GEORGIA TRANSPORTATION INSTITUTE/ UNIVERSITY TRANSPORTATION CENTER

GTI/UTC Newsletter

Volume III, Issue I Spring 2010

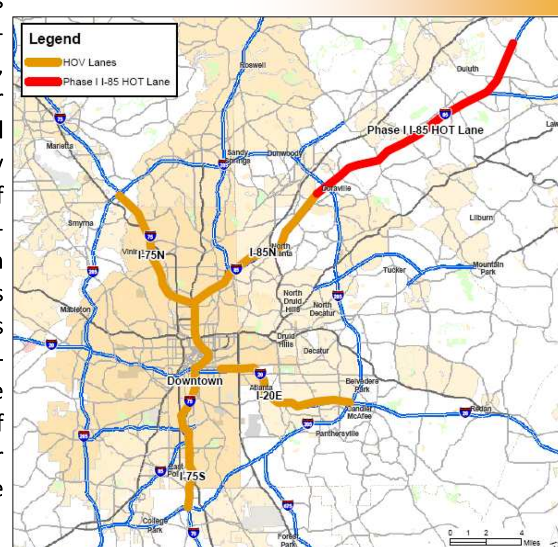
What is System Productivity? ….

The GTI/UTC has developed its research program around three major themes: economic development, finance and system productivity. This newsletter is devoted to research that has been supported by GTI/UTC funds focusing on system productivity. With constrained financial resources, one of the most important strategies for transportation agencies to meet the mobility needs of tomorrow will be through enhanced system productivity. By system productivity we mean reducing the level of resources consumed per unit of flow. This could mean reducing the amount of time needed to move people and goods a certain distance or reducing the amount of cost associated with such movement. Strategies for improving system productivity can utilize new control technologies, vehicle designs, operations strategies or improved network management. Examining the potential impact of such strategies on appropriate performance measures is particularly well suited to the application of simulation techniques. Many of the projects described in this newsletter are using advanced simulation models to investigate the effectiveness of alternative strategies.

In keeping with our policy of having a GTI/UTC graduate student be guest editor of each newsletter, we asked Dwayne Henclewood to take the lead on this newsletter. Dwayne, a Ph.D. student, is working with Dr. Michael Hunter on research pertaining to real time arterial performance measures. He has assumed key leadership roles in our student organizations and has contributed significantly to the GTI/UTC research program.

We introduce a new GTI/UTC initiative in this newsletter called "practitioners in the classroom." Given the three GTI/UTC themes, GTI/UTC leadership felt it was important for our graduates to be exposed to the practical aspects of development, system productivity and finance. It was our opinion that one of the best ways of doing this was to have government officials and representatives from the business community make presentations in graduate classes on the types of strategies needed to develop and implement successful transportation programs aimed at these three objectives. This is another example of how the GTI/UTC is reaching out to major stakeholders and bringing their knowledge and expertise into our programs.

—- Michael D. Meyer, Director



HOV to HOT Lane Conversion in Atlanta

Practitioners in the Classroom

The GTI/UTC has initiated a new program that sponsors transportation practitioners to interact with students in a classroom environment, targeting issues associated with economic development, system productivity, and transportation finance. This semester, six transportation officials representing a diverse set of interests in transportation spoke to GTI/UTC graduate students in the transportation policy course. The speakers included:

Dr. Beverly Scott, General Manager, Metropolitan Atlanta Regional Transit Authority

Sam Williams, Executive Director, Metropolitan Atlanta Chamber of Commerce

Debra Butler, Executive Vice President, Norfolk Southern Corporation

Dr. Catherine Ross, Professor, Georgia Tech and First Director, Georgia Regional Transportation Authority

Doug Stoner, Senator, Georgia General Assembly

Vance Smith, Commissioner, Georgia Department of Transportation

The speakers provided "real world" perspectives on the challenges facing the nation and the State of Georgia in transportation. These challenges were succinctly stated by one speaker as being "to provide mobility for people and goods in an era of shrinking resources and ever increasing demands and constraints." Sam Williams and Debra Butler, in particular, focused on the interaction between the governmental sector and private enterprise and the importance for firms and business associations to be involved in the policy process. Senator Stoner and Commissioner Smith discussed the difficulty of providing additional transportation funding in today's economic climate, but agreed that new sources of revenue need to be identified to support the transportation system.

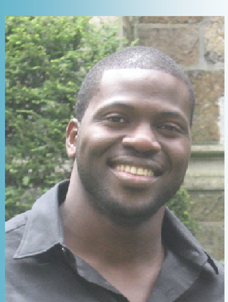

Dr. Beverly Scott


Mr. Sam Williams


Commissioner Vance Smith

Participants in the GTI/UTC Practitioners in the Classroom Initiative

Guest Editor: Dwayne Henclewood



Dwayne Henclewood, a native of Jamaica, obtained his Bachelor of Arts in Physics from the College of Holy Cross in Worcester, MA. Afterwards he returned home to teach science and mathematics at St. George's College High School, his alma mater. During his tenure as an educator, his commitment to education and a realization of the importance of transportation to the quality of life, he deicide to pursue an advance in Transportation Engineering. This quest took him to the University of Massachusetts Amherst, where he completed his Masters. A desire to further delve deeper into the issues that are plaguing our transportation sector as well as desire to take part in the education of future transportation engineers became the impetus for the pursuit of a doctoral degree in the said field. Dwayne entered the doctoral program at Georgia Tech in the fall of 2007. With guidance from Dr, Michael Hunter, Dwayne's current research efforts are centered on traffic operations with the use microscopic traffic simulation facility better decisions when managing and using arterial facilities. More specifically, Dwayne main research project involves the estimation on current and near future arterial performance measures in real-time to be used by travelers and transportation facility managers alike. Dwayne is slated to graduate in the spring of 2011, afterwards he looks forward to pursuing a career in academia or transportation consulting.

