AUTONOMOUS BUSES

Incorporated County of Los Alamos
Public Works Department

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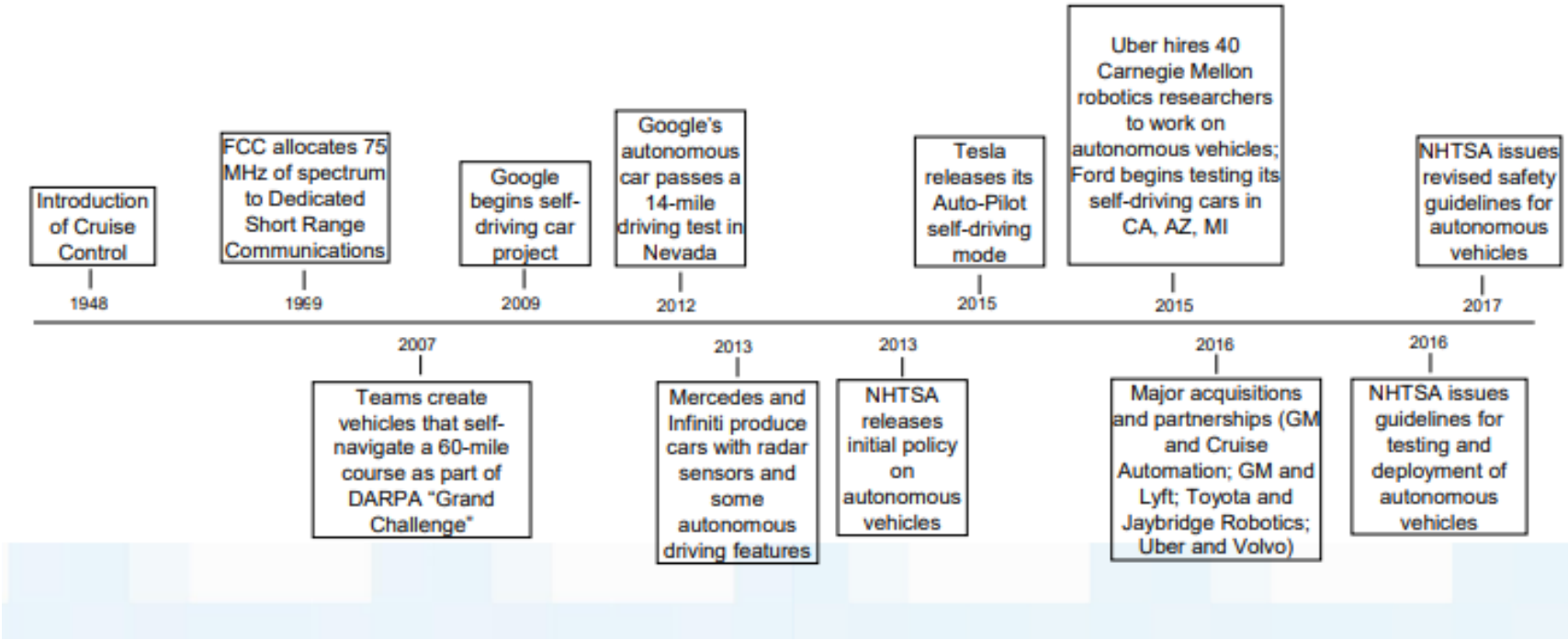
History of Autonomous Vehicles



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Society of Automotive Engineers(SAE)

SAE AUTOMATION LEVELS[1]

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.

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*.

2 Partial Automation
The *driving mode*-specific execution by one or more driver assistance systems of both 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*.

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*.

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*.

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*.

1 SAE International, J3016_201806: Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles (Warrendale: SAE International, 15 June 2018), https://www.sae.org/standards/content/j3016_201806/.

Source: https://www.nhtsa.gov/technology-innovation/automated-vehicles-safety

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How do self-driving cars work?

Most advanced driver-assistance systems (ADAS) powering vehicles with various levels of autonomy leverage a combination of specialized cameras and sensors to create an internal map of the vehicle's surroundings. These sensors include:

SENSOR TYPE	FUNCTION	CHALLENGES
LIDAR (light detection and ranging)	Measures distances, helps software build 3D map, detection of obstacles	Limited functionality in precipitation: rain, snow, etc.
Radar	Measures distance to obstacles. Sensors are mounted on all sides	Limited aperture/field of view
Cameras	Used for lane demarcation, obstacle detection, traffic sign identification; mounted for 360-degree views.	Can be blinded in certain conditions / limited functionality depending on light conditions
Environmental sensors	Identify temperature and precipitation conditions	Failure due to wear and tear, weather conditions
Global Navigation Satellite Service (GNSS) and stored maps	Stored roadway maps with detail on lane geometry and operational rules such as stop signs	Updates and connectivity are needed regularly to insure accuracy

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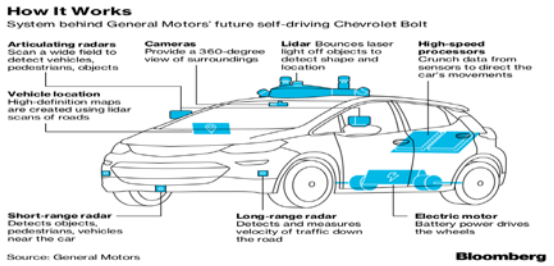
Areas of Innovation

Autonomous Driving:
Navigating a vehicle without human input from passengers using sensory (LIDAR)



Driver Assistance:
Enhances vehicle systems for safety and improved driving when the driver is in control.

