

Program Progress Performance Report



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Office of the Assistant Secretary for Research and Technology

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Project Title: Data-Supported Transportation Operations and Planning (D-STOP) Center

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Recipient Organization: The University of Texas at Austin
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Reporting Period End Date: September 30, 2019

Report Term: April 1, 2019 – September 30, 2019

Signature: 

1. ACCOMPLISHMENTS

What are the major goals of the program?

The Data-Supported Transportation Operations and Planning (D-STOP) Center's vision is to be a national and international multimodal and multidisciplinary center of excellence that promotes the integration of cutting-edge developments in wireless sensor networks and communications technology with transportation systems to improve the United States' economic competitiveness. This vision will be implemented through a research mission, an education and workforce development mission, and a technology transfer mission.

D-STOP's *research mission* is to develop fundamentally new methodologies to better harness traditional and recent data sources, and potentially develop new sources, in seeking to improve models for transportation planning and traffic operations. D-STOP research will occur in three areas: operations, planning, and technology, with significant priority placed on work that cuts across these areas.

The *education and workforce development (EWD) mission* is to build a transportation workforce that is able to use multi-disciplinary approaches to address multi-dimensional complex problems, through an emphasis on real-time data analysis and processing, the study of the dynamics underlying human activity-travel decision-making, and training on the effective use of information technology innovations.

D-STOP's *technology transfer (TT) mission* is to disseminate information on research activities and findings, and actively promote the utilization and implementation of research products/findings through demonstrations on small-scale networks (in collaboration with industry and public agency partners).

What was accomplished under these goals?

Research Program Accomplishments

D-STOP's research activities focus on harnessing innovative technologies and data sources to develop architectures and systems for data collection and analysis. The research will foster economic competitiveness through its focus on gathering and analyzing data to support effective and efficient decision-making. The major research accomplishment during this reporting period was the continued development of the research agenda in coordination with D-STOP faculty and researchers. A total of 15 projects were pursued with partial or full funding support from D-STOP. Of these, 5 projects were completed during this reporting period. Currently, 10 projects are underway.

Completed Projects

- 1. Spatial Correlation Estimation of Millimeter Vehicular Communication Channels Using Out-of-Band Information**
(PI: Robert Heath); End date: May 31, 2019
- 2. Joint Millimeter-Wave Communication and Radar for Automotive Applications**
(PI: Robert Heath); End date: May 31, 2019
- 3. Real-Time Signal Control and Traffic Stability**
(PI: Stephen Boyles); End date: August 31, 2019
- 4. Improved Models for Managed Lane Operations**
(PI: Stephen Boyles); End date: August 31, 2019
- 5. Transit Policy in the Context of New Transportation Paradigms**
(PI: Natalia Ruiz Juri); End date: September 30, 2019

Ongoing Projects

- 1. Video Data Analytics for Safer and More Efficient Mobility**
(PI: Natalia Ruiz Juri); Anticipated end date: September 30, 2020

2. **Data-Driven, Real-Time Traffic Signal Optimization: A Distributed Approach**
(PI: Stephen Boyles); Anticipated end date: September 30, 2020
3. **Real-time, Targeted Incentives for Strategic Travelers**
(PI: Stephen Boyles); Anticipated end date: September 30, 2020
4. **Tight-coupling of Vision, Radar, and Carrier-phase Differential GNSS for Robust All-weather Positioning**
(PI: Todd Humphreys); Anticipated end date: September 30, 2020
5. **Modeling Willingness-to-Share Trips in an Autonomous Vehicle Future: A stochastic psychological latent construct approach**
(PI: Chandra Bhat); Anticipated end date: September 30, 2020
6. **Emerging Transportation Mobility Options and Technologies: A comprehensive analysis of consumer preferences using survey and supplementary data**
(PI: Chandra Bhat); Anticipated end date: September 30, 2020
7. **Sensing and Communications in V2V and V2I Settings**
(PI: Sanjay Shakkottai); Anticipated end date: September 30, 2020
8. **Online Matching, Black-box Optimization and Hyper-parameter Tuning**
(PI: Sanjay Shakkottai); Anticipated end date: September 30, 2020
9. **Solving Perception Challenges for Autonomous Vehicles Using SGD**
(PI: Constantine Caramanis); Anticipated end date: September 30, 2020
10. **Large Scale Optimization with Small Scale Data**
(PI: Constantine Caramanis); Anticipated end date: September 30, 2020

Research Results Disseminated: 15 papers were published and 3 papers are forthcoming in refereed journals based on the research projects associated with D-STOP. Several other papers are in the review process. 43 presentations were made at conferences and meetings.

Research work being undertaken by Natalia Ruiz Juri for the project entitled “Video Data Analytics for Safer and More Efficient Mobility” was presented at the ITS America Annual Meeting in Washington, DC in June 2019, at the Joint ITE International/ITE Texas Annual Meeting in Austin, TX in July 2019, and will be presented at the upcoming ITS World Congress in Singapore in October 2019, where it has been recognized with the Best Paper Award.

Plans for Next Reporting Period to Accomplish Research Goal: Provide support, guidance, and assistance to project Principal Investigators so individual research project objectives can be achieved. Renew funding for supporting research through Cintra. Undertake supporting research funded through the Texas Department of Transportation and the North Central Texas Council of Governments (NCTCOG). Participate in the analysis and data processing of a multi-city survey undertaken in collaboration with TOMNET (Center for Teaching Old Models New Tricks) Tier 1 University Transportation Center.

Education and Workforce Development Accomplishments

The research projects outlined above have several students working on them. Please note that students work in groups. Some are on fellowships, or obtain funding from other sources too. Below, we indicate all students who undertake research associated with D-STOP, regardless of whether they obtain no funding support or only partial funding support from D-STOP. The students are:

Undergrad

Meagan Costey, Emily Niemeyer, Teagan Webb, (supervised by Chandra Bhat)
James Lentz, Karthik Velayutham (supervised by Stephen Boyles)

Grad

Supervised by Natalia Ruiz Juri: Natalia Zuniga (PhD).

Supervised by Chandra Bhat: Katie Asmussen (MS), Felipe Dias (PhD), Shuqing Kang (MS), Aupal Mondal (PhD), Michael Moore (PhD), Gopindra Nair (PhD), Abhilash Singh (PhD).

Supervised by Stephen Boyles: William Alexander (MS/PhD), Can Gokalp (PhD), Rachel James (PhD), Carlin Liao (PhD), Venkatesh Pandey (PhD), Rahul Patel (MS), Priyadarshan Patil (PhD), Cesar Yahia (PhD), Tengkuo Zhu (PhD).

