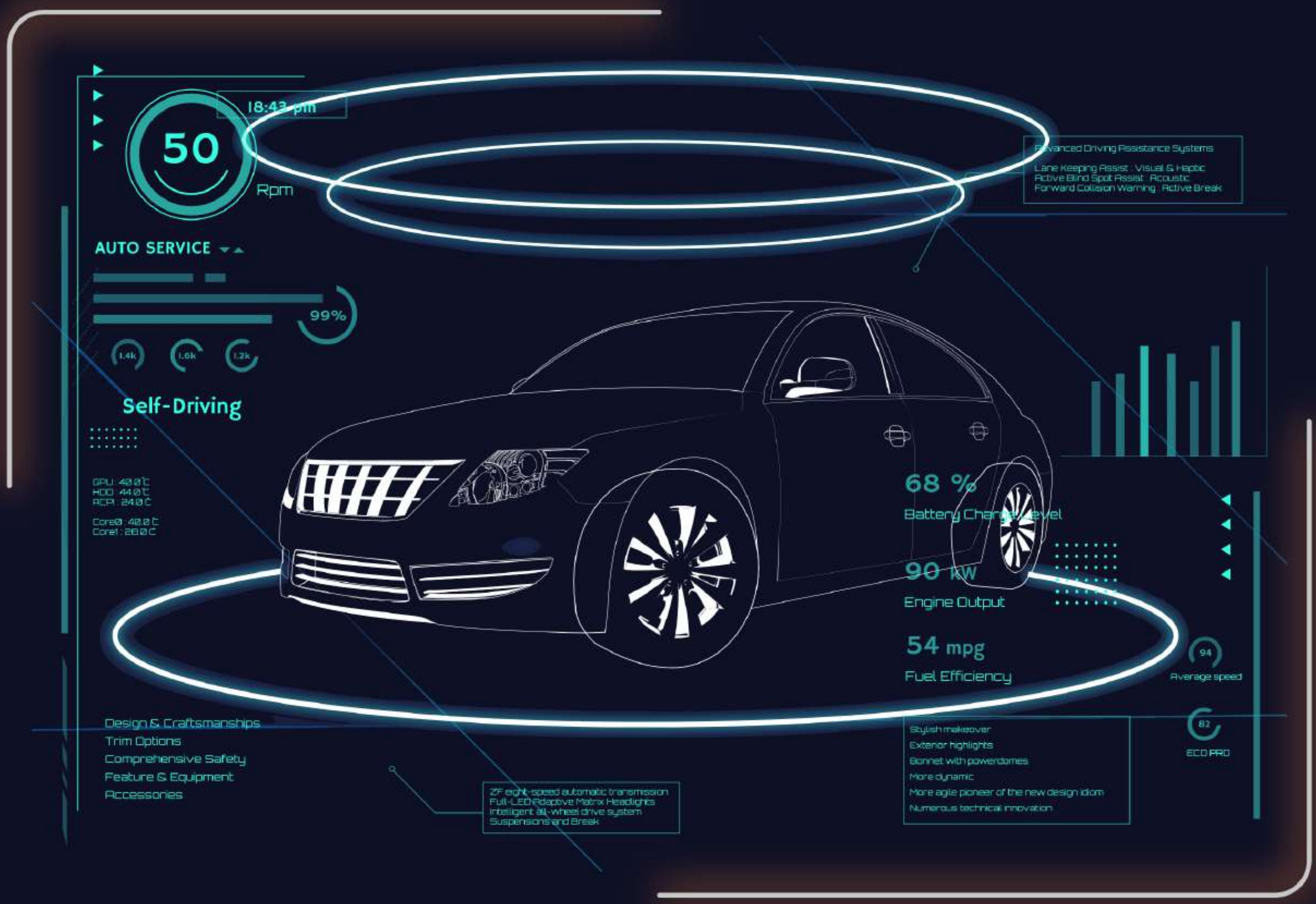
THE FUTURE OF INTEGRATED MOBILITY ECOSYSTEM



