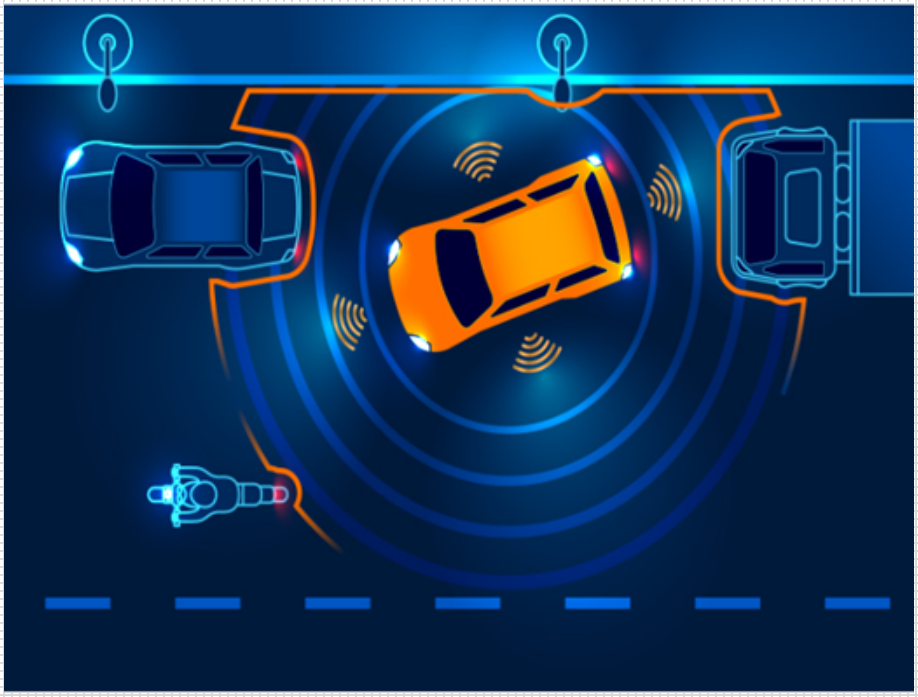

Autonomous Vehicle (AV) Study Update

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Prepared by the St. Lucie TPO

Prepared by the St. Lucie Transportation Planning Organization (TPO)

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AUTONOMOUS VEHICLES (AVs)

AVs have merged into the transportation system at a slower than anticipated pace. In 2021, the U.S. Department of Transportation (DOT) prepared the *Autonomous Vehicle Comprehensive Plan* to help stakeholders prepare for a revolution. Fast forward to 2024, and the complexity of AV technology is characterized by baby steps instead of revolutionary strides.

Major automakers who once pledged to produce AVs have walked back on these commitments. No automaker has produced a fully autonomous vehicle for mass consumption although many manufacturers are producing higher levels of automation. Following is a list of AV hierarchies:

Level 0 No driving automation, though the vehicle may have some automated features.

Level 1 Limited driver assistance. The car can control either speed or steering, but not both at the same time. An example is cruise control.

Level 2 Automated cars can control both speed and steering at the same time, but only under certain conditions. The driver must remain ready to take over driving if needed.

Level 3 The car is able to drive on its own under certain conditions but will alert the driver of the need to take control.

Level 4 The car is able to handle most normal driving conditions. If the car encounters a situation it cannot handle, the car will pull over or stop.

Level 5 The car can drive itself in all conditions.

Currently, the most advanced passenger AVs exist in the form of robo-taxis.

ROBO-TAXIS

Robo-taxis are generally Level 4 autonomy vehicles travelling within geofenced areas relying on maps provided by a transportation company. These maps are kept current with assistance from the vehicle itself, which reports back on roadway conditions.

Waymo and Cruise are leading players in the field of robo-taxis. The companies are at different stages of deployment and have different approaches to technology and testing.

Waymo, a subsidiary of Alphabet Inc., has been testing autonomous vehicles for over a decade. These vehicles have accumulated millions of miles in both simulated and real-world conditions. Waymo vehicles are equipped with an array of sensors, including LiDAR, radar, and cameras, and use a sophisticated AI (artificial intelligence) system to navigate and make decisions. As Waymo describes the process, the robo-taxi dubbed Waymo Driver ". . . understands how a car moves differently than a cyclist, pedestrian, or other object, and then predicts the many possible paths that the other road users may take, all in the blink of an eye."

