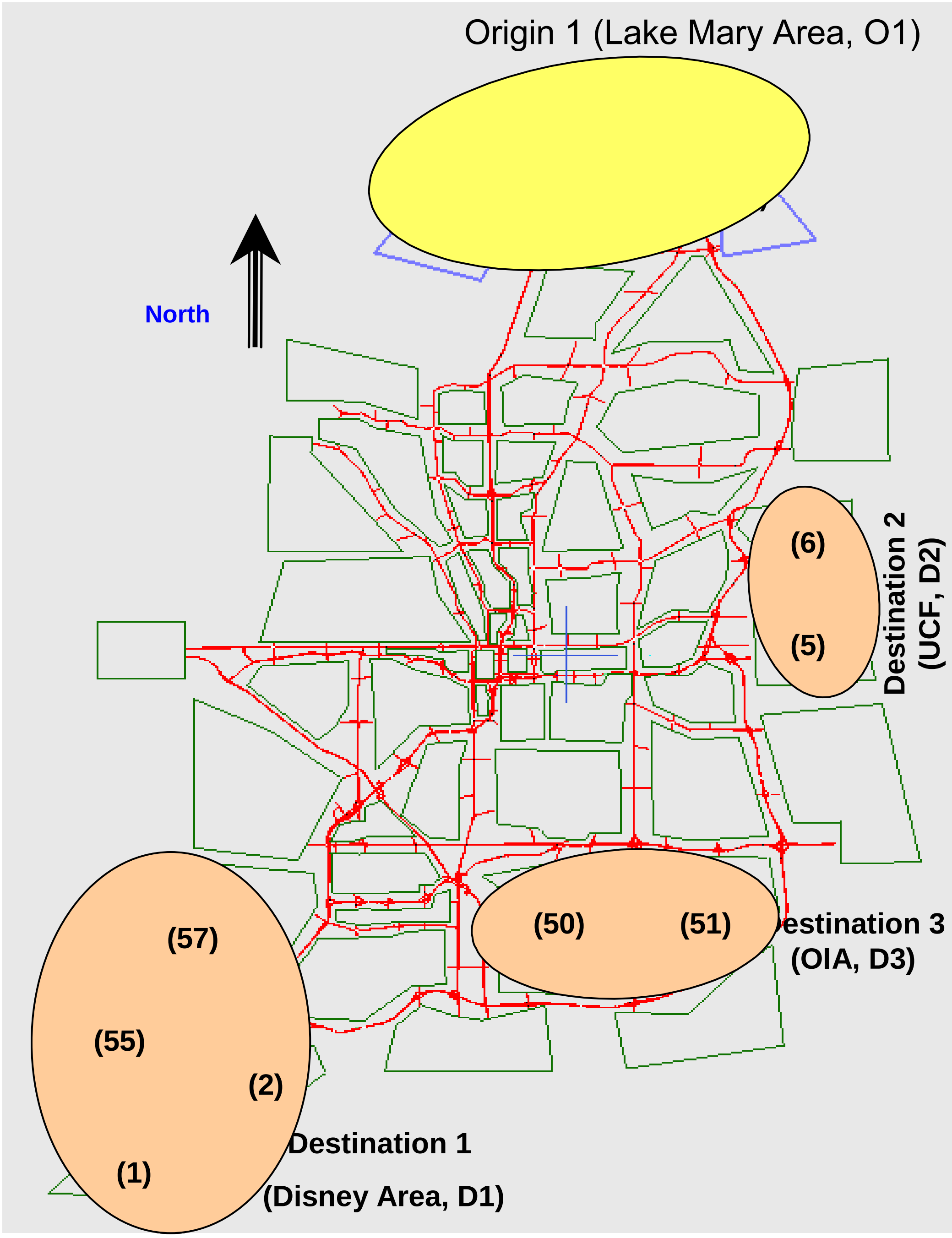


Figure 65: Location of the UCF-PARAMICS Network OD Pairs

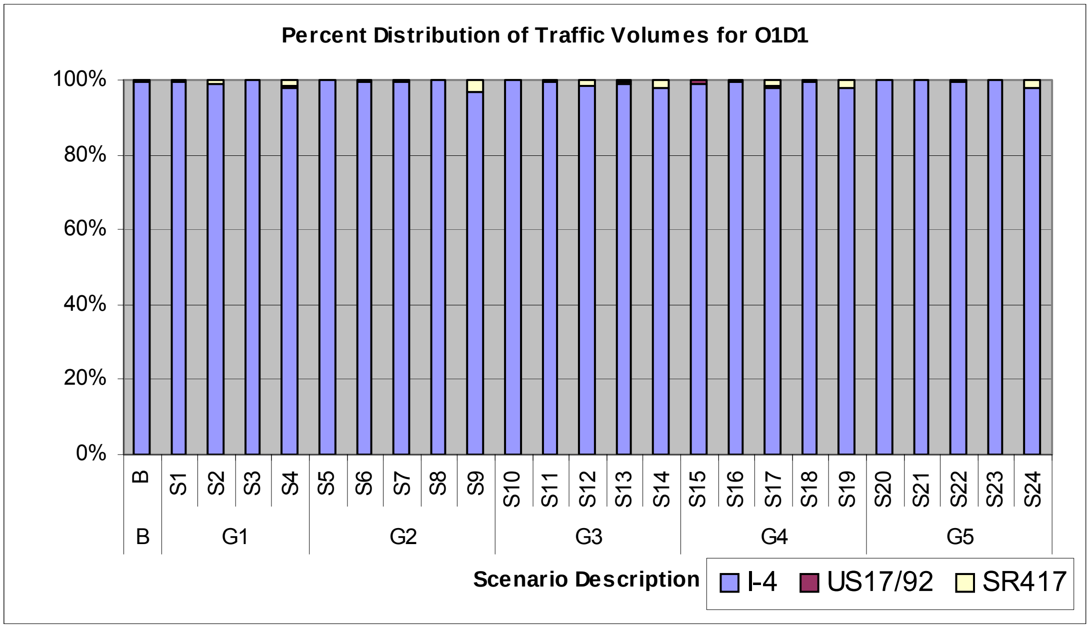


Figure 66: Percent Distribution of Traffic Volumes Using I-4, Us17/92, and Sr417 from Lake Mary Area (Zones: 8, 9, 10 & 12) to Disney Area (Zones: 1, 2, 55 & 57)

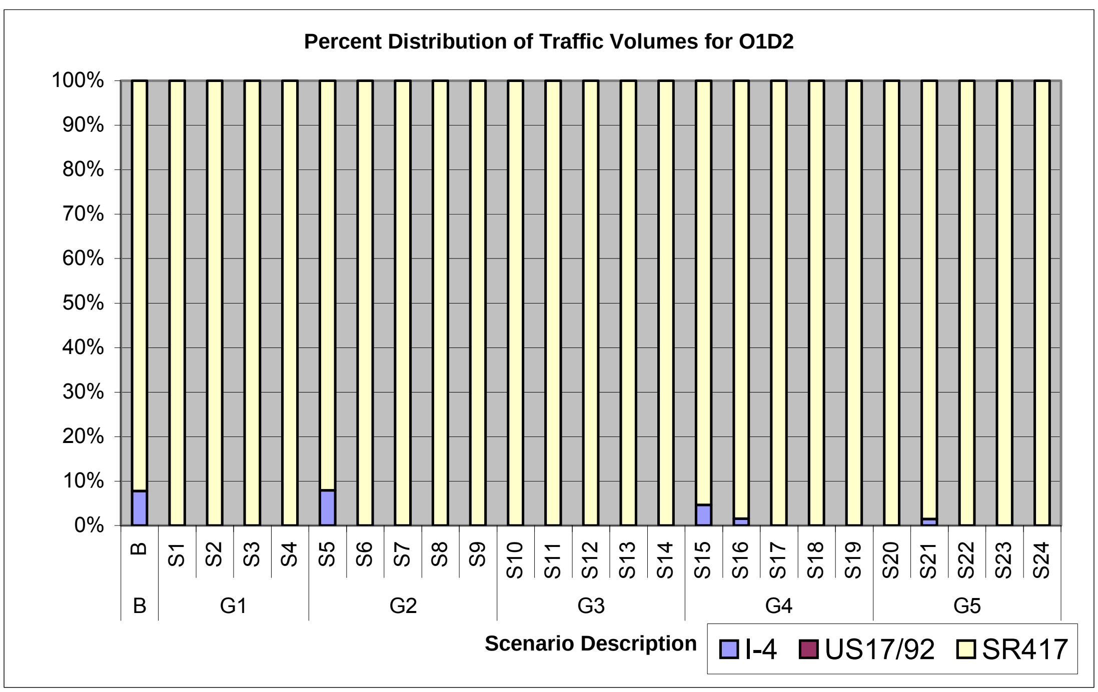


Figure 67: Percent Distribution of Traffic Volumes Using I-4, US17/92, and SR417 from Lake Mary Area (Zones: 8, 9, 10 & 12) to UCF Area (Zones: 5 & 6)

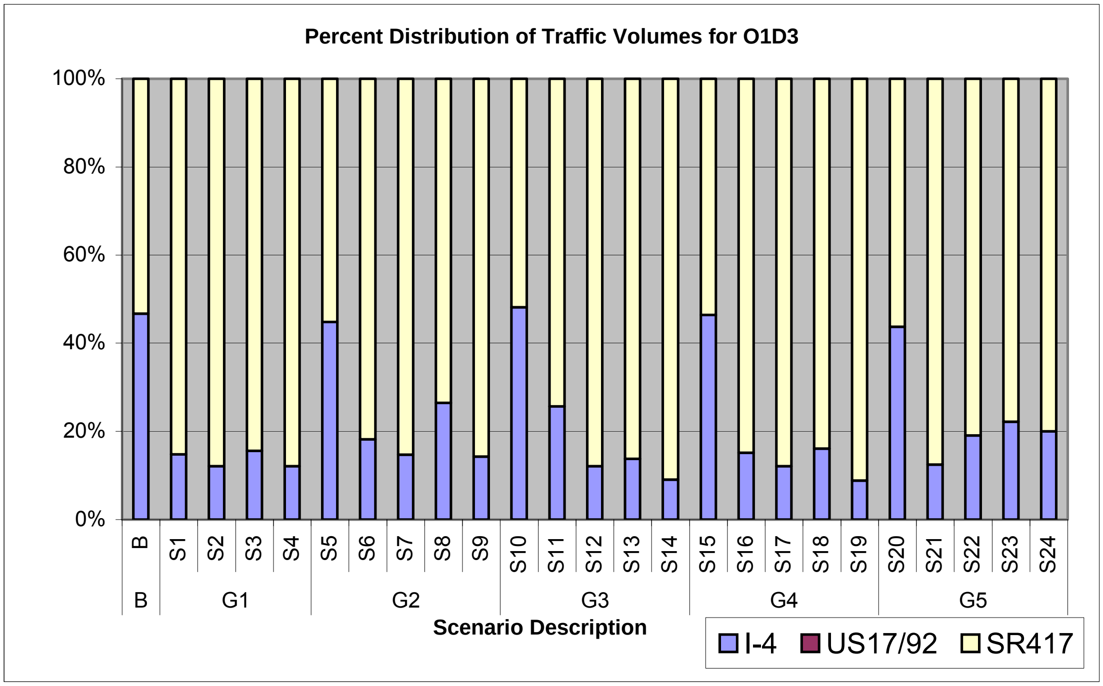


Figure 68: Percent Distribution of Traffic Volumes Using I-4, US17/92, and SR417 from Lake Mary Area to Orlando International Airport (O1D3)

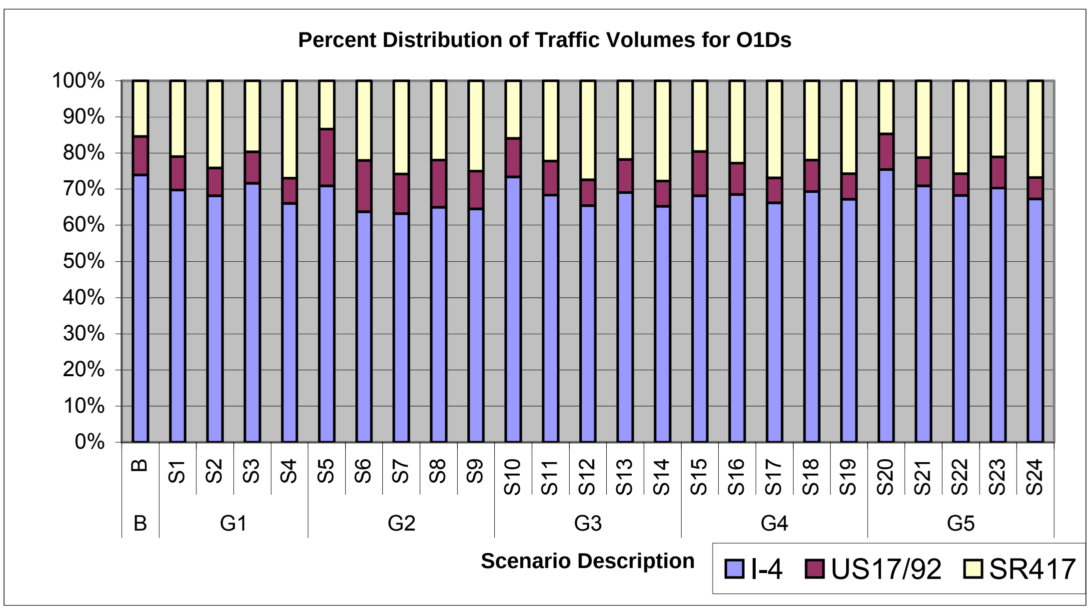


Figure 69: Percent Distribution of Traffic Volumes Using I-4, US17/92, and SR417 from Lake Mary Area to All Destinations (O1Ds)

From Figures 66-69, one can get a general idea of the demand for I-4 and its alternatives for a given specific OD pairs. It is interesting to note that for O1D1 there was insignificant diversion from I-4 to its alternative routes, even under the case of reduced or eliminated tolls. Clearly, I-4 was the preferred path under almost all conditions for almost all drivers corresponding to O1D1. Similarly for O1D2, SR417 attracted almost 100% demand for most of the scenarios. On the other hand, O1D3 exhibited varying levels of demand for I-4 and its alternative routes (SR417 and US17/92), and the same observations applied to the demand levels among O1Ds. Therefore, it is beneficial to assess the diversions and travel time benefits for these specific O-D pairs.

Figure 70 represents the actual hourly volumes for O1D3 that use I-4, US17/92 and SR417. It can be observed that there was an increase in traffic volume on SR417 for all scenarios and no demand for US17/92 for this O-D pair because it indirectly connected this origin (O1) with the destination (D3). Moreover, in the incident scenario, there was no significant diversion to 417 in spite of 100 % toll reduction. This was due to the diversion to the adjacent arterials (i.e. SR436), and the fact that there was no prior information on the accident. In fact, the drivers received the information during their trip (in route information). For lane closure scenarios however, the lanes were closed at the start of the simulation period, and hence this information was pre-trip information, which allowed more vehicles to divert to SR 417. Figure 71 shows the traffic volumes to all destinations from Lake Mary area. In this case too, reducing tolls increased the traffic on SR417 as well on US17/92 (though to a lesser extent than SR417). It is interesting to see that under Group 2 of scenarios (G2, Lane closure on I-4 between Lake Mary Blvd., and SR436 with varying toll structures), the volumes on I-4 increased.

This corresponded to the location of the lane closure. Since the off ramps were closed on I-4 between the lane closure sections, the vehicles already on I-4 had to continue on I-4 without getting off the exit. Therefore, the extra vehicles were the ones that remained longer on I-4 due to the ramp closure to get off I-4 from the next available exit.

Accordingly, it can be seen that reducing the tolls did increase the traffic on the toll roads, and marginally reduces the traffic on I-4. There was a need to compare the traffic volumes at various screen lines for each route individually to determine the following:

- Whether the additional traffic on SR 417 was from I-4,
- Whether the effect of the 50% toll reduction was similar to the 100% toll reduction
- Whether there was a need to reduce the tolls on SR528 and SR417 or on SR417 only.

Figure 72 shows the location of four screen lines that cut the network from west to east. Table 12 shows the mileage of the screen lines along the west direction on I-4 and south direction on SR417. Screen lines are defined as the set of count sites, which interrupt traffic/passenger flows between sets of zones and share the same general corridors of movement. By comparing volumes at these screen lines for all the alternative routes, the distribution of traffic across the alternative routes can be determined.

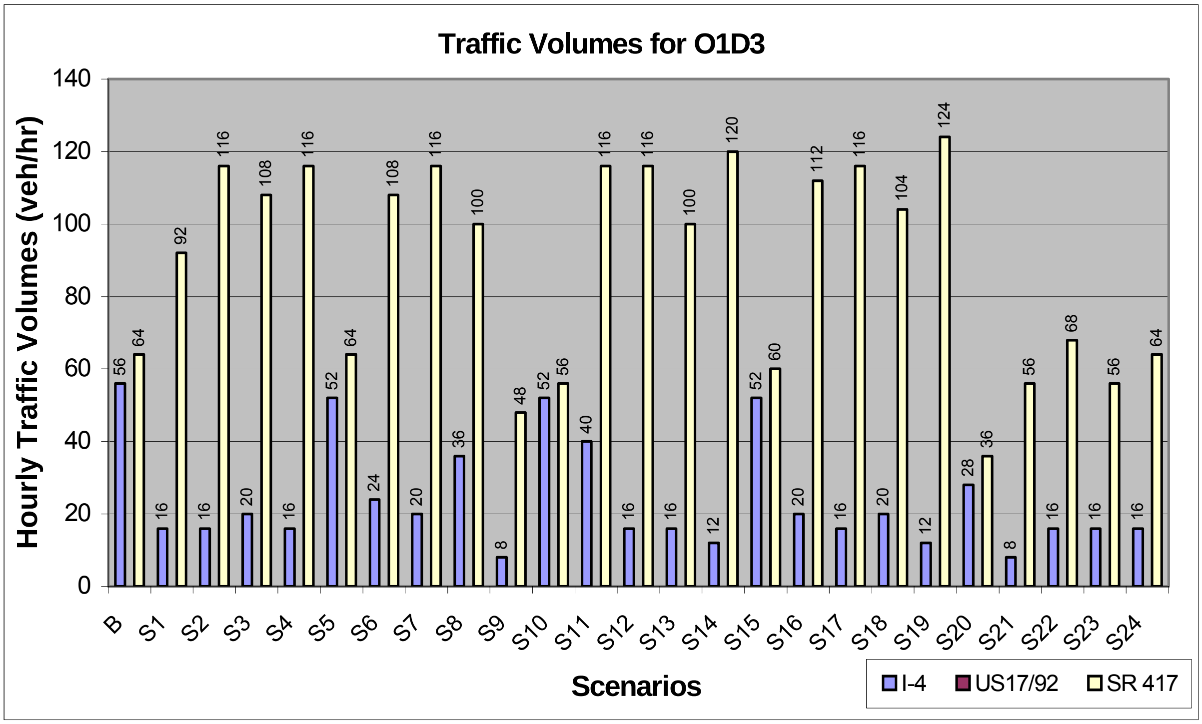


Figure 70: Hourly Traffic Volumes Using I-4, US17/92, and SR417 from Lake Mary Area to Orlando International Airport (O1D3)

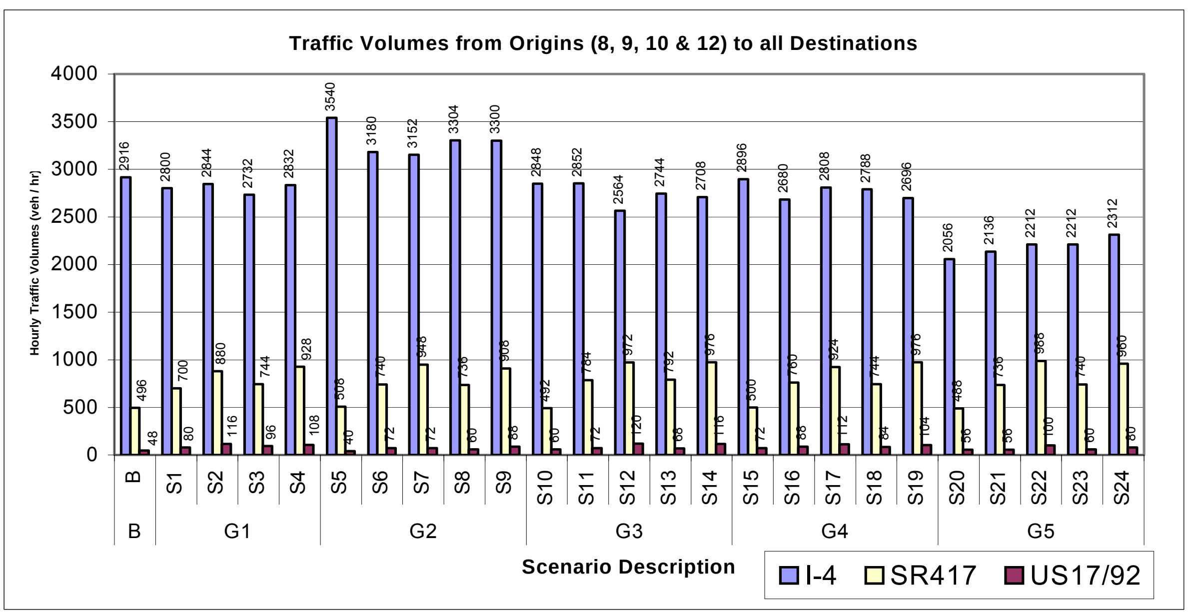


Figure 71: Hourly Traffic Volumes Using I-4, US17/92, and SR417 from Lake Mary Area to All Destinations (O1Ds)