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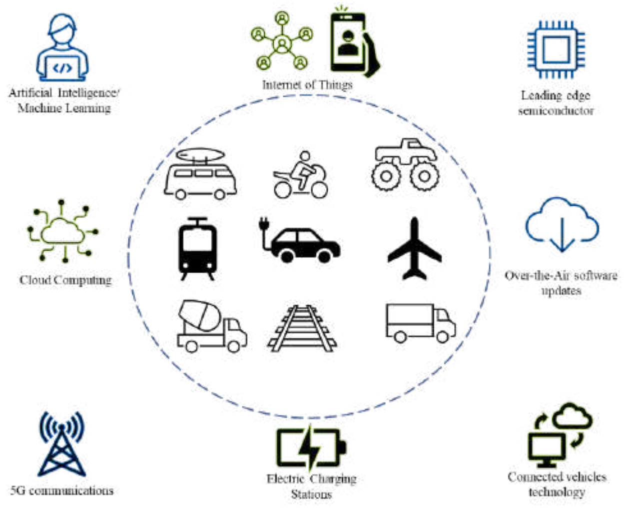
The Future of Integrated Mobility Ecosystem

Executive Summary

The Automotive industry is at the confluence of countless technologies and advancements made in related and disparate fields creating a future that eases present day human lives and solves problems of climate change and road accidents. Progress has been made in the areas of autonomous vehicles, electric vehicles, connected vehicles and mobility as a service over the last decade, with recent developments around the application of merging technologies. Autonomous electric vehicles are the most common applications of merged technologies today, with shared autonomous vehicles and connected autonomous vehicles also in use.



While we envision a future of the automotive industry evolving into a self-sustaining ecosystem, a lot needs to be done in terms of infrastructure, cyber security, determining the liability, and avoiding misuse of the ecosystem. This will require newer regulations, significant investments into research, incentives from the governments, and significant trials to support these. Pacing the robust testing of newer features and their rollout will ensure that it meets most of the mobility needs.

Introduction to the Future of Integrated Mobility Ecosystem

The problems in the current system of mobility are many, which are only going to get worse unless there are structural changes in the entire ecosystem of transportation. By integrating all the advancements made in autonomous vehicles, fully electric vehicles, connected vehicles, and shared mobility, along with newer technologies in the fields of communications and cloud computing, we can create an ecosystem of self-sustaining mobility solutions. This ecosystem would encompass all forms of transport and aid in freight mobility solutions, dynamic parking, analytics-based ride-sharing, and the use of big data in traffic signal management and public transport management. Harmonizing these technologies, however, need significant investments, tax breaks from the governments, and strong infrastructure.

Congested roads and Traffic Jams

Polluted cities with emissions from vehicles

High number of road accidents and deaths

The following industries could be impacted either directly or indirectly – technology, auto OEMs, metals, telecommunications, semiconductors, insurance, airlines, and energy generation companies.

Technologies shaping the Mobility Ecosystem

Autonomous Vehicles - A critical driver of the changing mobility ecosystem

Also known as self-driving cars, these run and operate without human drivers creating more free time and they play a critical role in ensuring robust road safety and better management of traffic and road usage. Autonomous vehicles (AVs) ensure better mileage by being in use throughout, also reducing the parking needs.

Since AVs must instantly process and react to changes in its surrounding, such as a sudden stop of a nearby car or a pedestrian crossing road, they are equipped with a complex, centralized electrical and electronic architecture (E/E) that comprises of various sensors, high-performance processors, and actuators (Image (a)).