Cruise, owned by General Motors, is also heavily invested in autonomous vehicle technology and has been testing its vehicles extensively, particularly in San Francisco. Cruise vehicles also use a comprehensive suite of sensors and AI to navigate and operate safely.

Cruise is known for its focus on urban environments and complex driving scenarios. Because Cruise has been actively testing its vehicles in dense urban areas, unique challenges arise. Consequently, the company has reported a variety of safety incidents.

Cruise recently paused all its driverless operations after a series of safety incidents in California. The California Department of Motor Vehicles (DMV) subsequently suspended Cruise's autonomous vehicle deployment and driverless testing permits. The DMV provided Cruise with the steps needed to apply to reinstate its suspended permits. Cruise has since resumed limited operations albeit with enhanced safety procedures. Uber recently announced a partnership with Cruise.

Waymo has reported relatively low numbers of safety incidents and has an extensive safety and testing program. Waymo currently offers rides in driverless passenger cars in several major cities, mostly on city streets, but testing is occurring on freeways as well. Uber recently announced a partnership with Waymo.

Tesla is poised to enter the robo-taxi space with Elon Musk, Tesla's CEO, touting a major announcement coming in early October 2024.

Musk has spoken about Tesla's potential to launch an autonomous ride-hailing service. This service would allow Tesla owners to earn income by having their vehicles operate as self-driving taxis when not in use. Tesla's robo-taxi concept would rely on Tesla's FSD (Full Self Driving) technology and is aimed at creating a network of autonomous vehicles that can provide transportation services on demand.

AV SHUTTLES

Whereas robo-taxis operate similar to Uber or Lyft, AV shuttles operate more like fixed-route buses, running along specified routes and stopping at specified locations. AV shuttles operate throughout the nation including in St. Lucie County. The St. Lucie County shuttle is called TIM (Tradition in Motion).

Tradition in Motion (TIM)

Beep, the operator of TIM, is an autonomous mobility solutions provider of driverless shuttles and fully managed services in both private and public communities. According to Beep's website, the personnel in Beep's Command Center located in Orlando continuously monitor the movement and operation of their shuttles nationwide using cameras installed inside and outside the shuttles. Human attendants onboard can communicate with the command center at any time should the need arise. The vehicles are 100-percent electric with no steering wheel or pedals and can travel up to 15mph.

TIM has operated in the Tradition area of Port St. Lucie, which is west of I-95 generally between Crosstown Parkway and Becker Road. Tradition is a master planned community consisting mostly of single-family homes and townhouses with several large apartment complexes, and commercial plazas. The TIM network is part of Tradition's larger plan called the T-Trail, which will consist of miles of trailheads for shuttle riders, bicyclists and pedestrians.

AUTONOMOUS TRUCKING

The first widespread deployment of driverless technology was initially assumed to be ride-hailing but self-driving trucks are now poised to become the first driverless vehicles deployed in significant numbers on public roads.

Whereas robo-taxis generally start out with a human operator onboard, autonomous trucks tend to be operated remotely, controlled from other sources such as satellites and GPS. A device implanted in the truck allows a human operator to "see" and control the truck's movements.

Economic incentives exist to develop autonomous trucking, among them a shortage of truck drivers, a shortage that is forecast to worsen. A factor in this shortage is the challenge of being away from home for extended periods on long-haul routes. Although autonomous trucking is expected to benefit long-haul trucking there is expected to remain a need for drivers to deliver goods and services locally.

Autonomous trucks are already appearing on highways in some stage of testing. According to the National Conference of State Legislators, Florida is one of 29 states that have enacted legislation related to testing autonomous trucks.

Autonomous technology will create efficiencies by allowing for truck platooning: convoys of trucks spaced much closer together than would be permitted with full human control. According to a Library of Congress research guide, "By 2027 fully autonomous trucks, including truck platoons of two or more trucks in which all trucks have a driver, but only the driver of the lead truck has full control of the vehicle, are anticipated to appear on highways."

