Incorporating Connected/Autonomous Vehicles into the Transportation Planning Process

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Facilitate the appropriate consideration of CVs in transportation planning activities carried out by States, MPOs and local agencies

- How should connected vehicles be considered across a range of planning activities?
- What changes are needed in techniques, tools, supporting data, organizational skills and expertise?
- What new stakeholders will be involved and how will the role of existing stakeholders change?
- How will needs vary in different contexts?
• Longer range plans require consideration of AV impacts as well as CV

• C/AV is the term used in this presentation, except in some shorter-term activities where only CV is being considered

• Ultimately they may merge into one general technology
Overview of Connected/Autonomous Vehicles
Connected Vehicles (CV) are vehicles that can communicate with each other, roadside devices (traffic signals), or non-motorized users (smart phones and other advanced devices)

- Vehicle to Vehicle (V2V)
- Vehicle to Infrastructure (V2I)
- Vehicle to Anything (V2X)
Connected Vehicles

- Dedicated Short-Range Communications (DSRC) frequency (5.9ghz) set aside for this purpose by FCC
  - Safety primary motivation
  - Pressure is on as tech companies fight for spectrum
Federal Automated Vehicle Policy (NHTSA)

- 15 Point Safety Assessment
- Model State Policy
- NHTSA’s Current Regulatory Tools
- Modern Regulatory Tools

More details about the policy may be found at www.transportation.gov/AV
• Autonomous & Driverless Car
  – Array of sensors to detect other vehicles and obstacles
  – Requires Detailed map
  – Uses machine learning to make software smarter
  – Does not rely on communication with other vehicles

Google’s automated vehicle
Autonomous Vehicles

Automation builds off current driver assistance technologies such as adaptive cruise control, lane departure warning, and left turn assist

- NHTSA initially defined 5 levels of automation
- **NEW POLICY** uses SAE International definition – 6 levels

<table>
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<tr>
<th>LEVEL 0</th>
<th>LEVEL 1</th>
<th>LEVEL 2</th>
<th>LEVEL 3</th>
<th>LEVEL 4</th>
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<tr>
<td>Driver Warning Systems</td>
<td>Automation of Isolated Driver Functions</td>
<td>Automation of Several Driver Functions</td>
<td>Limited Self-Driving Capability</td>
<td>Fully Autonomous Operation</td>
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<td>Provides guidance to the driver, but makes no decisions and does not take away control.</td>
<td>Manages individual driver functions, but requires a human driver to continue performing other essential functions.</td>
<td>Manages several driver functions simultaneously, but still requires a human driver to handle some essential functions.</td>
<td>Limited autonomous operation in certain environments, with human control needed to handle complex situations.</td>
<td>Capable of handling more advanced driving situations and environments, for fully autonomous driving from start to finish.</td>
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Greatest benefits come from both together. In addition to safety benefits, mobility and economic impacts become significant:

- Crash reduction
- Capacity increases in current roadway systems
- Cost savings running through many industries, possibly starting with freight
- The potential for disruption is enormous

With Platooning

Automatic control means shorter gaps are possible without compromising safety.

However, empirical data are needed to more accurately assess the impact, capacity, and emission impacts of this CV application.
Key Issues for Planning

• Technologies will advance – and roles will change

• Planners don’t need to know “guts” of technology but need to track developments
Overview of Impacts on the Transportation System, Planning, and Society
Research Findings from Project on Incorporating C/AV into Planning Process

• Results of:
  – Literature Search
  – Stakeholder Interviews

• Impact Categories
  – Strategy
  – Performance Measurement and Evaluation
  – Infrastructure Investment
  – Planning Products
  – Data Collection, Processing, Analysis
  – Education and Training
Findings – General Impacts

• **Societal**
  - Economic shifts resulting from increased capacity of existing system and reduced crash rates
  - Changed infrastructure investment strategies
  - “Mobile workplace” – In vehicle value of time increases
  - Shift from car ownership model to ridesharing/carsharing service model
  - Land use and economic changes
Impacts on Strategic Planning

- **Strategy**
  - C/AV will change both operational and capital investment strategies
    - C/AV infrastructure incorporated into ITS/TSMO plans and architectures
    - TSMO or equivalent funds for supporting infrastructure
    - Changed priorities for long-term investments
  - Goals and objectives will be modified to support C/AV impacts
    - More ambitious goals related to safety and congestion
    - Closer coordination between planning and operations
  - Awareness of and input to regulatory, *privacy*, and liability issues
  - New C/AV-related stakeholders, primarily private sector
    - Identify potential early adopters; freight, emergency response
    - Education programs for agency constituents