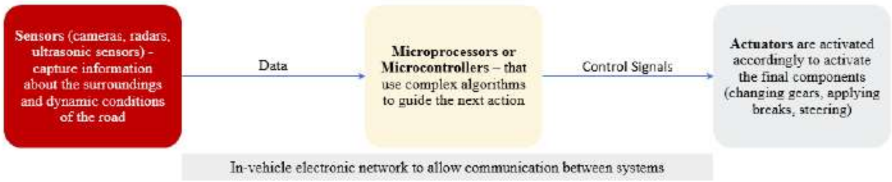


Image (a)

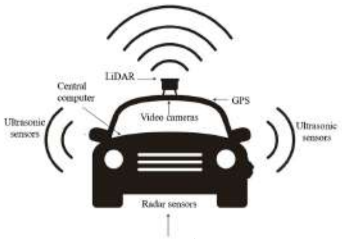


Image (b)

Society of Automotive Engineers (SAE) classification system, used globally, describes AVs based on the degree of automation to perform dynamic driving task (DDT) on a sustained basis.

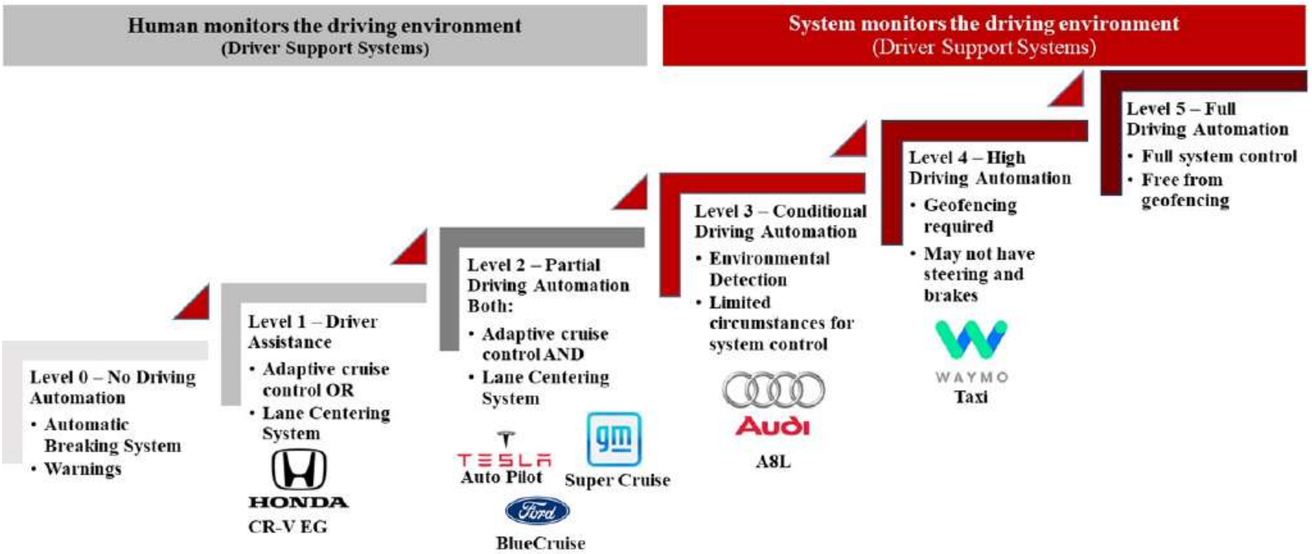


Image (c)

The US currently has Level 2 cars in mainstream production with higher levels not yet allowed by the regulators. Interestingly, in Europe, Level 3 cars can operate given they pass the regulatory requirements.

Electric Vehicles are a key step towards sustainability goals

An electric vehicle (EV) does not burn fuels such as oil and gas and runs on batteries. They are manufactured or prototyped by all the major Original Equipment Manufacturers (OEMs) including the traditional internal combustion engine (ICE) ones. What makes EVs attractive is their simplicity with fewer components needed to build, consisting of batteries, electric motors attached with one or more wheels or axles, and a drivetrain.

