ON TRACK WITH SELF-DRIVING VEHICLES 2.0

Whitepaper

JUNIPER RESEARCH

1.1 Introduction & Definition

AVs (Autonomous Vehicles) are being heralded as a way of greatly improving road safety and reducing accidents, the vast majority of which are caused by human error, as well as alleviating the tedium of driving in heavy traffic and providing increased mobility for the elderly or disabled.

Full AVs (fully Autonomous Vehicles) may not be in the showrooms in large numbers any time soon, but much of the technology that makes them work is available in many of today's new cars, including:

- ACC (adaptive cruise control) with automatic braking;
- pedestrian detection systems;
- lane change warning systems;
- hands-free parking systems.

Many of the luxury brands have also introduced so-called semi-autonomous systems such as Highway Pilots or Traffic Jam Assistants, where the vehicle drives itself under certain limited conditions.

ADAS (Advanced Driver Assistance Systems) are the core elements of AVs and their adoption in normal production cars is increasing rapidly, driven primarily by more stringent safety specifications from organisations such as Euro NCAP.

1.1.1 Definition & Classification

Juniper Research defines an AV as:

A vehicle with the ability to drive from one destination to another with minimal or no human interaction during the journey.

AVs, sometimes referred to as driverless vehicles, have been in development since the 1980s. For example, some of the key AV technologies were developed as part of the Eureka PROMETHEUS Project in 1987 and included the development and demonstration of V2V (Vehicle-to-Vehicle) connectivity.

1.1.2 AV Classification

In the US, the NHTSA (National Highway Traffic Safety Administration) has proposed a formal classification system for automated vehicles based on 5 levels. An alternative classification system based on 6 different levels (ranging from driver assistance to fully automated systems) has been published by the American automotive standardisation body, the SAE (Society of Automotive Engineers). In contrast to the NHTSA classification, the SAE system is based on the amount of driver intervention and attentiveness required, rather than the vehicle capabilities, although these are very closely related.

The classifications are shown in detail in the table below.

Table 1: Autonomous Vehicle Classifications According to the NHTSA & SAE

Level	NHTSA	SAE
Level 0	The driver completely controls the vehicle at all times.	Automated system has no vehicle control, but may issue warnings.
Level 1 (Feet-off)	Individual vehicle controls are automated, such as ESC (electronic stability control) or automatic braking.	Driver must be ready to take control at any time. Automated systems include: ACC, Parking Assistance with automated steering and LKA (Lane Keeping Assistance), Type II in any combination.
Level 2 (Hands-off)	At least 2 controls can be automated in unison, eg ACC with LKA.	Driver is obliged to detect objects and events and respond if the automated system fails to respond properly. Automated system controls acceleration, braking and steering and can deactivate immediately upon takeover by driver.
Level 3 (Eyes-off)	Driver can cede control of all safety-critical functionS in certain conditions. The car senses when conditions require the driver to retake control and provides a 'sufficiently comfortable transition time' for the driver to do so.	Within known, limited environments (eg motorways), the driver can safely turn their attention from driving tasks.
Level 4 (Mind-off)	Vehicle performs all safety-critical functions for the entire journey with the driver not expected to control the vehicle at any time. Vehicle capable of travelling with or without driver.	Automated system can control the vehicle in all but a few environments such as severe weather. Driver must enable the automated system only when it is safe to do so. When enabled, driver attention is not required.
Level 5		No human intervention is required other than to set destination and start system. Vehicle can drive to any location where it is legal to drive.

Source: NHTSA, SAE, Juniper Research

1.2 Key Market Trends Driving the AV Market

The global automotive industry is on the brink of a major transformation, driven by technology development and shaped by demographic, regulatory and environmental pressures, which together are leading to the perfect environment for the emergence of the driverless AV.

i. Stricter Driver Safety Regulation

An increase in the number of accidents, primarily triggered by the rise in the number of vehicles on the road in countries such as China, is leading to stricter vehicle-safety regulation in many countries, particularly in the Asia Pacific region.

This in turn is leading to an increased adoption of safety systems in cars, particularly active systems such as ADAS systems, key elements of future AVs. A rapid adoption of ADAS systems will clearly be an important catalyst driving the introduction and adoption of AVs.

