State of the Industry: Automated Buses and Transit

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National Center for Applied Transit Technology

Autonomous vehicles (AVs) can use connected vehicle technology and sensors to detect the environment and safely operate with little to no human control. Connected vehicle technology allows vehicles to "talk" with each other and infrastructure. This fact sheet provides an overview of the levels of automation, benefits and concerns of deploying AVs, a map of where AV transit projects have been piloted in the United States, and presents a case study on the highest level of automation in transit in the United States (US).

Levels of Automation

According to the Society of Automotive Engineers (SAE), there are five levels of Automation for AVs, ranging from no automation to fully automated. Most vehicles on the market today, such as those by Tesla, do not exceed level 2 automation. Some cities and transit systems around the United States are taking the lead in the transit world by deploying level 4 autonomous shuttles as demonstration projects.

0 - NO AUTONOMY

There are no autonomous features; everything is controlled manually by a driver.

1 - DRIVER ASSISTANCE

The vehicle has one automated system that provides steering or braking and acceleration assistance, but the driver is still controlling the vehicle and must be alert at all times.

2 - PARTIAL AUTOMATION

The vehicle has at least two automated systems and can control both steering and acceleration/deceleration. There is still a person in the driver's seat who monitors all tasks, must remain alert at all times, and can take control of the vehicle at any time. Some examples of automation include adaptive cruise control, lane centering, parking assistance, and lane-following assistance.

3 - CONDITIONAL AUTOMATION

Under certain circumstances, such as driving straight along a highway, the vehicle will drive autonomously. Drivers can temporarily turn their attention elsewhere or takes their hands off the wheel, but once a more complicated scenario pops up, such as navigating roadwork or taking an exit ramp, the vehicle hands back control to the driver.

4 - HIGH AUTOMATION

The vehicle operates in self-driving mode and performs all driving tasks, but a person is on board to manually override the system if needed. The safety driver is usually not necessary as the vehicle can maneuver itself to a safe space.

5 - FULL AUTOMATION

The vehicle performs all driving tasks under all conditions and requires no human attention or interaction. There isn't even a steering wheel or gas and brake pedals.

