



# BREAKOUT SESSION



## BREAKOUT SESSION # 1

### Research To Examine Behavioral Responses to AVs

Tuesday and Wednesday, July 11 & 12, 1:30 PM – 5:30 PM

Room: Yosemite C

#### Organizers

Johanna Zmud, Texas A&M Transportation Institute  
Yoram Shiftan, Technion  
Chandra Bhat, University of Texas at Austin Center for Transportation Research  
Ram Pendyala, Arizona State University  
Kristin Kolodge, J.D. Power and Associates  
Barbara Lenz, German Aerospace Center, DLR  
Maren Outwater, Resource Systems Group  
Joan Walker, University of California, Berkeley  
Liaison: Don MacKenzie, University of Washington

#### Session Information

Description: The goal of the session is to identify research needs and develop research approaches (both quantitative and qualitative) for gaining deep insight on behavioral responses to AVs in three priority areas: (1) vehicle ownership and use choices, (2) land use choices, where people choose to live and work, and (3) activity and travel choices, what people do, how often, how they get there.

End Product: A synthesis document describing a 3-5 year “research roadmap” of behavioral studies that identifies priority areas of research and associated research questions, and outlines “best practice” research approaches to obtain deep behavioral insights and address questions of interest

#### Tuesday 1:30 PM – 2:30 PM Overviews of Research Priorities

Moderator – Johanna Zmud, Texas A&M Transportation Institute

Short presentations will introduce three priority areas' research questions and rationale for their selection, and discuss research methods/considerations revolving around the questions. A presentation on Value of Time is included because it is an important topic with significant implications for land use choices and activity/travel choices.

#### Vehicle Ownership and Use

- Johanna Zmud, Texas A&M Transportation Institute
- Barbara Lenz, German Aerospace Center, DLR

#### Land Use Choices

- Eric Miller, University of Toronto
- Yoram Shiftan, Technion

#### Activity/Travel Choices

- Chandra Bhat, University of Texas at Austin Center for Transportation Research
- Mark Bradley, RSG

#### Value of Time

- Pat Mokhtarian, Georgia Tech
- Ram Pendyala, Arizona State University

### **Tuesday 3:00 PM – 5:30 PM Small Breakout Groups**

The planning committee is assuming 6-9 small groups will focus on each research topic in terms of research approaches and needs.

#### **Vehicle Ownership and Use**

Facilitators – Yoram Shiftan, Technion, and Barbara Lenz, German Aerospace Center

*Focusing on question: How and at what rate will fully autonomous vehicles be adopted?*

#### **Land Use Choices**

Facilitators – Eric Miller, University of Toronto and Johanna Zmud, Texas A&M Transportation Institute

*Focusing on question: Where will people live and work with fully autonomous vehicles?*

#### **Activity/Travel Choices**

Facilitators – Chandra Bhat, University of Texas at Austin Center for Transportation Research and Mark Bradley, RSG

*Focusing on question: How do daily activity/travel patterns change (activities, schedules, departure time, modes, destinations, with whom) with fully autonomous vehicles?*

### **Wednesday 1:30 PM – 2:30 PM Small Breakout Groups**

Each small group (from Tuesday) finalizes findings/ recommendations.

### **Wednesday 2:30 PM – 3:30 PM Small Breakout Groups Aggregated by Research Topic**

The groups working on same research topic compare/contrast/synthesize their findings on research approach and needs.

### **Wednesday 4:00 PM – 4:45 PM Report Out by Research Topic**

Three reports to entire group (1 for each research topic) of consolidated findings (outline of research approach and description of prioritized research needs)

### **Wednesday 4:45 PM – 5:30 PM Wrap-Up**

Discussion of strategy for next steps in development of multi-year research roadmap



# BREAKOUT SESSION



## BREAKOUT SESSION # 2.1

### Judging a Car by its Cover: Human Factors Implications for Automated Vehicle External Communication

*This break-out session is sponsored by the TRB Subcommittee on Human Factors in Road Vehicle Automation.*

Tuesday, July 11, 1:30 PM – 5:30 PM

Room: Yosemite A

#### Organizers

Andy Schaudt, Virginia Tech Transportation Institute  
John Shutko, Ford Motor Company  
Sheldon Russell, Virginia Tech Transportation Institute

#### Description

Currently road users communicate with one another in numerous ways. They communicate through eye contact, hand gestures, turn signals, horns, and even the control of their movement to show intent (e.g. easing vehicle forward). Uncertainty exists as to whether highly automated vehicles (HAVs) will be able to perceive and communicate intent in the same ways that a human can. Therefore, we should design HAVs to signal their intent in ways other roadway users can reliably understand. This session will bring together professionals to discuss “How” HAVs should communicate with all roadway users, “What” information is needed to communicate, and to what degree standardization of HAV external communication could be valuable. The session will provide presentations from experts currently researching this area. In addition, there will be breakout exercises to further explore use cases of HAVs and their interactions with other vehicles and vulnerable road users and how the application of human factors design principles could lead to potential solutions to these challenges.

Moderator – Andy Schaudt, Virginia Tech Transportation Institute

Presentation: Effects of Non-verbal Communication Cues on Decisions and Driver Confidence

- Satoshi Kitazaki, AIST

Presentation: Update on ISO Activities for HAV External Communication

- John Shutko, Ford Motor Company

Presentation: Needs of Pedestrians Interacting with Automated Vehicles

- Ruth Madigan, University of Leeds

Exercise: How and When Should a HAV Communicate with Road Users While it is in Motion?

- Breakout Groups of 4-6 people

Exercise: How and When Should a HAV Communicate with Road Users While it is Stopped?

- Breakout Groups of 4-6 people

Exercise: How and When Should a HAV Communicate with Road Users While it is in Transition?

- Breakout Groups of 4-6 people



# BREAKOUT SESSION



## BREAKOUT SESSION # 2.2

### Automated Vehicle Challenges: How can Human Factors Research Help Inform Designers, Road Users, and Policy Makers?

*This break-out session is sponsored by the TRB Subcommittee on Human Factors in Road Vehicle Automation.*

Wednesday, July 12, 1:30 PM – 5:30 PM

Room: Yosemite A

#### Organizers

Anuj K. Pradhan, University of Michigan Transportation Research Institute  
Chris Schwarz, University of Iowa National Advanced Driving Simulator  
Fred Feng, University of Michigan Transportation Research Institute  
John Sullivan, University of Michigan Transportation Research Institute  
Shan Bao, University of Michigan Transportation Research Institute

#### Session Description:

The purpose of the session is to provoke a lively discussion among industry, government, and academic experts with broad perspectives of the likely consequences that various levels of vehicle automation will have for humans adapting to these new technologies. We have deliberately sought experts outside of the usual human factors research community in an effort to understand those indirect effects that extend beyond immediate issue of vehicle control and operation. Indeed, we expect automation may alter how people have traditionally thought about mobility. Such changes will have likely consequences on the behavior of all road users.

Partially automated vehicles (SAE L2/L3), currently already deployed on public roads, are forerunners to those with high levels of automation (L3+). While these deployments are incremental and tentative, they have the potential to induce disruptions in the way people have traditionally interacted with vehicles. These disruptions will likely affect all road users—drivers of advanced vehicles, drivers of 'legacy' vehicles, pedestrians, and bicyclists. Significant gaps in our knowledge about users' expectations, their perceptions, their strategic and tactical use, and their understanding of these systems limit our ability to anticipate how adoption of these technologies will play out on real roads, in real time, with real limitations, and representative use cases.

Education, training, and effective HMI design can play critical roles in raising driver/road-user awareness to ensure clear understanding about appropriate use of and expectations about these and future vehicle capabilities. As long as a driver is responsible for the supervision of these systems, human factors research will be tasked with predicting their direct effects on driver behavior and decision-making. It is also essential to understand their indirect effects on associated stakeholders, including manufacturers, policy makers, educators, and local legislators.

To that end, this meeting convenes experts identified and invited from academia, government, and industry to learn about and discuss issues from different perspectives, with insights on various approaches to address them. This workshop builds on two successful workshops on related topics conducted at the TRB 2017 Annual Meeting. An end objective is to identify relevant and timely research needs based on discussions between experts and participants.

### **Speakers:**

Alex Epstein, *Senior Director, Digital Strategy and Content, National Safety Council*  
Emily Frascaroli, *Counsel, Ford Motor Co.*  
Nidhi Kalra, *Senior Information Scientist and Director San Francisco Bay Area, RAND Corp.*  
Alain Kornhauser, *Professor, Director, Transportation Program, Princeton University*  
Bernard Soriano, *Deputy Director, California Department of Motor Vehicles*  
Trent Victor, *Senior Technical Leader Crash Avoidance, Volvo Car Corp.*

### **Session structure & Activities:**

Moderator: Alex Roy

1. *Background & Introductions: (5 mins)*
2. *Frame: Brief presentations by the 6 expert panelists on critical issues*
3. *Deconstruct: Structured, moderated panel discussion*
4. *Catalyze: Interactive audience discussions/Q&A with panelists*
5. *Build: Focused audience discussion to identify, select, and prepare research needs statements*



# BREAKOUT SESSION



## BREAKOUT SESSION # 3

### Enabling Technologies for Automated Vehicles

Tuesday and Wednesday, July 11 & 12, 1:30 PM – 5:30 PM

Room: Franciscan A&B

#### Organizers

Carl Andersen, USDOT  
Stacy Randecker Bartlett, Ellis & Associates  
Jennifer Carter, HERE  
Rob Dingess, Mercer Strategic  
Dominique Freckmann, TE Connectivity  
Juhani Jaaskelainen, Independent  
Jim Misener, Qualcomm  
Sudararajan Sudharson, Booz Allen  
Valentin Scinteie, Kontron  
Virginia Stouffer, LMI

Vehicle automation has captured the hearts and minds of many, and the resulting prospect and promise of safety, mobility, convenience, comfort and a plethora of other potential benefits is indeed exciting. Just as exciting and crucial to envisioned applications are the enabling technologies that will literally and figuratively be under the hood.

This two-afternoon session will explore what is under that hood. It will begin with a series of moderated 45-minute "deep dives." The deep dives will feature two invited short presentations, but most of that deep dive will be the interactive moderated dialog that follows.

At the end of the second afternoon and based on integrated experience, we will invite all participants to collectively synthesize the current state relevant enabling technologies and challenges and opportunities that remain. In the end, we hope to achieve:

- Views of technology needs for successful models of deployment of automated vehicles
- A set of research topics based upon the groups analysis of gaps.
- Significant individual take-aways to include understanding of the diverse enabling technologies and a holistic perspective on how they might combine into future automated vehicle systems.

## **Agenda**

### **Tuesday, July 11**

#### **1:30 PM – 1:45 PM Introduction: Concept, Program, Panelists and Organizers**

Jim Misener, Qualcomm

#### **1:45 PM – 2:30 PM Positioning and Localization**

Moderator – Phillip Bernard, HERE

- Russ Shields, Ygomi
- Xinzhou Wu, Qualcomm

#### **2:30 PM – 3:15 PM Cybersecurity**

Moderator – Jonathan Petit, On Board Security

- Walter Sullivan, Elektrobit
- Harsh Patil, LG Electronics

#### **3:15 PM – 3:45 PM Break**

#### **3:45 – 5:30 PM Digital Infrastructure I and II**

Moderators – Robert Dingess, Mercer Strategic (Digital Infrastructure I) and Carl Andersen, USDOT (Digital Infrastructure II)

- Satoru Nakajo, Nissan Motor Company
- Maxime Flament, ERTICO
- Scott Nelson, HERE
- Paul Carlson, Texas A&M University
- Doug Dolinar, Limntech Scientific

### **Wednesday, July 12**

#### **1:30 PM – 2:15 PM Sensing and Perception**

Moderator – Dominique Freckmann, TE

- Allan Steinhardt, AEye
- Tony Han, JingChi.ai

#### **2:15 PM – 3:00 PM On-Board Computational Technologies**

Moderator – Valentin Scinteie, Kontron

- Jack Weast, Intel
- Wesley Shao, Baidu USA
- Tim Wong, NVIDIA

### 3:30 PM – 4:00 PM Break

### 4:00 PM – 4:45 PM Cellular/5G vs 802.11p-based Communications

Moderator – Jim Misener, Qualcomm

- John Kenney, Toyota ITC
- Tim Lienmueller, DENSO

### 4:45 PM – 5:30 PM Synthesis and Lessons Learned

Moderator – Jim Misener, Qualcomm

#### Speaker Profiles

**Speakers Name:** Doug Dolinar/Bill Haller

**Speakers Titles:** (Dolinar) President; (Haller) VP Engineering

**Speaker Organization:** LimnTech Scientific Inc.

**Presentation Title:** Real-time Lane Marking Location - Dynamic Map Updates: A Road Maintenance Perspective (10 Minutes)

#### **Presentation Description:**

Enhanced GPS, laser and video technologies are increasingly used to automate manufacturing processes. This presentation centers on a new method of automating the installation of road markings in which a spatially accurate, "digital marking" location is captured as part of normal lane marking maintenance or installation operations. The process can be accessible via a cloud-based process to provide "real-time" reliable lane location data for ADS or dynamic mapping processes.

**Key Takeaways:** A spatially accurate "virtual" marking, captured as part of the installation or maintenance of lane markings, provides a unique approach to dynamic mapping data systems. The utilization of virtual and physical markings may alleviate a key concern relative to marking visibility due to inclement weather, road maintenance or road construction. This type of digital/physical infrastructure interfacing may enhance the value of various ADAS systems and provide a second-wave technology model for the development of road readiness levels for machine vision.

**Speaker Bio:** Doug Dolinar is President of LimnTech Scientific. A former aerospace engineer where he worked on space shuttle and rotary wing aircraft, he eventually transitioned to designing, and manufacturing high production pavement marking application and removal equipment. He holds a Bachelor of Mechanical Engineering degree from the University of Detroit.

Doug's Contact Information:

Doug Dolinar, President

Limntech

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**Speaker Bio:** Bill Haller is Vice President of Engineering for LimnTech Scientific. After receiving his BS Engineering Physics and MS Electrical Engineering from Lehigh University, Bill co-founded

SciTronics Incorporated – a company dedicated to developing voice prosthetic devices. He subsequently founded Industrial Vision Systems Inc. – a manufacturer of laser based machine vision products.

