TRB FINAL PROGRAM

2012 Road Vehicle Automation Workshop

July 24-26, 2012
Irvine, California

Organized by
Transportation Research Board

Supported by

Intelligent Transportation Systems (AHB15)
Vehicle-Highway Automation (AHB30)
Major Activity Center Circulation Systems (AP040)
Emerging and Innovative Public Transport and Technologies (AP020)
Emerging Technology Law (AL040)
Vehicle User Characteristics (AND10)

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Steve Shladover - U.C. Berkeley, PATH Program – Co-chair

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Paul Rau - U.S. DOT, NHTSA

Shannon Sanders McDonald - Southern Illinois University

John Smith - U.S. DOT, Volpe Center

Steve Underwood - University of Michigan

Bryant Walker Smith - Stanford University

Timothy Weisenberger - U.S. DOT, Volpe Center

John Wojtowicz - U.S. DOT, Volpe Center

Steve Wood - U.S. DOT, NHTSA

Stan Young - University of Maryland

Shuttle Service

Tuesday, July 24

12:30 p.m.	Shuttle from Hyatt Newport Beach to Beckman
5:00 p.m. & 5:30 p.m.	Shuttle to Hyatt Newport Beach

Wednesday, July 25

7:00 a.m. & 7:30 a.m.	Shuttle from Hyatt Newport Beach to Beckman
7:30 p.m. & 8:00 p.m.	Shuttle to Hyatt Newport Beach

Thursday, July 26

7:15 a.m. & 7:45 a.m.	Shuttle from Hyatt Newport Beach to Beckman
6:30 p.m. & 7:00 p.m.	Shuttle to Hyatt Newport Beach

WORKSHOP AGENDA

Tuesday, July 24

Noon - 5:00 p.m.
Registration

Arrive Tuesday afternoon for a pre-workshop discussion of operational concepts that take advantage of emerging vehicle automation capabilities. (There is a separate registration for this workshop.)

1:00 p.m. - 5:00 p.m.
Early Automation Deployment Opportunities in Managed Lane Operations

Managed-use lanes offer the possibility of safely integrating early automated vehicles onto highways and arterials. The objective of this half-day workshop session is to define fertile research topics at the nexus between managed lane operations and road vehicle automation, so that public agencies and independent researchers, especially in universities, can focus their attention on these topics.

1:00 p.m. – 1:10 p.m.
Welcoming Remarks, Definition of Meeting Purpose
Bob Ferlis

1:10 p.m. – 1:30 p.m.
Introduction to the Current State of Development of Managed Lanes in the U.S.
Ginger Goodin, TRB Managed Lanes Committee Chair

1:30 p.m. – 1:50 p.m.
Presentation on potential synergies between managed lane operations and automated vehicle operations (example operating concepts) and capacity and access challenges
Steven Shladover

1:50 p.m. – 2:10 p.m.
Introduce discussion topics on opportunities and challenges, and solicit more topics from attendees. Converge on priority topics for more in-depth discussion.

2:10 p.m. – 2:30 p.m.
Break

2:30 p.m. – 5:00 p.m.
Discussion of priority topics and specific research needs in each topic area, concluding discussion, with research needs identified.

5:00 p.m.
Adjourn

Wednesday, July 25

7:00 a.m - 5:30 p.m.
Registration

7:30 a.m - 8:30 a.m.
Breakfast

8:00 a.m - 9:30 a.m.
Opening Session

Welcoming remarks and workshop plan
Jane Lappin, Volpe National Transportation Systems Center

Lexicon and Taxonomy of Automated Vehicle Systems
Steven Shladover, University of California Berkeley

Expert Panel Discussing the Benefits of Automation (to set the scene as motivation for interest in automation)

- Safety – Tim Johnson, NHTSA
- Energy and Environment – Matthew Barth, U.C. Riverside
- Traffic Flow and Capacity – Steven Shladover, U.C. Berkeley
- Mobility/Accessibility – Mohammed Yousuf, FHWA

9:30 a.m. - 9:45 a.m.
Break

9:45 a.m. - noon
State of the Art Session 1 – Private Personal Vehicles (Autonomous)

Google's Self-Driving Cars – Anthony Levandowski

Stanford University research – Chris Gerdes

TARDEC military vehicles – Jim Overholt

Vislab/University of Parma – Alberto Broggi

General Motors EN/V vehicles – Chris Borroni-Bird

Mercedes – Luca Delgrossi

Questions and Answers/Discussion

Noon - 1:00 p.m.
Lunch

1:00 p.m. - 3:15 p.m.
State of the Art Session 2 – Trucks and Transit Vehicles (Cooperative)

Energy ITS truck platoon – Sadayuki Tsugawa, Meijo University

SARTRE project mixed platoon – Erik Coelingh, Volvo Cars

KONVOI and interactIVe projects: Truck platooning and Crash Avoidance –Adrian Zlocki, RWTH Aachen University

Truck Platooning and Transit Bus Guidance – Steven Shladover, U.C. Berkeley PATH Program

CityMobil Project – Adriano Alessandrini, University of Rome

ULTra Personal Rapid Transit – Martin Lowson, ULTra PRT

Questions and Answers/Discussion

3:15 p.m. - 3:30 p.m.
Break

3:30 p.m. - 5:30 p.m.
State of the Art Session 3 – Cross-Cutting Activities

HAVEit Project – multiple levels of automation – Anna Schieben, DLR

GM EARP project on human factors of automation – Jeremy Salinger, GM

BASt study of legal issues in Germany– Tom Gasser, BASt

Legal issues in the U.S. – Bryant Walker Smith, Stanford University

European Commission Working Group on Automation – Joakim Svensson, Volvo Group Trucks Technology

