



Center for Advanced Multimodal Mobility Solutions and Education

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1. ACCOMPLISHMENTS

1.1. What are the major goals and objectives of the program?

The major goals and objectives of the program as outlined in the proposal include the following categories.

Research

CAMMSE will address the FAST Act research priority area of “Improving Mobility of People and Goods” by conducting multi-disciplinary, multi-modal research, education and workforce development, and technology transfer. CAMMSE is motivated by the recent advances in computing, smartphones and communication technologies, and ubiquitous data to create sustainable, efficient, and growth-enabling multimodal transportation systems. Cutting edge analytical methods and models will enhance the effectiveness, efficiency, and reliability of these systems accordingly. Recent technological advancements enable new perspectives and holistic approaches to address the well-known challenges in multimodal transportation systems planning, design, operations, and maintenance. In particular, the following research topic areas will be established to maximize synergy and adaptability across multiple modes and jurisdictions:

- Increase access to opportunities that promote equity in connecting regions and communities, including urban and rural communities;
- Generate innovations in multi-modal planning and modeling for high-growth regions;
- Develop data modeling and analytical tools to optimize passenger and freight movements;
- Innovations to improve multi-modal connections, system integration and security; and
- Smart Cities.

Leadership

The CAMMSE team is nationally and internationally recognized for its contributions to the field of transportation research, and for its deployment of successful solutions to critical, real-world transportation challenges. In addition, team members are committed advocates and longstanding leaders within the multimodal transportation community and the UTC system itself. Through this UTC grant, the Consortium plans to build on its demonstrated experience to mentor future leaders in the field of transportation. CAMMSE plans to nurture students through skill building and professional development

activities that promote notable research scholarships and successful transportation careers.

Education and Workforce Development

With years of collective education, research, and UTC experience, CAMMSE will provide a transportation education program through its partner universities. The program will promote creative and multidisciplinary problem-solving and exposure to a myriad of educational and workforce development experiences. The program will serve to attract, educate, and train future and existing transportation professionals with the know-how to undertake and implement innovative projects being or to be conducted.

The workforce development program will leverage the existing training skills and delivery resources available within partner universities. On-line webinars will be designed and delivered using available technical resources, which could provide Continuing Education Credits (CEUs) to interested course participants. In addition, UTC funds will be used to support and host the monthly transportation seminar series, particularly while classes are in session. The target audience is current students and the local university community. UTC funds will also enhance our ability to host nationally and internationally recognized speakers. The target audience is local and regional (onsite), and national when recording and posting talks online.

CAMMSE will support career-building activities that facilitate student transition from school to the workplace by offering enhanced student research opportunities, research seminars, guest speakers, professional conference travel and other professional networking opportunities. In addition, outreach programs at the pre-collegiate level (elementary to high school) will be designed to spark interest in transportation issues and to encourage youth to consider transportation academic programs and careers. The outreach initiatives will particularly focus on recruiting underrepresented minorities into transportation and other STEM fields.

Technology Transfer

The technology transfer program at CAMMSE is designed to support the USDOT in its objective of “expanding technology transfer to partners and stakeholders” by sharing research results quickly and to the widest possible audience. CAMMSE has demonstrated ability to disseminate research results, spur implementations, and conduct continuing education programs. The technology transfer program is a direct extension of the Center’s research and education programs; in other words, these activities are designed to increase the scope and effectiveness of research accomplishments and education initiatives. General objectives within the technology transfer area in CAMMSE will be to:

- Increase the national visibility of CAMMSE research and education activities.
- Increase the availability and speed at which CAMMSE research results are disseminated.
- Provide technical assistance based on CAMMSE research and development.

Collaboration

CAMMSE has an extensive history of forming collaborative relationships at a variety of technical, fiscal and administrative levels. Across all its activities, from conducting pooled fund studies to hosting tech transfer events, CAMMSE will seek to work with collaborators from all sectors.

Diversity

In order for the transportation workforce to reflect the diversity of the national workforce pool, CAMMSE will continue to pursue the development of innovative programs to encourage new entrants, particularly those from groups currently underrepresented in the field. CAMMSE will actively participate in a number of committed activities through which the CAMMSE will increase interest in STEM disciplines and raise awareness of transportation-related careers amongst underrepresented groups.

1.2. What was accomplished under these goals?

Research

As initially planned, the draft CAMMSE Call for Research Proposals for 2018 Year 2 was developed and sent out to Associate Directors at all member universities for review and input on June 25, 2017. After making careful changes by addressing some comments, CAMMSE officially issued the RFPs for the year of 2017-2018 on July 8, 2017. The submission deadline for all project proposals were Monday, August 7, 2017 at 4:00 pm. 24 research proposals were received. Rigorous peer-reviews were then conducted. After examining the proposal evaluation comments and review ratings of all proposals, CAMMSE Research Program Leadership Committee discussed and then selected 17 of them for funding and contracts were issued later. The decision letters were sent to all PIs by Friday, September 1, 2017.

For all research projects that were selected for funding, the CAMMSE Project Information Forms were developed including project title, university, principal investigator, PI contact information, funding source(s) and amounts provided (by each agency or organization), total project cost, agency ID or contract number, start and end dates, brief description of research project, implementation of research outcomes, and impacts/benefits of implementation. The project information was posted on the CAMMSE website as well as on RiP as required by OST-R. All funded projects in the second year (i.e., in the year of 2017-2018) are expect to be completed within one year. Final Reports will be submitted within two months after the completion of each project.

The appendix contains the list of the funded projects (in both Year 1 and Year 2) with respect to each member university.

CAMMSE was funded by USDOT in November 2016 under the FAST act. Although still ongoing, CAMMSE research results have been published in multiple journals, including *Transportation Research Part A: Policy and Practice*, *Transportation Research Part B: Methodological*, *Journal of Advanced Transportation*, *ASCE Journal of Transportation Engineering, Part A: Systems*, *ASCE Journal of Infrastructure Systems*, *ASCE Journal of Cold Regions Engineering*, *International Journal of Transportation Science and Technology*, *Journal of Transportation Planning and Technology*, *Journal of Transportation Systems Engineering and Information Technology*, *Accident Analysis and Prevention*, *Transportation Letters: the International Journal of Transportation Research*, *World Wide Web*, *IEEE Transactions on Vehicular Technology*, *IEEE/ACM Transactions on Networking*, *IEEE Transactions on Mobile Computing*, *IEEE Internet of Things Journal*, *Personal and Ubiquitous Computing*, *Journal of the Chinese Ceramic Society*, *Transportation Research Record: Journal of Transportation Research Board*, and *ACM Transactions on Embedded Computing System*. CAMMSE research results were also presented at many conferences on several occasions, which include the UNC Charlotte Research Institute (CRI) Spring Reception, 2017 Agricultural & Applied Economics Association Annual Meeting and the 97th Transportation Research Board (TRB) Annual Meeting in January 2018.

Leadership

CAMMSE Center Director Dr. Wei Fan attended the CUTC 2017 Annual Summer Meeting which started on Monday, June 19th and ran through Wednesday, June 21st in Buffalo, New York. Dr. Fan also attended the UTC Grantees' Meetings and the banquet at the 97th TRB Annual Meeting, January 7-11, 2018.

