



MECH5170M Connected and Autonomous Vehicles Systems

Levels of vehicle autonomy

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Introduction



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UNIVERSITY OF LEEDS

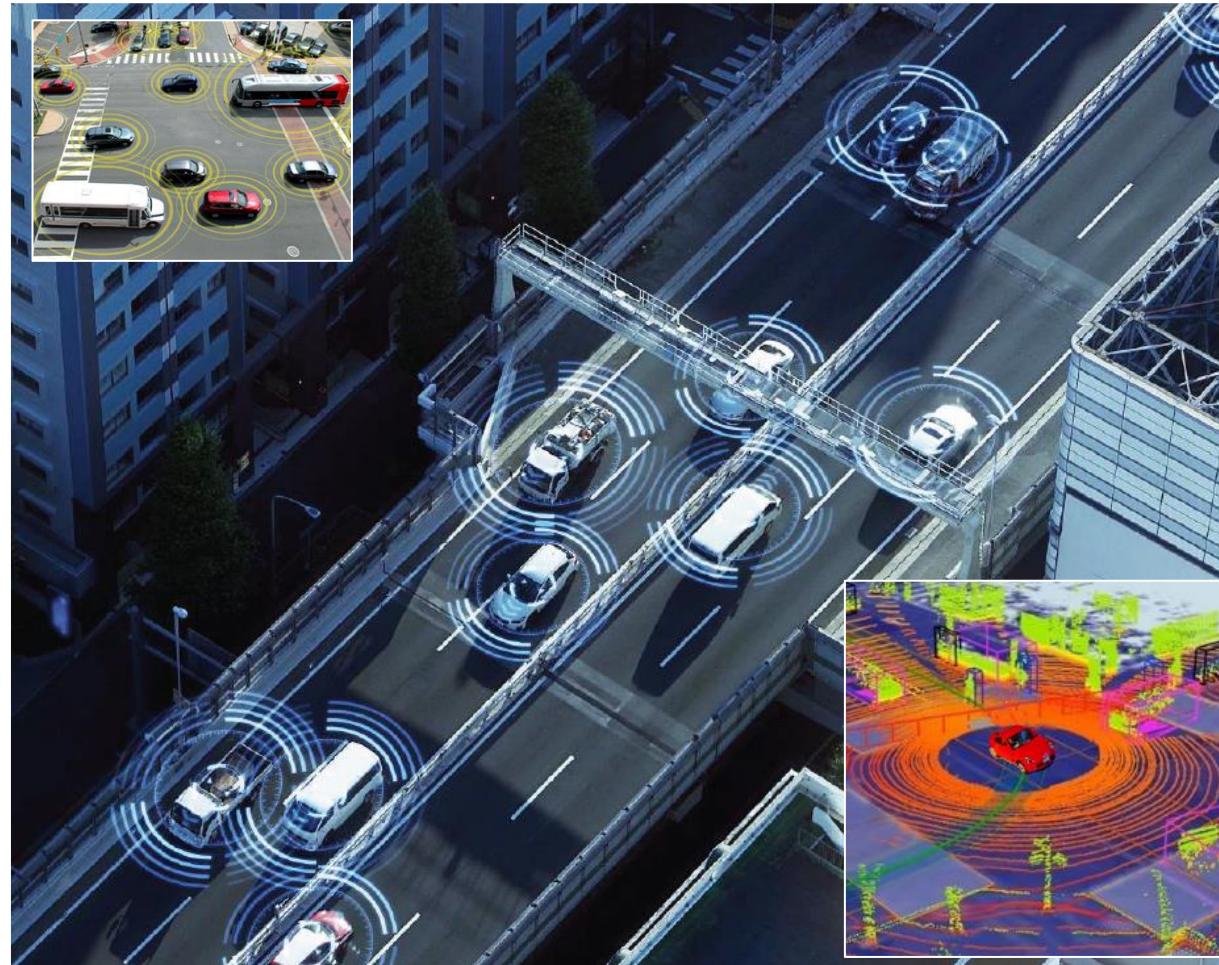
- Lidar
- Radars
- Cameras
- GPS positioning
- Accelerator/Gyroscope
- **4G / 5G connectivity**
- Processing unit
- Embedded systems
- A lot of advance software