A few companies are frequently cited as front-runners in the autonomous trucking space. These include Aurora, Plus.ai, Gatik, and Kodiak Robotics. Each of these companies is leading in different aspects of autonomous trucking technology, and their leadership status can vary based on specific criteria such as technology readiness, deployment scale, and industry partnerships. As technology continues to evolve, these leaders may shift, as new contenders enter the field and existing contenders drop out. Both Aurora and Kodiak Robotics claim they will have driverless trucks on highways within the next year.

Texas, a hub of AV trucking, can provide lessons learned to other states in their acceptance of the technology. Many factors have drawn AV trucking operators to Texas. These include business-friendly regulations, workforce capabilities, vast highway infrastructure, multimodal freight activities, strong research and development community, encouragement of public-private partnerships, and favorable weather conditions.

Texas embraced AV innovation early on. The state legislature passed its first regulation of autonomous vehicle technology in 2017. A statewide task force was created that provides Texans with a single, unified source of information regarding the coordination and advancement of automated technologies across the state. Members of the task force include representatives from other state agencies and public entities, as well as key industry stakeholders. The statewide task force now boasts numerous subcommittees.

Texas' location as a traditional transportation hub is yet another factor attracting autonomous trucking. The state is home to several truck routes between major cities that cannot be completed in a single day due to driver hours-of-service limitations. Such truck routes are especially suited for AV trucking.

DRIVER ASSISTANCE TECHNOLOGIES

Many of today's new vehicles feature "driver assist" capabilities that increase safety for drivers, passengers, and pedestrians. These technologies can steer, accelerate, and brake a vehicle autonomously. Some features are designed to warn of a crash while others are designed to take action to avoid a crash.

Today's driver assist technologies are designed with the assumption that the driver will continuously monitor the driving environment and will be prepared to take control of the vehicle as needed. According to the National Highway Traffic Safety Administration (NHTSA) "There are no vehicles available for purchase today that allow drivers to disengage from the driving task. Vehicles with partial automation capabilities are the highest level of automation that the public can purchase today."

NHTSA highlights the following types of driver automation assistance:

Forward Collision Warning

Detects a potential collision with a vehicle ahead and provides a warning to the driver. This is a NHTSA recommended safety technology.

Lane Departure Warning

Monitors the vehicle's position within the driving lane and alerts the driver as the vehicle approaches or crosses lane markers. This is a NHTSA recommended safety technology.

Rear Cross Traffic Warning

Warns the driver of a potential collision, while in reverse, that may be outside the view of the backup camera.

Blind Spot Warning

Warns of a vehicle in the driver's blind spot.

In addition to the above-described systems, there are partially automated systems that include features like adaptive cruise control and lane assist technologies.

According to a recent press release, NHTSA is developing proposed rule-making that would require automatic emergency braking (AEB) and pedestrian AEB systems on passenger cars and light trucks.

As described in the press release, an AEB system uses various sensor technologies and sub-systems that work together to detect when the vehicle is close to crashing, and then automatically applies the vehicle brakes if the driver has not done so or applies more braking force to supplement the driver's braking as necessary to avoid or mitigate the severity of the crash.

The proposed rule is expected to dramatically reduce crashes under certain conditions. NHTSA projects that this rule, if finalized, would save at least 360 lives a year and reduce injuries by at least 24,000 annually. In addition, these AEB systems would result in significant reductions in property damage caused by rear-end crashes. Many crashes would be avoided altogether, while others would be less destructive.

Source: GAO (photo). | GAO-24-106255

LONG RANGE TRANSPORTATION PLAN (LRTP) COMPLIANCE

AVs could lead to reductions in traffic congestion, increased mobility for all, and connectivity among vehicles and infrastructure. To reap these benefits, AV pilot programs are being established throughout the country.

The University of Oregon developed *Autonomous Vehicles: A Guidebook for Cities* as a tool to help stakeholders prepare for and respond to autonomous vehicle testing, pilots, and deployments in their respective jurisdictions. Stakeholders include the public, AV developers, state and local governments, and nonprofit organizations.

A key takeaway from the University's guidebook is that before launching any AV pilot program, stakeholders must determine if their goals and their community's vision align with AVs. In other words, do not adopt technology for technology's sake. The following section analyzes goals in the TPO's SmartMoves 2045 Long Range Transportation Plan (LRTP) which align with AV deployment.

