Program Progress Performance Report
University Transportation Centers
Cover Page TranLIVE

Submitted to: Office of the Assistant Secretary for Research and Technology

Federal Grant Number: DTRT12-G-UTC17

Project Title: TranLIVE (Transportation for Livability by Integrating Vehicles and the Environment

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Recipient Organization: University of Idaho, Office of Sponsored Programs, 875 Perimeter Dr., MS 3020, Moscow, ID 83844-3020

Recipient Account Number: KLK900

Grant Period: January 1, 2012 to May 31, 2016

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Signature of Submitting Official:

SEMI-ANNUAL REPORTING CATEGORIES
TranLIVE DTRT12GUTC17
July 1, 2015 to December 31, 2015

1. ACCOMPLISHMENTS:

A. University of Idaho:

i. *Developing and Testing Eco-Traffic Signal System Applications*

a. Developed a real-time traffic signal system instrumentation using NEMA TS2 SDLC as part of the hardware-in-the-loop simulation environment for connected-vehicle applications for coordinated systems.
b. Documented the impact of corridor signal timing plans, optimized using different objective functions, on the characteristics of traffic operations for vehicle groups with different origin-destination.
c. Provided guidelines on optimizing coordinated corridors to minimize fuel consumptions and emissions.
d. Provided guidelines on using advanced controller settings to optimize traffic operation at signalized intersections operating in an isolated mode.

ii. *Calibration of Multi-Scale Energy and Emissions Models*

a. Used vehicle-emission and fuel consumption data for different vehicle types under different speed and acceleration operation, generated using the GT-Suite advanced engine modeling software, to calibrate fuel consumption and emission models in two microscopic simulation models: VISSIM and Integration and one macroscopic model Transyt 7-F.
b. Used vehicle-emission and fuel consumption data for development and optimization of a rule-based energy management strategy for fuel economy in Hybrid Electric Vehicles.

iii. *Eco-driving Modeling Environment*

a. A web-based user interface to display Driver Simulator emissions.
b. Tested and validated a SimLink interface between the GT-Suite software and the NADS MiniSim Model. The interface will facilitate the integration of the two models to create an Eco-Driving model training tool.
c. Using Windows Presentation Foundation (WPF) an EcoDash was finalized. The model will run along with other system components in real-time with MiniSim.
d. A Java-based application to estimate fuel consumption for a center engine configuration under different driving cycles.

iv. *Eco-Traffic Signal System Applications*

a. Developed a connected-vehicle lab integrating DSRC receivers and road side units.
b. Validated the data exchange mechanics between the DSRC units, road side units, a microprocessor interface, and the traffic controller.

B. Old Dominion University:

i. *Smartphone-based Solutions to Monitor and Reduce Fuel Consumption and CO_2 Footprint*

a. The Android App (called GoGreen) was developed and improved upon to collect acceleration, gyroscope, magnetometer, and GPS data from smartphones. The App also connects to an OBD device on the vehicle if available. Speeds from GPS and OBD are used for model development and testing.
b. GoGreen App was further developed by integrating the VT-CPFM model to estimate fuel consumption which is currently computed based on GPS data. A user interface was

developed for the GoGreen App to show the fuel consumption rate graphically in real-time.

c. New algorithms based on support vector machines (SVMs), neural networks, and clustering techniques are developed to estimate whether the vehicle is in motion or stopping. The performance of the algorithms is tested on large datasets collected by the research team. Overall, the algorithms are found to be effective in detecting when the vehicle stops and for how long.
d. A module for estimating vehicle speed from accelerometer data is developed. The core algorithm for this module utilizes the Principal Component Analysis (PCA) technique to map the accelerometer readings from smartphones to the orientation/direction of travel of the vehicle. The performance of the module is evaluated offline on the collected data by the research team. Overall, the algorithms are found to be good in estimating vehicle speed independent of the phone orientation. Currently, we are integrating this module with GoGreen App for online speed estimation as well as improving the algorithm performance under different driving scenarios.
e. Algorithms have been developed and finalized to predict the mode of travel based on sensor data from smartphones. The performance of the algorithms is tested and the results are published in a journal paper.
f. Shorthest path algorithims are developed to detemine the eco-friendly shortest paths whicle considering both travel time and fuel consumption in the path cost function.
g. Tested impacts of drivers' responses to smartphone warning message in work zone advance warning area, including impacts on driving speed, accleration rate, braking distance, brake response time.
h. Tested impacts of drivers' responses to smartphone warning message in work zone activity area to increase safety of workers and drivers.
i. Tested drivers' reactions to smartphone messages when driving on a real artierial street in Houston. microprocessor interface, and the traffic controller.

C. <u>Syracuse University</u>:

i. *Enhancing TSM&O Strategies through User Cost Analysis and Life Cycle Assessment*

Recently, the research team completed revising the final report for this project. During the revision process, some of the assumptions made in the study were re-visited and the outputs were adjusted accordingly. The substantial effort placed on re-evaluating the procedures and assumptions resulted in improving the final report considerably.

ii. *Assessing Environmental Impacts of Traffic Congestion and Vehicular Emissions on Urban Fresh Water*

Efforts in the second half of 2015 focused on developing methods for analysis of vehicle-emitted pollutants on both the OnCenter green roof and the War Memorial control roof. Samples collected during several storms in 2015 are currently being analyzed for trace metals by Inductively Coupled Plasma Mass Spectrometry, as well as for sulfate, nitrate, and possibly other anions by Ion Chromatography. Results will be used to determine physical and chemical processes occurring on the green roof and control roof, and will identify the extent to which roof surfaces may be used for assessing contamination of rainwater and stormwater runoff by vehicle-emitted contaminants.

iii. *Studying the Impact of Accelerated Construction Methods in Work Zones Using Microsimulation on Vehicle Emissions and the Environment*

During the reporting time period, case studies related to highway construction, maintenance or repair activities were reviewed. Data on these case studies were collected from New York State's Online Data Repository. (Databases include "Transportation

Projects in your Neighborhood", "Capital Projects by NYS Thruway Authority" and "511 NY Events"). The research team is continuing to work on analyzing the collected data and to develop models using the collected information in INTEGRATION.

Note on Project 3: This research project is currently underway. Outcomes are expected to be achieved by the end of Spring Term in 2016.

iv. ***A Sustainable Asset Management Framework for Transportation System Management and Operation Systems***

The research team has completed reviewing literature on inspection and management of various components of TSM&O systems and has worked on development of a risk based prioritization tool for efficient management of TSM&O deployments. The research team is focusing on the Maintenance, Repair, and Rehabilitation (MRR) Alternatives that are applicable on certain TSM&O applications.

Note on Project 4: This research project is currently underway.

