Program Progress Performance Report

Submitted to:	U.S. Department of Transportation Office of the Assistant Secretary for Research and Technology
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Project Title:	Data-Supported Transportation Operations and Planning (D-STOP) Center
Program Director:	Chandra Bhat, Director, bhat@mail.utexas.edu, 512-471-4535
Submitting Official:	Lisa Macias, Executive Assistant, lisaweyant@mail.utexas.edu, 512-232-6272
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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 28 projects were pursued with partial or full funding support from D-STOP. Of these, 13 projects were completed during this reporting period. Currently, 15 projects are underway.

Completed Projects

1. **Transportation Data Discovery Environment**
   (PI: Natalia Ruiz Juri); End date: August 31, 2018

2. **Using Collected Data to Improve Dynamic Traffic Assignment Modeling**
   (PI: Natalia Ruiz Juri); End date: August 31, 2018

3. **Spatial Correlation Estimation of Millimeter Vehicular Communication Channels Using Out-of-Band Information**
   (PI: Robert Heath); End date: August 31, 2018

4. **Joint Millimeter-Wave Communication and Radar for Automotive Applications**
   (PI: Robert Heath); End date: August 31, 2018

5. **ADAS Enhanced by 5G Connectivity**
   (PI: Todd Humphreys); End date: September 30, 2018

6. **Capturing the Impacts of Ride-sourcing and HOVs**
   (PI: Chandra Bhat); End date: September 30, 2018

7. **Transition Period from Today to Fully Autonomous**
   (PI: Natalia Ruiz Juri); End date: September 30, 2018

8. **Statistical Inference Using Stochastic Gradient Descent**
   (PI: Constantine Caramanis); End date: August 31, 2018

9. **Clustering and Classification**
   (PI: Constantine Caramanis); End date: August 31, 2018

10. **Bandit Algorithms for Online Learning and Resource Allocation**
    (PI: Sanjay Shakkottai); End date: August 31, 2018

11. **V2X Spectrum Resource Allocation for Sensing and Communications**
    (PI: Sanjay Shakkottai); End date: August 31, 2018

12. **New Microeconomic Theory-Based Model for Ranking Data**
    (PI: Chandra Bhat); End date: September 30, 2018

13. **Megaregional Trends of Passenger and Freight Movement: Evidence from National Transportation Data Sources**
    (PI: Ming Zhang); End date: September 30, 2018

Ongoing Projects

1. **Real-Time Signal Control and Traffic Stability**
   (PI: Stephen Boyles); Anticipated end date: August 31, 2019

2. **Internet of Moving Things using Full Duplex Mesh Networks**
   (PI: Sriram Vishwanath); Anticipated end date: December 31, 2018

3. **Improved Models for Managed Lane Operations**
   (PI: Stephen Boyles); Anticipated end date: August 31, 2019

4. **Explorations to Inform V2I Managed Lanes Design and Development**
   (title updated from *V2I Managed Lanes Test Bed*)
   (PI: Natalia Ruiz Juri); Anticipated end date: February 28, 2019

5. **Transit Policy in the Context of New Transportation Paradigms**
   (PI: Natalia Ruiz Juri); Anticipated end date: September 30, 2019

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

7. **Data-Driven, Real-Time Traffic Signal Optimization: A Distributed Approach**
   (PI: Stephen Boyles); Anticipated end date: September 30, 2020

8. **Real-time, Targeted Incentives for Strategic Travelers**
   (PI: Stephen Boyles); Anticipated end date: September 30, 2020

9. **Tight-coupling of Vision, Radar, and Carrier-phase Differential GNSS for Robust All-weather Positioning**
   (PI: Todd Humphreys); Anticipated end date: September 30, 2020

10. **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

11. **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

12. **Sensing and Communications in V2V and V2I Settings**
    (PI: Sanjay Shakkottai); Anticipated end date: September 30, 2020

13. **Online Matching, Black-box Optimization and Hyper-parameter Tuning**
    (PI: Sanjay Shakkottai); Anticipated end date: September 30, 2020

14. **Solving Perception Challenges for Autonomous Vehicles Using SGD**
    (PI: Constantine Caramanis); Anticipated end date: September 30, 2020

15. **Large Scale Optimization with Small Scale Data**
    (PI: Constantine Caramanis); Anticipated end date: September 30, 2020

Research Results Disseminated: 18 papers were published and 11 papers are forthcoming in refereed journals based on the research projects associated with D-STOP. Several other papers are in the review process. 39 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 featured by MetroLab as the innovation of the month: "Analytics Tool Helps Improve Traffic Planning in Austin" Government Technology Magazine.
http://www.govtech.com/transportation/MetroLab-Innovation-of-the-Month-September-2018.html

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 the North Central Texas Council of Governments (NCTCOG). Undertake ongoing supporting research funded through the Texas Department of Transportation and Cintra.

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

Rachel Cooper, Justin Kinne, Daniel Guerrero, Andrea Vickers, Aarti Bhat, Gretchen Bella (supervised by Chandra Bhat)
James Lentz, Tejas Choudhary, Mark Stahl, Mathias Hanssen (supervised by Stephen Boyles)
Andrew Chou, Maximilian Grether, Martin Vicente (supervised by Natalia Ruiz Juri)
Jake Nimergood, Sai Annaluru, Sean Trembley (supervised by Robert Heath)
Sterling Burdine (supervised by Chris Claudel)

Grad

Supervised by Chandra Bhat: Sebastian Astroza (PhD), Felipe Dias (PhD), Joseph Hutchinson (MS), Patricia Lavieri (PhD), Kamryn Long (MS), Gopindra Nair (PhD), Abhilash Singh (MS).
Supervised by Stephen Boyles: William Alexander (MS), Can Gokalp (PhD), Dongxu (Henry) He (MS), Rachel James (PhD), Venktesh Pandey (PhD), Rahul Patel (MS), Priyadarshan Patil (PhD), Prashanth Venkatraman (MS), Cesar Yahia (MS), Tengkuo Zhu (PhD).
Supervised by Chris Claudel: Abduallah Mohamed (MS).
Supervised by Ming Zhang: Caleb Roberts (MS).
Supervised by Constantine Caramanis: Eirini Asteri (PhD), Tianyang Li (PhD), Liu Liu (PhD).
Supervised by Robert Heath: Anum Ali (PhD), Preeti Kumari (PhD), Khurram Mazher (PhD), Sungwoo Park (PhD), Vutha Va (PhD), Yuyang Wang (PhD), Ratbek Zhapparov (MS).
Supervised by Todd Humphreys: Daniel LaChapelle (PhD), Matthew Murrian (PhD), Lakshay Narula (MS/PhD).
Supervised by Sanjay Shakkottai: Soumya Basu (PhD).
Supervised by Joydeep Ghosh: Rahi Kalantari (PhD), Taewan Kim (PhD), Michael Motro (PhD), Jinsoo Park (MS).

