



## Dialogue Series Results and Summaries

### Autonomous and Connected Vehicles- Will They Make Things Better or Worse?

July 31, 2018

Leonard Transportation Center, CSUSB

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## Introduction

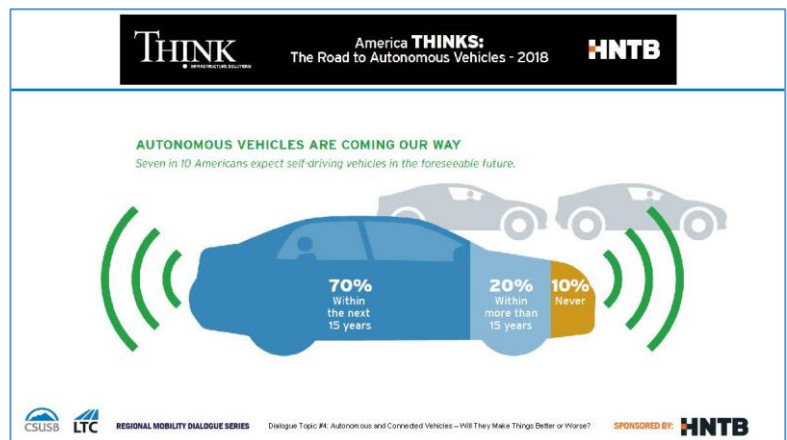
Urbanization and rising incomes have been driving rapid motorization mostly in major cities across the United States. The Inland Empire is no exception. This growth in automobile use threatens to gridlock our urban areas and brings with it a host of consequences that could seriously undermine the overall quality of life and economic vitality of our region. Automation has been suggested as one potential solution to this impending crisis. Among the potential advantages of automation is safer driving. A safer autonomous system could allow for different and significantly lighter vehicles that would need less energy. A fleet of easily available automated vehicles could also make ride-sharing more attractive, and potentially reduce levels of auto ownership. However, digital innovation does not automatically guarantee that the future of mobility will indeed be more sustainable. If we don't get it right, these disruptions could also exacerbate existing urban transport problems. It is not clear how autonomous vehicles will perform in a mixed environment – computer and human. Jaywalking pedestrians or less-than-perfect manual drivers would cause autonomous cars to stop. Moreover, by making driving virtually effortless, automated vehicles may also encourage longer trips and an exodus to the suburbs, translating into more and more urban sprawl. Combined with the ease of shared mobility, these factors can increase congestion and make public transport less viable. This Dialogue featured two thought leaders in transportation automation:

- Jim Barbaresso, HNTB Fellow, Senior Vice President and Practice Leader, Intelligent Transportation Systems
- Brian R. Simi, Office Chief, Office of Technology, Innovation and Deployment at Caltrans HQ Division of Traffic Operations

The main conclusions from this Dialogue are that the growth of autonomous technologies is going to change the way society functions by altering how our urban spaces are planned and built. Additionally, automation will dramatically change how we move about and how our urban spaces are shared. Large, looming questions surround infrastructure development to support connected and autonomous vehicles, cybersecurity to keep our data safe, and making sure the public is educated on benefits and use of new technologies.