CAMMSE Research Program Leadership Committee has also been in touch via emails on a regular and on an as-needed basis during this period. A special CAMMSE Leadership Meeting was held at the 97th Transportation Research Board (TRB) Annual Meeting, January 9, 2018. Center Director Dr. Wei Fan from UNC Charlotte, Associate Directors including Dr. Yi Qi from TSU, Dr. Randy Machemehl from UT Austin, Dr. Nicholas Lownes from UConn and Dr. Qun Zhang from WSU (attended the meeting on behalf of Dr. Xianming Shi). The topics discussed in this meeting included the grant requirements; immediate tasks; establishment of the technical advisory committee; contracts and cost share; and research proposals. Progresses on research, education and outreach, as well as technology transfer activities were discussed and the First Annual CAMMSE Summer Symposium was planned. Several decisions were made accordingly as results of this leadership meeting.

CAMMSE Center Director and Associate Directors have been actively serving on many editorial boards (e.g., Associate Editor of the *IEEE Transactions on Intelligent Transportation Systems*, *ASCE Journal of Transportation Engineering, Part A: Systems*, and *International Journal of Transportation Science and Technology*, *Journal of Transportation of the Institute of Transportation Engineers*, *Institute of Transportation Engineers*, *Transportation Letters*, *Transportmetrica A: Transport Science*) and many professional committees (e.g., member of the TRB Standing Committees (AHB60,

AHD60, AP025, ADB10, ABR10, ABJ70, AFN30, ADC20, ADC60, and AFP40), session chair of INFORMS), ASCE Connected & Autonomous Vehicles Impacts Committee, Advanced Technologies Committee, Public Transport Committee, Rail Transportation Committees, At large member of PENC state board, Connecticut Transportation Institute, and World Transport Convention) as well as proposal, book review committees (e.g., NCHRP, NSF, NDSEG Cognella, Inc., and Luxembourg National Research Fund).

Students funded by CAMMSE have received notable national and regional awards including *Roy D. Williams Memorial Scholarship*, *Dwight Eisenhower Fellowship*, *WTS Diane Woodend Jones Leadership Legacy Scholarship*, *International Road Federation Fellowship*, *ITMA Scholarship* and *Texas ITE Houston Section Scholarship*.

Education and Workforce Development

CAMMSE has been working with Institute of Transportation Engineers (ITE) Student Chapter at UNCC in supporting and hosting the bi-weekly transportation seminar series in which guest speakers are invited to UNCC to present their current project activities while classes are in session. The target audience is current students and the local university community. Dr. Fan's transportation research group has also been conducting graduate student seminars on a weekly basis.

CAMMSE Center Staff Meeting has officially started in the spring semester of 2018. The first meeting was held on Tuesday January 23, 2018. CAMMSE Center Staff (Drs. Wei Fan, Miguel Pando, David Weggel, Martin Kane, and Yu Wang) has been meeting on a bi-weekly basis. Topics discussed among these important regular meetings will include, but are not limited to, the annual research symposium in the summer, annual summer camp at UNC Charlotte, research, education and outreach as well as technology transfer activities. In particular, Dr. Miguel Pando, CAMMSE Assistant Director of Education and Outreach has successfully led several education and outreach activities at UNCC for CAMMSE during this reporting period. Such activities are detailed as follows:

- Led the design, organization, and implementation of the first CAMMSE Summer Camp on Transportation Engineering held at UNC Charlotte from Monday July 10, 2017 to Friday July 14, 2017.
 - Design of program was carried out with input and regular planning meetings with Drs. Wei Fan, David Weggel.
 - Summer camp program also included input from Dr. Martin Kane who led two traffic safety activities during the camp.
 - CAMMSE graduate students helped prepare handouts and materials and led the activity involving traffic simulation that was a huge success with camp participants.
 - Following the success of CAMMSE's summer camp of 2017, CAMMSE staff are currently planning another camp for Summer 2018; the camp will be held from June 11-15. Successful events from 2017 will carry over to the coming

summer camp, but less successful events will be either modified or discarded. In any case, new camp materials are presently under development.

- December 18, 2017 – Presentation about civil engineering to 3 sections of the Grade 9 Science course: Earth & Environmental Science of teacher Ms. Kristi McConnell at the Bradford Preparatory School of Charlotte, NC. Three 50 minute presentations for sections starting at 8 am, 9am, and 10 am. The total number of kids is 63.
- Research on K-12 outreach activities related to transportation.
- Contacted Brandon Baccio at the American Public Transportation Association (APTA) to obtain access to the APTA National Transit Curriculum for possible use in CAMMSE workforce training activities with a focus in public transit professionals.
 - Curriculum:
 - <http://www.apta.com/resources/workforce/national-transit-curriculum/Pages/Curriculum.aspx>
 - Access to PowerPoints
 - Youth summit 2019 (www.apta.com).
 - APTA's National Public Transportation Career Day.
- Correspondence with Dr. Hilary Nixon, Director of Research and Technology Transfer, Mineta Transportation Institute, San Jose State University about EOT strategies and activities at the MIT in SJSU.
 - Videoconference meeting with Dr. Nixon on February 28, 2018 discussed:
 - K-12 outreach strategies.
 - Discussed classroom activity designed by MTI where middle school students are asked about transportation, modes of transportation, CO2 footprint, etc.
 - Discussed MTI's Garret Morgan Competition for schools. Agreed that we could try to engage a CMS school to participate in the 2019 competition.
 - Discussed workforce development and training.
 - Discussed K-12 workforce development initiatives and suggested USDOT (Clark Martin) to find out more about workforce development programs and resources.
- Contacted Clark Martin at USDOT to find out about resources for workforce development and EOT activities in general.
- Met with the Dr. David Pugalee of the Center for STEM Education at UNC Charlotte to help us connect with local schools for the planned CAMMSE EOT activities. Meeting follow-up 4/6/19. Will identify CMS schools to pilot first EOT activity May 2018.
- Designed first draft of Middle and High school EOT activity on Transportation, Modes and Carbon footprint.
- Plan to pilot first EOT activity in Cabarrus J N Fries STEM School for mid-April or May 2018.

In particular, based on extensive research and meetings and conference calls with STEM experts, CAMMSE staff have developed a presentation and activity module for K-12 students. In its present form, the presentation outlines multimodal transportation topics at a general level (e.g., transportation modes, efficient movement of people and goods, energy requirements, environmental impacts) and targets middle school students. The intent is to modify the presentation as necessary to accommodate older or younger students. Further, depending on the size of the class and the desires of the K-12 teacher, the planned activities can be conducted individually, in small groups, or as a class.

A secondary presentation has been developed for K-12 students to impress upon them the vast array of goods that are transported by rail. The presentation is based upon a modern freight train, and includes an activity that reinforces the goods carried by the train to the type of train car. The activity can be done before and/or after the presentation, depending on the goals of the presenter or K-12 teacher.