D. <u>Texas Southern University</u>:

i. ***A Systematic Evaluation of the Impacts of Traffic Condition Information on the Reduction of On-road Mobile Emissions***

a. What we have done:

1) Submitted the developed research paper to Journal of Air and Waste Management Association, for publication and modify it according to the comments from the reviewers.
2) Further modified the final report draft.

b. What we have learned:

To further validate the results of this study, the estimated emission were compared with the results of literatures. It was found that our results consistent with the results of other studies such as Barth and Boriboonsoms (2008) and the EPA report (2014) "Greenhouse Gas Emissions from a Typical Passenger Vehicle."

The method developed in this study need to be further improved to better model the vehicle emission estimation for the signalized intersections.

ii. ***Developing Short Range Vehicle-to-Infrastructure Communication Systems***

- Further tested and analyzed the impacts of short-range V2I communication messages on driving behaviors when driving in work zone advance area, activity area, termination area, and at intersections.
- Results show that, wireless communication has great impacts on driving performance such as vehicle's approaching speed, acceleration rates, braking distance, and braking response time.
- Drivers' socio-demographic background has great impacts on driving performance.
- Wireless communication has impacts on vehicle emissions in tested cases in work zones and intersections for both field and simulation tests.

iii. ***Education and Outreach Activities***

- Successfully organized the summer transportation academy at TSU in summer 2015 for two sessions of high school students (minority). This summer academy is a continuation from Summers 2012-2015. Most of the students are minority students.
- Supported faculty and graduate students to present research papers in academic conferences such as:
    i. Intelligent Transportation Society (ITS) Texas Annual Meeting.
    ii. Institute of Transportation Engineers (ITE) Texas Fall Meeting.

iv. ***Develop an Integrated Data Management System at the Microscopic, Mesoscopic, and Macroscopic Levels to Assess the Environmental Impacts of Transportation System***

- Further tested vehicle emissions in State of Texas in Houston, El Paso, San Antonio, College Station, and Austin.
- Further compared emission data with highway roughness data.
- Incorporating with a project from Texas Department of Transportation, vehicle emissions have been tested in conjunction with the records of pavement roughness information.
- Tested and modeled in-vehicle noise emissions in Texas.
- Developed nonlinear emission models based on the established emission data management system.
- Research found that roadway roughness will impact vehicle emissions to some extent.
- Different pavement and roughness will induce different noise emissions to drivers and roadside users.

v. ***Use the Driving Simulator to Synthesize the Related Vehicle Specific Power (VSP) for Emission and Fuel Consumption Estimations***

- The final report is in preparation and will be finished before January 31, 2016.
- VSP from simulator for several additional tests were conducted and analyzed.
- This VSP from simulator and from real world are further compared and analyzed. A further summary of such comparison was presented at the Transportation Research Board Annual Meeting, Transportation Research Board of the National Academies, Washington, DC, January 11-15, 2015.
- The driving simulator is capable of testing driving performance in work zone when the Drivers' Smart Advisory System (DSAS) message and smartphone messages are provided.

vi. ***Develop Multi-scale Energy and Emission Models for Arterial Traffic Systems***

- Developed a set of nonlinear model (neural network, k-NN, etc.) to estimated vehicle emissions in relationships with vehicle activity information.

E. <u>Virginia Tech</u>:

i. ***Develop Multi-scale Energy and Emission Models***

a. Developed and validated the VT-CPFM model.
b. Developed a framework for modeling diesel engine vehicle fuel consumption levels.
c. Developed a framework for modeling transit vehicle fuel consumption and emission levels.
d. Investigated the potential for use of electrified vehicles to serve traveler needs using naturalistic driving data.
e. Extended VT-CPFM to model heavy-duty truck fuel consumption and CO, HC, and NO_x emissions.
f. Extended VT-CPFM to model electric vehicles (EVs).
g. Extending VT-CPFM to model vehicle emissions of CO, HC, and NOx.
h. Extending VT-CPFM to model plugin hybrid electric vehicles (PHEVs).
i. Extending VT-CPFM to model hybrid electric vehicles (HEVs).

ii. ***Develop Mesoscopic Fuel Consumption and CO_2 Emission Models***

a. This project was abandoned given the microscopic modeling project was expanded significantly.

iii. ***Develop Macroscopic Fuel Consumption and CO_2 Emission Models***

a. This project was abandoned given the microscopic modeling project was expanded significantly.

iv. ***Developing and Field Implementing a Dynamic Eco-Routing System***

a. Developed a simulation environment for testing the eco-routing system.
b. Studied the dynamics of driver routing behavior.
c. Developing algorithms to enhance eco-routing algorithms.
d. Conducting simulation tests.

v. ***Developing and Field Implementing an Eco-Cruise Control System in the Vicinity of Traffic Signalized Intersections***

a. Developed a simulation environment for testing the eco-routing system.
b. Studied the dynamics of driver routing behavior.
c. Developing algorithms to enhance eco-routing algorithms.
d. Conducting simulation tests.

2. <u>PRODUCTS</u>:

A. <u>University of Idaho</u>:

i. ***Developing and Testing Eco-Traffic Signal System Applications***

- Sherief A. Elbassuoni, Mostafa Asfoor, and Ahmed Abdel-Rahim, "Towards a Better Understanding of the Fuel Consumption and Environmental Costs of Traffic Operations at Signalized Intersection Approaches", CD-ROM, Proceedings of the TRB 95th Annual Meeting, Transportation Research Board, National Research Council, Washington, D.C., January 2016, Paper # 16- 3243.
- Sherief Elbassuoni, "Guidelines for Eco-Traffic Signal System Operations in Small and Medium Size City Environments", Doctoral Student Research in Transportation Operations and Traffic Control, TRB 94th Annual Meeting, Transportation Research Board, National Research Council, Washington, D.C., January 2015, Presentation # P15-7006.
- Jacob W. Preston, Richard W. Wall, and Ahmed Abdel-Rahim, "Real-Time Traffic Signal System Instrumentation using National Electrical Manufacturers Association TS2 Synchronous Data Link Control Networks", CD-ROM, Proceedings of the TRB 94th Annual Meeting, Transportation Research Board, National Research Council, Washington, D.C., January 2015, Paper # 15-3047.
- Sherief Elbassuoni, Chirstopher Divadson, and Ahmed Abdel-Rahim, "Guidelines for Eco-Traffic Signal System Operations for Isolated Actuated Intersections", Paper submitted for publication in ASCE Journal of Transportation Engineering.
- Sherief Elbassuoni,"Guidelines for Eco-Traffic Signal System Operations in Small and Medium Size Cities", Ph.D. Thesis, University of Idaho, May 2015.

ii. ***Calibration of Multi-Scale Energy and Emissions Models***

- R. Lilley, M. Asfoor, M. Santora, D. Coprdon, E. Odom, S. Beyerlein, "Design of the University of Idaho Formula Hybrid Vehicle", SAE International, Warrendale, PA, SAE Technical Paper 2015-01-0414, 2015.
- M. Asfoor, S. Beyerlein, R. Lilley, M. Santora, "Discrete Grid Optimization of a Rule-Based Energy Management Strategy for a Formula Hybrid Electric Vehicle," SAE International, Warrendale, PA, SAE Technical Paper 2015-04-14, 2015.
- Calibrated fuel consumption and emission models for three traffic engineering software tools: VISSIM, Integration, and Transyt 7-F.