Governments around the world have implemented incentives and tax breaks for EV manufacturers, with the UK planning to ban the sale of ICE vehicles by 2030. Falling prices of batteries make EVs price competitive with ICE vehicles. Lithium-ion battery average prices declined from over $1200/ kWh in 2010 to $132/ kWh in 2021 and are estimated to drop to below 100/ kWh by 2024.[1] Next- generation battery technologies such as silicon or lithium anodes, solid-state batteries and improved cell manufacturing processes are expected to bring the rates lower. Key trends in this space - battery manufacturing moving closer to vehicle assembly plants, especially in Germany, the UK, and France; OEMs integrating backward to have battery packs and cell production in-house.

Connected Vehicles communicating with their outer environment

According to the World Health Organization (WHO), annual traffic accidents account for 1.3 million and is a primary cause of death among people aged 5–29 years.[2] Connected vehicles (CVs) create new data-rich environments that enable many applications to make roads safer, less congested, and more eco-friendly. A connected vehicle can connect wireless networks to nearby devices. CV is an Internet of Things (IoT) technology and part of the Intelligent Transportations Systems, a U.S. government initiative. One of the primary use cases for the IoT car is safety via rapid vehicle-to-vehicle and vehicle-to-roadside unit communications (also known as V2X). Other applications include connected in-vehicle infotainment (IVI) systems, real-time navigation and routing, traffic information, safety warnings, accident avoidance, advanced driver-assistance systems (ADAS), automated driving systems (ADS), remote diagnostics.

The US dominates the global CV market due to its well-established networking infrastructure, followed by China and Europe. In 2021, over 90% of the cars shipped in the US had in-built connected features.

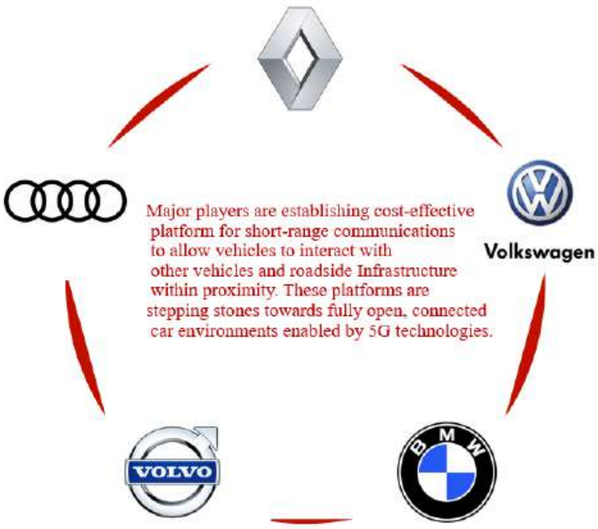


Image (d)

1. Bloomberg NEF report, 2021
2. WHO report - Road Traffic Injuries, 2021

While the latter half of the 20th century in North America and Europe emphasized personal vehicle ownership and usage in passenger transportation, innovations in information communication technology (ICT) have brought forth various modes beyond the traditional modes of road transport. This is all done using internet-enabled smartphones, tablets, and IoT devices.

The impacts of shared mobility have been documented worldwide, including cost savings and convenience, reduced vehicle miles travelled (VMT) as well as reduced greenhouse gas (GHG) emissions. Moreover, there are often economic benefits to shared mobility, such as increased economic activity near multimodal hubs.

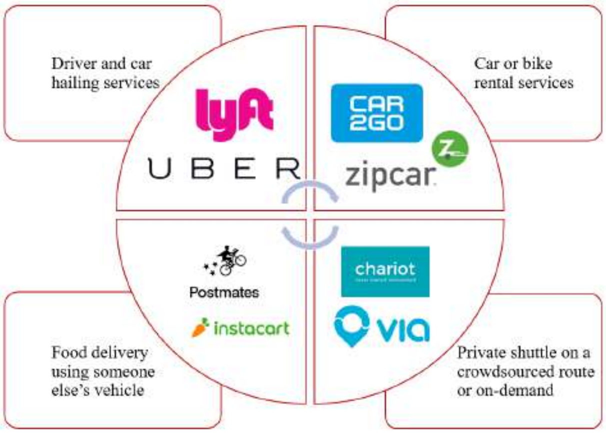


Image (e)

