Development of California Regulations for Testing and Operation of Automated Driving Systems

Steven E. Shladover, Sc.D.

California PATH Program

Institute of Transportation Studies

University of California, Berkeley

SIP-adus Workshop, Tokyo

November 17, 2014

Fundamental Challenges for Automated Driving Regulations

- **Balancing need to protect public safety with desire to encourage technological innovation**
- **Automation crosses the traditional boundary between federal responsibility for regulating new vehicle equipment and state responsibility for regulating how vehicles are operated**
- **No technical standards to provide baseline references for performance, safety or testing protocols or procedures**
- **No national standards, and diverse state attitudes**
- **Cultural differences between automotive and information technology industries**
- **Self-certification vs. third-party certification**

CALIFORNIA PATH

Issues to Consider in Regulations

- **Due diligence in protecting general public safety while unproven systems are being tested among them**
- **Trying to ensure that general public really understands limitations of their automated vehicles**
- **Detecting unsafe systems as early as possible (earlier than NHTSA?)**
- **Adapting or re-interpreting related rules:**
  - **Responding to law enforcement officer commands**
  - **Exchanging insurance information after crashes**
  - **Restrictions on driver behaviors (drunk driving, open alcohol containers, cell phones, texting, distraction, recklessness…)**
  - **Protection of unattended children…**

CALIFORNIA PATH

SAE J3016 Levels of Automation

SAE Level	Name	Narrative Definition	Execution of Steering/ Acceleration/ Deceleration	*Monitoring* of Driving Environment	Fallback Performance of *Dynamic Driving Task*	System Capability (*Driving Modes*)
Human driver monitors the driving environment						
0	No Automation	the full-time performance by the *human driver* of all aspects of the *dynamic driving task*, even when enhanced by warning or intervention systems	Human driver	Human driver	Human driver	n/a
1	Driver Assistance	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*	Human driver and system	Human driver	Human driver	Some driving modes
2	Partial Automation	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*	**System**	Human driver	Human driver	Some driving modes
Automated driving system ("system") monitors the driving environment						
3	Conditional Automation	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*	System	**System**	Human driver	Some driving modes
4	High Automation	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*	System	System	**System**	Some driving modes
5	Full Automation	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*	System	System	System	**All driving modes**

Example Systems at Each Automation Level

Level	Example Systems	Driver Roles
1	Adaptive Cruise Control OR Lane Keeping Assistance	Must drive other function and monitor driving environment
2	Adaptive Cruise Control AND Lane Keeping Assistance Traffic Jam Assist (Mercedes)	Must monitor driving environment (system nags driver to try to ensure it)
3	Traffic Jam Pilot Automated parking	May read a book, text, or web surf, but be prepared to intervene when needed
4	Highway driving pilot Closed campus driverless shuttle Driverless valet parking in garage	May sleep, and system can revert to minimum risk condition if needed
5	Automated taxi (even for children) Car-share repositioning system	No driver needed

CALIFORNIA PATH

Systems Covered by Regulations

- **"Autonomous technology" means technology that has the capability to drive a vehicle without the active physical control or monitoring by a human operator.**
- **"Autonomous vehicle" means any vehicle equipped with autonomous technology that has been integrated into that vehicle.**

- **California regulations do not apply to driver assistance systems**

→ SAE Level 3 or higher systems are covered, but:

- **"If the operator does not or is unable to take control of the AV, the AV shall be capable of coming to a complete stop." (which effectively prohibits many Level 3 systems)**

CALIFORNIA PATH

Testing on Public Roads (Published)

- **Legislative:**
  - **$5 M bond/proof of self-insurance**
  - **Test driver must be designated by manufacturer**
  - **“The driver shall be seated in the driver's seat, monitoring the safe operation of the AV, and capable of taking over immediate manual control…”**
- **Administrative:**
  - **Permit for testing covers specific vehicles and test drivers**
  - **Many test driver qualifications (driving record, training)**
  - **No motorcycle, commercial or heavy vehicle testing**
  - **Prior “controlled testing” under comparable conditions**
  - **Report total amount of test driving and all disengagements associated with failures or driving hazards**
  - **(no provision for ‘naturalistic’ testing by naïve drivers)**

CALIFORNIA PATH

Deployment for Public Operation

- **Legislative highlights in CA Vehicle Code:**
  - **"The AV shall allow the operator to take control in multiple manners, including, without limitation, through the use of the brake, the accelerator pedal, or the steering wheel…"**
  - **Separate event data recorder (EDR) for "autonomous technology sensor data" for at least 30 seconds**
  - **"The department [DMV] shall notify the Legislature of the receipt of an application from a manufacturer seeking approval to operate an AV capable of operating without the presence of a driver inside the vehicle…"**
  - **$5 M bond/proof of self-insurance**

CALIFORNIA PATH

Technical Issues for Public Operation

- **Defining limitations in operating environments ("areas of operation")**
  - **Limited-access highway, rural, urban areas**
- **Defining minimum driving behavior competencies for each area of operation**
  - **Basic maneuvering capabilities**
- **Verifying functional safety of system design and/or design process**
- **Educating users about system capabilities and limitations**
- **Monitoring driving safety records to identify potential problems as early as possible**

CALIFORNIA PATH

What next?

- **Release of draft California regulations for public use of AVs, for public comment**
- **Further updates of California regulations based on public input, experience in the field, new technology developments**
- **Unlikely to see additional state legislation, except as needed for "driverless" operation**
- **Industry standards development proceeding slowly**
- **Everybody waiting for NHTSA to act**
  - **Their 5/30/13 policy statement advised states to delay authorizing public use of Level 3 or above**

CALIFORNIA PATH

Save the Dates!

- **July 21-23, 2015**
- **Ancillary meetings July 20, 24**
- **Ann Arbor, Michigan**
- **For info: www.automatedvehiclessymposium.org**

CALIFORNIA PATH