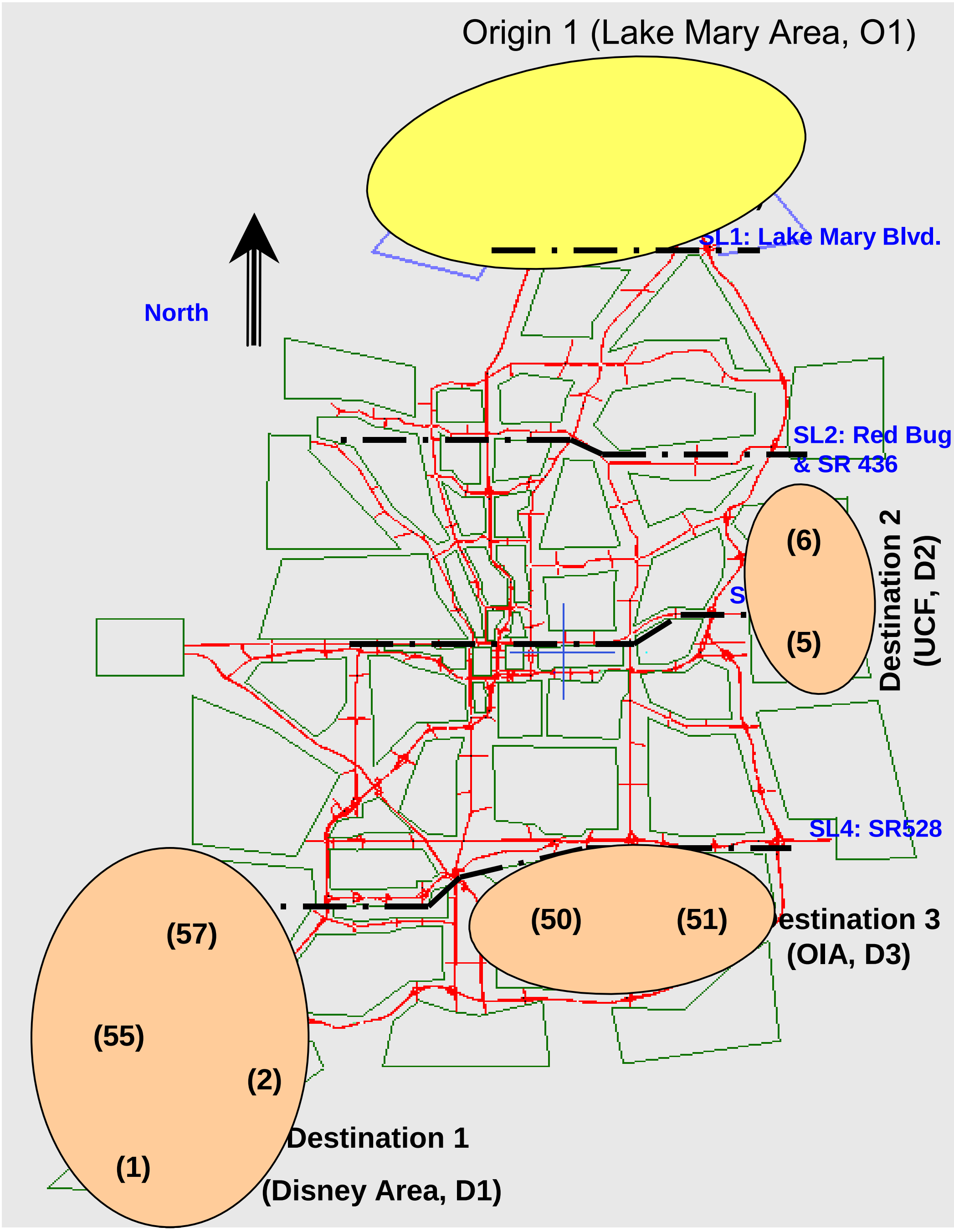


Figure 72: Location of Screen lines on UCF-PARAMICS Network

Table 12 Mileages of Screen Lines on I-4 West-bound and SR417 South-bound

SL No.	Description	I-4	SR-417
N/A	SR46 to Central Florida Greenway (SR417)	0.81	0.81
SL 1	Lake Mary Blvd.	3.35	6.89
SL 2	Red Bug Lake/SR436	10.76	14.80
SL 3	Colonial Dr. (SR50)	18.36	21.91
SL 4	SR528	30.37	30.67
N/A	I-4 and Central Florida Greenway (SR417) Interchange	37.20	54.95

6.3.1 Diversion to SR417 (O1Ds)

Figures 73-75 show the volumes and differences in volumes for various scenarios at various screen lines for SR 417 south bound. Figure 73 shows the groupwise volumes on SR 417, Figure 74 shows the difference in traffic volumes group wise, while Figure 75shows the difference in volumes by the toll reduction on SR 417 and SR 528. From Figure 75, it is evident that under no change in the toll structure, the diversion of volumes to SR 417 was insignificant under all lane closure/incident scenarios. Moreover, the 50 % toll reduction on SR 417 and the 50 % reduction for SR 417 and SR 528 have a similar effect on the hourly traffic volume diverted to SR417. The same conclusion can be drawn for 100% toll reduction on SR 417 and both SR417 and SR 528. Therefore, there appears to be no added benefit due to toll reduction on SR 528.

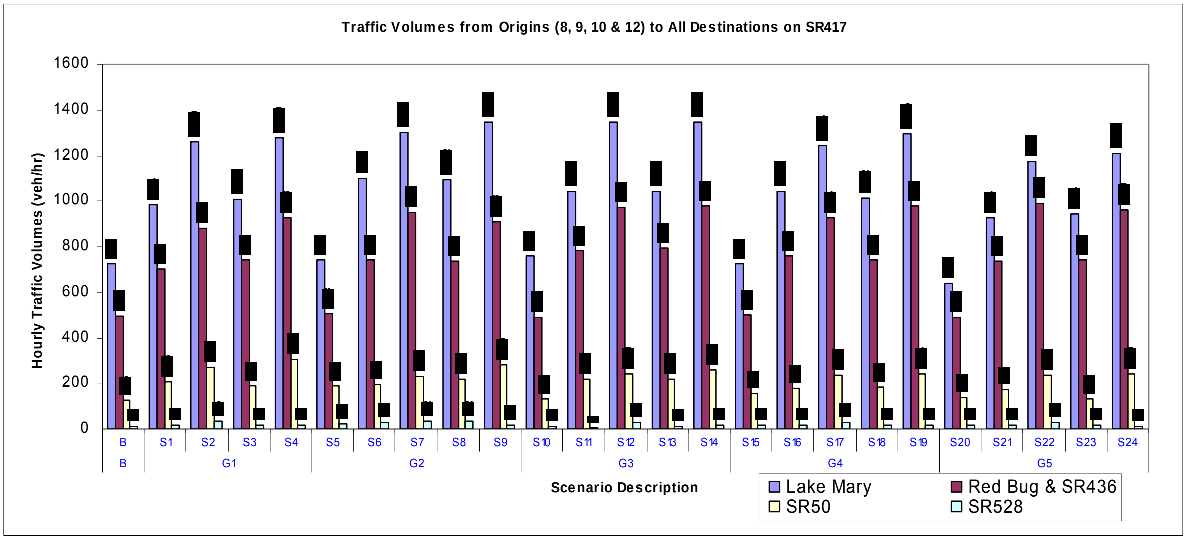


Figure 73: Hourly Traffic Volumes on SR417 (SB) Across the Screen lines

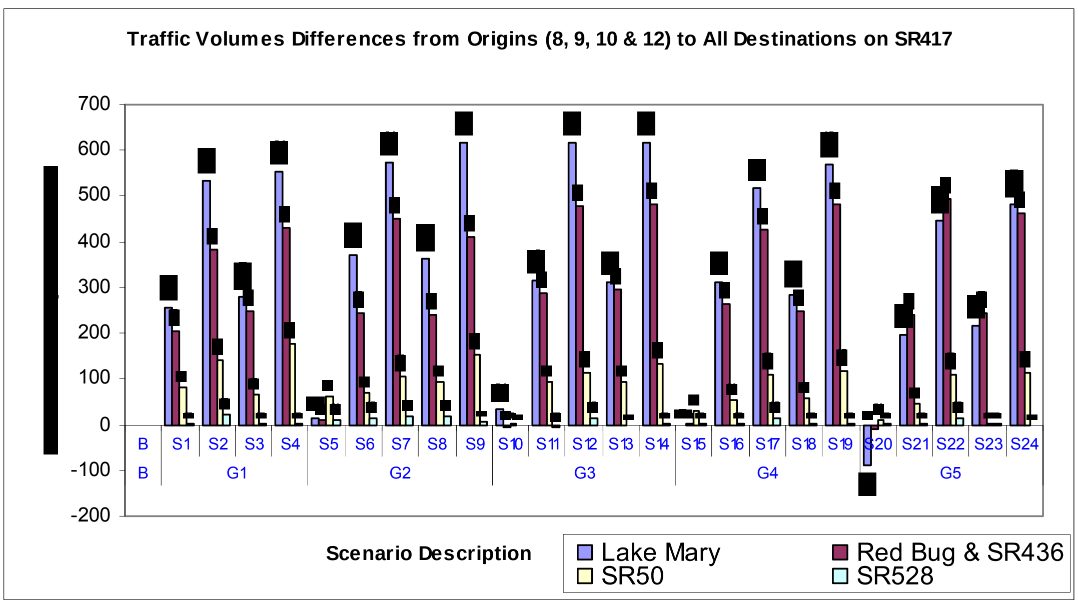


Figure 74: Hourly Traffic Volumes Differences on SR417 (SB) by Groups across the Screen lines

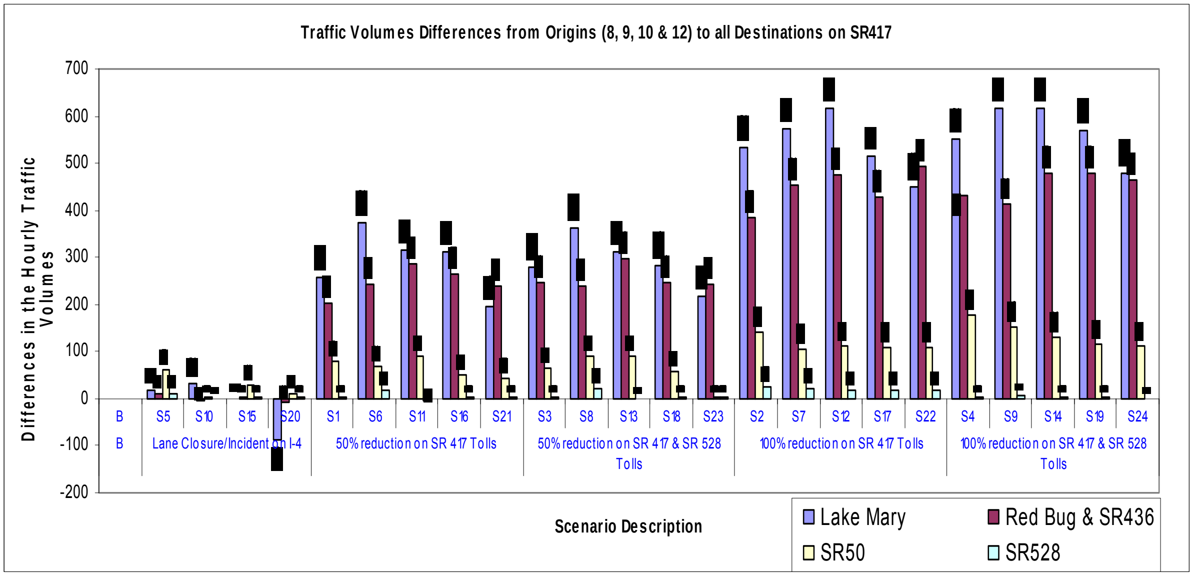


Figure 75: Hourly Traffic Volumes Differences on SR417 (SB) by Toll Reduction across the Screen lines

6.3.2 Diversion from I-4 (O1Ds)

Figures 76-78 demonstrate the volumes and differences in volumes for various scenarios at various screen lines for I-4 westbound. Figure 76 shows the groupwise volumes on I-4, Figure 77 shows the difference in traffic volumes groupwise, while Figure 78 shows the difference in volumes by the toll reduction on SR417 and SR528. Clearly, the 50%-100% toll reduction on SR 417 and the 50%-100% toll reduction on SR417 and SR528 have a similar effect on the hourly traffic volume diverted from I-4.

The traffic volume diverted from I-4 under the recurring congestion with 50% or 100% toll reduction scenarios at the first screen line (Lake Mary blvd.) was between 170 vph to 360 vph. With lane closure between Lake Mary blvd. and SR436 this range became 260 vph to 360 vph. While, this range became 290 vph to 480 vph with lane closure between SR91 and Central Florida Parkway. And for lane closure between Lee Rd. and SR50, the maximum diversion occurred at the third screen line (SR50) and it ranged between 380 vph and 420 vph. Under incident scenarios (between Maitland blvd. and Lee Rd.) with 50% or 100% toll reduction, the highest traffic volume diversion from I-4 was observed at the second screen line (SR436) between 600 vph and 860 vph. However, the traffic diverted back to I-4 down stream of the lane closure/incident, thereby restoring the default conditions on I-4. As such, there are no such significant changes in the traffic conditions on I-4.

Moreover, the hourly traffic volume on I-4 dropped in all scenarios for all locations except under the lane closure scenarios between SR436 and Lake Mary Blvd. (Group 2), where the traffic increased at the second screen line (Red bug and SR436). This was due to the closing of SR434 and SR436 off ramps on I-4. As a result, the vehicles on I-4 continued on I-4 without getting off the exit, which meant extra vehicles remained longer on I-4 to get off I-4 from the next available exit as shown in Figure 79 and Figure 80. Figures 79-80 are snapshots of the UCF-PARAMICS Network to show the movement on I-4 under the base scenario and the lane closure between Lake Mary Blvd., and SR436 without toll reduction scenario (S5) from Lake Mary area to a selected Traffic Analysis Zone (TAZ #18) where the white color on the highways show the path between the origin and the destination.

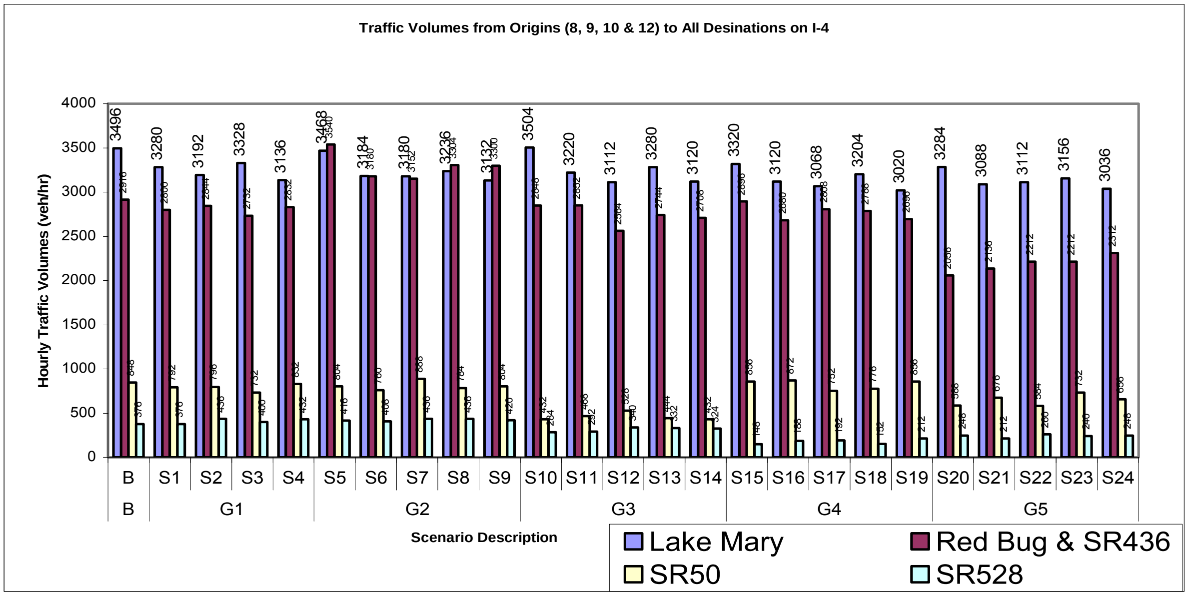


Figure 76: Hourly Traffic Volumes on I-4 (WB) Across the Screen lines

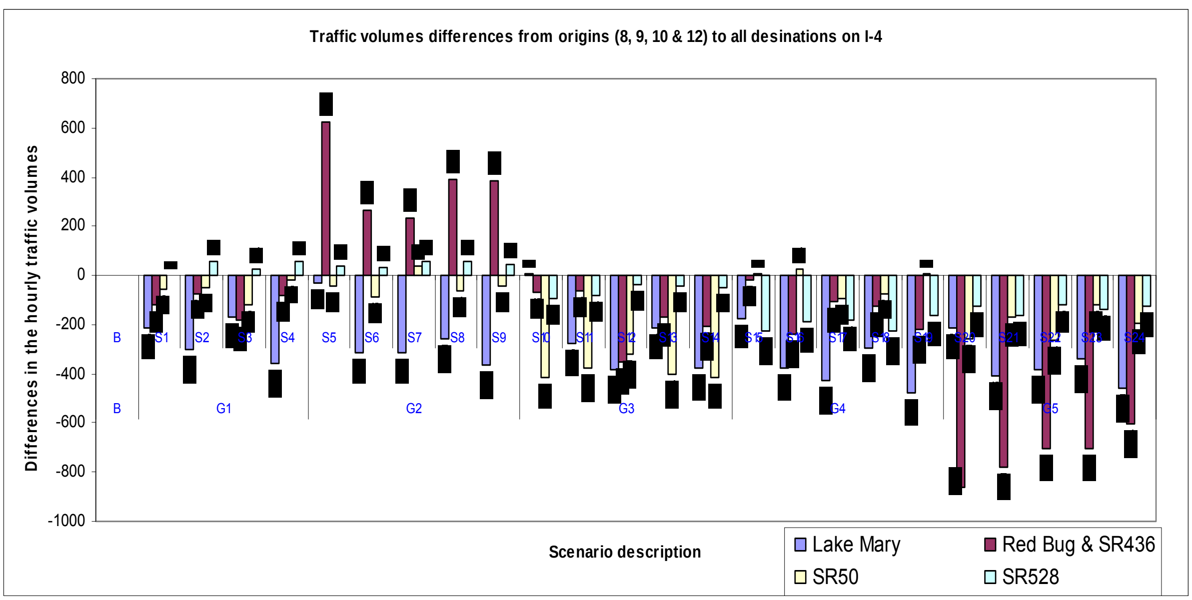


Figure 77: Hourly Traffic Volumes Differences on I-4 (WB) by Groups across the Screen lines

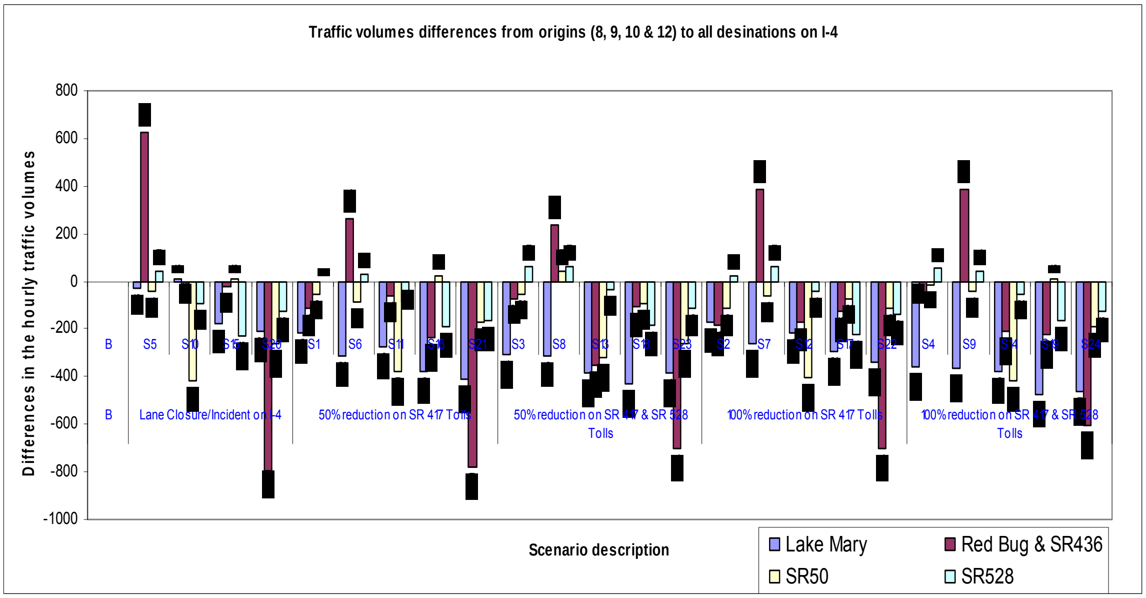


Figure 78: Hourly Traffic Volumes Differences on I-4 (WB) by Toll Reduction Across the Screen lines