Bill's Contact Information:  
Bill Haller, VP Engineering  
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**Speaker Name:** Jack Weast

**Speaker Title:** Chief Systems Architect for Autonomous Driving Solution

**Speaker Organization:** Intel

**Presentation Title:** L3 – L5 Development: Balanced Compute for Sequential and Parallel Workloads.

**Presentation Description:**

The fully autonomous vehicle will need a tremendous amount of both parallel and sequential computing to support three intertwined stages of driving: perception, sensor fusion, and decision-making. Each stage requires different types of compute. The autonomous vehicles being tested today are early prototypes that have not yet been optimized for power and performance. Before system designers can achieve level 4 and 5 driving automation, they must determine how to best place different compute elements to support each type of workload. However, as system designs and artificial intelligence evolve, this placement can be a moving target.

No fixed architecture can keep pace with the breakneck speed of innovation in artificial intelligence and system design. GPUs have gained momentum in autonomous vehicle design due to their performance in image rendering and convolutional neural networks (CNNs), but are quickly becoming commoditized. Algorithms and neural network topologies are rapidly evolving, with major breakthroughs happening roughly every three to six months. So what's the right mix? In this panel we'll discuss the technical advantages of all compute types for near- and long-term development, including GPUs, CPUs, FPGAs, and hardware acceleration.

**Speaker Bio:** Jack Weast is a Sr. Principal Engineer and the Chief Systems Architect for Autonomous Driving Solutions at Intel. In his nearly 20 career at Intel, Jack has built a reputation as a change agent in new industries with significant technical contributions to a wide range of industry-first products and standards that benefit from complex heterogeneous high performance compute solutions in markets that are embracing high performance computing for the first time. With an End to End Systems perspective, Jack combines a unique blend of embedded product experience with a knack for elegant Software and Systems design that will accelerate the adoption of Autonomous Driving. Jack is the co-author of "UPnP: Design By Example", is an Associate Professor at Portland State University and his the holder of 19 patents with dozens pending.

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<http://www.intel.com/content/www/us/en/embedded/automotive/go-automated-driving-solutions/overview.html?wapkw=automated+driving>

About Intel Autonomous Driving Solutions

Automated driving will change lives and societies for the better, resulting in fewer

accidents, greater mobility, and more efficient traffic flow. With the Intel® GO™ automated driving solutions portfolio for automotive, Intel brings its deep expertise in compute, connectivity, and the cloud to deliver solutions for automated driving. Intel® GO™ automated driving solutions give OEMs incredible scalability and a flexible architecture that maximizes hardware and software reuse. This means OEMs can pursue countless design iterations, differentiate brands, and accommodate every market need and increasing levels of autonomy—while potentially lowering the cost of development and accelerating time-to-market. Solutions are built upon a foundation of security and functional safety to help protect drivers and passengers, as well as vehicle systems and data.

**Speaker Name:** Wesley Shao

**Speaker Title:** Principal Architect for Intelligent Driving Group

**Speaker Organization:** Baidu USA

**Presentation Title:** Apollo – Open Platform for Autonomous Driving

**Presentation Description:**

Baidu recently announced the Apollo program, an open platform to build the brain that can drive autonomous vehicles. In this panel, we discuss the components and capabilities of its first release, the requirements of its onboard computing environment, the partners, the sensors, and their roadmap. We will also highlight the ways to contribute and to participate the program.

**Speaker Bio:** Wesley Shao is a system architect for Baidu's Intelligent Driving Group. He leads the hardware team that is responsible for the development of multiple generations of on-board computers and sensors of Baidu's autonomous driving cars. Recently he is involved with the Apollo program, building industry's first open platform for autonomous driving.

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Websites: <http://money.cnn.com/2016/11/16/technology/baidu-driverless-car/index.html>

About Baidu Intelligent Driving Group

Baidu formalized its autonomous driving development in 2016 and has since then engaged in L3, L4 and V2X development. It demonstrated its autonomous driving technologies at the World Internet Conference in WuZhen, ZheJiang, China last year. Recently it initiated the Apollo program to foster an open community and ecosystem for autonomous driving development.

**Speaker Name:** Dr. Allan Steinhardt

**Speaker Title:** AEye Chief Engineer

**Speaker Organization:** Aeye, Inc

**Presentation Title:** Computer Vision Myopia: Looking to the Future

**Presentation Description:**

Many in the computer vision community use video analytics as a framework for developing advanced vision solutions. While this works for implementations like Facebook image recognition, it's myopic to apply the same methodology for self-driving cars and robots. Video analytics assumes unlimited processing, massive data, high quality sensors, unlimited power and lots of time to analyze data. Robots offer no such luxuries, and their constraints require a different scientific approach.

In this session, AEye Chief Engineer, Dr. Allan Steinhardt explains robotic vision's role in advancing safe, reliable vision for robots and vehicles. These machines must navigate safely with an objective purpose in mind, and do so with limited processing, lower quality sensors, limited data (due to rapid transit) and quick reaction time (low latency). The dynamic nature of vision for mobile robot sight presents many challenges, and Steinhardt will discuss how we

can leverage other research community findings, including those from industrial engineering, missile seekers, energy harvesting and spacecraft GNC, in our quest for advanced robotic vision solutions.

**Speaker Bio:**

Dr. Steinhardt is among the world's most widely recognized and respected defense scientists. Prior to AEye, Steinhardt was Chief Scientist at Booz Allen, where he led a team of scientists, engineers, and mathematicians in providing prototyping, portfolio analysis, technology roadmaps, and innovation services to the Office of the Secretary of Defense, including DARPA, DTRA, and DDR&E. Prior to joining Booz Allen, Steinhardt held positions in National Laboratories (MIT Lincoln Laboratory, Radar Group), the Prime Contractor Defense Industry (BAE Systems), and academia (Cornell University, Assistant Professor in Electrical Engineering and Applied Mathematics). Steinhardt has published over 200 articles in academic and defense strategy journals, co-authored a book on Adaptive Radar, and held various leadership positions in the IEEE. He holds a bachelor degree in Mathematics, and graduate degrees in Electrical and Computer Engineering from the University of Colorado, Boulder. Steinhardt is a member of the National Academies' Naval Studies Board, the board of the Armed Forces Communications Electronics Association, and is a regional judge for the FIRST robotics competition.

Please return this completed form to Lindsay Voss at [lvoss@auvsi.org](mailto:lvoss@auvsi.org) no later than February 28, 2017.

**Speaker Name:** Tim Wong

**Speaker Title:** Technical Marketing for Autonomous Vehicles

**Speaker Organization:** NVIDIA

**Presentation Title:** AI platform for Self-Driving Cars

**Presentation Description:**

NVIDIA has created the DRIVE PX platform, the in-car AI supercomputer for autonomous driving. We envision running many deep neural networks (DNNs) simultaneously to drive the vehicle. One DNN could be a detection and classification network used not only for object detection (pedestrians, cars, trucks, motorcycles, bicycles, signs, lampposts, and even animals), but also for lane marking detection. Another would be a segmentation network which is useful to determine the free space around the vehicle that is available for driving, driving bounds (typically bounded curbs and medians), and blocking objects such as vehicles and pedestrians. A third DNN could be an end-to-end networks that mimic learned driving behavior. This can be used as a basic path planner to drive the vehicle under typical circumstances. These networks are working together to enable the vehicle's artificial intelligence to drive the vehicle, while keeping the driver, its occupants and pedestrians nearby safe.

**Speaker Bio:** Tim leads the Self-Driving Technical Marketing team for NVIDIA. He works with our customers, partners and suppliers to enable autonomous vehicle technology using our DRIVE PX platform and artificial intelligence for high-quality, robust and flexible self-driving solutions. Before joining NVIDIA, Tim was the president of the MHL Consortium where he drove the adoption and licensing of MHL technology into more than 900 million smartphones, displays and accessories. Tim received his B.S. in Computer Engineering from Boston University in 1986, his M.S. in Computer Science from the University of Southern California in 1988, and his Mini-MBA in Finance from the Wharton School at the University of Pennsylvania and the AT&T School of Business in 1995.

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About NVIDIA

NVIDIA is known for inventing the GPU, which enables modern computer graphics -- simulating human imagination and conjuring up the worlds of video games and films. Today, NVIDIA GPUs also simulate human intelligence, running deep learning algorithms and acting as the brain of computers, robots, and self-driving cars.

Autonomous vehicles require Artificial Intelligence to navigate the nearly infinite range of possible scenarios. Thanks to AI, cars can learn how to drive. NVIDIA AI platforms offer a cloud-to-car solution, with NVIDIA systems training deep neural networks in the datacenter, and NVIDIA DRIVE™ PX running in the car to process sensor data and drive safely.

NVIDIA is working with the world's leading companies, including Toyota, Mercedes-Benz, Audi, Volvo, and Tesla. By engaging with over 225 automakers, tier 1 suppliers, mapping companies, startups and research institutions, NVIDIA AI technology is revolutionizing the way people drive, and empowering vehicles to drive themselves.

**Speaker Name:** Russ Shields

**Speaker Title:** Chair

**Speaker Organization:** Ygomi LLC.

**Speaker Bio:** Russ Shields is Chair of Ygomi LLC. Businesses that Mr. Shields has founded and/or led include Shields Enterprises International, Cellular Business Systems, Inc. (later Convergys), Navigation Technologies (later Navteq, now HERE), and the current Ygomi companies – SEI, Connexis, and ArrayComm.

Mr. Shields is a Board Member of the ITS World Congress and Co Chair of the ITU Collaboration on ITS Communications Standards. He is also a member of the National Space-Based Positioning, Navigation and Timing Advisory Board, a Presidential advisory committee.

Mr. Shields is an SAE Fellow and recipient of the SAE Delco Electronics ITS Award. He was inducted into the inaugural class of ITS America's Hall of Fame and named the first U.S. member of the ITS World Congress Hall of Fame.

In 2008, Mr. Shields received the University of Chicago Booth School of Business Distinguished Alumni Award in Entrepreneurship. In 2013, the Hotchkiss School awarded Mr. Shields its Alumni Award.



# BREAKOUT SESSION

## BREAKOUT SESSION # 4

### An AV Crashes: What Happens Next?

Tuesday, July 11, 1:30 PM -5:00 PM

Room: Continental 2

#### Organizers

Karlyn Stanley, RAND Corp.  
Ellen Partridge, Environmental Law & Policy Center  
Cal Andersen, FHWA, USDOT  
James Anderson, RAND Corp.  
Todd Benoff, Alston & Bird  
Ryan Gammelgard, State Farm  
Don Slavik, Slavik Law Firm  
Dorothy Glancy, Santa Clara University School of Law  
Ryan Harrington, Exponent  
Austin Hensel  
Nira Pandya, U.C. Berkeley Law School

The goal of the session is to better understand what will happen immediately after an AV crash. A panel of experts will use multiple AV crash scenarios to offer perspectives on this new topic. We will hear from law enforcement, insurance experts, products liability lawyers on the plaintiffs' and defense side, transportation policy experts, and expert witnesses in automotive engineering. Topics will include how each of these different disciplines will use the new kinds of data that AVs provide, as well as the impact of this new technology on existing liability laws. We will assess all the stakeholders and their roles and consider their first steps after an AV crash in two lively, interactive panel discussions using different crash scenarios.

#### Agenda

**1:30 PM – 3:00 PM Scenario 1: A dark and stormy night, a rock slide, ice, and the AV goes over a cliff: What do stakeholders need to assess liability?**

**Moderated by Karlyn Stanley, RAND Corp.**

Panelists:

- James Epperson, California Highway Patrol
- Carl Andersen, FHWA, USDOT
- Ryan Gammelgard, State Farm
- Todd Benoff, Alston & Bird
- Don Slavik, Slavik Law Firm

- Ryan Harrington, Exponent

The panel of law enforcement, insurance, product liability, transportation policy, and crash reconstruction experts will discuss and debate their answers to questions produced by the scenario, such as:

- How will insurers, product liability lawyers, and expert witnesses use the new kinds of data to determine liability?
- How will law enforcement deal with an AV crash as a first responder?
- Who is responsible for that missing guardrail?

### **3:00 PM – 3:30 PM Break**

**3:30 PM – 5:00 PM** Scenario 2: A car rear-ends a vehicle that is stopped at a traffic light. One vehicle is a Level 4 AV driving within its Operational Design Domain. The other is not an AV—it is operated by a human driver. How does the liability scenario change, depending on which is the lead vehicle—and other factors?

### **Moderated by Ellen Partridge, Environmental Law & Policy Center**

- Panelists:
- James Epperson, California Highway Patrol
- Carl Andersen, FHWA, USDOT
- Ryan Gammelgard, State Farm
- Todd Benoff, Alston & Bird
- Don Slavik, Slavik Law Firm
- Ryan Harrington, Exponent

The panel of law enforcement, insurance, product liability, transportation policy, and crash reconstruction experts will discuss and debate their answers to questions produced by the scenario, such as:

- How does law enforcement interview two kinds of witnesses—the human driver and the data collection devices on both vehicles? What if they conflict?
- How does V2X change the liability picture for the different vehicles?
- What if the human driven car is stopped at the intersection and the AV causes the crash when a hacker takes control?



# BREAKOUT SESSION



## BREAKOUT SESSION # 5

### Public Transport and Shared Mobility

Tuesday and Wednesday, July 11 & 12, 1:30 PM – 5:30 PM

Room: Yosemite B

#### Organizers

Alejandro Henao, National Renewable Energy Laboratory  
Chris Kopp, HNTB  
Daniel Fagnant, General Motors  
Eli Machek, Volpe  
Gary Hsueh, Arup (Lead Organizer)  
James Fishelson, University of Michigan  
Jean Ruestman, Michigan DOT  
Katherine Freund, ITN America  
Matthew Lesh, Coast Autonomous  
Rachel Hiatt, San Francisco County Transportation Authority  
Sam Lott, Texas Southern University  
Scott Smith, Volpe  
Stanley Young, National Renewable Energy Laboratory  
Stephan Parker, Transportation Research Board  
Susan Shaheen, UC Berkeley TSRC  
Thomas Cerny, AECOM  
Tim Frisbie, Shared Use Mobility Center  
Tom Voegelé, OECD  
Wendy Tao, Siemens

#### Session Information

This two-day session seeks to address how vehicle automation technology can be harnessed across public transport and shared mobility services in order to provide mobility for all. How will vehicle automation disrupt traditional transit systems, what new and different types of market-driven or publicly-run services are emerging, and how should public transport perform in the future?

In the past year, numerous pilot projects and partnerships have been forged between innovators and public transport agencies, municipalities, and universities. What is their experience to date, and what are the lessons learned? New research efforts are yielding insight into the potential impacts of privately-owned automated vehicles on transportation networks. We will discuss the potential pitfalls and benefits in relation to Shared AVs, and explore policy changes that might help support public transport and sharing in an automated world. We will also discuss the cases in which automated vehicles – particularly for public

transport – could benefit from dedicated infrastructure. Throughout this breakout session, engage with your peers to help identify topics, issues, and solutions for anyone who is considering implementing a form of future public transport and shared mobility.