Three Ph.D. students of CAMMSE (Miao Yu, Zhen Chen and Zijing Lin) worked as a volunteer at different days during this 2018 ITS Carolinas Annual Meeting held at the Charlotte Convention Center from February 12-13, 2018 and helped with the conference registration and logistics. Students also conducted outreach activities for CAMMSE.

Five Ph.D. students of CAMMSE (Miao Yu, Zhen Chen, Pengfei Liu, Zijing Lin and Yang Li) served as a volunteer and helped organize the first annual Mini Civil Conference (MC²) organized by the Department of Civil and Environmental Engineering at UNC Charlotte on Friday March 2, 2018. Students also conducted outreach activities for CAMMSE.

CAMMSE Staff Dr. Martin Kane attended the Annual Professional Engineers of North Carolina (PENC) meeting and gave a presentation entitled "Innovations in Transportation for the Future" on June 16, 2017. The 10 CAMMSE Year 1 research projects underway by the CAMMSE consortium member institutions were highlighted. The 2017 PENC Summer Conference was attended by approximately 100 engineers, representing many disciplines of engineering from private sector, governmental, and academic organizations across North Carolina. Approximately 50 people attended the session, 'Innovations in Transportation for the Future.'

A student sponsored by CAMMSE at UNCC has graduated with a Ph.D. degree in Infrastructure and Environmental Systems (INES). Dr. Linfeng Gong was selected to receive the Roy D. Williams Memorial Scholarship in the amount of \$3,000 on November 16, 2017 during this NCSITE 2017 Annual Meeting. He was also selected to receive the Outstanding Graduate Student of Civil and Environmental Engineering Department award in EPIC G287 at UNC Charlotte on Friday, December 15, 2018.

CAMMSE also worked with the Women in Transportation Seminar (WTS), Institute of Transportation Engineers (ITE), and Intelligent Transportation Systems (ITS) Student Chapters at UT in supporting two educational and outreach events:

- The first event was “Introduce A Girl to Engineering Day”, which is a Science Technology Engineering and Math (STEM) festival that attracts 8,000 elementary and middle school students every year and provides activities and demonstrations to get the community excited about engineering. CAMMSE students along with WTS/ITE/ITS led activities with overarching concepts related to some of the active CAMMSE projects (i.e. Adaptive Signal Control & Rail Transit). CAMMSE along with ITE/ITS and WTS also spoke with adults about current research topics and the CAMMSE program.
- The second event supported by CAMMSE and ITE/ITS/WTS was “Explore UT”, which is UT-Austin’s annual “open-house” that attracts students, parents, teachers, and community members for all over the State of Texas. The purpose of Explore UT is to invite people of all ages to come learn about research experiences and participate in hands-on activities. During Explore UT, CAMMSE and ITE/ITS/WTS students led a hands-on activity and follow-up discussion with children and parents of all ages. The activity involved required participants to travel on a “one-lane road” with a specific set of rules about passing one another. The goal of the activity was to have all the players travel from one “side of town” to the other on this one-lane road very near to “full capacity” while following all the special rules. The purpose of the activity was to get both children and adults to understand concepts about capacity on a roadway and how allocating the available space requires consideration of the impacts to all the users and cooperation.

In particular, each year at the annual winter meeting of the Transportation Research Board, during the Council of University Transportation Centers Banquet, the U.S. Department of Transportation recognizes outstanding students from the University Transportation Centers (UTC) for their achievements and accomplishments in the transportation field during the year. This year’s banquet was held at the Marriott Marquis in Washington, D.C. on January 6, 2018, at 6:30pm. Mr. Scott Kilgore from UT Austin, was recognized and selected as the 2017 Outstanding Student of the Year for the CAMMSE.

At WSU, Michelle Akin has been hired to conduct future educational and outreach activities (<https://sites.google.com/site/greensmartinfrastructure/TeamMembers>). In addition, a list of students that were supported by CAMMSE were selected for many awards:

- Linh Duong, Suksdorf Fellowship, 2017.
- Linh Duong, Graduate School Recruitment Scholarship for STEM Disciplines, 2017.
- Jialuo He, Perteet Graduate Fellowship in Civil Engineering, 2017.
- Yan Zhang, Smart & Green Infrastructure Research Scholarship, 2017.
- Mehdi Honarvar Nazari, Perteet Graduate Fellowship in Civil Engineering, 2017.

Materials from the CAMMSE projects have been used in teaching two transportation related courses: Econometrics (Ph.D. level, 20 students) and Topics in Applied Microeconomics (Ph.D. level, 8 students).

At TSU, several education and outreach activities were carried out:

- 1) Summer Maritime Academy: TSU hosted a Summer Maritime Academy (SMA) during June 20-June 23, a four-day non-residential program designed to introduce high school students about the maritime transportation management and the multimodal connections at US ports. Twenty area high school students attended this summery program.
- 2) Summer Internship Program with Elkin High School Engineering Academy: In summer 2017, four students from Elkin High School were selected for working as interns in our research lab. They worked on research projects related to improving transportation mobility and safety. This two-week internship program offers high school students the opportunity to work with professors and graduate students in our research labs, enabling them to participate in various research projects and learn about many of the tools and software programs that were used for transportation research purpose.
- 3) Student Seminars: TSU has hosted a seminar on the topic of ““Border Security - Past, Present and Future” on February 21, 2018. DHS Retired Senior Executive of Field Operations Mr. Jeffrey O. Baldwin, Sr. introduced important issues related to border security.

Technology Transfer

A draft Technology Transfer and Research Implementation (TT&RI) Plan was completed in early August of 2017 for review and comment by CAMMSE Staff at UNC Charlotte. In the spirit of USDOT’s desire to enhance technology transfer of its centers, this formal Plan is a progressive effort to maximize the impact of CAMMSE activities. An associated TT&RI Questionnaire outlines and encourages TT&RI activities and has the potential to assist with tracking TT&RI progress. Initial internal review suggests that the Plan is thorough, but some feel that its execution might place undue burden on CAMMSE PIs. The Plan will be presented to all CAMMSE PIs (e.g. UNC Charlotte and all consortium university PIs) for their review and comment during the CAMMSE Symposium in August of 2018.

CAMMSE faculty, staff, researchers and students have been making presentations at different meetings including the Transportation Research Board 97th Annual Meeting, 2017 Southern District ITE Annual Meeting, UNC Charlotte Research Institute Spring Reception, and Professional Engineers of North Carolina Annual Meeting in June 2017. In addition, several other technology transfer activities are also being actively carried out. For example, the survey data was collected from Austin’s Capital Metro Red Line riders to create an access mode model.

Collaboration

CAMMSE created a diverse collaboration network with different state and local government agencies, and educational and professional organizations, as well as community practitioners. CAMMSE also worked to build collaborative relations with international transportation centers and universities.

CAMMSE Center Staff Meeting has officially started in the spring semester of 2018. The first meeting was held on Tuesday January 23, 2018. CAMMSE Center Staff (Drs. Wei Fan, Miguel Pando, David Weggel, Martin Kane, and Yu Wang) has been meeting on a bi-weekly basis. Topics discussed among these important regular meetings will include, but are not limited to, the annual research symposium in the summer, annual summer camp at UNC Charlotte, research, education and outreach as well as technology transfer activities.