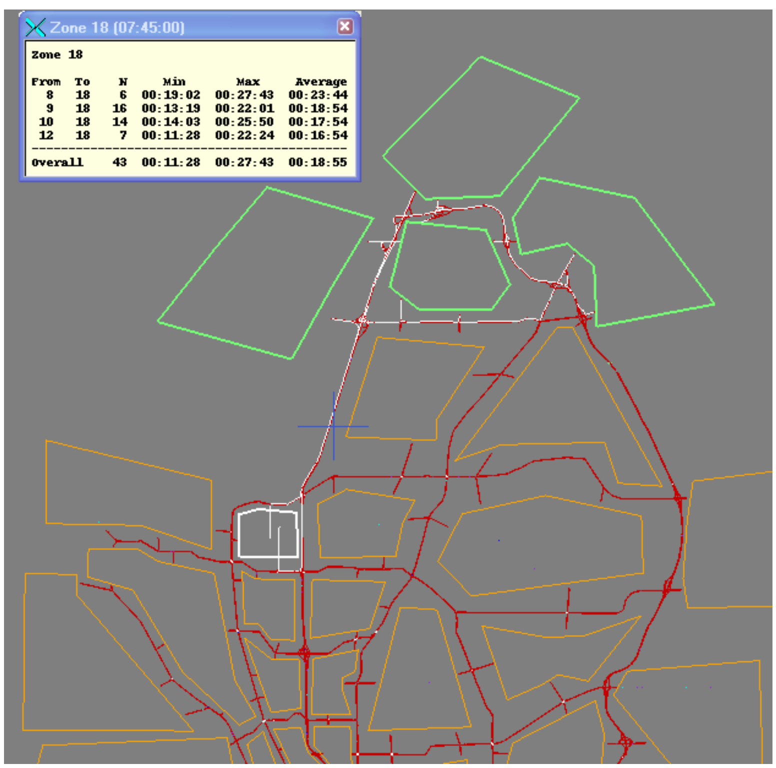


Figure 79: Snapshot of UCF PARAMICS Network under Base Scenario

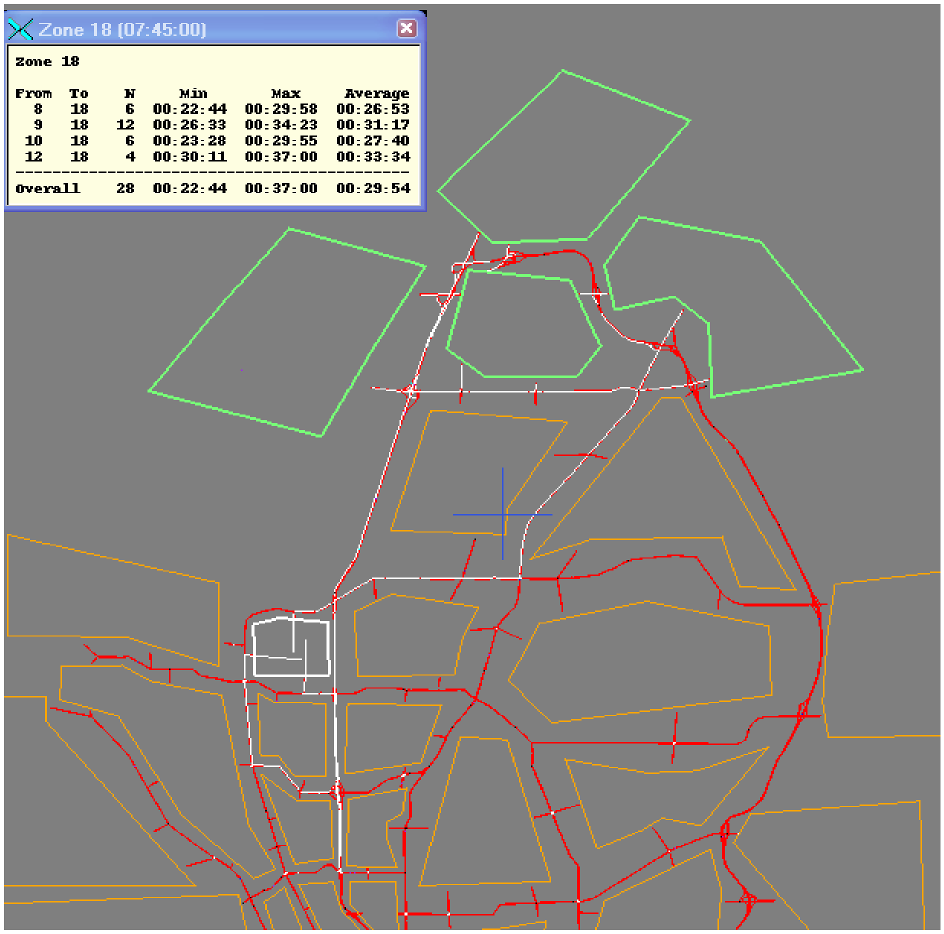


Figure 80: Snapshot of UCF PARAMICS Network under Scenario 5 (G2)

6.3.3 Diversion to US17/92 (O1Ds)

Figures 81-83 illustrate the volumes and differences in volumes for various scenarios at various screen lines for US17/92 westbound. Figure 81 shows the groupwise volumes on US17/92, Figure 82 shows the difference in traffic volumes groupwise, while Figure 83 shows the difference in volumes by the toll reduction on SR417 and SR528. It is evident that the 50%-100% toll reduction on SR 417 and the 50%-100% toll reduction on SR417 and SR528 have a similar effect on the hourly traffic volume diverted to US17/92.

Furthermore, the hourly traffic volume on US17/92 dropped in all scenarios at the first screen line (Lake Mary Blvd.) except under the lane closure scenarios between SR436 and Lake Mary Blvd. (Group 2) which meant that the US17/92 was the main alternative for I-4 without reducing or removing the tolls on SR417, because the diverted volume decreased with the reduction or the removal of the toll on SR417 or SR417 and SR528.

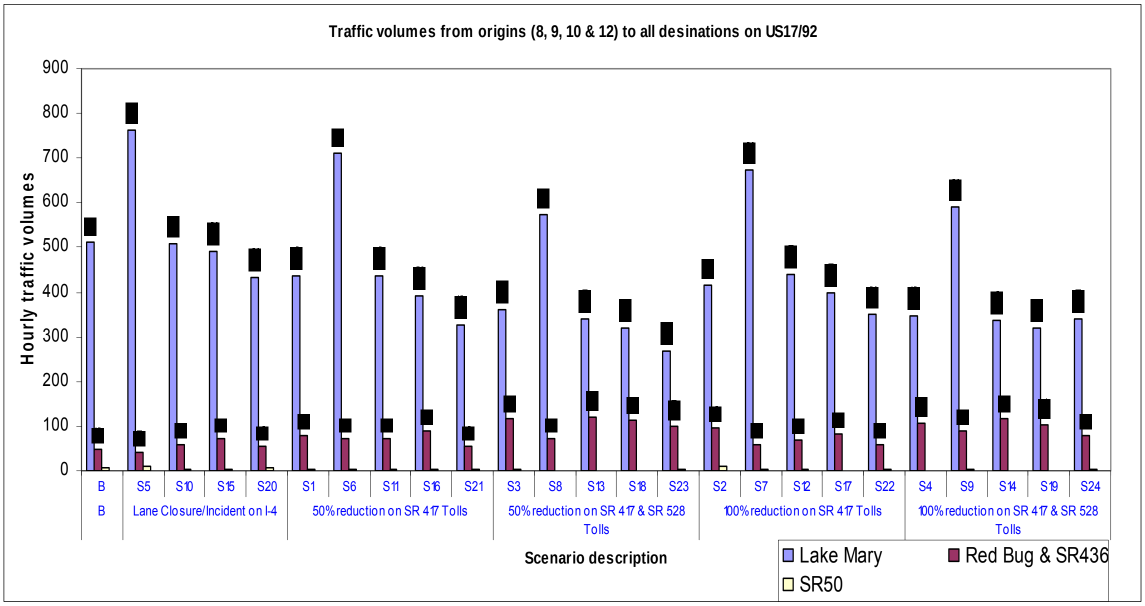


Figure 81: Hourly Traffic Volumes on I-4 (WB) Across the Screen lines

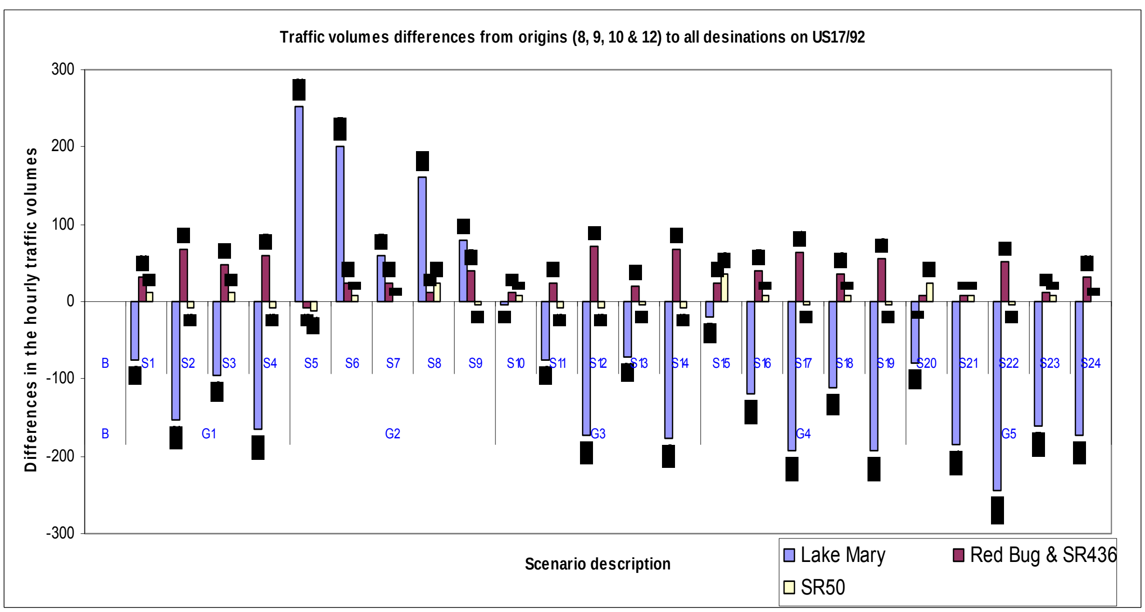


Figure 82: Hourly Traffic Volumes Differences on I-4 (WB) by Groups across the Screen lines

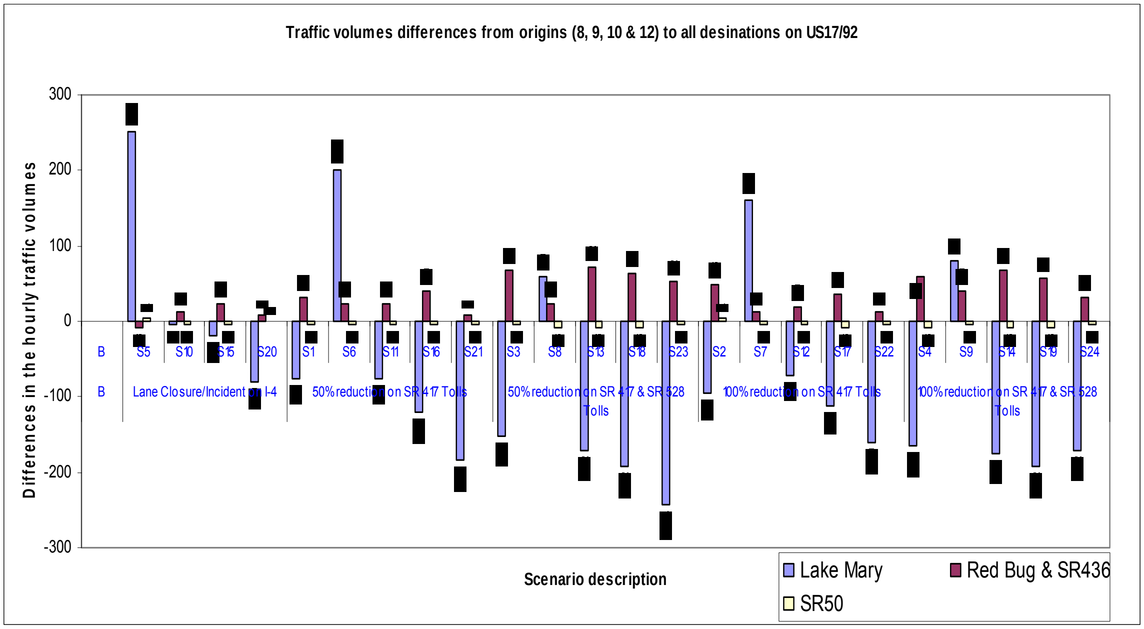


Figure 83: Hourly Traffic Volumes Differences on I-4 (WB) by Toll Reduction across the Screen lines

6.4 TRAVEL TIME ANALYSIS BETWEEN SPECIFIC O-D PAIRS

The second measure of effectiveness for assessing the toll reduction plans was the travel time. PARAMICS provides the users with O-D specific travel times and overall network travel time. The average of the difference in overall network travel times for all scenarios compared to the base was insignificant. Therefore, specific O-D pairs were compared for their travel times across the scenarios. If there was a significant difference in the travel times for these O-D pairs, it can be safely concluded that the toll reduction plans offer significant benefits (to these O-D pairs). For the current application, the critical issue was the savings in travel times for the public who continued on I-4 and the change in travel time for those who diverted to SR417.

Table 14 shows the average travel times for the O-D pairs O1D1, O1D2, O1D3 defined earlier, for all scenarios. When talking of benefits to I-4 commuters, O1D2 does not hold any relevance because commuters for O1D2 did not use I-4. If we look at O1D1, and O1D3, for which there were significant diversions from volumes, the savings in travel times did not seem to be significantly high. On an average, the differences in travel times in each group were less than a minute most of the time compared to the first scenario in the group, which was not significant.

It is possible that this conclusion can be misleading because travel times are computed across all possible routes between the O-D pairs. Therefore, significant travel time savings on one route can be cancelled by a corresponding increase in travel time in the other route. It therefore makes more sense to compare the travel times for individual paths than to do it for an O-D pair. Hence, for O1D1, we consider the path travel time on three alternative routes I-4 (Blue line), SR417 (Green line) and SR417 + SR528 + I-4 (Lavender line) as shown in Figure 84. Similarly for O1D3, we consider the path travel time on I-4 + SR528 (EB) (Blue line) and SR417 + SR528 (WB) (Green line) as shown in Figure 85. Since we are analyzing each path separately, it would be easier to quantify the benefits in terms of travel time savings for commuter drivers.

Table 13: Corresponding Scenarios Average Travel Time

Group	Scenario Description		O1D1"L.Mary – Disney"	O1D2 "L. Mary – UCF"	O1D3 "L. Mary – OIA"
B	B	Base Scenario	0:50:11	0:28:46	0:44:28
G1	S1	50% SR 417	0:50:49	0:29:43	0:43:24
	S2	100% SR 417	0:50:21	0:29:38	0:43:35
	S3	50% SR 417 & SR 528	0:50:24	0:29:27	0:42:47
	S4	100% SR 417 & SR 528	0:49:56	0:29:11	0:44:45
G2	S5	Lane Closure on I-4 (LC)	0:50:59	0:29:17	0:43:56
	S6	LC + 50% SR 417	0:50:38	0:28:47	0:43:07
	S7	LC + 100% SR 417	0:50:09	0:29:43	0:44:35
	S8	LC + 50% SR 417 & SR 528	0:50:04	0:29:13	0:44:06
	S9	LC + 100% SR 417 & SR 528	0:50:19	0:29:14	0:43:43
G3	S10	Lane Closure on I-4 (LC)	0:51:41	0:29:59	0:44:13
	S11	LC + 50% SR 417	0:51:12	0:29:28	0:42:28
	S12	LC + 100% SR 417	0:51:17	0:29:14	0:43:09
	S13	LC + 50% SR 417 & SR 528	0:51:18	0:29:07	0:42:02
	S14	LC + 100% SR 417 & SR 528	0:51:57	0:29:34	0:42:18
G4	S15	Lane Closure on I-4 (LC)	0:56:27	0:29:36	0:43:48
	S16	LC + 50% SR 417	0:55:46	0:29:58	0:43:12
	S17	LC + 100% SR 417	0:54:59	0:30:11	0:42:51
	S18	LC + 50% SR 417 & SR 528	0:57:54	0:29:42	0:43:07
	S19	LC + 100% SR 417 & SR 528	0:57:08	0:30:27	0:43:07
G5	S20	Incident on I-4	0:53:12	0:29:27	0:43:41
	S21	Inc + 50% SR 417	0:52:00	0:30:04	0:44:07
	S22	Inc + 100% SR 417	0:52:18	0:30:01	0:43:14
	S23	Inc + 50% SR 417 & SR 528	0:52:46	0:29:49	0:42:07
	S24	Inc + 100% SR 417 & SR 528	0:52:50	0:30:27	0:44:03

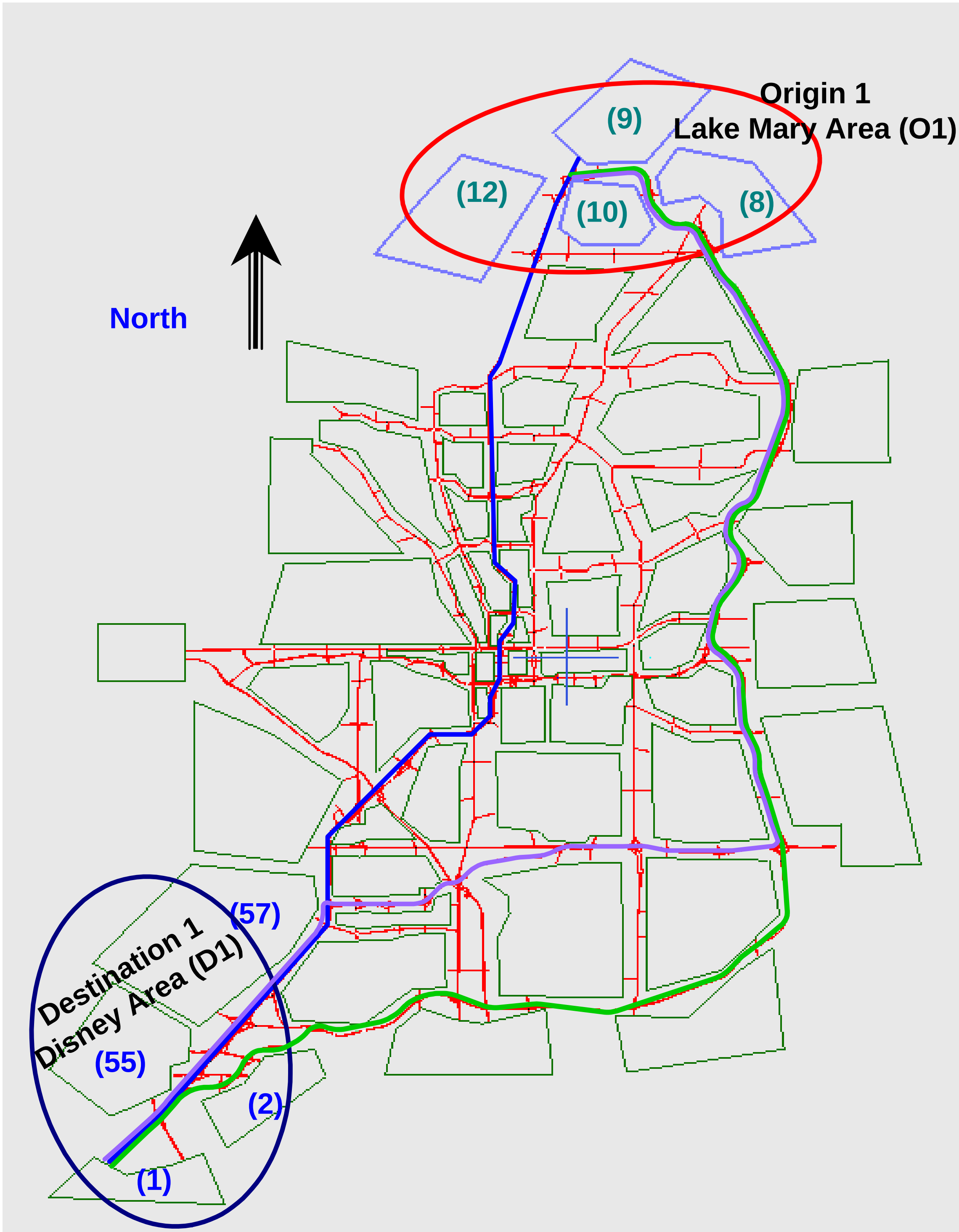


Figure 84: Alternatives from Lake Mary Area to Disney Area (O1D1)

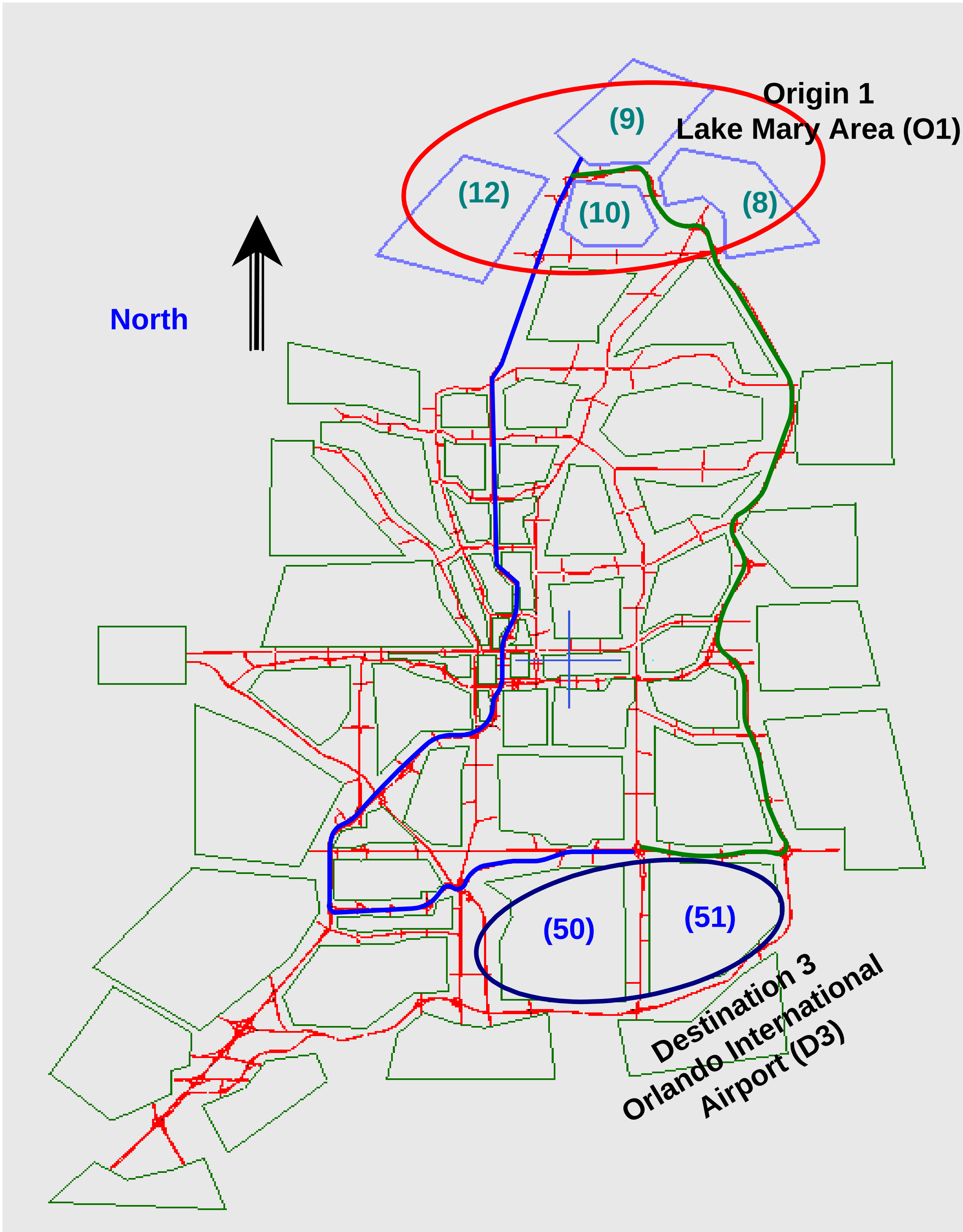


Figure 85: Alternatives from Lake Mary Area to Orlando International Airport (O1D3)

6.4.1 Travel Time between O1D1

Figure 86 and Figure 87 represent the cumulative travel times and differences in cumulative travel times along I-4 westbound for O1D1 for recurring congestion case with 100% toll reduction on SR417 (S2). Table 14 shows the mileage on I-4 westbound from northern end (O1) to the southern end (D1). It can be seen that there were no savings for up to North of SR436 on I-4. But by the end of the trip, the travelers on I-4 would have saved about 4 minutes.