Advanced Technologies

Technology convergence will revolutionise transportation and dramatically improving safety

- Connected Vehicles
- Vehicle Automation
- Internet of Things
- Machine Learning
- Big Data
- Mobility on Demand

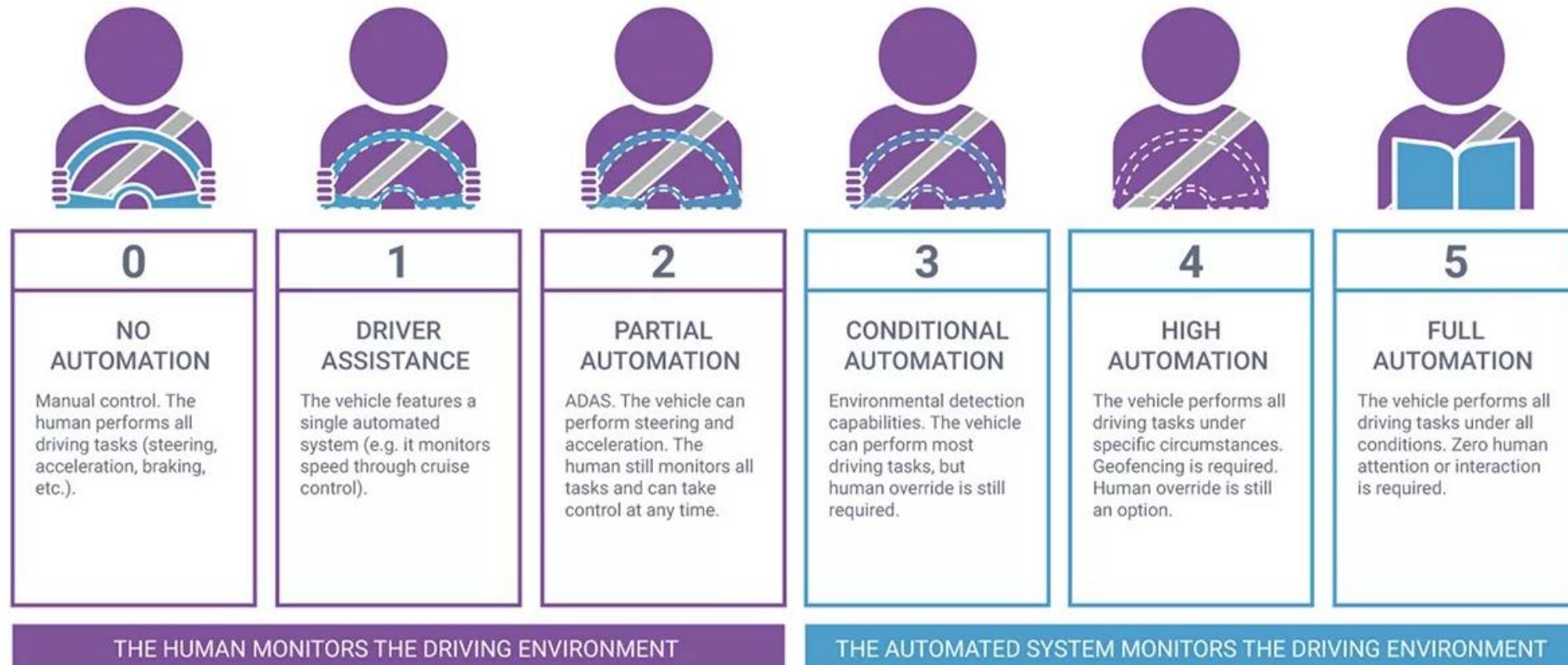


Benefits

- Order of magnitude safety improvements
- Reduced congestion
- Reduced emissions and use of fossil fuels
- Improved access to jobs and services
- Reduced transportation costs for gov't and users
- Improved accessibility and mobility

Levels of driving automation

The Society of Automotive Engineers (SAE) defines 6 levels of driving automation ranging from 0 (fully manual) to 5 (fully autonomous).