CAMMSE Director Dr. Wei Fan participated in the Center for Advanced Transportation Mobility (CATM) Annual Symposium at North Carolina Agricultural and Technical State University (NCAT) on Tuesday (October 17, 2017) at Greensboro, NC. Dr. Fan also participated in the UTC roundtable meeting with NCDOT senior management and technical experts on Monday (October 23, 2017) at Raleigh, NC. Dr. Fan gave a brief summary of the theme of CAMMSE led by UNC Charlotte, the current (both years 1 and 2) and anticipated research projects, as well as a brief look at how NCDOT can be engaged.

Mr. David Howard, the Chief Deputy Secretary of NCDOT, visited UNC Charlotte on Friday, November 10, 2017. CAMMSE Director Dr. Wei Fan gave a brief presentation about the theme of CAMMSE led by UNC Charlotte, as well as ongoing research projects that CAMMSE researchers are conducting in both years 1 and 2.

Dr. Fan attended the North Carolina Turnpike Authority (NCTA) Automated Vehicle Proving Ground (AVPG) partnership meeting and also gave a presentation during the meeting at Raleigh, February 27, 2018. Dr. Fan has been serving as a proposal reviewer for the USDOT Region 10 - The Pacific Northwest Transportation Consortium (PacTrans), University of Washington, March 2018, and the USDOT Tier-I Connected Cities for Smart Mobility toward Accessible and Resilient Transportation (C²SMART), New York University, January 2018.

Diversity

Several Ph.D. students from underrepresented groups have been hired to conduct CAMMSE's research during this reporting period. For example, at UNCC, three new students (Mr. Yang Li, Ms. Zijing Lin and Mr. Pengfei Liu) from China joined the INES Ph.D. program in August 2017 and since then, they have been working as CAMMSE research assistants. Ms. Abigail Preston, though not financially supported by CAMMSE, has also been an advisee of Dr. Fan. Two graduate students have also graduated who are affiliated with CAMMSE (Dr. Linfeng Gong with an INES Ph.D. under the supervision of Dr. Wei Fan and Ms. Ashley Hemming Graduated with a M.S. under

supervision of Dr. Martin Kane). Dr. Yongli Xu, a visiting female associate professor from Northeast Forestry University, China, has built a strong working relationship with Dr. Wei Fan at CAMMSE.

1.3. What opportunities for training and professional development has the program provided?

The bi-weekly seminars are open to the general public, particularly to the local and state transportation agencies, as well as the industry practitioners.

1.4. How have the results been disseminated?

CAMMSE has distributed its first quarterly electronic newsletter in October 2017. In addition to the newsletter, news items have been regularly posted on the website at <https://cammse.uncc.edu/news>.

1.5. What do you plan to do during the next reporting period to accomplish the goals and objectives?

The following tasks are planned in order to accomplish the goals and objectives of CAMMSE.

- (1) Issue the RFPs for the year of 2018-2019.
- (2) Conduct rigorous peer-reviews, select funded projects and issue contracts.
- (3) Project summaries will be posted and updated on the CAMMSE website as well as on RiP once all projects have been selected.
- (4) Attend NC Section Institute of Transportation Engineers (NCSITE) and Southern District ITE (SDITE) Annual Meetings, as well as the 2019 TRB 98th Annual Meeting to present papers based on research.
- (5) CAMMSE plans to be featured in the spotlight newsletter for USDOT UTC programs in March 2019.
- (6) CAMMSE plans to attend the First Annual National Mobility Summit of US DOT University Transportation Centers, April 12, 2018, Washington, D.C.
- (7) Explore UNC Charlotte (planned for April 21, 2018).
- (8) NC Science Festival (planned for April 29, 2018).
- (9) Planning and revising Summer Camp program to include 1 day of field trip (Traffic control center, transportation museum, and Light Rail UNCC station). 2nd CAMMSE Transportation Engineering Camp planned for the week of June 11-15, 2018. 2nd edition will build on the success of the first edition but will include more transportation activities and revise program based on feedback from participants.

2. PRODUCTS

2.1. Publications, conference papers, and presentations

Publications

- [1] Chang, L., Chen, X., Wang, Y., Fang, D., Wang, J., Xing, T. and Tang, Z., FitLoc: Fine-grained and Low-cost Device-free Localization for Multiple Targets over Various Areas, *IEEE/ACM Transactions on Networking*, Volume 25 Issue 4, pp. 1994-2007, August 2017.
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- [9] Guo, B., Chen, H., Han, Q., Yu, Z., Zhang, D. and Wang, Y., Worker-Contributed Data Utility Measurement for Visual Crowdsensing Systems, *IEEE Transactions on Mobile Computing*, Volume 16, Issue 8, pp. 2379-2391, August 2017.

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- [11] Hou, J., Li, X. Y., Jung, T., Wang, Y., and Zheng, D, CASTLE: Enhancing the Utility of Inequality Query Auditing without Denial Threats, *IEEE Transactions on Information Forensics and Security*, Volume 13, Issue 7, pp. 1656-1669, 2018.
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Conference papers

- [1] Chen, J., Yu, L., Song, G., Zhang, J. and Guo, J., Development of a Comprehensive Speed Correction Factor for Estimating Fuel Consumptions of Road Traffic Incorporating Vehicle Unit Weight, The 97th Annual Meeting of the *Transportation Research Board*, January 7-11, 2018, Washington, DC.
- [2] Enam, A., and Konduri, K.C., A Continuous Time and Temporally Constrained Tour Pattern Generation System for Jointly Modeling Daily Tours and Stops: Application of a Bi-level Multiple Discrete Continuous Probit (MDCP) Model, The 96th Annual Meeting of the *Transportation Research Board*, January 8-12, Washington, DC.
- [3] Liu, F.B., Xu, R.H., Fan, W., Jiang, Z.B. and Zhao, Z., Train Timetable Performance Measures Using Automatic Train Supervision Data: Data Analytics

Approach and A Case Study of Shanghai Metro, The 97th Annual Meeting of the *Transportation Research Board*, January 7-11, 2018, Washington, DC.

- [4] Liu, F.B., Xu, R.H., Jiang, Z.B. and Fan, W., Demand-Driven Coordinated Train Rescheduling for Delay Management of Urban Rail Transit Line, The 97th Annual Meeting of the *Transportation Research Board*, January 7-11, 2018, Washington, DC.
- [5] Zhao, Q., Goodman, T. and Qi, Y., Roadway Related Truck Crash Risk Analysis: Case Studies in Texas, Proceedings of the 97th Annual Meeting of *Transportation Research Board*, Jan 7-11, 2018, Washington, DC.
- [6] Zhang, J., Konduri, K.C., and Enam, A., Daily Activity-Travel Patterns of Different American Generations: An Exploratory Analysis Utilizing Multiple Waves of American Heritage Time Use Survey and National Household Travel Survey Datasets, Accepted for presentation at the 15th International Conference on *Travel Behaviour Research*, July 15-20, 2018, Santa Barbara, CA.