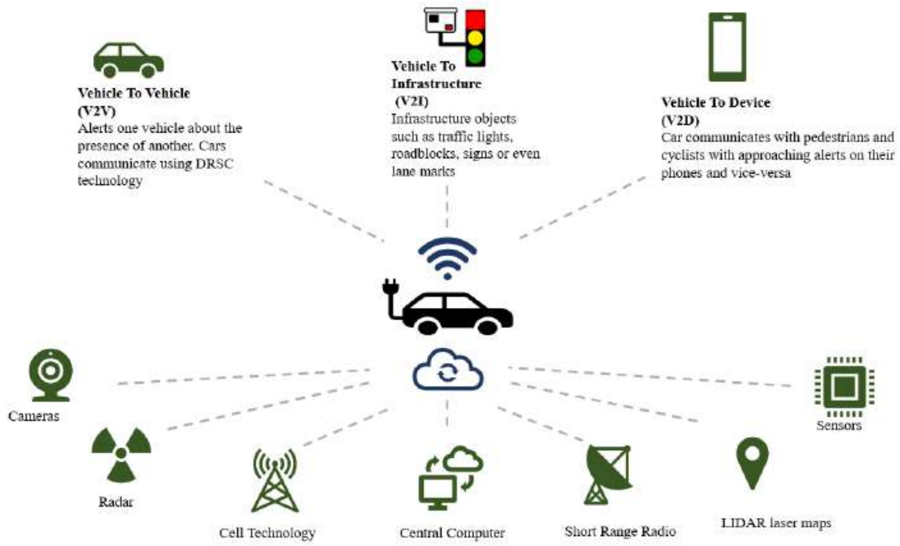
Combined Technologies in Action

Shared autonomous vehicles (SAVs), or robo-taxis, in the future, would replace a lot of private vehicle ownership. Most OEMs, suppliers, technology players and start-ups are testing large fleets of SAVs with planned launches in a few years for geofenced areas. The SAVs are expected to cannibalize many of the miles travelled today and free up parking spaces. There is a need for maturity in ridesharing and autonomous vehicles technologies, along with reduction in prices for mass adoption. The most advanced robo-taxis (Level 4) operate in limited conditions and in geofenced areas.

Image (f)

Connected autonomous vehicles (CAVs) Most of the advanced crash avoidance technologies present on vehicles today not only include on-board sensors, cameras, but they also communicate with their environment. These technologies alert drivers or car systems of impending danger based on the feedback received from other vehicles in their vicinity. V2V communications use on-board dedicated short-range radio communication devices to transmit messages about a vehicle's speed, heading, brake status, and other information to other vehicles and receive the same information from the messages, with range and 'line-of-sight' capabilities. CAVs can be controlled by a central monitoring system with respect to speeds, lanes, and sharing of information on blocked roads and unsafe pathways. GM has launched a 'digital nerve system' which allows over-the-air software updates at 4.5 terabytes per-hour.[1]

1.MDPI report, 2021



Autonomous electric vehicles (AEVs) are the most common applications with Tesla and traditional OEMs, such as General Motors, Ford, Volkswagen, making AEVs commercially available in major cities. Apple is aiming to launch an AEV by 2025. In addition, Volkswagen aims to launch a self-driving electric van in 2025 and Volvo expects to sell one million Level 4 autonomous vehicles by 2025. AVs are also in use in industrial settings in mining and farming with highway trucks, logistic vehicles, and construction equipment being next in line.

Future Possibilities and Endless Potential of Technologies in play

Future Possibilities on display

Consumer Electronics Show (CES), an annual trade fair, showcases the latest trends and innovations in the automotive industry. The new prototypes demonstrated here often become lenses for future possibilities. Both technology firms and traditional OEMs have been in a race to maximize intelligence in their vehicles.