Levels of driving automation

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 may be systems in place to help the driver.

An example would be the emergency braking system, since it technically doesn't "drive" the vehicle, it does not qualify as automation.

Levels of driving 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 accelerating (cruise control)**.

Adaptive cruise control, where the vehicle can be kept at a safe distance behind the next car, qualifies as Level 1 because the human driver monitors the other aspects of driving such as steering and braking.

Level 2 (Partial Driving Automation)

This means **advanced driver assistance systems** or ADAS.

The vehicle can control both **steering** and **accelerating/decelerating**.

Here the automation falls short of self-driving because a 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 systems both qualify as Level 2.

Level 3 (Conditional Driving Automation)

Level 3 vehicles have “environmental detection” capabilities and can make **informed decisions** for themselves, such as accelerating past a slow-moving vehicle. But they still require human override. The driver must remain alert and ready to take control if the system is unable to execute the task.

Audi (Volkswagen) announced that the next generation of the A8 was the **world's first production Level 3 vehicle**. It was introduced in 2019.

It features **Traffic Jam Pilot**, which combines a **lidar scanner** with advanced **sensor fusion** and processing power.

In Europe, however, Audi was roll out the full Level 3 A8L with Traffic Jam Pilot (in Germany first).

Level 4 (High Driving Automation)

The key difference between Level 3 and Level 4 automation is that Level 4 vehicles 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 evolves, they can only do so within a limited area (usually an urban environment where top speeds reach an average of 30mph). This is known as geofencing.

Levels of driving automation

Level 4 examples:

- NAVYA, a French company, is already building and selling **Level 4 shuttles and cabs** in the US that run fully on electric power and can reach a top speed of 55 mph.
- Alphabet's Waymo unveiled a **Level 4 self-driving taxi service in Arizona**, where they had been testing driverless cars (without a safety driver in the seat) for more than a year and over 10 million miles.
- Canadian automotive supplier **Magna** has developed technology (MAX4) to enable Level 4 capabilities in both **urban and highway** environments. They are working with Lyft to supply high-tech kits that turn vehicles into self-driving cars.
- Volvo and Baidu announced a strategic partnership to jointly develop Level 4 electric vehicles that will serve the robotaxi market in China.

Level 5 (Full Driving Automation)

Level 5 vehicles do not require human attention.

The “dynamic driving task” is eliminated.