Questions and Answers and Discussion

5:30 p.m. - 5:45 p.m.
Closing and adjourn for the day

5:45 p.m. - 7:30 p.m.
Reception

Thursday, July 26

7:00 a.m - 5:30 p.m.
Registration

7:30 a.m - 8:30 a.m.
Breakfast

8:30 a.m - 11:00 a.m.
Break-out Groups: Session 1

- Public Policy Issues
- Driver-vehicle Interaction
- Information Architecture and Operational Concepts
- Technology Needs and Constraints

11:00 a.m. - 11:30 a.m.
Break while group leaders prepare report-out

11:30 a.m. - 12:15 p.m.
Plenary report-out from Session 1

12:15 p.m. - 1:15 p.m.
Lunch

1:15 p.m. - 3:45 p.m.
Break-out Groups: Session 2

- Transition and Deployment Strategies
- Legal, Liability, and Risk
- Vehicle Safety and Security

3:45 p.m. - 4:15 p.m.
Break while group leaders prepare report-out

4:15 p.m. - 5:00 p.m.
Plenary report-out from Session 2

5:00 p.m. - 5:15 p.m.
Closing

5:15 p.m. - 6:30 p.m.
Reception

Friday, July 27

7:00 a.m - 11:00 a.m.
Registration

7:30 a.m - 8:30 a.m.
Breakfast

8:00 a.m. -11:00 a.m.
Post-Workshop planning

The workshop team (at least one reporter from each discussion group) plans next steps including proceedings and panel session at the 2013 TRB annual meeting.

BREAKOUT SESSION SUMMARIES

The objective of the breakout groups is the development of research needs statements to inform future research on automated vehicles.

Morning

Public Policy Issues

This session will explore the public policy and spatial implications of vehicle automation in terms of urban planning, architecture, land use, economic impacts, traffic patterns, public transportation, newly mobile populations and other social issues.

Driver-vehicle Interaction

This session will discuss a wide variety of human factors considerations for automated vehicles including driver expectations, safety issues surrounding the transition between manual and automated driving modes, trust in automation, and unintended consequences of automation. The session will also address individual differences in drivers due to ability and impairment. The group will generate research ideas and data needs as applied to all levels of automation.

Information Architecture and Operational Concepts

This session will address the application and role of vehicle communications and the use of roadway infrastructure for automated vehicles, considering the respective roles of the private and public sectors.

Technology Needs and Constraints

This session will address the technology needs of and constraints on automated vehicles including sensors, actuators, microprocessors, location devices, antennae, and the full range of hardware and software requirements to enable the vehicle to assist the driver and drive itself.

Afternoon

Vehicle System Safety and Security

A focus on issues related to safety, security, and reliability including: threats from hackers and data security, defending a system and maintaining vehicle safety in an autonomous or cooperative automated driving environment.

Legal, Liability, and Risk

The current legal framework, which generally assumes that a human is in control of a vehicle at all times, may not clearly or sufficiently address high levels of vehicle automation. This session will seek to identify new scenarios for which current law may be unprepared, isolate the issues presented, and articulate the information still needed to develop the steps, ideally short of full-scale reforms, that could help ease the transition.

Transition and Deployment Strategies

How will the world transition to a road environment with automated vehicles and how will deployment occur? Will the deployment be entirely market-led or will public sector incentives shape automated mobility? What will be the deployment trajectories of different types of passenger and commercial vehicles? How will infrastructure factor into the transition to automated vehicles? This break-out session will use future automated-vehicle scenarios as a point of departure for exploration of transition and deployment strategies--investments, innovations, practices, and policies--that have enabled the "future."

Public Policy Issues

Summary
This session will explore the public policy and spatial implications of vehicle automation in terms of urban planning, architecture, land use, economic impacts, traffic patterns, public transportation, newly mobile populations and other social issues.

Objective
The workshop will identify priorities for a research agenda (and the issues that such an agenda should analyze) and messaging on this topic that can be used to engage and inform stakeholder awareness and understanding.

Agenda

8:30 a.m. – 8:35 a.m.
Welcome/Introductions/Overview
Scott Le Vine

8:35 a.m. – 8:40 a.m.
Setting the stage: Vision and Outcomes
Our speakers represent a rich and diverse perspective on technology, people and environmental considerations in the context of the overarching policy challenges we face. Each speaker is asked to succinctly identify the primary challenge in this topic, key factors that will help influence or shape events going forward, and the most important priority to be addressed in a future research agenda. Speakers will have 10 minutes to cover these questions, leaving 5 minutes for Q&A. The open discussion will be framed initially by key questions that speakers and participants will be asked, all with the focus on priority setting for a research agenda and how best to more broadly engage stakeholder and the public and increase awareness in the field. The action planning and wrap-up will capture the major conclusions of the workshop and identify next steps, including assignments to those willing to continue their involvement. The workshop will include three components:

- Presentations from speakers
- Open discussion, facilitated by key questions
- Action planning and wrap-up, based on the presentations and discussion

Speaker Presentations

Overarching Issues
Michael Toscano, President & CEO, Association for Unmanned Vehicle Systems International (AUVSI)

Technology issues
Adriano Alessandrini, Transport Department, Sapienza University of Rome

Issues of alternative operating concepts:
Alain Kornhauser, Transportation Program, Princeton University

Environmental issues
Matthew Barth, University of California/Riverside

Financial and policy issues
Brian Cronin, Joint Program Office, Research and Innovative Technologies Administration, US Department of Transportation

9:30 a.m. - 10:55 a.m.