### **Goals/Outputs**

- Latest updates on policy and research related to Mobility On Demand, Shared AVs, impacts on Public Transport
- Lessons learned from pilot programs/demonstrations
- In-depth discussion of policy implications and implementation for Shared AVs and public transport
- Topics, issues, and solutions for anyone who is considering implementing a form of future public transport and shared mobility.

## **Tuesday, July 11, 1:30 PM – 5:30 PM**

### **1:30 PM Introduction and Announcements**

- Gary Hsueh, Arup

### **1:40 PM National and International Policy and Research**

Short presentations on national and international scale policy and research related to Shared AVs and Public Transport.

Host:

- Eli Machek, Volpe

Presenters:

- *FTA MOD Sandbox 1.0 & 2.0*  
Vincent Valdes, Federal Transit Administration
- *TRB Research Updates*  
Mark Norman, Transportation Research Board
- *Impact of Mobility-on-Demand Services and Highly Automated Vehicles*  
Stephan Parker, Transportation Research Board
- *NCHRP 20-102: Impacts of CVs and AVs on State and Local Transportation Agencies*  
Doug Gettman, Kimley-Horn Associates
- *Key Messages from the Commercial Vehicle On-Board Safety Systems Roundtable*  
Tom Voegelé, ITF-OECD

### **2:40 PM Break**

### **2:55 PM State of Shared AV Developments**

A state-of-the-state presentation on activities, pilots, and policies.

- Featured Presenter: Susan Shaheen, UC Berkeley Transportation Sustainability Research Center

### **3:15 PM Panel: Opportunities and Risks on the Road Toward Shared AVs**

Why should automated vehicles be shared? Will they be accessible to riders of different needs, and reach a wide variety of communities? Policy makers, community advocates, and others must work together today to identify policies that ensure this emerging technology supports important societal goals.

Moderator:

- Tim Frisbie, Shared Use Mobility Center

Panelists:

- Mark Dowd, UC Berkeley
- Steve Mortensen, FTA
- Alejandro Henao, National Renewable Energy Laboratory
- Bruce Schaller, Schaller Consulting

#### **4:15 PM Break**

#### **4:30 PM Updates and Lessons Learned: Sharing and Transit**

Short presentations on projects, partnerships, and services related to Shared AVs and Public Transport and most importantly, lessons learned along the way.

Host:

- Daniel Fagnant, General Motors

Presenters:

- *TNC-Transit Partnerships Overview*  
Sharon Feigon, Shared Use Mobility Center
- *AC Transit Flex*  
John Uργο, AC Transit
- *Costs and Benefits of Automation in U.S. Bus Fleets*  
Neil Quarles, UT Austin
- Jonathan Matus, Zendrive
- Leemor Chandally, Bestmile

#### **5:25 PM Conclusion / Agenda for tomorrow**

- Gary Hsueh, Arup

### **Wednesday, July 12, 1:30 PM – 5:30 PM**

#### **1:30 PM Introduction and Announcements**

- Gary Hsueh, Arup

#### **1:35 PM Treasure Island Case Study**

- Featured Presenter: Rachel Hiatt, San Francisco County Transportation Authority

#### **1:45 PM Panel: Policy Implementation**

What policies and mechanisms are needed to achieve our goals for Shared Mobility and Public Transport?

Moderator:

- Susan Shaheen, UC Berkeley Transportation Sustainability Research Center

Panelists:

- Emily Castor, Lyft
- Frank Douma, Univ. of Minnesota Center for Transportation Studies
- Jack Clark, Transportation Learning Center
- Doug Gettman, Kimley-Horn Associates

### **2:50 PM Break**

### **3:05 PM Updates and Lessons Learned: Shared AVs**

Short presentations on the latest AV/public transport policy, research, partnerships, and projects, and most importantly, lessons learned along the way.

Host:

- James Fishelson, Univ. of Michigan

Presenters:

- *Lessons Autonomous Vehicles can Learn from Automated Vehicles*  
Wessel van der Pol, 2getthere
- *Creating Shared AV partnerships*  
Koorosh Olyai, Stantec
- *MaaS Component Implementation*  
Speaker: Wendy Tao, Siemens
- Gilbert Gagnaire, Easymile (invited)

### **3:50 PM Break**

### **4:05 PM Panel: Infrastructure**

What thresholds or use cases require dedicated lanes or guideways for Shared AVs or automated public transport, vs. operations in mixed traffic?

Moderator:

- Stan Young, National Renewable Energy Laboratory

Panelists:

- Yuche Chen, National Renewable Energy Laboratory
- Sam Lott, Texas Southern University
- Wessel van der Pol, 2getthere
- Major Brandon Newell, US Marine Corps
- Brad Thoburn, Jacksonville Transportation Authority (invited)

### **5:20 PM Conclusion**

- Gary Hsueh, Arup



# BREAKOUT SESSION

## BREAKOUT SESSION # 6

### Trucking Automation: Key Deployment Scenarios

Tuesday, July 11, 1:30 PM – 5:30 PM

Wednesday, July 12, 1:30 PM – 3:30 PM

Room: Continental 1

#### Organizers

Johan Engström, Virginia Tech Transportation Institute

Richard Bishop, Bishop Consulting

#### Objective

The objective of this breakout session is to address key challenges and opportunities in the deployment of on-road truck automation. The session starts with a set of presentations providing an overview of the current state of the art of automated trucks and identifying key deployment issues. This sets the stage for two panels with key stakeholders focusing on platooning and highway automation applications respectively. The second day is devoted to two deep dive sessions. The first addresses a specific use case for automated trucking with a freight carrier and their customer. The second deep dive discusses the application and deployment of Localizing Ground Penetrating Radar technologies to military vehicles and automated trucks.

#### Agenda

##### Tuesday, July 11

##### **1:30 PM – 1:40 PM Welcome and introduction**

*Johan Engström, Virginia Tech Transportation Institute*

##### **1:40 PM – 2:50 PM Setting the scene: State-of-the-art and key deployment issues in automated trucking**

Moderator – Johan Engström, Virginia Tech Transportation Institute

State-of-the-art: Platooning, Steven Shladover, UC Berkeley

State-of-the-art: Highway automation, Richard Bishop, Bishop Consulting

Lessons learned from the deployment of off-road automated trucks, Michael Murphy, Caterpillar

Report from the ITF-OECD Roundtable, Tom Vöge, ITF-OECD

Key deployment issues in on-road truck automation - Laurence O'Rourke, ICF

**2:50 PM – 3:00 PM Break**

**3:00 PM – 5:15 PM Stakeholder panels**

**3:00 PM – 4:00 PM Panel 1: Deployment of platooning**

Moderator: Richard Bishop - Bishop Consulting

*Panelists*

- Bill Kahn, Manager, Advanced Concepts, Peterbilt
- Fred Andersky, Director, Government and Industry Affairs, Bendix
- Steve Boyd, Co-founder, Peloton
- Osman Altan, Research Transportation Specialist, Federal Highway Administration
- Max Fuller, Executive Chairman, US Xpress
- Ed Hutchinson, Manager, Florida DOT
- John Schroer, Commissioner, Tennessee DOT
- Andrew Bremer, Deputy Director of Strategic Programs and Initiatives, Ohio DOT

**4:00 PM – 4:10 PM: Break**

**4:10 PM – 5:10 PM: Panel 2: Deployment of highway automation**

Moderator: Bob Denaro - ITS Consulting

*Panelists*

- Franklin Josey, Manager, Technology & Project Planning, Vehicle Technology & Safety Department, Volvo Group Trucks Technology
- Ognen Stojanovski, Policy and government relations, Uber Advanced Technology Group
- Kelly Regal, Associate Administrator of Research and Information Technology, Federal Motor Carrier Safety Administration
- Greg Larson, Acting District Liaison, Caltrans
- Bryan Jones, Chief Operating Officer, Martin Brower

**5:10 PM – 5:30 PM Wrap-up, Day 1**

Richard Bishop - Bishop Consulting

**Wednesday, July 12**

**1:30 PM – 2:30 PM Deep dive: Trucking Automation: The Future of Supply Chain Transportation**

Moderators: Richard Demato, Divya Demato (GoodOps)

Join us for a behind-the-scenes look at how Martin Brower, one of the world's largest global distributors with clients including McDonald's, Chick-fil-A and Chipotle, is taking an early market initiative to harness vehicle automation technology for cold chain transportation.

The global cold chain market, utilizing temperature-controlled logistics operations for perishable food transport, is projected to reach \$271 billion by 2022. Adoption of commercial vehicle automation is attractive for its potentially significant savings in fuel and driver costs, and the possibility of ensuring fresher food across the nation. However, this transition must also properly address food safety, quality concerns and risk management to ensure brand trust and reputation.

Senior executives from Martin Brower will share how they're approaching vehicle automation as a way to improve the cold chain and support their customers during a time of transformative change. The conversation will center around the implications and ancillary benefits of vehicle automation technology on the food supply chain, exploring different solutions due to the operating environment, route structures, regulations, policies and technical challenges, as well as plans for a live freight automation pilot tailored to their unique multi-modal logistics requirements.

A major goal of this presentation is engaging the audience and Martin Brower's leadership to discuss the challenges and opportunities in deploying autonomous technology across their client supply chains.

**2:30 PM – 2:35 PM: Break**

**2:35 PM – 3:30 PM Deep dive 2: Localizing Ground Penetrating Radar for Robust Autonomous Lane-Keeping**

*Moderators: Byron Stanley (MIT Lincoln Laboratory), David Cist, Babak Memarzadeh (Geophysical Survey Systems, Inc.)*

Have you ever wondered how autonomous vehicles will operate reliably in snow storms or when there aren't sufficient landmarks for camera or lidar based localization? What about in foggy conditions, in heavy rains, or on dirt roads? Localizing Ground Penetrating Radar (LGPR) is a completely new way to do lane-keeping and localization using underground maps. Join us for a deep dive into this novel technology that is just now coming to market. We'll discuss LGPR implementations from the automated nine-ton military vehicles fielded in Afghanistan that used neither lidar nor camera to recent demonstrations of centimeter-level localization at highway speeds at 4 a.m. in a snowstorm. One key factor required for this technology to be successful has to do with the stability of underground maps. Forty years of geophysical surveys seems to show that the reference map should remain valid for a long time. We detail the strengths and weaknesses of the LGPR technology and discuss the power of fusing this independent method of localization into autonomous lane-keeping.



# BREAKOUT SESSION

## BREAKOUT SESSION # 8

### Automated Vehicle's Effects on Urban Development: An Interactive Planning Charrette

Tuesday, July 11, 1:30 PM – 5:30 PM

Room: Golden Gate 5

#### Organizers

Nico Larco, Department of Architecture – Sustainable Cities Initiative, University of Oregon  
Caroline Rodier, Institute of Transportation Studies, University of California, Davis

This half-day workshop/charrette will bring together engineers, urban designers, planners, architects, and real estate professionals to investigate automated vehicles effects on land use, physical city design, urban densification or sprawl, and changes in local vitality and activity. Participants will work in focused groups, developing scenarios of how different areas of cities might shift with this new technology. This will include looking at potential shifts in the urban core and more suburban contexts.

#### **1:30 PM – 3:00 PM What do we know about the travel, land use, and design effects of automated vehicles?**

The session will begin with four short presentations on the effects of automated vehicles on travel behavior and traffic, urban form, street design, and development. These will create a framework for participants to consider during the charrette portion of the session.

Secondary Effects: Framing AVs Effects on Urban Design and Development

- Nico Larco

Travel behavior and Traffic: Owned and Shared Automated Vehicles

- Billy Riggs, Assistant Professor, CalPoly SLO

Adaptive Parking Designs

- Joshua Karlin-Resnick, Senior Associate, Nelson-Nygaard

Redesigning Streets

- Melissa Ruhl, Transportation Planner, ARUP
- Gerry Tierney, Associate Principal, Perkins+Will

#### **3:00 PM – 4:30 PM Hands-On Charrette**

The second part of the session will be a hands-on charrette where groups will look at the secondary effects of automated vehicles on land use, street and parking design. This session

will address future public policy needs of different urban areas (core and inner and outer suburbs). Through discussion and sketching/design, participants will investigate plans for prototypic sites, key concerns and opportunities, and critical regulatory issues.

- Nico Larco, Facilitator
- Moderators:
  - Melissa Ruhl
  - Gerry Tierney
  - Billy Riggs
  - Joshua Karlin-Resnick
  - (Additional Moderators TBA)

#### **4:30 PM – 5:30 PM Response and Wrap-Up**

Each group will share key finding from their scenario planning exercise. This will be followed by a larger group discussion on the implications for planning, design and policy for automated vehicles and the built environment.

- Nico Larco and Caroline Rodier, Facilitators



# BREAKOUT SESSION

## BREAKOUT SESSION #9

### Effects of Vehicle Automation on Energy-Usage and Emissions

Tuesday, July 11, 1:30 PM-5:30 PM

Room: Golden Gate 6

#### Co-Chairs:

Avi Mersky, Carnegie Mellon University  
Zhenhong Lin, Oak Ridge National Laboratory

#### Organizing Committee:

Amitai Bin-Nun, Securing America's Future Energy  
T. Donna Chen, University of Virginia  
William Chericoff, Toyota  
Jia Hu, Federal Highway Administration  
Natarajan Janarthanan, Washington State Department of Transportation  
Paul Leiby, Oak Ridge National Laboratory  
Xiao-Yun Lu, University of California, Berkeley  
Don MacKenzie, University of Washington  
Mathieu Joerger, University of Arizona  
Jimmy O'Dea, Union of Concerned Scientists  
Constantine Samaras, Carnegie Mellon University  
Tom Stephens, Argonne National Laboratory  
Zia Wadud, University of Leeds  
Jacob Ward, Carnegie Mellon University  
Guoyuan Wu, University of California, Riverside

#### Session Goals

The goal of the session is to provide a forum for an exploration on the current issues being investigated, by the profession, on the subjects pertaining to the potential energy and emissions implications of automation technology, in the transportation sector. Also, to provide an open forum for discussion of these and other issues among the current investigators/researchers, industry, regulators and interested parties.

#### Format

Presenters will be divided into 5 main subject groups: Systems Wide Models; Adaptive and Cooperative Adaptive Cruise control; Specific Technologies, Policy; and Vehicle Sharing and Routing. Each speaker will present 15 slides at 20 seconds per slide, for a total presentation

time of 5 minutes per speaker. Each Subject group will be given an open discussion, after each presenter in that group has presented. This discussion will be 5 minutes long for each presentation in the group.