Table 14: Mileage on I-4 Westbound

Distance (Mile)	Interchange
3	N. Lake Mary Blvd.
8	SR434
11	SR436
13	SR414
17	Princeton Dr.
18	SR50
20	SR408
22	SR441 (OBT)
26	TPK (SR91)
28	N. SR482 (Sand Lake)
30	SR528
36	SR536
40	World Drive

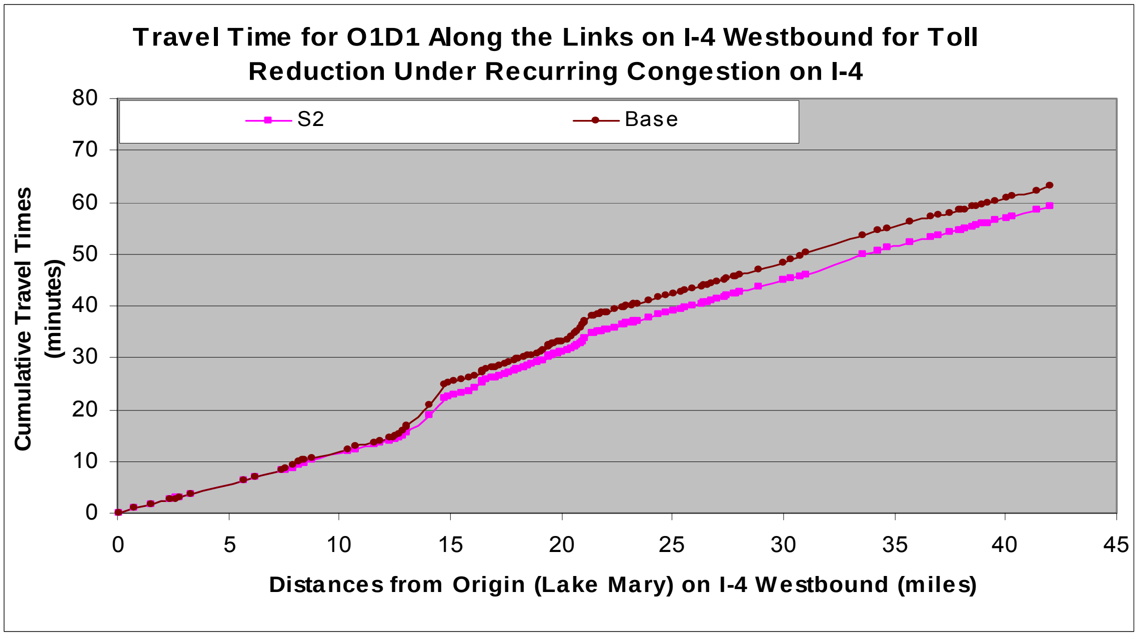


Figure 86: Average Travel Time from Lake Mary Area to Disney Area on I-4 for Recurring Congestion

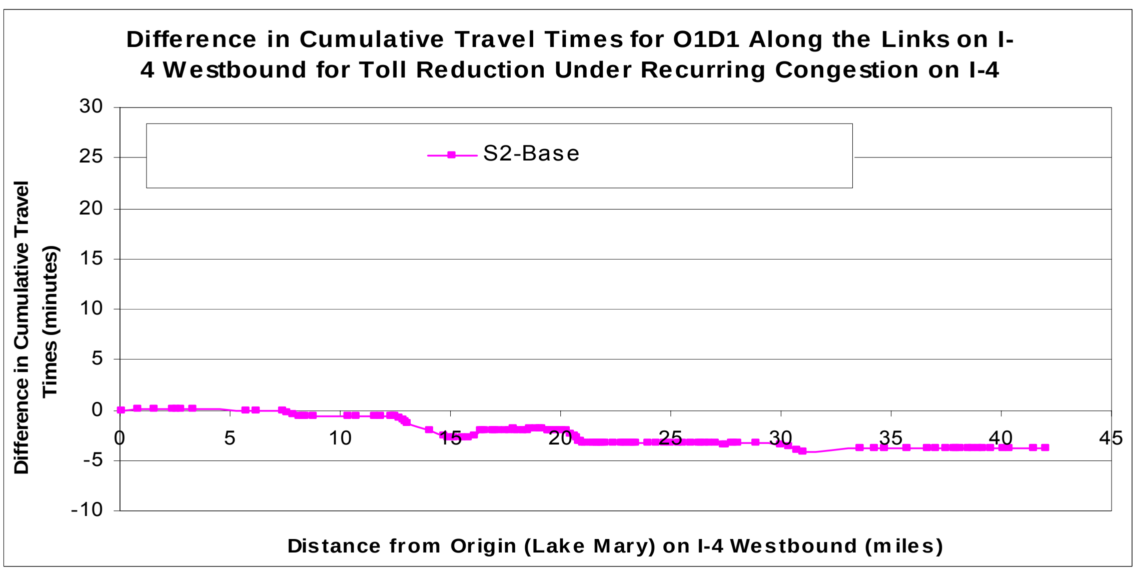


Figure 87: Differences in Cumulative Travel Times from Lake Mary Area to Disney Area on I-4 for Recurring Congestion

Figure 88 and Figure 89 represent the cumulative travel times and differences in cumulative travel times along I-4 westbound for O1D1 for lane closure (represented by two vertical lines) case between SR91 and Central Florida Parkway (S15) with 100% toll reduction on SR417 (S17). Table 14 shows the mileage on I-4 westbound from northern end (O1) to the southern end (D1). Due to lane closure, commuters started diverting upstream of the location of lane closure, which reduced the travel times. In the absence of toll reduction, the diverted vehicles came back on I-4, downstream of the location of lane closure, which increased the travel time thereon by 15 minutes from the base scenario. Due to toll reduction (S17), some of the diverted vehicles did not get back on to I-4, but continued on the toll alternatives, which resulted in a travel time savings of about 5 minutes from the lane closure scenario with no toll reduction (S15).

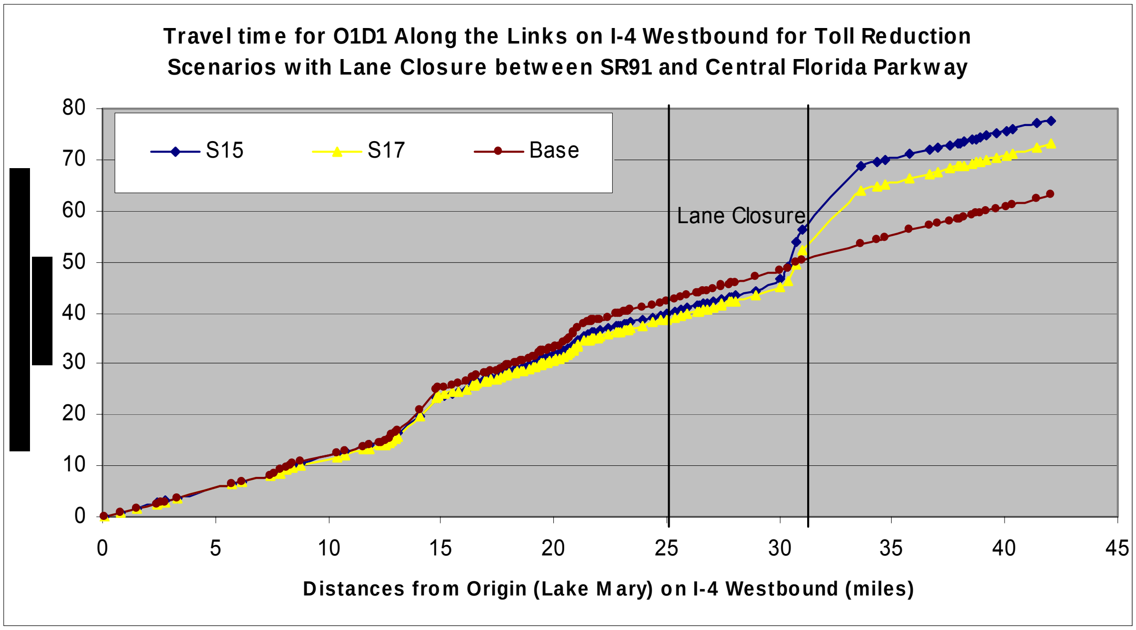


Figure 88: Average Travel Time from Lake Mary Area to Disney Area on I-4 for Lane Closure

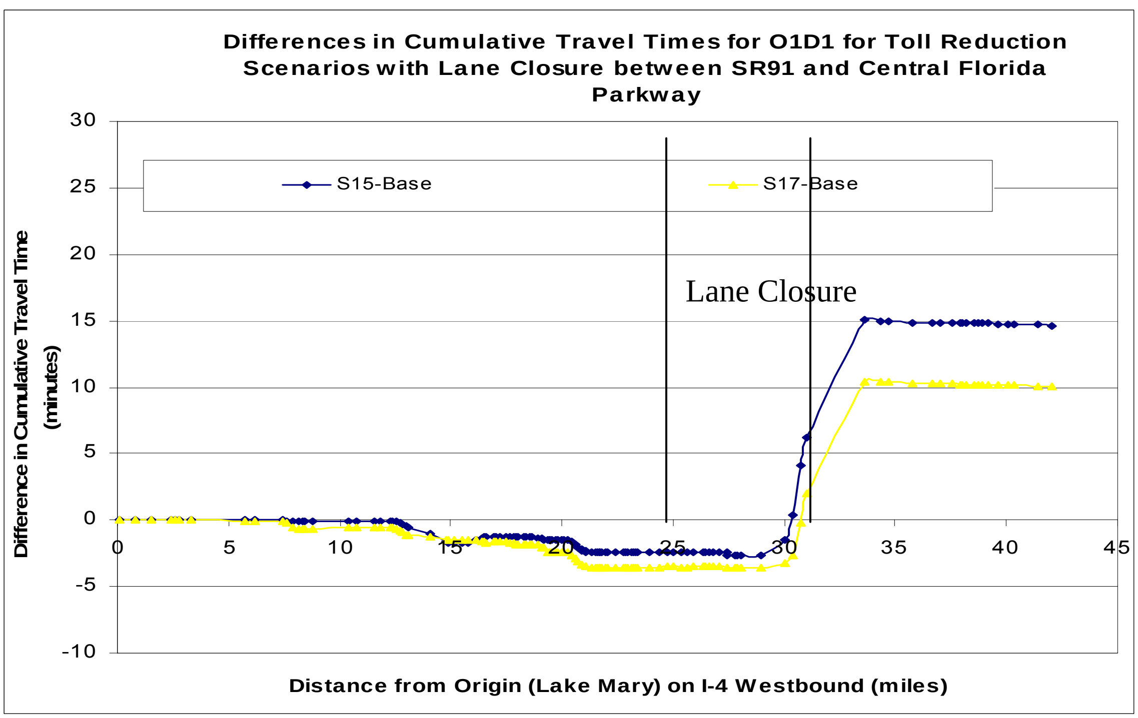


Figure 89: Differences in Cumulative Travel Times from Lake Mary Area to Disney Area on I-4 for Lane Closure

Figure 90 and Figure 91 represent the cumulative travel times and differences in cumulative travel times along I-4 westbound for O1D1 for incident between Maitland Blvd and Lee Road (S20) with 100% toll reduction on SR417 (S22). Table 14 shows the mileage on I-4 westbound from northern end (O1) to the southern end (D1). Due to incident, there was a queue backed up upstream of the location of incident, which increased travel times by 10 minutes for the whole trip. The vehicles stuck in the queues continued on I-4 in the absence of any toll reduction. Due to toll reduction (S22), some of the vehicles upstream of the incident diverted from I-4, and continued on the toll alternatives, which resulted in a travel time savings of about 2 minutes from S20.

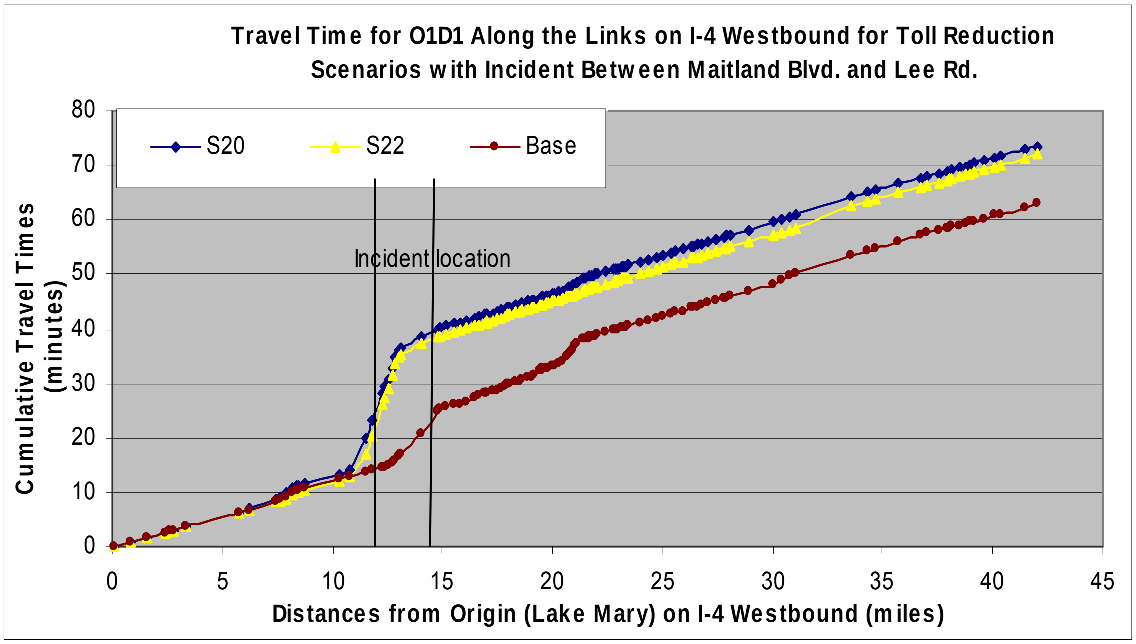


Figure 90: Average Travel Time from Lake Mary Area to Disney Area on I-4 for Incident

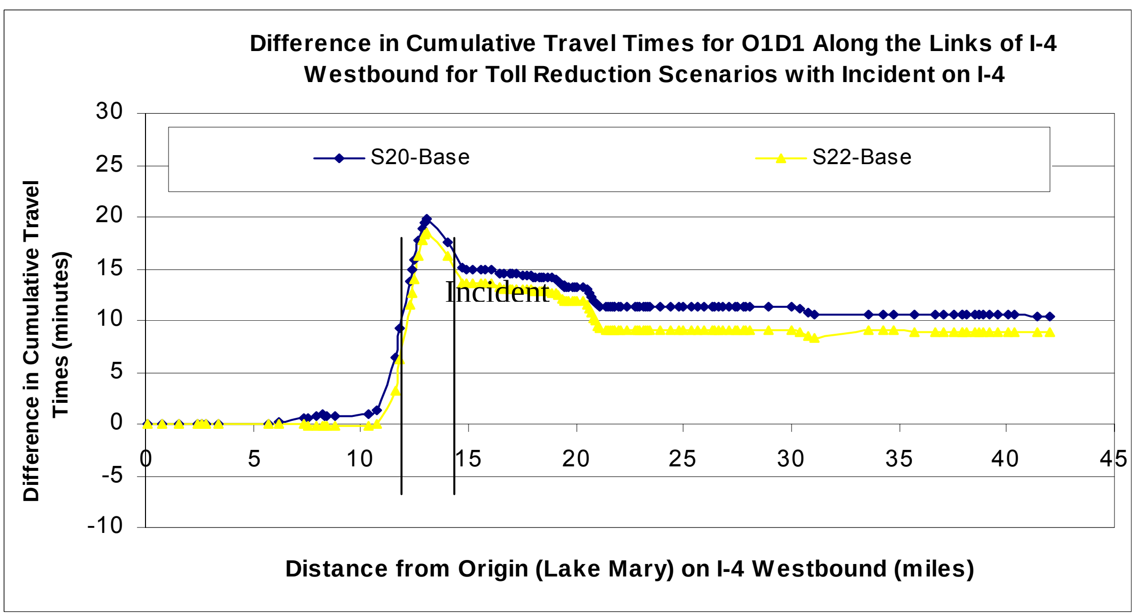


Figure 91: Differences in Cumulative Travel Times from Lake Mary Area to Disney Area on I-4 for Incident

Figure 92 represents the cumulative travel times on SR417 for a lane closure between SR91 and Central Florida Parkway with no toll reduction (S15) and lane closure with 100% toll reduction on SR417 (S17). Figure 93 shows a similar scenario of lane closure, but in a different location. The travel time on SR417 included the toll amount in dollars converted to minutes (1$ = 4 minutes). It is evident that the base scenario and the lane closure scenarios with no toll reduction were almost identical for SR417. This was because no diversion happened to SR417 without toll reduction. When the tolls were removed, the commuters saved on the time equivalent of toll dollars and so saved on the travel cost. Table 15 shows the mileage on SR417 southbound from northern end (O1) to the southern end (D1). There were no sudden jumps in the travel time on SR417 with 100% toll reduction (S17, S7), which showed that SR417 was not loaded beyond capacity at any point.