A Methodology to Provide Current and Near-Future Arterial Performance Measures in Real Time

Traffic congestion is an $87 billion "cost" to the US economy. In 2007, Americans spent approximately four billion additional hours and purchased an estimated three billion gallons of additional gas due to congestion [1]. Historically, road congestion was "fixed" by increasing the roadway's capacity. However, expanding roads, especially in urban areas, has become increasingly difficult and expensive. Thus, there has been a significant push by the government, private industry, and the research community to develop and implement alternate means of alleviating congestion. This research project is developing a methodology to provide both public and transportation facility managers with current and near future arterial performance measures. It will utilize point sensors to develop an online, data-driven, microscopic traffic simulation approach to determine and provide the necessary information to aid in the decision making process as to how to use and operate transportation facilities with greater efficiency. More specifically, the problem that this research effort will be addressing is the lack of available real time and near-future traffic performance measures along arterials that can be used by facility managers to better manage facility operations. Such performance measures include speed, travel time, delay estimates and queue lengths. It is envisioned that such information will be disseminated through a variety of media including dynamic message signs (DMS), highway advisory radio (HAR), the internet, and in-vehicle and other portable GPS navigation systems.

The research methodology involves the use of point sensor traffic data to drive a microscopic traffic simulation, VISSIM, in real time. The data from the detectors will be transmitted and then be used as input in an empty VISSIM model of the area being studied. Once the necessary data is implemented in VISSIM, current and near-future traffic states, as well as performance measures, will be estimated.

Figure 1 illustrates the conceptual framework for developing a real time, online, data-driven simulation tool. The first step is to obtain traffic-related data from the network's roadway detectors. The processed detector data will then be used to populate a VISSIM model of the study area. Once the traffic's current state is captured in the simulated environment, the model will be used to provide an estimate of future traffic conditions. From these future states, a probable future state is then estimated. In this framework, both the probable future traffic state as well as the traffic's current state can be transmitted to the various end users.

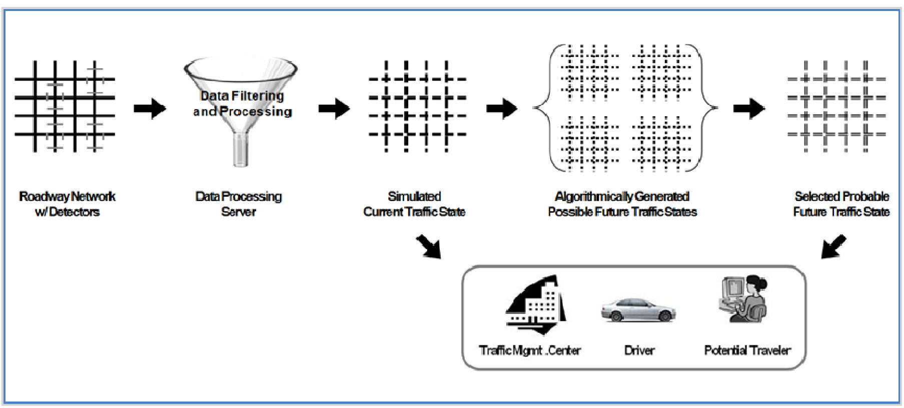


Figure 1: Conceptual Framework for Proposed Methodology

A number of preliminary tests have been conducted to determine the feasibility of the proposed methodology. One such test was aimed at determining whether a VISSIM simulation can be driven by detector data streaming in real time, and having its performance measures reflect those of the area being simulated. To conduct this experiment, a road corridor on Georgia Tech's campus was selected as the arterial to be studied. The data stream came from temporary mid-block and boundary detectors that were placed throughout the corridor.

The results from the collected data and the output from the VISSIM model were compared to determine how well the data-driven simulation was able to reflect the performance measures of the real world. Travel time was the primary performance measure that was analyzed. It was concluded that the research results supported the likely feasibility of the proposed method. Sources of error have been identified and future work will implement mechanisms to address these errors.

1. D. Schrank and T. Lomax, "Urban Mobility Report 2009," Report for the Texas Transportation Institute, 2009

This project is a part of GTI/UTC project 08-05: Integration of Real Time, Fixed Sensor Data and Simulation/Development and Evaluation of an Advanced Traveler Information System Using Vehicle to Vehicle Communication Systems

Dwayne A. Henclewood, Ph.D. Student, Georgia Tech
Dr. Richard Fujimoto, Georgia Tech
Angshuman Guin, Georgia Tech
Dr. Michael Hunter, Georgia Tech

Maximizing Port and Transportation System Productivity by Exploring Alternative Port Operation Strategies (GTI/UTC Project 09-03)

Ports are one of the most important intermodal nodes in the nation's transportation system. This research project involves working closely with the Georgia Logistics Innovation Center (GLIC) and the Georgia Ports Authority (Port of Savannah) to study logistics operations and to develop a 3D container-terminal simulation model to explore and evaluate new processes and alternatives for improving port logistics. By using a simulation tool, the impact of quay crane capacity increases on berth productivity can be quantitatively evaluated, and quay crane utilization (e.g. working and idle time) can be visualized in a 3D environment to identify bottlenecks. An example of tracking and visualizing the detailed yard operation, such as quay crane idle and jockey truck queue under rubber tyred gantry (RTG), using the detailed 3D container-terminal simulation model is shown in Figure 1. This simulation can identify risks before the implementation of port changes, and can explore and evaluate alternatives to improve productivity.