THE HUMAN MONITORS THE DRIVING ENVIRONMENT

THE AUTOMATED SYSTEM MONITORS THE DRIVING ENVIRONMENT

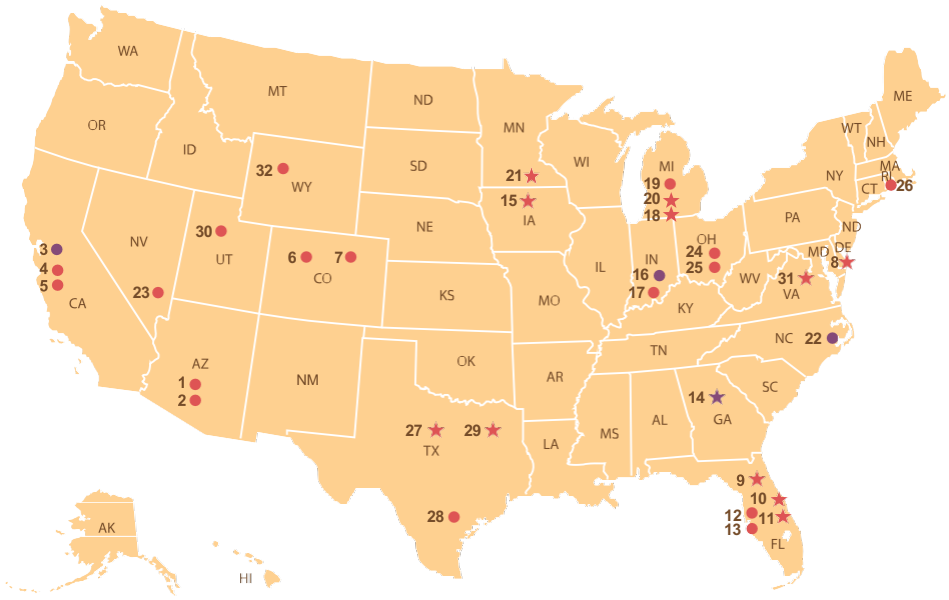
BENEFITS

- Decrease in vehicle crashes and traffic-related deaths and injuries
- Decease in passenger injuries from sudden stops for smaller vehicles.
- Better ADA access due to a consistent curb approach
- Better schedule adherence
- Zero-emission vehicles that reduce harmful emissions
- Reduced traffic delay from crashes and elimination of stop-and-go creates faster travel times
- Provide better data to enhance operational performance
- Increase in mobility in difficult to serve areas such as low-density environments and in off-peak periods.
- Increased mobility for seniors.

CONCERNS

- Government regulations
- Cybersecurity and data privacy
- Increased vehicle and infrastructure costs
- Job loss for operators
- Passenger assistance and safety - lack of assistance from operators
- Public perception
- Enforcement (e.g., how does an officer pull over an AV?)
- Increased urban sprawl

To date, there have been 32 AV transit shuttle demonstration and pilot projects, of which 12 are in process, and 20 have been completed. The shuttles range in capacity from 4 to 16 passengers, have ramps for ADA accessibility, average 13' x 6.5' in size, have low speeds of 12 - 15 mph, have maximum speeds of 25 mph, and are fully electric with ranges of up to 14 hours. While most operate in mixed traffic on public roads, some operate on dedicated roadways, lanes, and paths. For more information got to the FTA's Transit Automation Webpage https://www.transit.dot.gov/automation-research.



LEGEND:

○ Completed ☆ Operational

Mixed Traffic Dedicated

	PROGRAM NAME	CITY	STATE
1	Robo Ride	Peoria	AZ
2	RideChoice Waymo	Phoenix	AZ
3	Bishop Ranch	Contra Costa	CA
4	SAV	Dublin	CA
5	Accessible Automated Vehicle Project	Santa Clara	CA
6	61AV	Denver	CO
7	AvCo	Golden	CO
8	DelDOT AV Shuttles	Dover	DE
9	AV Shuttle	Gainesville	FL
10	Move Nona	Lake Nona	FL
11	Tradition in Motion	Port St. Lucie	FL
12	HART SMART AV	Tampa Bay	FL
13	AVA Shuttle	Tampa Bay	FL
14	PAUL	Peachtree Corners	GA
15	ADS for Rural America	Iowa City	IA
16	Fast Forward Bloomington	Bloomington	IN
17	Together in Motion	Fishers	IN
18	A2GO	Ann Arbor	MI
19	AVGR	Grand Rapids	MI
20	MSU Automated Bus	Lansing	MI
21	Med City Mover	Rochester	MN
22	CASSI	Kill Devil Hills	NC
23	AAA Free Self Driving Shuttle	Las Vegas	NV
24	Linden LEAP	Columbus	OH
25	Smart Circuit	Columbus	OH
26	Little Roady	Providence	RI
27	RAPID	Arlington	TX
28	SURGE	Corpus Christi	TX
29	DFW EasyMile	Dallas	TX
30	Automated Shuttle Pilot	Salt Lake City	UT
31	Relay Shuttle	Merrifield	VA
32	T.E.D.D.Y.	Canyon Village	WY

Case Study

The Connecticut Department of Transportation (CTDOT) will be the first to pilot full-sized, heavy-duty, 40', level 4 autonomous transit buses in revenue service. The pilot project will deploy three autonomous electric buses along CTfastrak, a 9.4-mile limited-access busway. The autonomous technology will operate the vehicle while it is on the busway with an safety driver on board who will take control on local streets. The safety driver will also take over control if the system disengages or is unable to operate in certain conditions (e.g., bad weather).Some areas of focus for the project will be automatic docking, autonomous vehicles operating in tandem, and communication with the traffic signal at an intersection. Buses will be delivered for testing in Fall of 2022 .