Supervised by Constantine Caramanis: Tianyang Li (PhD).

Supervised by Robert Heath: Anum Ali (PhD), Preeti Kumari (PhD).

Supervised by Todd Humphreys: Lakshay Narula (PhD).

Supervised by Sanjay Shakkottai: Adam Allevato (PhD), Mai Lee Chang, Shih-Yun Lo, Kartik Patel (PhD), Rajat Sen (PhD), Isfar Tariq (PhD), Yi Zhang (PhD).

2019 Texas District Traffic Bowl: The student team from The University of Texas at Austin won the 2019 Texas District Traffic Bowl in April 2019. The Texas District Traffic Bowl took place at the TextITE Spring Meeting in San Antonio.



Traffic Bowl TextITE Winning Team!!

(L to R: Rydell Walthall, William Alexander, Christine Cheng, and Murthy Gurumurthy)

2019 ITE Collegiate Traffic Bowl Grand Championship: The student team from The University of Texas at Austin went on to win the 2019 ITE Collegiate Traffic Bowl Grand Championship in July 2019 at the Joint ITE International and Texas District Annual Meeting and Exhibit held in Austin, TX.



2019 Summer Internship: We welcomed four undergraduate summer interns to our transportation program, with two of them supported by D-STOP, in the sixth University Transportation Center-Undergraduate Internship (UTC-UI) hosted at The University of Texas at Austin. The D-STOP interns were Meagan Costey (from UT Austin) and Emily Niemeyer (from UT Austin). Each intern participated in a research project related to the D-STOP center, and were assigned to faculty and researchers associated with the Center for Transportation Research. A weekly seminar was held, consisting of lectures by experts in both wireless networking and transportation research, and served as the basis for conversations on research lying at the intersection of these fields (see attached weekly lecture schedule). The interns were also involved in professional development and social activities organized by the student chapters of the Institute of Transportation Engineers (ITE), ITS America (ITS), and Women's Transportation Seminar (WTS).



Final Intern Presentations (Meagan Costey and Emily Niemeyer with Dr. Boyley, UTC-UI Faculty Coordinator for D-STOP), 8/9/19



Our 2019 Summer Interns! (L to R: Dr. Prozzi, Dr. Claudel, Meagan Costey, Maximillian Pleason, Ekin Ugurel, Emily Niemeyer, and Dr. Boyley), 8/9/19

New Student Orientation: The transportation and wireless networking programs welcomed many new graduate students to D-STOP, including a new student orientation, discussion of ongoing D-STOP projects, and faculty/student discussions of how data is fundamentally changing how we think and plan transportation systems.



New Student Welcome Social, September 2019 (sponsored by WTS)

Prof. Robert Heath received the 2019 Joe J. King Professional Engineering Achievement Award for the academic year 2018 – 2019. The Cockrell School of Engineering established this award in 1977 to recognize a faculty member who has made significant contributions in furthering the profession of engineering.

Prof. Todd Humphreys received a Presidential Early Career Award for Scientists and Engineers (PECASE). Humphreys was one of five faculty members from The University of Texas at Austin to receive the award for 2019. The PECASE is the “highest honor bestowed by the United States Government to outstanding scientists and engineers who are beginning their independent research careers and who show exceptional promise for leadership in science and technology.” The award is coordinated by the White House Office of Science and Technology Policy along with a number of federal departments and agencies.

The Wireless Networking and Communications Group (WNCG) welcomed a new Director in Spring 2019 – Prof. Constantine Caramanis, who began his three-year term as WNCG Director. Prior to that, he served as the group’s Associate Director. WNCG’s previous Director, Prof. Sanjay Shakkottai, officially concluded his term after four years in the position. Shakkottai began his directorship in Spring 2015. During Shakkottai’s tenure as Director, he oversaw the creation of the SAVES (Situation-Aware Vehicular Engineering Systems) research initiative, focusing on the integration of communications, sensing and analytics. SAVES is led by Prof. Robert Heath.

Education and Workforce Development Results Disseminated:

Graduates Linked with Undergraduates in Engineering (GLUE)

Graduate student Lakshay Narula (supervised by Prof. Todd Humphreys) continued to mentor Roberto Padilla, an undergraduate aerospace engineering student at UT Austin. This is for the Graduates Linked with Undergraduates in Engineering (GLUE) program organized by the Women in Engineering Program (WEP). Roberto is working on analysis and visualization of radar data under Lakshay’s guidance for the Spring 2019 semester. The WEP GLUE program is limited to about 30 undergraduates and is open to all degree-seeking engineering students in all majors who have *never* done research in a university setting. Undergraduate participants gain valuable experience working with a graduate mentor on a research project for eight hours per week and participating in a weekly seminar class.

Graduate Student Symposium: The Center for Transportation Research (CTR) organized the first Graduate Student Symposium on May 8, 2019 at the West Pickle Research building. This event gave grad students the opportunity to practice their presentation skills in a timed competition—each student had seven minutes to encapsulate their research on a particular project. Oscar Galvis Arce and Ramez Hajj won the overall competition, while Amy Fong won the Research Communication Award. D-STOP student Felipe Dias won the Presentation Style Award. The students and researchers enjoyed the cross-pollination of ideas, and have already begun speculating on potential collaborations. Future symposia will broaden to involve students from all branches of the CAEE Department, to provide grad students this valuable presentation experience.

Dr. Bhat is a member of the Engineering Advisory Board of Westwood High School and continues to advise the school on engineering curriculum issues.

Plans for Next Reporting Period to Accomplish Education and Workforce Development Goal:

Begin organization of the seventh University Transportation Center-Undergraduate Internship (UTC-UI) program to be held the summer of 2020. Initiating conversations with the ASCE Transportation and Development Institute (T&DI) to explore avenues for graduate student, young faculty members, and young practitioners to improve teaching/communication skills.

Technology Transfer Accomplishments

Technology transfer activities will be pursued to deliver timely information on research activities and findings. These activities include: maintaining a D-STOP website, producing high quality peer-reviewed journal papers, and supporting researcher travel to participate in conferences that disseminate research results.