2018 Summer Internship: We welcomed six undergraduate summer interns to our transportation program, with three of them supported by D-STOP, in the fifth University Transportation Center-Undergraduate Internship (UTC-UI) hosted at The University of Texas at Austin. The D-STOP interns were Rachel Cooper (from U. of Michigan), Sterling Burdine (from UT Austin), and James Lentz (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 and ITS America.

University Transportation Center-Undergraduate Internship (UTC-UI) Welcome Lunch, 5/29/18

Final Intern Presentations (Rachel Cooper w. Dr. Boyles, UTC-UI Faculty Coordinator for D-STOP), 8/10/18

Our 2018 Summer Interns! (L to R: Dr. Boyles, with Maria Cardenas, James Lentz, Sydney Abrisz, Yifan Ling, Rachel Cooper, and Sterling Burdine), 8/10/18

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.

Education and Workforce Development Results Disseminated:

Combined D-STOP/UT-SAVES Meeting
The 2018 D-STOP Business Advisory Council (BAC) meeting and Symposium, in combination with the meeting of the UT-SAVES (for UT- Situation-Aware Vehicular Engineering Systems) Center, was held April 11, 2018 (see attached agenda). This was the second board meeting of UT SAVES and the third D-STOP BAC meeting. UT-SAVES was an outgrowth of the D-STOP Center activities, and is a collaboration between the Wireless Networking and Communications Group (WNCG) and the Center for Transportation Research (CTR). Specifically, UT-SAVES combines WNCG's expertise in wireless networking and communications, data and signal processing, with CTR's experience in transportation, traffic modeling, and policy and planning to help reduce collisions, design faster commutes, and increase connectivity to make the automated aspects of driving more efficient.

The overall purpose of the D-STOP BAC is to help guide the direction of the Center's overall research and education/work force development efforts. With the pairing of the meeting with UT-SAVES, we hope to further integrate wireless communications and transportation issues as we move into the new landscape of automated and connected transportation systems.

The BAC helps (a) provide strategic planning advice to the Center, (b) provide input on Center activities and review/recommend new project statements for research, (c) identify research projects for further collaborative funding and possible implementation beyond Center funding, and (d) facilitate the collaborative process of linking the Center with private, public, and policy entities, and with regional and national activities.

Workshop on Writing Technical Papers
Hosted by the UT student chapter of the Institute of Transportation Engineers, this workshop in June 2018 featured an engaging presentation by Dr. Stephen Boyles. The workshop was geared for UT transportation graduate students, as well as the UTC-UI interns and interested postdocs/recent graduates. More than 30 students attended the event, which included these components:

- Presentations on technical writing, writing journal articles, and on time management and tactical writing strategies to overcome procrastination.
- A panel discussion with senior Ph.D. students and recent graduates on their experiences with publication.
- Short "breakout groups" for discussion and practicing concepts discussed in the presentations.
- A packet of "writing advice" from different researchers Dr. Boyles has collected over the years.

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:
Organize the third board meeting of UT SAVES. In partnership with CTR, WNCG has created this Center to address the challenges of wireless, networking, and sensing in vehicular systems. Continue discussions with the Business Advisory Council (BAC), and organize a fourth BAC meeting along with the 5th D-STOP Symposium in Spring 2019. Begin organization of the sixth University Transportation Center-Undergraduate Internship (UTC-UI) program to be held the summer of 2019.

Initiating conversations with the Mineta Transportation Institute in San Jose CA to design and deliver a STEM outreach program in the Oakland school district.

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

2018 IEEE Green Technologies Conference

The IEEE Green Technologies Conference (GreenTech) was held in Austin, TX at the UT Austin campus on April 4-6, and the 2018 conference theme was "Smart City". This conference aims to address one of the most pressing challenges of our time–securing green and clean energy sources for the 21st century to protect the environment and help build a more resilient power grid.

Natalia Ruiz Juri was a panel organizer for a panel entitled *Enabling Socially Responsible Travel through Technology: Opportunities and Challenges*. This panel discussed social and technological aspects of new technologies and corresponding data. It included representatives from public agencies (City of Austin) and the private sector (Waze, Metropia), and was moderated by Dr. Sherri Greenberg from UT Austin's LBJ School of Public Affairs. For this same conference, James Kuhr organized the panel entitled *A Taste of Future Transportation Technologies in the Real World*, which covered ongoing and prospective pilots to deploy and incentivize the use of innovative technologies in real transportation networks, including autonomous vehicles, electric vehicles and innovative transit solutions. This panel provided the viewpoints of representatives from Austin Energy, the Texas Department of Transportation, Capital Metro (Austin's transit agency), Via (a transportation network company), and the North Central Texas Council of Governments.

Center for Transportation Research (CTR) Annual Symposium

The annual CTR Symposium was held on April 12, 2018, 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. Boyles made a keynote presentation at this symposium on "Preparing for a World of Connected and Automated Vehicles".

CAR-STOP Demonstrations

Three live demonstrations of research being conducted in TxDOT Project 0-6877 entitled "Communications and Radar-Supported Transportation Operations and Planning (CAR-STOP)" were held in early September 2018 to TxDOT and MPO staff. Each demo is a prototype of a cost-effective preventative safety tool for construction teams or other commercial vehicles:

- *Demonstration 1 – Construction Zone*: A stationary camera+radar unit locates all objects in a zone and communicates this information with nearby devices, which can see a bird's-eye view of the zone and are warned when a vehicle may hit a pedestrian.
- *Demonstration 2 – Pedestrian Crossing*: A vehicle equipped with camera, lidar, and radar demonstrates automated detection of nearby pedestrians and alerts the driver when a collision is possible.
- *Demonstration 3 – Highway Merging*: A stopped vehicle is waiting to enter a high-speed road (for example, while exiting a construction zone). It uses vehicle-to-vehicle communication to detect oncoming vehicles and warns the driver when it not safe to merge.