Table 15: Mileage on SR417 southbound

Mileage	Road	Mileage Points
9.25	SR-417	Lake Jesup Plaza
20.07	SR-417	University Plaza
27.52	SR-417	Curry Plaza
40.39	SR-417	Boggy Creek
48.22	SR-417	John Young Parkway
53.93	SR-417	Celebration Avenue

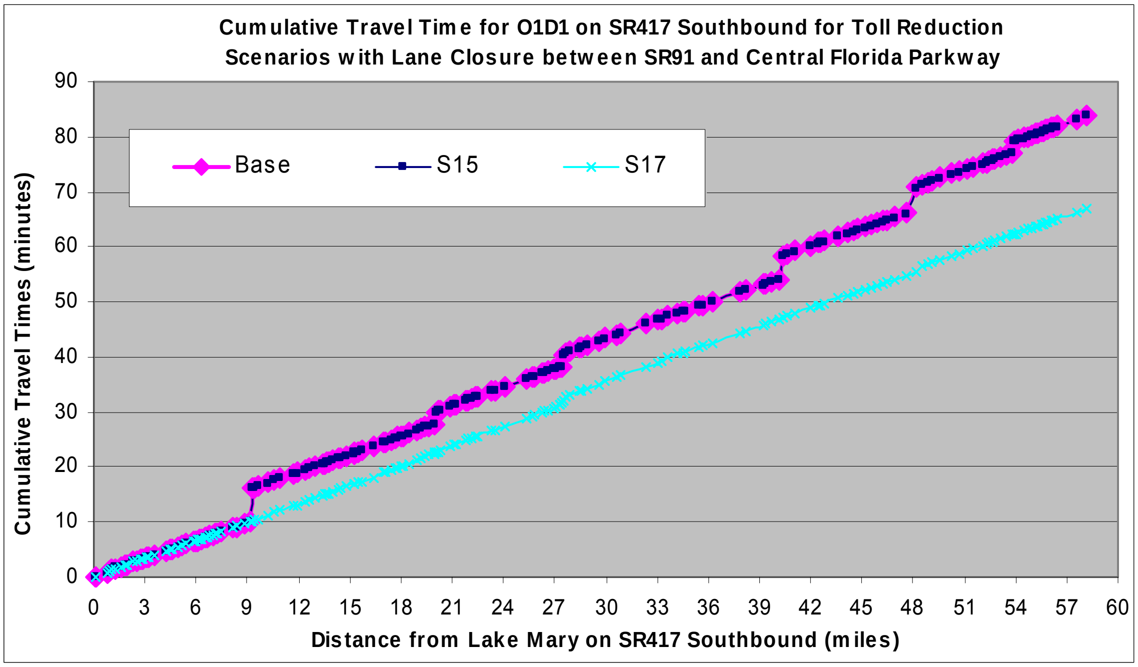


Figure 92: Average Travel Time from Lake Mary Area to Disney Area on SR-417 for Lane Closure on I-4

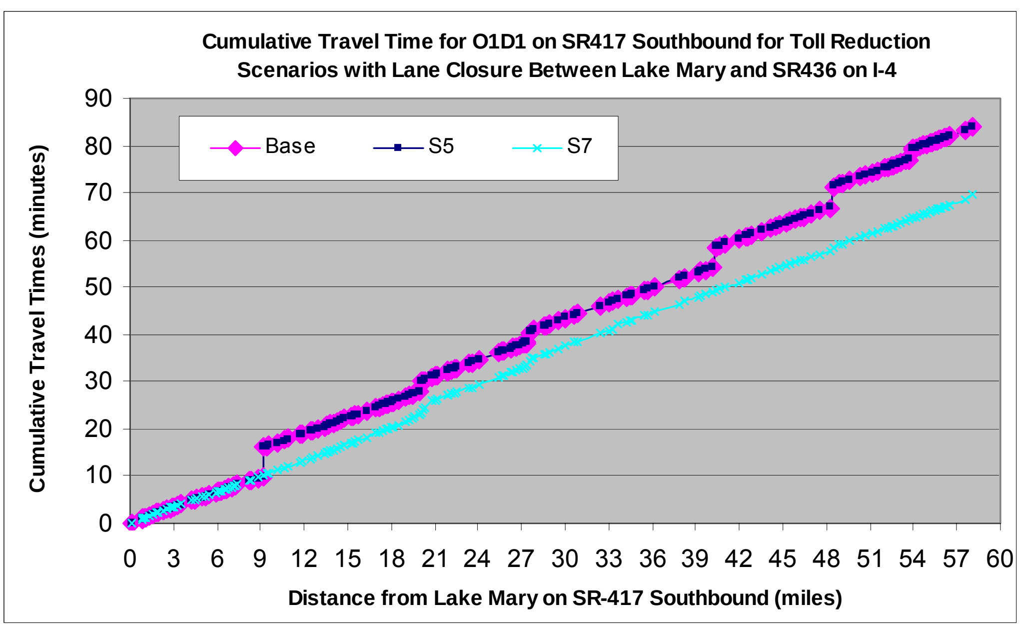


Figure 93: Average Travel Time from Lake Mary Area to Disney Area on SR417 for Lane Closure on I-4

Figure 94 represents the cumulative travel times on SR417+SR528+I-4 for a lane closure between SR91 and Central Florida Parkway with no toll reduction (S15) and lane closure with 100% toll reduction on SR417 only (S17). The travel time on SR417 and SR528 included the toll amount in dollars converted to minutes (1$ = 4 minutes). It is evident that the base scenario and the lane closure scenarios with no toll reduction were almost identical for SR417 and SR528. Near SR528 interchange with I-4, there was an increase in travel times, due to lane closure at this location. When the tolls were removed, the commuters saved on the time equivalent of toll dollars and so saved on the travel cost. Table 16 shows the mileage on SR417, SR528, I-4 westbound from northern end (O1) to the southern end (D1). The sudden jumps in the travel time on SR528 were due to tolls and the drastic jump near I-4 was due to the lane closure.

Table 16: Mileage on SR417+SR528+I-4

Mileage	Road	Mileage Points
9.25	SR417	Lake Jesup
20.07	SR417	University Plaza
27.52	SR417	Curry Ford Plaza
35.67	SR528	Airport Plaza
39.58	SR528	Beeline West Plaza
46.50	SR528	I-4
52.50	I-4	SR536
56.50	I-4	World Dr.

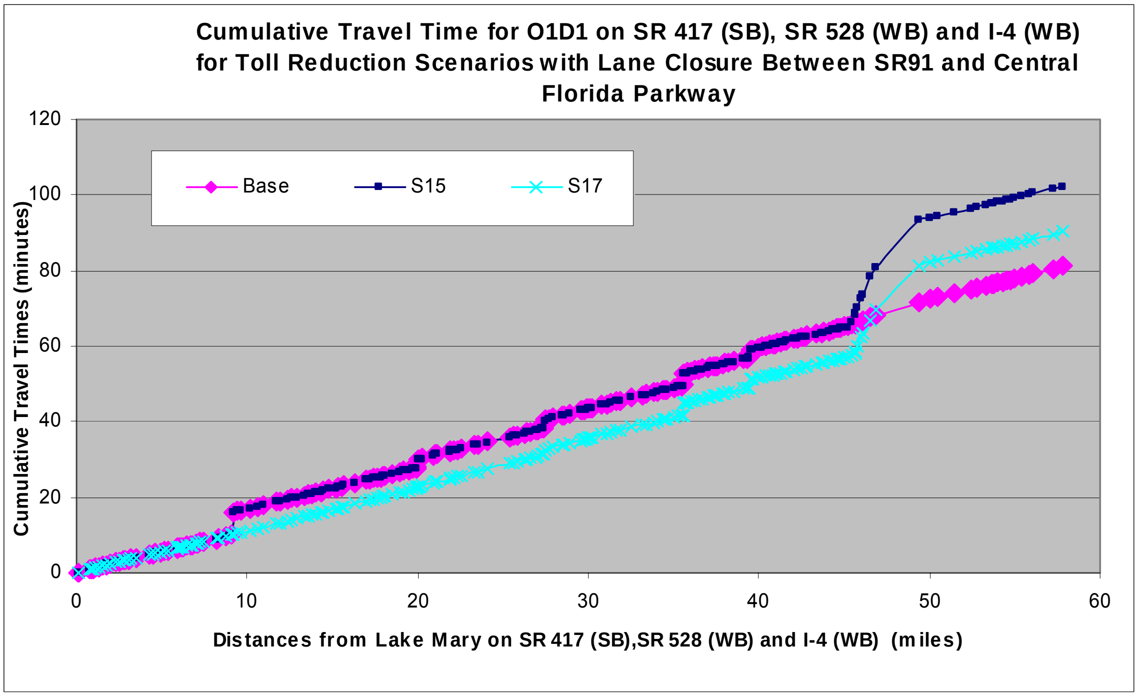


Figure 94: Average Travel Time from Lake Mary Area to Disney Area on SR417+SR528+I-4 for Lane Closure on I-4

Figure 95 and Figure 96 present the comparisons between travel times of all scenarios between the three alternative routes for O1D1 – I-4, SR417, SR417+SR528+I-4. The travel times in Figure 95 included the toll cost converted to minutes for the toll roads. For instance, traveling along SR417 end to end, one would have to pay 5$ which translates to 20 minutes. Therefore, I-4 would usually hold a 20-minute advantage over SR417 under base conditions due to the toll on SR417. Hence, unless there's a severe impacting lane closure or an incident, no significant potential diversion is likely for I-4 users. On the other hand, Figure 96 shows the absolute travel times without the toll costs included. It shows how the toll roads were competitive alternatives to I-4 in terms of travel times excluding the time equivalent of toll costs, especially for the majority of lane closure (G3, G4) and incident scenarios (G5). Hence, it was apparent from these figures that the potential diversion was dependent on the user perception of travel time / travel cost. It can be noted that 100% toll reduction on SR417 had a lower travel time than I-4 when the incident or lane closure location was south of Maitland Blvd on I-4. Moreover, reducing tolls on SR528 did not make the SR417+SR528+I-4 route more competitive to I-4 or SR417. It therefore proved that there was no potential benefit of reducing tolls on SR528.

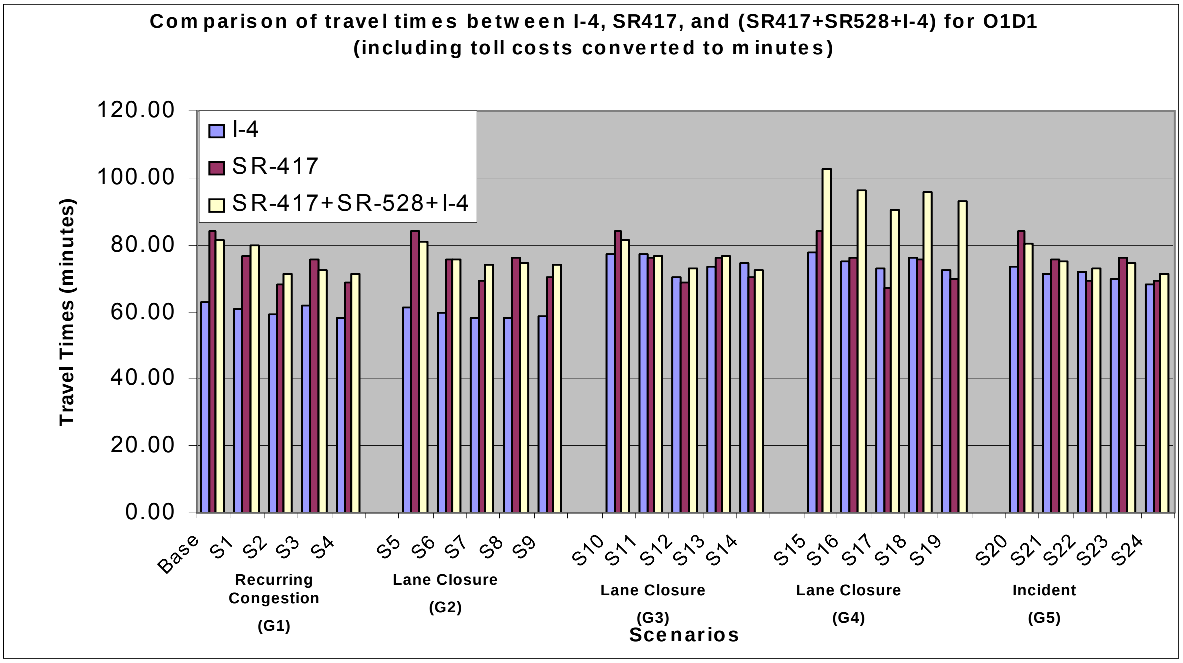


Figure 95: Travel time comparisons between the three alternative routes for O1D1

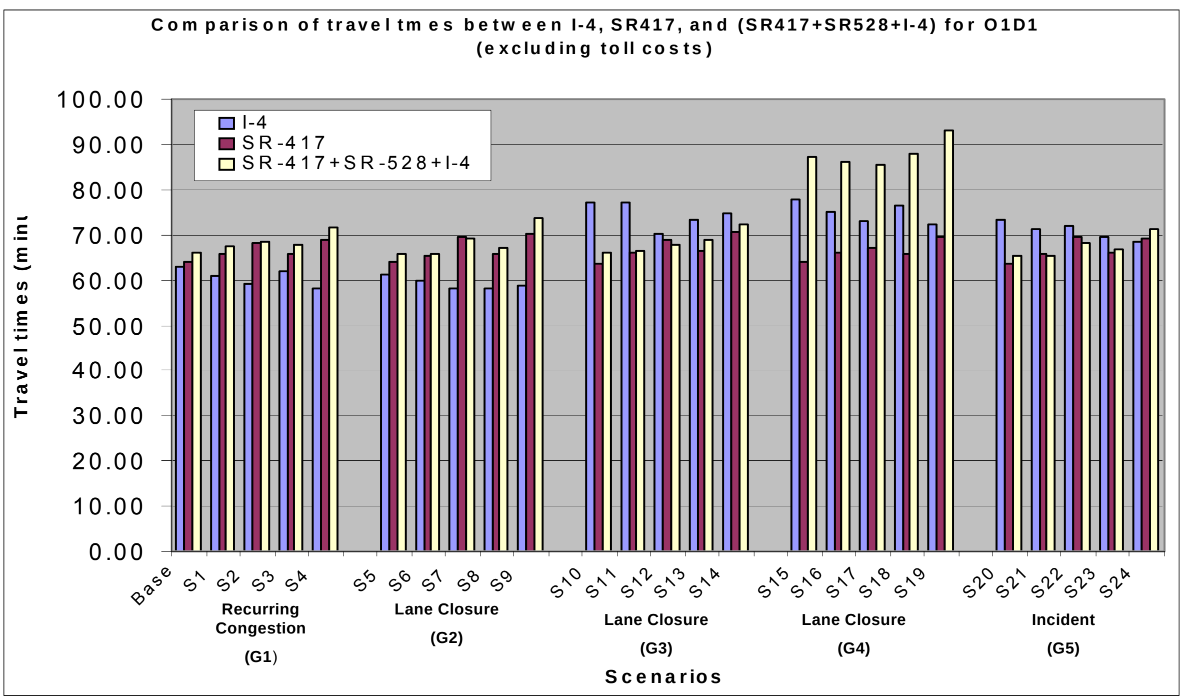


Figure 96: Travel time comparisons between the three alternative routes for O1D1

6.4.2 Travel Time for O1D3

Figure 97 and Figure 98 present the comparisons between travel times of all scenarios between the two alternative routes for O1D3: I-4+SR528(EB) and SR-417+SR528(WB). The travel times in Figure 97 included the toll cost converted to minutes for the toll roads. Alternately, Figure 98 shows the absolute travel times without the toll costs included. From these figures it is apparent that the toll roads were a better alternative to travelers when their destination is the Orlando International Airport (OIA) and the origin was from the north of I-4/SR417 interchange. Whether the tolls were included or not in the travel times, SR417+SR528 (WB) was the least cost path. By reducing the tolls, more commuters were encouraged to switch to this route from the I-4.

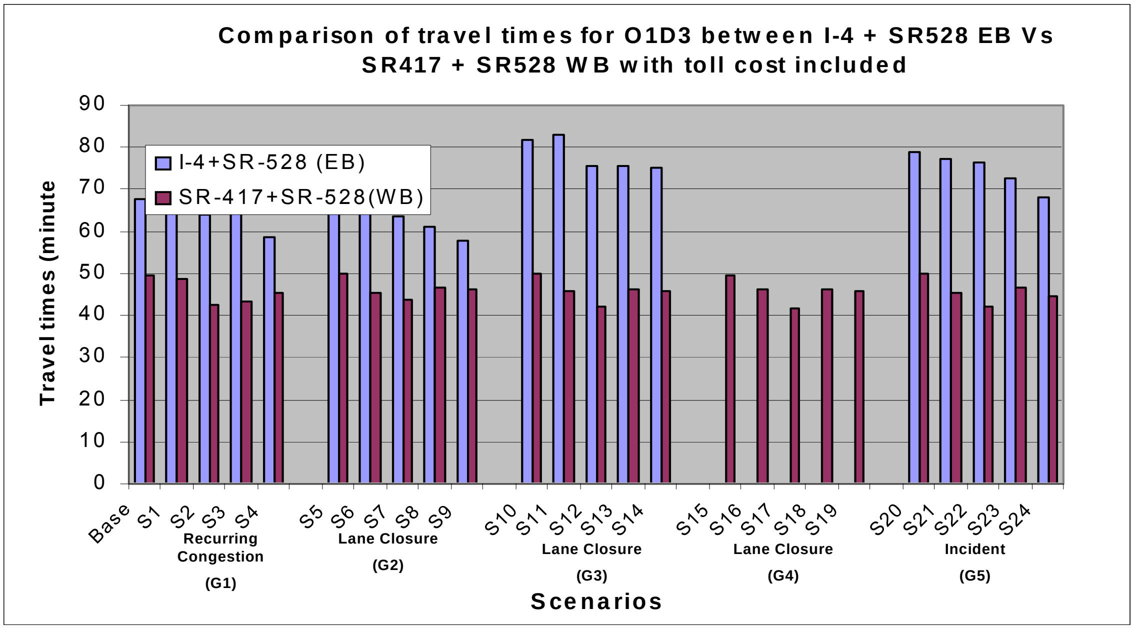


Figure 97: Travel time comparisons between the three alternative routes for O1D1

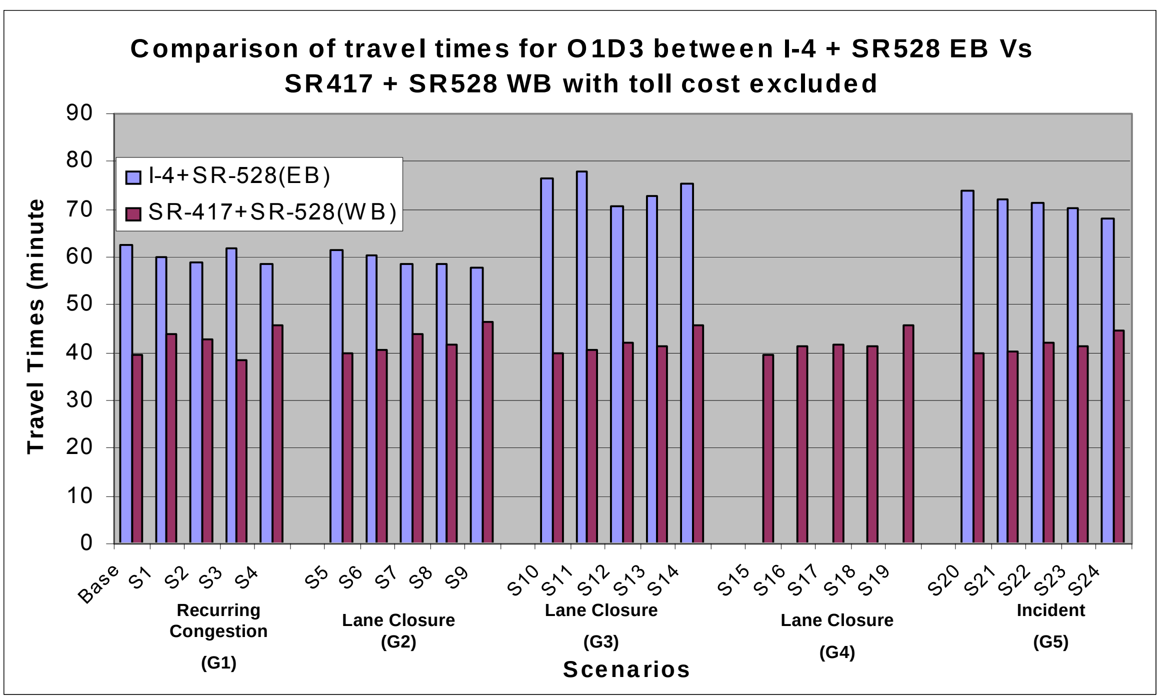


Figure 98: Travel time comparisons between the three alternative routes for O1D1

CHAPTER 7

CONCLUSIONS AND RECOMMENDATIONS

The main goal of this project was to develop a Central Florida road network that included segments of the I-4, SR408, SR417, SR 528, Florida Turnpike (SR91), and major arterials in the Central Florida area to execute and evaluate the effectiveness of alternative toll pricing scenarios as traffic diversion strategies on toll and non-toll facilities in the network study area.

PARAMICS, a microscopic simulation software package was calibrated, validated, and used to investigate the number of vehicles currently not using the toll roads that may divert from the Interstate 4 during congestion created from construction (such as a one lane closure for a specified distance) during the morning peak hour or an incident with varied toll pricing strategies. In addition, the developed and validated UCF-PARAMICS model network was used to check if the local arterial traffic would divert onto I-4 if the congestion was reduced to a level that would make it more attractive to local drivers in terms of short trips, which would then show no benefits of diversion for the goal of improving traffic on the Interstate.

Twenty-four scenarios incorporating various locations of the lane closures/incidents, and different toll reduction strategies were defined in addition to the base scenario, which was calibrated to reflect the existing conditions. The performance of the simulated scenarios was evaluated using two measures of effectiveness: traffic volumes on selected paths and links and travel times. The volume diversion analysis was performed at four screen lines to compare the changes in volume from the base scenario for trips originating from Lake Mary area or north thereof.

The results demonstrated that the hourly traffic volume that diverted to SR417 was about 200 vph to 400 vph higher with 100% toll reduction scenarios compared to 50% toll reduction scenarios on SR417 (SB). And, the hourly traffic volume diverted to SR417 was about 200 vph to 350 vph higher (from Lake Mary Blvd. to SR528) on SR417 (SB) with 100% toll reduction scenarios compared to 50% toll reduction scenarios on SR417 and SR528. With respect to travel times, the overall network travel time did not change across the scenarios. It was expected that there would be improvement in travel time for some Origin-Destination pairs (ODs). While for some ODs there would be degradation in travel time due to increase in traffic because of diversion. These two opposite effects may negate each other at a macroscopic level.

The Turnpike Enterprise was interested in analyzing the diversion of traffic volumes and the benefits in terms of travel time savings for commuters originating from the northern section of the defined UCF-PARAMICS Network (Lake Mary area, O1) to all destinations (O1Ds). In addition, the Disney area attractions (D1), University of Central Florida - UCF (D2), and Orlando International Airport –OIA (D3) were chosen as three specific destinations.

The results demonstrated that under no change in the toll structure, the diversion of traffic volumes to SR417 was insignificant under all lane closure/incident scenarios. For O1D1, no significant diversion to SR417 was observed under any of the toll reduction scenarios. For O1D2, as all the traffic used SR417, there was no additional traffic diverted from I-4. For O1D3 and O1Ds, the 50% toll reduction on SR417 and the 50% toll reduction for both SR417 and SR528 simultaneously had a similar effect on the hourly traffic volume diverted to SR417. The same conclusion applied for scenarios with 100% toll reduction on SR417 and toll reduction on both SR417 and SR528 simultaneously.

