

# Advancing Transportation through Innovation

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# What does it mean to advance transportation through innovation?

It's not just a motto...

- We are innovators
- We anticipate the needs of our partners and sponsors
- Work to create real solutions that enhance safety
- We are pioneers; examples:
  - Smart Road
  - Sled Lab
  - Naturalistic driving studies
  - Global Center for Automotive Performance Simulation

# VTTI Facts

- By most metrics the largest university-level transportation institute in the U.S.
  - #1 in federal grants and contracts
  - #1 in private-sector contracts
  - Largest group of driving safety researchers in the world
    - Active + Passive
    - Experimental, Naturalistic, Epidemiological
    - Pioneer of Naturalistic Driving Study Research Method
- 72 sponsors; 270 projects
  - More than 40 ongoing proprietary projects
- 475+ employees
- More than 150 grads/undergrads supported annually
- Projected to grow 50% during the next three years

# VTTI Organizational Structure

## ***14 Research Centers/Initiatives/Groups***

- Advanced Automotive Research
- Automated Vehicle Systems
- Data Reduction and Analysis Support
- Infrastructure-based Safety Systems/Virginia Green Highway Initiative
- Injury Biomechanics
- Public Policy, Partnerships, and Outreach
- Sustainable Mobility
- Sustainable Transportation Infrastructure
- Technology Development
- Technology Implementation
- Truck and Bus Safety
- Vulnerable Road User Safety
- Motorcycle Research Group
- Global Center for Automotive Performance Simulation

## ***3 Nationally Known Centers***

- National Surface Transportation Safety Center for Excellence
- National Tire Research Center
- Connected Vehicle/Infrastructure University Transportation Center

# *Virginia Smart Road*

An active, connected, automated test  
bed for 16 years

On March 23, 2000, VTTI officially opened the Smart Road in co-sponsorship with VDOT.

To date, over 22,000 hours of groundbreaking research have been logged on this 2.2-mile test bed.



photo by Michael Kiernan



- Inclement weather testing (snow, fog, rain)
- 75 custom towers
  - Supported by a 500,000-gallon water tank
  - ½ mile of roadway

- Variable lighting section
  - 60 light towers
  - ~95% of lighting configurations found on U.S. highways
  - Differential spacing
  - Height adjustable
  - Intelligent Transportation Systems (ITS) equipment
  - 3 luminaires/poles
  - Varying intensities



# *Automated Vehicle Systems*

- VTTI is actively working with NHTSA, OEMs, and suppliers on groundbreaking automated-vehicle studies
- Awarded IDIQ worth up to \$25M across five years

	SAE Level	Name	Steering, acceleration, deceleration	Monitoring driving environment	Fallback performance of dynamic driving task	System capability (driving modes)
Human monitors environment	0	<b>No automation</b> the full-time performance by the human driver of all aspects of the dynamic driving task, even when enhanced by warning or intervention systems				
	1	<b>Driver assistance</b> the driving mode-specific execution by a driver assistance system of either steering or acceleration/deceleration using information about the driving environment and with the expectation that the human driver perform all remaining aspects of the dynamic driving task.				Some driving modes
	2	<b>Partial automation</b> the driving mode-specific execution by one or more driver assistance systems of both steering and acceleration/deceleration using information about the driving environment and with the expectation that the human driver perform all remaining aspects of the dynamic driving task				Some driving modes
Car monitors environment	3	<b>Conditional automation</b> the driving mode-specific performance by an automated driving system of all aspects of the dynamic driving task with the expectation that the human driver will respond appropriately to a request to intervene				Some driving modes
	4	<b>High automation</b> the driving mode-specific performance by an automated driving system of all aspects of the dynamic driving task, even if a human driver does not respond appropriately to a request to intervene				Some driving modes
	5	<b>Full automation</b> the full-time performance by an automated driving system of all aspects of the dynamic driving task under all roadway and environmental conditions that can be managed by a human driver				All driving modes