Dr. Bhat participated and contributed to CAV infrastructure plans in the nation as part of the USDOT AV Proving Grounds (AVPG) Community of Practice (CoP) Quarterly Meeting and the San Diego Regional Proving Ground Consortium Meeting: Preparing the Public for Automation, held June 19-20, 2018 in San Diego, CA. He also made a presentation discussing ways to incorporate connected and autonomous vehicles within the current four-step modeling process at the 7th Transportation Research Board Innovations in Travel Modeling (ITM) Conference, held June 24-27, 2018 in Atlanta, GA.

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

Published:

Narula, L., Wooten, J., Murrian, M., LaChapelle, D., Humphreys, T. (2018). Accurate Collaborative Globally-Referenced Digital Mapping with Standard GNSS. *Sensors*, 18(8), 2452.

Humphreys, T.E., Murrian, M., Narula, L. (2018, April). Low-cost precise vehicular positioning in urban environments. In Position, Location and Navigation Symposium (PLANS), 2018 IEEE/ION (pp. 456-471). IEEE. GEOSLAM Collaborative Mapping Software

Rambha, T., S. D. Boyles, A. Unnikrishnan, and P. Stone. (2018) Marginal cost pricing for system optimal traffic assignment with recourse under supply-side uncertainty. *Transportation Research Part B* 110, 104-121.

Shahabi, M., A. Tafreshian, A. Unnikrishnan, and S. D. Boyles. (2018) Joint production-inventory-location problem with correlated demand. *Transportation Research Part B* 110, 60-78.

Melson, C., M. W. Levin, B. Hammit, and S. D. Boyles. (2018) Dynamic traffic assignment of cooperative adaptive cruise control. *Transportation Research Part C* 90, 114-133.

Bansal, P., R. Shah, and S. D. Boyles. Robust network pricing and system optimization under combined long-term stochasticity and elasticity of travel demand. *Transportation* 45(5), 1389-1418.

Bhat, C.R., "New Matrix-Based Methods for the Analytic Evaluation of the Multivariate Cumulative Normal Distribution Function," *Transportation Research Part B*, 109, 238-256, 2018.

Bhat, C.R., "A New Flexible Multiple Discrete-Continuous Extreme Value (MDCEV) Choice Model," *Transportation Research Part B*, 110, 261-279, 2018.

Singh, A.C., S. Astroza, V.M. Garikapati, R.M. Pendyala, C.R. Bhat, and P.L. Mokhtarian, "Quantifying the Relative Contribution of Factors to Household Vehicle Miles of Travel," *Transportation Research Part D*, 63, 23-36, 2018.

Astroza, S., P.C. Bhat, C.R. Bhat, R.M. Pendyala, and V.M. Garikapati, "Understanding Activity Engagement Across Weekdays and Weekend Days: A Multivariate Multiple Discrete-Continuous Modeling Approach," *Journal of Choice Modelling*, 28, 56-70, 2018.

Kumari, P., J. Choi, N. González-Prelcic, and R.W. Heath Jr., "IEEE 802.11ad-based Radar: An Approach to Joint Vehicular Communication-Radar System." *IEEE Transactions on Vehicular Technology*, 67(4), 3012-3027, April 2018. doi: 10.1109/TVT.2017.2774762

Va, V., J. Choi, T. Shimizu, G. Bansal and R.W. Heath Jr., "Impact of Measurement Noise on Millimeter Wave Beam Alignment Using Beam Subsets." *IEEE Wireless Communications Letters, 7(5), 784-787, April 2018*. doi: 10.1109/LWC.2018.2825326

Wesson, K.D., J.N. Gross, T.E. Humphreys, and B. L. Evans, "GNSS Signal Authentication Via Power and Distortion Monitoring." *IEEE Transactions on Aerospace and Electronic Systems*, *54(2), 739-754, April 2018*. doi: 10.1109/TAES.2017.2765258

Rodriguez-Fernandez, J., N. González-Prelcic, K. Venugopal, and R.W. Heath Jr., "Frequency-domain Compressive Channel Estimation for Frequency-selective Hybrid mmWave MIMO Systems." *IEEE Transactions on Wireless Communications*, 17(5), 2946-2960, May 2018. doi: 10.1109/TWC.2018.2804943

Va, V., J. Choi, T. Shimizu, G. Bansal, and R.W. Heath Jr., "Inverse Multipath Fingerprinting for Millimeter Wave V2I Beam Alignment." *IEEE Transactions on Vehicular Technology*, 67(5), 4042-4058, May 2018. doi: 10.1109/TVT.2017.2787627

Eltayeb, M.E., T.Y. Al-Naffouri, and R.W. Heath Jr., "Compressive Sensing for Millimeter Wave Antenna Array Diagnosis." *IEEE Transactions on Communications*, *66(6), 2708-2721, June 2018.* doi: 10.1109/TCOMM.2018.2790403

Basu, S., A. Sundarrajan, J. Ghaderi, S. Shakkottai and R. Sitaraman, "Adaptive TTL-Based Caching for Content Delivery." *IEEE/ACM Transactions on Networking*, *26(3), 1063-1077, June 2018.* doi: 10.1109/TNET.2018.2818468

Narula, L., and T.E. Humphreys, “Requirements for Secure Clock Synchronization." *IEEE Journal of Selected Topics in Signal Processing*, 12(4), 749-762, Aug. 2018. doi: 10.1109/JSTSP.2018.2835772

Forthcoming:

Pandey, V. and Ruiz Juri, N. "Using National Performance Management Research Data Set (NPMRDS) for Corridor Performance Measures: A US-281 N Corridor Case Study." *Transportation Research Record: Journal of the Transportation Research Board*, forthcoming, 2018.

Pandey, V., and S. D. Boyles. Dynamic pricing for managed lanes with multiple entrances and exits. Accepted for publication in *Transportation Research Part C*.

Lukose, E., M. W. Levin, and S. D. Boyles. Incorporating insights from signal optimization into reservation-based intersection controls. Accepted for publication in *Journal of Intelligent Transportation Systems*.