Interactive Discussion

Moderators: Barry Pekilis and Tom Kern

The workshop organizers have identified a number of discussion questions for attendees to address, with the understanding that there may not be sufficient time for all to be covered in appropriate detail. Key to the discussion will be a vetting of perspectives and a focus two sets of actions: 1) priorities for a research agenda (and the issues that such an agenda should analyze) and 2) messaging on this topic that can be used to engage and inform stakeholder awareness and understanding. Questions to consider (attendees are invited to suggest additional questions and help prioritize them for discussion):

1. How could different operating concepts of autonomous vehicles lead to different economic / social / spatial impacts?
2. What can we expect from NV/FL/CA pilot projects? What do we want to learn? How do we communicate with stakeholders and the public at large?
3. What pressures would arise for changes to the built environment? How could parking and our current notion of public transportation (taxi, demand-responsive, car-sharing, traditional public transportation) be affected?
4. What are the key uncertainties, are there foreseeable unintended consequences and what policies could prevent/mitigate them? What is the appropriate balance between policy predictability and flexibility? Degree of reversibility?
5. What data are needed re: impacts? Practicalities? What can be learned from urban/regional-level simulations?
6. What is the role of the public sector, at various levels of government? What would be over-reaching, and what would be not enough? (to cover Federal/State/Local levels)

Sample stakeholder roles for consideration

USDOT regulatory, MPO planner, state DOT design bureau, municipal zoning staff / traffic engineer, rural / small town perspective, real estate developer, facility operations manager (mall/airport/ stadium/university), drivers-only couple, family with dependent non-drivers (elderly / children), etc.

10:55 a.m. – 11:00 a.m.

Wrap-up/Next Steps

The session organizers have been charged with developing a summary and list of next steps at the Plenary Report-out from Session 1 taking place from 11:30 to 12:15

Facilitators

Barry Pekilis, Transportation Infrastructure Programs, Transport Canada
Thomas E. Kern, The Intelligent Transportation Society of America

Note Takers

Shannon Sanders McDonald, Southern Illinois University Carbondale
Scott Le Vine, Centre for Transport Studies, Imperial College London

Organizers

Shannon Sanders McDonald, Southern Illinois University Carbondale
Scott Le Vine, Centre for Transport Studies, Imperial College London
Barry Pekilis, Transportation Infrastructure Programs, Transport Canada
Thomas E. Kern, The Intelligent Transportation Society of America

Driver Vehicle Interaction

Summary

This session will discuss a wide variety of human factors considerations for automated vehicles including driver expectations, safety issues surrounding the transition between manual and automated driving modes, trust in automation, and unintended consequences of automation. The session will address also individual differences in drivers due to ability and impairment. The group will generate research ideas and data needs as applied to all levels of automation.

Objective

The information collected at this session will provide the foundational human factors/user-centered content for the National Highway Traffic Safety Administration autonomous roadmap. Furthermore it will enable the creation of a logic model (that is, an interconnected model depicting concerns and needs, data and project to inform those needs, outputs, outcomes and impacts connected to safety and other elements of the NHTSA roadmap) of human factors topics and concerns related to autonomous road vehicles, research projects to understand and reduce these concerns through specifications and recommendation, and metrics by which to evaluate success of adoption/implementation.

Agenda

8:30 a.m. - 8:35 a.m.
Welcome and introductions

8:35 a.m. - 8:45 a.m.
Provocative questions to set the stage

8:45 a.m. – 9:05 a.m.
Identification of specific system aspects.
The discussion will focus on the human systems engineering integration approach to examine the following issues:

- Level of automation
- Automation integration/implementation approach (learning/use)
- Adaptive automation
- Allocation of autonomy to keep driver in the loop
- Nature of hand off between manual and automated control

9:05 a.m. – 9:25 a.m.
Identification of specific demographic and vehicle user characteristics to be considered by system designers and evaluation protocols to include:

- Description of targeted user populations
- Planned levels of driver impairment (i.e., from fatigue, drugs, alcohol, distraction)
- Planned levels of driver experience (i.e., new, older, non-US/left side of road, etc.)
- Planned levels of driver ability (i.e. drivers with physical limitations, novice drivers)

9:25 a.m. – 9:40 a.m.
Adoption of a model regarding human-automation interaction and performance.

To set the stage for discussion, we will identify outcome measurements and driver performance metrics to include:

- Safety
- Ease of use
- Comfort, convenience
- Mobility, livability
- Energy efficiency

9:40 a.m. – 9:55 a.m.
Identification of plausible test and evaluation scenarios to include in system development and testing

- Testing context, cover stories, length of testing
- Secondary tasks, workload, attention, speed, traffic settings
- Motivation for disengaging from/engaging automation

9:55 a.m. – 10:15 a.m.
Unintended consequences of automation and behavior in face of system failure or unreliability.