## Schedule

### 1:30 PM – 1:40 PM Session Opening

### Presentation Groups

#### 1:40 PM – 2:30 PM System Wide Models of Energy and Demand

Moderator – Jimmy O’Dea

Preliminary analysis of the impacts of CAV technologies on travel demand and energy use

- Joshua Auld, Argonne National Laboratory

A new framework for the utility of autonomous vehicles: Impacts on energy

- Amitai Bin-Nun, Securing America’s Future Energy
- Isabel Binamira, Georgetown University

Quantifying Fuel Impacts of Connected and Automated Vehicles Through a Bottom-up Energy Inventory Model and National Traffic Data

- Yuche Chen, National Renewable Energy Laboratory
- Jeff Gonder, National Renewable Energy Laboratory
- Eleftheria Kontou, National Renewable Energy Laboratory

Challenges in Modeling CAV Energy-Emission Impacts, and What (If anything) can be Learned from Compact Equilibrium Modeling

- Paul Leiby, Oak Ridge National Laboratory

Energy Impact of CAV — Reducing Estimation Uncertainty with Disaggregate Consumer Choice Modeling

- Zhenhong Lin, Oak Ridge National Laboratory

#### 2:40 PM – 3:10 PM Impacts of Cooperative Adaptive Cruise Control

Moderator – Avi Mersky

Truck CACC Fuel Economy Test

- Xiao-Yun Lu, University of California, Berkeley
- Steven Shladover, University of California, Berkeley
- Brian McAuliffe, National Research Council, Canada
- T. Barry, Transport Canada
- S. Bergqvist, Volvo
- A. Kailas, Volvo
- O. Altan, Federal Highway Administration

Evaluating Energy and Emissions Impacts of Cooperative Adaptive Cruise Control through Traffic Microsimulations

- Andrew Eilbert, US Department of Transportation
- Lauren Jackson, US Department of Transportation
- George Noel, US Department of Transportation
- Brian O’Donnell, SGT
- Scott Smith, US Department of Transportation

Road Test of CAV Eco-ACC on Rolling Terrain

- Jia Hu, Federal Highway Administration
- Jiaqi Ma, Leidos

Estimating Energy Efficiency of Connected and Autonomous Vehicles in a Mixed Fleet

- Liang Hu, Iowa State University
- Jing Dong, Iowa State University

#### 3:30 PM – 4:00 PM Impacts of Vehicle Sharing and Routing

Moderator – Xiaoyun Lu

Travel and environmental impacts of unoccupied VMT in Robotaxi fleet based on GPS trajectory data

- Morteza Taiebat, University of Michigan, Ann Arbor
- Shihong Huang, University of Michigan, Ann Arbor
- Neda Masoud, University of Michigan, Ann Arbor
- Henry Liu, University of Michigan, Ann Arbor
- Ming Xu, University of Michigan, Ann Arbor

A Green Routing Fuel Saving Opportunity Study on Large-Scale Real-World Travel Data

- Lei Zhu, National Renewable Energy Laboratory
- Jacob Holden, National Renewable Energy Laboratory
- Jeffrey Gonder, National Renewable Energy Laboratory
- Eric Wood, National Renewable Energy Laboratory

Leveraging Shared Autonomous Electric Vehicles as First/Last-Mile Connections for Transit

- T. Donna Chen, University of Virginia
- Farhan Javed, University of Virginia
- Zhuoyi (Tony) Zhang, University of Virginia

#### **4:10 PM – 4:30 PM Impacts of Specific Technologies: Other**

Moderator – Paul Leiby

Holistic Assessment of the Co-Benefits and Tradeoffs between Safety, Mobility and the Environment for Automated and Connected Vehicles

- Matthew Barth, University of California-Riverside
- Guoyuan Wu, University of California-Riverside
- Danyang Tian, University of California-Riverside

Electric Vehicle Charging Placement Optimization with Vehicle Automation

- Avi Mersky, Carnegie Mellon University
- Constantine Samaras, Carnegie Mellon University

#### **4:40 PM – 5:10 PM Policy Impacts and Implications**

Moderator – Jia Hu

Eligibility of vehicle automation and connectivity technologies for credits in fuel economy and GHG regulatory programs

- Therese Langer, American Council for an Energy-Efficient Economy

Incentives to Promote Sustainable Energy Outcomes with CAVs: Taxation Strategies and Energy/Demand Responses

- Paul Leiby, Oak Ridge National Laboratory
- Jonathan D. Rubin, University of Maine

Exploring the Energy, Economic, and Travel Implications of Changes in Parking Choices due to Driverless Vehicles

- Corey Harper, Carnegie Mellon University
- Constantine Samaras, Carnegie Mellon University
- 

#### **5:10 PM – 5:30 PM Session Closing**



# BREAKOUT SESSION

## BREAKOUT SESSION # 10

### Data Sharing Models and Policy

Tuesday, July 11, 1:30 PM – 5:30 PM

Room: Franciscan C&D

#### Organizers

Shawn Kimmel, Booz-Allen Hamilton  
Anita Kim, U.S. DOT Volpe Center  
Ginger Goodin, Texas Transportation Institute  
Baruch Feigenbaum, Reason Foundation  
Richard Mudge, Compass Transportation and Technology  
Amitai Bin-Nun, Security America's Future Energy  
David Perlman, U.S. DOT Volpe Center  
Carl Andersen, U.S. DOT Federal Highway Administration

#### Session Description

Data exchange amongst various private and public sector entities is critical for successful widespread adoption of automated vehicles (AV). This session will explore governance models and implementation challenges related to data collection, storage, and access. Two panels will focus specifically on data sharing related to (1) safety and performance and (2) operations and infrastructure, and answer questions such as:

- What are the value exchanges between various public and private entities that incentivize sharing?
- What types, formats, and granularity of data are needed to achieve desired benefits?
- How can public agencies best prepare data infrastructure and policy to be ready for AVs?
- How can AV data be shared while protecting proprietary and liability concerns?
- What data standards are needed to support data sharing, and what is the role of public vs. private sector in developing and enforcing these standards?

#### Agenda

##### **1:30 PM – 2:00 PM Introduction to Data Sharing Issues and Activities**

Moderator - Shawn Kimmel, Lead Engineer, Booz-Allen Hamilton

Overview of session goals and a brief background on data sharing models and policy to set the stage for the panels and technical discussions. This will include a review of the foremost data issues of 2017 and an update of certain federal efforts in the space:

- Steve Sill (f.b.c.), US DOT ITS JPO, Standards Program: Standards Roadmap activities as it relates to data, including a report out from the Monday auxiliary session on technical standards prioritization.

- Ariel Gold (t.b.c.), US DOT ITS JPO Data Program: Existing and proposed efforts to support AV implementation through data management tools and guidelines.

### **2:00 PM – 3:30 PM Panel on Safety and Performance Data**

This panel will explore issue with types of data that can improve overall transportation system safety and support safety assurance. Example types of data include: driving scenarios, event data recorders, lessons learned, aggregated safety performance data, test cases, and disengagement reports.

Panel:

- David Kidd, Senior Research Scientist, Insurance Institute for Highway Safety
- National Highway Traffic Safety Administration, speaker t.b.c.
- Automotive Information Sharing and Analysis Center (AutoISAC), speaker t.b.c.
- Jim Adler, Vice President of Data, Toyota Research Institute
- Bob Lange, Vice President of Vehicle Engineering, Exponent

Interactive discussion with audience (30 mins)

### **3:00 PM – 3:30 Break**

### **3:30 PM – 5:00 PM Panel on Operations and Infrastructure Data**

This panel will explore the various local, state, federal, and international models for sharing data that can improve situational awareness, efficiency, and resource allocation for AVs and agencies alike. Example types of data include: work zones, signal phase and timing, road closures, weather, incidents, and traffic conditions.

Panel:

- Shailen Bhatt, Executive Director, Colorado DOT
- Scott Marler, Director of Traffic Operations, Iowa DOT
- Jennifer Carter, Sr. Manager of Government Solutions, HERE (representing USA and EU efforts)
- Sue Bai, Principal Engineer of Automobile Technology Research, Honda R&D Americas
- Jun Shibata, Senior Researcher, Japan Digital Road Map Association
- Thomas Bamonte, Program Manager for Automated Vehicles, North Central Texas Council of Governments

Interactive discussion with audience (30 mins)

### **5:00 PM – 5:30 PM Closing Discussion**

The session will conclude with an round-up of major themes through an interactive discussion with the audience. The session organizers will capture take-away points and seek audience input on how to best to frame these points in conference proceedings. The discussion will explore how these issues relate to the practitioners, policy makers, industry representatives and others in the audience.



# BREAKOUT SESSION

## BREAKOUT SESSION # 11

### Artificial Intelligence (AI) and Machine Learning (ML) for Automated Vehicles (AV): Exploring Tools, Algorithms, and Emerging Issues

Tuesday, July 11, 1:30 PM – 5:30 PM

Room: Golden Gate 3

#### Organizers

Sherif Ishak, Louisiana State University  
Shawn Kimmel, Booz Allen Hamilton

Autonomous driving relies on in-vehicle computers that emulate the functions of a human brain in making informed decisions. Such systems employ artificial intelligence and sophisticated machine learning methods to support object tracking and various pattern recognition capabilities. This session will provide an overview of applications that utilize Artificial Intelligence and Machine Learning tools supporting critical autonomous vehicles functions, as well as highlight emerging issues and challenges to overcome with such advanced computing tools.

This breakout session will feature seven presentations, each limited to 20 minutes followed by 5 minutes for questions. There will be a 20 min break half way through the session and a 45 min interactive discussion with the speakers at the end of the session. Given that the theme of this breakout session is to highlight the crucial role of artificial intelligence and machine learning tools in supporting the technology and applications for vehicle automation, all presenters are required to state clearly in their presentation how their work is aligned with the theme of this session. In essence, the speakers must highlight the elements of artificial intelligence and machine learning in their work so that the audience can understand the relevance of this work to the mission and scope of ABJ70.

Moderator – Sherif Ishak, Louisiana State University

#### 1:30 PM – 1:55 PM

A Real-Time Data-Driven Decision-Support Toolkit for the Incentivization and Guidance of Shared, Electrified, and Automated Vehicles (SEAVs)

- Chenfeng Xiong, University of Maryland

#### 1:55 PM – 2:20 PM

Coordinated Decentralized Optimal Control for Connected and Automated Vehicles

- Andreas A. Malikopoulos, University of Delaware

#### 2:20 PM – 2:45 PM

Seeing Safety: Deep Learning, Virtual Environments, and the Future of Autonomous Vehicles

- Artur Filipowicz, Princeton University

**2:45 PM – 3:10 PM**

How Machine Learning and Swarm Intelligence Improve Efficiency of Connected & Automated Vehicles (CAV)

- Xuewei Qi, University of California-Riverside

**3:10 PM – 3:30 PM**

BREAK

**3:30 PM – 3:55 PM**

A centralized and decentralized approach for incentive allocation as a part of smart mobility solutions

- Mehrdad Shahabi, University of Michigan

**3:55 PM – 4:20 PM**

Seeing traffic signal bulb colors is not enough: predictive data for connected & autonomous driving

- Thomas Bauer, Traffic Technology Services, Inc. Beaverton

**4:20 PM – 4:45 PM**

A Convolutional Neural Network Model for Detection of Road Features

- Tim Wong, NVIDIA

**4:45 PM – 5:30 PM**

Discussion and closing remarks



# BREAKOUT SESSION

## BREAKOUT SESSION # 12

### Testing Connected and Automated Vehicles (CAVs): Accelerating Innovation, Integration, Deployment and Sharing Results

Tuesday, July 11, 1:30 PM – 5:30 PM

Room: Continental 8

#### Organizers

Shannon Barnes, CSG Government Solutions  
Jennifer Carter, HERE  
Andrea Gold, University of Texas, Austin, Center for Transportation Research  
Mathieu Joerger, University of Arizona Transportation Research Institute  
Cynthia Jones, Ohio Department of Transportation  
James Li, Oak Ridge National Research Laboratory  
Taylor Lochrane, FHWA Office of Operations Research and Development  
Barry Pekilis, Transport Canada  
Valerie Shuman, Shuman Consulting Group, LLC  
Junhua Wang, Tongji University

#### Description

This session will explore opportunities and best practices regarding connected and automated vehicles (CAV) testing throughout the industry. CAVs offer the promise of improved safety and performance, compared to the current human driver paradigm. Both closed course and open road testing are critical components of technology evaluation, improvement, integration and acceptance. Diversity of testing sites and attributes will multiply the scenarios tested and mitigate operating risk once the technology is implemented. The USDOT has cited acceleration of learning and development expected from the mandatory Community of Practice within their Automated Vehicle Proving Ground Pilot Program.

We will include US and international speakers and participants from CAV experts, the USDOT AV Proving Grounds Pilot network, and other closed course and open road sites. The following items are the foundation of our session planning:

- Education, Sharing and Collaboration Opportunities
  - Safety: testers and public
  - Interoperability including V2V and V2I
  - Testing Standards and Procedures
  - Diverse sites: density, weather, scenarios, communications, closed course/open road

- Expand Community of Practice
- Share Best Practices
- Highway Operations
  - Public/Private Partnerships
  - Initial Development of testing sites
  - Provide and share results

### Goals

- Showcase diverse CAV Proving Grounds
- Understand various purposes of CAV Proving Grounds (e.g., Closed, open, urban, cross border)
- Understand planned outcomes of CAV Proving Grounds (e.g., functional innovation, roadworthiness certification, digital infrastructure interoperability)
- Explore roles and partnerships for different types of testing (public/private/academic, military, standards bodies, global, etc.)