Levin, M. W., H. Smith, and S. D. Boyles. A dynamic four-step planning model of empty repositioning trips for personal autonomous vehicles. Accepted for publication in *Journal of Transportation Engineering*.

Krishnasamy, S., P. T. Akhil, A. Arapostathis, R. Sundaresan and S. Shakkottai, “Augmenting Max-Weight with Explicit Learning for Wireless Scheduling with Switching Costs”. Accepted for publication in *IEEE/ACM Transaction on Networking* 2018.

Astroza, S., V.M. Garikapati, R.M. Pendyala, C.R. Bhat, and P.L. Mokhtarian, "Representing Heterogeneity in Structural Relationships Among Multiple Choice Variables Using a Latent Segmentation Approach." *Transportation*, forthcoming.

Lavieri, P.S., F.F. Dias, N. Ruiz Juri, J. Kuhr, and C.R. Bhat, "A Model of Ridesourcing Demand Generation and Distribution." *Transportation Research Record*, forthcoming.

Lavieri, P.S., Q. Dai, and C.R. Bhat, "Using Virtual Accessibility and Physical Accessibility as Joint Predictors of Activity-Travel Behavior." *Transportation Research Part A*, forthcoming.

Nair, G.S., S. Astroza, C.R. Bhat, S. Khoeini and R.M. Pendyala, "An Application of a Rank Ordered Probit Modeling Approach to Understanding Level of Interest in Autonomous Vehicles." *Transportation*, 2018 TRB Annual Meeting Special Issue, forthcoming.

Vinayak, P., F.F. Dias, S. Astroza, C.R. Bhat, R.M. Pendyala, and V.M. Garikapati, "Accounting for Multi-Dimensional Dependencies Among Decision-Makers Within a Generalized Model Framework: An Application to Understanding Shared Mobility Service Usage Levels." *Transport Policy*, forthcoming.

Meirom, E.A., C. Caramanis, S. Mannor, A. Orda, and S. Shakkottai, "Detecting Cascades from Weak Signatures." *IEEE Transactions on Network Science and Engineering*, forthcoming. doi: 10.1109/TNSE.2017.2764444

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

Presented:

Boyles, S., "Preparing for a World of Connected and Automated Vehicles," *Center for Transportation Research Annual Symposium*, Austin, TX, April 2018.

Motro, M., "Object Tracking with Low-Res Lidar and Single Camera," Poster presented at the *Center for Transportation Research (CTR) Annual Symposium*, Austin, TX, April 2018.

Pandey, V., “Processing Large-scale Video Data to Support Transportation Safety, Planning, and Operations: a Flexible Approach to Data Storage and Integration," Poster presented at the *Center for Transportation Research (CTR) Annual Symposium*, Austin, TX, April 2018.

Singh, A.C., “Quantifying the Contribution of Various Factors to Household Vehicle Miles of Travel," Poster presented at the *Center for Transportation Research (CTR) Annual Symposium*, Austin, TX, April 2018.

Boyles, S., "Status of two projects: Real-time Signal Control and Traffic Stability; Improved Models for Managed Lane Operations,” *D-STOP/UT-SAVES Meeting*, Austin, TX, April 2018.

Caramanis, C., L. Liu, A. Kyrillidis, and T. Li, “Statistical Inference Using Stochastic Gradient Descent,” *D-STOP/UT-SAVES Meeting*, Austin, TX, April 2018.

Heath Jr., R.W., “Advances in Millimeter Wave for V2X,” *D-STOP/UT-SAVES Meeting*, Austin, TX, April 2018.

Huhmphreys, T., Narula, L., M. Murrian, and D. Lachapelle, “Collaborative Sensing for Automated Vehicles,” *D-STOP/UT-SAVES Meeting*, Austin, TX, April 2018.

Kuhr, J., “CAV/Mixed Transportation Modeling,” *D-STOP/UT-SAVES Meeting*, Austin, TX, April 2018.

Ruiz Juri, N., “Sharing Novel Data Sources to Promote Innovation through Collaboration: Case Studies in Austin TX,” *D-STOP/UT-SAVES Meeting*, Austin, TX, April 2018.

Shakkottai,S., “Regret of Queueing Bandits,” *D-STOP/UT-SAVES Meeting*, Austin, TX, April 2018.

Sen, R., K. Shanmugam and S. Shakkottai, “Contextual Bandits with Stochastic Experts”. Proceedings of the 21st Annual Conference on Artificial Intelligence and Statistics (AISTATS 2018), Canary Islands, April 2018.

Kumari, P., S.A. Vorobyov, R.W. Heath, Jr. “Virtual Pulse Design for IEEE 802.11ad-Based Joint Communication-Radar”. *IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP) 2018*, Alberta, Canada, April 2018.

Upadhya, K., S.A. Vorobyov, R.W. Heath, Jr. “Low-Overhead Receiver-side Channel Tracking for mmWave MIMO” *IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP) 2018*, Alberta, Canada, April 2018.

Kumari, P., M.E. Eltayeb, R.W. Heath, Jr. “Sparsity-Aware Adaptive Beamforming Design for IEEE 802.11ad-based Joint Communication-Radar”. *2018 IEEE Radar Conference (RadarConf)*, Oklahoma City, OK, April 2018.

Rodriguez-Fernandez, J., N. Gonzalez-Prelcic and R. W. Heath, "Channel Estimation for Millimeter Wave MIMO Systems in the Presence of CFO Uncertainties," *2018 IEEE International Conference on Communications (ICC)*, Kansas City, MO, May 2018.

Kumari, P., K. Usman, A. Mezghani, R.W. Heath, Jr. “Low Resolution Sampling for Joint Millimeter-Wave MIMO Communication-Radar”. *IEEE Statistical Signal Processing (SSP) Workshop 2018*, Freiburg, Germany, June 2018.

Boyles, S., and N. Ruiz Juri. (2018) Understanding the tradeoffs between DTA models’ realism and robustness: the impact of spillback modeling. *7th International Symposium on Dynamic Traffic Assignment (DTA2018)*, Hong Kong, China, June 2018.

Xu, W., Ruiz Juri, N., Hunag, R., Duthie, J., Clary, J. “Automated pedestrian safety analysis using data from traffic monitoring cameras”. *ACM’s Smart Cities and Communities (SCC) 2018*, Portland, OR, June 2018.

