



# Connected and Autonomous Vehicles

Where are we?

Where are we going?

A presentation to ITS/Georgia

May 25, 2016



# If we are to understand where we are

- Don't we need to understand where we came from?

# CV/AV Significant Events

## Connected Vehicle

- 1999 – FCC allocates 5.9 GHz
- 2010 – Shelley Row (effectively) leaves USDOT
- 2012 – Ann Arbor Pilot
- 2014 – GM’s Mary Bara announcement
- 2015 – NHTSA Advance NPRM
- 2016? – NPRM and rulemaking?

## Autonomous Vehicles

- 2004 – DARPA Grand Challenge
- 2009 – Google
- 2014 – Google Car
- 2012 - Elon Musk/Tesla
- 2016 – Tesla Autopilot



# CV Applications

- The Connected Vehicle Reference Implementation Architecture is based on a set of Applications that have been defined by various connected vehicle programs.
- The source for the application descriptions ranges from:
  - Concepts of Operations (ConOps),
  - Requirements
  - Specifications, or
  - existing Standards and Architectures.
- There are four types of Connected Vehicle Applications:
  - Environmental,
  - Mobility,
  - Safety, and
  - Support.
- Each type is comprised of groups of applications.
- Click on an Application name in the table below to see and description of the application, its source references, and the subset of the Connected Vehicle Reference Implementation Architecture that pertains to that application, including sub-tabs for each view (enterprise, functional, physical, and communications).



Type	Group	Application Name
Environmental	AERIS/ Sustainable Travel	<a href="#">Connected Eco-Driving</a>
		<a href="#">Dynamic Eco-Routing</a>
		<a href="#">Eco-Approach and Departure at Signalized Intersections</a>
		<a href="#">Eco-Cooperative Adaptive Cruise Control</a>
		<a href="#">Eco-Freight Signal Priority</a>
		<a href="#">Eco-Integrated Corridor Management Decision Support System</a>
		<a href="#">Eco-Lanes Management</a>
		<a href="#">Eco-Multimodal Real-Time Traveler Information</a>
		<a href="#">Eco-Ramp Metering</a>
		<a href="#">Eco-Smart Parking</a>
		<a href="#">Eco-Speed Harmonization</a>
		<a href="#">Eco-Traffic Signal Timing</a>
		<a href="#">Eco-Transit Signal Priority</a>
		<a href="#">Electric Charging Stations Management</a>
	<a href="#">Low Emissions Zone Management</a>	
	<a href="#">Roadside Lighting</a>	
	Road Weather	<a href="#">Enhanced Maintenance Decision Support System</a>
		<a href="#">Road Weather Information and Routing Support for Emergency Responders</a>
		<a href="#">Road Weather Information for Freight Carriers</a>
		<a href="#">Road Weather Information for Maintenance and Fleet Management Systems</a>
<a href="#">Road Weather Motorist Alert and Warning</a>		
<a href="#">Variable Speed Limits for Weather-Responsive Traffic Management</a>		
Mobility	Border	<a href="#">Border Management Systems</a>
	Commercial Vehicle Fleet Operations	<a href="#">Container Security</a>
		<a href="#">Container/Chassis Operating Data</a>
		<a href="#">Electronic Work Diaries</a>
		<a href="#">Intelligent Access Program</a>
	Commercial Vehicle Roadside Operations	<a href="#">Intelligent Access Program - Mass Monitoring</a>
		<a href="#">Intelligent Speed Compliance</a>
	Electronic Payment	<a href="#">Smart Roadside Initiative</a>
		<a href="#">Electronic Toll Collection</a>
	Freight Advanced Traveler Information Systems	<a href="#">Road Use Charging</a>
		<a href="#">Freight Drayage Optimization</a>
	Planning and Performance Monitoring	<a href="#">Freight-Specific Dynamic Travel Planning</a>
		<a href="#">Performance Monitoring and Planning</a>
	Public Safety	<a href="#">Advanced Automatic Crash Notification Relay</a>
		<a href="#">Emergency Communications and Evacuation</a>
		<a href="#">Incident Scene Pre-Arrival Staging Guidance for Emergency Responders</a>
		<a href="#">Incident Scene Work Zone Alerts for Drivers and Workers</a>
Traffic Network	<a href="#">Cooperative Adaptive Cruise Control</a>	
	<a href="#">Queue Warning</a>	
	<a href="#">Speed Harmonization</a>	
	<a href="#">Vehicle Data for Traffic Operations</a>	
	<a href="#">Emergency Vehicle Preemption</a>	
	<a href="#">Freight Signal Priority</a>	