- Mostafa Asfoor, “Development and Optimization of a Rule-Based Energy Management Strategy for Fuel Economy Improvements in Hybrid Electric Vehicles”, Ph.D. Thesis, University of Idaho, June 2014.

iii. ***Eco-Driving Modeling Environment***

- A web-based user interface to display Driver Simulator emissions.
- A prototype for a MiniSim EcoDash display providing fuel consumption and emission data for users.
- Java-based application to estimate fuel consumption for a center engine configuration under different driving cycles.

iv. ***Eco-Traffic Signal System Application***

- Two pilot field tests to demonstrate connected vehicle traffic signal system applications.
- A pilot field test to demonstrate the security and survivability of connected vehicles communication exchange at signalized intersection approaches.
- A connected vehicle traffic signal system lab in which data are exchanged between the vehicle, the road side unit, and the traffic controller that will facilitate field deployment.
- A laboratory prototype for connected vehicle traffic signal system application.

B. <u>Old Dominion University</u>:

i. ***Smartphone-based Solutions to Monitor and Reduce Fuel Consumption and CO_2 Footprint***

The following papers presented or will be presented:

- M. Cetin, I. Ustun, and O. Sahin, “Classification Algorithms for Detecting Vehicle Stops from Smartphone Accelerometer Data”, The 95th Annual meeting of the Transportation Research Board, Washington, D.C., January 10-14, 2016.
- G. Bakhtyar, V. Nguyen, M. Cetin, and D. T. Nguyen “Backward Dijkstra Algorithms for Finding the Departure Time Based on the Specified Arrival Time for Real-Life Time Dependent Networks”, presentation at the 3-rd Computational Mathematics and Applications (CMA’2016) Conference in Bangkok, ThaiLand (January 14-16, 2016).
- Jahangiri A. and Rakha H. (2015), "Distributed Learning: An Application to Transportation Mode Identification," Presented at the 94th Transportation Research Board Annual Meeting, Washington DC, January 11-15, CD-ROM [Paper # 15-0826].
- I. Makohon, Z. Li, M. Sosonkina, Y. Shen, M.Cetin, M. Ng, D.T. Nguyen, “JAVA Based Visualization and Animation for Teaching Dijkstra Shortest Path Algorithm in Transportation Networks”, Presented at the MODSIM ‘2015 conference, Virginia Beach Convention & Visitor Bureau, VA Beach, VA, March 31-April 2, 2015.
- Z. Li, I. Makohon, M. Sosonkina, Y. Shen, D.T. Nguyen, “Visualization and Animation for Teaching Frank-Wolfe Transportation Network Equilibrium”, Presented at the MODSIM ‘2015 conference, Virginia Beach Convention & Visitor Bureau, VA Beach, VA, March 31-April 2, 2015.
- A. Salem, T. Nadeem, M. Cetin, S. EL-Tawab, “DriveBlue: Traffic Incident Prediction through Single Site Bluetooth”, Presented at the 18th International IEEE Conference on Intelligent Transportation Systems, Spain, 15 – 18 September 2015.
- Li, Q., F. Qiao, and L. Yu. (2016). Performance Measures of Smartphone Warning Messages in Work Zones and Intersections. Submitted to 23rd ITS World Congress, Melbourne, Australia, 10–14 October 2016.
- F. Qiao, Rahman, R., Q. Li, and L. Yu. (2016). Identifying Suitable Warning Message from Smartphone App to Enhance Safety around Work Zone Activity Area. Submited to the 2016 World Conference on Transport Research, July 10-16, 2015. Shanghai, China.

- Li, Q., F. Qiao, Y. Qiao, and L. Yu. Implications of Smartphone Messages on Driving Performance along Local Streets. Accepted for Presentation and Publication in the Proceedings in the 11th Asia Pacific Transportation Development Conference and 29th ICTPA Annual Conference - Bridging the East and West: Theories and Practices of Transportation in the Asia Pacific. ASCE Publishing, May 27-29, 2016. Hsinchu, Taiwan.

Journal Papers:

- Bakhtyar, G. , Nguyen, V. , Cetin, M. and Nguyen, D. (2016) Backward Dijkstra Algorithms for Finding the Departure Time Based on the Specified Arrival Time for Real-Life Time-Dependent Networks. Journal of Applied Mathematics and Physics, 4, 1-7. doi: 10.4236/jamp.2016.41001.
- Jahangiri, A.; Rakha, H.A., "Applying Machine Learning Techniques to Transportation Mode Recognition Using Mobile Phone Sensor Data," in Intelligent Transportation Systems, IEEE Transactions on , vol.16, no.5, pp.2406-2417, Oct. 2015.
- Drs. Nguyen/Ng and Paul Johnson submitted a paper " A New Large-Scale Network Partitioning Algorithm and Its Application to Transportation Networks (TRC-D-13-00556R1) " for possible publication to Transportation Research Part C, and are now addressing the reviewers' comments.
- The ODU research team is preparing a journal paper to be submitted to IEEE ITS Transactions.
- Qiao, F., R. Rahman, Q. Li, and L. Yu. (2016) Identifying Smartphone Based Intelligent Messages for Worker's Crossing in Work Zone. Special Issues on ITS, Journal of Transportation Technologies, ISSN Online: 2160-0481. In Press.

C. <u>Syracuse University</u>:

i. *Enhancing TSM&O Strategies through User Cost Analysis and Life Cycle Assessment*

- Enhancing TSM&O Strategies through User Cost Analysis and Life Cycle Assessment Final Report (needs peer-review).
- Chen, X., Salem, O., and Salman, B. (2016). "Life-Cycle Benefit-Cost Analysis Framework for Ramp Metering Deployments" TRB 95th Annual Meeting. Washington, D.C.: Transportation Research Board.

ii. *Assessing Environmental Impacts of Traffic Congestion and Vehicular Emissions on Urban Fresh Water*

- Johnson, Alex, Cliff I. Davidson, and Mario Montesdeoca, Analysis of trace metals in stormwater runoff from two building roofs, Poster Presentation, AEESP Conference, New Haven, CT, June 13-16, 2015.
- Johnson, Alex and Cliff Davidson, Influence of Urban Aerosols on the Chemistry of Stormwater Runoff from Building Roofs, Presented at the National Meeting of the American Association for Aerosol Research, Minneapolis**,** MN, October 12-16, 2015.

iii. *Studying the Impact of Accelerated Construction Methods in Work Zones Using Microsimulation on Vehicle Emissions and the Environment*

- Salem, O., & Ghorai, S. (2015). "Environmental Life-Cycle Assessment of Pavement Maintenance, Repair and Rehabilitation Activities." TRB 94th Annual Meeting. Washington, D.C.: Transportation Research Board.
- Ghorai, S., Salem, O., and Salman, B. (2016). "Assessment of Traffic Emission Impacts due to Flexible Pavement Repair and Rehabilitation Activities" The First European and Mediterranean Structural Engineering and Construction Conference, Istanbul, Turkey.