Regulators are well-positioned to speed the rate of ADAS adoption and this has already been effective in the European market with other markets, particularly China, intending to emulate the success seen in Europe.

ii. Environmental Pressures

Increased pollution and CO^2 emissions are leading to ever more stringent emission regulations, a trend which is forcing the automotive industry to look for cleaner alternatives to the internal combustion engine. Although the production of EVs (electric vehicles) remains low relative to the rest of the automotive industry, the EV market, led by new entrants such as Tesla as well as industry stalwarts like Toyota and Nissan, is expected to grow rapidly in future driven by the availability of AV technology. This will enable services in which EVs are connected to the web and can be summoned to provide rides on-demand. In future this could lead to the production of EVs being dominated by non-traditional OEMs (Original Equipment Manufacturers) like Tesla.

iii. Technological Developments – The Rise of the Smart Car

- Connected car:
    a) The connected car is already disrupting the automotive ecosystem, allowing the car and its occupants to be directly connected to the Internet, enabling automated links to all other connected devices, including smartphones, tracking devices, traffic lights, other vehicles and even home appliances.
    b) Both premium and volume car OEMs see connected car technologies as essential to their futures and a key element leading to the widespread availability of semi-AVs followed by an eventual shift to full AVs.
- EVs:
    a) Likewise, advances in EV technology, particularly in relation to batteries, is another trend that will be a catalyst leading to the introduction of AVs.
    b) Juniper Research forecasts that the total number of consumer and commercial alternative fuel vehicles is set to exceed 17 million on public roads by 2020.

- Other technologies:

    a) The emergence of full AVs will depend on the availability and reliability of other key technologies, in particular, high accuracy maps and software algorithms.

Figure 2: First Driverless Taxi Service Launched By nuTonomy in Singapore

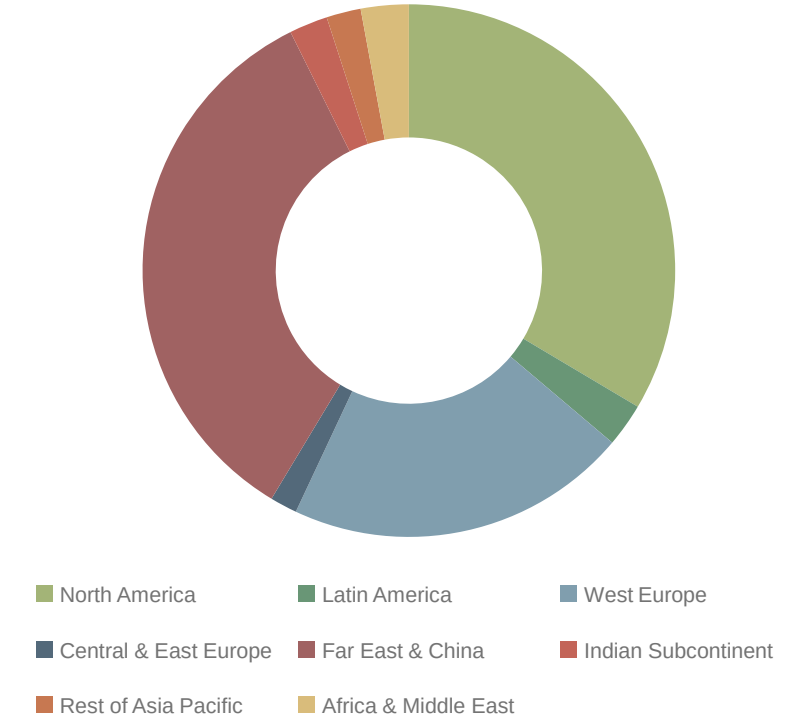
Source: nuTonomy

1.3 Market Forecast Summary: Autonomous Vehicles

Juniper forecasts that the annual production of self-driving cars (Level 4 – see Table 1) will reach 14.5 million in 2025, up significantly from only a few thousands in 2020, to give a global installed base of more than 22 million vehicles by 2025.

Juniper believes that Level 4 vehicles will not be deployed in any significant numbers until well into the second half of the forecast period (2020-2025), although some OEMs expect to launch some vehicles before 2020. The chart below excludes any Level 1, Level 2 or Level 3 vehicles.

Figure 3: Number of Level 4Autonomous Vehicles in the Consumer Sector, Installed Base Split by 8 Key Regions in 2025 – 22m



Source: Juniper Research

In contrast to the other vehicle categories, Juniper expects that the Far East & China region will either lead, or at least be on a par, with North America and West Europe in terms of the number of Level 4 vehicles deployed at the end of 2020.

The Far East & China region is expected to extend its market position thereafter so that by the end of 2025, it will dominate the market with a market share of 34%, followed by North America and West Europe.

Unsurprisingly, the lowest adoption rates will be seen in the less affluent regions of the Indian Subcontinent, Rest of Asia Pacific and Africa & Middle East.