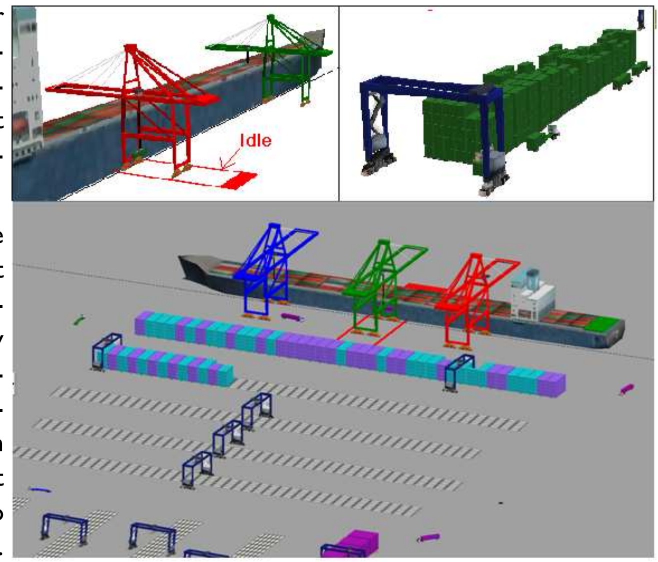


Figure 1: Detailed 3D container-terminal simulation model

The current focus of this effort is on analysis of port gate operations, which is closely related to both port and fleet productivity. The ultimate objective of this project is to explore solutions for maximizing both port and fleet industry productivity by improving visibility, understanding, and measurement of their operations and interactions. These interactions will include gate queue behavior and communication (e.g. container arrival times) between the port and the fleet industry. A video-based sensing system will be developed to provide better visibility of gate operations and activities (e.g. truck waiting time and characteristics of the queued trucks). It has been shown that increasing port gate congestion will substantially impact the productivity of port and fleet industries, emissions, and local community living quality.

This research will develop an intelligent sensing system using an image processing algorithm to automatically detect/measure truck queue time. The sensing system will enable researchers, ports, and the freight industry to better understand port gate congestion. This queue time distribution is extremely valuable for exploring gate congestion behavior and alternative ways to mitigate it. Port gate simulations will be conducted to explore different alternatives to improve both port and freight productivity.

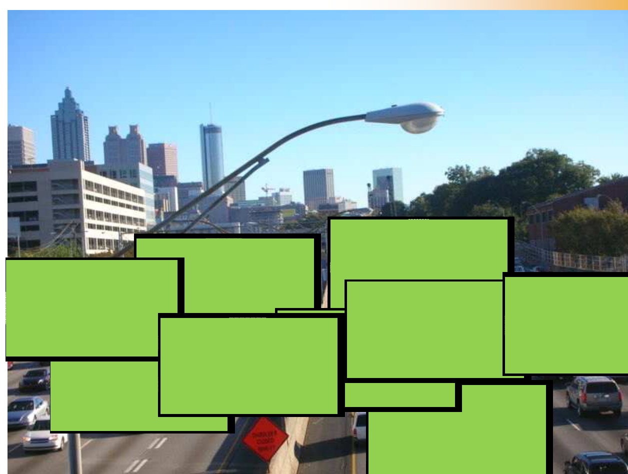
Figure 2: Truck queuing at the Port of Savannah

Dr. James Tsai, Georgia Tech-Savannah

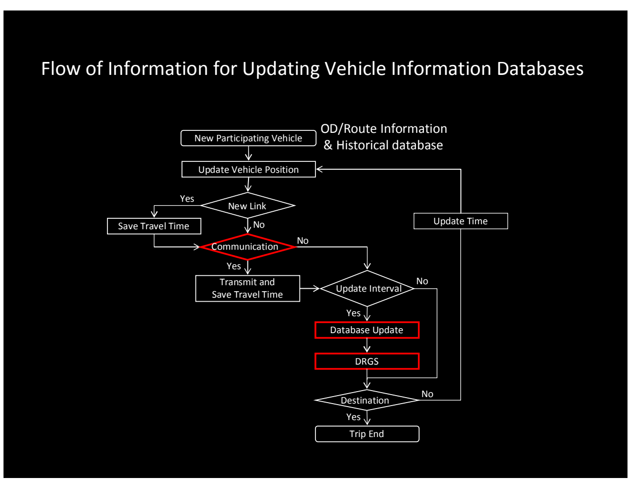
Integration of Real Time, Fixed Sensor Data and Simulation/ Development and Evaluation of an Advanced Traveler Information System (ATIS) Using Vehicle-to-Vehicle (V2V) Communication Systems (GTI/UTC Project 08-05)

With the recent advent of more advanced technologies, particularly wireless communication technology, more economical traffic information systems are becoming possible. Numerous researchers are exploring in-vehicle and between-vehicle communication systems, focusing on hardware and software development and testing, aiming to achieve more efficient and effective exchange of information. Given these recent advances in information technology, the opportunity now exists to evaluate the utilization of dynamic, vehicle-oriented information exchanges with respect to their impact on transportation system performance.

This research project is targeting the improvement of arterial road performance through the integration of real time fixed sensor data and simulation. This project has also examined the exciting possibility of developing and evaluating an advanced traveler information system (ATIS) using vehicle-to-vehicle (V2V) communication systems with a microscopic simulation model.


Conceptual Illustration of Vehicle Information Exchange

The V2V model was tested on notional small traffic networks (non-signalized and signalized) and a 6 x 6 typical urban grid network (signalized traffic network). The V2V model consisted of three key modules: vehicle communication, on-board travel time database management, and a Dynamic Route Guidance System (DRGS). In addition, the V2V system performance was enhanced by applying three complementary functions: Autonomous Automatic Incident Detection (AAID), a minimum sample size algorithm, and a simple driver behavior model. To select appropriate parameter ranges for the complementary functions a sensitivity analysis was conducted. The model performance examined network performance characteristics relative to three underlying system parameters: traffic flow, communication radio range, and the penetration ratio of participating vehicles in the V2V system. In addition, V2V approach was compared to similar network capabilities only using a centralized traffic information system



This research found that an enhanced V2V model outperforms the basic model in terms of travel time savings and produces more consistent and robust system output under non-recurrent traffic states (i.e., traffic incident) in a simple traffic network. Traffic incident detection time and drivers' route choice decision rules are the most crucial factors influencing system performance. As traffic flow and penetration ratios increased, the V2V system becomes more efficient, with non-participating vehicles also benefiting from the re-routing of vehicles that are sharing link performance information. Different communication radio ranges were not found to have a significant influence on system operations. It was found that a dynamic infrastructure-based traffic information system could replace a fixed infrastructure-based traffic information system with enhanced benefits, allowing for considerable savings in fixed costs and ready expansion of the system off of the main network corridor.

