**Autonomous Vehicles**

**What Does it do**: - An autonomous vehicle is a vehicle that can drive itself without input from a human driver. There are several types of self-driving vehicles depending on their level of automation. These levels have been defined by Society of Automotive Engineers (SAE) which has set 6 of them adopted by U.S. department of Transportation ranging from level 0 (fully manual) to level 5 (fully autonomous). In some ways the story of the autonomous vehicle is a tale of technological evolution that is yet not finished, a gradual advance of integrated artificial intelligence services and sensor-based driver features that may or may not eventually replace human drivers entirely.

Level 0 (No Driving Automation); - Most vehicles on the road today are level 0 manually controlled. The human provides the dynamic driving task although there maybe systems in place to help the driver. An example would be emergency braking system, since it technically doesn’t drive the vehicle. It does not qualify as automation.

Level 1 (Driver Assistance): - This is the lowest level of automation. The vehicle features a single automated system for driver assistance such as steering or acceleration (cruise control). Adoptive cruise control where the vehicle can be kept at a safe distance behind the nest car, qualifies as level 1 because the human driver monitors the other aspects of the driving such as steering and braking.

Level 2 (Partial Driving Automation): - This means advanced driver assistance systems or ADAS. The vehicle can control steering and accelerating/deaccelerating. Here the automation falls short of self-driving because the human sits in the driver’s seat and can take control of the car at any time. Tesla autopilot and Cadillac (General Motors) Super cruise control systems both qualify as level 2.

Level 3 (Conditional Driving Automation): - The jump from level 2 to level 3 is substantial from a technological level but subtle if not negligible from a human perspective. Level 3 vehicles have environmental detection capabilities and can make informed decisions for themselves, such as accelerating past a slow-moving vehicle but the still require human override. The driver must remain alert and ready to control if the system is unable to execute the task.

Level 4 (High Driving Automation): -The key difference between Level 3 and Level 4 automation is that Level 4 vehicle can intervene if things go wrong or there is a system failure. In this sense these cars do not require human interaction in most circumstances. However, a human still has the option to manually override. Level 4 vehicles can operate in self driving mode but until legislation and infrastructure are in place, they can only do so within a limited area which is known as geofencing. Navya a French company is already building and selling level4 shuttles and cabs in US that run fully on electric power. Alphabet’s Waymo recently unveiled a level 4 self-driving taxi service in Arizona.

Level 5 (Full Driving Automation): - Level 5 vehicles do not require human attention, the dynamic driving task is eliminated. Level 5 cars won’t have even steering wheel or accelerator and braking pedal. They will be free from geofencing, able to go anywhere and do anything that an human driver can do. Fully autonomous cars are undergoing testing in many pockets of the world, but none are yet available to general public.

Autonomous cars rely on presence of sensors situated in various parts of the vehicle to sense their surroundings. Lider is mostly used for ranging purposes, measure distances, identify lane markings and anomalies such as holes and pits on the road. Radars are used to track other vehicles, while video cameras, while video cameras can be used to read road signs and detect traffic lights. Advanced AI powered software will then process all those inputs coming from sensors and generate instructions to the car’s actuators to plot paths, control steering, braking and acceleration or dodge obstacles.

**What is likely impact**: - Although AVs alone are unlikely to have significant direct impacts on energy consumption and GHG emission when AVs are effectively paired with other technologies and new transportation models, significant indirect and synergistic effects on economics, the environment and society are possible. One study found that when eco driving platooning, intersection connectivity and faster highway speeds are considered direct effects of connected and automated vehicles. Energy use and GHG emissions can be reduced by 9%. There are many other impacts are predicted are as below.

Congestion is predicted to decrease, reducing fuel consumption by 0-4%, however decreased congestion is likely to lead to increased vehicle miles travelled, limiting the fuel consumption benefits.

* Eco driving a set of practices that reduces fuel consumption are predicted to reduce energy consumption by up to 20%.
* Platooning of detached vehicles that collectively travel closely together is expected to reduce energy consumption between 3-25% depending on vehicles and their characteristics.
* Vehicle performance such as fast acceleration is likely to become de emphasized potentially leading to 5-23% reduction in fuel consumption.
* Improved crash avoidance systems will reduce the likelihood crash occurrence allowing for reduction of vehicle weight and size decreasing fuel consumption between 5-23%
* The ability to match the utility of a vehicle to given need has the potential to decrease energy consumption between 21-45%
* Increased highway speeds are likely due to improved safety increasing fuel consumption by 7-30%
* AVs are predicted to reduce the cost of travelling due to decreased insurance cost.
* AVs are likely to add new user groups especially elderly and disabled users and can increase fuel consumption through new users by 2-10%
* Ride sharing on demand business models are likely to utilize AVs due to significant reduction of labour costs. This model is estimated to reduce energy consumption by 0-20%

Although an accurate assessment of these interconnected impacts can not currently be made one study revealed the potential impacts of four scenarios each with unlikelihood. The most optimistic scenario projected a 40% decrease in total road transport energy and most pessimistic scenario projected a 105% increase in total road transport energy.

**How will this affect Us**: -While the future of autonomous vehicles is promising and exiting mainstream production is still a few years away from anything higher than level 2 not because technological capabilities but because of security or the lack thereof. Earlier this year Ponemon Institute published a report titled “Securing the connected car: A study of Automotive Industry Cybersecurity Practices” the report found that connected vehicles like autonomous cars are rich in physical safety features such seatbelts, airbags, antilock brakes but not so rich in digital features. When it comes to what’s needed for safe operation in an online world connected cars are not yet ready for prime time.

The report is based on a survey of 593 security practitioners, product development professionals and engineers. More than two thirds of respondents acknowledged that the need for better cybersecurity is urgent for obvious reasons. 62% said they think a malicious or proof of concept attack against automotive software/components is very likely in the next 12 months.

It’s fair to say that consumers will not accept autonomous cars unless they are confident that they will be at least as safe as they would be on a commercial jet, train or bus. The day is coming but automotive industry must get over a few speedbumps first.

Some of the technologies required for build a functional self-driving car are very expensive, making the final cost of each vehicle prohibitive for the general public. Radar and Lidar work for prototypes but if mass production is achieved their signals and frequency might interfere with each other.

Many anomalous conditions such as snow, debris or oil may represent a significant challenge whenever they cover lane markings and dividers. Also, it’s still early to trust AI to be smart enough to make consistent decisions or split-second judgement calls in life and death scenarios, such as when a pedestrian suddenly transverses the road after steep turn.

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