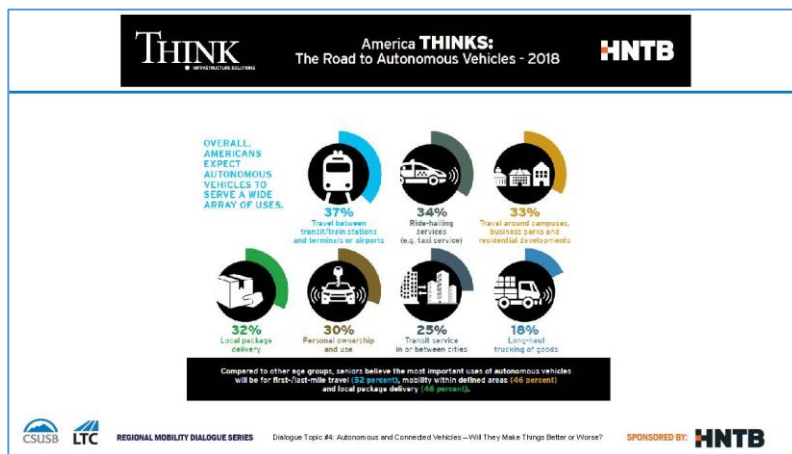
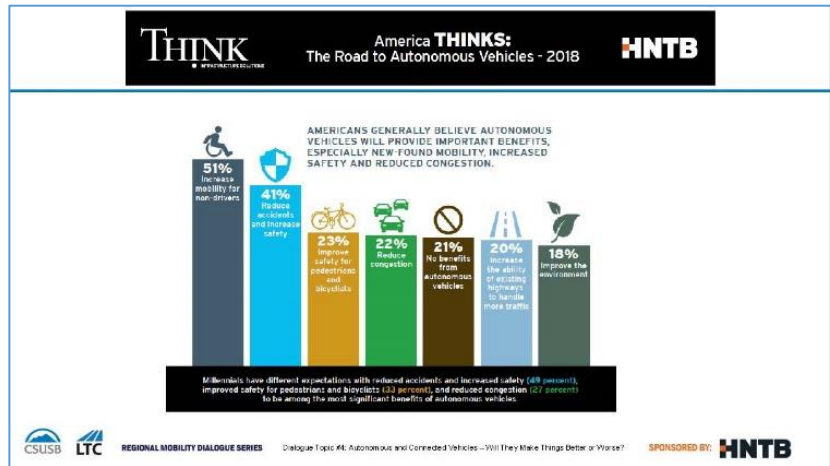
## Opening Statements

To begin the conversation, Greg Hulziser, Vice President of Mobility Solutions at HNTB, provided the results of a recently conducted HNTB survey on autonomous and connected. In this survey participants were asked a number of questions regarding their perceptions of autonomous vehicles. A few of the main findings included:



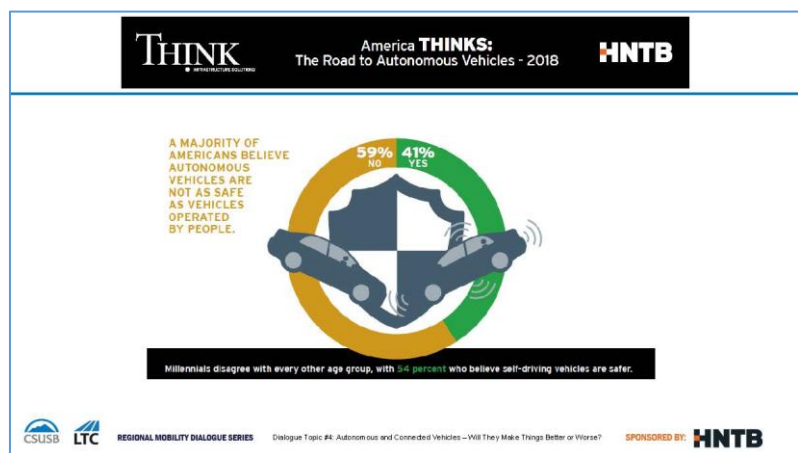
“Seven in ten Americans expect to see within the next 15 years, so clearly within our lifespan here in this room most people believe we're going to see that. And ten percent say never.”

The two biggest benefits expected with autonomous vehicles will be increased mobility for non-drivers (51%) and the reduction of accidents with increased safety (41%). Approximately 20% of participants believed there to be no benefits from autonomous and connected vehicles. Other responses included benefits such as improved safety for pedestrians and bicyclists, reduced congestion, and improvement to the environment.



Autonomous vehicles are expected to serve in a variety of ways in the near future. They will help provide an answer to the last and first mile questions; be part of the taxi and personal car fleets; provide transportation at university campuses, business parks, and residential areas; deliver packages locally; serve as part of the public transit infrastructure; and part of the fleet of long-haul trucks.



Even though 41% of the respondents believed there would be fewer accidents as noted above, a slight majority of Americans believe that autonomous vehicles are not as safe as vehicles operated by people. These views are bound to change as 54% of the millennials believe that autonomous vehicles are safer.



## The viewpoint of a business leader

Jim Barbaresso started the conversation discussing what he believes to be the cusp of a transformation in transportation that is being driven by what he calls, the “four aces.” These four trends are disrupting how we will provide transportation services to the community, and, according to Barbaresso, interfering with the way we design and build our infrastructure.