Moreover under all the lane closure/incident scenarios the hourly traffic volume on I-4 dropped at the location of lane closure except at locations where off ramps were closed. The volumes that diverted upstream of the lane closure/incident were observed to be less than 15%. However, the traffic diverted back to I-4 downstream of the lane closure/incident, thereby restoring the default conditions on I-4. As such, there is no such significant change in the traffic conditions on I-4.

With respect to travel times, due to multiple alternatives available across these OD pairs, the overall travel times for the ODs did not provide any significant insight into the benefits. Therefore, a microscopic assessment of travel times across critical routes, which included significant portions of I-4, SR417 and SR528, was deemed necessary.

For O1D1, the results demonstrated that the travel time on I-4 was the least among the alternatives (I-4, SR417, SR417+SR528+I-4) under the current toll structure and recurring congestion conditions. Due to the toll costs and physical distance to be traveled, I-4 had at least a 20-minute advantage compared to other routes in the base scenario. On the other hand, travel time on I-4 increased by 20 minutes due to a lane closure on I-4 between SR91 and Central Florida Parkway or a major incident between Maitland Blvd. and Lee Rd. Hence, no significant diversion was obtained for any of the lane closure/incident scenarios <u>without toll reduction</u>.

With toll reduction, the maximum travel time savings on I-4 (WB) among all the 24 scenarios were 5 minutes during the peak hour. It was observed also that scenarios with lane closure or incident on I-4 but without toll reduction did not show a significant impact on SR417 travel time. Moreover, the results demonstrated that the toll roads are competitive alternatives to I-4 in terms of "time-on-route" or absolute travel times for those drivers who value time much more than out of pocket toll cost.

For O1D3, there are two alternatives: I-4+SR528 (EB) and SR417+SR528 (WB). For these commuters, it is advantageous in terms of travel times to be off I-4, since the toll road alternative has the least cost, as well as the least travel time.

The major conclusions of this study are that there appears to be no significant benefit of toll reduction to I-4 at the macroscopic network level, and that there is no benefit of reducing tolls on SR528. This is because whatever diversion happens due to toll reduction makes I-4 only more attractive to the local commuters who use arterials. These arterial commuters switch to I-4 bringing its conditions back to where they were before. Unless some form of restricting this diversion to I-4 is implemented, in the form of ramp metering strategies or the like, it is difficult to significantly alleviate the congestion on I-4 using toll reduction. In addition, there is some diversion to SR417 due to toll reduction though not necessarily from I-4.

Future Research

This study provided a foundation for further investigative scenarios as well as conclusions on the level of benefits from the defined network in this research. In addition, Florida's Turnpike Enterprise can evaluate the cost vs. benefit for implementing such a plan and can have invaluable insight for an accurate economic evaluation of the diversion and what amount of toll reduction would be the most beneficial to the state.

It is recommended that the UCF team update and apply the UCF-PARAMICS validated network model for the Central Florida area to simulate and execute some new traffic management strategies. The validated and updated UCF-PARAMICS model network can be used to estimate traffic diverted to Turnpike facilities such as the SR 417 as a result of alternative toll pricing plans. Of particular interest to the Turnpike Enterprise is to investigate the number of ETC/AVI vehicles currently not using the toll roads that may divert from the Interstate 4 during congestion created from construction (such as a one lane closure for a specified distance) during the peak hour if a discount structure based on their destination was provided to these vehicles.

While PARAMICS has severe limitations in terms of tracking the path of individual vehicles before and after implementing toll reduction scenarios, newly developed packages such as CUBE Voyager and Dynasim could be used for this purpose and other applications as well. CUBE can also used to investigate all ETC/AVI vehicles based on their destination and then only those that divert which previously did not use SR417. CUBE can be used to find out if the local arterial traffic will divert onto I-4 if the congestion was reduced to a level that will make it more attractive to local drivers in terms of short trips, which will then show no benefits for diversion for the goal of improving traffic on the Interstate.

Finally, the following are proposed for future investigation in CUBE:

- Evaluation of traffic with construction on Interstate 4 and minor network updates
    - Toll pricing alternatives
    - Varied locations and size of construction projects
    - Selected origins and destinations
- Evaluation of the impacts of Dynamic traffic information made available to

commuters through features in the CUBE Dynasim software such as:

- Dynamic Feedback (DFB) and
- Dynamic Message Signs (DMS)

- Impact of increased traffic on toll facility operations and level of service.
- Traffic volumes on selected non-toll roads after diversion and their resulting traffic operational level of service.

REFERENCES

Abdulhai, B., "Development of HOV Lane Treatment Plan For Highway 401In Toronto Using Microsimulation", Presented at the Transportation Research Board 81st Annual Meeting, January 2001, Washington D.C.

Abdulhai, B., Sheu, J., and Recker, W. Simulation of ITS on the Irvine FOT Area using PARAMICS 1.5 Scalable Microscopic Traffic Simulator: Phase 1: Model Calibration and Validation; California PATH Research Report, ISSN 1055-1425; Berkeley 1999.

Abou-Senna H. Investigating the Potential of Route Diversion through ITS Application on an Orlando Transportation Network Using Paramics Simulation Model. M.S. Thesis, University of Central Florida, 2003

Al-Deek, H. "The Role of Advanced Traveler Information Systems in Incident Management," Ph.D. Dissertation presented at the 71st Transportation Research Board Annual Meeting, Washington, D.C., January 1992.

Al-Deek, H. and Kanafani, A., "Modeling the Benefits of Advanced Traveler Information Systems in Corridors with Incidents," Transportation Research Journal, Part-C, Vol. 1 No. 4, pp. 303-324, December 1993.

Al-Deek, H., Khattak, A., and Thananjeyan, P., "A Combined Traveler Behavior and System Performance Model with ATIS," Transportation Research Journal, Part-A, Vol. 32, No. 7, pp. 479-493, September 1998.

Al-Deek, H., Klodzinski, J., and ElHelw, A. "Development of A Statewide Model For Heavy Truck Freight Movement on External Road Networks Connecting With Florida Ports, Phase-III-," Final Research Report, Transportation Systems Institute (TSI), Department of Civil & Environmental Engineering, University of Central Florida, 300 pages, December 2002.

Al-Deek, H., Martello, M. and May, A. "Potential Benefits of In-Vehicle Information Systems (IVIS)," Proceedings of the 1st Vehicle Navigation and Information Systems VNIS Conference, sponsored by IEEE, Toronto, Canada, pp. 288-291, September 1988.

Al-Deek, H., Martello, M., Sanders, W. and May, A. "Potential Benefits of In-Vehicle Information Systems in A Real Life Freeway Corridor," Proceedings of the 1st International Conference on Applications of Advanced Technologies in Transportation Engineering, American Society of Civil Engineers, San Diego, California, pp. 500-505, February 1990.

Bertini, R., Lindgren, R., and Tantiyanugulchai, S. Application of PARAMICS Simulation at a Diamond Interchange. Portland State University, Transportation Research Group, Research Report PSU-CE-TRG-02-02, April 2002.

Boxill, S. A., and Yu, L. “An Evaluation of Traffic Simulation Models for Supporting ITS Development”. Center for Transportation Training and Research, Texas Southern University, October 2000.

Choa, F. “CORSIM, PARAMICS, and VISSIM: What the Manuals Never Told You” http://www.fehrandpeers.com/publications/papers/corsim_paramics_vissim.pdf. <Accessed January 2005>.

Chu, L., Liu, H., and Recker, W. Development of A Simulation Laboratory for Evaluating Ramp Metering Algorithms. Presented at the Transportation Research Board 81st Annual Meeting, January 2002, Washington D.C.

Elefteriadou, L. "Beyond the Highway Capacity Manual- Framework for Selecting Simulation Models in Traffic Operational Analyses". Transportation Research Record 1678, TRB, National Research Council, Washington, D. C., 1999, pp. 96-106.

Emam, E. and Al-Deek, H., "A New Methodology for Estimating Travel Time Reliability in A Freeway Corridor," presented at the Transportation Research Board 84nd Annual Meeting, Washington D.C., January 8-13, 2005.

Gardes, Y., May, A., Dahlgren, J., and Skabardonis, A. Freeway Calibration and Application of the PARAMICS Model. Transportation Research Board 81st Annual Meeting. Washington, D.C. Jan. 2002

Klodzinski, J. and Al-Deek, H., "Methodology for Modeling a Road Network with High Truck Volumes Generated By Vessel Freight Activity from an Intermodal Facility," presented at the Transportation Research Board 83nd Annual Meeting, Washington D.C., January 11-15, 2004.

Klodzinski, J. and Al-Deek, H., "Using Seaport Freight Transportation Data to Distribute Heavy Truck Trips on Adjacent Highways," presented at the Transportation Research Board 82nd Annual Meeting, Washington D.C., January 2003.

Klodzinski, J. and Al-Deek, H., "Methodology for Modeling a Road Network with High Truck Volumes Generated By Vessel Freight Activity from an Intermodal Facility," Journal of the Transportation Research Board, No. 1873, pp. 35-44, November 2004.

Korve Engineers Inc. State Route 242 Widening Project. Operations Analysis Report to Contra Costa Transportation Authority (1996).

Lee, D., Wang, H., and Cheu, R. Dynamic Routing Decisions for Commercial Vehicle Operations based on Real-Time Traffic Conditions. Presented at the Transportation Research Board 82nd Annual Meeting, January 2003, Washington D.C.

Lee, D., Yang, X., Chandrasekar, P. Parameter Calibration for PARAMICS Using Genetic Algorithm. Presented at the Transportation Research Board 81st Annual Meeting, January 2001, Washington D.C.

Leftwich Consulting Engineers. Simulation and Analysis of Miami Downtown withParamicsModelingSuite,2001.http://www.paramicsonline.com/projects/Leftwich-miami.htm Browsed on January 10, 2003.

Lianyn Chu, Henrt X. Liu, Jun-Seok Oh, and Will Recker (2004). "A Calibration Procedure for Microscopic Traffic Simulation", Paper #04-4165, Transportation Research Board 2004 Annual Meeting CD-ROM, Washington, D.C.

Liu, H., Chu, L., and Recker, W. Paramics API Development document for Actuated Signal, Signal Coordination and Ramp Control. California PATH ATMIS Center, University of California at Irvine, December 2000

Mahmassani, H. and Jayakrishnan, R. System performance and user response under real-time information in a congested traffic corridor. Transportation Research 25A, 293-307, 1991.

May, A.D. "Traffic Flow Fundamentals", Prentice Hall, Englewood Cliffs, New Jersey, 1990.

Nam, H. and Shaw, W. "Microsimulation, Freeway System Operational Assessment, and Project Selection in Southeastern Wisconsin: Expanding the Vision ", Presented at the Transportation Research Board 81st Annual Meeting, January 2001, Washington D.C.

Quadstone Ltd. "PARAMICS ModellerV4.2 User Guide and Reference Manual". Edinburgh, February 2003.

Ramasamy, S. Development of the Traffic Simulation Model for the UCF Campus Using Paramics. Thesis submitted at University of Central Florida, Orlando, FL, Fall 2002.

Shaw, J., and Nam, D. Micro-simulation: Freeway System Operational Assessment and Project Selection in Southeastern Wisconsin: Expanding the Vision. Presented at the 81st TRB Annual Meeting. Washington, D.C. Jan. 2002.

Stewart, P. M8 Paramics Ramp Metering Assessment, Executive Summary forms ScottishExecutiveDevelopmentDepartment,2001.www.scotland.gov.uk/library3/transport /m8paramics.pdf. Browsed on February 20, 2004

The Smartest Project. "Review of Micro-Simulation Models" Appendix D: Analysis of Tools. Leeds University, 1997.

Trapp, R. Microscopic Traffic Flow Modeling of Large Urban Networks -Approach and Techniques at the Example of the City of Cologne. Presented at the Transportation Research Board 81st Annual Meeting, January 2002, Washington D.C.

UK Highways Agency, "UK design manual for roads and bridges," London, UK, 1996.

Yang, Q., and Koutsopoulos, H. A Microscopic Traffic Simulator for Evaluation of Dynamic Traffic Management Systems. Transportation Research C 4(3), pp. 113-129, 1996.

APPENDIX A.

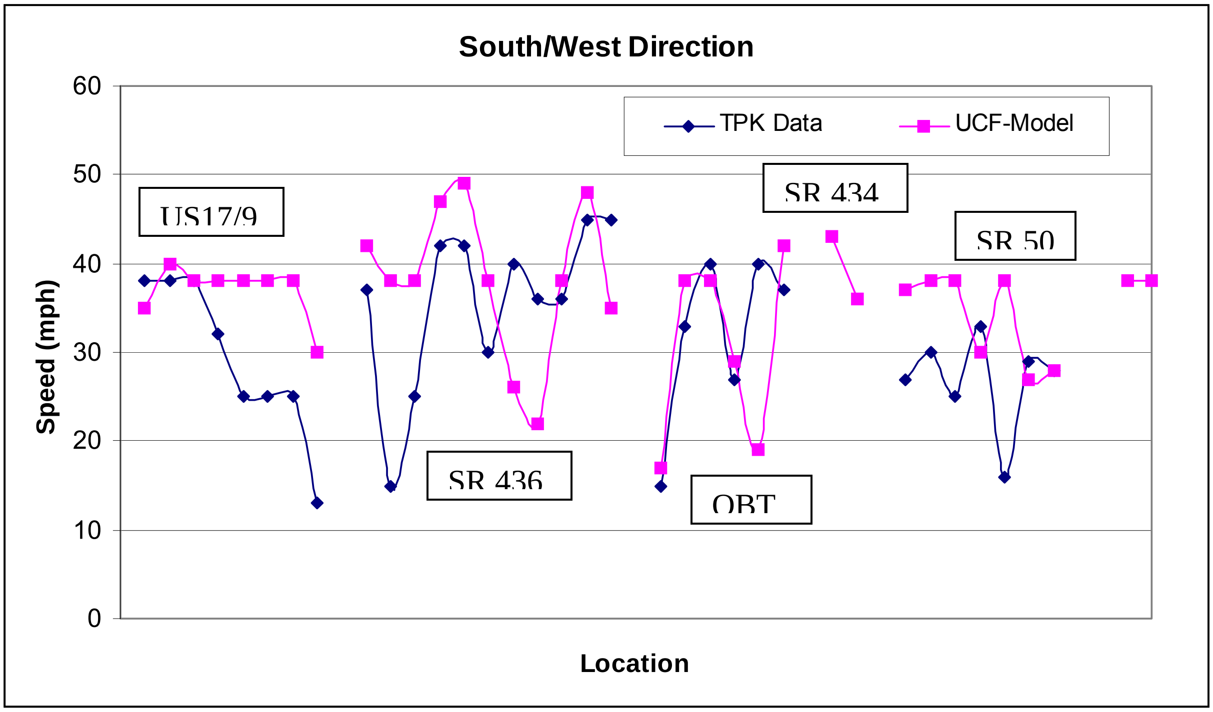
Major Arterials Calibration Results

Table 17: Final Calibration Results for UCF-PARAMICS Network (Major Arterials)

South/West Direction				North/East Direction		
Description	TPK Data	UCF-Model		Description	TPK Data	UCF-Model
US 17-92				**US 17-92**		
North of SR 417 from Sanford	38	35		South of SR 408		12
SR 417 to Lake Mary Blvd	38	40		SR 50 to SR 426	24	19
Lake Mary Blvd to SR 434	38	38		SR 426 to Maitland Blvd	24	38
SR 434 to SR 436	32	38		Maitland Blvd to SR 436	24	38
SR 436 to Maitland Blvd	25	38		SR 436 to SR 434	28	26
Maitland Blvd to SR 426	25	38		SR 434 to Lake Mary Blvd	44	38
SR 426 to SR 50	25	38		Lake Mary Blvd to SR 417	44	38
South of SR 408	13	30		North of SR 417 to Sanford	44	36
Semoran Blvd				**Semoran Blvd**		
OBT to SR 434	37	42		South of 417		31
SR 434 to I-4	15	38		SR 417 to SR 528	60	54
I-4 to US 17-92	25	38		SR 528 to Curry Ford Rd	35	37
US 17-92 to Red Bug Rd	42	47		Curry Ford Rd to SR408	35	38
Red Bug Rd to SR 426	42	49		SR 408 to SR 50	20	38
SR 426 to SR 50	30	38		SR 50 to SR 426	35	43
SR 50 to SR 408)	40	26		SR 426 to Red Bug Rd	42	49
SR 408 to Curry Ford Rd	36	22		Red Bug Rd to US 17-92	42	49
Curry Ford Rd to SR 528	36	38		US 17-92 to I-4	30	47
SR 528 to SR 417	45	48		I-4 to SR 434	25	36
SR 417 south	45	35		SR 434 to OBT	37	43
Orange Blossom Trail				**Orange Blossom Trail**		
SR 436 to SR 50	15	17		SR 417 south	37	27
SR 50 to SR 408	33	38		SR 417 to SR 528	26	41
SR 408 to I-4	40	38		SR 528 to I-4	36	49
I-4 to SR 528	27	29		I-4 to SR 408	20	43
SR 528 to SR 417	40	19		SR 408 to SR 50	24	24
SR 417 south	37	42		SR 50 to SR 436	33	38

Table 18: Final Calibration Results for UCF-PARAMICS Network (Major Arterials)

South/West Direction				North/East Direction		
Description	TPK Data	UCF-Model		Description	TPK Data	UCF-Model
SR-434				**SR-434**		
North of Altamonte Drive		43		East of I-4		38
East of I-4		36		North of Altamonte Drive		22
Colonial Drive				**Colonial Drive**		
West of 417	27	37		East of Pine Hills Road	30	38
East of 436	30	38		East of 408	38	38
West of 17/92	25	38		Good Homes & Hiawassee	37	37
West of I-4	33	30		West of OBT	30	28
West of OBT	16	38		West of I-4	16	33
East of 408	29	27		West of 17/92	22	38
East of Pine Hills Road	28	28		East of 436	33	38
				West of 417	43	44
Central Florida Parkway				**Central Florida Parkway**		
West of I-4		38		West of I-4		36
OBT to I-4		38		I-4 to OBT		38



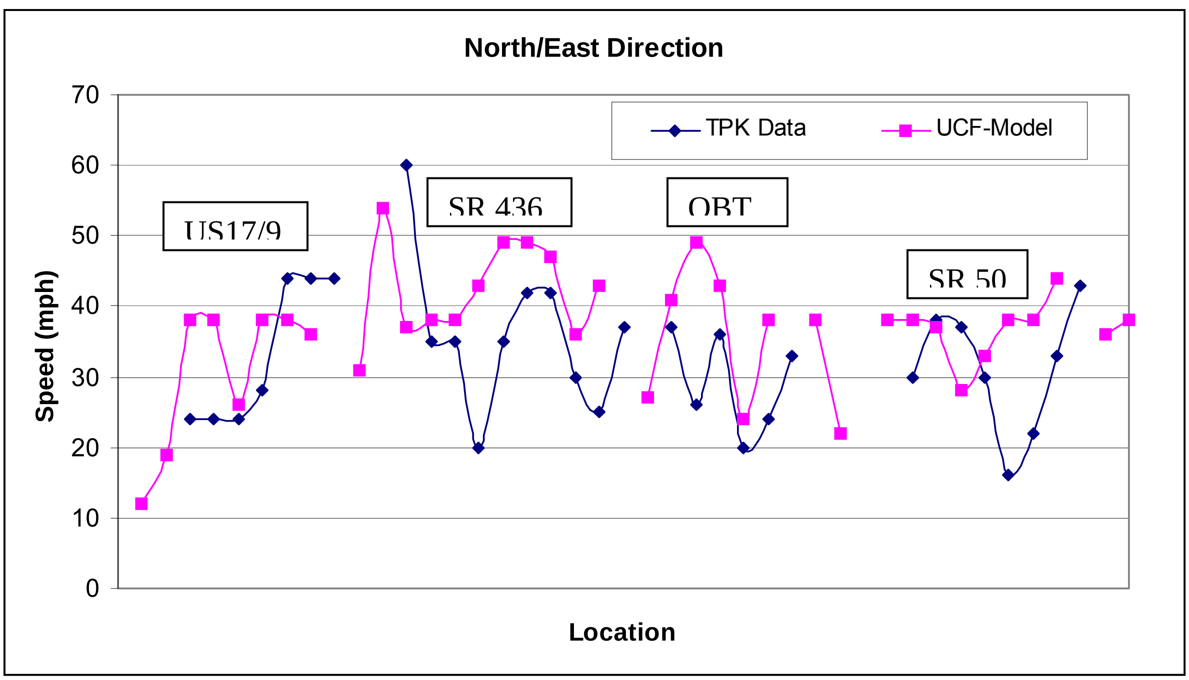


Figure 99: Calibration of Travel Speeds on the Major Arterials

Table 19: Final Validation Results for UCF-PARAMICS Network (Major Arterials)

South/West Direction					North/East Direction			
Description	TPK Data	UCF-Model	Lanes		Description	TPK Data	UCF-Model	Lanes
US 17-92					**US 17-92**			
North of SR 417 from Sanford	1156	1266	2		South of SR 408		558	2
SR 417 to Lake Mary Blvd	1496	928	2		SR 50 to SR 426	1041	956	2
Lake Mary Blvd to SR 434	1824	1078	2		SR 426 to Maitland Blvd	1545	882	3
SR 434 to SR 436	2391	1470	3		Maitland Blvd to SR 436	1943	856	3
SR 436 to Maitland Blvd	2290	1202	3		SR 436 to SR 434	2029	1860	3
Maitland Blvd to SR 426	1408	1094	3		SR 434 to Lake Mary Blvd	1518	786	2
SR 426 to SR 50	1566	888	2		Lake Mary Blvd to SR 417	1468		2
South of SR 408		676	2		North of SR 417 to Sanford	1155		2
Semoran Blvd					**Semoran Blvd**			
OBT to SR 434		1794	3		South of 417		890	2
SR 434 to I-4	2149	1516	3		SR 417 to SR 528		1468	2
I-4 to US 17-92		1064	3		SR 528 to Curry Ford Rd	1695	1268	2
US 17-92 to Red Bug Rd	2858	928	3		Curry Ford Rd to SR408	2015	906	2
Red Bug Rd to SR 426	2578	1506	3		SR 408 to SR 50	1948	1424	3
SR 426 to SR 50	2697	948	3		SR 50 to SR 426	2283	1144	3
Semoran Blvd (SR 50 to SR 408)	2300	2012	3		SR 426 to Red Bug Rd	2183	1616	3
SR 408 to Curry Ford Rd	2380	1572	2		Red Bug Rd to US 17-92	2639	1650	3
Curry Ford Rd to SR 528	1656	1092	2		US 17-92 to I-4	2086	354	3
SR 528 to SR 417		576	2		I-4 to SR 434	1828	1368	3
SR 417 south		672	2		SR 434 to OBT	1695	372	3

Table 20: Final Validation Results for UCF-PARAMICS Network (Major Arterials)

South/West Direction					North/East Direction			
Description	TPK Data	UCF-Model	Lanes		Description	TPK Data	UCF-Model	Lanes
Orange Blossom Trail					**Orange Blossom Trail**			
SR 436 to SR 50		1862	2		SR 417 south		1120	2
SR 50 to SR 408			2		SR 417 to SR 528		2120	3
SR 408 to I-4		1552	2		SR 528 to I-4	2064	962	2
I-4 to SR 528		1510	3		I-4 to SR 408	1112	546	2
SR 528 to SR 417		2048	2		SR 408 to SR 50		314	2
SR-434					**SR-434**			
East of I-4		652	2		East of I-4		966	2
North of Altamonte Drive		1376	2		North of Altamonte Drive		1828	2
Colonial Drive					**Colonial Drive**			
East of Pine Hills Road		540	3		East of Pine Hills Road		1782	2
East of 408			2		East of 408		1100	3
Good Homes and Hiawassee			3		Good Homes & Hiawassee		988	2
West of OBT		1026	2		West of OBT		1788	2
West of I-4		790	2		West of I-4		1452	2
West of 17/92		1274	3		West of 17/92		782	3
East of 436		1604	2		East of 436		1224	2
West of 417		1234			West of 417		412	3
Central Florida Parkway					**Central Florida Parkway**			
West of I-4		202	2		West of I-4		532	2
I-4 to OBT		628	2		I-4 to OBT		664	2

APPENDIX B.