- BMW's Vision iNext replaces all car buttons with voice, touch, and gesture controls
- Toyota's Guardian tech instantly shifts modes in case of an impending crash between human and system
- Chip-making companies, NVIDIA, Qualcomm and Samsung have custom-made advanced automotive cockpit chips. Samsung has a digital assistant for cars that connects to and controls smart home devices.
- Mercedes-Benz displayed Vision AVTR inbuilt with biometrics that will track a passenger's pulse or heartbeat. It also showcased a 56-inch OLED 'Hyper screen' supported by 8 CPU cores
- Hyundai plans to have solar panels installed on the highly efficient Sonata car roofs
- Visa and SiriusXM launched a car as a payment system to pay for food, tolls, fuel
- Panasonic's Augmented Reality technology for windshields has markers on the windshields
- Harman (a Samsung company) will have live concerts experience in cars with in-built 5G, OLED, interactive lighting, high-tech audio

Vehicles of the future will be software-centric than hardware-based. Just like smartphones, the cars will receive over-the-air updates for routine maintenance and adding of new features.

Merging autonomous, connected vehicles, electric vehicles, shared mobility (ACES) technologies to bring about a master aggregator of transportation services, called a 'mobility manager' is the answer to hazardous pollution levels, a high number of road accidents and deaths, congested roads, and lack of parking spaces. The new mobility solution would encompass cars, rails, bikes, busses, planes, commercial trucks, freight, and logistic vehicles and would be managed by a central operator hosted by humans with detailed control systems. The mobility manager would plan the journey for a passenger based on the preferences set and usage history, as shown in Image (g). This, when implemented on a mass scale would end the current trend of private vehicle ownership to move to a shared model of travelling that is cheaper, convenient, and highly customizable. Services would range from value to premium, upscale to luxury and could mirror the first-class and economy class travels of an airplane.

The ecosystem would also save many lives in case of accidents or emergencies by alerting the nearby vehicles, hospitals and city authorities for timely assistance. One such example is covered in Image (h).

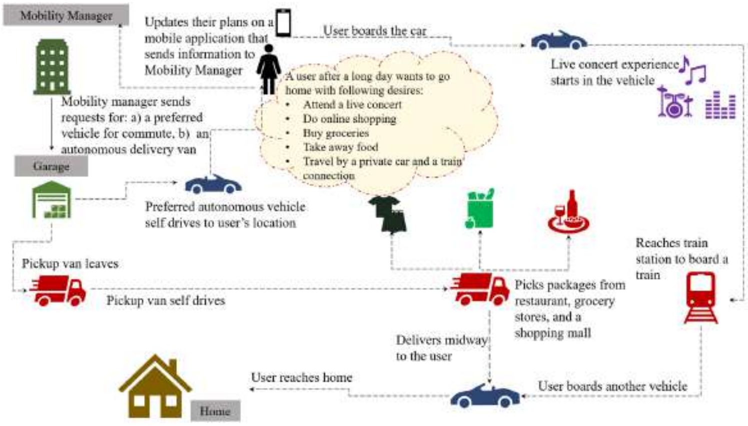


Image (g)

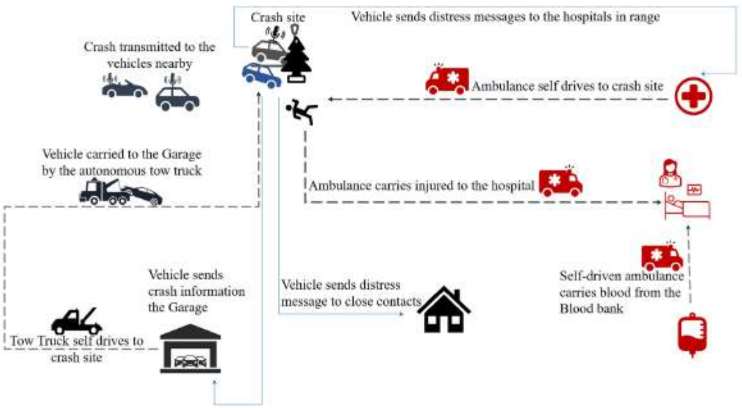


Image (h)