- Ghorai, S., Salem, O., and Salman, B. (2016). "Assessment Of Traffic Emission Impacts Due To Rigid Pavement Repair And Rehabilitation Activities." Eighth International Conference on Maintenance and Rehabilitation of Pavements.

iv. ***A Sustainable Asset Management Framework for Transportation System Management and Operation Systems***

- The research team initiated preparation of the final report.

D. <u>Texas Southern University</u>:

i. ***A Systematic Evaluation of the Impacts of Traffic Condition Information on the Reduction of On-road Mobile Emissions***

- Qi, Y., A. Padiath, and L. Yu. Development of Operating Mode ID Distributions For Different Types Of Roadways Under Different Congestion Levels For Vehicle Emission Assessment Using Moves. Accepted for 93rd Transportation Research Board Annual Meeting, Transportation Research Board of the National Academies, Washington, DC, Jan 12-16, 2014. In addition, it has been submitted to Journal of Air and Waste Management Association for publication.

ii. ***Developing Short Range Vehicle-to-Infrastructure Communication Systems***

- Drivers Smart Advisory System Improves Driving Performance at STOP Sign Intersections. Submitted to Journal of Traffic and Transportation Engineering (English Edition).
- Li, Q., F. Qiao, and L. Yu. (2016). Vehicle Emission Implications of Drivers Smart Advisory System for Traffic Operations in Work Zones. Journal of Air & Waste Management. In Press.
- Li, Q., F. Qiao, and L. Yu. (2015). Fuzzy lane-changing models with socio-demographics and Vehicle-to-Infrastructure system based on a simulator test. the Journal of Ergonomics. http://dx.doi.org/10.4172/2165-7556.1000144. ISSN:2165-7556 JER, an open access journal. Volume 5 • Issue 4 • 1000144.
- Li, Q., F. Qiao, and L. Yu. (2015). Implications of Advanced Warning Messages on Eliminating Sun Glare Disturbances at Signalized Intersections. Journal of Traffic and Transportation Engineering (English Edition). In Press.
- Li, Q., F. Qiao, L. Yu. (2015). Socio-demographic impacts on lane-changing response time and distance in work zone with drivers' smart advisory system, Journal of Traffic and Transportation Engineering (English Edition), Volume 2, number 5, October 2015. Elsevier Publishing. http://dx.doi.org/10.1016/j.jtte.2015.08.003.
- Li, Q., F. Qiao, and L. Yu. (2015). Will Vehicle and Roadside Communications Reduce Emitted Air Pollution? International Journal of Science and Technology, Vol. 5, No. 1, 2015. 17-23. http://ejournalofsciences.org/archive/vol5no1/vol5no1_3.pdf.
- Qiao, F., J. Jia, L. Yu, Q. Li, and D. Zhai, (2014) Drivers' Smart Assistance System Based on Radio Frequency Identification. In Transportation Research Record: Journal of Transportation Research Board, No. 2458, Transportation Research Board of the National Academies, Washington, DC, 2014, pp. 37-46.

iii. ***Education and Outreach Activities***

- The summer transportation academy for high school students.

iv. ***Develop an Integrated Data Management System at the Microscopic, Mesoscopic, and Macroscopic Levels to Assess the Environmental Impacts of the Transportation System***

- This research work is still on-going. There are several research papers utilized the emission and activity data from the database for related research. Some of them have been presented or will be presented in conferences such as the TRB annual meeting and Air & Waste Management Association (AWMA) Annual Meeting.

Publications:

- Wu Ying, Fengxiang Qiao, Lei Yu. Evaluation of the Impact of Work Zone on Vehicular Emissions in Consideration of Roughness Profile. Proceedings of the Transportation Research Board Meeting, January 10-14, 2016, Washington DC.
- Li, Q., F. Qiao, and L. Yu. (2016) Clustering Pavement Roughness Based on the Impacts on Vehicle Emissions and Public Health. Journal of Ergonomics. In Press.
- Li, Q., F. Qiao, and L. Yu. (2016) Developing Texas Emission Factors Considering Pavement Roughness under Different Operational Mode Identification Bins. Submitted to the 108th Air & Waste Management Association (AWMA), June 20-23, 2016. New Orleans, LA. USA.
- Li, Q., F. Qiao, and L. Yu. (2016) Texas Specific Operating Mode Bins Based on Field Test Data Using Portable Emission Measurement System. Submitted to the 108th Air & Waste Management Association (AWMA), June 20-23, 2016. New Orleans, LA, USA.
- Li, Q., F. Qiao, and L. Yu. (2016). Calibrating Emission Factors for Highways Considering Pavement Roughness Information. Paper # 80. Accepted for Presentation and publication in the proceedings of the 2016 Air Quality Measurement Methods and Technology. March 15-17, 2016, Chapel Hill, North Carolina.
- Khan, M., F. Qiao, and L. Yu. (2016). Development and Validation of Neural Network Model to Calibrate Emission Factor Using On-Road Data. Extended Abstract#96. Accepted for Presentation and publication in the proceedings of the 2016 Air Quality Measurement Methods and Technology. March 15-17, 2016, Chapel Hill, North Carolina.
- Li, Q., F. Qiao, and L. Yu. (2016). Estimating Vehicle Idle Emissions Based on On-Board Diagnostic II Data. Paper # 70. Proceedings of the 2016 Air Quality Measurement Methods and Technology. March 15-17, 2016, Chapel Hill, North Carolina.
- F. Qiao, Rahman, R., Q. Li, and L. Yu. (2016). Identifying Suitable Warning Message from Smartphone App to Enhance Safety around Work Zone Activity Area. Accepted for presentation and publication in the 2016 World Conference on Transport Research, July 10-16, 2015. Shanghai, China.
- F. Qiao, Q. Li, and L. Yu. (2016). Neural Network Modeling of In-Vehicle Noises with Different Roadway Roughness. Proceedings in the 11th Asia Pacific Transportation Development Conference and 29th ICTPA Annual Conference - Bridging the East and West: Theories and Practices of Transportation in the Asia Pacific. ASCE Publishing, May 27-29, 2016. Hsinchu, Taiwan.

v. ***Use the Driving Simulator to Synthesize the Related Vehicle Specific Power (VSP) for Emission and Fuel Consumption Estimations***

- Qiao, F., R. Rahman, Q. Li, and L. Yu. (2016) Identifying Smartphone Based Intelligent Messages for Worker's Crossing in Work Zone. Special Issues on ITS, Journal of Transportation Technologies, ISSN Online: 2160-0481. In Press.
- Qiao, F., R. Rahman, Q. Li, and L. Yu. (2016) Identifying demographical effects on speed patterns in work zones using smartphone based audio warning message system. Submitted to Journal of Ergonomics.
- Li, Q., F. Qiao, and L. Yu. (2016). Vehicle Emission Implications of Drivers Smart Advisory System for Traffic Operations in Work Zones. Journal of Air & Waste Management. In Press.
- Li, Q., F. Qiao, and L. Yu. (2015). Fuzzy lane-changing models with socio-demographics and Vehicle-to-Infrastructure system based on a simulator test. The Journal of

Ergonomics. http://dx.doi.org/10.4172/2165-7556.1000144. ISSN:2165-7556 JER, an open access journal. Volume 5 • Issue 4 • 1000144.