Telematics:
Includes telecommunications, vehicular technologies, road transportation, road safety, electrical engineering.

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Autonomous Vehicles in Public Transit Today…and in the Future

Public transportation agencies are showing interest in incorporating autonomous vehicles into their service, and looking at pilot programs using Avs

- Use of AVs for “micro-transit” or “first/last mile” service could expand accessibility
- Reduction in costs – maintenance is could be less expensive
- Safety benefits – less accidents
- Driver/operators will need to be retrained to become “computer technicians”
- ADA compliance requirements – may need an on-bus presence of an operator

Three key benefits of autonomous buses and shuttles

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Enhance Connectivity

- One of the key goals of the public transportation system is to increase connectivity, and first/last mile commutes.
- They help to increase the frequency of public buses travelling on fixed routes.
- The on-demand service can be an optimal mode of transportation in areas that are not traditionally served by public buses to extend the reach of public transportation.
- Autonomous vehicles are also able to function round-the-clock, as they have low to no downtime.

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Improve Safety

- Autonomous vehicles go through rounds of testing and global safety standards are being set to ensure safer navigation.
- Autonomous vehicles can reduce the risk of human error, which is one of the key causes of road accidents.
- With artificial intelligence (AI), self-driving vehicles are more likely to reduce the number of vehicle-related injuries and accidents.

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Drive Sustainability

- Autonomous buses are likely to pave the way for more sustainable transportation.
- On-demand autonomous shuttles can be booked in advance or when needed.
- It reduces unnecessary trips carried out by fixed-route buses or buses that serve low-demand areas.
- Connected vehicle technology that enables more informed driving
- Autonomous shuttles could connect with the surrounding environment through infrastructures and other vehicles for smoother driving, without frequently braking and accelerating.
- This can reduce carbon emissions due to unnecessary idling on the road and delays caused by traffic accidents.

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Advantages of autonomous vehicles

- ***360° vision -*** With high-precision technology, autonomous vehicles can view the environment in a 360° range (twice as much as humans, who have a viewing angle of only 180° horizontally).

- ***Reduced accidents -*** With 360° vision and vehicles could interconnect with each other and be in constant communication, accidents may be significantly reduced. It might reduce accidents caused by human driving.

- ***Higher traffic efficiency -*** Reduce road congestion.

- ***Access for persons with disabilities or with reduced mobility -*** Autonomous vehicles may require practically no human interaction for its operation, even people with visual or hearing disabilities will be able to have one.

- ***Sustainable vehicles -*** These vehicles have the potential to operate based on clean energy, so carbon and greenhouse gas could lower tailpipe emissions.

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Disadvantages of autonomous vehicles

- ***Data protection issues -*** An autonomous vehicle's operating system could be hacked.

- ***High cost of implementation -*** Autonomous vehicle infrastructure revolves around 5G network coverage - might be costly, so it may take considerable time to invest in sufficient infrastructure.

- ***High cost of vehicles -*** Although progress is being made in reducing the cost of producing, these cuts might not be low enough to make them a financially alternative.

- ***Inclement Weather -*** Radars, lidars, and cameras not only perceive objects in their surroundings, but are also influenced by environmental conditions due to weather.

- ***Ability to maintain -*** Repair and maintenance of technology.

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Current Pilot Projects

Keolis Pilot Project in Las Vegas

• Las Vegas and Nevada are leading the way in legislative and regulatory changes to facilitate the introduction of autonomous and connected vehicles

• Keolis operates Navya-supplied Arma Shuttle that seats up to 8 passengers, 6 days a week up to 8 hours a day, in traffic, in a pilot sponsored by AAA

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Sienna Autono-MaaS (Mobility as a Service) Platform

New and emerging safety and customer experience features
Cabin awareness

Comfortable ride
MPDM integration with carefully tuned ride feel

Open feel
- Open view - no front passenger seat
- Ambient lighting

Connectivity
Rider wifi hotspot, USB charging

Configurability
- Low power tablet displays
- App based GUI

Fuel Efficiency
Hybrid - 35 mpg

Rider capacity
Comfortable seating for 4 (max 5)

Easy ingress/egress
Sliding doors, captain seats

Space for storage
Large and small (Scooter, stroller, groceries)

Accessibility
Wheelchair accessible with 2 additional passengers; accommodates service animal & attendant. passenger screens, audio queues

Specs: 17'3" Length | 7'7" Width | 6'7" Height | ~4,800 lbs GVWR

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What does this mean for Los Alamos?

Potential Benefit

- Greater Road Safety
- Greater Independence
- Saving Money
- Congestion

Transit

- Driver Vacancy
- More Productivity
- Peak Service
- Express Routes

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Questions?

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Thank You!