- For driver expectations of system operations based on early exposure and early adopters
- For vehicle based safety system operations and driver expectations of future system operation
- Behavioral adaptation to automation, traffic flow adaptation
- Effect on social aspects of driving
- Over/extended reliance on technology to compensate for degraded driving skills
- Effects on social aspects of driving

10:15 a.m. – 10:30 a.m.
Identification of data needs and sources for future research and system development

- Visual gaze/attention surrogates
- Response time
- Control inputs
- Establishment of a data sharing community

10:30 a.m. – 11:00 a.m.
Review Research Needs Statements

Facilitators
Natasha Merat, University of Leeds (UK)
Susan Chrysler, University of Iowa

Note Takers
Susan Chrysler, University of Iowa
Tim Gordon, University of Michigan

Organizers
Susan Chrysler, University of Iowa
Tim Gordon, University of Michigan
Steve Popkin, US DOT – Volpe Center
Paul Rau, US DOT – NHTSA
Natasha Merat, University of Leeds (UK)

Information Architecture and Operational Concepts

Summary
This session will address the application and role of vehicle communications and the use of roadway infrastructure for automated vehicles, considering the respective roles of the private and public sectors.

Description
This session will address the application and role of vehicle communications and the use of roadway infrastructure for automated vehicles. The objective is to **predict the roadmap through which automated vehicles will evolve**, considering the respective roles of the private sector (e.g., the automobile manufacturers) and the public sector (e.g., highway authorities). Although some logic suggests that dedicated lanes might be an early desirable phase, current activities by **the automakers do not appear to expect such an infrastructure to exist** in the early stages and are proceeding with concepts that appear to be independent of infrastructure. On the other hand, it is conceivable that **special-use facilities and infrastructure could emerge** that are restricted to automated vehicles or fleets, or benefit from the presence of automated vehicles. How might dedicated infrastructure-use concepts evolve? In addition, there is concurrent substantial development of connected cars, including private sector initiatives as well as a potential government-mandated communications infrastructure for safety. Given this vehicle communications development in parallel to automated vehicle development**, how might communications be used to enable and enhance automated vehicle operations**? What might the **relative roles of government communications networks, like DSRC, and private sector public networks, like cellular**? What other operational concepts might emerge such as **restrictions** on operating locations, weather conditions, local regulations, etc.? The end product of this subcommittee will be a white paper, or contributions to a section of a broader white paper, on the research needs for information architecture and operational concepts for automated vehicles.

Agenda

8:30 a.m. – 9:15 a.m.
Identify Key Issues That Need to be Addressed
Facilitator: Denaro; Note-taker - Krueger

Role of Road Owner/Operator and Infrastructure?
As automated vehicles begin to become more widely used, what impact will they have on traditional infrastructure owners and operators? The automakers and researchers, such as Google, seem to be forging ahead with the assumption that these vehicles can operate without any dependence on physical infrastructure (Note that communications systems are discussed in a later segment of this session). Others in the industry are concerned about the need for dedicated infrastructure, while still others see opportunities for using infrastructure to capture local benefits of automated vehicles. Finally, in either scenario, there will be some interaction between automated and non-automated vehicles that may require new operational concepts to both handle this interaction and address the different operational

characteristics of these two vehicle types. What are some of the key issues with all of these scenarios that need to be addressed? What operational changes are necessary? What infrastructure changes are necessary? What effects might weather and location play in the eventual deployment roadmap for automated vehicles? Are there any other issues that could create restrictions?

Role of Communications

Vehicle to vehicle communications can play a significant role in supporting automated vehicle operation. Again, as with infrastructure dependence, there appears to be two sides to this issue. The automobile manufacturers are mostly assuming autonomous operation, and at best would likely have communications only with their proprietary communications and information cloud-based eco-systems. On the other hand, the government (e.g., the US DOT possible mandating of DSRC V2V) and some major system integrators (e.g., IBM and their "Smart Cities" initiative) are proceeding down a path to provide standardized, ubiquitous vehicle communications. While their motivations may be safety and mobility, nevertheless if they are successful then automated vehicles will likely exploit the availability of such communications and information infrastructure. What are the benefits of V2V communications to automated vehicles, and how likely is that feature to be part of automated vehicle deployment? And if a government network such as DSRC does emerge, how will it play in the automated vehicle application relative to public networks such as cellular, digital broadcast and satellite broadcast. Will one or the other dominate for automated vehicles, or will both contribute, perhaps with different features and applications assigned to one or the other networks?

9:15 a.m. – 10:00 a.m.

Deeper Dive on Key Issues

facilitator - Bishop; note-taker - Young

This item will prioritize the issues identified in the first item, decide on a goal of how many we want to address in this period, then proceed to flesh out the issues with respect to:

- What makes the issue important?
- How does the issue impact autonomous vehicles?
- What are the research needs embedded in the issue?

10:00 a.m. – 11:00 a.m.

Near-term Research Needs

facilitator - Krueger; note-taker - Young

- Organize the research needs with an eye to how this would be presented in a white paper
- Generate ideas on research approaches, methods, scope where necessary
- Formulate report-out for general session to follow

Facilitators

Bob Denaro, Nokia Location and Commerce
Richard Bishop, Bishop Consulting
Greg Krueger, SAIC

Note Takers

Greg Krueger, SAIC
Stan Young, University of Maryland

Organizers

Richard Bishop, Bishop Consulting

Bob Denaro, Nokia Location and Commerce
Shannon Sanders McDonald, Southern Illinois University
Stan Young, University of Maryland
Greg Krueger, SAIC

Technology Needs and Constraints

Summary

This session will address the technology needs of and constraints on automated vehicles including sensors, actuators, microprocessors, location devices, antennae, and the full range of hardware and software requirements to enable the vehicle to assist the driver and drive itself.