# Human Factors Evaluation of Level 2 and Level 3 Automated Driving Concepts

Experiment 1  
(L2 ADS)



2009 Chevy Malibu



Experiment 2  
(L2 ADS)



2010 Cadillac SRX



Experiment 3  
(L3 ADS)



2012 Lexus RX450h



Sponsors: NHTSA & ITS JPO

# Naturalistic Study of Level 2 Automated Vehicle Functions

- Sponsors: NHTSA & ITS JPO
- Investigate driver interaction with market-ready Level 2 systems through a naturalistic driving study (NDS)
  - Investigate how wide variety of drivers interact with L2 systems
  - Investigate how L2 systems operate when controlled by a variety of drivers
  - Monitor vehicle data relevant to targeted functions
- 120 drivers from the Northern Virginia/Washington, D.C. region
  - Equal number of males and females; younger and older group
  - Each participant will drive a study vehicle for 4 weeks



Audi Q7



Infiniti Q50



Mercedes-Benz E350

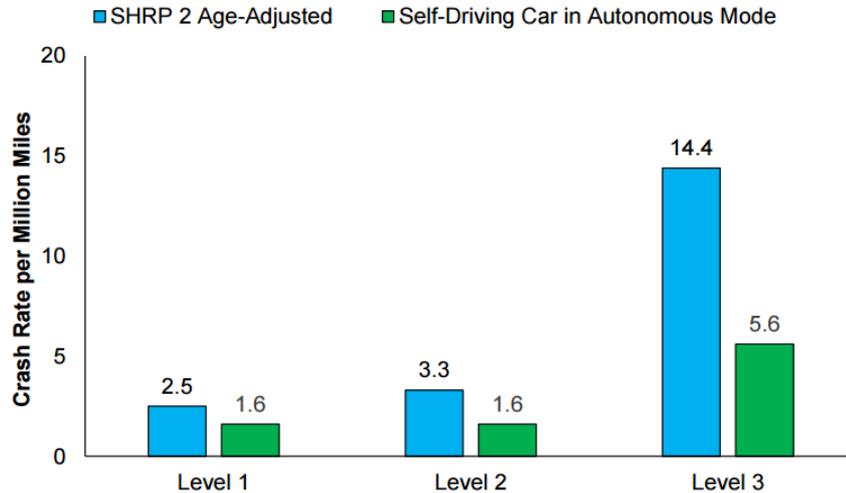


Tesla Model S



Volvo XC90

# Automated Vehicle Crash Rate Comparison Using Naturalistic Data





Virginia Automated Corridors

# Development and Deployment Opportunity

Created through a partnership between



# The Challenge

- Vehicle automation development is progressing at a rapid pace
- Pre-deployment testing requires complex vehicle interaction scenarios and real roadway environments
- The availability of real-world test environments is extremely limited due to reliability and safety concerns

Challenge = Opportunity

# Vehicle Automation in Virginia



Governor Terry McAuliffe

Building a  
New Virginia Economy

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## Support for Virginia Tech Transportation Institute and Automated and Autonomous Vehicles

Archive

2015

3/4/2015

**WHEREAS**, the Commonwealth of Virginia is on the cusp of the next revolution in the automobile industry with automated and autonomous vehicles, also known as “self-driving” cars; and

**WHEREAS**, the Commonwealth has an unparalleled higher education system with world recognized research facilities and a mission to be leaders in innovation; and

**WHEREAS**, the Commonwealth is in a position to be a leader in welcoming, supporting and developing the automated vehicle industry, the emerging technologies used in such vehicles, and the business that will provide the support necessary to make the innovations a reality; and

**WHEREAS**, the Virginia Tech Transportation Institute Center for Automated Vehicle Systems is providing the necessary leadership to study all aspects related to automated and autonomous vehicles, and to develop partnerships with groups involved in researching, planning, and producing automated vehicles;

**NOW, THEREFORE**, I, Terence R. McAuliffe, do hereby declare that the COMMONWEALTH OF VIRGINIA supports the mission of the Virginia Tech Transportation Institute Center for Automated Vehicle Systems and its self-driving on-road studies, and is open for business for the vehicle and technology manufacturers and researchers committed to the development, testing and deployment of automated and autonomous vehicles, and I call this observance to the attention of all our citizens.