- Li, Q., F. Qiao, and L. Yu. (2015). Implications of Advanced Warning Messages on Eliminating Sun Glare Disturbances at Signalized Intersections. Journal of Traffic and Transportation Engineering (English Edition). In Press.
- Ziyue Li, Lei Yu, Fengxiang Qiao, Jinghui Wang (2015). Feasibility Study of Using Driving Simulator to Develop Operating Mode Distributions for Emission Analysis. Presentation and published in the proceedings of the Transportation Research Board Annual Meeting, Transportation Research Board of the National Academies, Washington, DC, Jan 11-15, 2015.
- Li, Q. and F. Qiao. (2014). How Drivers' Smart Advisory System Improves Driving Performance? A Simulator Imitation of Wireless Warning on Traffic Signal under Sun Glare. LAMBERT Academic Publishing. ISBN-13: 978-3-659-57193-0.
- Johora Munni, Fengxiang Qiao, Qing Li, Lei Yu, and Po-Hsien Kuo. (2015). Driving Behavior and Emission Analysis at Yellow Intervals with Advanced Warning Message under Foggy Weather Condition: A Simulator Test. Presented at the Transportation Research Forum for the 56th Annual Forum to be held March 12-14, 2015 in Atlanta, GA.
- You, B., F. Qiao, Q., and L. Yu. (2015). Implications of Left Turn Smartphone Warning Messages in Work Zone Termination Areas through Driving Simulator Tests. Accepted for publication in the proceedings of the 28th Annual Conference of the International Chinese Transportation Professionals Association (ICTPA), May 14 ~ 16, 2015, Los Angeles, USA.
- Qiao, F., Li, Q., and L. Yu (2014). Testing Impacts of Work Zone X2V Communication System on Safety and Air Quality in Driving Simulator, Proceedings of the 21st ITS World Congress, Detroit, USA, September 7-11, 2014.

vi. ***Develop Multi-scale Energy and Emission Models for Arterial Traffic Systems***

- Li, Q., F. Qiao, and L. Yu. (2016). Developing Texas Emission Factors Considering Pavement Roughness under Different Operational Mode Identification Bins. Submitted to the 108th Air & Waste Management Association (AWMA), June 20-23, 2016. Raleigh, North Carolina, USA.
- Li, Q., F. Qiao, and L. Yu. (2016). Texas Specific Operating Mode Bins Based on Field Test Data Using Portable Emission Measurement System. Submitted to the 108th Air & Waste Management Association (AWMA), June 20-23, 2015. Raleigh, North Carolina, USA.
- Li, Q., F. Qiao, and L. Yu. (2016). Calibrating Emission Factors for Highways Considering Pavement Roughness Information. Paper # 80. Accepted for Presentation and publication in the proceedings of the 2016 Air Quality Measurement Methods and Technology. March 15-17, 2016, Chapel Hill, North Carolina.
- Li, Q., F. Qiao, and L. Yu. (2016). Estimating Vehicle Idle Emissions Based on On-Board Diagnostic II Data. Paper # 70. Proceedings of the 2016 Air Quality Measurement Methods and Technology. March 15-17, 2016, Chapel Hill, North Carolina.
- Khan, M., F. Qiao, and L. Yu. (2016). Development and Validation of Neural Network Model to Calibrate Emission Factor Using On-Road Data. Extended Abstract#96. Accepted for Presentation and publication in the proceedings of the 2016 Air Quality Measurement Methods and Technology. March 15-17, 2016, Chapel Hill, North Carolina.
- Wu Ying, Fengxiang Qiao, and Lei Yu. (2015). Modeling of Real Time Emission Related to Vehicle Speed and RPM on Driving Mode. Presented and published in the proceedings of

The 108th Air & Waste Management Association (AWMA) Annual Meeting, Raleigh, June 22-25, 2015, North Carolina.

- Fengxiang Qiao, Ling Liu, Wen Long, and Lei Yu. (2015). Modeling Excess Carbon Dioxide Emissions from Traffic Congestion in Urban Areas. World Soft Computing Conference WSC18 Proceeding in the Springer Book Series "Advances in Intelligent Systems and Computing" 2015. In Print.
- Fengxiang Qiao, Ling Liu and Lei Yu. (2015). Quantifying Changes of Mobile Source Air Pollution in Metropolitan Areas Using Vehicle Emission Model MOVES. Journal of Environmental Science and Engineering. David Publishing Company.
- Tang, P., L. Yu, and G. Song. Effect of Driving Behaviors on Emissions in Eco-driving at Intersections. Proceedings of the 93rd Transportation Research Board Annual Meeting, Transportation Research Board of the National Academies, Washington, DC, Jan 12-16, 2014.
- Qiao, F., P. Kuo, and L. Yu. Fuzzy Modeling of Pedestrian Related Conflict Events at Intersections. Presented at the 93rd Transportation Research Board Annual Meeting, Transportation Research Board of the National Academies, Washington, DC, Jan 12-16, 2014.
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- Song, G., L. Yu, and L. Long. Development of Speed Correction Factors based on Speed-Specific VSP Distributions for Urban Restricted Access Roadways in Beijing. Presented at the 93rd Transportation Research Board Annual Meeting, Transportation Research Board of the National Academies, Washington, DC, Jan 12-16, 2014.
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E. <u>Virginia Tech</u>:

i. *Develop Multi-scale Energy and Emission Models*

- Park S., Rakha H., Ahn K., and Moran K. (2013), "Virginia Tech Comprehensive Power-based Fuel Consumption Model (VT-CPFM): Model Validation and Calibration Considerations," International Journal of Transportation Science and Technology, Vol. 2, no. 4, pp. 317-336.
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- Edwardes W. and Rakha H. (2014), "Virginia Tech Comprehensive Power-Based Fuel Consumption Model: Modeling Diesel and Hybrid Buses," Transportation Research Record: Journal of the Transportation Research Board, Issue 2428, pp. 1-9.