Presentations

- [1] Chen, Z. and Fan, W., Extracting Bus Transit OD Information Using Smart Card Transaction Data, NCSITE Annual Meeting, November 16, 2017.
- [2] Fan, W. Connected and Automated Vehicles: Research Projects at UNC Charlotte, University Research Panel, NCTA AVPG Partnership Meeting, Institute for Transportation Research and Education, NC State University, February 27, 2018.
- [3] Fan, W. Connected and Automated Vehicles: Research Projects at UNC Charlotte and Beyond, University Research Panel, 2018 ITS Carolinas Annual Meeting, Charlotte Convention Center, February 12, 2018.
- [4] Fan, W., Center for Advanced Multimodal Mobility Solutions and Education University Transportation Center, Presented during the UTC roundtable meeting with NCDOT senior management and technical experts, Raleigh, NC, October 23, 2017.
- [5] Fan, W., Data Analytics Approach to Identifying and Ranking Freeway Bottlenecks: A Case Study in Charlotte, North Carolina, The Chinese Overseas Transportation Association (COTA) 21st Annual Winter Symposium, Chinatown (M3), Marriott Marquis, Washington DC, Sunday, January 7, 2018.
- [6] Fan, W., Transportation Research Projects at UNC Charlotte and Center for Advanced Multimodal Mobility Solutions and Education (CMMSE) University Transportation Center, Presented during Mr. David Howard's Visit to UNC Charlotte, November 10, 2017.
- [7] Gong, L. and Fan, W., Modeling Single-Vehicle Run-Off-Road Crash Severity in Rural Areas: Accounting for Unobserved Heterogeneity and Age Difference, NCSITE Annual Meeting, November 16, 2017.
- [8] Kane, M, Innovations in Transportation for the Future, Presented at the Summer Conference of Professional Engineers of North Carolina (PENC), Wilmington, NC, June 15-17, 2017.
- [9] Li, T., Jung, T., Li, H., Cao, L., Wang, W., Li, X.Y. and Wang, Y., Scalable Privacy-Preserving Participant Selection in Mobile Crowd Sensing at the Edge,

Invited Keynote, 13th International Conference on Mobile Ad-hoc Sensor Networks (MSN), Beijing, China, December 18, 2017.

- [10] Li, T., Jung, T., Li, H., Cao, L., Wang, W., Li, X.Y. and Wang, Y., Scalable Privacy-Preserving Participant Selection in Mobile Crowd Sensing, School of Electronic Information and Communications, Huazhong University of Science and Technology, July 24, 2017.
- [11] Liu, F.B., Xu, R.H., Fan, W., Jiang Z.B. and Zhao Z., Train Timetable Performance Measures Using Automatic Train Supervision Data: Data Analytics Approach and A Case Study of Shanghai Metro, The 97th Annual Meeting of the Transportation Research Board, January 7-11, 2018, Washington, DC.
- [12] Liu, F.B., Xu, R.H., Jiang Z.B. and Fan, W., Demand-Driven Coordinated Train Rescheduling for Delay Management of Urban Rail Transit Line, The 97th Annual Meeting of the Transportation Research Board, January 7-11, 2018, Washington, DC.
- [13] Shi, X. and Nazari, M.H., Best Practices in Preventing & Mitigating the Corrosion Risk of Roadway Deicers to Winter Maintenance Equipment., Invited Presentation for the Corrosion Protection Technology (CPT) for Winter Maintenance: A Peer Exchange Workshop, by the University of California, Davis, and California Department of Transportation, Davis, CA, April 5, 2018.
- [14] Shi, X., Multiple Dimensions in Sustainable Winter Road Operations, Invited Presentation by the ASCE Construction Institute, for the ASCE Congress on Technical Advancement, Duluth, MN, September 11, 2017.
- [15] Shi, X., Six Key Elements of High-Quality Technical Writing, Webinar for the International Association of Chinese Infrastructure Professionals (IACIP), January 14, 2018.
- [16] Shi, X., Sustainable Transportation Infrastructure Enabled by Innovative Materials, Invited Presentation by the School of Engineering and Applied Sciences, Washington State University, Tri-Cities, WA, November 3, 2017.
- [17] Shi, X., Sustainable Transportation Infrastructure: Innovative Materials and Practices, School of Transportation Engineering, Southeast University, Nanjing, China, July 4, 2017.
- [18] Yu, M. and Fan, W., Calibration of Microscopic Traffic Simulation Models: An Optimization Based Approach, NCSITE Annual Meeting, November 16, 2017.
- [19] Zhang, J. and Konduri, K.C., Daily Activity-Travel Trends: An Exploratory Approach Utilizing Multiyear NHTS/NPTS Data and Sequence Alignment Technique, Poster Presented at the Summer Program on Transportation Statistics, Durham, NC, August 14-18, 2017.
- [20] Zhang, J. and Konduri, K.C., Daily Activity-Travel Trends: An Exploratory Approach Utilizing Multiyear NHTS/NPTS Data and Sequence Alignment Technique, Presented at the 2017 ITE New England Section Annual Meeting, Warwick, RI, December 4, 2017
- [21] Zhang, J. and Konduri, K.C., Daily Activity-Travel Trends: An Exploratory Approach Utilizing Multiyear NHTS/NPTS Data and Sequence Alignment

Technique, Poster Presented at the 4th Annual Engineering Graduate Poster Competition & Presentation, Storrs, CT, March 9, 2018.

2.2. Website(s) or other internet site(s)

The CAMMSE website is located at <http://cammse.uncc.edu/>. This website has been used to disseminate any information related to the program.

In March 2018, news was released in which CAMMSE Associate Director Dr. Xianming Shi made comments. The news is entitled “Idaho Mountain Express: Road deicing increases safety - at a cost to car owners” and a full story can be obtained via this link [“Get the Full Story”](#).

In January 2018, news was released in which CAMMSE Associate Director Dr. Xianming Shi made comments. The news is entitled “Boston Globe: It turns out vodka and icy roads can be a good mix” and a full story can be obtained via this link [“Get the Full Story”](#).

A journal paper, entitled “Developing a Systematic Method for Identifying and Ranking Freeway Bottlenecks Using Vehicle Probe Data” by Linfeng Gong and CAMMSE Director Dr. Wei (David) Fan, was published in the Journal of Transportation Engineering, Part A: Systems Volume 144 Issue 3. The paper was specifically selected by ASCE and featured in the ASCE SmartBrief today on March 15, 2018 (in the Section “Ease highway congestion with strategies in free ASCE Journal paper”) and was in the ASCE eNews message to members on March 16, 2018.

2.3. Technologies or techniques

Nothing to report.

2.4. Inventions, patent applications, and/or licenses

Nothing to report.

2.5. Other products

CAMMSE Graduate Seminar Series @ UNCC, Sponsored by CAMMSE

- [1] “Calibration of Microscopic Traffic Simulation Models Using Metaheuristic Algorithms”, Presented by Mr. Miao Yu (CAMMSE INES Ph.D. research assistant), 10-11am, August 31, 2017, EPIC CEE Conference Room 3344.