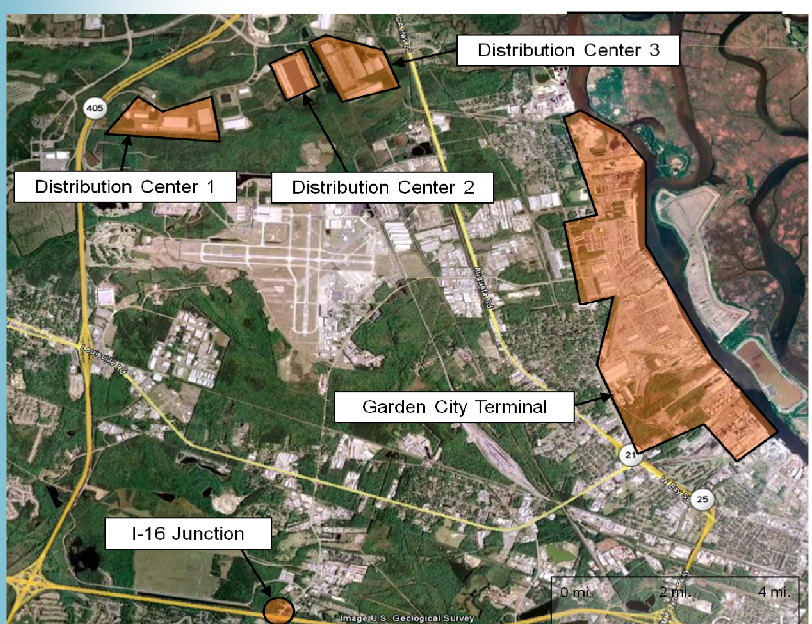
Hoe Kyoung Kim, Ph.D. Student, Georgia Tech
Dr. Jorge Laval, Georgia Tech
Dr. Richard Fujimoto, Georgia Tech
Dr. Michael Hunter, Georgia Tech
Dr. Angshuman Guin, Georgia Tech

Federated Simulation Modeling of Port and Roadway Operations

The increasingly global nature of trade in the United States has brought with it the expansion of our nation's freight transportation systems and seaports – from Long Beach to New York. In Georgia, the Port of Savannah has been steadily growing in response to this trend of increased trade, becoming the nation's fourth busiest container port in 2007 (1). In their 2008 Annual Report, the Georgia Port Authority outlined a substantial expansion program that will triple the Port of Savannah's capacity to accommodate the projected growth of global trade over the coming decade (2). This program includes the development of a new port facility in cooperation with the State of South Carolina and substantial expansion of Savannah's Garden City Terminal. To maintain the port's current efficiency and productivity, this expansion has signaled a need to better understand the complex interaction between the port's terminal facility and the surrounding road and railway systems responsible for moving containers to and from inland facilities.

Transportation research being conducted at the Georgia Institute of Technology is aimed at using computer simulation techniques to model the complex interaction of port and roadway facilities. This project uses the Port of Savannah as a focused example in an effort to better understand the impact of future freight transportation demands at port and intermodal facilities, ensuring the productivity of these facilities into the future.

As computer modeling and simulation methods have improved over the past decades, so too have our abilities as engineers to model increasingly complex systems. However, the increased capability of simulation software has been accompanied by increased specialization of simulation tools. Therefore, from the outset of this research effort, an underlying tenet has been to recognize that no single simulation software package is capable of effectively modeling all modes or aspects of the transportation system.



Port of Savannah and Surrounding Areas

This project has modeled each system component – in this case the roadway network and the seaport terminal – using the computer simulation programs that are best suited to each component. We then combine these two separate models into a larger, federated computer simulation that executes these separate models simultaneously. This federated simulation allows the models to interact during runtime, passing information and simulation objects, and establishing a dynamic feedback loop wherein changes in the operational efficiency of one system component may affect that of the other.

The Port of Savannah Garden City Terminal is modeled using Rockwell Automation Arena 12.0©, a discrete event-based, object-oriented simulation software package. Included in the port model are the arrival, departure, processing, and movement of containers within the terminal. The roadway network surrounding the Port of Savannah is modeled using PTV-VISSIM 5.10©, a microscopic, behavior based traffic simulator. The roadway model captures the movement of trucks and containers on the major roadways providing access to the Garden City Terminal. For example, the life cycle of a container may be arrival from a container ship, processing at the Port's Garden City Terminal, transfer onto a truck for transport to a distribution center, further processing at the distribution center, and final truck transport to an inland destination. Under more traditional supply chain simulation methods, the truck would be assigned some average delay value to represent its roadway in-transit time. Instead, during runtime, our federated simulation program "passes" the truck and container from the Arena 12.0© model of the Garden City Terminal to the VISSIM 5.10© model of the roadway. In the VISSIM 5.10© model, the truck and container are routed to the appropriate destination, at which time the federated simulation program "passes" the truck and container back to an Arena 12.0© model of a distribution center.

The benefits of this approach includes an ability to pinpoint and accurately model critical design elements, with significantly different operational characteristics, within the larger transportation system. Secondly, it allows dynamic feedback loops to be established between the two models during simulation runtime. This, in turn, gives port planners and engineers the ability to see how subtle changes in one set of facilities, i.e. the port or roadway, affects the productivity of the other, and to identify future needs of the integrated transportation system.