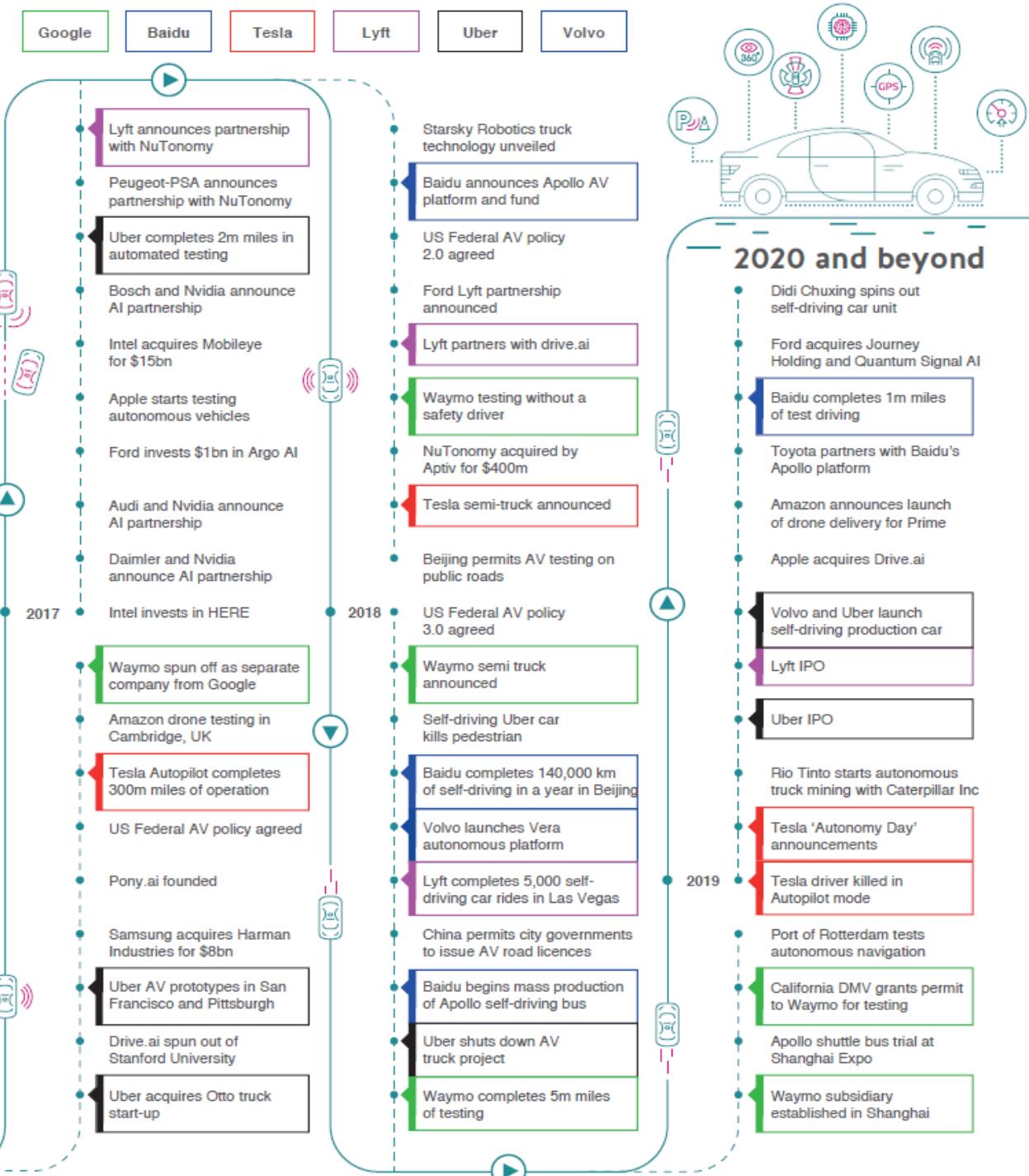
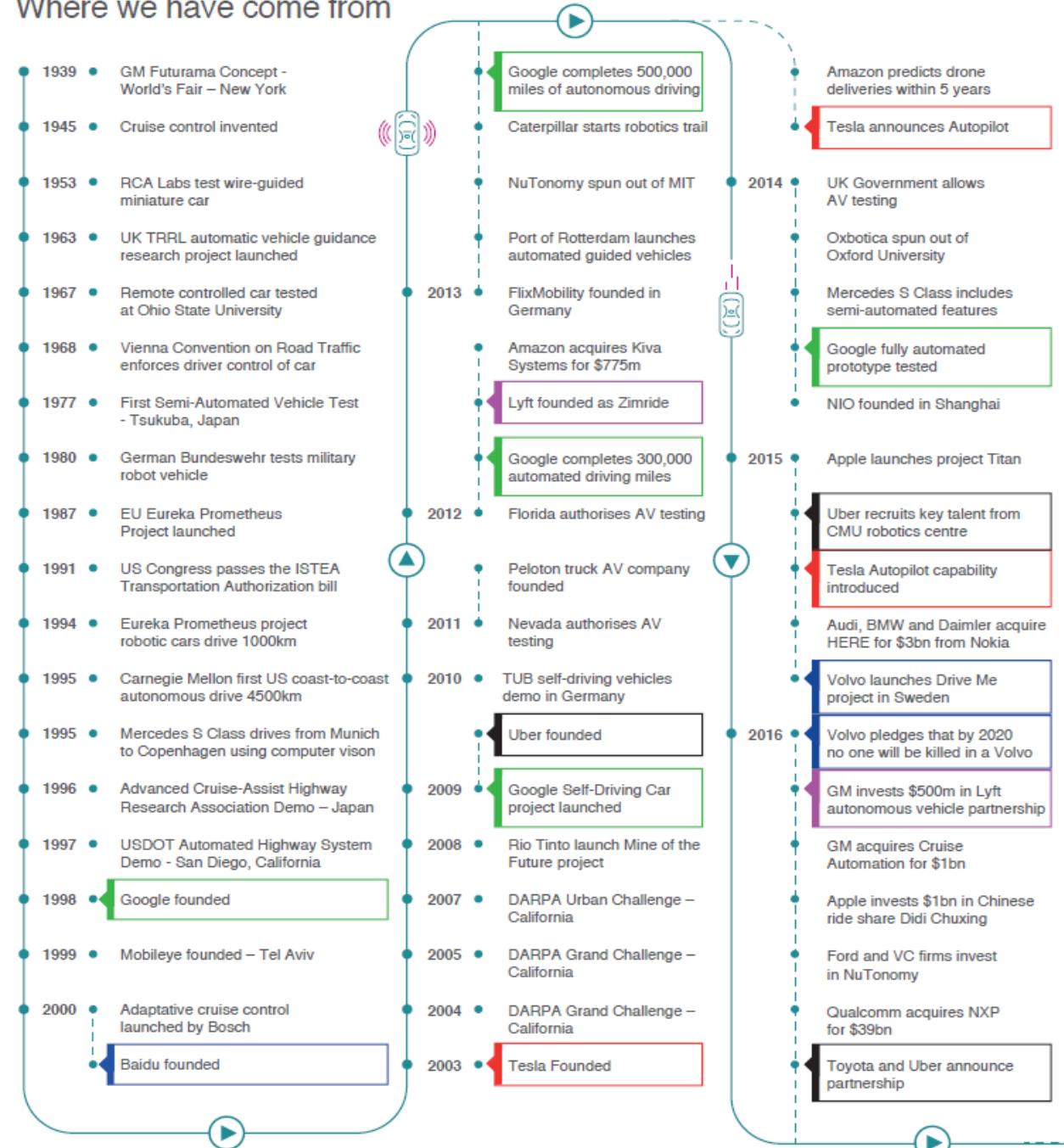
Level 5 cars won’t even have **steering wheels or acceleration/braking pedals.**