- [2] “Developing a Systematic Approach to Improving Bottleneck Analysis in North Carolina”, Presented by Mr. Linfeng Gong (CAMMSE INES Ph.D. research assistant), 10-11am, September 14, 2017, EPIC CEE Conference Room 3344.
- [3] “Extracting Bus Transit OD Information Using Smart Card Transaction Data”, Presented by Mr. Zhen Chen (CAMMSE INES Ph.D. research assistant), 10-11am, September 21, 2017, EPIC CEE Conference Room 3344.
- [4] “Major Steps of Large Truck Crash Analysis”, Presented by Pengfei liu (CAMMSE INES Ph.D. research assistant), 10-11am, September 28, 2017, EPIC CEE Conference Room 3344.
- [5] “Impact of Newly Built Metro Lines on Public Transport Mode Choice Behavior: A Case Study of Dalian”, Presented by Ms. Zijing Lin (CAMMSE INES Ph.D. research assistant), 10-11am, October 05, 2017, EPIC CEE Conference Room 3344.
- [6] “Evaluating and Improving Public Transit Equity Using GTFS Data”, Presented by Mr. Yang Li (CAMMSE INES Ph.D. research assistant), 10-11am, October 12, 2017, EPIC CEE Conference Room 3336.
- [7] “Tabu Search Strategies for Variable Speed Limit Control at A Lane Drop Bottleneck”, Presented by Mr. Miao Yu (CAMMSE INES Ph.D. research assistant), 10-11am, October 19, 2017, EPIC CEE Conference Room 3344.
- [8] “Modeling single-vehicle run-off-road crash severity in rural areas: Accounting for unobserved heterogeneity and age difference”, Presented by Mr. Linfeng Gong (CAMMSE INES Ph.D. research assistant), 10-11am, October 26, 2017, EPIC CEE Conference Room 3344.
- [9] “Developing a systematic approach to modeling travel time reliability at the arterial level”, Presented by Mr. Zhen Chen (CAMMSE INES Ph.D. research assistant), 10-11am, November 09, 2017, EPIC Building CEE Conference Room 3344.
- [10] “Connected and autonomous vehicle”, Presented by Pengfei liu (CAMMSE INES Ph.D. research assistant), 10-11am, November 30, 2017, EPIC CEE Conference Room 3344.
- [11] “Evaluating the Potential Use of Crowdsourced Bicycle Data in North Carolina”, Presented by Ms. Zijing Lin (CAMMSE INES Ph.D. research assistant), 10-11am, December 07, 2017, EPIC CEE Conference Room 3344.
- [12] “Assessing Public Transit Equity — some literature findings”, Presented by Mr. Yang Li (CAMMSE INES Ph.D. research assistant), 10-11am, January 11, 2018, EPIC CEE Conference Room 3344.
- [13] “Accessibility impact of future high speed rail corridor on the Atlanta piedmont megaregion”, Presented by Mr. Miao Yu (CAMMSE INES Ph.D. research assistant), 10-11am, January 25, 2018, EPIC CEE Conference Room 3344.
- [14] “Extracting bus transit destination information using smart card transaction data”, Presented by Mr. Zhen Chen (CAMMSE INES Ph.D. research assistant), 10-11am, February 01, 2018, EPIC CEE Conference Room 3344.
- [15] “Impact of connected and automated vehicles on freeway capacity - literature review”, Presented by Pengfei liu (CAMMSE INES Ph.D. research assistant), 10-11am, February 08, 2018, EPIC CEE Conference Room 3344.

- [16] “USDOT Research Project: Evaluating the Potential Use of Crowdsourced Bicycle Data in North Carolina - Task 1 Literature Review”, Presented by Ms. Zijing Lin (CAMMSE INES Ph.D. research assistant), 10-11am, February 15, 2018, EPIC CEE Conference Room 3344.
- [17] “Household Activity Based Model — A brief introduction and HAPP model”, Presented by Mr. Yang Li (CAMMSE INES Ph.D. research assistant), 10-11am, February 22, 2018, EPIC CEE Conference Room 3344.
- [18] “VISSIM & Connected and Autonomous Vehicles”, Presented by Mr. Miao Yu (CAMMSE INES Ph.D. research assistant), 10-11am, March 01, 2018 EPIC CEE Conference Room 3344.
- [19] “Weather data in travel time reliability analysis”, Presented by Mr. Zhen Chen (CAMMSE INES Ph.D. research assistant), 10-11am, March 15, 2018, EPIC CEE Conference Room 3344.
- [20] “Impact of Connected and Automated Vehicles on Freeway Capacity — Identify Potential Freeway Segments”, Presented by Pengfei liu (CAMMSE INES Ph.D. research assistant), 10-11am, March 21, 2018, EPIC CEE Conference Room 3344.
- [21] “Crowdsourced Bicycle Data Collected from Strava”, Presented by Ms. Zijing Lin (CAMMSE INES Ph.D. research assistant), 10-11am, March 29, 2018 EPIC CEE Conference Room 3344.
- [22] “USING GTFS to assess transit equity - Collecting Data and Brief Introduction to Methodology”, Presented by Mr. Yang Li (CAMMSE INES Ph.D. research assistant), 10-11am, April 05, 2018, EPIC CEE Conference Room 3344.
- [23] “VISSIM COM Programming in MATLAB”, Presented by Mr. Miao Yu (CAMMSE INES Ph.D. research assistant), 10-11am, April 11, 2018 EPIC CEE Conference Room 3344.
- [24] “Modeling Travel Time Reliability (step 1)”, Presented by Mr. Zhen Chen (CAMMSE INES Ph.D. research assistant), 10-11am, April 18, 2018, EPIC CEE Conference Room 3344.

ITE Seminar Series @ UNCC, Co-organized and sponsored by UNCC ITE Student Chapter and CAMMSE

- [1] “Resume Building (with ASCE)” by Ms. Becky Stevens from UNCC Career Center. Location: EPIC G256, September 14, 2017.
- [2] “Engineering.... Opportunities are Endless” by Ms. Walta Brumskine, PE from the City of Charlotte. Location: EPIC 3336, September 26, 2017.
- [3] “Introduction of STV Projects” by Mr. Alex Wiseman & Justin Carroll from STV Inc. Location: EPIC 3336, October 12, 2017.
- [4] “Introduction of NCSITE Young Member Committee” by Mr. Cliff Lawson from NCSITE Young Member Committee. Location: EPIC 3336, October 17, 2017.
- [5] “How to adult: What Happens after College (with ASCE)” by Ms. Allison Drake, PE & Mr. Brian McGill, PE from RS&H. Location: EPIC G256, January 30, 2018.

Other Seminars

In conjunction with the CCI Distinguished Lecture Series, CAMMSE jointly host Professor Wenjing Lou Friday (1/26/2018) 11:30-12:30 in Woodward Hall 106. Title: Internet of Things and its Security Challenges.