1. Port of Savannah fourth-busiest, fastest-growing in the U.S., in Atlanta Business Chronicle. 2007, American City Business Journals: Atlanta.
2. Authority, G.P., GEORGIA'S PORTS for GEORGIA'S PEOPLE: Georgia Ports Authority Annual Report Fiscal Year 2008. 2008, Georgia Ports Authority: Savannah.

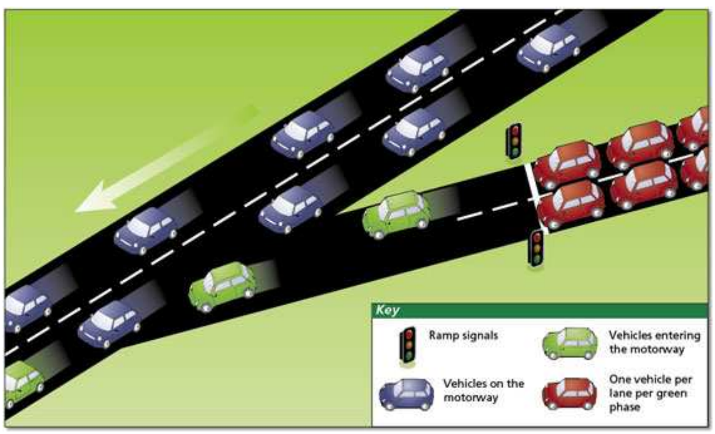
Tom Wall, Ph.D. student, Georgia Tech
Dr. Michael Hunter, Georgia Tech
Dr. Michael Rodgers, Georgia Tech
Chris Puglisi, MS student , Georgia Tech

This project is part of GTI/UTC Project 09-03, Maximizing Port and Transportation System Productivity by Exploring Alternative Port Operation Strategies

Development of Optimal Ramp Metering Strategies

The Federal Highway Administration and several state DOTs have identified ramp metering as one of the key congestion mitigation strategies. According to the Texas Transportation Institute's 2009 Mobility Report, ramp metering in the 25 cities reduced delay by 39.8 million person hours in 2007. However, the potential of ramp metering is currently under-utilized with metering rates based on local conditions, limited consideration to linking all the on-ramps along a corridor, and no consideration for the type of bottlenecks such as merge, diverge, etc. Thus, sub-optimal operation results in excessively long queues on the entrance ramps, and insufficient reduction in system delay.

This project is developing optimal ramp metering strategies using the recent advances in traffic flow theory and simulation. A recently developed theory that can explain stop-and-go oscillations, capacity drop during congestion, and traffic dynamics under ramp metering, will be utilized to perform realistic simulations to evaluate new strategies.



How Ramp Signals Work (New Zealand Transport Agency)

The System-Wide Adaptive Ramp Metering (SWARM) algorithm will be studied and a set of ramp-metering strategies for congestion mitigation will be proposed. Although different strategies are expected to have different impacts under different traffic conditions and network configuration scenarios, the research will focus on peak demands to design the strategies. The microscopic simulation program that will be used for this purpose is being built at Georgia Tech. It is essential to use a specialized simulation package instead of an off-the-shelf commercial simulation tool since none of the off-the-shelf packages model the traffic dynamics at congested ramp merges and diverges with sufficient accuracy. [For an online demo of the proposed simulation model please visit http://trafficlab.ce.gatech.edu/ and click on "Freeway ramp-metering" on the left]. The final report will contain guidelines and the methodological steps that are required to optimize operations on a corridor and eliminate a significant portion of the recurrent congestion in the network.

The project team consists of Dr. Jorge Laval (Assistant Professor of CEE), Dr. Angshuman Guin (Research Engineer II), and Rama Chilukuri (graduate research assistant and Ph.D. student in Transportation Systems).

Rama Chilukuri, Ph.D. student, Georgia Tech

This project is part of GTI/UTC project 08-05, Integration of Real Time, Fixed Sensor Data and Simulation/Development

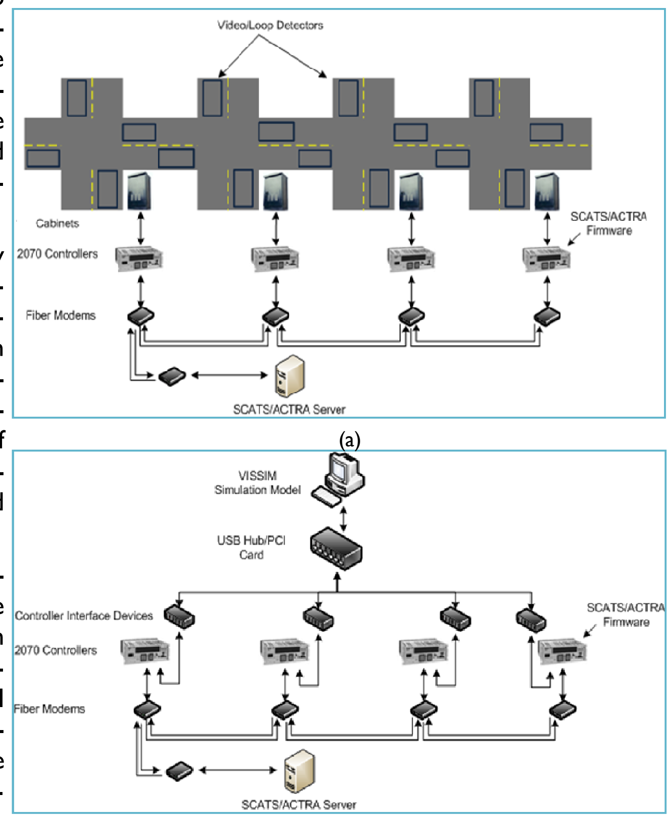
Hardware-in-the-Loop Simulation Evaluation of Adaptive Signal Control

Increasingly, adaptive signal control and other non-traditional solutions are being implemented in an attempt to improve signal system efficiencies, reduce congestion, enhance signal control responsiveness to incidents, and reduce signal re-timing costs. As part of a recent adaptive signal control implementation in Cobb County, Georgia, a before-and-after operational comparison of an optimized time-of-day (T.O.D.) and an adaptive control system was undertaken. The focus of this operational analysis was typical operating performance during the weekday peak, weekday off-peak, and weekend travel periods. The initial study resulted in a general conclusion that under typical existing traffic conditions, both the well calibrated T.O.D. and adaptive control systems provided good, although similar, performance. Numerous others have also conducted field studies of various adaptive control systems. A lack of consensus seems to be present regarding the benefits of adaptive control, with results often dependent on site specific issues, quality of before timing plans, selected performance metrics, etc.