U.S. Department of Transportation
Federal Highway Administration
Performance Measure and Evaluation

- Benefit/cost evaluation needed for deployments
  - FHWA CO-PILOT program available for use
  - Look at cost versus alternative solutions
- Business case needed for short-term investments
  - Convincing to decision makers and the general public
- Possible changes in measures and targets due to C/AV
- CA/V enables new opportunities for data collection
- Some models and simulation programs may no longer be necessary as real-time data can provide full picture
  - Other modeling activities will still be required and new one may be needed to support C/AV
- New models may be necessary to simulate operational strategies
**Short-Term Planning Impacts**

- **Short term planning (0-5 years)**
  - Connected Vehicle for data gathering and operational strategies on arterial corridors
  - ConOps and planning documents for C/AV projects different than for previous Operations/ITS projects
  - Benefit-cost for C/AV-related projects
  - Engagement of new stakeholders
  - Increased need to track technology developments
  - Data collection opportunities that require relatively small CV market penetration
  - Operational analysis to accommodate AVs on roadway as they come into the market
Short-term Infrastructure Investment Impacts

- **Infrastructure Investment – Short Term**
  - Likely to be phased in starting with CV supporting infrastructure
    - Backhaul communications infrastructure for transmission of CV data to TOCs and other recipients
    - Replacement of field equipment, such as signal controllers, should accommodate V2I technology; for example incorporating DSRC units
    - Conduit provided to arterial upgrades
    - Concept of data management, privacy, and operation needed
  - Cost tracking important for integration into investment plans
  - Assess management of existing infrastructure
  - Improve network operation of existing infrastructure
  - Operational requirements for vehicle platoons
Medium and Long Range Planning Impacts

- **Medium (5-20 years) and Long term (20+ years) planning**
  - Need to look at wider range of alternative futures in long-range planning
    - Land use and economic changes
    - Change in physical infrastructure requirements
    - Change in operational strategies and requirements
    - Where is “tipping point” when investment decisions change?
  - Change in project life cycles with more focus on communications
  - Plan for increasingly rapid technological change
  - Possible change in agency roles and new skill requirements
  - Need to manage and make useful information out of “big data”
Long-Term Infrastructure Investment Impacts

• **Infrastructure Investment –Long Term**
  – Larger questions about future capital investment strategies
    • Will capacity improvements from C/AV reduce need for physical expansion?
    • Will safety improvements from C/AV reduce need for safety infrastructure investments?
    • Will roadway configurations have to change during period of mixed fleet operation? Separation of automated and non-automated vehicles?
    • What are impacts on major transit investments? Will automated vehicles replace or supplement some transit services?
    • What functions will be handled solely by the vehicle and what functions will need agency support?
• **Planning Products**
  – ITS Strategic Plans as way of incorporating short-term C/AV projects
    • Replacement of current ITS functions
    • Federal and/or State grant opportunities
  – Toolbox needed for developing short-range projects
    • Understanding opportunities and constraints
  – Need criteria for investment in both short-range and longer-range plans
    • Priority corridors
    • Scenario planning for TSMO
    • Scenario planning for land use/economic impacts
Data Collection, Processing and Analysis

Impacts

- Data Collection, Processing and Analysis
  - Allowing transportation agencies to use data
    - Privacy, ownership and security concerns to be addressed
    - Coordination with private parties
    - Compatibility with current and planned DOT systems
  - Need to aggregate and turn large amounts of data into useful information
  - Applications for real-time systems analysis and operational planning
  - Applications for asset management – possible replacement of labor-intensive methods
  - Making efficient use of the data across multiple functions
Product and Process Specific Impacts

- What is role of C/AV on both general activities and specific products?
  - Where is “tipping point” when investment decisions change?
  - What are locations, costs and impacts of incorporating CV infrastructure into projects? How does this change with project timeframe?
  - What are impacts on agency tools and processes and when do they come into play?
  - What changes will happen in stakeholder mix, public-private partnerships and financing?
For More Information:
Project Documents

- Technical Memorandum #2: Connected Vehicle Planning Processes and Products and Stakeholder Roles and Responsibilities
- Analysis of the Need for New and Enhanced Analysis Tools, Techniques and Data
- Federal Automated Vehicle Policy
  - www.transportation.gov/AV
Thanks!

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