Technical Reports

- [1] Fan, W. and Gong, L. *Developing a Systematic Approach to Improving Bottleneck Analysis in North Carolina*, Technical Report for Research Project 2016-10, North Carolina Department of Transportation (NCDOT), FHWA/NC/2016-10, September 2017. (<https://connect.ncdot.gov/projects/research/RNAProjDocs/2016-10%20Final%20Report.pdf>)
- [2] Gong, Linfeng, *Applying Travel Time Reliability Measures in Identifying and Ranking Freeway Bottlenecks at the Network Level*. Ph.D. Dissertation. The University of North Carolina at Charlotte, ProQuest Dissertations Publishing, 2017. 10690796. (<https://search.proquest.com/docview/1969448735?pq-origsite=gscholar>)
- [3] Kilgore, Scott. *Modeling Commuter Rail Riders' Access Mode Decision-Making Using Revealed Preference Data from Austin, Texas*. MS Thesis. The University of Texas at Austin, 2017. (<https://repositories.lib.utexas.edu/handle/2152/63559>)
- [4] Xu, G., Shi, X., Sturges, L., Chapman, M., Albrecht, C., Bergner, D. *Snow Removal Performance Metrics*. Final report for the Clear Roads Pooled Fund and Minnesota Department of Transportation, May 2017. (http://clearroads.org/wp-content/uploads/dlm_uploads/FR_CR.14-05_Final.pdf)

Software Products

CAMMSE research will result in enhancements to existing open-source software projects including:

- [1] PopGen: see <https://github.com/foss-transportationmodeling/popgen/releases>, and
- [2] DaySim: see <https://github.com/RSGInc/DaySim/releases>.

Since research is still in progress, nothing has been pushed to these products yet.

3. PARTICIPANTS AND OTHER COLLABORATING ORGANIZATIONS

3.1. Who has worked on the program?

The members of CAMMSE UTC include the University of North Carolina at Charlotte (UNCC); the University of Texas at Austin (UT Austin); the University of Connecticut (UConn); Washington State University – Pullman (WSU); and Texas Southern University (TSU). Table 1 lists the leadership team members who have worked on the program during this reporting period.

Table 1. CAMMSE Staff Working on the Program

Name	Wei Fan	Randy Machemehl	Nicholas Lownes	Xianming Shi	Yi Qi
Program/Project Role	Center Director	Associate Director at UT Austin	Associate Director at UConn	Associate Director at WSU	Associate Director at TSU
Contribution to Program/Project	Oversees overall operations of the program. Responsible for coordinating with stakeholders and developing and implementing the CAMMSE strategic plan	Serves as liaison between CAMMSE and UT Austin	Serves as liaison between CAMMSE and UConn	Serves as liaison between CAMMSE and WSU	Serves as liaison between CAMMSE and TSU
Funding Support	UNCC	UT Austin	UConn	WSU	TSU
Collaborated with Individual(s) in Foreign Country(ies)	Yes	No	Yes	Yes	Yes
Country(ies) of Foreign Collaborator(s)	P.R.China	No	Australia	P.R.China	P.R.China
Traveled to Foreign Country(ies)	N/A	N/A	N/A	N/A	N/A
If traveled to foreign country(ies), duration of stay	N/A	N/A	N/A	N/A	N/A

3.2. What organizations have been involved as partners?

Table 2 provides a list of the organizations that have partnerships with CAMMSE.

Table 2. A List of Organizations Creating Partnerships with CAMMSE

Organization Name	Type / Location	Partners Contribution to Project				
		Financial Support	In-kind Support	Facilities	Collaborative Research	Personal Exchanges
Capital Metro – Austin Public Transit	Government /TX		X	X		
Centralina Council of Governments	MPO/NC		X			
Charlotte Area Transit System	Government /NC		X			
City of Austin	Government /TX		X	X		
City of Charlotte	Government /NC		X			
Connecticut Department of Transportation	Government /CT				X	
CTTransit	Transit Operator				X	X
Houston Bike Share	Non-profit/ TX				X	
North Carolina Department of Transportation	Government /NC		X			
North Carolina Turnpike Authority Automated Vehicle Proving Ground (NCTA-AVPG)	Government /NC				X	
Northeast Forestry University	University /China				X	
Texas Department of Transportation	Government /TX		X	X		
Texas Southern University	University /TX	X	X	X		
Tongji University	University /China				X	
University of Arizona	University /AZ				X	
University of Houston	University /TX				X	
University of Connecticut	University /CT	X	X	X		
University of North Carolina at Charlotte	University /NC	X	X	X		
University of Texas at Austin	University /TX	X	X	X		
Washington Department of Transportation	Government /WA				X	
Washington State University	University /WA	X	X	X		

Our CAMMSE UTC has successfully established an external advisory board which will contain members from a variety of universities and government agencies. The detailed information about all five advisory board members is provided below:

- Dr. Michael Accorsi, Professor and Senior Associate Dean, School of Engineering, University of Connecticut.
Email: michael.accorsi@uconn.edu
- Dr. Amit Bhasin, Director, Center for Transportation Research, Associate Professor, Transportation Engineering, The University of Texas at Austin.
Email: a-bhasin@mail.utexas.edu
- Elizabeth Robbins, Planning Policy & Partnerships Manager, Multimodal Planning Division, Washington State Department of Transportation.
Email: robbins@wsdot.wa.gov
- Neil Mastin, Research and Development Manager, North Carolina Department of Transportation.
Email: jmastin@ncdot.gov
- Wade Odell, Research Engineer, Texas Department of Transportation.
Email: Wade.Odell@txdot

3.3. Have other collaborators or contacts been involved?

Dr. Wei Fan, CAMMSE Director, has been working, co-writing and publishing papers with faculty and researchers from the Key Laboratory of Road and Traffic Engineering, Ministry of Education and College of Transportation Engineering at Tongji University in Shanghai, P.R.China. A collaborative relationship has been successfully developed between two universities.

Dr. Yi Qi developed two new NSF proposals, one with professors from University of Houston and another with professors from University of Arizona. Dr. Yi Qi also collaborated with University of Houston to submit a new TxDOT project.

TSU established a collaboration with Houston Bike Share, a 501(c)(3) non-profit organization the bike share program (Houston BCycle) in Houston. Dr. Mehdi Azimi talked to a member of the board of directors and also the Executive Director. Houston Bike Share will share the ridership data including trip start time and date, trip end time and date, trip duration, start station, end station, number of docks per station, bicycle id, etc. to be used in CAMMSE's research project.

4. IMPACT

The CAMMSE is currently conducting a variety of research, education and outreach, technology transfer, and diversity activities and as such, the impact of this program cannot be measured during this reporting period.

4.1. What is the impact on the development of the principal discipline(s) of the program?

Nothing to report.

4.2. What is the impact on other disciplines?

Nothing to report.

4.3. What is the impact on the development of transportation workforce development?

Nothing to report.

4.4. What is the impact on physical, institutional, and information resources at the university or other partner institutions?

Nothing to report.

4.5. What is the impact on technology transfer?

Nothing to report.