D-STOP website: The D-STOP website provides information about the Center and includes a listing of current research projects being conducted, as well as educational information, technology transfer, news and events, publications, and resources applicable to the to the overall D-STOP effort. The website address is dstop.utexas.edu

Center for Transportation Research (CTR) Annual Symposium

The annual CTR Symposium was held on April 10, 2019, and was attended by TxDOT staff, as well as representatives from transportation public agencies in the Austin area. CTR staff, faculty, and students were present to discuss ongoing research pursuits. This included D-STOP-related poster presentations made by D-STOP funded students. This year's event demonstrated our tremendous range of transportation expertise, encompassing next-generation connected/autonomous vehicle technologies. Dr. Bhat and Kenneth Perrine made a featured presentation at this symposium on "Weather-Responsive Road Sensing and Data Analytics to Keep Texans Safe".

2019 UTC Spotlight Conference

Dr. Bhat was invited to present a poster about research activities being pursued through D-STOP at the 2019 UTC Spotlight Conference in Washington D.C. at the U.S. House of Representatives in May 2019. This one-day conference highlighted UTC activities for Congress and other stakeholders. The conference was co-hosted by the Council of University Transportation Centers (CUTC) and the Research, Education, and Training Reauthorization Coalition (RETRC).

Publications: Papers whose research is fully or partially supported by D-STOP:

Published:

Green, G.N., and T.E. Humphreys (2019). Position-Domain Integrity Analysis for Generalized Integer Aperture Bootstrapping. *IEEE Transactions on Aerospace and Electronic Systems*, 55(2), 734-746, April. doi: 10.1109/TAES.2018.2864766

Green, G.N., and T.E. Humphreys (2019). Data-Driven Generalized Integer Aperture Bootstrapping for High-Integrity Positioning. *IEEE Transactions on Aerospace and Electronic Systems*, 55(2), 757-768, April. doi: 10.1109/TAES.2018.2864770

- Wang, Y., A. Klautau, M. Ribero, A.C.K. Soong and R.W. Heath (2019) MmWave Vehicular Beam Selection with Situational Awareness Using Machine Learning. *IEEE Access*, 7, 87479-87493. doi: 10.1109/ACCESS.2019.2922064
- Va, V., T. Shimizu, G. Bansal and R.W. Heath (2019) Online Learning for Position-Aided Millimeter Wave Beam Training. *IEEE Access*, 7, 30507-30526. doi: 10.1109/ACCESS.2019.2902372
- Ali, A., E.D. Carvalho and R.W. Heath (2019) Linear Receivers in Non-Stationary Massive MIMO Channels With Visibility Regions. *IEEE Wireless Communications Letters*, 8(3), 885-888, June. doi: 10.1109/LWC.2019.2898572
- Boyles, S., and N. Ruiz Juri (2019). Queue Spillback and Demand Uncertainty in Dynamic Network Loading. *Transportation Research Record*, 2673(2), 38-48.
- James, R., B. E. Hammit, and S. D. Boyles (2019). Methods to Obtain Representative Car-following Model Parameters from Trajectory-level Data for Use in Microsimulation. *Transportation Research Record*, 2673(7), 62-73.
- Levin, M. W., H. Smith, and S D. Boyles (2019). A Dynamic Four-step Planning Model of Empty Repositioning Trips for Personal Autonomous Vehicles. *Journal of Transportation Engineering, Part A: Systems*, 145(5), May.
- Lavieri, P.S., and C.R. Bhat (2019). Modeling Individuals' Willingness to Share Trips with Strangers in an Autonomous Vehicle Future. *Transportation Research Part A*, 124, 242-261.
- Nair, G.S., C.R. Bhat, R.M. Pendyala, B.P.Y. Loo, and W.H.K. Lam (2019). On the Use of Probit-Based Models for Ranking Data Analysis. *Transportation Research Record*, 2673(4), 229-240.
- Dias, F.F., P.S. Lavieri, T. Kim, C.R. Bhat, and R.M. Pendyala (2019). Fusing Multiple Sources of Data to Understand Ride-Hailing Use. *Transportation Research Record*, 2673(6), 214-224.
- Long, K., D. Capasso da Silva, F.F. Dias, S. Khoeini, A.C. Bhat, R.M. Pendyala, and C.R. Bhat (2019). Role of Childhood Context and Experience in Shaping Activity-Travel Choices in Adulthood. *Transportation Research Record*, 2673(7), 575-585.
- Lavieri, P.S., and C.R. Bhat (2019). Investigating Objective and Subjective Factors Influencing the Adoption, Frequency, and Characteristics of Ride-hailing Trips. *Transportation Research Part C*, 105, 100-125.
- Astroza, S., V.M. Garikapati, R.M. Pendyala, C.R. Bhat, and P.L. Mokhtarian (2019). Representing Heterogeneity in Structural Relationships among Multiple Choice Variables Using a Latent Segmentation Approach. *Transportation*, 46(5), 1755-1784.
- Xu, W., K. Pierce, N. Ruiz Juri, and H. Ross (2019). Task 2018-13 Video Analytics for Vision Zero 2 – Final Report. Submitted to the City of Austin Transportation Department.
- Forthcoming:*
- Pandey, V., and S.D. Boyles. Comparing Route Choice Models for Managed Lane Networks with Multiple Entrances and Exits. Accepted for publication in *Transportation Research Record*, 2019.
- Patel, R., P. Venkatraman, and S.D. Boyles. Optimal Placement of Reservation-based Intersections in Urban Networks. Accepted for publication in *Transportation Research Record*, 2019.
- Ali, A., N. González-Prelcic and R. W. Heath. Spatial Covariance Estimation for Millimeter Wave Hybrid Systems using Out-of-Band Information. Accepted for publication in *IEEE Transactions on Wireless Communications*. doi: 10.1109/TWC.2019.2932404

Presentations whose research is fully or partially supported by D-STOP:

Presented:

Bhat, C.R., "In-Person or Online? The Rich Interplay between Physical and Virtual Activity Engagement." *Invited seminar*, Department of Civil Engineering, Auburn University, April 2019.

Bhat, C.R., and K. Perrine, "Weather-Responsive Road Sensing and Data Analytics to Keep Texans Safe." Presented at the *Center for Transportation Research (CTR) Annual Symposium*, Austin, TX, April 2019.

Perrine, K., C.R. Bhat, C. Claudel, N. Ruiz Juri, K. Long, A. Mohamed, T. Lei, K. Khan, and J. Butler, "Enhancing Road Weather Management during Wildfires and Flash Floods through New Data Collection, Sharing, and Public Dissemination Technologies." Poster presented at the *Center for Transportation Research (CTR) Annual Symposium*, Austin, TX, April 2019.