Analysis of ATIS Scenarios Groups

Table 21: Hourly Traffic Volumes on Selected Links on SR417 SB for Recurring Congestion (G1) Scenarios

Location	Description	B	S1	S2	S3	S4
1	I-4 to Reinhart Road	816	866	854	856	848
2	Reinhart Road to SR-46	900	952	950	938	936
4	SR-46 to US17-92	532	654	728	640	744
6	US17-92 to Lake Mary Blvd	612	824	1026	844	1054
8	Lake Mary Blvd to Lake Jesup toll plaza	882	1288	1672	1276	1692
10	Lake Jesup toll plaza to SR-434	862	1260	1630	1246	1666
12	SR-434 to Red bug Lake road	1454	1926	2182	1866	2192
14	Red bug Lake road to Aloma Avenue	1808	2226	2450	2260	2526
16	Aloma Avenue to University Blvd	2018	2436	2622	2398	2720
18	University Toll Plaza to Colonial Drive	3044	3478	3722	3454	3782
19	Colonial drive to Curry Ford road	2238	2548	2980	2716	3258
20	Curry Ford Toll Plaza to Lake Drive	1944	2414	2652	2562	2816
22	Lake Drive to Beeline Expressway	2016	2330	2436	2458	2690
24	Beeline Expressway to Narcossee road	976	1188	1396	1044	1030
26	Narcossee road to Boggy creek road	414	572	784	500	510
28	Boggy Creek Road to Boggy Creek Toll Plaza	680	928	1182	788	822
30	Boggy Creek Toll Plaza to Landstar Blvd	874	1016	1254	940	880
31	Landstar Blvd to Orange Blossom Trail	744	898	1236	852	966
33	Orange Blossom Trail to John Young Parkway	1144	1308	1810	1240	1598
34	John Young Parkway to John Young Toll Plaza	1100	1276	1722	1214	1558
36	John Young Toll Plaza to International Drive	650	740	884	704	776
37	International Drive to Osceola Parkway	640	738	850	690	760
39	Osceola Parkway to Celebration Main Toll Plaza	322	332	468	412	442

Table 22: Hourly Traffic Volumes on Selected Links on I-4 WB for Recurring Congestion (G1) Scenarios

Location	Description	Base	S1	S2	S3	S4
1	SR-46 to Central Florida Greenway	2460	2472	2474	2476	2462
2	Central Florida Greenway to Lake Mary Blvd	3738	3498	3426	3538	3400
3	Lake Mary Blvd to SR-434	4938	4706	4570	4692	4546
4	SR-434 to SR-436	4282	4088	4056	4092	4028
5	SR-436 to Maitland Blvd	4964	4812	4818	4862	4788
6	Maitland Blvd to Lee Road	4376	4482	4532	4326	4456
7	Lee Road to Fairbanks Avenue	4830	4866	4864	4722	4844
8	Fairbanks Ave to Par Avenue	4680	4670	4650	4506	4676
9	Par Avenue to Princeton Street	4844	4828	4644	4694	4788
10	Princeton Street to Ivanhoe Blvd	4598	4638	4574	4614	4698
11	Ivanhoe Blvd to Colonial Drive	3468	3410	3478	3490	3404
12	Colonial Drive to Amelia	5148	5138	5162	5176	5112
13	Amelia to East West Expressway	5092	5160	5154	5124	5044
14	East West Expressway to Anderson Street	4304	4372	4316	4268	4226
15	Kaley Avenue to Michigan Street	2928	3058	2952	2972	2894
16	Michigan Street to Orange Blossom Trail	4570	4562	4764	4464	4582
17	Orange Blossom Trail to John Young Parkway	4120	4218	4306	4168	4322
18	John Young Parkway to Conroy Road	3390	3434	3392	3310	3282
19	Conroy Road to Florida Turnpike	4168	4218	4196	4130	4048
20	Florida Turnpike to Kirkman Road	3598	3722	3720	3670	3600
21	Kirkman Road to Universal Drive	2998	2998	2988	2954	2830
22	Beeline Expressway to Central Florida Parkway	4894	4728	4818	4876	4948
23	Central Florida Parkway to SR-535	5212	5086	5036	5372	5306
24	SR-535 to Osceola Parkway	3468	3312	3230	3510	3442
25	Osceola Parkway to US-192	1930	1890	1862	1982	1960
26	US-192 to World Drive	1906	1862	1820	1934	1878
27	World Drive to Western Beltway	2216	2138	2120	2318	2174

Table 23: Hourly Traffic Volumes on Selected Links on SR528 WB for Recurring Congestion (G1) Scenarios

Location	Description	Base	S1	S2	S3	S4
1	East of Sr-417 Interchange	910	904	904	904	904
3	SR-417 Interchange to CR-15	1288	1328	1280	1624	1938
4	CR-15 to Golden Rod Road	1372	1338	1300	1634	1964
6	Golden Rod Road to Semoran Blvd	1792	1760	1664	2068	2364
8	Semoran Blvd to Airport Toll Plaza	2258	2174	1988	2790	3160
9	Airport Toll Plaza to Conway Road	2236	2146	1988	2738	3134
10	Conway road to Sand Lake Road	1554	1390	1200	1902	2274
12	Sand Lake Road to Beeline West Main Plaza	1152	1040	910	1420	1842
14	Beeline West Main Plaza to Orange Blossom Trail	1128	1024	886	1356	1794
15	Orange Blossom Trail to John Young Parkway	1428	1264	1148	1482	1676
16	John Young Parkway to Orange Wood Road	1558	1388	1238	1556	1718
17	Orange Wood Road to International Drive	1784	1588	1450	1742	1914
18	International Drive to I-4	2398	2204	2044	2354	2520

Table 24: Hourly Traffic Volumes on Selected Links on Arterials SB for Recurring Congestion (G1) Scenarios

Location	Description	B	S1	S2	S3	S4
1	US 17-92 (north of SR 417) from Sanford	652	662	678	656	666
3	US 17-92 (Lake Mary Blvd to SR 434)	176	194	202	190	194
4	US 17-92 (SR 434 to SR 436)	910	788	654	784	682
5	US 17-92 (SR 436 to Maitland Blvd)	858	876	970	864	906
6	US 17-92 (Maitland Blvd to SR 426)	1264	1266	1266	1274	1266
7	US 17-92 (SR 426 to SR 50)	908	862	816	842	802
8	US 17-92 (south of SR 408)	944	882	758	864	756
1	Semoran Blvd (OBT to SR 434)	1756	1770	1398	1400	1370
2	Semoran Blvd (SR 434 to I-4)	856	844	1002	1108	1056
3	Semoran Blvd (I-4 to US 17-92)	1738	1718	1772	1752	1782
4	Semoran Blvd (US 17-92 to Red Bug Lake Rd)	1026	916	708	916	726
5	Semoran Blvd (Red Bug Lake Rd to SR 426)	1464	1372	1514	1540	1466
6	Semoran Blvd (SR 426 to SR 50)	1460	1454	1494	1494	1536
7	Semoran Blvd (SR 50 to SR 408)	1270	1116	500	610	572
8	Semoran Blvd (SR 408 to Curry Ford Rd)	704	624	530	670	610
9	Semoran Blvd (Curry Ford Rd to SR 528)	786	674	1048	1046	1030
10	Semoran Blvd (SR 528 to SR 417)	490	420	776	838	752
11	Semoran Blvd (SR 417 south)	986	880	794	894	806
1	Orange Blossom Trail (SR 436 to SR 50)	1232	1158	314	334	288
2	Orange Blossom Trail (SR 50 to SR 408)	1738	1776	724	710	690
3	Orange Blossom Trail (SR 528 to SR 417)	306	404	512	334	372
4	Orange Blossom Trail (SR 417 south)	60	58	56	58	56

Table 25: Hourly Traffic Volumes on Selected Links on SR417 SB for Lane Closure Scenarios between Lake Mary and SR436 on I-4 (G2)

Location	Description	B	S5	S6	S7	S8	S9
1	I-4 to Reinhart Road	806	728	788	816	786	786
2	Reinhart Road to SR-46	874	844	922	944	906	918
4	SR-46 to US17-92	526	660	802	882	812	866
6	US17-92 to Lake Mary Blvd	608	630	932	1092	890	1090
8	Lake Mary Blvd to Lake Jesup toll plaza	898	910	1346	1702	1338	1748
10	Lake Jesup toll plaza to SR-434	864	892	1332	1670	1316	1718
12	SR-434 to Red bug Lake road	1452	1492	1926	2210	1930	2234
14	Red bug Lake road to Aloma Avenue	1872	1888	2264	2512	2260	2538
16	Aloma Avenue to University Blvd	2064	2072	2424	2622	2420	2778
18	University Toll Plaza to Colonial Drive	3028	3058	3426	3496	3486	3672
19	Colonial drive to Curry Ford road	2250	2250	2604	2850	2710	3316
20	Curry Ford Toll Plaza to Lake Drive	1962	1972	2456	2712	2558	2774
22	Lake Drive to Beeline Expressway	2016	1998	2336	2516	2436	2628
24	Beeline Expressway to Narcossee road	982	988	1164	1426	1048	1060
26	Narcossee road to Boggy creek road	406	422	562	780	490	528
28	Boggy Creek Road to Boggy Creek Toll Plaza	678	660	904	1188	788	852
30	Boggy Creek Toll Plaza to Landstar Blvd	862	868	1002	1248	930	910
31	Landstar Blvd to Orange Blossom Trail	740	732	900	1252	830	982
33	Orange Blossom Trail to John Young Parkway	1066	1050	1300	1790	1244	1576
34	John Young Parkway to John Young Toll Plaza	1044	1026	1276	1746	1224	1526
36	John Young Toll Plaza to International Drive	638	642	736	904	714	788
37	International Drive to Osceola Parkway	638	636	712	890	682	764
39	Osceola Parkway to Celebration Main Toll Plaza	320	338	432	746	518	536

Table 26: Hourly Traffic Volumes on Selected Links on SR528 WB for Lane Closure Scenarios between Lake Mary and SR436 on I-4 (G2)

Location	Description	B	S5	S6	S7	S8	S9
1	East of Sr-417 Interchange	904	904	904	904	904	904
3	SR-417 Interchange to CR-15	1306	1296	1358	1302	1608	1848
4	CR-15 to Golden Rod Road	1404	1360	1360	1288	1638	1954
6	Golden Rod Road to Semoran Blvd	1822	1800	1746	1676	2042	2368
8	Semoran Blvd to Airport Toll Plaza	2284	2294	2176	2058	2786	3178
9	Airport Toll Plaza to Conway Road	2264	2276	2152	2044	2778	3154
10	Conway road to Sand Lake Road	1530	1544	1364	1266	1932	2274
12	Sand Lake Road to Beeline West Main Toll Plaza	1192	1176	1038	924	1454	1808
14	Beeline West Main Toll Plaza to Orange Blossom Trail	1152	1144	1012	910	1402	1794
15	Orange Blossom Trail to John Young Parkway	1356	1348	1276	1128	1468	1692
16	John Young Parkway to Orange Wood Road	1468	1452	1384	1234	1548	1706
17	Orange Wood Road to International Drive	1654	1638	1578	1446	1746	1910
18	International Drive to I-4	2260	2256	2206	2066	2346	2508

Table 27: Hourly Traffic Volumes on Selected Links on I-4 WB for Lane Closure Scenarios between Lake Mary and SR436 on I-4 (G2)

Locations	Description	B	S5	S6	S7	S8	S9
1	SR-46 to Central Florida Greenway	2460	2460	2448	2464	2470	2452
2	Central Florida Greenway to Lake Mary Blvd	3722	3636	3442	3400	3482	3334
3	Lake Mary Blvd to SR-434	4950	3910	3756	3748	3788	3706
4	SR-434 to SR-436	4274	3610	3342	3352	3414	3394
5	SR-436 to Maitland Blvd	5084	5104	4932	4880	4916	4896
6	Maitland Blvd to Lee Road	4476	4494	4438	4860	4436	4578
7	Lee Road to Fairbanks Avenue	4868	4746	4704	5038	4698	4788
8	Fairbanks Ave to Par Avenue	4682	4550	4492	4748	4500	4606
9	Par Avenue to Princeton Street	4766	4622	4688	4658	4638	4822
10	Princeton Street to Ivanhoe Blvd	4552	4418	4562	4576	4556	4706
11	Ivanhoe Blvd to Colonial Drive	3458	3454	3318	3320	3526	3488
12	Colonial Drive to Amelia	5200	5070	5034	4974	5070	5104
13	Amelia to East West Expressway	5152	5110	4996	4960	5128	5186
14	East West Expressway to Anderson Street	4366	4330	4168	4146	4466	4398
15	Kaley Avenue to Michigan Street	4308	4198	4402	4246	4382	4212
16	Michigan Street to Orange Blossom Trail	3662	3510	3708	3616	3680	3438
17	Orange Blossom Trail to John Young Parkway	3906	3854	3978	3798	3922	3660
18	John Young Parkway to Conroy Road	3480	3466	3496	3366	3496	3260
19	Conroy Road to Florida Turnpike	4280	4264	4332	4170	4248	4064
20	Florida Turnpike to Kirkman Road	3612	3618	3814	3732	3700	3598
21	Kirkman Road to Universal Drive	2930	2916	3092	2986	2978	2862
22	Beeline Expressway to Central Florida Parkway	4648	4710	4944	4794	4966	4520
23	Central Florida Parkway to SR-535	5322	5204	5380	5146	5336	4962
24	SR-535 to Osceola Parkway	3508	3418	3506	3248	3492	3226
25	Osceola Parkway to US-192	1938	1968	1978	1898	1960	1880
26	US-192 to World Drive	1938	1954	1946	1836	1902	1826
27	World Drive to Western Beltway	2252	2230	2288	2380	2250	2278

Table 28: Hourly Traffic Volumes on Selected Links on Arterials SB for Lane Closure Scenarios between Lake Mary and SR436 on I-4 (G2)

Location	Description	B	S5	S6	S7	S8	S9
1	US 17-92 (north of SR 417) from Sanford	1266	1272	1266	1266	1266	1278
3	US 17-92 (Lake Mary Blvd to SR 434)	1078	1410	1274	1036	1242	1022
4	US 17-92 (SR 434 to SR 436)	1470	1528	1710	1556	1606	1556
5	US 17-92 (SR 436 to Maitland Blvd)	1202	1194	1314	1408	1300	1414
6	US 17-92 (Maitland Blvd to SR 426)	1094	1092	1072	1082	1076	1074
7	US 17-92 (SR 426 to SR 50)	888	886	808	800	782	772
8	US 17-92 (south of SR 408)	676	654	678	656	626	654
1	Semoran Blvd (OBT to SR 434)	1794	1750	1792	1716	1794	1682
2	Semoran Blvd (SR 434 to I-4)	1516	1546	1620	1576	1620	1588
3	Semoran Blvd (I-4 to US 17-92)	1064	1064	1064	1046	1056	1038
4	Semoran Blvd (US 17-92 to Red Bug Lake Rd)	928	816	870	758	824	812
5	Semoran Blvd (Red Bug Lake Rd to SR 426)	1506	1514	1436	1408	1440	1410
6	Semoran Blvd (SR 426 to SR 50)	948	922	846	756	820	744
7	Semoran Blvd (SR 50 to SR 408)	2012	2038	1918	1788	1932	1836
8	Semoran Blvd (SR 408 to Curry Ford Rd)	1572	1558	1508	1522	1524	1482
9	Semoran Blvd (Curry Ford Rd to SR 528)	1092	1114	970	866	1094	1072
10	Semoran Blvd (SR 528 to SR 417)	576	574	574	488	610	574
11	Semoran Blvd (SR 417 south)	672	668	638	534	662	610
1	Orange Blossom Trail (SR 436 to SR 50)	1862	1880	1868	1868	1880	1876
2	Orange Blossom Trail (SR 408 to I-4)	1552	1654	1532	1438	1586	1522
3	Orange Blossom Trail (I-4 to SR 528)	1510	1426	1468	1460	1502	1512
4	Orange Blossom Trail (SR 528 to SR 417)	2048	2078	2074	2004	2060	2038

Table 29: Hourly Traffic Volumes on Selected Links on SR417 SB for Lane Closure Scenarios between Lee Road and Colonial Drive on I-4 (G3)

Location	Description	B	S10	S11	S12	S13	S14
1	I-4 to Reinhart Road	816	768	858	848	870	826
2	Reinhart Road to SR-46	900	842	956	980	984	938
4	SR-46 to US17-92	532	530	664	734	658	738
6	US17-92 to Lake Mary Blvd	612	620	866	1086	844	1080
8	Lake Mary Blvd to Lake Jesup toll plaza	882	874	1314	1710	1316	1732
10	Lake Jesup toll plaza to SR-434	862	854	1290	1676	1280	1700
12	SR-434 to Red bug Lake road	1454	1442	1882	2192	1854	2214
14	Red bug Lake road to Aloma Avenue	1808	1842	2212	2512	2206	2558
16	Aloma Avenue to University Blvd	2018	2034	2422	2614	2382	2724
18	University Toll Plaza to Colonial Drive	3044	3024	3462	3648	3458	3676
19	Colonial drive to Curry Ford road	2238	2194	2556	2966	2712	3248
20	Curry Ford Toll Plaza to Lake Drive	1944	1948	2368	2726	2522	2824
22	Lake Drive to Beeline Expressway	2016	2008	2244	2516	2454	2668
24	Beeline Expressway to Narcossee road	976	1020	1150	1458	1088	1078
26	Narcossee road to Boggy creek road	414	414	546	778	486	514
28	Boggy Creek Road to Boggy Creek Toll Plaza	680	682	930	1270	790	858
30	Boggy Creek Toll Plaza to Landstar Blvd	874	848	988	1260	884	906
31	Landstar Blvd to Orange Blossom Trail	744	752	1182	1628	1120	1362
33	Orange Blossom Trail to John Young Parkway	1144	1194	1874	2356	1820	2134
34	John Young Parkway to John Young Toll Plaza	1100	1142	1782	2184	1750	2044
36	John Young Toll Plaza to International Drive	650	664	708	854	690	768
37	International Drive to Osceola Parkway	640	648	698	840	666	746
39	Osceola Parkway to Celebration Main Toll Plaza	322	328	460	694	436	526

Table 30: Hourly Traffic Volumes on Selected Links on SR528 WB for Lane Closure Scenarios between Lee Road and Colonial Drive on I-4 (G3)

Location	Description	B	S10	S11	S12	S13	S14
1	East of Sr-417 Interchange	904	910	910	910	910	910
3	SR-417 Interchange to CR-15	1306	1272	1324	1344	1592	1882
4	CR-15 to Golden Rod Road	1404	1386	1344	1278	1652	1948
6	Golden Rod Road to Semoran Blvd	1822	1802	1736	1676	2050	2354
8	Semoran Blvd to Airport Plaza	2284	2252	2128	1986	2714	3116
9	Airport Toll Plaza to Conway Road	2264	2232	2124	1994	2672	3066
10	Conway road to Sand Lake Road	1530	1510	1374	1214	1848	2200
12	Sand Lake Road to Beeline West Main Toll Plaza	1192	1142	1032	884	1360	1670
14	Beeline West Main Toll Plaza to Orange Blossom Trail	1152	1116	992	866	1264	1614
15	Orange Blossom Trail to John Young Parkway	1356	1388	1846	1704	2046	2260
16	John Young Parkway to Orange Wood Road	1468	1564	1994	1858	2174	2336
17	Orange Wood Road to International Drive	1654	1804	2210	2070	2376	2536
18	International Drive to I-4	2260	2388	2590	2656	2810	3008