- Faris, W.F., Rakha, H.A. and Elmoselhy (2014), “Supercharged Diesel Powertrain Intake Manifold Analytical Model,” *International Journal of Vehicle Systems Modelling and Testing*, 9(1), pp. 1-35.
- Faris, W.F., Rakha, H.A. and Elmoselhy (2014), "Impact of Intelligent Transportation Systems on Vehicle Fuel Consumption and Emission Modelling: An Overview," SAE Transactions: International Journal of Materials and Manufacturing, 7 (1), pp. 129-146.
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- Edwardes W. and Rakha H. (2015), "Modeling Diesel and Hybrid Bus Fuel Consumption using VT-CPFM: Model Enhancements and Calibration," Transportation Research Record: Journal of the Transportation Research Board.
- Park S., Ahn K., Rakha H., and Lee C. (2015), "Real-Time Emission Modeling with EPA MOVES: Framework Development and Preliminary Investigation," Transportation Research Record: Journal of the Transportation Research Board.
- Fiori C., Ahn K., and Rakha H. (2016), "Virginia Tech Comprehensive Power-based Electric Vehicle Energy Consumption Model: Model Development and Validation," Accepted for presentation at the 95th Transportation Research Board Annual Meeting, Washington DC, January 10-14. [Paper # 16-0631]
- Wang J. and Rakha H. (2016), "Heavy-Duty Diesel Truck Fuel Consumption Modeling," Accepted for presentation at the 95th Transportation Research Board Annual Meeting, Washington DC, January 10-14. [Paper # 16-2147]
- Wang J. and Rakha H. (2016), "Hybrid-Electric Bus Fuel Consumption Modeling: Model Development and Comparison with Conventional Buses," Accepted for presentation at the 95th Transportation Research Board Annual Meeting, Washington DC, January 10-14. [Paper # 16-0660]
- Abdelmegeed M., Ahn K., and Rakha H. (2016), "Modeling Light Duty Vehicle Emissions Exploiting VT-CPFM Fuel Estimates," Accepted for presentation at the 95th Transportation Research Board Annual Meeting, Washington DC, January 10-14. [Paper # 16-2448]

ii. ***Develop Mesoscopic Fuel Consumption and CO_2 Emission Models***

- Nothing to Report.

iii. ***Develop Macroscopic Fuel Consumption and CO_2 Emission Models***

- Nothing to Report.

iv. ***Developing and Field Implementing a Dynamic Eco-Routing System***

- Ahn K. and Rakha H. (2014), "Eco-Lanes Applications: Preliminary Testing and Evaluation," Transportation Research Record: Journal of the Transportation Research Board, Issue 2427, pp. 41-53.
- Wang J. and Rakha H. (2015), "Impact of Dynamic Route Information on Day-to-Day Driver Route Choice Behavior," Presented at the 94th Transportation Research Board Annual Meeting, Washington DC, January 11-15, CD-ROM [Paper # 15-4918].
- Tawfik A. and Rakha H. (2015), "Modeling Heterogeneity of Driver Route Choice Behavior using Hierarchical Learning-Based Models: A Longitudinal, In-Situ Experiment in Real World Conditions," Presented at the 94th Transportation Research Board Annual Meeting, Washington DC, January 11-15, CD-ROM [Paper # 15-3135].

- Wang J., Rakha H. and Yu L. (2015), "Operating Mode Distribution Characteristics of Different Freeway Weaving Configurations and their Effects on Vehicular Emissions," Presented at the 94th Transportation Research Board Annual Meeting, Washington DC, January 11-15, CD-ROM [Paper # 15-1429].
- Elbery A., Rakha H.A., ElNainay M., and Hoque M.A., (2015) "VNetIntSim: An Integrated Simulation Platform to Model Transportation and Communication Networks," International Conference on Vehicle Technology and Intelligent Transport Systems, Lisbon, Portugal, May 20-22.
- Van Essen, M., Rakha, H., Vreeswijk, J., Wismans, L., & Van Berkum, E. (2015). "Day-to-day route choice modeling incorporating inertial behavior." IATBR Conference, 19-23 July, 2015, Windsor, UK.
- Elbery A., Rakha H., El-Nainay M., Drira W., and Filali F., (2015), "Eco-Routing Using V2I Communication: System Evaluation," IEEE 18th International Conference on Intelligent Transportation Systems, Las Palmas de Gran Canaria, Spain, Sept. 15-18. [Paper # 1436]

v. ***Developing and Field Implementing an Eco-Cruise Control System in the Vicinity of Traffic Signalized Intersections***

- Kishore Kamalanathsharma, R., & Rakha, H. A. (2014). Leveraging Connected Vehicle Technology and Telematics to Enhance Vehicle Fuel Efficiency in the Vicinity of Signalized Intersections. Journal of Intelligent Transportation Systems, (ahead-of-print), 1-12.
- Kamalanathsharma, R. K., and Rakha, H. A. (2014). Agent-Based Simulation of Ecospeed-Controlled Vehicles at Signalized Intersections. Transportation Research Record: Journal of the Transportation Research Board, 2427(1), 1-12.
- Kamalanathsharma R., Rakha H., and Zohdy I. (2015), "Survey on In-vehicle Technology Use: Results and Findings," International Journal of Transportation Science and Technology, vol 4(2), pp. 135-150.
- Kamalanathsharma R., Rakha H. and Yang H. (2015), "Network-wide Impacts of Vehicle Eco-Speed Control in the Vicinity of Traffic Signalized Intersections," Transportation Research Record: Journal of the Transportation Research Board.
- Venkat Ala M., Yang H., and Rakha H. (2016), "Sensitivity Analysis of Eco-Cooperative Adaptive Cruise Control at Signalized Intersections," Accepted for presentation at the 95th Transportation Research Board Annual Meeting, Washington DC, January 10-14. [Paper # 16-2891]
- Yang H., Ala V.M., and Rakha H. (2016), "Eco-Cooperative Adaptive Cruise Control at Signalized Intersections Considering Queue Effects," Accepted for presentation at the 95th Transportation Research Board Annual Meeting, Washington DC, January 10-14. [Paper # 16-1593]

3. <u>PARTICIPANTS & OTHER COLLABORATING ORGANIZATIONS</u>:

A. <u>University of Idaho:</u>

UI has been working with the Idaho Transportation Department, Harbrick, and AutonomouStuff, LLC., and holding various meetings to collaborate on projects and holding training meetings.

B. <u>Old Dominion University:</u>

ODU is working jointly with fellow TranLIVE Institutions Virginia Tech and Texas State University.

C. <u>Syracuse University:</u>

Nothing to report.

D. <u>Texas Southern University:</u>

i. ***A Systematic Evaluation of the Impacts of Traffic Condition Information on the Reduction of On-road Mobile Emissions***
PI and Dr. Xumei Chen collaborate on a research paper related to this project and thus paper has been accepted for 95rd Transportation Research Board Annual Meeting, Transportation Research Board of the National Academies, Washington, DC, Jan 12-16, 2016.

ii. ***Developing Short Range Vehicle-to-Infrastructure Communication Systems***
Professor Juan Li from ShangDong Jiaotong University, and Professor Liqing Wei from Chongqing Jiaotong University (both from China) work as visiting scholars at Texas Southern University being partially involved in this project.

iii. ***Education and Outreach Activities***
One exchange graduate student from Beijing Jiaotong University visited TSU in summer 2015, exchanging research ideas and activities with TSU graduate students.

iv. ***Develop an Integrated Data Management System at the Microscopic, Mesoscopic, and Macroscopic Levels to Assess the Environmental Impacts of the Transportation System***
Exchanged ideas and potential collaborative work with researchers at University of Texas. Professor Juan Li from Shangdong Jiaotong University works as visiting scholars at Texas Southern University and is partially involved into this projectConducted collaborative research with National Science Foundation (NSF) CREST center on complex network, especially its subcenter on wireless communications at TSU.

v. ***Use the Driving Simulator to Synthesize the Related Vehicle Specific Power (VSP) for Emission and Fuel Consumption Estimations***
One graduate student from Beijing Jiaotong University visited TSU in summer of 2015 and tested impacts of roadside message on vehicle emissions using the driving simulator.

vi. ***Develop Multi-scale Energy and Emission Models for Arterial Traffic Systems***
Conducted collaborative research with National Science Foundation (NSF) CREST center on complex network at TSU.