DISRUPTIVE FORCES AT WORK - ACES



We're on the cusp of a transformation in transportation, driven by advances in vehicle **A**utomation, **C**onnectivity, **E**lectrification and **S**haring. The changes will be disruptive.

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**TECHNICAL CHALLENGES**

- Interoperability and standards
- Implementation and support of specific applications & technologies
- Data management
- Data privacy
- Communications and network management
- Security management
- Local network security
- Technical obsolescence

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These changes present public and private agencies with significant challenges, such as how to implement and prepare for new technologies. “Two things I want to highlight; data management and security management. Data management in particular, when you think about the data that these vehicles are generating, gigabytes per second, and then communicating that data ten times per second with other vehicles around it and

with the infrastructure,” says Barbaresso. How do you manage the large quantity of data being generated? That is where security management comes into play. How would we secure the automated vehicles to ensure that data remains private and prevents this information from being hacked? Both important issues to keep in mind.

In addition, there are institutional issues to consider, and one that stood out in the survey by HNTB on AVs was funding. Practitioners want to know how we will implement these new technologies, and who will pay for it? Barbaresso also discussed new partnerships and business models. “Because we are entering the phase where we're looking at innovative delivery of these new technologies, but also new

**INSTITUTIONAL CHALLENGES**


- **Funding.** Shortfalls impact the operational capabilities.
- **Education & workforce considerations.** Lack of staff with necessary technical skills.
- **Business case.** Lack of benefit and cost information to support investment decisions.
- **New partnerships and business models.** Public and private.
- **Data ownership.** How to access it, who owns it, how do they support it?
- **Liability.** What's the risk and how does it get allocated?
- **Forces outside their control.** Changing technologies and political climate leave public agencies feeling uncertain.

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partnerships and business models with the private sector and with industry because it's no longer a silo

as it has been in the past where we build roads, they build cars, no, it's an integrated system going forward and we need to treat it that way," stated Barbaresso.

"And then when it comes to operations, the top one really is the most important and that is the workforce and educational requirements to maintain and operate the new technologies. We don't have enough technical people or the STEM education capabilities within the U.S. We rank very low internationally in that regard and we need to really boost that up to deal with these types of technologies going forward."



**OPERATIONAL CHALLENGES**

- **Education & workforce considerations.** New skills needed in data analytics, IT, application support, software and new algorithms
- **Data management.** Big data from connected vehicles will challenge operational staff – a blessing in disguise
- **Keeping up with advances.** The operations environment will continue to evolve at a rapid pace
- **Giving up control.** Greater automation of public agency functions, greater empowerment of travelers, and impacts of connected automation

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**AUTOMATED VEHICLES**



- Updated USDOT Policy released Sept. 12, 2017
- SELF DRIVE Act passed by the House
- USDOT AV Proving Grounds designations
- Industry leading the way
- Dynamic mobility ecosystem

Source: General Motors

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The first opportunity is found in with automation. From a policy perspective, USDOT Secretary Chao issued an update to the automated vehicle policy guidance last fall and it is going to be updated again later this year to support the safety, the privacy, and security aspects of automated vehicles. "The Self-Drive Act was passed by the House of Representatives. But the AV Start Act has stalled in the Senate and there's

some reluctance to go forward with that bill at this time," said Barbaresso.

General Motors and Waymo announced that next year they will have ride-hailing services with autonomous vehicles in select markets. "At Automated Vehicle Symposium (AVS) in San Francisco a couple of weeks ago I saw a number of Waymo and GM Cruise AVs running around downtown," stated Barbaresso. They have mapped out the entire city and it will more than likely be one of the first cities to have automated vehicle ride-hailing services. This includes "inter-modal facilities with first and last mile services, and different types of automated shuttles like this this one here" (image pictured above).

Jim continued with a highlight of important developments in highway maintenance operations in places like, Colorado, Texas, and Florida. These states have tested automated trucks and attenuator trucks to protect their workers. Another development Barbaresso mentioned for truck automation is platooning. Uber has eliminated their program for truck automation, but Waymo as well as a number of other companies are actively working on platooning.