Bhat, C.R., "A “True” Multiple Discrete-Continuous Extreme Value (MDCEV) Choice Model," *7th Transportation Research Board Innovations in Travel Modeling (ITM) Conference*, Atlanta, GA, June 2018.

Bhat, C.R., and S. Astroza, "A Spatial Multiple Discrete-Continuous Model with a Multivariate Skew-Normal Distribution for the Kernel Error Term and Unobserved Heterogeneit**y**," *7th Transportation Research Board Innovations in Travel Modeling (ITM) Conference*, Atlanta, GA, June 2018.

Bhat, C.R., and P.S. Lavieri, "Modeling Willingness-to-Share Trips in an Autonomous Vehicle Future: A Stochastic Psychological Latent Construct Approach," *7th Transportation Research Board Innovations in Travel Modeling (ITM) Conference*, Atlanta, GA, June 2018.

Bhat, C.R., F.F. Dias, G.S. Nair, J. Kuhr, N. Ruiz-Juri, and A. Mirzaei, "Incorporating Connected and Autonomous Vehicles and Ride-Hailing Services in the Traditional Four Step Model," *7th Transportation Research Board Innovations in Travel Modeling (ITM) Conference*, Atlanta, GA, June 2018.

Bhat, C.R., "Consumer Choice Modeling: The Promises and the Cautions," Keynote presentation, *15th International Conference on Travel Behaviour Research*, Santa Barbara, CA, July 2018.

Bhat, C.R., G.S. Nair, and R.M. Pendyala, "Alternative Decision Mechanisms to Model Ranking Data," *15th International Conference on Travel Behaviour Research*, Santa Barbara, CA, July 2018.

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Khoeini, S., D. Capasso Da Silva, S. Sharda, R.M. Pendyala, and C.R. Bhat, "An Exploration of the Role of Childhood Context and Experiences in Shaping Attitudes and Travel Behavior in Adulthood," *15th International Conference on Travel Behaviour Research*, Santa Barbara, CA, July 2018.

Khoeini, S., S. Sharda, D. Capasso Da Silva, R.M. Pendyala, and C.R. Bhat, "Unraveling the Relationship between Attitudes and Behavioral Choices Using a Latent Segmentation Approach," *15th International Conference on Travel Behaviour Research*, Santa Barbara, CA, July 2018.

Khoeini, S., D. Capasso Da Silva, T. Kim, R.M. Pendyala, and C.R. Bhat, "Are Millennials Really Different in Their Activity-Travel and Time Use Behaviors?," *15th International Conference on Travel Behaviour Research*, Santa Barbara, CA, July 2018.

Lavieri, P.S., and C.R. Bhat, "Combining Individual and Group Representations of Taste Heterogeneity to Evaluate Consumer’s Perceptions of Safety and Intention to Adopt Autonomous Vehicle Technology: A latent-variable and latent-class approach," *15th International Conference on Travel Behaviour Research*, Santa Barbara, CA, July 2018.

Nair, G. S., C.R. Bhat, and N. Ruiz-Juri, "Evaluation of Techniques based on Vehicle-to-Infrastructure Communication to Optimize Traffic Flow after a Freeway Incident," ASCE International Conference on Transportation & Development (ICTD 2018), Pittsburgh, PA, July 2018.

Motro, M., and J. Ghosh, “Measurement-Wise Occlusion in Multi-Object Tracking,” *2018 21st International Conference on Information Fusion (FUSION)*, Cambridge, UK, July 2018.

Bhat, C.R., J. Hutchinson, and F.F. Dias, "The Changing Nature of the Activity-Travel Behavior of the Elderly," National Household Travel Survey (NHTS) Data for Transportation Applications Workshop, Washington D.C., August 2018.

Singh, A.C., K. Abel, J. Hutchinson, K. Faust, and C.R. Bhat, "Food Access for Low Income Individuals," National Household Travel Survey (NHTS) Data for Transportation Applications Workshop, Washington D.C., August 2018.

Lavieri, P.S., and C.R. Bhat, "Modeling Individuals' Willingness to Share Trips with Strangers in an Autonomous Vehicle Future," *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 2018.

Bhat, C.R., "Three-day Workshop on How to Write a Paper for Submission to a Refereed Scholarly Journal," *Invited Workshop*, Department of Civil and Environmental Engineering, The Hong Kong Polytechnic University (PolyU), Hong Kong, August 2018.

Bhat, C.R., and P.S. Lavieri, "The Interplay of Virtual Accessibility and Physical Accessibility in Shaping Activity-travel Behavior," *Invited Seminar*, Institute of Transport Studies and the Department of Geography, The University of Hong Kong (HKU), Hong Kong, August 2018.

Bhat, C.R., "Connected and Autonomous Vehicles: The Uncertain Driverless Road Ahead," *Invited Seminar*, Focus on the Future of Personal Lines Workshop, American Association of Insurance Services (AAIS), Atlanta, GA, August 2018.

Lavieri, P.S., and C.R. Bhat, "On Willingness to Share Trips in an Autonomous Vehicle Future," *Invited Seminar*, UIC Civil and Materials Engineering, University of Illinois at Chicago, Chicago, IL, September 2018.

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 2018 Texas Wireless Summit to be held November 6, 2018 at UT Austin (The faculty organizers for TWS 2018 are WNCG Professors Constantine Caramanis and Sujay Sanghavi). The Texas Wireless Summit (TWS) is hosted by the Wireless Networking and Communications Group (WNCG), Dept of Electrical and Computer Engineering. Organize the 4th Data Supported Transportation Operations and Planning (D-STOP) Symposium to be held in Spring 2019. Organize a Center for Transportation Research (CTR) Symposium to be held in Spring 2019.

2. PRODUCTS

Publications, conference papers, and presentations:

Journal Publications - Published

Narula, L., Wooten, J., Murrian, M., LaChapelle, D., Humphreys, T. (2018). Accurate Collaborative Globally-Referenced Digital Mapping with Standard GNSS. *Sensors*, 18(8), 2452.

Humphreys, T.E., Murrian, M., Narula, L. (2018, April). Low-cost precise vehicular positioning in urban environments. In Position, Location and Navigation Symposium (PLANS), 2018 IEEE/ION (pp. 456-471). IEEE. GEOSLAM Collaborative Mapping Software

Rambha, T., S. D. Boyles, A. Unnikrishnan, and P. Stone. (2018) Marginal cost pricing for system optimal traffic assignment with recourse under supply-side uncertainty. *Transportation Research Part B* 110, 104-121.