### Outputs

- Summary for TRB proceedings, including workshop results
- Chapter for Road Vehicle Automation Series of AVS Highlights
- Research Needs or Synthesis Statements (as defined)
- Expand the Community of Practice
- Next Steps for Collaboration
- Document Cyber Security impacts and issues

### 1:30 PM- 1:35 PM Welcome and Overview

Cynthia Jones – Ohio Department of Transportation

### 1:35 PM – 2:30 PM CAV Proving Grounds Showcase

Moderator – Andrea Gold, University of Texas, Austin, Center for Transportation Research

Presentations

Reflections

- Texas Automated Vehicle Proving Ground Partnership, Bryan, Austin and San Antonio, Texas
- GoMentum Station, Concord, California
- SunTrax and the Central Florida Automated Vehicle Partnership, Orlando, Florida
- Iowa AV Proving Grounds, Iowa City, Iowa
- UK Centre for Connected and Autonomous Vehicles, United Kingdom: London (Greenwich), Coventry, Milton Keynes, Bristol, Oxford, Cranfield interurban roads
- GoMentum Station Contra Costa Transportation Authority, Concord, California

### 2:30 PM – 3:30 PM Roles and Partnerships Panel

Moderator – Taylor Lochrane, USDOT FHWA Office of Operations Research and Development

Introductory panel

- Hajime Amano, ITS Japan
- Maxime Flament, ERTICO
- Brett Roubinek, Transportation Research Center

Jam session – Table discussions

Report out and feedback

**3:30 PM – 4:00 PM Break**

**4:00 PM – 5:00 PM CAV Path to Collaboration Panel**

Moderator – Valerie Shuman, Shuman Consulting Group, LLC

Introductory panel

- Carla Bailo, The Ohio State University
- Ed Bradley, Toyota Motor North America
- Sondra Rosenberg, Nevada Department of Transportation

Jam session – table discussions

Report out and feedback

Draft next steps for collaboration

**5:00 PM – 5:30 PM Lightening Round**

Moderator – Mathieu Joerger, University of Arizona Transportation Research Institute

Each participant has one minute to provide any further insights

**Sponsor**

TRB ABJ50 Information Systems and Technology Committee



# BREAKOUT SESSION

## BREAKOUT SESSION # 13

### Challenges and Opportunities for the Intersection of Vulnerable Road Users (VRU) and AVs

Tuesday, July 11, 1:30 PM – 5:30 PM

Room: Continental 9

#### Organizers

Justin M. Owens, Virginia Tech Transportation Institute  
Laura Sandt, University of North Carolina Highway Safety Research Center

#### Description

The primary goals of the session is to raise awareness of the safety and mobility needs of physically vulnerable road users (e.g., pedestrians, bicyclists, and people with disabilities) as they share roadways with partially and highly automated vehicles (HAVs). This is crucial to the safe and accepted development of HAV systems, as it will encourage roadway designers, AV developers, and policy makers to consider the needs of the entire traveling population. We will discuss existing, ongoing, and needed research to improve safety for VRUs when interacting with AVs, with a particular focus on technological issues, and we will generate discussion about technical and policy barriers and opportunities to enhance VRU safety and mobility as they interact with AVs.

#### Agenda

##### **1:30 PM – 2:30 PM Vulnerable Road User Safety Needs and Concerns**

Moderator – Laura Sandt, UNC Highway Safety Research Center

Introduction to Session and Overview of AV/VRU Research

- Laura Sandt, UNC Highway Safety Research Center

Key Human Factors Challenges and Opportunities within AV/VRU Interactions

- Justin Owens, Virginia Tech Transportation Institute

Reconstruction of Vehicle-Pedestrian Collisions: Powerful Data to Inform the Design of Automation and Active Safety Systems

- Justin Morgan, Forensic Engineering Technologies

Needs and Challenges of Pedestrians with Disabilities with Respect to Automated Vehicles

- Sudharson Sundararajan, Booz Allen Hamilton

**2:30 PM – 3:15 PM Panel Discussion**

**3:15 PM – 4:15 PM Technology, Infrastructure, and Policy Considerations**

Moderator – Michael Clamann, Duke University Humans and Autonomy Lab

AutonoVi: A General Purpose Simulator to Evaluate Driving and Navigation Strategies of Autonomous Vehicles

- Dinesh Manocha, University of North Carolina, Computer Sciences Department

Bystander Interaction with Autonomous Vehicles and Robots

- Aaron Steinfeld, Carnegie Mellon University

Urban Form and Automated Flows - The Prospect of Automation in Transportation for Future City Form

- Tanvi Maheshwari, Future Cities Laboratory, Singapore

**4:15 PM – 4:45 PM Panel Discussion**

**4:45 PM – 5:20 PM General/Research Needs Discussion**

**5:20 PM – 5:30 PM Wrap Up and Next Steps**



# BREAKOUT SESSION

## BREAKOUT SESSION # 14

### Enhancing the Validity of Traffic Flow Models with Emerging Data

Tuesday, July 11, 1:30 PM – 5:30 PM

Room: Continental 7

#### Organizers

Meng Wang, Delft University of Technology, chair  
Xiaopeng (Shaw) Li, University of South Florida, co-chair  
Samer, Hamdar, George Washington University, co-chair  
Haizhong Wang, Oregon State University  
Soyoung Ahn, University of Wisconsin – Madison  
Mark Brackstone, TSS -Transport Simulation Systems  
Danjue Chen, University of Massachusetts Lowell  
Steven Mattingly, University of Texas Arlington  
Alexander Skabardonis, University of California, Berkeley  
Michael Levin, University of Minnesota

#### Session description

This breakout session provides an opportunity to bring together the cyber-physical, communications, vehicle and traffic flow communities to better understand the fundamental characteristics of traffic flow with varying levels of automation and identify the research needs for developing models to assess real-world mobility and environmental sustainability implications of connected automated vehicles (CAV).

This breakout session will focus on discussion of innovative traffic flow modeling techniques and simulation tools to quantify the mobility and environment impacts of CAV and their implications on highway capacity and freeway operations and designs. Special attention will be given to insights into behavioral differences in terms of lane-changing (lane choice, lane change execution) and car-following (following gap, reaction time, acceleration distribution) maneuvers and validation of existing and new CAV traffic flow models according to empirical data from CAV field tests.

Invited representatives from road authorities, industry, and academia will share state-of-the-art research findings and challenges for this growing interdisciplinary field and the whole group will discuss data needs, data availability, and validation and calibration methods for CAV traffic flow models, plausible scenarios to be modeled with different vehicle classes, facilities and market penetration rates. The breakout session will provide opportunities for collaboration across research communities.

This breakout session will generate session presentations, research needs statements, discussion group notes, and a chapter of the symposium proceedings.

## **Agenda**

### **1:30 PM – 1:40 PM: Welcome (AHB45(3) Goals and Activities)**

Meng Wang, Delft University of Technology

### **1:40 PM – 3:50 PM: Panel: Data and Test-Beds Examples: An International Overview**

Moderator – Meng Wang, Delft University of Technology

Co-Chairs:

Steve Mattingly, University of Texas Arlington (Co-Moderator and Questions)

Xiaopeng (Shaw) Li, University of South Florida (Co-Moderator)

Michael Levin, University of Minnesota (Note Taking)

#### **Presentations:**

The role of data collected in Australian deployments and pilots to inform how humans want to interact with technology

- Rita Excell, Australia and New Zealand Driverless Vehicle Initiative

Connected and Automated Vehicular Flows: Modeling Framework and Data Availability

- Jiaqi Ma, Leidos Inc.

Selected Field Experiments on the Chang'an University CAV Testbed

- Zhigang (David) Xu, Chang'an University, China

Recent findings from micro-simulation of traffic impacts of cooperative longitudinal control systems

- Steven Shladover, PATH Berkeley, University of California

Control of traffic with a small number of automated vehicles

- Daniel Work, University of Illinois at Urbana Champaign

### **3:50 PM – 4:00 PM Break**

### **4:00 PM – 5:00 PM Panel discussion**

Panelists:

- Rita Excell, Australia and New Zealand Driverless Vehicle Initiative
- Jiaqi Ma, Leidos Inc.
- Zhigang (David) Xu, Chang'an University, China
- Steven Shladover, PATH Berkeley, University of California
- Daniel Work, University of Illinois at Urbana Champaign

### **5:00 PM – 5:30 PM Reporting and concluding**

## Speakers:

**Rita Excell**, Australia and New Zealand Driverless Vehicle Initiative (Executive Director)

**Title:** The role of data collected in Australian deployments and pilots to inform how humans want to interact with technology.

**Abstract:**

This presentation will outline the numerous activities being undertaken in Australia and how a coordinated approach is facilitating the sharing of lessons learnt and next steps in Australia and beyond. In 2015 the Australian Road Research Board formed a collaboration of like minded organisations to work together to rapidly progress the introduction of driverless vehicles onto Australian roads. As we approach the second year of the Australia and New Zealand driverless vehicle initiative the collaboration has grown to over 100 partners and active deployment of research and trials of connected and automated vehicles taking place across Australia and in New Zealand. Data being generated and collated from these pilots and research projects will be explained and how this collaborative approach is supporting a customer and end user centric deployment strategy in Australia.

**Bio:**



Rita Excell is the Executive Director of the Australia and New Zealand Driverless Vehicle Initiative (ADVI) Centre for Excellence and is responsible for delivering ADVI's contribution to the safe and successful introduction of driverless vehicle technologies into Australia and New Zealand.

Her prior roles include Regional Manager of ARRB Group's South Australian office, where she managed key strategic policy projects for State Road Authorities and organisations that manage public and private road infrastructure.

Rita is a qualified Civil Engineer with over 25 years' experience, which has included roles in Local Government and more than 13 years with RAA - where she worked on strategic transport planning, road safety and advocacy. She is currently the President of the IPWEA South Australia and sits on the Australasian board of IPWEA, as well as the Port Adelaide Development Assessment Panel".

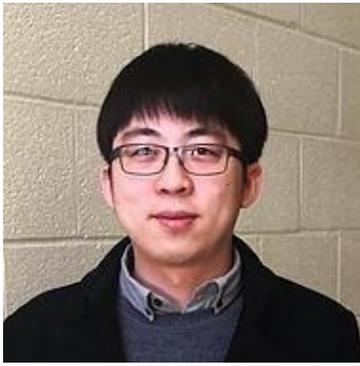
**Jiaqi Ma**, Leidos, Inc. [Research Scientist and Project Manager]

**Title:** Connected and Automated Vehicular Flows: Modeling Framework and Data Availability

**Abstract:**

Advanced connected automated vehicle (CAV) technologies enable us to modify driving behavior and control vehicle trajectories, which have been greatly constrained by human limits in existing manually-driven highway traffic. Understanding and modeling automated vehicle driving behavior is critical to evaluating transportation system performance under different CAV deployment scenarios. This presentation firstly introduces a general CAV analysis, modeling and simulation (CAV AMS) framework currently under development by Federal Highway Administration (FHWA). Then, data needs and available datasets to calibrate these models are discussed. Lastly, data collection efforts through field experiments using CAVs and connected infrastructure at the FHWA Saxton Transportation Operations Lab are discussed. These projects include cooperative adaptive cruise control, cooperative merge, eco approach and departure and eco-driving on rolling terrains.

**Bio:**



Dr. Jiaqi Ma is a Research Scientist and Project Manager with Leidos, Inc., working at the FHWA Turner Fairbank Highway Research Center. He received his Ph.D. degree from the Department of Civil and Environmental Engineering at the University of Virginia. His areas of expertise include connected automated vehicles, Intelligent Transportation Systems, traffic modeling and simulation, network optimization, planning for operations, travel demand forecasting, and data mining. He has managed and participated in many research projects funded by USDOT and state DOTs, covering a wide range of areas including vehicle automation-based Speed Harmonization, Cooperative Adaptive Cruise Control, bottleneck identification and mitigation, and Benefit/Cost analysis of Traffic Incident Management Strategies, etc. He has published more than 30 articles in prestigious peer-review journals and over 30 papers published and presented at top conferences. He is a Member of the TRB Standing Committee on Vehicle-Highway Automation, a member of the TRB Subcommittee on Travel Time Speed and Reliability, and a member of the American Society of Civil Engineers.

**Zhigang (David) Xu:** Chang'an University, China

**Title:** Selected Field Experiments on the Chang'an University CAV Testbed

**Abstract:** Chang'an University (CU) CAV testbed (CU-CAVTest) is located on Weishui Campus of CU, which occupies 282,000 square meters (about 70 acres). It includes a 2.4 kilometer high-speed circular test track with 2 lanes and an extra 1.1 kilometer straight 4-lane test road with 4 kinds of pavement (asphalt, concrete, bricks, and dirt). It is furnished with a fleet of connected and autonomous vehicles and smart infrastructure, including five heterogeneous wireless networks, a UWB-based high precision positioning system and high performance computing resources. Overall, this testbed is one of the few large-scale CAV test sites around the world with comprehensive smart highway systems under a fully controlled environment. 4 field experiments conducted on this testbed will be introduced, including 1) 4G-LTE vs. DSRC field performance comparison; 2) aggregated fuel consumption estimation using connected vehicle data; 3) trajectory tracking algorithms for AV; and 4) trajectory optimization for CAV platoons.

**Bio:**



Dr. Zhigang Xu is currently an Associate Professor of the College of Information Engineering, Chang'an University, China. He is also the vice director of the Joint Lab of Internet of Vehicles Sponsored by China Mobile and Ministry of Education. He is also the Secretary General of China Innovation Alliance of Connected and Automated Vehicles Testing (CAVTest) and the Chair of Connected and Automated Vehicle Committee under World Transport Convention (WTC). He received his M.S. and Ph.D. degrees in Traffic Information Engineering & Control from Chang'an University, respectively. He had worked at the University of California, Davis as a visiting scholar in 2015.

Dr. Xu's research focuses on the Connected and Automated Vehicles, Nondestructive Testing on Transportation Infrastructure and Image Processing. He led the construction of the first large-scale Cooperative Vehicle-Infrastructure System (CU\_CVIS) among China Universities, which is also among the first few of its kind around the world. He conducted joint research projects with several famous domestic IT giants such as China Mobile, Datang Mobile and Neusoft. He has published more than 40 articles in peer-reviewed journals and 15 patents. He was invited to make presentations and keynote speeches at a number of international conferences such as TRB, COTA, TRC, ICTIM. He organized a team named "Xinda" on developing autonomous cars and participating grand challenges. Dr. Xu won 1 National and 2 Provincial Scientific and Technological Progress Awards in China for his research contribution on testing the performance of vehicles and transportation infrastructure.

Contact:

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The middle section of the S. 2<sup>nd</sup> Ring-road, Xi'an, Shaanxi, P. R. China, 710064  
Email: [xuzhigang@chd.edu.cn](mailto:xuzhigang@chd.edu.cn), [xzgmail@qq.com](mailto:xzgmail@qq.com)

**Steven Shladover**; PATH, UC Berkeley

**Title:**

Recent findings from micro-simulation of traffic impacts of cooperative longitudinal control systems

**Abstract:**

This presentation presents state-of-the-art simulation results representing the microscopic interactions between manually driven vehicles and vehicles that use automatic longitudinal control systems, both autonomous (ACC) and cooperative (CACC). The models representing the automated car following behavior of the ACC and CACC systems are derived directly from the experimental responses of full-scale vehicles equipped with these systems, so they are much more realistic than previous theoretical models that have over-estimated traffic flow benefits of ACC. The models of manual driving include details of lane changing interactions on multi-lane highways, and have been calibrated using field data from a complex freeway corridor. Results from this simulation study show the effects on highway throughput of various operational strategies including both continuous and limited access managed lanes for the equipped vehicles, limitations on discretionary lane changing, and limitations on the lengths of coordinated strings of vehicles, with varying levels of on-ramp and off-ramp traffic and for various market penetrations of equipped vehicles.