E. Virginia Tech:

i. ***Develop Multi-scale Energy and Emission Models***
The research team collaborated with researchers from the International Islamic University of Malaysia (IIUM).

ii. ***Develop Mesoscopic Fuel Consumption and CO_2 Emission Models –*** Nothing to report.

iii. ***Develop Macroscopic Fuel Consumption and CO_2 Emission Models*** – Nothing to report.

iv. ***Developing and Field Implementing a Dynamic Eco-Routing System***
Collaborated with the University of Twente in the Netherlands.

vi. ***Developing and Field Implementing an Eco-Cruise Control System in the Vicinity of Traffic Signalized Intersections***
Lamar University.

4. IMPACT:

A. University of Idaho:

i. ***Developing and Testing Eco-Traffic Signal System Applications***
Education:

1) Two Bachelor of Science in Civil Engineering student graduated and joined the transportation engineering graduate program at the University of Idaho.
2) Three undergraduate Civil Engineering students joined as undergraduate research intern.
3) One Ph.D. student graduates in May 2015 and joined the Transportation Engineering workforce joining a lead consultant firm in the area of traffic signal system operations.

Research:

1. Guidelines for actuated control parameters to minimize fuel consumption and vehicle emissions for fully actuated signaled intersections operating on isolated or free mode of operation.
2. Guidelines for optimizing coordinated corridors to minimize fuel consumptions and emissions.
3. Guidelines on using advanced controller parameters to minimize fuel consumption and vehicle emissions for fully actuated signaled intersections operating on isolated or free mode of operation.
4. An architecture for a Hardware-in-the-loop simulation environment for connected-vehicle applications for corridor operations integrating.

Technology Transfer:

1. Sherief A. Elbassuoni, Mostafa Asfoor, and Ahmed Abdel-Rahim, "Towards a Better Understanding of the Fuel Consumption and Environmental Costs of Traffic Operations at Signalized Intersection Approaches", CD-ROM, Proceedings of the TRB 95th Annual Meeting, Transportation Research Board, National Research Council, Washington, D.C., January 2016, Paper # 16- 3243.
2. Sherief Elbassuoni, "Guidelines for Eco-Traffic Signal System Operations in Small and Medium Size City Environments", Doctoral Student Research in Transportation Operations and Traffic Control, TRB 94th Annual Meeting, Transportation Research Board, National Research Council, Washington, D.C., January 2015, Presentation # P15-7006.
3. Jacob W. Preston, Richard W. Wall, and Ahmed Abdel-Rahim, "Real-Time Traffic Signal System Instrumentation using National Electrical Manufacturers Association TS2 Synchronous Data Link Control Networks", CD-ROM, Proceedings of the TRB 94th Annual Meeting, Transportation Research Board, National Research Council, Washington, D.C., January 2015, Paper # 15-3047.
4. Sherief Elbassuoni, Chirstopher Divadson, and Ahmed Abdel-Rahim, "Guidelines for Eco-Traffic Signal System Operations for Isolated Actuated Intersections", Paper submitted for publication in ASCE Journal of Transportation Engineering.
5. Sherief Elbassuoni, "Guidelines for Eco-Traffic Signal System Operations in Small and Medium Size Cities", Ph.D. Thesis, University of Idaho, May 2015.

ii. ***Calibration of Multi-Scale Energy and Emissions Models***

Education:

1) One Ph.D. student in Mechanical Engineering graduated.
2) One undergraduate electrical engineering student continued working as undergraduate research intern.

Research

1. R. Lilley, M. Asfoor, M. Santora, D. Coprdon, E. Odom, S. Beyerlein, "Design of the University of Idaho Formula Hybrid Vehicle", SAE International, Warrendale, PA, SAE Technical Paper 2015-01-0414, 2015.
2. M. Asfoor, S. Beyerlein, R. Lilley, M. Santora, "Discrete Grid Optimization of a Rule-Based Energy Management Strategy for a Formula Hybrid Electric Vehicle," SAE International, Warrendale, PA, SAE Technical Paper 2015-04-14, 2015.
3. Calibrated fuel consumption and emission models for three traffic engineering software tools: VISSIM and Integration, and Transyt 7-F.

4. A rule-based energy management strategy for fuel economy improvements in Hybrid Electric Vehicles.

iii. ***Eco-driving Modeling Environment***

Education

1. One computer science undergraduate student and one psychology graduate student.
2. One Mechanical Engineering undergraduate student.

Research

1. A web-based user interface to display Driver Simulator emissions.
2. An Eco-Driving modeling environment that integrates the NADS MiniSim driver simulator model and the GT-Suite advanced engine modeling tool.

iv. ***Eco-Traffic Signal System Application***

Education:

1. Two Ph.D., and one M.Sc. computer science student and one Civil Engineering Ph.D. student working on the project.
2. Three undergraduate students working on the field demonstrations.

Research:

1. Two pilot field tests to demonstrate connected vehicle traffic signal system applications.
2. A pilot field test to demonstrate the security and survivability of connected vehicles communication exchange at signalized intersection approaches.
3. A connected vehicle traffic signal system lab in which data are exchanged between the vehicle, the road side unit, and the traffic controller that will facilitate field deployment.
4. A laboratory prototype for connected vehicle traffic signal system application.

B. <u>Old Dominion University</u>:

i. ***Smartphone-based Solutions to Monitor and Reduce Fuel Consumption and CO_2 Footprint***

Education:

1. ODU: Four faculty members, four PhD and one Masters student.
2. VT: One faculty member and one PhD Student.
3. Two Faculty, one PhD student, and one Masters student.

Research:

The results of the research are being disseminated though journal publications and presentations at international conferences and workshops. (See the list of products above.)

C. <u>Syracuse University</u>:

i. The literature search conducted by project participants in all TranLIVE projects resulted in development of a comprehensive database and assisted students in generating a deeper understanding with regards to various aspects involved in sustainability of transportation systems. The literature review efforts were particularly beneficial for graduate students in acquiring knowledge on their respective TranLIVE project components and in improving their problem solving skills. Participating in TranLIVE projects taught them to critically analyze the existing information in a scientific manner and to develop the most feasible methodology to address the research needs. In addition, students excelled in defining the scope of their projects, selecting the right model to conduct their analyses, filtering out the less important factors and comparing their results against other published work.

ii. The conferences attended by the project participants allowed them to showcase their ongoing research and obtain useful feedback from transportation experts.