Lavieri, P.S., and C.R. Bhat, "Modeling Individuals' Willingness to Share Trips with Strangers in an Autonomous Vehicle Future." Poster presented at the *Center for Transportation Research (CTR) Annual Symposium*, Austin, TX, April 2019.

Lavieri, P.S., and C.R. Bhat, "A Multivariate Model of Ride-Hailing Trip Characteristics in Dallas." Poster presented at the *Center for Transportation Research (CTR) Annual Symposium*, Austin, TX, April 2019.

Bhat, C.R., "Smart and Sustainable Infrastructure Design in the Emerging Transportation Landscape." Keynote presentation, *Challenges in Developing Sustainable Infrastructures Conference*, Kuwait City, Kuwait, April 2019.

Ali, A., "Radar aided mmWave Beam Training." Poster presented at the Wireless Networking and Communications Group (WNCG) Annual Open House, Austin, TX, April 2019.

Kumari, P., "Millimeter-wave Joint Communication and Radar." Poster presented at the Wireless Networking and Communications Group (WNCG) Annual Open House, Austin, TX, April 2019.

Ali, A., "Millimeter Wave Link Configuration Using Out-Of-Band Information." Invited talk, *Mitsubishi Electric Research Laboratories*, Cambridge, MA, April 2019.

Sen, R., K. Kandasamy, and S. Shakkottai, "Noisy Blackbox Optimization using Multi-fidelity Queries: A Tree Search Approach." Presented at the *22nd International Conference on Artificial Intelligence and Statistics (AISTATS 2019)*, Naha, Okinawa, Japan, April 2019.

Mezghani, A., and R.W. Heath Jr, "MIMO Beampattern and Waveform Design with Low Resolution DACs," Presented at the *2019 IEEE Radar Conference (RadarConf)*, Boston, MA, April 2019.

Basu, S., and S. Shakkottai, "Switching Constrained Max-Weight Scheduling for Wireless Networks," Presented at *IEEE INFOCOM 2019 - IEEE Conference on Computer Communications*, Paris, France, April 2019.

Tariq, I., R. Sen, G. d. Veciana and S. Shakkottai, "Online Channel-state Clustering And Multiuser Capacity Learning For Wireless Scheduling," Presented at *IEEE INFOCOM 2019 - IEEE Conference on Computer Communications*, Paris, France, April 2019.

Sharon, G., S. Boyles, S. Alkoby, and P. Stone, "Marginal Cost Pricing with a Fixed Error Factor in Traffic Networks." Presented at the *18th International Conference on Autonomous Agents and Multiagent Systems (AAMAS 2019)*, Montreal, Canada, May 2019.

Bhat, C.R., and M. Zhang, "Data Supported Transportation Operations & Planning (D-STOP) and Cooperative Mobility for Competitive Megaregions (CM²)." Poster presented at the *2019 University Transportation Centers Spotlight Conference*, Washington, DC, May 2019.

- Bhat, C.R., "Activity-Travel Patterns in a New Technology Era: The Interplay between Human Movements and Digital Interactions." Keynote presentation, *15th World Conference on Transport Research (WCTR)*, Mumbai, India, May 2019.
- Xu, W., N. Ruiz Juri, R. Huang, J. Duthie, J. Meyer, and J. Clary, "Deep Learning Methods to Leverage Traffic Monitoring Cameras for Pedestrian Data Applications." Presented at the *28th ITS America Annual Meeting*, Washington, DC, June 2019.
- Heath, R., A. Ali, and N. Gonzalez-Prelcic, "Radar aided V2X communications at mmWave." Presented to Nokia Bell Labs, Austin, TX, June 2019.
- Shakkottai, S., "Multi-Fidelity Tree-Search for Hyper-parameter Tuning." Distinguished speaker at the *4th Information Modeling, Analysis, and Control of Complex Systems (IMACCS) Workshop 2019*, Ohio State University, June 3-4, 2019.
- Shakkottai, S., "Multi-Fidelity Tree-Search for Hyper-parameter Tuning." *Qualcomm CR&D Seminar*, June 14, 2019.
- Shakkottai, S., "Multi-Fidelity Tree-Search for Hyper-parameter Tuning." *IBM Research Math of AI Seminar*, June 20, 2019.
- Lavieri, P.S., and C.R. Bhat, "Modeling the Adoption, Frequency, and Characteristics of Ride-Hailing Trips in Dallas, Texas." *ASCE International Conference on Transportation & Development (ICTD) 2019*, Alexandria, VA, June 2019.
- Bhat, C.R., "Modeling Individuals' Willingness to Share Trips with Strangers in an Autonomous Vehicle Future." *ASCE International Conference on Transportation & Development (ICTD) 2019*, Alexandria, VA, June 2019.
- Bhat, C.R., "Virtual Activity and Physical Activity Interactions in a CAV Landscape." *ASCE International Conference on Transportation & Development (ICTD) 2019*, Alexandria, VA, June 2019.
- Bhat, C.R., "Travel Demand Management in a Technology-Transformed Transportation Era." Keynote presentation, *9th International Symposium on Travel Demand Management (TDM 2019)*, Edinburgh, U.K., June 2019.
- Dias, F.F., C.R. Bhat, and W.H.K. Lam, "The Evolution of Ride-Hailing Usage in the Puget Sound Region." *9th International Symposium on Travel Demand Management (TDM 2019)*, Edinburgh, U.K., June 2019.
- Nair, G.S., C.R. Bhat, and W.H.K. Lam, "Forecasting of Empty Trips by Ride-Hailing Vehicles." *9th International Symposium on Travel Demand Management (TDM 2019)*, Edinburgh, U.K., June 2019.
- Bhat, C.R., "The Growing Nexus between Computational Data Science and Transportation Science: The Excitement and the Challenges." Keynote presentation, *11th International Workshop on Computational Transportation Science (CTS-2019)*, Tianjin, China, June 2019.
- Shakkottai, S., "Hyper-parameter Tuning for ML Models: An MCTS Approach." Invited Speaker at the *7th ACM MobiHoc Workshop on the Frontiers of Networks: Theory and Algorithms*, Catania, Italy, July 2, 2019.
- Zhang, Y., K. Patel, S. Shakkottai, and Heath Jr., "Side-information-aided Non-coherent Beam Alignment Design for Millimeter Wave Systems." Presented at the *20th International Symposium on Mobile Ad Hoc Networking and Computing (ACM MobiHoc 2019)*, Catania, Italy, July 2019.