Goal One: Support Economic Activities

Autonomous Trucking

Trucking supports local economies, and AVs would facilitate trucking. AV trucks could improve supply chain management and could allow vehicles to operate in complex environments 24/7.

Congestion is one of the highest costs for freight movement, and AVs could dramatically reduce congestion by enabling truck platooning which could reduce energy costs as well.

AV trucking could reduce labor expenses which could make business operations more productive.

Robo-taxis/AV Shuttles

AV shuttles/robo-taxis could promote increased access to goods and services.

The ability of AVs to reduce car accidents, injuries and fatalities could itself result in economic savings.

AVs will impact land use. Currently, a significant amount of land is needed for parking traditional autos when not in use. This land could be freed up for more productive purposes.

Since AVs tend to drive more efficiently than humans, AV shuttles/robo-taxis could potentially reduce traffic congestion. According to auto insurer Progressive, the most common causes of traffic congestion are car accidents, road debris, road construction, rush hours, and phantom traffic jams. Reduced traffic congestion generally leads to economic growth.

Driver Assistance Technologies

Driver assistance technologies hold the potential to reduce traffic crashes and save thousands of lives each year, the economic benefits of which are enormous. These benefits can be quantified in terms of insurance savings, reduced healthcare costs, and reallocation of emergency-related resources, among others.

Goal Two: Provide Travel Choices

Autonomous Trucking

Autonomous trucking will allow freight companies to operate vehicles 24/7 thus enabling them to avoid rush hours whenever possible. Fewer trucks on the road would lead to reductions in traffic congestion. Less traffic congestion would improve the range of travel times available to non-freight movement.

Robo—taxis/AV Shuttles

AVs could enable commuters to be productive while traveling, consequently resulting in greater control of personal time and choices for where people choose to work. With their abilities to operate 24/7, AVs would result in more flexibility in travel times and less congestion during commute hours, thus improving travel time reliability for all users.

Driver Assistance Technologies

Based on their improvements to safety, driver assistance technologies would support drivers in travelling during all hours of the day. For example, many senior drivers choose not to drive at night due to glare from oncoming headlights or streetlights or even during the day due to blinding sun. Driver assistance technologies also support drivers whose capacity to drive is diminished, for instance through fatigue or distraction.

Goal Three: Maintain the Transportation System

Autonomous Trucking

Most AVs are electric vehicles (EVs). A drawback of EVs is they generally weigh more than gas-powered vehicles, thus producing more wear and tear on roadways. This could result in greater deterioration of roadway surfaces and could also impact bridges, parking garages, parking lots, and driveways.

Robo-taxis/AV Shuttles

Robo-taxis/AV shuttles, being EVs, will produce more wear and tear on roadway infrastructure because EVs are generally heavier in weight than gas-powered vehicles. However, robo-taxis/AV shuttles could reduce the overall number of vehicles on the road, thus mitigating the impact of the added weight.

Driver Assistance Technologies

Driver Assistance Technologies will make driving easier, more efficient, safer, and more accessible. As driving becomes more efficient and safer more drivers will opt to drive, leading to greater deterioration of roadway surfaces.

Goal Four: Provide Equitable, Affordable, and Sustainable Urban Mobility

Autonomous Trucking

To the extent driverless trucks reduce shipping costs and to the extent those savings are passed on to consumers, driverless trucks could contribute to equity and affordability.

The sustainability aspect of driverless trucks relates to the potential for decreased gas consumption in their capacity as EVs.

In general, technology becomes more affordable as it matures, and it is conceivable that small trucking companies could eventually have driverless trucks in their fleets.

Because no human is needed behind the wheel to drive or operate these trucks and because there is a shortage of truck drivers, autonomous trucks could lead to goods being distributed in rural areas that previously were not served.

Robo—taxis/AV Shuttles

AVs could provide greater freedom for persons with disabilities, those without driver's licenses, older adults who can no longer drive, and for persons who simply choose not to drive.

In terms of affordability, owning a personal car is more expensive than the occasional use of Uber/Lyft, which in turn is more expensive than public transit.

AV shuttles, if more cost efficient than traditional transit, could benefit residents of rural areas, where the operation of traditional transit is cost prohibitive.

In terms of sustainability, in general, EVs are more environmentally friendly than their gas-powered counterparts.