Objective

The output of this session includes (1) issues and/or groupings by priority and rationale, (2) questions and challenges for further research and related influencing factors, and (3) specific near-term high-priority research questions/issues.

Description

This session will address the technology needs of and constraints on automated vehicles including sensors, actuators, microprocessors, gateway controllers, location devices, antennae, and the full range of hardware and software requirements to enable the vehicle to assist the driver and potentially drive itself. The objective of this session is to identify the most important systems, subsystems, modules, and devices, to describe the functions of these components, and to identify the greatest opportunities and challenges for making improvements through advanced research and development. The discussion will address hardware, software, and systems integration issues at the following levels:

Component levels

- Sensors
- Processing
- Actuators
- Location devices (e.g., gps)
- Communications – V2V and V2I
- Internal networking and buses
- Software (covers from object detection to system control)
    - Operating systems
    - Control systems
    - Learning systems
    - Neural networks
    - Knowledge based systems
    - Etc.

Subsystem levels

- Longitudinal control
- Lateral control

Impact of enabling technologies on longitudinal and lateral control

System level issues including applications

- System architecture- top level
- System integration
- Applications

The participants will investigate operational and performance gaps, immediate and long-term research, technical standards, and testing requirements for the full range of levels of automation.

Agenda

8:30 a.m. – 8:45 a.m.
Introduce the topic and expert survey on autonomous vehicle research
Steve Underwood

8:45 a.m. – 10:00 a.m.
Facilitate discussion and address questions
Corey Clothier

- Example questions include:
- What engineering research will lead to critical advances in automated vehicles?
- What are the most important subsystems or functions to improve?
- For each of the functions, what components will provide the most improvement?
- What is the specific issue and what are the most important design objectives for each of the components?
    - Cost
    - Improve functionality
    - Improve reliability
- What components are system components tend to fail first in current and future designs of automated vehicles?

10:00 a.m. – 10:30 a.m.
Rate research questions/issues and establish priorities.

10:30 a.m. – 11:00 a.m.
Detail highest priority research questions/issues.

Speaker
Steve Underwood (moderator, expert survey results)

Facilitator
Corey Clothier

Note Takers
Mark Crawford (automated system architecture)
Dan Bartz (subsystem integration and testing)
Bobby Hambrick (sensors and components)

Organizers

Osman Altan, US DOT – Volpe Center
Bob Denaro, Nokia Location and Commerce
Jim Misener, Booz Allen Hamilton
Paul Rau, US DOT - NHTSA
Steve Underwood, University of Michigan - Dearborn

Vehicle System Safety and Security

Summary

This session explores the resiliency of road-vehicle automation systems, with the objective of exploring, then framing relevant research issues. Resiliency can be defined as a three-component vector: safety, reliability and security. We begin from the perspective that system safety can be measured similarly as today's road safety (e.g., fatalities per VMT, incidents) – with the exception that this future system will have as a major or even predominate road user the automated vehicles. Reliability relates to safety, perhaps by considering also today's definition of non-recurring incidents and coupled with the prospect that some future road-vehicle automation systems may increase throughput, placing a high premium on reliability. Additionally, we consider the security of such a system, where a system of trust must be part of these possibly cooperative cyber systems.

Objective

Today's session is designed to elicit participant feedback and discussion on the safety, reliability and security issues related to road-vehicle automated systems. This information will include specific concerns, data and research needs, and areas of expertise the research community can bring to bear on informing and support the mitigation of these concerns. The information collected at this session will provide resiliency content for future research. Furthermore it will enable the creation of a logic model (that is, an interconnected model depicting concerns and needs, data and project to inform those needs, outputs, outcomes and impacts connected to safety and other elements of research roadmap) of reliability topics and concerns related to road-vehicle automation systems, research projects to understand and reduce these concerns through specifications and recommendation, and metrics by which to evaluate success of adoption/implementation

Agenda

1:15 p.m. – 2:00 p.m.
Baseline and Setting the Stage (Group Introduction, then focus on three 10-minute tutorials)

- Tutorial 1: How Security can Affect the Safety and Reliability of Automated Highway Systems (Prof. Ryan Gerdes, Utah State University)
- Tutorial 2: Functional Safety (Irene Ibarra, Mira Ltd)
- Tutorial 3: Security: Vehicle-Highway Trusted Networks (Jim Misener, Booz Allen Hamilton)

2:00 – 3:45
Discussion Topics and Associated Provocative Questions:

- Policy
- What are issues of privacy and tractability for which we should be concerned?
- How is the security aspect different than some of the emerging considerations for security with the USDOT's vision of a connected vehicle system?
- How does that security system transition to automated highway system security?

Costs and Benefits

- What are the lifecycle cost considerations?
- Who invests? To what degree is the investment commercial?
- What resources and investments are needed for: making and installing equipment, operate and monitor?
- How do we balance privacy, safety and security costs and benefits?

Institutions

- Who are the stakeholders?
- What is the involvement of the USDOT? FCC? Others?

Operations

- Define a system and end-to-end security and safety needs. This certainly transcends a "vehicle-only" system.
- What is the acceptable reliability and other pertinent requirements of this system?
- How do we monitor the system?

Technologies

- How do we preserve security in light of the threat, e.g., autonomic computing?