Shahabi, M., A. Tafreshian, A. Unnikrishnan, and S. D. Boyles. (2018) Joint production-inventory-location problem with correlated demand. *Transportation Research Part B* 110, 60-78.

Melson, C., M. W. Levin, B. Hammit, and S. D. Boyles. (2018) Dynamic traffic assignment of cooperative adaptive cruise control. *Transportation Research Part C* 90, 114-133.

Bansal, P., R. Shah, and S. D. Boyles. Robust network pricing and system optimization under combined long-term stochasticity and elasticity of travel demand. *Transportation* 45(5), 1389-1418.

Bhat, C.R., "New Matrix-Based Methods for the Analytic Evaluation of the Multivariate Cumulative Normal Distribution Function," *Transportation Research Part B*, 109, 238-256, 2018.

Bhat, C.R., "A New Flexible Multiple Discrete-Continuous Extreme Value (MDCEV) Choice Model," *Transportation Research Part B*, 110, 261-279, 2018.

Singh, A.C., S. Astroza, V.M. Garikapati, R.M. Pendyala, C.R. Bhat, and P.L. Mokhtarian, "Quantifying the Relative Contribution of Factors to Household Vehicle Miles of Travel," *Transportation Research Part D*, 63, 23-36, 2018.

Astroza, S., P.C. Bhat, C.R. Bhat, R.M. Pendyala, and V.M. Garikapati, "Understanding Activity Engagement Across Weekdays and Weekend Days: A Multivariate Multiple Discrete-Continuous Modeling Approach," *Journal of Choice Modelling*, 28, 56-70, 2018.

Kumari, P., J. Choi, N. González-Prelcic, and R.W. Heath Jr., "IEEE 802.11ad-based Radar: An Approach to Joint Vehicular Communication-Radar System." *IEEE Transactions on Vehicular Technology*, 67(4), 3012-3027, April 2018. doi: 10.1109/TVT.2017.2774762

Va, V., J. Choi, T. Shimizu, G. Bansal and R.W. Heath Jr., "Impact of Measurement Noise on Millimeter Wave Beam Alignment Using Beam Subsets." *IEEE Wireless Communications Letters, 7(5), 784-787, April 2018*. doi: 10.1109/LWC.2018.2825326

Wesson, K.D., J.N. Gross, T.E. Humphreys, and B. L. Evans, "GNSS Signal Authentication Via Power and Distortion Monitoring." *IEEE Transactions on Aerospace and Electronic Systems*, *54(2), 739-754, April 2018*. doi: 10.1109/TAES.2017.2765258

Rodriguez-Fernandez, J., N. González-Prelcic, K. Venugopal, and R.W. Heath Jr., "Frequency-domain Compressive Channel Estimation for Frequency-selective Hybrid mmWave MIMO Systems." *IEEE Transactions on Wireless Communications*, 17(5), 2946-2960, May 2018. doi: 10.1109/TWC.2018.2804943

Va, V., J. Choi, T. Shimizu, G. Bansal, and R.W. Heath Jr., "Inverse Multipath Fingerprinting for Millimeter Wave V2I Beam Alignment." *IEEE Transactions on Vehicular Technology*, 67(5), 4042-4058, May 2018. doi: 10.1109/TVT.2017.2787627

Eltayeb, M.E., T.Y. Al-Naffouri, and R.W. Heath Jr., "Compressive Sensing for Millimeter Wave Antenna Array Diagnosis." *IEEE Transactions on Communications*, *66(6), 2708-2721, June 2018.* doi: 10.1109/TCOMM.2018.2790403

Basu, S., A. Sundarrajan, J. Ghaderi, S. Shakkottai and R. Sitaraman, "Adaptive TTL-Based Caching for Content Delivery." *IEEE/ACM Transactions on Networking*, *26(3), 1063-1077, June 2018.* doi: 10.1109/TNET.2018.2818468

Narula, L., and T.E. Humphreys, “Requirements for Secure Clock Synchronization." *IEEE Journal of Selected Topics in Signal Processing*, 12(4), 749-762, Aug. 2018. doi: 10.1109/JSTSP.2018.2835772

Presentations

Boyles, S., "Preparing for a World of Connected and Automated Vehicles," *Center for Transportation Research Annual Symposium*, Austin, TX, April 2018.

Motro, M., "Object Tracking with Low-Res Lidar and Single Camera," Poster presented at the *Center for Transportation Research (CTR) Annual Symposium*, Austin, TX, April 2018.

Pandey, V., “Processing Large-scale Video Data to Support Transportation Safety, Planning, and Operations: a Flexible Approach to Data Storage and Integration," Poster presented at the *Center for Transportation Research (CTR) Annual Symposium*, Austin, TX, April 2018.

Singh, A.C., “Quantifying the Contribution of Various Factors to Household Vehicle Miles of Travel," Poster presented at the *Center for Transportation Research (CTR) Annual Symposium*, Austin, TX, April 2018.

Boyles, S., "Status of two projects: Real-time Signal Control and Traffic Stability; Improved Models for Managed Lane Operations,” *D-STOP/UT-SAVES Meeting*, Austin, TX, April 2018.

Caramanis, C., L. Liu, A. Kyrillidis, and T. Li, “Statistical Inference Using Stochastic Gradient Descent,” *D-STOP/UT-SAVES Meeting*, Austin, TX, April 2018.

Heath Jr., R.W., “Advances in Millimeter Wave for V2X,” *D-STOP/UT-SAVES Meeting*, Austin, TX, April 2018.

Huhmphreys, T., Narula, L., M. Murrian, and D. Lachapelle, “Collaborative Sensing for Automated Vehicles,” *D-STOP/UT-SAVES Meeting*, Austin, TX, April 2018.

Kuhr, J., “CAV/Mixed Transportation Modeling,” *D-STOP/UT-SAVES Meeting*, Austin, TX, April 2018.

Ruiz Juri, N., “Sharing Novel Data Sources to Promote Innovation through Collaboration: Case Studies in Austin TX,” *D-STOP/UT-SAVES Meeting*, Austin, TX, April 2018.

Shakkottai,S., “Regret of Queueing Bandits,” *D-STOP/UT-SAVES Meeting*, Austin, TX, April 2018.