## Virginia Automated Corridors

- In June 2015, VTTI partnered with VDOT, Virginia DMV, Transurban, and HERE to unveil the VAC
- Goal of VAC is to provide an automation-friendly environment that multiple suppliers and developers will use to test and certify their systems
- VAC allows users to develop test and certification protocols
  - Provide a system migration path from test-track to real-world operating environments for multiple projects
- Goals are rapid, efficient, and achieved at a reasonable cost
  - No “partnership fees,” no bond required
  - Strictly fee-for-service model
  - Licensing and insurance provided through the state
  - IRB process provided for human subjects
  - Can be completely proprietary
  - “Blanket agreements”

# VAC/VCC Demo

## October 19-20, 2015

- Hosted by VTTI, VDOT, and Transurban
- Designed to demonstrate the latest in automated- and connected-vehicle concepts operating on the I-95 Express Lanes, an active public roadway system in NoVA
- Featured a Level 3 automated vehicle (i.e., hands-off, feet-off, eyes-off per SAE Levels of Automation definition) and a DSRC-/cellular technology-equipped connected vehicle responding to a variety of challenging driving scenarios



# VAC/VCC Demo (cont.)

- Designed to show how connected- and automated-vehicle concepts can be integrated to improve safety, increase operational efficiency, and enhance the commuter driving experience
- 80+ in attendance, including Sen. Warner, USDOT Assistant Secretary for Research and Technology Mark Winfree, Dr. Sands, Va. Secretary of Technology Karen Jackson, NHTSA Administrator Mark Rosekind, VDOT Commissioner Charles Kilpatrick, Va. DMV Commissioner Richard Holcomb, and members of national media
- Demo video available: <https://vimeo.com/142905461>



# VAC/VCC Demo Media Coverage



**AP**

**THE BIG STORY**

**Key test for self-driving cars: A northern Virginia highway**

**The Washington Post**

Transportation

**In technology test, senator is along for the ride – the driver-less ride**

**CNN**

News Video TV Opinions

U.S. World Politics Tech Health

**Take a ride in a driverless car**

**wtop**

WASHINGTON'S TOP NEWS



**USA TODAY**  
A GANNETT COMPANY

**The ultimate test for self-driving vehicles: The I-395 express lanes**

**Richmond Times-Dispatch**

**Virginia Tech's self-driving car takes to the road in NoVa**

**WDBJ7**

**The New York Times**

**Virginia Tech makes history with self driving cars on DC expressway**

**ASCE** AMERICAN SOCIETY OF CIVIL ENGINEERS

**FOX 5** Local News

**Self-driving car hits Va. highway for key test**

RESEARCHERS DEMONSTRATE THE PROMISE OF AUTOMATED, CONNECTED CARS

# State Regulatory Actions

- What kinds of regulations have other states established or proposed w.r.t. autonomous and highly automated cars?
- Are the regulations driven by actual data (e.g., accident and incident data), or are they driven more by fear of the unknown and concern about what might happen?
- What are the industry's reactions/responses to the regulations? Which regulations are supported by industry, and which are not?
- What are the pros and cons of establishing regulations w.r.t. public safety, industry innovation, and any other relevant topics?
- How effective have those regulations been in achieving their stated objectives (or is it too early to tell)?
- Does VTTI have positions on state regulatory actions? If so, what are those positions and why?

# Other Topics

- Federal regulatory actions
- Vehicle-collected data collection and analysis
- Insurance
- Societal acceptance
- Road and other infrastructure

# Questions?

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