Facilitators
Ed Fok, US DOT – FHWA
Jim Misener, Booz Allen Hamilton
Barry Pekilis, Transport Canada

Note Takers
Jim Misener, Booz Allen Hamilton
Barry Pekilis, Transport Canada

Organizers
Art Carter, US DOT – NHTSA
Ed Fok, US DOT – FHWA
Ryan Gerdes, Utah State University
Jim Misener, Booz Allen Hamilton
Barry Pekilis, Transport Canada
Jack Smith, US DOT – Volpe Center
Tim Weisenberger, US DOT – Volpe Center
John Wojtowicz, US DOT – Volpe Center

Legal, Liability, and Risk

Summary
The current legal framework, which generally assumes that a human is in control of a vehicle at all times, may not clearly or sufficiently address high levels of vehicle automation. This session will seek to identify new scenarios for which current law may be unprepared, isolate the issues presented, and articulate the information still needed to develop the steps, ideally short of full-scale reforms, that could help ease the transition.

Objective
In preparation for presentation to the general session, the group will articulate key research needs by prioritizing and refining the top priority questions relating to liability and related legal issues.

Description
Increased automation of road vehicles presents an intriguing and sometimes troubling legal crossroads: can we change our legal infrastructure to facilitate vehicle automation, or do we force vehicle technologies to adapt to our current vehicle codes and liability rules? While all issues may ultimately be settled through litigation, legislation or regulation, thoughtful reforms to existing laws and regulations put in place prior to widespread deployment could significantly reduce uncertainty, reduce litigation and even accelerate product development. However, even desirable reforms could have unintended consequences.

The main issue driving consideration of legal reforms is that most liability and risk laws and regulations currently assume that a human is in control of the vehicle. As immediate control of the vehicle shifts away from a human driver, the proper allocation of responsibility for safe operation of the vehicle may come into question. The ultimate distribution of legal responsibility may differ radically, depending on whether the vehicle's assumption of control can be overridden or even turned off by that person. However, even this question is not dispositive: it raises the question of whether the driver must be alert enough and have enough time to take over, or if the mere availability of an override is sufficient for the ultimate responsibility to remain with the person in the "driver's" seat.

One potentially obvious answer would be a large scale shift of potential responsibility and liability from the driver, which in many cases includes criminal liability, to the companies (and perhaps individuals) that design, manufacture, sell, maintain, operate, and provide data or other services to the vehicle, which would mean increased activity in the role of products liability and other civil issues. However, such a prospect could have a significant chilling effect on product development and deployment. It also ignores the fact that the transition to fully autonomous vehicles will likely be gradual, reversible, and uneven, leaving drivers to bear at least partial responsibility for years to come.

Consequently, a more sophisticated approach that anticipates as many of the potential issues as possible, and proposes methods of addressing them, would be appropriate. For example, lessons may be learned from regulation of air travel and other modes that currently operate on "auto-pilot" or similarly automatic or autonomous methods at certain times. This session will seek to identify new scenarios for which there is not adequate legal recourse at the current time, isolate the issues presented, and discuss what steps, ideally short of full-scale reforms, could help ease the transition.

Agenda

1:15 p.m. – 1:45 p.m.
Part I: Background and Presentation of Research Questions - Bryant Walker Smith

This section will be a reprise of the previous afternoon's presentation outlining current regulations and highlighting the shortcomings as they relate to vehicle automation. The presentation will vary from the previous day in that it will focus more detail on affected laws and opportunities for change, rather than on policy questions.

1:45 p.m. – 2:45 p.m.
Part II: The second part will be introduction of a number of potential research questions arising out of the first portion. Each question will be presented with some background, but only enough to demonstrate its relevance to the overall topic. Potential questions include:

1. What does "control" actually mean?
2. What relevant economics and empirical research is available? For example are there any order-of-magnitude estimates of the current and future costs of crashes to (a) society (lots of research), (b) insurers (semipublic), and (c) manufacturers?
3. What legal lessons can be drawn from existing automotive technologies such as airbags, antilock brakes, and ESC?
4. How do legal theory and legal practice diverge in automotive litigation?
5. How would the law treat particular standards of performance for an automated system (such as "perfect," "as good as a perfect human driver," "as good as an average human driver")?
6. What do subjective terms like "reasonable," "due care," and "practicable" mean in the context of automated driving? What about absolute terms like "safe"?
7. The opportunity for a large scale shift of liability from drivers to manufacturers exists. What are the roles and responsibilities of the public and private sectors with regards to liability? How might this impact on development and deployment of these technologies?
8. Who will "own" the data that is required to make these systems work?
9. Other ideas from participants

2:45 p.m. – 3:15 p.m.
Part III: Prioritization of research questions. The group will take 30 minutes to make final comments about the importance of the various questions, and then prioritize the top 3-5 questions

3:15 p.m. – 3:45 p.m.
Part IV: Refinement and presentation. The group will refine the top priority questions to best express the particular research need, in preparation for presentation to the general session.