**Bio:**



Dr. Steven Shladover has been researching road vehicle automation systems for more than forty years, beginning with his masters and doctoral theses at M.I.T. in the 1970s. He is the Program Manager, Mobility at the California PATH Program of the Institute of Transportation Studies of the University of California at Berkeley. He led PATH's pioneering research on automated highway systems, including its participation in the National Automated Highway Systems Consortium from 1994-98, and has continued research on fully and partially automated vehicle systems since then. This work has included definition of operating concepts, modeling of automated system operations and benefits, and design, development and testing of full-scale prototype vehicle systems. His target applications have included cooperative adaptive cruise control, automated truck platoons, automated buses and fully-automated vehicles in an automated highway system.

Dr. Shladover joined the PATH Program in 1989, after eleven years at Systems Control, Inc. and Systems Control Technology, Inc., where he led the company's efforts in transportation systems engineering and computer-aided control engineering software products. He chaired the Transportation Research Board Committee on Intelligent Transportation Systems from 2004-2010, and currently chairs the TRB Committee on Vehicle-Highway Automation. He was the chairman of the Advanced Vehicle Control and Safety Systems Committee of the Intelligent Transportation Society of America from its founding in 1991 until 1997. Dr. Shladover leads the U.S. delegation to ISO/TC204/WG14, which develops international standards for "vehicle-roadway warning and control systems".

**Daniel Work**; University of Illinois at Urbana Champaign, USA

**Title:** Control of traffic with a small number of automated vehicles

**Abstract:**

Traffic control via mobile actuation is now viable thanks to recent and significant improvements in self-driving and connected vehicle technologies, and may offer new traffic management opportunities beyond today's fixed control systems such as variable speed limits. As a motivating example, we show experimental evidence suggesting that careful control of a small number of autonomous vehicles in the traffic stream is sufficient to completely eliminate "phantom" traffic jams caused by human driving. We build on the seminal demonstration conducted by the Mathematical Society of Traffic Flow, in which 22 human-driven vehicles that initially drive smoothly around a circular track eventually degrade into substantial stop-and-go traffic. These experiments resolved a long-standing discussion in transportation science, namely that traffic waves can in fact arise without any external causes, but did not offer a solution to prevent it. We repeat the 22 vehicle experiments with the modification that one intelligently controlled autonomous vehicle replaces a single human-piloted vehicle. A series of experiments in Tucson, Arizona are conducted to measure the influence of the carefully controlled AV on human-piloted vehicles. Our main experimental result indicates that even when the penetration rate of autonomous vehicles is as low as 5%, stop and go traffic can be eliminated. The elimination of waves allows significant improvements in the total traffic fuel efficiency and safety, and is achievable long before the majority of vehicles are automated.

**Bio:**



Daniel Work is an assistant professor in the Department of Civil and Environmental Engineering, the Department of Electrical and Computer Engineering (courtesy), the Coordinated Science Laboratory, and the National Center for Supercomputing Applications at the University of Illinois at Urbana-Champaign. Prof. Work earned a B.S. (2006) from the Ohio State University, and an M.S. (2007) and Ph.D. (2010) from the University of California, Berkeley, each in civil engineering. Prior to joining the faculty at Illinois, Work was a research intern at Nokia Research Center, Palo Alto from 2008-2009, and a guest researcher at Microsoft Research

Redmond in 2010. Prof. Work has research interests in control, estimation, and optimization of transportation cyber physical systems. Prof. Work has received a number of honors and awards including selection to participate in the National Academy of Engineering's 2016 EU-US Frontiers of Engineering Symposium, being named a UIUC CEE Excellence Faculty Fellow in 2016, the 2015 UIUC ASCE Outstanding Professor Award, and the CAREER Award from the National Science Foundation in 2014.

**Session facilitators**

- Note taker: Michael Levin
- Research needs statements writers: Samer Hamdar, Meng Wang, Xiaopeng Li, Stephen Mattingly



# BREAKOUT SESSION

## BREAKOUT SESSION #15

### CAV Scenarios for High-Speed, Controlled Access Facilities

Tuesday, July 11, 1:30 PM – 5:00 PM

Room: Golden Gate 2

#### Organizers

Christopher Poe, TTI  
Steve Kuciemba, WSP  
James Colyar, FHWA  
Taylor Lochrane, FHWA  
Greg Krueger, HNTB  
Nick Wood, TTI  
Patrick Vu, VTA  
Angela Jacobs, FHWA  
Alex Skabardonis, UC Berkeley  
Tim Gates, Michigan State University  
Jon Obenberger, FHWA

#### Description

This session will focus on scenario planning for CAV (Connected and Automated Vehicles) on freeways and managed lanes. Through a series of presentations and break-out group discussions, dialogue with audience participants will be a critical component as we explore specific scenario development with operational and real-world implementation issues at the forefront. This session is being developed with joint involvement from Freeway Operations, ITS, Managed Lanes, Highway Capacity and Quality of Service, and Traffic Control Device Committees. The goals of this session are:

1. Discussion of likely CAV scenarios for high-speed, controlled access facilities
2. Identification of infrastructure needs (roadway & ITS) to support the CAV scenarios
3. Identification of near term implementation opportunities
4. Discussion and identification of research needs

#### Agenda

##### **1:30 PM Opening Discussion: Welcome and Introductions**

Moderator: Christopher Poe, TTI

- Introductions around the room
- Brief overview of the afternoon
- Research Needs from the Sponsoring TRB Committees

### **1:40 PM Perspectives**

Moderator: Steve Kuciemba, WSP

- Infrastructure Owner Operator Perspective, Greg Larson, Caltrans
- Vehicle Perspective (TBD - CAMP or OEM representative)
- Infrastructure Vendor Perspective Ken Smith, 3M
- Emerging Technology Perspective, Casey Emoto, VTA

### **2:30 PM Presentation of Scenarios - What is the general operational concept for the given CAV scenario?** (Presenters will also serve as facilitators)

- Temporary traffic control event (work zone or incident scenario), Greg Kreuger, HNTB
- Truck automation and truck platooning on controlled access facility, Mike Lukuc, TTI
- CAVs allowed on Freeways In Mixed Traffic, Alex Skabardonis, UC Berkeley
- Transit & Shared Mobility using CAV on Dedicated Managed Lanes, Patrick Vu, VTA

### **2:40 PM Breakout Part 1 - Near Term - timeframe of 1-5 years**

- What are the infrastructure (roadway, ITS) needs to support the scenario?
- What additional traffic control needs would be required?
- What are ideas on implementation ready technologies?

### **3:40 PM Short Break**

### **3:50 PM Breakout Part 2 - Long Term - timeframe of 5+ years**

- How data gathered from CAVs can support agencies with facility operation?
- What are possible private and public sector business case ideas?
- What are the design (geometric, traffic control, ITS) issues for the facility to accommodate CAVs?

### **4:50 PM Session Wrap-Up**

Moderators: Christopher Poe, TTI & Steve Kuciemba, WSP

- Summarize what near term issues need to be discussed further in upcoming conferences and workshops
- Summarize identified research needs that could be expanded into formal research needs statements supported by the sponsoring TRB Committees.

### **5:00 PM Adjourn**



# BREAKOUT SESSION



## BREAKOUT SESSION # 16

### Aftermarket Systems (ADAS-Related)

Wednesday, July 12, 1:30 PM – 5:30 PM

Room: Golden Gate 6

#### Organizers:

Chris Borroni-Bird, VP, Strategic Development, Qualcomm Technologies Incorporated  
Jim Misener, Director, Technical Standards, Qualcomm Technologies Incorporated

The goal of the session is to better understand the role that aftermarket systems may play in accelerating the deployment of automated vehicles. Aftermarket systems can accelerate deployment of automated vehicles while providing safety benefits with a viable business model. Examples of aftermarket systems may include those that provide collision avoidance warnings, train computer vision algorithms, or transmit and receive V2V messages. The session will bring together speakers from technology startups and established Tier 1 suppliers to discuss the benefits and challenges associated with aftermarket system deployment. Consideration will be given to the business model as well, since aftermarket systems cannot expect to be mandated by government.

#### 1:30 PM – 2:50 PM: Presentations

Roger Lanctot, Associate Director, Global Automotive Practice, Strategy Analytics  
Steve Boyd, Co-founder & VP External Affairs, Peloton Technology  
Stefan Heck, CEO, Nauto  
Paul Sakamoto, COO, Savari

#### 2:50 PM – 3:20 PM: Break

#### 3:20 PM – 4:40 PM: Presentations

Elan Nyer, Director Business Development, Nexar  
Joao Barros, CEO, Veniam  
Cory James Hohs, CEO Haas Alert  
Praveen Singh, VP Connectivity Business, Lear

#### 4:40 PM – 5:30 PM: Panel Session

Moderated by Roger Lanctot

Panelists: Stefan Heck, Steve Boyd, Paul Sakamoto, Eran Shir, Joao Barros, Cory James Hohs



# BREAKOUT SESSION

## BREAKOUT SESSION # 17

### Safety Assurance

Wednesday, July 12, Afternoon

Room: Golden Gate 3

#### Organizers

Hermann Winner, Technische Universität Darmstadt (Germany), Institute of Automotive Engineering (FZD), Chair  
Ching-Yao Chan, California PATH, UC Berkeley, Co-Chair

#### Introduction

Safety Assurance of Automated Vehicle (SAAV) is a still unsolved problem for introduction of automated driving. In 2016, AVS experts of different countries have presented aspects and approaches of SAAV. These contributions and the discussions led to key issues, which will be in the focus of the 2017 AVS breakout session on Safety Assurance.

Starting with a 5-10 min stimulation presentation, we would motivate the audience to be ready for discussions. In 15-20 min discussions, we will find more about the opinions of the audience and would gather their proposals.

#### Agenda

Session 1: Technical Approaches on Safety Assurance

#### **Prof. Dr. Lutz ECKSTEIN, RWTH Aachen University, Chair of ika and Director of the board of fka, Germany**

Having obtained a PhD in mechanical engineering, Lutz Eckstein joined Daimler AG where he became responsible for Safety Assurance of Advanced Driver Assistance Systems. In 2005 he was appointed by BMW AG to take over responsibility for HMI and Human Factors for all BMW, MINI and Rolls-Royce vehicles. Since 2010 Dr. Eckstein is chairing the Institute for Automotive Engineering of Aachen University, which has a strong record in innovative Chassis and Vehicle Concepts as well as in Automated Driving. He has contributed to more than 100 patents and is dedicated to increasing traffic safety as well as creating new driving experiences.

Topic:

Creating a reference for Automated Driving – the approach followed by PEGASUS. Since absolute safety is not existing, a commonly accepted safety reference for Automated Driving is needed. This speech gives a systematic description of the approach followed by the German project PEGASUS and points out, how this reference can be used along the development process in order to assure safety of Automated Driving functionalities.

Moreover, the required tool chain is described and possible models for cooperation between stakeholders are discussed.

**Karl ZIPSER, Ph.D., Helen Wills Neuroscience Institute, Berkeley DeepDrive Center & Redwood Center for Theoretical Neuroscience, UC Berkeley**

Karl Zipser did his PhD on the primate visual system at the Department of Brain and Cognitive Sciences at M.I.T. His work there and in subsequent postdoc positions is recognized as an important contribution to the field and his publications have received hundreds of citations. Following a transition to the visual arts, he studied fMRI methodology at UC Berkeley and has a research paper currently in press. Next Karl decided to combine his interest in deep networks with remote control cars, initially training the cars to drive on Berkeley sidewalks, then creating more than a dozen cars for multi-car experiments. He is currently pursuing this research as part of the Berkeley DeepDrive program.

Topic:

Vehicle-vehicle interaction is a major problem in autonomous driving research, but the most relevant interactions -- those involving dangerous situations such as high speed near misses or crashes -- cannot be safely or economically studied with real cars. We believe that scientific research on this problem requires a model system in which the cars and the environment are under control and 'risks' can be taken without risk to human beings or fear of expensive car demolition. For this purpose our Autonomous Model Car team has developed a fleet of self-driving 1:10 model cars and an outdoor arena for them to drive in. Neural networks of increasing behavioral complexity are trained on the data acquired from experimental sessions with five or more cars driving together.

**Dr. Edward R. GRIFFOR, Associate Director, Smart Grid and Cyber Physical Systems Program Office**

Topic:

Software-defined Intra-Vehicular Networking for Autonomy. NIST has been able to use 'software defined vehicle networks' (SDN) to develop this new approach to vehicle networking, build the simulation environment in their labs and test this approach. In the presentation, they introduce software defined networking (SDN) for Intra-Vehicular Networks, bringing SDN's traffic prioritization and resource management capabilities to make better use of the available bandwidth offered by vehicular buses and to enable the improved safety, security and reliability of automotive networks needed for automated vehicles. This approach has been tested for key AV systems.

**Chad PARTRIDGE, CEO of Metamoto, Inc., a startup specializing in test and validation of autonomous systems.**

Chad is an accomplished executive making his recent mark as an entrepreneur in enterprise software contributing mission critical video, geospatial metadata, and computer vision within unmanned systems markets. Starting as co-founder and then as President, he grew Sensing Systems through to its acquisition by 2d3 and then provided executive leadership through its subsequent evolution, ultimately highlighted in 2d3 Sensing's acquisition by Boeing/Insitu. Chad has been deeply involved with the Association for Unmanned Vehicle Systems International (AUVSI) and previously served on the AUVSI and AUVSI Foundation Board of Directors. Chad has a distinguished background and education in software engineering, machine learning, computer vision, sensing, control, automation, robotics, and hardware design. He has worked on various projects involving the development of complex autonomous systems. He holds engineering degrees from Stanford University, the University of Illinois, and the University of Michigan.

Topic:

Satisfying safety requirements for AVs embodied in software and deep learning is a massive

challenge of scale. Tests across many thousands of parameterized scenarios must be run during development and every time vehicle software, sensors, and infrastructure change. To realize this need, physical tests are supplemented with extensive on-demand simulation, which must validate the integrity of the software often before a vehicle hits the pavement. Traditional automotive simulation tools are not up to the task of this scale of simulation. Further, mature agile software engineering approaches, especially those involving continuous test and integration, provide a proven way forward. We will be discussing these topics surrounding evolving AV simulation best practices.

Session 2:

Presentations (2nd Session): Societal Perspectives on Safety Assurance

Speakers:

**Bernard C. SORIANO, Ph.D., California Department of Motor Vehicles**

Bernard C. Soriano is a Deputy Director for the California Department of Motor Vehicles and is in charge of the department's autonomous vehicles program. He has over 30 years of engineering and management experience in the private and public sector. Bernard holds a Ph.D. in Engineering and was a Lieutenant in the U.S. Navy Reserve and has numerous publications and patents. His honors and achievements include selection as a finalist in the NASA astronaut program.