- Nevares, J., and N. Ruiz Juri, "Benefits and Challenges of Combining Sensor and Probe-Based Data to Quantify the Impacts of Freeway Lane Closures: A Practical Application in Texas." Presented at the *Joint ITE International and Texas District Annual Meeting and Exhibit*, Austin, TX, July 2019.
- Xu, W., N. Ruiz Juri, J. Meyer, J. Duthie, and H. Ross, "Understanding the Impact of Pedestrian Safety Measures Through the Automated Analysis of Data from Traffic Monitoring Cameras." Presented at the *Joint ITE International and Texas District Annual Meeting and Exhibit*, Austin, TX, July 2019.
- Bhat, C.R., "The Driverless Road Ahead." *Invited Seminar*, Illinois Road and Transportation Builders Association (IRTBA) Planning and Design Division (P&D) Annual Conference, Oak Brook, IL, July 2019.
- Bhat, C.R., "The Growing Nexus between Computational Data Science and Transportation Science: The Excitement and the Challenges." *Invited Seminar*, Department of Civil and Environmental Engineering, The Hong Kong Polytechnic University (PolyU), jointly organized with the Hong Kong Society for Transportation Studies (HKSTS), Hong Kong, August 2019.
- Bhat, C.R., "Three-day Workshop on Activity-Based Modeling: Recent Advances and Possible Application to the Hong Kong Region." *Invited Seminar*, Department of Civil and Environmental Engineering, The Hong Kong Polytechnic University (PolyU), Hong Kong, August 2019.
- Bhat, C.R., and A. Verma, "Approaches in Travel Behavior Research for Transportation Planning and Policy Decision Support." *Short Course*, Sponsored by the MHRD Scheme on Global Initiative on Academic Network (GIAN), IISc Bangalore, Bangalore, India, August 2019.
- Dias, F.F., P.S. Lavieri, C.R. Bhat, R.M. Pendyala, and W.H.K. Lam, "The Interplay between Virtual and In-Person Activity Engagement: The Case of Shopping and Eating Meals," *6th International Choice Modelling Conference (ICMC 2019)*, Kobe, Japan, August 2019.
- Lavieri, P.S., F.F. Dias, C.R. Bhat, S. Sharda, and R.M. Pendyala, "Modeling Respondent Self-Selection Biases in the Choice for Travel Diary Reporting Instrument: The Smartphone Effects." *6th International Choice Modelling Conference (ICMC 2019)*, Kobe, Japan, August 2019.
- Shakkottai, S., "Hyper-parameter Tuning for ML Models: An MCTS Approach." *SINE Seminar*, Coordinated Science Laboratory, University of Illinois at Urbana-Champaign (UIUC), August 26, 2019.
- Humphreys, T., "Insights from Two Years of GNSS Interference Observations from Space." PNT Security and Robustness Panel, *Institute of Navigation GNSS+ 2019 Meeting*, Miami, FL, September 2019.
- Humphreys, T., "Belt-and-suspenders PNT for Self-driving Cars and Air Taxis." Navigating Smart and Connected Cities Panel, *Institute of Navigation GNSS+ 2019 Meeting*, Miami, FL, September 2019.
- Murrian, M.J., L. Narula, and T.E. Humphreys, "Characterizing Terrestrial GNSS Interference from Low Earth Orbit." *Institute of Navigation GNSS+ 2019 Meeting*, Miami, FL, September 2019.
- Bhat, C.R., "Emerging New Choice Analysis Directions and Challenges in a Fast Evolving Technological Environment." Keynote presentation, *8th Conference of the European Association for Research in Transportation (hEART)*, Budapest, Hungary, September 2019.

Plans for Next Reporting Period to Accomplish Technology Transfer Goal: Continue to support researchers as they present their research results through peer-reviewed publications and professional presentations. Organize the 2019 Texas Wireless Summit to be held November 12, 2019 at UT Austin. The Texas Wireless Summit (TWS) is hosted by the Wireless Networking and Communications Group (WNCG), Dept of Electrical and Computer Engineering. Organize a Center for Transportation Research (CTR) Symposium to be held in Spring 2020.

2. PRODUCTS

Publications, conference papers, and presentations:

Journal Publications - Published

Green, G.N., and T.E. Humphreys (2019). Position-Domain Integrity Analysis for Generalized Integer Aperture Bootstrapping. *IEEE Transactions on Aerospace and Electronic Systems*, 55(2), 734-746, April. doi: 10.1109/TAES.2018.2864766

Green, G.N., and T.E. Humphreys (2019). Data-Driven Generalized Integer Aperture Bootstrapping for High-Integrity Positioning. *IEEE Transactions on Aerospace and Electronic Systems*, 55(2), 757-768, April. doi: 10.1109/TAES.2018.2864770

Wang, Y., A. Klautau, M. Ribero, A.C.K. Soong and R.W. Heath (2019) MmWave Vehicular Beam Selection with Situational Awareness Using Machine Learning. *IEEE Access*, 7, 87479-87493. doi: 10.1109/ACCESS.2019.2922064

Va, V., T. Shimizu, G. Bansal and R.W. Heath (2019) Online Learning for Position-Aided Millimeter Wave Beam Training. *IEEE Access*, 7, 30507-30526. doi: 10.1109/ACCESS.2019.2902372

Ali, A., E.D. Carvalho and R.W. Heath (2019) Linear Receivers in Non-Stationary Massive MIMO Channels With Visibility Regions. *IEEE Wireless Communications Letters*, 8(3), 885-888, June. doi: 10.1109/LWC.2019.2898572

Boyles, S., and N. Ruiz Juri (2019). Queue Spillback and Demand Uncertainty in Dynamic Network Loading. *Transportation Research Record*, 2673(2), 38-48.

James, R., B. E. Hammit, and S. D. Boyles (2019). Methods to Obtain Representative Car-following Model Parameters from Trajectory-level Data for Use in Microsimulation. *Transportation Research Record*, 2673(7), 62-73.

Levin, M. W., H. Smith, and S D. Boyles (2019). A Dynamic Four-step Planning Model of Empty Repositioning Trips for Personal Autonomous Vehicles. *Journal of Transportation Engineering, Part A: Systems*, 145(5), May.

Lavieri, P.S., and C.R. Bhat (2019). Modeling Individuals' Willingness to Share Trips with Strangers in an Autonomous Vehicle Future. *Transportation Research Part A*, 124, 242-261.

Nair, G.S., C.R. Bhat, R.M. Pendyala, B.P.Y. Loo, and W.H.K. Lam (2019). On the Use of Probit-Based Models for Ranking Data Analysis. *Transportation Research Record*, 2673(4), 229-240.