However, in addition to operational performance under current traffic conditions the evaluation and selection of a signal control system should consider the system responsiveness to normal day-to-day variation in traffic demands, special events, incidents, future traffic demands, and other conditions. A field data based study will typically not allow for an evaluation of control types under such conditions. Non-recurring and future growth performance testing is more directly suited to simulation based evaluations. Simulation is often utilized for the evaluation of Intelligent Transportation Systems (ITS) because it allows for controlled experiments to be conducted and statistically strong conclusions to be drawn, particularly in instances where it is not feasible or possible to use field data for an evaluation. However, potential drawbacks exist when utilizing simulation to evaluate cutting-edge or proprietary ITS implementations. First, no software emulation of the ITS in question may be available, and second, the software emulation of the ITS, if available, is not guaranteed to be an accurate representation of its real-world counterpart.

To overcome the limitations of field data or simulation only studies, hardware-in-the-loop simulation (HILS) may be utilized. In traffic engineering the concept of HILS typically involves combining a microscopic traffic simulation program with a real-world traffic controller. By enabling the controller to interact with the simulation model, the benefit of simulation analysis is gained while retaining the full functionality of the real-world system. There have been numerous successful applications of HILS in the development, testing and evaluation of ITS in the transportation environment.

The schematic in Figure 1-a represents a notational field implementation of adaptive control and T.O.D. control. The controllers residing in field cabinets communicate through fiber optic cables and modems. The schematic shown in Figure 1-b is the adopted HILS system that replaces the physical roadway network with a simulated one. The detector actuations from vehicles in the VISSIM model are sent out to the real-world controllers. Signal state information from the real-world controllers is accepted by the model. Between the model and the real-world controller is a hardware device that facilitates the communication between the two, called a Controller Interface Device (CID).



(b)

Figure 1: Signal system deployment (a) in the field and (b) in HILS system

This research examined the initial findings of a HILS evaluation of ACTRA (i.e. T.O.D.) and SCATS (i.e. adaptive) signal control on an eleven-intersection section of Cobb Parkway, in Cobb County, Georgia. It was seen that the HILS test bed generally provided a reasonable representation of both the T.O.D. and adaptive signal control performance. However, it was noted that the adaptive control AM HILS results contain some unexpected behaviors, not observed in the field, in the southbound direction. The explanation currently under investigation is that the responsive nature of adaptive control may be resulting in poor performance when the simulation contains a short term unrealistic behavior, whereas the relatively consistent nature of T.O.D control dampens the variability due to the simulation bias and avoid short periods of sub-optimal timings. The initial findings appear to indicate that for the system studied, the adaptive control may be more responsive to overall traffic demand. Initial indications are that during peak conditions, both control strategies provide similar performance, however, during the hours bordering the peaks, adaptive control is likely able to provide control more tailored to the current conditions. Future efforts will further explore the findings. In addition, the next phase of this effort will expand the scenario analysis to include growth scenarios, non-recurring congestion, and special events.

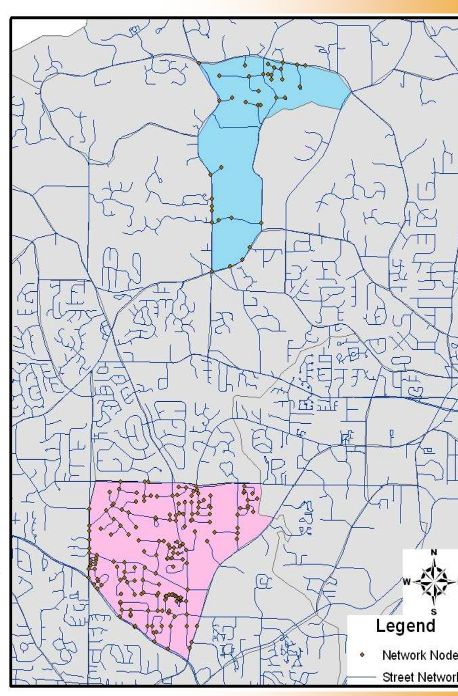
Dr. Seung Kook Wu, Georgia Tech
Dr. Michael Rodgers, Georgia Tech
Matthew Row, MSCE, Georgia Tech
Dr. Michael Hunter, Georgia Tech

A Novel Data Collection Methodology from Instrumented Vehicles (GTI/UTC Project 09-02, Value Pricing Data Analysis of HOV Lane Conversion)

This project is developing a data collection element of an HOV to HOT lane conversion project in Atlanta. The Commute Atlanta research project is one of the most comprehensive instrumented vehicle projects deployed in the US. The dataset from this project includes second-by-second speed and position data for more than 1.8 million trips over a three year period. The dataset also includes household demographics, vehicle data, and trip purpose data. Given the richness of the dataset and the desire to protect participant anonymity, researchers are developing processed instrumented vehicle data sets that retain the detailed trip information, but eliminate the details about the trip ends to prevent identification of the home location.