Such an ecosystem entails many benefits. Firstly, the cars would be utilized to full capacity that can self- drive to a desired location without sitting in the garages post their use. With only autonomous vehicles running on the roads, they can run much faster. Secondly, massive parking real estate could be unblocked with an organized system to manage idle cars. These cars in the parking spaces could be stacked closer and plugged into an electric grid for recharging of their batteries. Moreover, with immersive cockpit technologies, one can now have live experiences of concerts, sports, and other events in vehicles. Finally, if combined with drones, this ecosystem would ensure faster and secure delivery of goods. It would also aid city planners in designing the public transport system, as well as benefit different service providers.

As concepts, there are several possibilities for the next two decades. Cars could become pods with wheels that could latch on to a larger vehicle once they hit the highways and be carried with the other pods at a much faster speed. They could dislodge themselves from the larger engine as they start to exit the highways for their destinations. This, if implemented, would maximize the utilization of the highways, without any collisions.

Roadblocks in realizing the full potential

Technological robustness

The foremost challenge is guaranteeing the safety of everyone around an ACES vehicle, which must react instantly to unexpected changes in its vicinity and have instant communication with the infrastructure. The current Level 2 AVs have had instances of unaware drivers and systems injuring pedestrians fatally. System algorithm training is needed on copious amounts of data for all kinds of roads and all the weather conditions.

Cybersecurity

Passenger data could be hacked by other parties or governments for their own benefit. Current regulations require manufacturers to manage vehicle cyber risks by securing vehicles to mitigate risks along the value chain and providing secure software updates on a legal basis. However, it needs regular updates and modifications.

Insurance liability

One of the controversial topics is determining the liability in case of accidents. While some driver assistance systems let humans take control of the car, most Level 4 and Level 5 cars lack steering wheels and braking pads. Moreover, human drivers in such cases would be in a relaxed state to react to any sudden events. With V2V and V2X too, accidents due to delay in communication can create issues in determining the liable parties.

Regulations

Regulations need to be supported through years of data in all scenarios and situations to arrive at statistical conclusions about safety. Jurisdictions must allow investments and incentives for more research and use cases.

Infrastructure

None of these would inspire demand from users unless there is a resilient infrastructure in place that ensures wide availability of charging stations, ultra-fast & reliable network coverage, and seamless integration of systems.

Our Verdict

The current state of automotive technology and constant development in technologies for AVs, EVs, and CVs has enabled endless future possibilities of better connectivity and safety, and greater economic opportunities. An integrated mobility model has the potential to match the impact the smartphone has had over the last decade. Improvements made in sensors, radio signals, cameras, communications, and the cloud have been a catalyst for change, yet a lot needs to be resolved in terms of roll-out plans by OEMs and governments. The introduction of such a platform cannot be rushed and requires cooperation from regulatory bodies.

List of Abbreviations

- ACES - Autonomous Connected Electric Shared
- ADAS - Advance Driver Assistant Systems
- ADS - Automated Driving Systems
- AEV - Autonomous Electric Vehicle
- AVs - Autonomous Vehicles
- BEV - Battery Electric Vehicles
- CAVs - Connected Autonomous Vehicles
- CVs - Connected Vehicles
- DDT - Dynamic Driving Task
- DSS - Driver Support System
- E/E - Electronic Architecture
- EVs - Electric Vehicles
- GM - General Motors
- ICE - Internal Combustion Engine
- LIDAR - Light Detection and Ranging
- OEMs - Original Equipment Manufacturers
- O.T.A - Over the Air
- SAVs - Shared Autonomous Vehicle
- VKT - Vehicle Kilometer Travelled
- V2V - Vehicle to Vehicle
- V2I - Vehicle to Infrastructure
- IoT - Internet of Things

Sources

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