Speakers
Frank Douma, University of Minnesota
Leslie Fowler, KSDOT
Brant Walker Smith, Stanford University
Steve Wood, US DOT – NHTSA

Facilitators
Frank Douma, University of Minnesota
Leslie Fowler, KSDOT
Bryant Walker Smith, Stanford University
Steve Wood, US DOT – NHTSA

Note Takers
Frank Douma, University of Minnesota
Bryant Walker Smith, Stanford University
Steve Wood, US DOT – NHTSA
Leslie Fowler, KSDOT

Organizers
Frank Douma, University of Minnesota
Barry Pekilis, Transport Canada
Steve Wood, US DOT – NHTSA
Leslie Fowler, KSDOT
Bryant Walker Smith, Stanford University

Transition and Deployment Strategies

Summary
How will the world transition to a road environment with automated vehicles and how will deployment occur? Will the deployment be entirely market-led or will public sector incentives shape automated mobility? What will be the deployment trajectories of different types of passenger and commercial vehicles? How will infrastructure factor into the transition to automated vehicles? This break-out session will use future automated-vehicle scenarios as a point of departure for exploration of transition and deployment strategies--investments, innovations, practices, and policies--that have enabled the "future."

Objective
Develop a more complete understanding of the full range of social and technical implications of a future transportation enterprise that includes a variety of automated vehicles.

Discussion
There are many factors influencing the emergence of increasingly automated passenger and commercial vehicles. The DARPA Challenges and similarly funded contests have helped to generate interest in vehicle automation. Consumer demand and market competition fuel technology innovations; investors seek new avenues for growth. Governments seek to improve national mobility, safety, and efficiency, but with insufficient budgets to maintain current infrastructure. The complexity of these factors makes it hard to predict when or how the vehicle fleet will include fully automated vehicles, but recent events make it clear that increasingly automated vehicles are on the way. We are inspired by the utopian promise of increasingly capable, lower-cost, specialized vehicles. But we don't know how or when these vehicles will enter the market, or what type or duration of transitional conditions will prevail. We would like to influence the development of new vehicle capability to enhance its benefits and reduce its risks, but experience with other advanced transportation applications has shown how difficult it can be to predict, much less affect, technological and social change. Thus, this break-out session on Transition and Deployment Strategies will use hypothetical future scenarios as a facilitative method to explore the challenges and solutions that may lead us from here to there.

Please note that the discussion will focus on the transportation enterprise implications of vehicle automation rather than a full consideration of social, environmental, and political forces that are often part of the scenario development process.

Agenda

1:15 p.m. – 1:45 p.m.
Orientation to the session, introduction to the candidate scenarios, and description of the task

1:45 p.m. – 3:15 p.m.
Divide into two groups for scenario and implications development

3:15 p.m. – 3:45 p.m.
Reconvene full group, compare scenarios and continue the discussion

Scenario Discussion Guide

- Flesh out the scenario description and narrative. What is the nature of the vehicles operating in this scenario? Are there additional dimensions to be considered, such as private and commercial vehicles, or connected and autonomous vehicles? *(Recommend spending only 15 min on this for all 4 scenarios.)*

- Implications spreadsheet. For each of the four scenarios, consider the implications of the scenario, the impact of the applications. Consider the extended implications; for example, if the vehicle functionality requires a radically new body design, it may also imply a change in NHTSA safety regulations for structural safety.

- What were the sequence of events or accomplishments that led to this application or scenario? Would any breakthrough events or accomplishments trigger deployment of, or strong market demand for, this scenario or application?

IMPLICATIONS: How do these applications operate?

(Note: There is more than one possible answer to these questions, and not all questions apply equally to all scenarios)

Applications: What applications and vehicle types are enabled within this scenario? The answer to this will help everyone to visualize the scenario.

Technology*:* What are the component and system technologies required to successfully deploy the applications and vehicles in this scenario?

Safety and security*:* What are the safety and security implications of this scenario? What protections and guarantees must be in place to allow the applications in this scenario to operate?

User interface*:* What is the "driver" doing? Where are her eyes? Where are her hands and feet? How does the transition (if there is one) operate between manual and automated?

Roads and fixed guideways*:* What is the role of the infrastructure in this application? How will different types of infrastructure enable different types/levels of functionality?

Information and communications architecture: What information is being exchanged between the vehicles? Between the vehicles and the infrastructure? Between the vehicle and the "cloud"? What capabilities are housed in the vehicle, independent of external sources such as the "cloud"?

Economics, finances, markets*:* What is the business model that supports this application? Who operates and maintains the infrastructure? Who owns the vehicles? How do the users pay? What new businesses are enabled by this application? What benefits accrue to the investors? To the public?

User acceptance and personal mobility: Why do consumers want to buy this application? What benefits does it provide to the users? How does this application address the first-mile/last-mile challenge? What other forms of mobility services or vehicles will people want to own or otherwise access to? Does this application increase or decrease the amount of time an individual must spend in transit?

Political*:* What does this imply about the transportation legislation that is in place? What is the role of the USDOT in this scenario? What is the role of the states?

Legal and Regulatory*:* Who is licensed to drive these vehicles? Who is liable for vehicle malfunction? Who is liable for system malfunction?

Built environment: Offices, retail outlets, housing, parking areas*:* What does this application suggest about the design, functionality, or location of buildings and parking lots?