Dias, F.F., P.S. Lavieri, T. Kim, C.R. Bhat, and R.M. Pendyala (2019). Fusing Multiple Sources of Data to Understand Ride-Hailing Use. *Transportation Research Record*, 2673(6), 214-224.

Long, K., D. Capasso da Silva, F.F. Dias, S. Khoeini, A.C. Bhat, R.M. Pendyala, and C.R. Bhat (2019). Role of Childhood Context and Experience in Shaping Activity-Travel Choices in Adulthood. *Transportation Research Record*, 2673(7), 575-585.

Lavieri, P.S., and C.R. Bhat (2019). Investigating Objective and Subjective Factors Influencing the Adoption, Frequency, and Characteristics of Ride-hailing Trips. *Transportation Research Part C*, 105, 100-125.

Astroza, S., V.M. Garikapati, R.M. Pendyala, C.R. Bhat, and P.L. Mokhtarian (2019). Representing Heterogeneity in Structural Relationships among Multiple Choice Variables Using a Latent Segmentation Approach. *Transportation*, 46(5), 1755-1784.

Xu, W., K. Pierce, N. Ruiz Juri, and H. Ross (2019). Task 2018-13 Video Analytics for Vision Zero 2 – Final Report. Submitted to the City of Austin Transportation Department.

Presentations

Bhat, C.R., "In-Person or Online? The Rich Interplay between Physical and Virtual Activity Engagement." *Invited seminar*, Department of Civil Engineering, Auburn University, April 2019.

Bhat, C.R., and K. Perrine, "Weather-Responsive Road Sensing and Data Analytics to Keep Texans Safe." Presented at the *Center for Transportation Research (CTR) Annual Symposium*, Austin, TX, April 2019.

Perrine, K., C.R. Bhat, C. Claudel, N. Ruiz Juri, K. Long, A. Mohamed, T. Lei, K. Khan, and J. Butler, "Enhancing Road Weather Management during Wildfires and Flash Floods through New Data Collection, Sharing, and Public Dissemination Technologies." Poster presented at the *Center for Transportation Research (CTR) Annual Symposium*, Austin, TX, April 2019.

Lavieri, P.S., and C.R. Bhat, "Modeling Individuals' Willingness to Share Trips with Strangers in an Autonomous Vehicle Future." Poster presented at the *Center for Transportation Research (CTR) Annual Symposium*, Austin, TX, April 2019.

Lavieri, P.S., and C.R. Bhat, "A Multivariate Model of Ride-Hailing Trip Characteristics in Dallas." Poster presented at the *Center for Transportation Research (CTR) Annual Symposium*, Austin, TX, April 2019.

Bhat, C.R., "Smart and Sustainable Infrastructure Design in the Emerging Transportation Landscape." Keynote presentation, *Challenges in Developing Sustainable Infrastructures Conference*, Kuwait City, Kuwait, April 2019.

Ali, A., "Radar aided mmWave Beam Training." Poster presented at the Wireless Networking and Communications Group (WNCG) Annual Open House, Austin, TX, April 2019.

Kumari, P., "Millimeter-wave Joint Communication and Radar." Poster presented at the Wireless Networking and Communications Group (WNCG) Annual Open House, Austin, TX, April 2019.

Ali, A., "Millimeter Wave Link Configuration Using Out-Of-Band Information." Invited talk, *Mitsubishi Electric Research Laboratories*, Cambridge, MA, April 2019.

Sen, R., K. Kandasamy, and S. Shakkottai, "Noisy Blackbox Optimization using Multi-fidelity Queries: A Tree Search Approach." Presented at the *22nd International Conference on Artificial Intelligence and Statistics (AISTATS 2019)*, Naha, Okinawa, Japan, April 2019.

Mezghani, A., and R.W. Heath Jr, "MIMO Beampattern and Waveform Design with Low Resolution DACs," Presented at the *2019 IEEE Radar Conference (RadarConf)*, Boston, MA, April 2019.

Basu, S., and S. Shakkottai, "Switching Constrained Max-Weight Scheduling for Wireless Networks," Presented at *IEEE INFOCOM 2019 - IEEE Conference on Computer Communications*, Paris, France, April 2019.

Tariq, I., R. Sen, G. d. Veciana and S. Shakkottai, "Online Channel-state Clustering And Multiuser Capacity Learning For Wireless Scheduling," Presented at *IEEE INFOCOM 2019 - IEEE Conference on Computer Communications*, Paris, France, April 2019.

Sharon, G., S. Boyles, S. Alkoby, and P. Stone, "Marginal Cost Pricing with a Fixed Error Factor in Traffic Networks." Presented at the *18th International Conference on Autonomous Agents and Multiagent Systems (AAMAS 2019)*, Montreal, Canada, May 2019.

- Bhat, C.R., and M. Zhang, "Data Supported Transportation Operations & Planning (D-STOP) and Cooperative Mobility for Competitive Megaregions (CM²)." Poster presented at the *2019 University Transportation Centers Spotlight Conference*, Washington, DC, May 2019.
- Bhat, C.R., "Activity-Travel Patterns in a New Technology Era: The Interplay between Human Movements and Digital Interactions." Keynote presentation, *15th World Conference on Transport Research (WCTR)*, Mumbai, India, May 2019.
- Xu, W., N. Ruiz Juri, R. Huang, J. Duthie, J. Meyer, and J. Clary, "Deep Learning Methods to Leverage Traffic Monitoring Cameras for Pedestrian Data Applications." Presented at the *28th ITS America Annual Meeting*, Washington, DC, June 2019.
- Heath, R., A. Ali, and N. Gonzalez-Prelcic, "Radar aided V2X communications at mmWave." Presented to Nokia Bell Labs, Austin, TX, June 2019.
- Shakkottai, S., "Multi-Fidelity Tree-Search for Hyper-parameter Tuning." Distinguished speaker at the *4th Information Modeling, Analysis, and Control of Complex Systems (IMACCS) Workshop 2019*, Ohio State University, June 3-4, 2019.
- Shakkottai, S., "Multi-Fidelity Tree-Search for Hyper-parameter Tuning." *Qualcomm CR&D Seminar*, June 14, 2019.
- Shakkottai, S., "Multi-Fidelity Tree-Search for Hyper-parameter Tuning." *IBM Research Math of AI Seminar*, June 20, 2019.
- Lavieri, P.S., and C.R. Bhat, "Modeling the Adoption, Frequency, and Characteristics of Ride-Hailing Trips in Dallas, Texas." *ASCE International Conference on Transportation & Development (ICTD) 2019*, Alexandria, VA, June 2019.
- Bhat, C.R., "Modeling Individuals' Willingness to Share Trips with Strangers in an Autonomous Vehicle Future." *ASCE International Conference on Transportation & Development (ICTD) 2019*, Alexandria, VA, June 2019.
- Bhat, C.R., "Virtual Activity and Physical Activity Interactions in a CAV Landscape." *ASCE International Conference on Transportation & Development (ICTD) 2019*, Alexandria, VA, June 2019.
- Bhat, C.R., "Travel Demand Management in a Technology-Transformed Transportation Era." Keynote presentation, *9th International Symposium on Travel Demand Management (TDM 2019)*, Edinburgh, U.K., June 2019.
- Dias, F.F., C.R. Bhat, and W.H.K. Lam, "The Evolution of Ride-Hailing Usage in the Puget Sound Region." *9th International Symposium on Travel Demand Management (TDM 2019)*, Edinburgh, U.K., June 2019.
- Nair, G.S., C.R. Bhat, and W.H.K. Lam, "Forecasting of Empty Trips by Ride-Hailing Vehicles." *9th International Symposium on Travel Demand Management (TDM 2019)*, Edinburgh, U.K., June 2019.
- Bhat, C.R., "The Growing Nexus between Computational Data Science and Transportation Science: The Excitement and the Challenges." Keynote presentation, *11th International Workshop on Computational Transportation Science (CTS-2019)*, Tianjin, China, June 2019.
- Shakkottai, S., "Hyper-parameter Tuning for ML Models: An MCTS Approach." Invited Speaker at the *7th ACM MobiHoc Workshop on the Frontiers of Networks: Theory and Algorithms*, Catania, Italy, July 2, 2019.