The precision, resolution, and level of detail in the processed instrumented vehicle data sets with respect to departure time, trip distance and trip duration is very high. For each repeat trip, the travel distances are very accurate. Given repetitive travel data and detailed trip summary information, it is therefore possible to triangulate and resolve the home location simply because there are a limited number of reasonable paths between any origin or destination in the network and the participants' home or work locations. During the first phase of this research, the team is working to demonstrate that it is possible to identify the Commute Atlanta physical household locations using only these travel summary data (no second-by-second data) by applying advanced GIS techniques. The team will then evaluate new methods to post-process the data and effectively "anonymize" the home and work locations. The results from this project will help in identifying the maximum level of detail that could be provided in instrumented vehicle data for public-release.

The research team has developed the first iteration in a new methodology to identify household locations using a combination of trip summary data and land use data. The initial routines process the travel data using the underlying GIS network and assign actual origin and destination coordinates collected by the onboard equipment to four geographic levels: census tract, TAZ, census block group, and census block. The geographic grouping will be used later in the study to examine whether assignment to the higher level census tract or TAZ is enough to protect the coordinate of the home location. The underlying GIS road network is then overlaid to identify all intersections that fall within a specified geographic zone. A variety of GIS tools are then used in an iterative process to identify potential routes and ultimately the most likely intersections that represent the origin-destination pair for repetitive trips made by the household. The final step is to identify the actual household location by analyzing the land use characteristics around the selected intersection along with other heuristic techniques.



The results from this study will help the research team identify the maximum geographic resolution for origin and destination locations that should be included in processed instrumented vehicle data sets (e.g. tying a trip to a single latitude and longitude for a census tract, TAZ, or census block group). In addition, the team hopes to assess the number of repetitive trips and level of trip summary details (departure time, distance, and duration) that are reasonable to release from instrumented vehicle studies while still ensuring that third party analysts will not be able to post process the data and infer the physical home location of a participant. Ensuring the protection of participant privacy is the cornerstone for instrumented vehicle sampling and will ensure that we can maximize volunteer participation in future studies.

Dr. Randall Guensler, Georgia Tech

Embedded Ad Hoc Distributed Simulation for Transportation System Monitoring and Control (GTI/UTC Project 08-05)

Transportation is the largest industry in the world. Our transportation system significantly impacts every individual and the welfare of our entire nation in terms of economics, health, and quality of life to name a few. However, for many decades improvements to our ability to actively manage our surface transportation system in real-time have been stagnant. Today, wide-spread deployment of sensors, computers, and communications in vehicles and roadways is creating new challenges and opportunities to effectively exploit the wealth of real-time data and information that are becoming available. We attempt to capitalize on these rapid technology and communications advancements using ad hoc distributed simulations that features dynamic collections of autonomous simulations interacting with each other and with real-time data in a continuously running, real-time, distributed simulation environment. One can envision a distributed, adaptive, self-optimizing transportation infra-structure that can automatically reconfigure itself to maximize efficiency and minimize the effects of unexpected events ranging from everyday crashes to catastrophic natural or human generated disasters.

Our current research efforts are aimed at developing an embedded, distributed, simulation based transportation management system, combining in-vehicle simulators with information servers and simulations running within the roadside infrastructure. In our current implementation each participating vehicle contains a simulator that models the roadway network in the immediate vicinity of the vehicle, illustrated in Figure 1. Thus, as the vehicle traverses the network it will be simulating a dynamic roadway topology that must be continuously updated to reflect the current vehicle position.

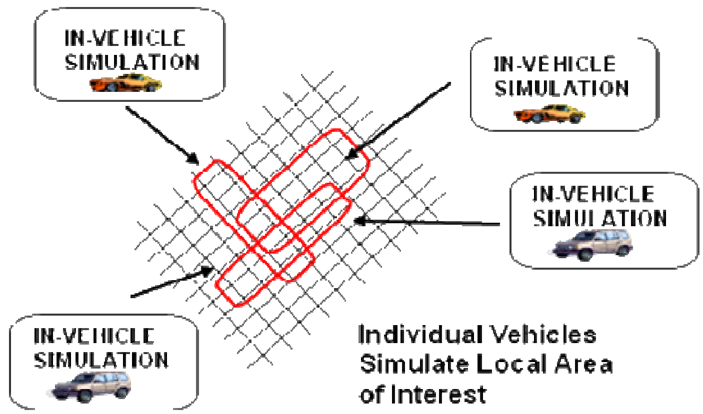


Figure 1: In-Vehicle Simulation

The initial approach to implement an ad hoc distributed simulation system is a client/server architecture, where global state objects (i.e. simulation results from participating vehicles and sensor data) and associated composition functions (i.e. methods to aggregate data from the distributed simulations) are implemented at the server level (Fujimoto et al. 2007, Hunter et al. 2009). The server receives and stores state updates, compute composite values, and disseminates this information to other simulators. The key elements of our initial approach include Space Time Memory, State Aggregation, and Rollback Based Synchronization.

Our preliminary work assumed that the vehicle simulators were already configured to model the designated scenario, and focused on predicting the effects of changes in traffic patterns. One of our initial experiments involved a Manhattan-style 10 x 10 grid with two-lane, two-way roads. Forty participating vehicles (i.e. vehicles with on-board simulators) are distributed over the network at initialization, each simulating a group of intersections and connected roads, with the arrival rate on all boundary input roads initialized to a specified value. Each client simulation area depends upon the vehicle location and the direction in which the vehicle is traveling. The simulation region for each client is defined as the 5 x 3 intersection area in front of the vehicle assigned to it. If the network area in front of the client is smaller than the region, then the client only simulates the smaller extent.