## TRANSITIONING ON OUR HIGHWAYS



- Managed lanes in a new context
- Should we separate automated vehicles from others to generate the most benefits?
- At what penetration rate should we dedicate a lane?
- Incrementally increase the number of special lanes as the fleet turns over?

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With all these technological advancements taking place, we will experience about a 30-year transition period for our highway infrastructure. Barbaresso pointed out the different ways our infrastructure can change to accommodate autonomous vehicles. One way is to have automated vehicle lanes. “When you look at this type of solution, it’s pretty

incredible because what you can do is shorten up the headways between vehicles by platooning and increasing the speed.” In doing so, both lane capacity, and the capacity of the entire facility is increased. “This is an opportunity for highways to increase capacity.

Next, we have the second ace in the deck, connected vehicles. There are a few things to consider when thinking about connected vehicles – the first being there are no set-in-stone rules, and part of that has to do with the administration and their stance on regulations. Secondly, there are questions in regard to spectrum. The communications industry wants to share the autonomous vehicle spectrum,

which is 5.9 gigahertz and sits adjacent to the Wi-Fi spectrum, according to Barbaresso. The sharing of the spectrum could pose some risks for vehicle connectivity. This puts driver safety at risk, which ultimately defeats the main purpose of connected vehicles altogether. Lastly, there has been tremendous progress on cellular connectivity with vehicles. “Since most vehicles have cellular within them already then why do they need to add another radio device to their vehicles if they can support the same sort of functionality using the cellular based technology, they already have in the vehicles,” said Barbaresso. The auto industry’s response has been mixed, but according to Barbaresso, General Motors announced that the 2023 new Cadillac lineup are going to be connected vehicles.

## CONNECTED VEHICLES



Source: Florida DOT

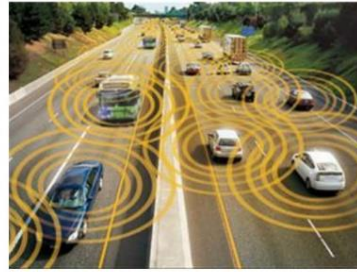
- Notice of Proposed Rulemaking on December 12, 2016
- Final rule on V2V pending
  - Change in administration
  - Spectrum challenge
  - Privacy and security challenges
  - Progress on 5G M2M and C-V2X solutions
- Auto industry response
- Government stimulus for V2I
  - Connected Vehicle Pilot Program
  - Smart City Challenge
  - SPaT Challenge



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## OPPORTUNITIES FOR CONNECTIVITY

- Signal Phase and Timing
  - Eco-Driving
  - Transit Signal Priority
- Safety Applications
  - Intersection Collision Avoidance
  - Queue Warnings
  - Pavement Condition Warnings
  - Work Zone Applications
  - Incident Warnings
- Congestion Reduction
  - Traveler Information
  - Routing and Navigation
  - Location Services



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Connectivity provides a number of opportunities. Barbaresso addressed signal phase and timing, safety applications, and congestion reduction. “Some of the various applications apply to roadways and roadway design, roadway operations in terms of signal phase and timing.” California is a leader in vehicle electrification, but when we look around the state and country,

there are a lack of charging stations, and an antiquated grid that are holding us back. The best way to overcome these hurdles is by making infrastructure enhancements a priority going forward.

When it comes to shared mobility, there has been tremendous growth. It is not just Uber and Lyft anymore, auto companies are also getting into the game. For example, Ford and General Motors. “People are starting to buy rides more than cars.” Moving forward there are opportunities with integrated intermodal information and payment solutions; mobility hubs; repurposed parking lots; and transit partnerships and integration. Focusing on ways to transform our future of mobility is what our main concern should be.

## SHARED MOBILITY OPPORTUNITIES

- Integrated Intermodal Information and Payment Solutions
- Mobility Hubs
  - Centers for Shared Mobility Services
  - Design, Deployment, Operations
- Repurposing Parking Lots
- Partnership and Integration with Transit
  - Off-Peak Solutions
  - First and Last Mile Solutions
  - Lesser Used Routes

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Barbaresso concluded by discussing how autonomous and connected vehicles are going to impact urban form and land use, how we design and operate our highways, and the amount of green space with reductions in parking spaces. “The bottom line is we can’t leave the future to chance, we have got to plan this out, we have got to be prepared for the impacts, both negative and positive, to support these types of opportunities,” stated Barbaresso.