Topic:

The presentation will explore the various measures that can be used to assess the safe operation of autonomous vehicles. The role of governmental agencies and the current landscape will also be discussed..

**Ryan HARRINGTON, Exponent, Inc.**

Ryan Harrington is a Principal within the Vehicle Engineering Practice at Exponent, Inc. Having worked directly on the development of automotive technologies and federal regulations, Mr. Harrington specializes in the analysis of complex technical and policy issues while fostering collaboration between industry executives, senior government officials, and engineers related to the deployment of automated vehicles, advanced driver assistance systems (ADAS) and fuel saving technologies. Prior to joining Exponent, Mr. Harrington was a Division Chief at the U.S. DOT's Volpe Center where he led a cross-functional team focused on the deployment of emerging transportation technologies. In this role he initiated and co-authored a report reviewing Federal Motor Vehicle Safety Standards (FMVSS) as they relate to automated vehicles and he led the development of technology assumptions and engineering analyses used to develop Corporate Average Fuel Economy (CAFE) standards. Prior to joining the Volpe Center, Mr. Harrington worked at Cummins Inc. and Delphi Automotive Systems. Mr. Harrington holds a master's degree in Automotive Engineering from the University of Michigan and a bachelor's degree in Mechanical Engineering from the University of Nebraska.

Topic:

The media frenzy surrounding automated vehicle technology and autonomous vehicles seems to be shaping unrealistic consumer expectations, at least for near-term deployments. This is compounded by the fact that increased technology complexity drives larger differences between consumer understanding and reality, leading to potential misuse. This presentation will focus on discussing the following questions. What role will instructions and warnings play in setting realistic consumer expectations? How can consumer education and marketing be used to shape more realistic expectations and thus more successful automated vehicle deployments?

**Shawn KIMMEL, Ph.D., Lead Engineering, Booz Allen Hamilton**

Shawn Kimmel is a robotics and automation engineer with over 10 years of experience developing automated vehicle (AV) technology and policy. He currently supports AV research at US DOT, including testing and standards. He obtained his graduate degrees from Virginia Tech and Colorado School of Mines, and previously researched vehicle automation for DARPA, RAND Corporation, National Academies, and Caterpillar. Notable accomplishments include leading testing and evaluation for DARPA Urban Challenge team Victor Tango (3rd place), developing system requirements for Caterpillar's automated load-haul-dump and drilling machines, and serving as a technology policy adviser in US Congress, including drafting automated vehicle legislation that was passed into law in 2015.

Topic:

Automated driving systems (ADS) present many challenges to existing vehicle testing and certification approaches in the US. The US DOT is undertaking research to identify potential testing frameworks and standards to support ADS safety assurance. This talk will discuss research to develop objective and repeatable test cases and scenarios for highly automated vehicles. Factors that are considered in test case development include ADS functionality, operational design domain (ODD), object and event detection and response (OEDR) requirements, and fail-safe/ fail-operational mechanisms. An analysis of the technical standards landscape will be discussed, which includes identifying the needs and gaps in technical standards for safety assurance.



# BREAKOUT SESSION



## BREAKOUT SESSION # 18

### Reading the Road Ahead: Infrastructure Readiness

Wednesday, July 12, 1:30 PM – 5:30 PM

Room: Continental 7

#### Organizers

Scott O. Kuznicki, P.E., Transpo Group

*IN COOPERATION WITH*

Dr. Paul Carlson, Texas A&M Transportation Institute

Brian Watson, American Traffic Safety Services Association

Robert Dingess, Mercer Strategic Alliance

#### Session Description

Today's automated vehicles collect primary guidance information from visible-light optical imagery machine vision equipment supported by complementary sensors and integrated with global navigation satellite systems. Without consistently-placed traffic control devices and geometric design, these cloud-supported multi-client machine learning systems will struggle to operate with predictable accuracy. This points to the need to determine the suitability of roadway segments for AV operations in support of the fast-emerging ubiquity of Level II and para-Level III AV systems and in preparation for consistent implementations of Level IV and Level V systems.

The outcome of this year's infrastructure session will be a working group for developing roadway readiness criteria, a clearinghouse for information, and an identification of key supporting organizations and contacts. These criteria will be based on the interplay of readiness with levels of automation and machine vision capabilities and potential rating systems for state of readiness, supported by an architecture for a national readiness clearinghouse. The ultimate goal is a peer-reviewed handbook for assessing roadway readiness.

The work products of this session will be a recommended set of research problem statements for synthesis and practice evaluations and also a research problem statement for the development of an information clearinghouse for the classification of machine vision systems and roadway segment properties. Scott Kuznicki, Jon Obenberger, and Paul Carlson will cooperate in writing these problem statements.

#### Agenda

**Worldwide State of Machine Vision Systems (75 minutes)**

Moderator – Scott O. Kuznicki, P.E., Transpo Group

The introductory presentations will outline the problems facing automated vehicle machine vision systems, worldwide approaches to anticipating and addressing these challenges, and the current U.S. efforts to determine levels of readiness of roadway systems for automated vehicles.

Ambiguous Infrastructure: A Worldwide Perspective

- Scott O. Kuznicki, P.E., Transpo Group

V2X Applications for Intersections

- Jaap Vreeswijk, MAP Traffic Management

Facilitating Automated Driving: The EU EIP Experience

- Tom Alkim, Dutch Road Authority

The Role of Mapping in Automated Driving: Capturing Infrastructure for the Operator

- Monali Shah, HERE

CDOT RoadX Program and Preparing for AVs

- Peter Kozinski, Colorado Department of Transportation

### **Workshop: Machine Vision and Traffic Control Devices (60 minutes)**

Moderator – Brian Watson, American Traffic Safety Services Association

Participants will enjoy a facilitated question-and-answer session to understand how machine vision experts, vehicle manufacturers, traffic control device suppliers, and transport agencies are cooperating to ensure that the systems are integrated. Participants will gain an understanding of how we can obtain maximum effectiveness from our roadway systems, including traffic control devices, in the automation environment.

Smart Work Zones for the AV Environment

Ross Sheckler, iCone Products

Signs and Lines of the Future

- Ken Smith, Ph.D., 3M Corporation

Hybrid Infrastructure for Automated Driving

- Panagiotis Lytrivis, I-Sense Group

### **Workshop: Developing a Level of Readiness Framework (75 minutes)**

Moderators – Scott O. Kuznicki and Peter Kozinski

This workshop will build on the information from the presentations and machine vision/TCD workshop to begin development of a framework for implementing a levels of readiness evaluation system and information clearinghouse. Participants will first assess the capabilities of SAE Levels of Automation and common machine vision systems in the context of the roadway environment, including signing and pavement markings. To enhance coordination between suppliers and vehicle manufacturers in the development of TCDs that are highly-compatible with AV machine vision systems, participants will develop a capabilities matrix for machine vision systems and, based on this, develop a corresponding recommendation for roadway readiness based on TCD applications and condition.



# BREAKOUT SESSION

## BREAKOUT SESSION #19

### SHARK TANK – Change is Coming: Who will Survive?

Wednesday, July 12, 1:30 PM – 5:00 PM

Room: Golden Gate 4

#### Organizers

Richard Mudge, Compass Transportation and Technology  
Alain Kornhauser, Princeton University  
Scott Smith, U.S. DOT Volpe Center  
David Pickerall, Smart and Connected Transportation  
Amitai Bin-Nun, Security America's Future Energy  
Reinhard Pfliegl, A3PS  
Alan Chachih, U.S. DOT Volpe Center

#### Session Summary

Automated vehicles provide a classic example of disruptive innovation. Change will be non-linear in nature (difficult to predict impacts with precision) and likely to generate new markets and new ways to provide traditional transportation services. Implications cover economic and social changes, well beyond those of traditional transportation investments.

Rather than talk in generalities, this workshop will focus on specific changes that have been advocated or predicted. A panel (the sharks) will provide a critical review of each potential change and ask about feasibility, unanswered technical or market questions, planning and policy implications, and possible future research.

#### Sharks – commentators

- Alain Kornhauser, Princeton University
- Randy Iwasaki, Contra Costa County Transportation Authority
- Jim Scheinman, Maven Ventures
- Iain Forbes, Head of the Centre for Connected and Autonomous Vehicles;UK Ministry of Transportation
- Chris Gerdes, Center for Automotive Research at Stanford
- Reinhard Pfliegl, A3PS
- Brad Templeton, Singularity University

**1:30 PM – 3:15 PM**

Moderator – Alain Kornhauser, Princeton University

### **1:40 PM – 2:25 PM Freight Revolution**

Truck pelotons have been tested and appear on the verge of operation. This session will not focus on energy savings such as from truck trains where each truck has a driver, but rather on driverless trucks. These offer the opportunity to travel long distances without a stop – coast to coast in two days? We may touch on high-speed intercity passenger service as well.

- Steve Boyd, Peloton Technologies

### **2:25 PM – 3:15 PM The End of Traffic Congestion.**

Reduced crashes and shorter headways (platoons) should increase the effective capacity of expressways and other roads. US DOT's report *Beyond Traffic* mentioned a possible five-fold increase in road capacity. Even less dramatic changes would have major implications for economics (improved access to labor/jobs and markets); finance (reduced need for public spending); and land use (encourage increased VMT). This session focus on economic, social, and environmental implications rather than traffic simulation models.

- Richard Mudge, Compass Transportation and Technology Inc.

### **3:15 PM – 3:45 PM Break**

### **3:45 PM – 5:15 PM Second Two Topics**

Moderator: Richard Mudge, Compass Transportation and Technology Inc.

### **3:45 PM – 4:15 PM No One Owns Cars Any More**

A growing number of people support the idea that the combination of autonomous vehicles, shared mobility, and reduced interest in driving will eliminate auto ownership – at least in urban areas. This is linked with the Mobility As A Service concept. A recent MIT study said that 3,000 vehicles was enough to handle all the traffic in Manhattan.

- Susan Shaheen, Director of Innovative Mobility Research, University of California at Berkeley

### **4:15 PM – 5:00PM Will State and Local Transport Agencies Fade Away?**

Does the Growth of Autonomous Vehicles Leave State DOTs and MPOs with Less To Do? Connected and automated vehicles require little if any financial support from public agencies. That is, deployment will happen largely based on market forces.

- Baruch Feigenbaum, Reason Foundation

### **5:00 PM – 5:30 PM Summary and Closing Remarks**



# BREAKOUT SESSION

## BREAKOUT SESSION # 20

### Making Automation Work for Cities

Wednesday, July 12, 1:30 PM – 5:30 PM

Room: Golden Gate 2

#### Organizers

Siegfried Rupprecht, Rupprecht Consult  
Jane Lappin, Toyota Research Institute  
Steve Buckley, WSP Parsons Brinckerhoff  
Scott Smith, U.S. DoT / Volpe Center  
Ellen Partridge, University of Chicago / Booth School of Business  
Amitai Bin-Nun, Securing America's Future Energy (SAFE)  
Dirk Heinrichs, Institute of Transport Research - German Aerospace Center (DLR)  
Karen Vancluysen, Polis

The session will discuss the status of automation planning/ implementation in cities in the the US and in Europe. We shall also identify priority activities to create an enabling policy framework for transport automation that contributes to meeting key urban policy goals. The primary target group for this breakout session are urban/ metropolitan planners and policy makers, as well as potential implementers of automation technology in cities and regions.

#### 1:30 PM Welcome

- Jane Lappin, Toyota Research Institute

Introduction: What cities hope and fear of automation

- Steve Buckley, WSP Parsons Brinckerhoff
- Siegfried Rupprecht, Rupprecht Consult

#### 1:45 PM Forging the silver bullet: How to prepare for a new generation of shared collective transport services?

Making automation work in Boston

- Kristopher Carter, City of Boston, Mayor's Office of New Urban Mechanics

Automated transport, curse or blessing ? A small cities' view

- Geert Blom, City of Helmond, The Netherlands

**2:20 PM Automating vital city functions: Can we facilitate automated freight distribution, waste collection or street cleaning?**

Automating urban waste collection.

- David Murphy, Waste Management Inc.

**2:40 PM Coexistence strategies: How can cities get ready for the market introduction of privately owned, single use vehicles?**

Planning for the transition phase: How Milton Keynes will facilitate CAV introduction

- Brian Matthews, Milton Keynes

**3:00 PM Expectations of urban automation**

Expected impacts of connected and automated driving in cities.

- Scott Smith, Volpe Center
- Martin Russ, Austriatech

**3:30 PM – 3:45 PM Break**

What transport authorities/ MPOs expect from automation? Perspectives from EU and US cities.

- Ivo Cré, POLIS
- Mollie Pelon, National Association of City Transportation Officials (NACTO)

Modelling Connected Automated Vehicles in urban traffic simulation models. Expectations from US-EU research cooperation.

- Jiaqi Ma, Leidos
- Siegfried Rupprecht, CoEXist Project

**4:45 PM Panel discussion "Action planning: What can cities do to make automation work for them?"**

The concluding panel discussion will aim to identify key elements of an urban automation policy agenda and how this could be coordinated with industry plans. Participants include presenters from the session/ session organisers.

**5:30 PM Close of session**



# BREAKOUT SESSION

## BREAKOUT SESSION # 21

### Connected and Automated Vehicles in Traffic Signal Systems

Wednesday, July 12, 1:30 PM – 5:30 PM

Room: Continental 8

#### Organizers

Larry Head, University of Arizona  
Henry Liu, University of Michigan  
Young-Jun Moon, The Korea Transport Institute

The goal of this two-part breakout session is to explore opportunities for new approaches to control of signalized intersections (or more broadly controlled junctions) for CAV. This session explores the role of infrastructure and the vehicle in decision making and control decisions and how vehicles and the infrastructure can cooperate to safely and efficiently operate the intersection of roadways.