- Zhang, Y., K. Patel, S. Shakkottai, and Heath Jr., "Side-information-aided Non-coherent Beam Alignment Design for Millimeter Wave Systems." Presented at the *20th International Symposium on Mobile Ad Hoc Networking and Computing (ACM MobiHoc 2019)*, Catania, Italy, July 2019.
- Nevares, J., and N. Ruiz Juri, "Benefits and Challenges of Combining Sensor and Probe-Based Data to Quantify the Impacts of Freeway Lane Closures: A Practical Application in Texas." Presented at the *Joint ITE International and Texas District Annual Meeting and Exhibit*, Austin, TX, July 2019.
- Xu, W., N. Ruiz Juri, J. Meyer, J. Duthie, and H. Ross, "Understanding the Impact of Pedestrian Safety Measures Through the Automated Analysis of Data from Traffic Monitoring Cameras." Presented at the *Joint ITE International and Texas District Annual Meeting and Exhibit*, Austin, TX, July 2019.
- Bhat, C.R., "The Driverless Road Ahead." *Invited Seminar*, Illinois Road and Transportation Builders Association (IRTBA) Planning and Design Division (P&D) Annual Conference, Oak Brook, IL, July 2019.
- Bhat, C.R., "The Growing Nexus between Computational Data Science and Transportation Science: The Excitement and the Challenges." *Invited Seminar*, Department of Civil and Environmental Engineering, The Hong Kong Polytechnic University (PolyU), jointly organized with the Hong Kong Society for Transportation Studies (HKSTS), Hong Kong, August 2019.
- Bhat, C.R., "Three-day Workshop on Activity-Based Modeling: Recent Advances and Possible Application to the Hong Kong Region." *Invited Seminar*, Department of Civil and Environmental Engineering, The Hong Kong Polytechnic University (PolyU), Hong Kong, August 2019.
- Bhat, C.R., and A. Verma, "Approaches in Travel Behavior Research for Transportation Planning and Policy Decision Support." *Short Course*, Sponsored by the MHRD Scheme on Global Initiative on Academic Network (GIAN), IISc Bangalore, Bangalore, India, August 2019.
- Dias, F.F., P.S. Lavieri, C.R. Bhat, R.M. Pendyala, and W.H.K. Lam, "The Interplay between Virtual and In-Person Activity Engagement: The Case of Shopping and Eating Meals," *6th International Choice Modelling Conference (ICMC 2019)*, Kobe, Japan, August 2019.
- Lavieri, P.S., F.F. Dias, C.R. Bhat, S. Sharda, and R.M. Pendyala, "Modeling Respondent Self-Selection Biases in the Choice for Travel Diary Reporting Instrument: The Smartphone Effects." *6th International Choice Modelling Conference (ICMC 2019)*, Kobe, Japan, August 2019.
- Shakkottai, S., "Hyper-parameter Tuning for ML Models: An MCTS Approach." *SINE Seminar*, Coordinated Science Laboratory, University of Illinois at Urbana-Champaign (UIUC), August 26, 2019.
- Humphreys, T., "Insights from Two Years of GNSS Interference Observations from Space." PNT Security and Robustness Panel, *Institute of Navigation GNSS+ 2019 Meeting*, Miami, FL, September 2019.
- Humphreys, T., "Belt-and-suspenders PNT for Self-driving Cars and Air Taxis." Navigating Smart and Connected Cities Panel, *Institute of Navigation GNSS+ 2019 Meeting*, Miami, FL, September 2019.
- Murrian, M.J., L. Narula, and T.E. Humphreys, "Characterizing Terrestrial GNSS Interference from Low Earth Orbit." *Institute of Navigation GNSS+ 2019 Meeting*, Miami, FL, September 2019.
- Bhat, C.R., "Emerging New Choice Analysis Directions and Challenges in a Fast Evolving Technological Environment." Keynote presentation, *8th Conference of the European Association for Research in Transportation (hEART)*, Budapest, Hungary, September 2019.

Websites:

<http://dstop.utexas.edu>, D-STOP website
<http://ctr.utexas.edu/>, Center for Transportation Research (CTR)
<http://ctr.utexas.edu/nmc/>, Network Modeling Center at CTR
<http://www.datarodeo.org/>, Data Rodeo, A Data Analytics Environment for the Central Texas Region
<http://wncg.org/>, Wireless Networking & Communications Group (WNCG)
http://www.caee.utexas.edu/prof/bhat/fULL_PAPERS.htm, Dr. Bhat's personal webpage
<http://tinyurl.com/steveboyles/>, Dr. Boyles' personal webpage
<http://www.profheath.org/>, Dr. Heath's personal webpage

Technologies or techniques: Nothing to report for this period.

Inventions, patent applications, and licenses: Nothing to report for this period.

Other products: Nothing to report for this period.