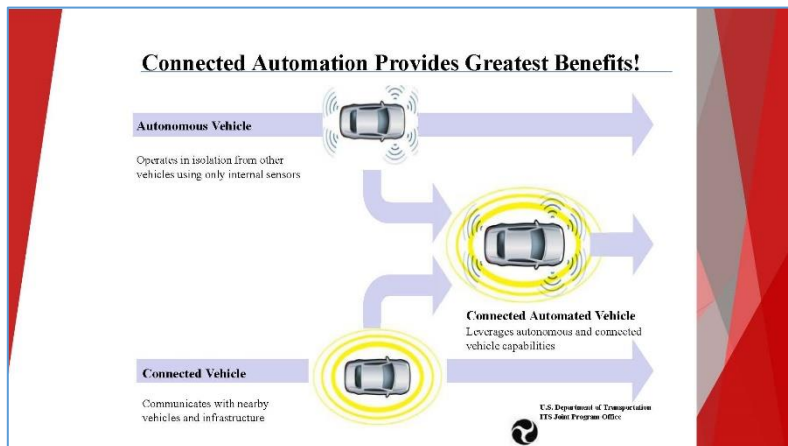
### The viewpoint from a government leader

Brian Simi, Office Chief of Innovation and Deployment at Caltrans, discussed how we make these changes a reality with the new up and coming technologies. The importance of these changes were highlighted with Brian’s opening statement: “We have 560,000 hours of delay a day on roads and 30-50 percent of the delay is caused by accidents,” said Simi.

Brian opened with a quick review of the California administrative structure. The lead transportation agency is the California State Transportation Agency (CalSTA), headed by the Secretary of Transportation. This agency oversees five departments: California Department of Transportation (Caltrans); the Department of Motor Vehicles (DMV); California Highway Patrol (CHP); California Transportation Commission (CTC), and the Office of Traffic Safety (OTS). Caltrans does not set policies or determine what cars are allowed to drive on the freeway, the DMV does.



As of July 2018, there are about 55 companies registered with the DMV to operate autonomous vehicles on state highways. Once the autonomous vehicles are on the road, it is duty of the CHP to enforce the regulations. The CTC supplies the funding for these projects and makes sure the planning documents are correct and that all the departments are on the same page. The Office of Traffic Safety's main priority is safety, with a focus on seatbelt, cellphone laws, texting and driving, etc. Caltrans is responsible for building out the infrastructure to accommodate all these changes. With this in mind, the vision of Caltrans is to: Provide a safe, sustainable, integrated, and efficient transportation system to enhance California's economy and livability.

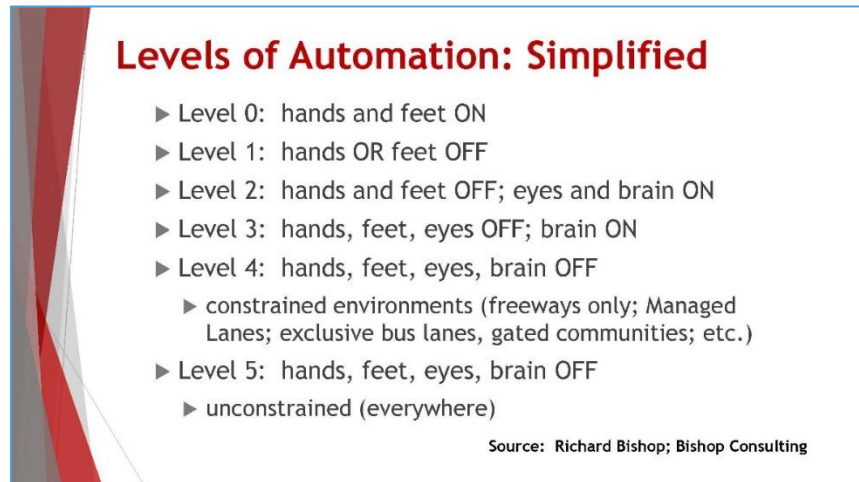


Caltrans main objective is safety and mobility, safety always being number one. Automated vehicles assist with this. There is vehicle to vehicle, and vehicle to infrastructure data that is transferred back and forth to help us make better decisions from car to car and car to traffic signal. The public sometimes has a misconstrued understanding of connected and autonomous. Automated vehicles use sensors to communicate with the infrastructure around it and have a driver. Autonomous vehicles are free of human intervention and can "think" about decisions on the road. Caltrans believes that the connected automated vehicles is the pinnacle of what should be on the roadways.