Driver Assistance Technologies

A safer driving environment could encourage walking and bicycling, especially in historically disadvantaged communities where studies show that crashes involving vulnerable road users are more prevalent.

Automobile crashes themselves create huge economic burdens across a wide spectrum of society. Reducing this burden would be a social benefit.

Goal Five: Improve Safety and Security

Autonomous Trucking

Common causes of truck accidents are driver fatigue or driver distraction. By eliminating human factors, autonomous trucking could improve roadway safety. Autonomous trucks, being newer vehicles, also would benefit from the latest tech advances in safety that assist in crash avoidance and prevention.

Technology presents the challenges of cybersecurity and privacy concerns. Vehicle connectivity exacerbates these concerns. Vehicle connectivity is expected to be a hallmark of autonomous trucking. Connected vehicles use vehicle-to-vehicle, vehicle-to-infrastructure, and infrastructure-to-vehicle communication to exchange information between vehicles, drivers, the roadside, bicyclists and pedestrians. To earn public trust, cybersecurity and privacy concerns due to vehicle connectivity must be addressed.

Robo-taxis/AV Shuttles

AVs could improve safety by eliminating human error, the main cause of car accidents. Robo-taxis/AV shuttles could further enhance roadway safety by virtue of getting more cars and drivers off the roads.

Security is more problematic. AVs are expected to be connected vehicles, a connectivity which relies on computer software. All software is vulnerable to interference by bad actors. On the other hand, gas-powered vehicles are becoming increasingly connected, so this vulnerability would not be limited to AVs.

Driver Assistance Technologies

Automobile manufacturers are making continuous improvements in safety, resulting in newer vehicles being safer than older vehicles. When driver assistance technologies are made mandatory, the safety gap between older and newer vehicles will widen.

The extent to which driver assistance technologies are wireless could present cybersecurity issues. These issues could be mitigated by proactive security enhancements.

AV BENEFITS/DISADVANTAGES

Autonomous trucking benefits:

- Cost savings due to more efficient deliveries
- Reduced pollution due to more efficient deliveries
- Increased safety due to reduced chance of human error
- Reduced fuel consumption due to truck platooning which reduces wind resistance
- 24/7 operations
- Connectivity among vehicles and infrastructure

Autonomous trucking disadvantages:

- Job losses in certain categories
- Implementation expense
- Obsolescence due to rapid changes in technology
- Cybersecurity risks
- Computer malfunction risks
- Delays resulting from AV's inability to react appropriately under novel driving conditions

Robo-taxis/AV Shuttles advantages:

- Help seniors stay independent
- Help persons with disabilities achieve independence
- Reduce the number and duration of traffic jams
- Improve safety since most traffic accidents result from human error
- Decreased fuel consumption since most AVs are electric
- Lower transportation costs due to reductions in human labor costs
- Improved connectivity among vehicles and infrastructure
- Reduced strain on the healthcare system due to fewer traffic accidents

Robo-taxis/AV Shuttles disadvantages:

- Elimination of certain jobs
- Social isolation for passengers who value driver interaction
- Delays since AVs may not react appropriately under novel driving conditions
- Potential disruptions to emergency vehicles
- Cybersecurity risks
- Higher initial costs

Driver Assistance Technologies benefits:

- Improved traffic safety
- Reduced fuel consumption in their capacity as newer vehicles
- Decreased insurance costs
- Increased mobility

Driver Assistance Technologies disadvantages:

- Decreased driver awareness of surroundings
- Potential for computer malfunctions
- Increased manufacturing costs
- Potential for distracted driving

RECOMMENDATIONS

Although AV deployment is driven by the private sector, governments are partners in the process. Governments can provide guidance, implement best practices, conduct research, initiate pilot programs, and develop assistance to help stakeholders plan and make the investments needed to be proactive about technology.

Technology, especially in its beginning stages, has its fair share of issues and concerns. Even in its mature stages, technology solves certain problems and creates others. Therefore, the pros, cons, and unintended consequences of AVs must be monitored. Considerations that merit further study by governments include:

- Safety for all road users
- Shifts in travel behavior and mode choice
- Environmental justice and affordability
- Transportation network impacts
- Land use impacts
- Energy use
- Emergency services impacts
- Workforce impacts
- Regulatory frameworks