Autonomous Vehicles

A Brief History

1478: Leonardo Da Vinci sketches plans for a programmable three-wheeled driverless cart.

1925: Francis Houdina's radio-controlled "Phantom Auto" wows passersby as it cruises the streets of New York with no one behind the wheel.

1939: GM's World's Fair exhibit predicts driverless cars will be traveling along automated highways by 1960.

1958: Researchers begin experimenting with autonomous cars controlled by signals from cables buried in the pavement.

1994: Two robotic vehicles successfully travel 1,000 kilometers of multilane highways from Munich to Paris.

1997: The Demo '97 program tests Automated Highway System technology on closed portions of Interstate 15 near San Diego.

2004: Of the 15 competitors in the first Defense Advanced Research Projects Agency (DARPA) Grand Challenge, a government-sponsored contest to develop autonomous vehicles, none manage to traverse more than 8 miles of the 150-mile off-road course.

2005: The second running of DARPA's Grand Challenge sees five of the 23 entries complete the 132-mile course through the Mojave Desert.

2009: Google begins testing its self-driving cars on Bay Area roads.

2010: A driverless Audi sports car travels to the summit of Pikes Peak in 27 minutes, just 10 minutes shy of times set by professional race car drivers competing in the annual hill climb event.

2011: Nevada passes the first legislation specifically approving autonomous car operation on state roadways. Florida and California quickly follow suit.

2012: Nissan debuts autonomous car that can drop you off, park itself and return to pick you up.

Sourced from AAA Arizona

Levels of Automation

SAE level	Name	Narrative Definition	Execution of Steering and 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**

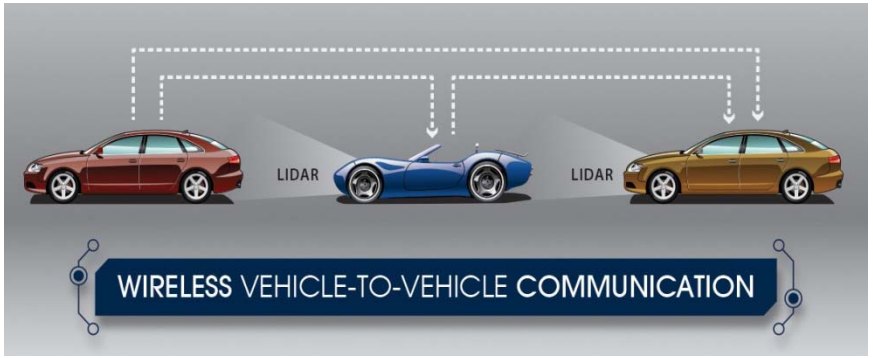
Sourced from the Society of Automotive Engineers: http://www.sae.org/misc/pdfs/automated_driving.pdf

Overview

Two types of competing AV technology design

- Google's independent system which does not transmit information about itself to nearby vehicles is a truly autonomous vehicle. It makes decisions based on onboard sensory input only.

- Backed by GM, cooperative systems transmit and receive information to/from other vehicles in order to optimize driving state and coordinate actions. Provides enhanced situational awareness.



Regulation

- National Highway Traffic Safety Administration (NHTSA) in a report to congress determined that the 5.9Ghz for dedicated short-range communications (DSRC) is ready for deployment as the preferred choice for V2I communication
- DSRC is a Wi-Fi derivative developed to meet specialized needs for secure and low-latency wireless connections in data communications
- Major milestones were identified for the year 2040: 90% of light duty vehicle fleet is DSRC enabled; 80% of all traffic signals are DSRC equipped
- Report describes recommended implementation path, beginning with crash avoidance moving to fully automated driving

Sourced from: NHTSA's Status of the Dedicated Short-Range Communications Technology and Applications: Report to Congress

- February 2016 NHTSA, in a letter to Google, says Google's Self-Driving System can be considered the 'driver' under federal law
- Also noted legal obstacles to putting fully autonomous vehicles on the road. Existing regulations requiring some auto safety equipment can not be waived immediately, such as requirements for braking systems activated by foot control
- NHTSA has said it would write guidelines for self-driving cars within six months.
- Transportation Secretary Anthony Foxx said the administration may seek new legal authority to allow deployment of autonomous vehicles "in large numbers," when they are deemed safe

AVs and London

- Impact to municipal revenue streams
  - Vehicles that can meticulously obey the speed limit and respect all bylaws will not get tickets
  - Vehicles which can be sent home after dropping the passenger (or owner) off at the desired destination do not need to pay for parking.
  - Other vehicle related revenue streams such as permits and registration
  - Tax base erosion if people choose to live outside urban municipalities*
  - Job losses: taxi, truck, and bus drivers

*http://www.pbs.org/wgbh/nova/next/tech/cities-autonomous-vehicles/

- Transit ridership could be negatively impacted*
- Under the current ownership model, it is possible that vehicle traffic and congestion will increase**
- Real time traffic management capability
- V2X infrastructure upgrades required. Who pays and operates?

<u>If municipal:</u>

  - Liability: Needs to be secure and free from malfunction (FBI has warned on risks of car hacking)
  - Privacy: what data is collected, how long is it kept, how will it be used, who has access, and is the data capable of identifying individuals

*http://www.vtpi.org/avip.pdf
**http://www.journals.elsevier.com/transportation-research-part-a-policy-and-practice/

Applications

- Startups appearing which promise retrofit AV tech for older vehicles (Otto, Cruise Automotive and others)
- Project in Greenwich to repurpose Heathrow airport shuttles for use on public streets
- Manufacturer Local Motors and IBM will 3D print AV shuttle buses (called Olli) for trial in DC. Olli is Uber-like that it wont need you to wait at pre-determined bus stop.
- Uber and Lyft heavily invested and looking to transform their fleet into AVs
- Driverless trucks being trialed in the US, UK and EU
- Beverly Hills will have AV public transportation by 2026 along the Purple Line. Once fully operational, residents will use an app to request on-demand shuttles