4.6. What is the impact on society beyond science and technology?

Through events like “Introduce a Girl to Engineering Day”, “Explore UT” and “Explore UNCC”, CAMMSE has provided a medium for sponsored students to develop important soft skills. All these events required that students interact with the local community and think of creative ways to portray complicated concepts in a simple and easy to understand way. Students also had to use creativity to think of an interesting way to capture young children’s attention and keep them engaged. The CAMMSE has had

impacted both the local community and the sponsored students by encouraging creativity and fostering human-to-human connections.

5. CHANGES/PROBLEMS

5.1. Changes in approach and reasons for change

Nothing to report.

5.2. Actual or anticipated problems or delays and actions or plans to resolve them

Due to different reasons, a few CAMMSE Year 2 research projects have been experiencing some delays. For example, due to the award timing and the contracting issues and primarily due to the lack of time to recruit students for the projects, the three Year 2 research projects at the University of Connecticut (UCONN) were not able to get off the ground. As such, a no-cost extension for these projects will be needed through September 30, 2019, which will give researchers at UCONN more time to complete all research projects and submit final reports and participate in the Annual CAMMSE Summer Meeting in Summer 2019. To resolve them, Dr. Nicholas Lownes, the Associate Director of CAMMSE at UCONN will work with his grant management staff so that when Year 3 funds come in, if 75% of their total grant has not be expended, the new projects can get off the ground right away.

The Texas Southern University campus was affected by the catastrophic flooding caused by Hurricane Harvey at the end of August 2017. The floods inundated hundreds of thousands of homes, displaced more than 30,000 people, including TSU's faculty members and students. One major investigator's home is totally flooded and has not been fully repaired yet. This disaster caused school to be closed for several weeks and affected the research progresses. While at Washington State University, there are a number of issues that made a project extension necessary. First, the PI at WSU run into difficulty recruiting a qualified PhD student for a CAMMSE research project titled "Modeling the Macroscopic Effects of Winter Maintenance Operations on Traffic Mobility on Washington Highways". The student whom WSU planned to bring on board is in the process of retaking the English test and will not join their program until this September 2018. Second, there are significant delays in Task 1 (Data collection from WSDOT practitioners). Currently, the research team at WSU has been working closely with various WSDOT stakeholders to address this issue.

5.3. Changes that have a significant impact on expenditures

Nothing to report.

5.4. Significant change in use or care of animals, human subjects, and/or biohazards

Nothing to report.

5.5. Changes of primary performance site location from that originally proposed

Nothing to report.

5.6. Additional information regarding products and impacts

Nothing to report.

6. SPECIAL REPORTING REQUIREMENTS

- (1) **External Advisory Board:** Available on the program website:
<https://cammse.uncc.edu/directory/external-advisory-board>
- (2) **Financial and Annual Recipient Share Reports:** The SF 425 requirements will be met by separate reports.

APPENDIX

CAMMSE @ UNC Charlotte Funded Projects, 2016-2018 (Year 1)

University	Principle Investigator	Category	Title of the Funded Project
University of North Carolina at Charlotte	Wei Fan	Advanced Research	Estimation of Origin-Destination Matrix and Identification of User Activities Using Public Transit Smart Card Data
	Wei Fan	Applied Research	Improving the Movements of People and Freight: A Case Study of the Piedmont Atlantic Megaregion
University of Texas at Austin	Randy Machemehl	Applied Research	Forecasting Ridership for Commuter Rail in Austin
	Randy Machemehl	Advanced Research	Corridor Level Adaptive Signal Control
University of Connecticut	Nicholas Lownes	Basic Research	Stochastic Multimodal Network Modeling
	Nicholas Lownes	Basic Research	Robust Routing, Assignment, and Simulation of Transit Systems
Washington State University	Xianming Shi	Applied Research	The Use of Connected Vehicle Technology to Facilitate Multimodal Winter Travel
	Jia Yan	Applied Research	The Effect of Competition of Transport Modes on Mobility
Texas Southern University	Mehdi Azimi Yi Qi	Applied Research	Use of Vessel Automatic Information System Data to Improve Multi-modal Transportation in and around the Ports
	Yi Qi	Applied Research	Use of Innovative Intersection Designs for Improving Mobility and Reducing Roadway Traffic Congestion

CAMMSE @ UNC Charlotte Funded Projects, 2017-2018 (Year 2)

University	Principle Investigator(s)	Category	Title of the Funded Project
University of North Carolina at Charlotte	Wei Fan	Advanced Research	Use of Multisensor Data in Modeling Freeway Travel Time Reliability
	Wei Fan Martin Kane	Applied Research	Using General Transit Feed Specification (GTFS) Data as a Basis for Evaluating and Improving Public Transit Equity
	Wei Fan Yu Wang	Applied Research	Evaluating the Potential Use of Crowdsourced Bicycle Data in North Carolina
	Wei Fan	Advanced Research	Impact of Connected and Automated Vehicles (CAVs) on Freeway Capacity
	Wei Fan	Advanced Research	Optimal Variable Speed Limit Control for the Mixed Traffic Flows in a Connected and Autonomous Vehicle Environment
University of Texas at Austin	Randy Machemehl	Applied Research	Characterization of Bicycle Rider Behavior among Various Street Environments
	Randy Machemehl	Advanced Research	Evolution of Advanced Transit Signal Priority with Gap-Based Signal Recovery Strategy
	Stephen Boyles	Applied Research	Assessment of Parcel Delivery Systems Using Unmanned Aerial Vehicles
	Christian Claudel	Advanced Research	Deep-learning Based Trajectory Forecast for Safety of Intersections with Multimodal Traffic
University of Connecticut	Nicholas Lownes Charles Patton Kelly Bertolaccini	Advanced Research	Investigating the Linkage between Transit Access to Services and Affordable Housing Availability
	Karthik Charan Konduri	Basic Research	Development of Continuous Time, Temporally Constrained and Behaviorally Consistent Tour Pattern Generation System for Modeling the Impacts of Autonomous Vehicle Future
	Norman Garrick Carol Atkinson - Palombo	Applied Research	What Do We Want from Autonomous Vehicles (AVs)? Using Participatory Planning and Scenario Analysis of Alternative Futures to Identify Stakeholders' Desired Outcomes from the Strategic Deployment of Emerging Transportation Technology
Washington State University	Xianming Shi	Applied Research	Developing Friction Data to Support the Optimal Use of Pre-wet Deicing Salt for Enhanced Winter Mobility
	Xianming Shi	Applied Research	Modeling the Macroscopic Effects of Winter Maintenance Operations on Traffic Mobility on Washington Highways
Texas Southern University	Yi Qi Mehdi Azimi Qun Zhao	Applied Research	Determination of Freeway Acceleration Lane Length for Smooth and Safe Truck Merging
	Yi Qi Mehdi Azimi	Applied Research	Innovative Countermeasures for Reducing the Truck Waiting Time at

	Qun Zhao		Marine Terminals
	Mehdi Azimi Yi Qi Qun Zhao	Applied Research	Investigating the Impact of Different Attributes on Bicycling Mode Share as A Multimodal Connectivity Strategy in Large Cities: A Case Study in Houston



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