Safety	Traffic Signals	<a href="#">Freight Signal Priority</a>	
		<a href="#">Intelligent Traffic Signal System</a>	
		<a href="#">Pedestrian Mobility</a>	
		<a href="#">Transit Signal Priority</a>	
	Transit		<a href="#">Dynamic Ridesharing</a>
			<a href="#">Dynamic Transit Operations</a>
			<a href="#">Integrated Multi-Modal Electronic Payment</a>
			<a href="#">Intermittent Bus Lanes</a>
			<a href="#">Route ID for the Visually Impaired</a>
			<a href="#">Smart Park and Ride System</a>
			<a href="#">Transit Connection Protection</a>
	Traveler Information		<a href="#">Transit Stop Request</a>
			<a href="#">Advanced Traveler Information Systems</a>
			<a href="#">Traveler Information- Smart Parking</a>
	Safety	Transit Safety	<a href="#">Transit Pedestrian Indication</a>
<a href="#">Transit Vehicle at Station/Stop Warnings</a>			
<a href="#">Vehicle Turning Right in Front of a Transit Vehicle</a>			
V2I Safety			<a href="#">Curve Speed Warning</a>
			<a href="#">In-Vehicle Signage</a>
			<a href="#">Oversize Vehicle Warning</a>
			<a href="#">Pedestrian in Signalized Crosswalk Warning</a>
			<a href="#">Railroad Crossing Violation Warning</a>
			<a href="#">Red Light Violation Warning</a>
			<a href="#">Reduced Speed Zone Warning / Lane Closure</a>
			<a href="#">Restricted Lane Warnings</a>
			<a href="#">Spot Weather Impact Warning</a>
			<a href="#">Stop Sign Gap Assist</a>
			<a href="#">Stop Sign Violation Warning</a>
		<a href="#">Warnings about Hazards in a Work Zone</a>	
		<a href="#">Warnings about Upcoming Work Zone</a>	
V2V Safety			<a href="#">Blind Spot Warning + Lane Change Warning</a>
			<a href="#">Control Loss Warning</a>
			<a href="#">Do Not Pass Warning</a>
			<a href="#">Emergency Electronic Brake Light</a>
			<a href="#">Emergency Vehicle Alert</a>
			<a href="#">Forward Collision Warning</a>
			<a href="#">Intersection Movement Assist</a>
			<a href="#">Motorcycle Approaching Indication</a>
			<a href="#">Pre-crash Actions</a>
			<a href="#">Situational Awareness</a>
			<a href="#">Slow Vehicle Warning</a>
		<a href="#">Stationary Vehicle Warning</a>	
		<a href="#">Tailgating Advisory</a>	
	<a href="#">Vehicle Emergency Response</a>		
Support	Core Services	<a href="#">Core Authorization</a>	
		<a href="#">Data Distribution</a>	
		<a href="#">Infrastructure Management</a>	
		<a href="#">Location and Time</a>	
		<a href="#">Map Management</a>	
		<a href="#">Object Registration and Discovery</a>	
		<a href="#">Privacy Protection</a>	
	<a href="#">System Monitoring</a>		
	Security	<a href="#">Security and Credentials Management</a>	





# Autonomous Vehicles

In the United States, the National Highway Traffic Safety Administration (NHTSA) has proposed a formal classification system:

- **Level 0:** The driver completely controls the vehicle at all times.
- **Level 1:** Individual vehicle controls are automated, such as electronic stability control or automatic braking.
- **Level 2:** At least two controls can be automated in unison, such as adaptive cruise control in combination with lane keeping.
- **Level 3:** The driver can fully cede control of all safety-critical functions in certain conditions. The car senses when conditions require the driver to retake control and provides a "sufficiently comfortable transition time" for the driver to do so.
- **Level 4:** The vehicle performs all safety-critical functions for the entire trip, with the driver not expected to control the vehicle at any time. As this vehicle would control all functions from start to stop, including all parking functions, it could include unoccupied cars.

An alternative classification system based on five different levels (ranging from driver assistance to fully automated systems) has been published by SAE, an automotive standardisation body.





# Which One Wins?

Connected  
Vehicles

Autonomous  
Vehicles





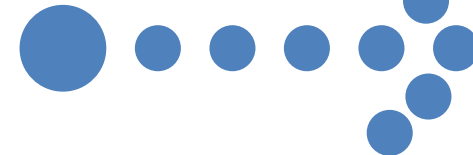
# What is Winning?

- Is it:
  - Connected – ONLY?
  - Autonomous – ONLY?
- Or, more like this:

Connected Vehicles



Brave New World



Autonomous Vehicles





# So, What is the Brave New World?

- Perhaps it's a combination of:
  - An autonomous vehicle
  - With “connected vehicle” info providing:
    - Traffic signal data (SPAT)
    - Certain time-critical traveler information



# So, Where Are We?

- The Industry
  - CV
    - Tampa, Wyoming, and New York
  - AV
    - Depends on who you ask
- GDOT
  - CV
    - We have a feasibility study
  - AV
    - We're spending \$MM/yr on pavement markings



# And, Where Are We Going?

- The Industry
  - CV
    - The next set of pilots?
    - The NPRM?
  - AV
    - Depends on who you ask
- GDOT
  - CV
    - Traffic Signal Software
    - Installing fiber
  - AV
    - More pavement markings?



**Questions?**

**Comments?**