Facilitators
Bob Denaro, Nokia Location and Commerce
Kevin Heaslip, Utah State University

Note Taker
Shannon Sanders McDonald, Southern Illinois University

Organizers
Jane Lappin, US DOT - Volpe Center
Bob Denaro, Nokia Location and Commerce
Steve Shladover, UC Berkeley
Kevin Heaslip, Utah State University
Shannon Sanders McDonald, Southern Illinois University
Stan Young, University of Maryland
Richard Bishop, Bishop Consulting
Jim Misener, Booz Allen Hamilton

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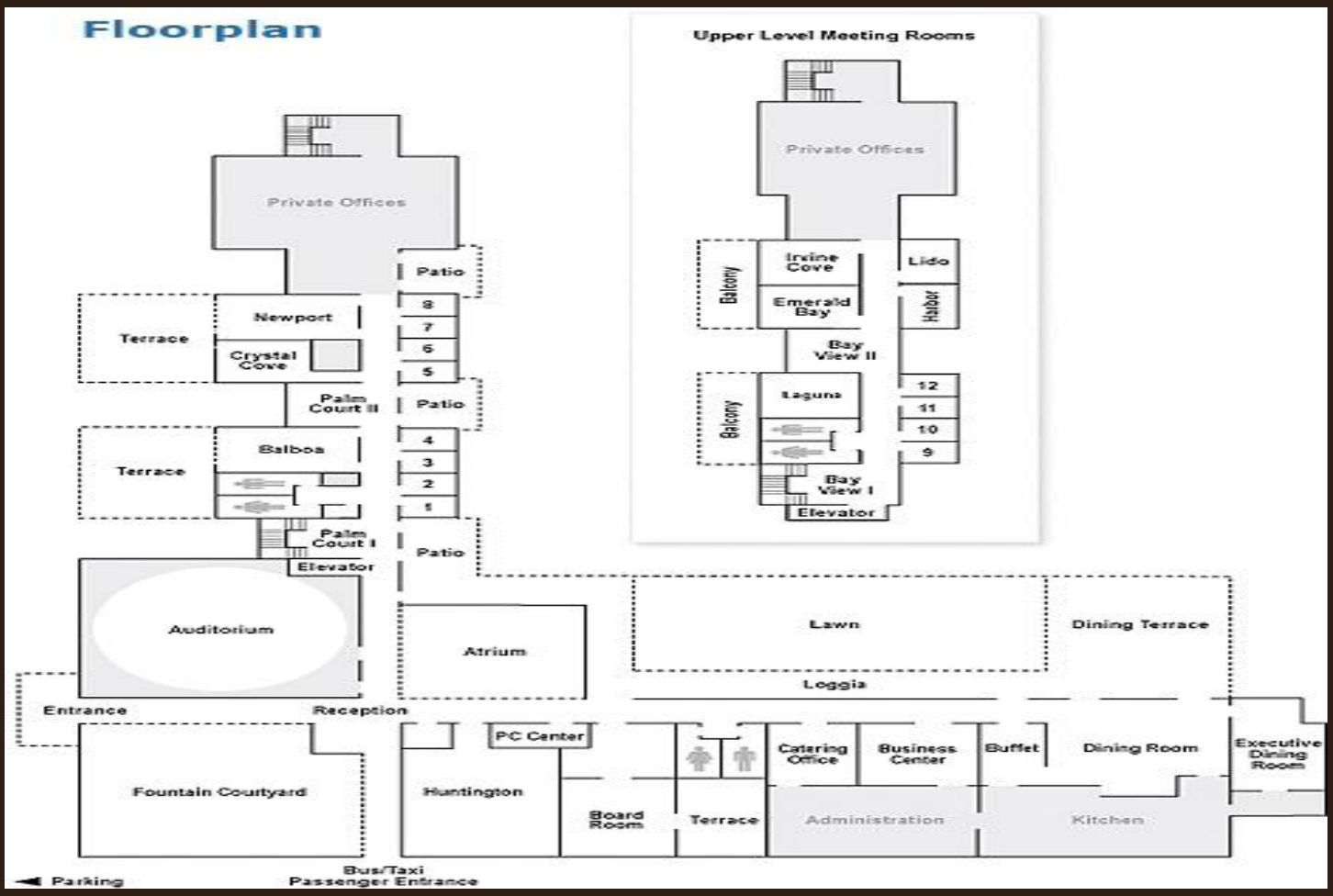
The table below shows PDHs that can be earned for the continuing education activities included in the Transportation Research Board **Road Vehicle Automation Workshop** held in Irvine, California, July 25-26, 2012.

Mark R. Norman
Director, Technical Activities

JULY 2012	SESSIONS			
DAY	**TIME**	**TITLE**		**HOURS**
Tuesday, July 24	1:00 p.m. – 5:00 p.m.	Early Automation Deployment Opportunities in Managed Lane Operations	4.0	
Wednesday, July 25	8:00 a.m. – 9:30 a.m.	Opening Session	1.5	
	9:45 a.m. – 12:00 pm	State of the Art Session 1	2.25	
	1:00 p.m. – 3:15 p.m.	State of the Art Session 2	2.25	
	3:30 p.m. – 5: 30 p.m.	State of the Art Session 3	2.0	
	5:30 p.m. – 5:45 p.m.	Closing	.25	
Thursday, July 26	8:30 a.m. – 11:00 am	**Breakout Groups – Session 1**		
		Public Policy Issues	2.5	
		Driver-Vehicle Interactions	2.5	
		Information Architecture and Operational Concepts	2.5	
		Technology Needs and Constraints	2.5	
	11:30 a. m. – 12:15 p.m.	Plenary Report-out from Session 1	.75	
	1:15 p.m. – 3:45 p.m.	**Breakout Groups – Session 2**		
		Transition and Deployment Strategies	2.5	
		Legal, Liability and Risk	2.5	
		Vehicle Safety and Security	2.5	
	4:15 p.m. – 5:00 p.m.	Plenary Report-out from Session 2	.75	
	5:00 p.m. – 5:15 p.m.	Closing	.25	
Total PDH Units:				

Name _____ Date _____



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