3. PARTICIPANTS & COLLABORATING ORGANIZATIONS

What organizations have been involved as partners?

City of Austin, Austin, TX: In-kind support, technical consultancy
Texas Department of Transportation, Austin, TX: In-kind support, financial support
North Central Texas Council of Governments (NCTCOG): financial support
Huawei Technologies, USA: In-kind support, technical consultancy
Cintra, In-kind support, financial support
Nuria G. Prelcic, Universidade de Vigo, Department of Signal Theory and Communications, Vigo, Spain:
Technical consultancy.
Sergiy A. Vorobyov, Dept of Signal Processing and Acoustics, Aalto University, Espoo, Finland: Technical
consultancy
Amine Mezghani, Dept of Electrical and Computer Engineering University of Texas at Austin: Technical
consultancy
Kirthevasan Kandasamy, School of Computer Science, Carnegie Mellon University: Technical
consultancy
Texas Advanced Computing Center (TACC), University of Texas at Austin, technical consultancy
Honda R&D Americas, technical consultancy
Samsung Research America: technical consultancy
Toyota, technical consultancy
Qualcomm, technical consultancy
Sandia National Lab, technical consultancy

Have other collaborators or contacts been involved?

D-STOP has allowed us to build new relationships, including a contract with TxDOT San Antonio District to assist with DTA modeling, and also a new task with TxDOT Austin District to help with planning to use advanced modeling.

We have made DSTOP known to industrial affiliates of the Wireless Networking & Communications Group (WNCG): Crown Castle; Cisco; Huawei; Qualcomm; DOCOMO; Department of Defense; AT&T; CoomScope; National Instruments; Samsung; Yokagawa; Universidade de Vigo, Spain; Toyota; Iteris; Microsoft Research; 3M Traffic Safety Systems; RideScout.

We have also discussed DSTOP with several public agencies who have come on board as members of the D-STOP Business Advisory Council (BAC). These include North Central Texas Council of Governments (NCTCOG), Capital Metro, Austin Chamber of Commerce, the City of Austin, Texas, FHWA Texas Division, and the Texas Dept of Transportation.

4. IMPACT

Impact on the development of the principal disciplines of the program:

D-STOP projects have contributed to ways in which traffic mobility and reliability may be improved through a heterogeneous system of wireless sensors. They have also demonstrated how smart technologies can promote ride-hailing and traffic road safety. A recent matching fund TxDOT project is developing sensor-based mechanisms to improve traffic safety during extreme weather conditions.

Impact on other disciplines:

The D-STOP research projects involve collaborations with faculty in other disciplines, including Electrical Engineering, Computer Science, Digital Humanities, Information Technology and English. Several demonstrations and presentations contribute in substantive ways to incorporate the human element in the fast developing technology landscape.

Impact on the transportation workforce development:

Continuing to prepare the leaders of tomorrow through undergraduate and graduate student research and education. Our students obtain experiential training in real-world problems through our research interactions with practice-oriented agencies such as Capital Area Metropolitan Planning Organization (CAMPO), North Central Texas Council of Governments (NCTCOG), Cintra, and TxDOT. As part of D-STOP activities, we have reached out to high school students in the Austin region, providing a glimpse of the exciting transportation research landscape.

Impact on physical, institutional, and information resources at the university or other partner institutions:

Contributed to the establishment of the Good Systems Bridging Barriers theme at UT Austin. The Good Systems theme focuses on how best to choreograph the evolution of technology to meet the needs of society. Dr. Bhat is one of eight leaders in this effort, which officially kicked off in September 2019.

Impact on technology transfer:

Developed a travel model system that incorporates ride-hailing and autonomous vehicle technologies in collaboration with the North Central Texas Council of Governments (NCTCOG) and Cintra.

Impact on society beyond science and technology:

The models developed under DSTOP-supported research can lead to more efficient and safe use of transportation infrastructure, decreasing congestion, improving roadway safety, and supporting the economic competitiveness of the nation. It also contributes to assessing the impact of autonomous vehicles on activity travel patterns, as a means of design proactive policies and regulations in the emerging driverless vehicle era.

5. CHANGES/PROBLEMS

Nothing to report.

UTC-UI 2019 SUMMER SYMPOSIUM SERIES

Date/Time	Lecturer	Room
Tuesday, May 28 11:30-12:30 pm 12:30-1:30 pm	UTC-UI 2019 Orientation and Welcome Reception Orientation Session Welcome Reception	ECJ 6 th Fl, Rm 6.706 ECJ 4 th Fl, Rm 4.304
Tuesday, June 4 1:00-2:00pm	Prof. Amit Bhasin , Transportation Engineering “The Rocket Science used in the Design of Pavements and Materials”	ECJ 6.706
Tuesday, June 11 1:00-2:00pm	Prof. Kara Kockelman , Transportation Engineering “Anticipating a World of Shared Autonomous Vehicles: Cost, Energy, and Urban Implications”	ECJ 6.706
Tuesday, June 18 1:00-2:00pm	Prof. Randy Machemehl , Transportation Engineering “Bicycle Safety”	ECJ 6.706
Tuesday, June 25 1:00-2:00pm	Prof. Zhanmin Zhang , Transportation Engineering “Managing Transportation Infrastructure Assets”	ECJ 6.706
Tuesday, July 2 1:00-2:00pm	Prof. Christian Claudel , Transportation Engineering “Data Assimilation and Optimal Control in the Context of UAV-based Flash Flood Monitoring”	ECJ 6.706
Tuesday, July 9 1:00-2:30pm	UTC-UI Presentations 1 UTC-UI Interns	ECJ 4.304
Tuesday, July 16 1:00-2:00pm	Mr. Kirk Fauver , Federal Highway Administration, TX Division “New Transportation Paradigm Shifts in the 21 st Century”	ECJ 6.706
Tuesday, July 23 1:00-2:00pm	Dr. Heena Rathore , Hiller Measurements “Data Analytics for Cooperative Intelligent Transport Systems”	ECJ 6.706
Tuesday, July 30 1:00-2:00pm	Prof. Jorge Prozzi , Transportation Engineering “Research Issues in Pavement Engineering”	ECJ 6.706
Tuesday, August 6 1:00-2:00pm	Prof. Steve Boyles , Transportation Engineering “Transportation, Networks, and Paradoxes”	ECJ 6.706
Friday, August 9 1:00-2:00 pm 2:00-3:00 pm	UTC-UI 2019 Final Presentations & Farewell Reception Final Intern Presentations Farewell Reception	ECJ 4.304