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The Society of Automation Engineers (SAE) have identified five different levels to automation. Tesla has a training for their drivers to educate them on their vehicle, and Simi believes moving forward we will have to do outreach for the public to make sure people know what they are getting into and what their vehicles can and can't do. "But I think what we are probably going to see, is a jump from a level two or three type driving, straight into level five."



### Levels of Automation: Simplified

- ▶ Level 0: hands and feet ON
- ▶ Level 1: hands OR feet OFF
- ▶ Level 2: hands and feet OFF; eyes and brain ON
- ▶ Level 3: hands, feet, eyes OFF; brain ON
- ▶ Level 4: hands, feet, eyes, brain OFF
  - ▶ constrained environments (freeways only; Managed Lanes; exclusive bus lanes, gated communities; etc.)
- ▶ Level 5: hands, feet, eyes, brain OFF
  - ▶ unconstrained (everywhere)

Source: Richard Bishop; Bishop Consulting

When discussing the deployment scenario for autonomous vehicles, Simi had a similar take on it as Barbaresso; Caltrans thinks integrating them into managed lanes to start off would be easiest. "Caltrans has a network of managed lanes, High Occupancy Vehicle (HOV) lanes, sometimes High Occupancy Toll (HOT) lanes, and a lot of times I'd say those are managed by the local agencies, local metropolitan planning organizations (MPOs), and so there's thoughts about let's convert that, let's have a special AV lane. There will be headways in these lanes, and we can move a lot more cars," said Simi.



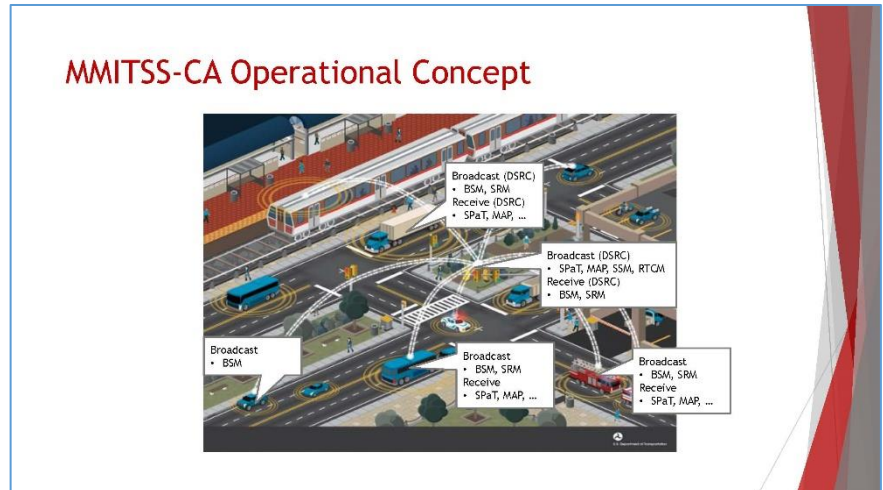
### Major Policy Challenges

- ▶ Balancing the need for public safety while encouraging technological innovation
  - ▶ Crossing boundaries of federal and state regulatory responsibilities for motor vehicle content and operations
  - ▶ States moving faster than the federal government (analogous to emissions regulations)
- ▶ Harmonizing state regulations for a uniform national market
- ▶ Maintaining realistic expectations amid the hype
- ▶ Vehicle and Passenger Safety
- ▶ Providing cooperative infrastructure

There are a number of policy challenges with automated and connected vehicles. The first is creating the right balance between public safety and promoting technological innovation. There is currently a patchwork of regulations across the nation, with states developing regulations faster than the federal government. This could create challenges in traveling across state lines.