D. Texas Southern University:

i. ***A Systematic Evaluation of the Impacts of Traffic Condition Information on the Reduction of On-road Mobile Emissions***

This project will provide transportation planners or environmental analysts with qualitative assessments of the impacts on air quality of different types of traffic condition information. It will also help the traffic engineer to appropriately deploy the most effective traveler information systems to achieve more environmental benefits. In addition, since very few studies have been performed to directly investigate the impacts of the traveler information on on-road mobile emissions, the proposed research will fill this gap and will help the researchers and practitioners to better understand the related issues in the future. Furthermore, the operating mode ID distributions developed by this study can be used as input to run MOVES and obtain the emission level of any pollutants. The results of this study will facilitate the evaluation of transportation operation and demand management strategies with respect to their impacts on air quality. Finally, the results of project can be incorporated into some teaching curriculums, such as the class TMGT 885 "Quantitative Assessment of Transportation Environmental Impact" at TSU.

ii. ***Developing Short Range Vehicle-to-Infrastructure Communication Systems***

The developed system can help to not only enhance safety, but also reduce vehicle emissions. With more tests, it can be widely used in research, industry and for education purposes.

iii. ***Education and Outreach Activities***

The education program helps to promote interests of high school and college students in STEM programs, especially in transportation and environment related areas. The developed curriculum and experiences can be easily further expanded and applied to other schools and other areas.

The education program has brought awareness to students, teachers, community organizers, organizations and families about the impact of transportation on the environment. In addition, these groups have come to understand that their personal decisions regarding transportation impact the quality of their environment.

The students learned new transportation and environmental concepts and terms; the students made a connection to how goods, services and people are transported efficiently through various modes and networks of transportation infrastructure.

iv. ***Develop an Integrated Data Management System at the Microscopic, Mesoscopic, and Macroscopic Levels to Assess the Environmental Impacts of the Transportation System***

The research papers indicated in item 2 have been or will be presented in several important international conferences, TRB, AWMA…

The tested vehicle emissions and the established models can be used to characterize the local-specific emissions in Texas and other area.

v. ***Use the Driving Simulator to Synthesize the Related Vehicle Specific Power (VSP) for Emission and Fuel Consumption Estimations***

The developed algorithm will help to calibrate the simulation results from driving simulator, which will thus make better use of the driving simulator for vehicle emission and fuel consumption analyses.

The test procedure is a good material for the development of a lab test for graduate students in courses such as Quantitative Analyses of Vehicle Emissions.

vi. ***Develop Multi-scale Energy and Emission Models for Arterial Traffic Systems***

The developed models are important to further research in developing suitable urban transportation management system and vehicle emission reduction strategies. They also

provide very good examples for undergraduate and graduate level courses. The developed techniques can be expanded for direct use by industry and government.

E. Virginia Tech:

i. ***Develop Multi-scale Energy and Emission Models***

a. **Education**: The funding of several graduate student assistantships.

b. **Research**: Development of fuel consumption models for light duty cars, buses, heavy duty trucks, EVs, PHEVs and HEVs.

c. **Technology Transfer**: Publication of results at various conferences.

ii. ***Develop Mesoscopic Fuel Consumption and CO_2 Emission Models –*** Nothing to report.

iii. ***Develop Macroscopic Fuel Consumption and CO_2 Emission Models*** – Nothing to report.

iv. ***Developing and Field Implementing a Dynamic Eco-Routing System***

a. **Education**: The funding of several graduate student assistantships.

b. **Research**: Development of an eco-routing prototype.

vii. ***Developing and Field Implementing an Eco-Cruise Control System in the Vicinity of Traffic Signalized Intersections***

a. **Education**: The funding of several graduate student assistantships.

b. **Research**: Development of an eco-CACC prototype and testing it in the field.

5. CHANGES/PROBLEMS

A. University of Idaho:

i. ***Developing and Testing Eco-Traffic Signal System Applications***

Nothing to Report.

ii. ***Calibration of Multi-Scale Energy and Emissions Models***

Nothing to Report.

iii. ***Eco-driving Modeling Environment***

Nothing to Report.

iv. ***Eco-Traffic Signal System Applications***

a. Field deployment implementation delay issues due to the time needed to integrate different test components.

b. Project has been extended to June 2016 to allow for field demonstration.

B. Old Dominion University:

Nothing to report.

C. Syracuse University:

Nothing to report.

D. Texas Southern University:

i. ***A Systematic Evaluation of the Impacts of Traffic Condition Information on the Reduction of On-road Mobile Emissions***

A no-cost extension to May 31 2016 is requested.

ii. ***Developing Short Range Vehicle-to-Infrastructure Communication Systems***

The drivers' performance for work zone, intersection, and other locations need to be systematically analyzed.

iii. ***Education and Outreach Activities***

Many of the education activities are on-going and this project is combined with the project "2013-2014 education and outreach activities."

iv. ***Develop an Integrated Data Management System at the Microscopic, Mesoscopic, and Macroscopic Levels to Assess the Environmental Impacts of the Transportation System***

Due to new tests with pavement roughness in conjunction with a TxDOT project, this project has been extended to May 31, 2016.

v. ***Use the Driving Simulator to Synthesize the Related Vehicle Specific Power (VSP) for Emission and Fuel Consumption Estimations***

Nothing to report.

vi. ***Develop Multi-scale Energy and Emission Models for Arterial Traffic Systems***

This project will be finished by January 31, 2016 so as to systematically summarize all developed models and analytical results.

E. Virginia Tech:

i. ***Develop Multi-scale Energy and Emission Models***

The scope of the project has been changed to focus on expanding the microscopic modeling framework to consider: (1) buses; (2) trucks; (3) electric vehicles (4) plug-in hybrid electric vehicles; and (5) hybrid electric vehicles. This extensive framework will be the first to model all these different vehicle types.

ii. ***Develop Mesoscopic Fuel Consumption and CO_2 Emission Models***

This project has been dropped.

iii. ***Develop Macroscopic Fuel Consumption and CO_2 Emission Models*** – Nothing to report

This project has been dropped.

iv. ***Developing and Field Implementing a Dynamic Eco-Routing System***

Nothing to report.

viii. ***Developing and Field Implementing an Eco-Cruise Control System in the Vicinity of Traffic Signalized Intersections***

Nothing to report.

6. SPECIAL REPORTING REQUIREMENTS

Financials will be sent by the University of Idaho's Office of Sponsored Programs as needed.

Completed by:
University of Idaho: Ahmed Abdel-Rahim
Old Dominion University: Mecit Cetin
Syracuse University: O. Sam Salem
Texas Southern University: Fengxiang Qiao, Yi Qi
Virginia Tech: Hesham Rakha