Table 31: Hourly Traffic Volumes on Selected Links on I-4 WB for Lane Closure Scenarios between Lee Road and Colonial Drive on I-4 (G3)

Location	Description	B	S10	S11	S12	S13	S14
1	SR-46 to Central Florida Greenway	2460	2472	2462	2468	2452	2446
2	Central Florida Greenway to Lake Mary Blvd	3738	3728	3496	3416	3546	3374
3	Lake Mary Blvd to SR-434	4938	4984	4700	4552	4746	4480
4	SR-434 to SR-436	4282	4246	4136	3866	4040	3996
5	SR-436 to Maitland Blvd	4964	4842	4602	4610	4790	4626
6	Maitland Blvd to Lee Road	4376	2828	2710	3042	2960	2752
7	Lee Road to Fairbanks Avenue	4830	3388	3478	3332	3410	3432
8	Fairbanks Ave to Par Avenue	4680	3416	3424	3344	3418	3444
9	Par Avenue to Princeton Street	4844	3350	3426	3320	3420	3470
10	Princeton Street to Ivanhoe Blvd	4598	3340	3358	3318	3416	3472
11	Ivanhoe Blvd to Colonial Drive	3468	2400	2218	2382	2320	2298
12	Colonial Drive to Amelia	5148	3996	3868	4020	3932	3788
13	Amelia to East West Expressway	5092	4086	4008	4100	4060	3918
14	East West Expressway to Anderson Street	4304	3682	3596	3662	3668	3578
15	Kaley Avenue to Michigan Street	2928	2516	2412	2428	2514	2398
16	Michigan Street to Orange Blossom Trail	4570	4544	4452	4532	4522	4296
17	Orange Blossom Trail to John Young Parkway	4120	4236	4282	4252	4278	4072
18	John Young Parkway to Conroy Road	3390	3344	3352	3346	3356	3112
19	Conroy Road to Florida Turnpike	4168	4156	4116	4118	4130	3912
20	Florida Turnpike to Kirkman Road	3598	3644	3658	3642	3730	3476
21	Kirkman Road to Universal Drive	2998	3026	3014	2982	3046	2762
22	Beeline Expressway to Central Florida Parkway	4894	4686	4678	4616	4506	4810
23	Central Florida Parkway to SR-535	5212	5014	5320	5154	4978	5260
24	SR-535 to Osceola Parkway	3468	3286	3498	3284	3248	3378
25	Osceola Parkway to US-192	1930	1858	1946	1836	1890	1924
26	US-192 to World Drive	1906	1830	1902	1794	1832	1846
27	World Drive to Western Beltway	2216	2190	2248	2322	2226	2242

Table 32: Hourly Traffic Volumes on Selected Links on Arterials SB for Lane Closure Scenarios between Lee Road and Colonial Drive on I-4 (G3)

Location	Description	B	S10	S11	S12	S13	S14
1	US 17-92 (north of SR 417) from Sanford	652	678	684	704	674	712
3	US 17-92 (Lake Mary Blvd to SR 434)	176	214	210	202	222	210
4	US 17-92 (SR 434 to SR 436)	910	934	838	692	834	676
5	US 17-92 (SR 436 to Maitland Blvd)	858	840	850	888	822	918
6	US 17-92 (Maitland Blvd to SR 426)	1264	1260	1268	1268	1268	1268
7	US 17-92 (SR 426 to SR 50)	908	598	578	614	588	596
8	US 17-92 (south of SR 408)	944	920	852	746	864	744
1	Semoran Blvd (OBT to SR 434)	1756	1756	1428	1438	1436	1384
2	Semoran Blvd (SR 434 to I-4)	856	830	1074	1008	1118	1056
3	Semoran Blvd (I-4 to US 17-92)	1738	1762	1780	1730	1756	1780
4	Semoran Blvd (US 17-92 to Red Bug Lake Rd)	1026	1052	894	710	894	708
5	Semoran Blvd (Red Bug Lake Rd to SR 426)	1464	1466	1556	1502	1562	1518
6	Semoran Blvd (SR 426 to SR 50)	1460	1486	1476	1480	1486	1482
7	Semoran Blvd (SR 50 to SR 408)	1270	1190	584	500	594	578
8	Semoran Blvd (SR 408 to Curry Ford Rd)	704	670	652	558	644	616
9	Semoran Blvd (Curry Ford Rd to SR 528)	786	744	1058	1046	1046	1036
10	Semoran Blvd (SR 528 to SR 417)	490	476	842	774	812	734
11	Semoran Blvd (SR 417 south)	986	1022	918	818	934	822
1	Orange Blossom Trail (SR 436 to SR 50)	1232	1240	324	316	332	304
2	Orange Blossom Trail (SR 50 to SR 408)	1738	1758	714	694	690	692
3	Orange Blossom Trail (SR 528 to SR 417)	306	308	426	564	334	376
4	Orange Blossom Trail (SR 417 south)	60	60	56	58	56	58

Table 33: Hourly Traffic Volumes on Selected Links on SR417 SB for Lane Closure Scenarios between Florida Turnpike and Central Florida Parkway on I-4 (G4)

Location	Description	B	S15	S16	S17	S18	S19
1	I-4 to Reinhart Road	812	786	866	876	852	842
2	Reinhart Road to SR-46	880	880	958	968	940	940
4	SR-46 to US17-92	532	534	664	724	648	750
6	US17-92 to Lake Mary Blvd	622	610	858	1044	842	1066
8	Lake Mary Blvd to Lake Jesup toll plaza	894	898	1324	1676	1308	1720
10	Lake Jesup toll plaza to SR-434	880	892	1300	1646	1284	1704
12	SR-434 to Red bug Lake road	1446	1432	1858	2124	1852	2170
14	Red bug Lake road to Aloma Avenue	1844	1876	2256	2486	2252	2538
16	Aloma Avenue to University Blvd	2028	2052	2378	2582	2430	2640
18	University Toll Plaza to Colonial Drive	3006	3012	3284	3624	3358	3596
19	Colonial drive to Curry Ford road	2214	2264	2556	3030	2698	3298
20	Curry Ford Toll Plaza to Lake Drive	1910	1972	2408	2704	2484	2766
22	Lake Drive to Beeline Expressway	1976	1938	2224	2474	2328	2562
24	Beeline Expressway to Narcossee road	1008	1000	1176	1472	1116	1078
26	Narcossee road to Boggy creek road	408	418	546	784	496	526
28	Boggy Creek Toll Plaza to Landstar Blvd	664	690	924	1118	786	880
30	Landstar Blvd to Orange Blossom Trail	858	866	1004	1178	918	890
31	Orange Blossom Trail to John Young Parkway	730	774	974	1308	908	1116
33	John Young Parkway to John Young Toll Plaza	1146	1092	1494	1994	1458	1856
34	John Young Toll Plaza to International Drive	1110	1062	1486	1924	1444	1830
36	International Drive to Osceola Parkway	642	642	750	888	722	774
37	Osceola Parkway to Celebration Main Toll Plaza	632	624	720	838	698	748
39	Celebration Main toll Plaza to I-4	322	318	422	572	448	464

Table 34: Hourly Traffic Volumes on Selected Links on 528 WB for Lane Closure Scenarios between Florida Turnpike and Central Florida Parkway on I-4 (G4)

Location	Description	B	S15	S16	S16	S17	S18
1	East of Sr-417 Interchange	910	880	880	880	880	880
3	SR-417 Interchange to CR-15	1232	1170	1266	1256	1474	1728
4	CR-15 to Golden Rod Road	1338	1240	1234	1176	1454	1794
6	Golden Rod Road to Semoran Blvd	1758	1642	1654	1556	1872	2146
8	Semoran Blvd to Airport Toll Plaza	2224	2046	2038	1888	2462	3038
9	Airport Plaza to Conway Road	2222	2018	2006	1890	2454	3012
10	Conway road to Sand Lake Road	1528	1290	1216	1088	1618	2068
12	Sand Lake Road to Beeline West Main Toll Plaza	1156	932	840	730	1114	1480
14	Beeline West Main Toll Plaza to Orange Blossom Trail	1106	892	812	700	1066	1408
15	Orange Blossom Trail to John Young Parkway	1406	950	902	814	1054	1226
16	John Young Parkway to Orange Wood Road	1572	932	860	756	968	1104
17	Orange Wood Road to International Drive	1796	1010	950	838	1070	1196
18	International Drive to I-4	2412	1268	1204	1094	1318	1430

Table 35: Hourly Traffic Volumes on Selected Links on I-4 WB for Lane Closure Scenarios between Florida Turnpike and Central Florida Parkway on I-4 (G4)

Location	Description	B	S15	S16	S17	S18	S19
1	SR-46 to Central Florida Greenway	2462	2458	2448	2434	2436	2448
2	Central Florida Greenway to Lake Mary Blvd	3730	3664	3488	3404	3468	3376
3	Lake Mary Blvd to SR-434	4980	4890	4694	4526	4664	4484
4	SR434 to SR436	4328	4312	4034	4074	4122	4052
5	SR-436 to Maitland Blvd	5002	5024	4792	4816	4830	4748
6	Maitland Blvd to Lee Road	4710	4686	4502	4362	4432	4718
7	Lee Road to Fairbanks Avenue	4988	4956	4802	4692	4748	4828
8	Fairbanks Ave to Par Avenue	4792	4708	4588	4430	4564	4674
9	Par Avenue to Princeton Street	4672	4610	4702	4502	4654	4738
10	Princeton Street to Ivanhoe Blvd	4500	4380	4466	4414	4406	4514
11	Ivanhoe Blvd to Colonial Drive	3390	3412	3396	3354	3346	3418
12	Colonial Drive to Amelia	5102	4928	4960	4944	4960	5014
13	Amelia to East West Expressway	5022	4970	5058	4964	4980	4966
14	East West Expressway to Anderson Street	4256	4216	4288	4150	4196	4094
15	Kaley Avenue to Michigan Street	2904	2858	2866	2804	2856	2804
16	Michigan Street to Orange Blossom Trail	4510	4582	4566	4608	4684	4566
17	Orange Blossom Trail to John Young Parkway	4098	4174	4140	4232	4320	4334
18	John Young Parkway to Conroy Road	3392	3436	3388	3414	3444	3372
19	Conroy Road to Florida Turnpike	4212	4244	4180	4184	4244	4154
20	Florida Turnpike to Kirkman Road	3602	3696	3692	3714	3712	3614
21	Kirkman Road to Universal Drive	3052	2994	2982	2974	2986	2844
22	Beeline Expressway to Central Florida Parkway	4744	3388	3492	3382	3476	3420
23	Central Florida Parkway to SR-535	5134	3176	3150	3104	3250	3254
24	SR-535 to Osceola Parkway	3356	1894	1920	1850	1900	1952
25	Osceola Parkway to US-192	1880	1310	1324	1324	1374	1376
26	US-192 to World Drive	1888	1302	1322	1284	1330	1344
27	World Drive to Western Beltway	2230	1746	1730	1816	1722	1846

Table 36: Hourly Traffic Volumes on Selected Links on Arterials SB for Lane Closure Scenarios between Florida Turnpike and Central Florida Parkway on I-4 (G4)

Location	Description	B	S15	S16	S17	S18	S19
1	US 17-92 (north of SR 417) from Sanford	658	652	656	668	626	664
3	US 17-92 (Lake Mary Blvd to SR 434)	160	202	184	194	198	194
4	US 17-92 (SR 434 to SR 436)	894	900	770	648	782	646
5	US 17-92 (SR 436 to Maitland Blvd)	900	866	870	934	920	888
6	US 17-92 (Maitland Blvd to SR 426)	1268	1254	1250	1254	1254	1254
7	US 17-92 (SR 426 to SR 50)	908	902	846	782	856	832
8	US 17-92 (south of SR 408)	926	896	850	750	846	748
1	Semoran Blvd (OBT to SR 434)	1738	1740	1396	1380	1412	1364
2	Semoran Blvd (SR 434 to I-4)	886	920	1102	1016	1094	1046
3	Semoran Blvd (I-4 to US 17-92)	1736	1772	1656	1742	1762	1740
4	Semoran Blvd (US 17-92 to Red Bug Lake Rd)	1030	1044	898	732	898	712
5	Semoran Blvd (Red Bug Lake Rd to SR 426)	1440	1478	1582	1542	1556	1476
6	Semoran Blvd (SR 426 to SR 50)	1534	1544	1492	1516	1482	1522
7	Semoran Blvd (SR 50 to SR 408)	1278	1240	558	462	586	544
8	Semoran Blvd (SR 408 to Curry Ford Rd)	686	678	604	524	644	590
9	Semoran Blvd (Curry Ford Rd to SR 528)	816	750	1042	1034	1058	1022
10	Semoran Blvd (SR 528 to SR 417)	486	472	832	744	848	746
11	Semoran Blvd (SR 417 south)	1000	1002	866	776	894	746
1	Orange Blossom Trail (SR 436 to SR 50)	1244	1734	314	294	302	306
2	Orange Blossom Trail (SR 50 to SR 408)	1808	1760	744	762	728	714
3	Orange Blossom Trail (SR 528 to SR 417)	290	330	426	548	346	388
4	Orange Blossom Trail (SR 417 south)	60	60	60	58	60	60

Table 37: Hourly Traffic Volumes on Selected Links on SR417 SB for Incident Scenarios between Maitland Blvd and Lee Road on I-4 (G5)

Locations	Description	B	S20	S21	S22	S23	S24
1	I-4 to Reinhart Road	816	764	818	810	812	792
2	Reinhart Road to SR-46	900	852	894	906	900	900
4	SR-46 to US17-92	532	482	618	678	600	690
6	US17-92 to Lake Mary Blvd	612	578	836	1006	826	1040
8	Lake Mary Blvd to Lake Jesup toll plaza	882	888	1274	1626	1264	1650
10	Lake Jesup toll plaza to SR-434	862	866	1260	1620	1248	1632
12	SR-434 to Red bug Lake road	1454	1586	1982	2268	1998	2304
14	Red bug Lake road to Aloma Avenue	1808	2040	2398	2576	2382	2616
16	Aloma Avenue to University Blvd	2018	2168	2468	2648	2468	2698
18	University Toll Plaza to Colonial Drive	3044	3008	3340	3522	3248	3600
19	Colonial drive to Curry Ford road	2238	2120	2404	2760	2458	3048
20	Curry Ford Toll Plaza to Lake Drive	1944	1916	2302	2602	2382	2662
22	Lake Drive to Beeline Expressway	2016	1944	2172	2394	2282	2560
24	Beeline Expressway to Narcossee road	976	934	1116	1348	1006	1030
26	Narcossee road to Boggy creek road	414	362	448	620	406	412
27	Boggy Creek Road to Boggy Creek Toll Plaza	716	674	874	1084	778	820
28	Boggy Creek Toll Plaza to Landstar Blvd	680	684	876	1082	774	828
30	Landstar Blvd to Orange Blossom Trail	874	862	978	1164	898	886
31	Orange Blossom Trail to John Young Parkway	744	774	958	1338	896	1142
33	John Young Parkway to John Young Toll Plaza	1144	1208	1538	2070	1564	1932
34	John Young Toll Plaza to International Drive	1100	1168	1530	2026	1508	1906
36	International Drive to Osceola Parkway	650	696	804	896	772	844
37	Osceola Parkway to Celebration Main Toll Plaza	640	702	798	892	762	812
39	Celebration Main toll Plaza to I-4	322	352	474	644	404	594

Table 38: Hourly Traffic Volumes on Selected Links on 528 WB for Incident Scenarios between Maitland Blvd and Lee Road on I-4 (G5)

Location	Description	Base	S20	S21	S22	S23	S24
1	East of Sr-417 Interchange	910	872	872	872	872	872
3	SR-417 Interchange to CR-15	1288	1254	1328	1312	1500	1758
4	CR-15 to Golden Rod Road	1372	1322	1312	1270	1530	1818
6	Golden Rod Road to Semoran Blvd	1792	1688	1640	1538	1860	2086
8	Semoran Blvd to Airport Toll Plaza	2258	2106	2020	1868	2494	2962
9	Airport Toll Plaza to Conway Road	2236	2096	2004	1872	2482	2846
10	Conway road to Sand Lake Road	1554	1318	1202	1074	1640	1964
12	Sand Lake Road to Beeline West Main Toll Plaza	1152	1024	920	810	1194	1580
14	Beeline West Main Toll Plaza to Orange Blossom Trail	1128	984	888	794	1168	1548
15	Orange Blossom Trail to John Young Parkway	1428	1346	1300	1174	1460	1678
16	John Young Parkway to Orange Wood Road	1558	1562	1482	1384	1620	1820
17	Orange Wood Road to International Drive	1784	1870	1782	1678	1904	2110
18	International Drive to I-4	2398	2438	2348	2268	2472	2666

Table 39: Hourly Traffic Volumes on Selected Links on I-4 WB for Incident Scenarios between Maitland Blvd and Lee Road on I-4 (G5)

Location	Description	B	S20	S21	S22	S23	S24
1	SR-46 to Central Florida Greenway	2460	2340	2342	2332	2348	2348
2	Central Florida Greenway to Lake Mary Blvd	3738	3634	3436	3372	3474	3324
3	Lake Mary Blvd to SR-434	4938	4858	4648	4450	4580	4432
4	SR-434 to SR-436	4282	3702	3724	3756	3832	3818
5	SR-436 to Maitland Blvd	4964	3378	3264	3172	3392	3418
6	Maitland Blvd to Lee Road	4376	2946	2960	2832	3064	3006
7	Lee Road to Fairbanks Avenue	4830	3746	3638	3640	3680	3668
8	Fairbanks Ave to Par Avenue	4680	3544	3414	3484	3520	3510
9	Par Avenue to Princeton Street	4844	3614	3552	3560	3536	3618
10	Princeton Street to Ivanhoe Blvd	4598	3578	3548	3614	3580	3662
11	Ivanhoe Blvd to Colonial Drive	3468	2604	2676	2760	2694	2740
12	Colonial Drive to Amelia	5148	4160	4212	4188	4210	4186
13	Amelia to East West Expressway	5092	4322	4342	4358	4332	4340
14	East West Expressway to Anderson Street	4304	3842	3810	3760	3826	3830
15	Kaley Avenue to Michigan Street	2928	2700	2708	2634	2700	2670
16	Michigan Street to Orange Blossom Trail	4570	4522	4500	4558	4618	4568
17	Orange Blossom Trail to John Young Parkway	4120	4308	4218	4366	4398	4256
18	John Young Parkway to Conroy Road	3390	3268	3258	3322	3430	3238
19	Conroy Road to Florida Turnpike	4168	4066	4076	4124	4192	4016
20	Florida Turnpike to Kirkman Road	3598	3434	3534	3584	3596	3460
21	Kirkman Road to Universal Drive	2998	2830	2874	2894	2932	2796
22	Beeline Expressway to Central Florida Parkway	4894	4696	4530	4364	4666	4602
23	Central Florida Parkway to SR-535	5212	5264	5224	4886	5174	4806
24	SR-535 to Osceola Parkway	3468	3226	3196	2932	3206	2928
25	Osceola Parkway to US-192	1930	1804	1826	1700	1846	1742
26	US-192 to World Drive	1906	1784	1788	1614	1800	1662
27	World Drive to Western Beltway	2216	2074	2050	2028	2086	2076

Table 40: Hourly Traffic Volumes on Selected Links on Arterials SB for Incident Scenarios between Maitland Blvd and Lee Road on I-4 (G5)

Location	Description	Base	S20	S21	S22	S23	S24
1	US 17-92 (north of SR 417) from Sanford	652	694	720	750	722	722
3	US 17-92 (Lake Mary Blvd to SR 434)	176	270	250	292	224	284
4	US 17-92 (SR 434 to SR 436)	910	960	834	710	844	732
5	US 17-92 (SR 436 to Maitland Blvd)	858	822	844	890	826	874
6	US 17-92 (Maitland Blvd to SR 426)	1264	1176	1176	1176	1176	1176
7	US 17-92 (SR 426 to SR 50)	908	850	786	732	786	756
8	US 17-92 (south of SR 408)	944	812	752	614	734	630
1	Semoran Blvd (OBT to SR 434)	1756	1762	1418	1386	1422	1368
2	Semoran Blvd (SR 434 to I-4)	856	868	1050	932	1072	1008
3	Semoran Blvd (I-4 to US 17-92)	1738	1798	1796	1798	1796	1794
4	Semoran Blvd (US 17-92 to Red Bug Lake Rd)	1026	1080	934	756	966	760
5	Semoran Blvd (Red Bug Lake Rd to SR 426)	1464	1466	1494	1410	1474	1396
6	Semoran Blvd (SR 426 to SR 50)	1460	1378	1446	1422	1446	1414
7	Semoran Blvd (SR 50 to SR 408)	1270	1216	518	434	586	534
8	Semoran Blvd (SR 408 to Curry Ford Rd)	704	684	618	482	654	606
9	Semoran Blvd (Curry Ford Rd to SR 528)	786	690	1122	1096	1104	1068
10	Semoran Blvd (SR 528 to SR 417)	490	462	856	774	830	778
11	Semoran Blvd (SR 417 south)	986	1008	902	800	922	786
1	Orange Blossom Trail (SR 50 to SR 408)	1738	1822	696	716	674	688
2	Orange Blossom Trail (SR 528 to SR 417)	306	292	406	532	306	352
3	Orange Blossom Trail (SR 436 to SR 50)	1232	1216	356	356	352	334
4	Orange Blossom Trail (SR 417 south)	60	44	44	40	44	38