#### **1:30 PM – 3:00 PM Session 1: Signal Control for Connected and Automated Vehicles**

Moderator – Mehdi Zamanipour, FHWA

Centralized v.s. Distributed Speed Coordination of Cooperative Vehicles at Intersections

- Meng Wang, Technical University of Delft

Connected and Automated Driving at an Signalized Intersection – Two Examples of Vehicle-Signal Cooperation

- Jia Hu, FHWA and Mehdi Zamanipour, FHWA

Dynamic Optimization of Spatial-Temporal Resources for an Isolated Intersection in a Connected and Automated Vehicles Environment

- Wanjing Ma, Tongji University

Traffic Signal Optimization under the Connected Vehicle Environment

- Wan Li, Xuegang (Jeff) Ban; University of Washington

Optimal Intersection Control for Automated Vehicles

- Henry Liu and Yiheng Feng, University of Michigan

#### **3:30 PM – 5:00 PM Session 2: Experience and Research Towards Traffic Management Systems in a Connected and Automated Vehicle Environment**

Moderator – Yiheng Feng, University of Michigan

Innovation in Action: Deploying one of the First U.S. Instances of Vehicle-to-Infrastructure Technology in Tampa, Florida

- Marcus Welz, CEO, Siemens Intelligent Traffic Systems

Managing automated vehicles at signalized intersections

- Jaap Vreeswijk, MAP Traffic Management

The Capacity and Delay Implications of CAV at Signalized Intersections and How Can be Accounted in the Highway Capacity Manual Approach

- Eric Ruehr and Alex Skabardonis,

CoVASS Application in Urban Intersections

- Moon, Young-Jun, The Korea Transport Institute
- Lee, Sang Heon, Ministry of Land, Infrastructure & Transport (MOLIT)

Group Discussion: Research Needs and Opportunities for Innovative Approach's to Controlled Junctions in a Connected and Automated Vehicle Environment

- Henry Liu and Larry Head



# BREAKOUT SESSION

## BREAKOUT SESSION # 22

### Legal and Policy Approaches: Finding the Right Balance on Legislating for Automated Vehicles

Wednesday, July 12, 1:30 PM – 5:30 PM

Room: Franciscan C&D

#### Organizers

Karlyn Stanley, RAND  
Ellen Partridge, Environmental Law Policy Center  
Anita Kim, U.S. DOT Volpe Center  
Ginger Goodin, Texas A&M Transportation Institute  
Baruch Feigenbaum, Reason Foundation  
Dov Friedman, Securing America's Future Energy  
Carl Andersen, U.S. DOT Federal Highway Administration  
Tammy Trimble, Virginia Tech Transportation Institute  
[Amitai Bin-Nun](#), Securing America's Future Energy  
[Shawn Kimmel](#), [Booz Allen Hamilton](#)

States are taking different approaches towards developing and enacting legislation specific to automated vehicles (AV). While some have defined clear and explicit rules for testing and operation of AVs on public roads, others have adopted a more 'hands-off' approach and avoided legislating in this area. Last year, the U.S. Department of Transportation released a model state policy to guide state and local agencies. In addition, several legal associations have started their own initiatives on developing model state legislation regarding AVs. The goal of this session is to bring together the various groups working on or influencing legislation development and to dive into a discussion on how to develop a framework and potentially desirable elements of effective legislation for AVs.

#### Agenda

**1:30 PM – 3:00 PM “Speed Dating”**  
**Moderated by Bryant Walker Smith**

Because so much work has been done in the last year, this session will present a quick overview of who is doing what through a "speed-dating" round. Presenters, from ten organizations, will make a very short presentation on what their organization is doing (e.g., developing principles, drafting legislative language, convening, etc.), and their key policy wish from Federal, State or local government, or standards development organizations.

Following the brief presentations, the presenters will join a table with audience members and have a sparkling "speed-dating" conversation. Presenters will continue to rotate to other tables for new conversation every 5-10 minutes.

Presenters include:

- James Fackler, Vice-chair of AAMVA's AV Working Group
- Lindsay Beaver, Legislative Counsel for the ULC AV project
- David Kidd, Ph.D., IIHS Senior Research Scientist
- Mollie Pelon, NACTO
- Russ Martin, Director of Government Relations for GHSA
- Art Guzzetti, APTA
- Mark Norman, TRB
- Anne Marie Lewis, Auto Alliance
- Jack Pokrzywa, SAE

### **3:00 PM – 3:15PM Break**

### **3:15 PM – 4:15 PM Developing Legislation: A Panel of State Elected Officials**

This panel includes representative from states that have been involved in developing automated vehicle legislation. The panel will discuss their perspective and challenges with crafting legislation and offer insight into their state's experience.

- Senator Jeff Brandes, Florida State Senate, Chair, Appropriations Subcommittee on Transportation
- Representative Jeff Bridges, Colorado General Assembly
- Senator Jon Lundberg, Tennessee State Senate, Vice Chair, Government Operations Committee
- Assemblyman Jim Wheeler, Nevada (invited)
- CA State Assembly member Susan Bonilla (retired), CA Director of Council for a Strong America

### **4:15 PM – 5:30 PM Harmonizing AV Legislation: Interactive Breakout**

This session includes an interactive discussion on developing uniform legislation regarding AVs. This discussion will focus on key topics, such as local preemption, state regulatory rules, and operational challenges. The session will draw upon the expertise from both the previous panel and the audience to discuss the benefits and pitfalls of various elements of automated vehicle legislation.



# BREAKOUT SESSION

## BREAKOUT SESSION # 23

### Connected Automated Vehicle Early Deployment Alternatives

Tuesday, July 11, 1:30 PM – 3:00 PM

Room: Golden Gate 4

#### Organizers

Dale Thompson, USDOT FHWA  
Xiaoyun Lu, University of California, Berkeley  
Taylor Lochrane, USDOT FHWA  
Jiaqi Ma, Leidos

#### Description

The objective of this break-out session is to identify the research topics that must be addressed to overcome the challenges and take advantage of the opportunities from using connected automation to improve transportation operations. Break-out sessions in previous AVS events have focused on Connected Level 1 Automation, i.e., connected longitudinal control, by means of V2V or V2I. This session will continue by briefly introducing two promising applications: (1) Cooperative adaptive cruise control (CACC) for freeway operations and (2) Eco-approach and departure (EAD) to signalized intersections, and will describe ongoing research progress by government and industry toward developing them for possible future deployment. The test facilities and test progress for early CACC prototypes will be described. Finally, results of simulation studies of CACC for application to realistic traffic scenarios will be presented. A general discussion will then be followed by collaborative identification of research gaps that will lead to outlines of possible Research Needs Problem Statements for consideration by TRB committees as products of the breakout session.

#### Agenda

##### **1:30 PM Opening Discussion: Welcome and Introductions**

Moderator: Dale Thompson, FHWA

- Introductions around the room
- Brief overview of the Session Objectives
  - Share new simulation results in CACC research
  - Present High Density CACC modeling results conducted by PATH
  - Present new FHWA research project next phase CACC Prototype I testing
  - Identification of near term implementation opportunities
  - Discussion and identification of cybersecurity and other challenges and research gaps to deployment
  - Identify and define research needs statements to guide future research

**1:40 PM – 2:20 PM Leading Research in CACC and Signal Approach and Departure**

Moderator: Dale Thompson, FHWA

- CACC, Speed Harmonization, Eco-Approach/Departure - Jiaqi Ma, Leidos
- CACC High Density Modeling - Xiaoyun Lu, University of California Berkeley
- Next Phase CACC Prototype Development – Taylor Lochrane, FHWA

**2:20 PM – 2:50 PM Breakout Session – Identify Near-term Research to Deployment Needs**

- Institutional and policy barriers to real world CACC and Advanced Traffic Signal approach and departure deployment?
- Technical barriers to real world CACC and Advanced Traffic Signal approach and departure deployment?
- Research gaps and needs statements?
- Cybersecurity issues in CAV deployment?

**2:50 PM Session Wrap-Up**

Moderators: Taylor Lochrane, FHWA

- Summarize near term issues that need to be discussed further in upcoming venues
- Summarize identified research needs that could be expanded into formal research needs statements.

**3:00 PM Adjourn**



# BREAKOUT SESSION



## BREAKOUT SESSION # 24

### Automated Vehicles for People with Disabilities

Wednesday, July 12, 1:30 PM – 5:30 PM

Room: Golden Gate 5

#### Organizers

Mohammed Yousuf, USDOT  
Sudharson Sundararajan, Booz Allen Hamilton  
Jeff Gerlach, Securing America's Future Energy  
Murat Omay, Federal Transit Administration  
Aaron Steinfeld, Carnegie Mellon University  
Corey Harper, PhD student at Carnegie Mellon University

In 2010, the U.S. Census reported that approximately 56.7 million people in the United States had some type of disability. Inadequate and/or lack of mobility and transportation provisions can hinder people with disabilities and older adults from completing essential tasks such as obtaining and maintaining employment, keeping medical appointments, pursuing education, shopping for groceries and running errands, enjoying recreational activities, or attending social events that many people take for granted. The USDOT's Accessible Transportation Technologies Research Initiative (ATTRI) Program aims to provide technology-based transportation solutions for people with disabilities and older adults by leveraging recent advances in vehicle, infrastructure, and pedestrian-based technologies, as well as accessible data, mobile computing, robotics, artificial intelligence, object detection, and navigation. These technologies are enabled by established wireless communications that connect travelers and their mobile devices, vehicles, and roadside infrastructure, thus providing a linked transportation system that provides mobility options and allows seamless travel for everyone.

Automated vehicles (AVs) and other complementary technologies have the potential to support ATTRI's objectives by introducing many transformational changes to the lives of people with disabilities. During the development stages of AV technologies undertaken both by the public and private sector organizations, it is important to explore pathways to ensure that those new technologies are accessible, designed for and available to everyone. This breakout session will invite some of the key technology developers, stakeholders in the disability community, and other industry experts to explore different aspects of this development process including several key elements such as universal design, inclusive ICT, institutional and policy barriers, interoperability, and standards harmonization. The session will also explore how AV technologies crosscuts other ATTRI application focus areas such as 'safe intersection crossing', 'pre-trip concierge and virtualization', and 'smart wayfinding and navigation'.

## Agenda

### **1:30 PM – 2:00 PM Introduction to Session**

**Moderator:** Mr. Mohammed Yousuf

The moderator will open the session, and lead a brief round of self-introductions. Next he will explain the objectives, agenda, and expected outcomes of the breakout session. He will provide a brief introduction to the USDOT ATTRI Program and the upcoming prototype development efforts under the 2016 Broad Agency Announcement (BAA) contracts.

The focus of this session will be on creating awareness about the transportation needs and challenges that people with disabilities face. The emphasis will be on how embracing universal design principles in developing the AV technologies can make a significant difference in catering to all users equitably by enabling standards harmonization, data needs, and partnerships, as well as addressing policy barriers and technology challenges. The session will have an interactive format through thought-provoking but short presentations, and discussion questions to obtain feedback to inform the USDOT ATTRI Program and help to develop research topic recommendations for the Program's next phases in the near future..

### **2:00 PM – 3: 30 PM Panel Presentation/Discussion 1**

**Moderator:** Mr. Sudharson Sundararajan

The panel presentations aim to set the stage for the sub-breakout sessions. Presentations will be focused and limited to five minutes. The moderator will contact and instruct the speakers about the format/content in advance, introduce the speakers during the session, and lead the Q&A session after the presentations. A set of discussion questions will immediately follow after each presentation and discussion on a topic area will be limited to a maximum of 15 minutes.

The first panel will focus on design related AV topics such as: user needs and challenges, universal design principles for AVs, technical standards harmonization, and data needs.

- Speaker 1: User Needs and Challenges -- Aaron Steinfeld, Carnegie Mellon University
- Speaker 2: Universal Design Principles for Vehicles – Edward Steinfeld, University at Buffalo, SUNY
- Speaker 3: Data Needs (platforms, formats, etc.) – Anat Capsi, Taskar Center for Accessible Technology
- Speaker 4: Importance of Standards Harmonization – Colleen Casey. Toyota

Q&A

### **3: 30 PM – 3:40 PM Break**

### **3:40 PM – 5:10 PM Panel Presentation/Discussion 2**

**Moderator:** Dr. Aaron Steinfeld

The panel presentations aim to set the stage for the sub-breakout sessions. Presentations will be focused and limited to five minutes. The moderator will contact and instruct the speakers about the format/content in advance, introduce the speakers during the session, and lead the Q&A session after the presentations. A set of discussion questions will immediately follow after each presentation and discussion on a topic area will be limited to a maximum of 15 minutes.

The second panel will focus on public policy and infrastructure related topics such as: institutional and policy barriers, needs of other vulnerable road users, infrastructure needs, and public/private partnerships.

- Speaker 1: Institutional and Policy Barriers – Shawn Kimmel, Booz Allen Hamilton
- Speaker 2: Vulnerable Road Users – Justin Owens, Center for Vulnerable Road User Safety
- Speaker 3: Infrastructure Needs – Robbie Diamond, Securing America's Future Energy
- Speaker 4: Public Private Partnerships – Dick Alexander, Transdev

Q&A

**5:10 PM – 5: 30 PM Summary and Wrap Up**



# BREAKOUT SESSION

## BREAKOUT SESSION # 25

### Ethical and Social Implications

Wednesday, July 12, 1:30 PM - 3:00 PM

Room: Continental 9

#### Organizers

Noah Goodall, Virginia Transportation Research Council  
Norio Komoda, Sakura Associates LLC  
Yuri Gawdiak, NASA  
Filippo Santoni de Sio, TU Delft  
Brant Horio, LMI

This breakout will examine the ethical and social challenges of vehicle automation beyond the legal, policy, and technical issues discussed in other sessions. Experts will discuss the ethics behind routine driving decisions, industry responses to the ethics requirement in NHTSA's guidelines, and approaches to similar ethics challenges in other fields.

#### Agenda

Moderator – Noah Goodall, Virginia Transportation Research Council

#### **1:30 PM – 2:00 PM Ethics of Routine Driving**

While some automated vehicle crashes have clear moral implications, these crashes may be quite rare. More common but less obvious are the ethics of routine driving, where small decisions may have ethical implications when scaled over trillions of miles. An automated vehicle's decision to provide more space when passing a cyclist, for example, will slightly increase the risk of colliding with oncoming traffic. Examples of these situations, and ways to address them, will be explored.

Panelists:

- Selina Pan, Ford Motor Company
- Erik Stayton, Massachusetts Institute of Technology

#### **2:00 PM – 2:30 PM Responding to NHTSA's Guidelines on Ethical Compliance**

In September 2016, the National Highway Safety Administration released their "Federal Automated Vehicle Policy." As part of this policy, NHTSA requested that automated vehicle developers provide reports describing how they plan to address "ethical considerations,"

especially in scenarios where the goals of safety, mobility, and legality come into conflict. This panel will discuss how automated vehicle developers plan to respond to NHTSA's request.

Panelists:

- Stephen Zoepf, Stanford University
- TBD

### **2:30 PM – 3:00 PM Ethical Challenges in Related Fields**

This panel will consider how similar ethical challenges have been handled in other fields. If driving can be described as a series of decisions about how to distribute crash risks, then experts from industries that distribute risks and ration benefits may have important lessons to share.

Panelists:

- Jason Millar, Stanford University (invited)
- Melissa Cefkin, Nissan Research Center Silicon Valley (invited)