Sen, R., K. Shanmugam and S. Shakkottai, “Contextual Bandits with Stochastic Experts”. Proceedings of the 21st Annual Conference on Artificial Intelligence and Statistics (AISTATS 2018), Canary Islands, April 2018.

Kumari, P., S.A. Vorobyov, R.W. Heath, Jr. “Virtual Pulse Design for IEEE 802.11ad-Based Joint Communication-Radar”. *IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP) 2018*, Alberta, Canada, April 2018.

Upadhya, K., S.A. Vorobyov, R.W. Heath, Jr. “Low-Overhead Receiver-side Channel Tracking for mmWave MIMO” *IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP) 2018*, Alberta, Canada, April 2018.

Kumari, P., M.E. Eltayeb, R.W. Heath, Jr. “Sparsity-Aware Adaptive Beamforming Design for IEEE 802.11ad-based Joint Communication-Radar”. *2018 IEEE Radar Conference (RadarConf)*, Oklahoma City, OK, April 2018.

Rodriguez-Fernandez, J., N. Gonzalez-Prelcic and R. W. Heath, "Channel Estimation for Millimeter Wave MIMO Systems in the Presence of CFO Uncertainties," *2018 IEEE International Conference on Communications (ICC)*, Kansas City, MO, May 2018.

Kumari, P., K. Usman, A. Mezghani, R.W. Heath, Jr. “Low Resolution Sampling for Joint Millimeter-Wave MIMO Communication-Radar”. *IEEE Statistical Signal Processing (SSP) Workshop 2018*, Freiburg, Germany, June 2018.

Boyles, S., and N. Ruiz Juri. (2018) Understanding the tradeoffs between DTA models’ realism and robustness: the impact of spillback modeling. *7th International Symposium on Dynamic Traffic Assignment (DTA2018)*, Hong Kong, China, June 2018.

Xu, W., Ruiz Juri, N., Hunag, R., Duthie, J., Clary, J. “Automated pedestrian safety analysis using data from traffic monitoring cameras”. *ACM’s Smart Cities and Communities (SCC) 2018*, Portland, OR, June 2018.

Bhat, C.R., "A “True” Multiple Discrete-Continuous Extreme Value (MDCEV) Choice Model," *7th Transportation Research Board Innovations in Travel Modeling (ITM) Conference*, Atlanta, GA, June 2018.

Bhat, C.R., and S. Astroza, "A Spatial Multiple Discrete-Continuous Model with a Multivariate Skew-Normal Distribution for the Kernel Error Term and Unobserved Heterogeneit**y**," *7th Transportation Research Board Innovations in Travel Modeling (ITM) Conference*, Atlanta, GA, June 2018.

Bhat, C.R., and P.S. Lavieri, "Modeling Willingness-to-Share Trips in an Autonomous Vehicle Future: A Stochastic Psychological Latent Construct Approach," *7th Transportation Research Board Innovations in Travel Modeling (ITM) Conference*, Atlanta, GA, June 2018.

Bhat, C.R., F.F. Dias, G.S. Nair, J. Kuhr, N. Ruiz-Juri, and A. Mirzaei, "Incorporating Connected and Autonomous Vehicles and Ride-Hailing Services in the Traditional Four Step Model," *7th Transportation Research Board Innovations in Travel Modeling (ITM) Conference*, Atlanta, GA, June 2018.

Bhat, C.R., "Consumer Choice Modeling: The Promises and the Cautions," Keynote presentation, *15th International Conference on Travel Behaviour Research*, Santa Barbara, CA, July 2018.

Bhat, C.R., G.S. Nair, and R.M. Pendyala, "Alternative Decision Mechanisms to Model Ranking Data," *15th International Conference on Travel Behaviour Research*, Santa Barbara, CA, July 2018.

Dias, F.F., P.S. Lavieri, C.R. Bhat, and R.M. Pendyala, "Understanding Patterns Associated with Ride-Hailing Users and Their Trips," *15th International Conference on Travel Behaviour Research*, Santa Barbara, CA, July 2018.

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Nair, G. S., C.R. Bhat, and N. Ruiz-Juri, "Evaluation of Techniques based on Vehicle-to-Infrastructure Communication to Optimize Traffic Flow after a Freeway Incident," ASCE International Conference on Transportation & Development (ICTD 2018), Pittsburgh, PA, July 2018.

Motro, M., and J. Ghosh, “Measurement-Wise Occlusion in Multi-Object Tracking,” *2018 21st International Conference on Information Fusion (FUSION)*, Cambridge, UK, July 2018.

Bhat, C.R., J. Hutchinson, and F.F. Dias, "The Changing Nature of the Activity-Travel Behavior of the Elderly," *National Household Travel Survey (NHTS) Data for Transportation Applications Workshop*, Washington D.C., August 2018.

Singh, A.C., K. Abel, J. Hutchinson, K. Faust, and C.R. Bhat, "Food Access for Low Income Individuals," *National Household Travel Survey (NHTS) Data for Transportation Applications Workshop*, Washington D.C., August 2018.

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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
Samsung Research America, Dallas, TX: In-kind support
Huawei Technologies, USA: In-kind support, technical consultancy
Cintra, In-kind support, financial support
Universidade de Vigo, Department of Signal Theory and Communications, Vigo, Spain - Nuria G. Prelcic: Technical consultancy.
Sergiy A. Vorobyov, Aalto University, Espoo, Finland, Technical Consultancy
Mohammed E. Eltayeb, California State University, Sacramento, CA, Technical Consultancy
Texas Advanced Computing Center (TACC), University of Texas at Austin, technical consultancy
Honda R&D Americas, technical consultancy
Toyota, technical consultancy
Qualcomm, 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 enhance safety at roadway intersections, work zone areas, and at pedestrian-vehicle conflict zones.

Impact on other disciplines:
The D-STOP research projects involve collaborations with faculty in other disciplines, including electrical engineering and computer science. Several demonstrations and presentations contribute in substantive ways to new methods to fuse data and translate data into actionable intelligence for congestion relief and safety improvements.

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. We have also held out summer internship program, exposing students to a variety of research challenges and implementation possibilities of emerging technology.