Finally, Brian touched upon the multimodal intelligent traffic system (MMITSS-CA). MMITSS-CA is a suite of connected vehicle applications and products that assist with mobility functions, such as intersection control, basic safety message (BSM) transit signal priority, freight signal priority, and pedestrian signal interaction. This system allows Caltrans to test transit signal priority. This is just one of many applications that Caltrans has in the works. "We are working on an autonomous vehicle deployment plan, to be completed by next year, which will set the parameters for the needed infrastructure. Going back to Jim's point on data, we need to have high-speed internet connections at many of these sites in

order to manage the data. It's the details of the fiber-optic communication infrastructure backbone and broadband that needs to be figured out," explained Simi. Without a balance between the developments and need of the private sector with the regulatory frameworks being developed by the state, more challenges will arise.



### Moving the Dialogue Forward: Ideas from the Participants

After the presentations, Dialogue attendees discussed the ideas presented and worked together in groups to discuss solutions to move the discussion forward. The top three ideas from each table have been categorized and summarized below.

**Preparing and planning our infrastructure and regulatory structure for the needs of autonomous and connected vehicles.** There were a number of questions and considerations regarding how to plan and provide the right infrastructure for these technological advancements.

- Infrastructure enhancements -- are companies ready and is there equipment designed to provide for autonomous and connected vehicles?
- Charging stations for electrification, where to build them and how to incorporate them into our infrastructure.
- How do we achieve a standardization of vehicles and infrastructure?
- Need more work on utility regulation improvements and rethinking street parking policies.
- What about gas taxes, what will replace vehicle related revenue?

**More public education on what AVs mean for our future is needed.** Many participants discussed how AVs and connected vehicles will appeal to the general public. Most people are not ready to give up driving on their own and are not educated on autonomous vehicles.

- Thinking about how we incentivize people to adopt AV/CV. What is the role of the driver, we need to educate the public on what it means.
- Communicate the safety incentives of autonomous vehicles to the public.
- Develop an educational plan for the general public so they can understand their role and the benefits of adopting autonomous vehicles.
- Think about how to facilitate the move to AVs to consumers.
- Hold forums with the public and communicate employment impacts of autonomous vehicles.

**Further address cybersecurity concerns in more detail.** Various participants mentioned that cybersecurity is a big issue with autonomous vehicles and it is one that needs to be addressed in more detail.

- How do we ensure that information shared between connected vehicles remains private and safe?
- Need to discuss how we can secure the system from potential hackers.
- The main concern for the public is cybersecurity. They want to feel safe and know their system cannot be compromised.

*The Leonard Transportation Center (LTC) at California State University San Bernardino (CSUSB), presented a bi-monthly dialogue series on topics relevant to the future of transportation in the Inland Empire. The series, which was open to the public, was sponsored by HNTB Corporation and was held every other month starting in February 2018.*

*Dialogue topics ranged from understanding the current mobility dilemma and its causes to potential solutions like congestion pricing, transit; emerging technologies such as autonomous and connected vehicles and new ways of funding transportation infrastructure. Attendees had the opportunity to hear from transportation experts and engage in vigorous discussion about the transportation challenges facing the Inland Empire.*

### **About Leonard Transportation Center**

*The Leonard Transportation Center (LTC) at California State University, San Bernardino opened in 2006 with a focus on regional transportation needs. The vision of Bill and Barbara Leonard was to create a center that focuses on the unique transportation opportunities and challenges the Inland Empire faces. Today, the LTC is working to expand its research and student engagement programs. Focal points include transportation management and governance issues, development of new technologies, and transnational studies. Their vision is to work collaboratively to seek solutions to assist residents, businesses, government and nonprofit agencies, and international partners to work together on improving sustainability and quality of life in the Inland Empire. For more information, visit [www.csusb.edu/ltc](http://www.csusb.edu/ltc).*

### **About HNTB**

*HNTB Corporation is an employee-owned infrastructure solutions firm serving public and private owners and contractors. HNTB's work in California dates back to its founding in 1914. Today, HNTB continues to grow in size and service offerings to clients in California from seven office locations, currently employing more than 350 full-time professionals. With more than a century of service, HNTB understands the life cycle of infrastructure and addresses clients' most complex technical, financial and operational challenges. Professionals nationwide deliver a full range of infrastructure-related services, including award-winning planning, design, program management and construction management. For more information, visit [www.hntb.com](http://www.hntb.com)*