One of experiments that were conducted to examine the feasibility of this approach involved an instance when the input arrival rate changes suddenly for the study network. Unlike the results from a steady state study, which experienced no rollbacks at the low input rate

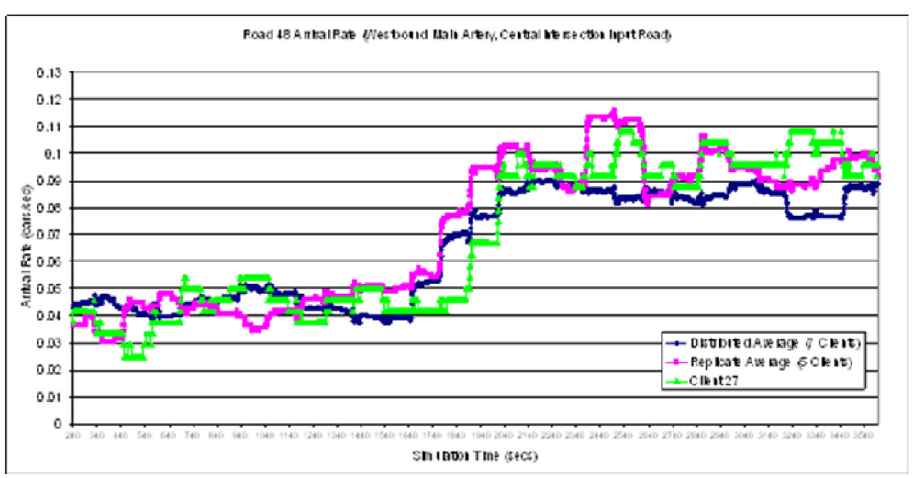


Figure 2: Steady state experiments, arrival rates on internal road in eastbound main artery

settings, a distributed simulation will require rollbacks in order to successfully simulate the increase in traffic. Figure 2 focuses on a typical road segment along the east bound main artery. The set of experiments at each input rate is represented in the figure by three lines showing the average input rate over time of the replicated trials, the ad hoc simulation, and a single ad hoc distributed client (which illustrates how individual clients are reacting to the change in the arrival rate). The ad hoc simulation approach is able to track the unexpected change in input rate. Measurements on a variety of points in the network demonstrated that the ad hoc approach was able to track this change in traffic flow at different locations throughout the network.

Initial results support the potential of this approach. The above demonstrated that real-time transportation system monitoring and control is in fact feasible and will subsequently increase the system efficiency as facility managers will in-turn make better-informed decisions when operating transportation facilities.

Jason Sirichoke, Georgia Tech
Dr. Richard Fujimoto, Georgia Tech
Ya-Lin Huang, Georgia Tech
Dr. Michael Hunter, Georgia Tech

GTI/UTC Professors Participate in Pie a Professor Day for Charity

On February 25, 2010 a number of GTI/UTC professors participated in the Pie a Professor for Refugees fundraising event, which was hosted by the Student Movement for Real Change (SMRC) at GA Tech. The purpose of this event was not only to raise funds but also increase awareness for the building of a business center in Rift Valley, Kenya. The community who will be served by this business center was displaced by post-election tribal violence in Kenya in 2007-2008. Similar to other communities in Kenya, this community is extremely poor, and is currently relying predominantly on donations. The goal of the SMRC at GA Tech and our partner organizations in Kenya is to enable this community to build a sustainable livelihood for itself. Land has already been purchased for the business center, and the first addition to it will be a corn mill. Additional information about this project, the Vumilia Mill Project, as well as other projects and the mission of SMRC at GA Tech can be found at http://gtsmrc.com.

Dr. Randall Guensler and MS student Lian Duan

Dr. Michael Hunter (center) with PhD students Dwayne Henclewood (left) and Thomas Wall (right)

Dr. Michael Meyer and MS student Matthew Kittleson

Georgia Tech

GTI/UTC

GEORGIA INSTITUTE OF TECHNOLOGY/ UNIVERSITY TRANSPORTATION CENTER

Georgia Institute of Technology
School of Civil and Environmental Engineering
790 Atlantic Drive
Atlanta, GA 30332-0355

Phone: 404.894.0418
Fax: 404.894.5418
E-mail: lisa.baxter@ce.gatech.edu

GTI/UTC Staff

- Dr. Michael Meyer
  Director

- Dr. Michael Hunter
  Deputy Director

- Dr. Laurie Garrow
  Associate Director, Research

- Dwayne Henclewood
  Student Guest Editor

- Lisa Baxter
  Administrative Manager

http://www.utc.gatech.edu

GTI/UTC News

GTI/UTC Spring Seminar Series

Dr. G. Edward Gibson, Programs Chairman for the Del E. Webb School of Construction at Arizona State University kicked off the 2010 spring seminar series on Friday, January 29, 2010. Dr. Gibson's presentation was entitled "Advance Planning of Highway Projects". The presentation described the advance planning process as well discussed management tools and methods that have been developed to help multi-disciplined project development teams improve the effectiveness of transportation infrastructure risk management.

Dr. Gibson

Dr. Carl T. Haas, from the University of Waterloo, participated in our GTI/UTC Seminar Series on March 5, 2010. Dr. Haas' presentation was entitled "Infrastructure State Estimation", where he briefly discussed four application areas for automated state estimation for sustaining infrastructure and improving project and asset performance.

For more information regarding past and upcoming presentations visit our website at www.utc.gatech.edu.

Dr. Haas

The University Transportation Center at the Georgia Transportation Institute (GTI/UTC) is committed to developing into a Center of excellence providing high-quality leadership on research, education and technology transfer to address issues related to transportation system productivity (including both passenger travel and freight of all modes), economic growth, and finance.

GTI/UTC works with local, state and regional agencies to identify research problems that support their needs and identify opportunities for them to advance to the next level; educate a new generation of students who well versed in art of multidisciplinary thinking and problem solution, collaborating effectively in teams to tackle problems with systems dimensions; provide continuing education opportunities to keep practitioners at the cutting edge of systems methodologies and technologies with transportation applications; and provide technology transfer resources to disseminate knowledge.