Impact on physical, institutional, and information resources at the university or other partner institutions:
Research work being undertaken by Natalia Ruiz Juri for the project entitled “Video Data Analytics for Safer and More Efficient Mobility” was featured by MetroLab as the innovation of the month: “Analytics Tool Helps Improve Traffic Planning in Austin” Government Technology Magazine.
http://www.govtech.com/transportation/MetroLab-Innovation-of-the-Month-September-2018.html

The design of effective, flexible, and scalable data workflows as part of the project entitled “Transportation Data Discovery Environment” were leveraged to develop a web-based application (the Bond Corridor Performance Analysis Tool) for multi-modal corridor performance analysis.

Impact on technology transfer:
D-STOP provided demonstrations of the potential of hybrid sensing-communication technologies for safety enhancement. These demonstrations were made to TxDOT staff as well as MPO staff on Sept 5, 2018. https://youtu.be/VDxAsk_-mTU

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.

5. CHANGES/PROBLEMS

James Kuhr, a PI of two research projects, has left UT Austin, and we transitioned the research being conducted under these two projects to Natalia Ruiz Juri. The two projects are “Explorations to Inform V2I Managed Lanes Design and Development” (title updated from *V2I Managed Lanes Test Bed*) (#142) and “Transit Policy in the Context of New Transportation Paradigms” (#150). The new PI has requested an extension for the first project to February 28, 2019 and the second project to September 30, 2019.

Stephen Boyles, the PI of two research projects that were anticipated to end on 8/31/2018, requested a one-year extension of these two projects until 8/31/2019 to further the research. The two projects are “Real-Time Signal Control and Traffic Stability” (#125) and “Improved Models for Managed Lane Operations” (#140). Under project #125, the research team will explore artificial intelligence and machine learning techniques to generalize the signal optimization methods they have created in earlier tasks. The goal is to scale these methods to apply to large networks of signals, resulting in a "learning agent" for traffic management. For project #140, the research team will compare alternative lane choice models for managed lane facilities. The literature has proposed several lane choice models (e.g., logit, VOT, online shortest path) and they will be compared quantitatively. The research team will also identify techniques for embedding the managed lane models developed in earlier tasks into larger regional models. Candidate techniques include bush-based sensitivity analysis, multiclass user equilibrium with recourse, and calibration of link performance function parameters.

UTC-UI 2018 SUMMER SYMPOSIUM SERIES

Date/Time	Lecturer	Room
Tuesday, May 29	**UTC-UI 2018 Orientation and Welcome Reception**	
11:00-12:00 pm	Orientation Session	ECJ 6th Floor, Rm 6.706
12:00-1:00 pm	Welcome Reception	ECJ 4th Floor, Rm 4.304
Tuesday, June 5	**Dr. Heena Rathore**, Hiller Measurements	ECJ 6.706
1:00-2:00pm	"Blockchain Technology to Make Self-Driving Cars Safer"	
Tuesday, June 12	**Prof. Amit Bhasin**, Transportation Engineering	ECJ 6.706
1:00-2:00pm	"The Rocket Science used in the Design of Pavements and Materials"	
Tuesday, June 19	**Prof. Kara Kockelman**, Transportation Engineering	ECJ 6.706
1:00-2:00pm	"Anticipating a World of Shared Autonomous Vehicles: Cost, Energy, and Urban Implications"	
Tuesday, June 26	**Prof. Todd Humphreys**, Aerospace Engineering	ECJ 6.706
1:00-2:00pm	"All Weather Collaborative Sensing for Connected and Automated Vehicles"	
Tuesday, July 3	**Ms. Meg Merritt**, Nelson\Nygaard	ECJ 6.706
1:00-2:00pm	"Emerging Mobility 101"	
Tuesday, July 10	**UTC-UI Presentations 1**	ECJ 4.304
1:00-3:00pm	UTC-UI Interns	
Tuesday, July 17	**Prof. Steve Boyles**, Transportation Engineering	ECJ 6.706
1:00-2:00pm	"Transportation, Networks, and Paradoxes"	
Tuesday, July 24	**Prof. Randy Machemehl**, Transportation Engineering	ECJ 6.706
1:00-2:00pm	"Bicycle Safety"	
Tuesday, July 31	**Prof. Jorge Prozzi**, Transportation Engineering	ECJ 6.706
1:00-2:00pm	"Research Issues in Pavement Engineering"	
Tuesday, August 7	**Mr. Kirk Fauver**, Federal Highway Administration, Texas Division	ECJ 6.706
1:00-2:00pm	"Transportation Planning and Research Initiatives within the State of Texas"	
Friday, August 10	**UTC-UI 2018 Final Presentations & Farewell Reception**	ECJ 4.304
1:00-3:00 pm	Final Intern Presentations	
3:00-4:00 pm	Farewell Reception	

D-STOP and SAVES MEETING

AGENDA

Date: Wednesday, April 11, 2018

Location: EER 0.806 and EER 0.808 South Tower
2501 Speedway, Austin TX 78712
For detailed directions, visit: https://wncg.org/about/visit
You can park in the San Jacinto Garage
https://parking.utexas.edu/parking/garages/sjg.php

12:00 – 1:00pm Lunch (combined with the WNCG Open House)

1:00pm – 1:15pm Introductions (Robert Heath)

1:15pm – 1:30pm D-STOP update (Chandra Bhat)

1:30pm – 1:45pm SAVES update (Robert Heath)

1:45pm – 3:15pm D-STOP and SAVES Updates, Part 1

- A framework to support data-centric transportation research: the Data Rodeo concept (Natalia Ruiz)
- Pressure-based policies for reservation-based intersection control (Steve Boyles)
- Travel demand modeling in an era of CAVs and ridesharing (James Kuhr)
- Computing confidence intervals using stochastic gradient descent: applications to defending neural network classification from adversarial attacks (Constantine Caramanis)
- Presentation and approval of new D-STOP projects (Chandra Bhat)

3:15pm – 3:45pm Break

3:45pm – 5:15pm D-STOP and SAVES Updates, Part 2

- Cooperative sensing for automated vehicles (Todd Humphreys)
- Collaborative sensing and heterogeneous networking leveraging vehicular fleets (Gustavo de Veciana)
- Advances in millimeter wave for V2X (Robert Heath)
- Online learning for resource allocation (Sanjay Shakkottai)
- Flying with SAVES: current work and project ideas (Nuria Gonzalez Prelcic)