They will be free from geofencing, able to go anywhere and do anything that an experienced human driver can do.

Fully autonomous cars are undergoing testing in several pockets of the world, but none are yet available to the general public.

Future of Autonomous Vehicles

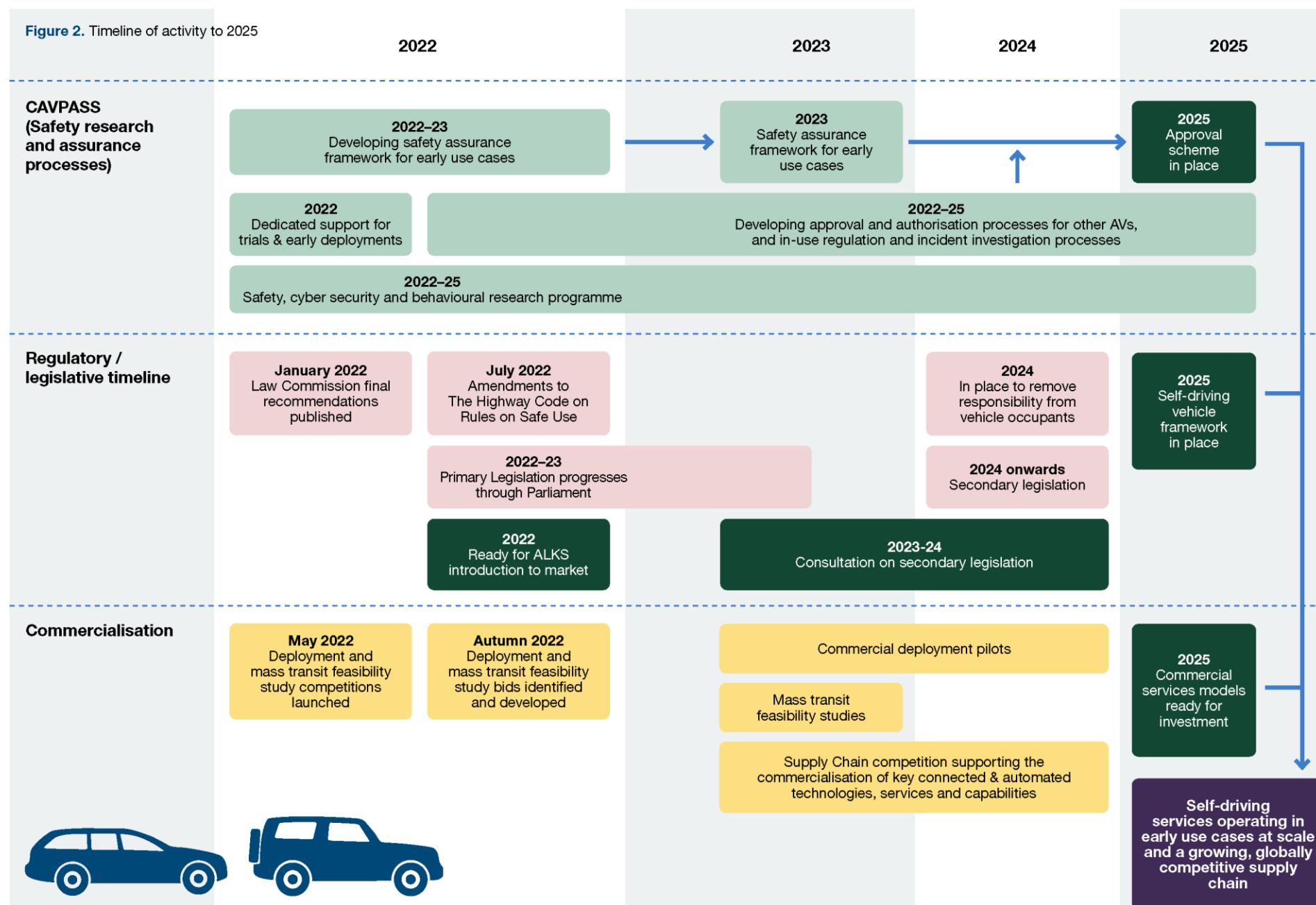
Where we have come from



2020 and beyond

- Didi Chuxing spins out self-driving car unit
- Ford acquires Journey Holding and Quantum Signal AI
- Baidu completes 1m miles of test driving
- Toyota partners with Baidu's Apollo platform
- Amazon announces launch of drone delivery for Prime
- Apple acquires Drive.ai
- Volvo and Uber launch self-driving production car
- Lyft IPO
- Uber IPO
- Rio Tinto starts autonomous truck mining with Caterpillar Inc
- Tesla 'Autonomy Day' announcements
- Tesla driver killed in Autopilot mode
- Port of Rotterdam tests autonomous navigation
- California DMV grants permit to Waymo for testing
- Apollo shuttle bus trial at Shanghai Expo
- Waymo subsidiary established in Shanghai



Figure 2. Timeline of activity to 2025

Summary

- 6 levels of autonomy
- Level 4 achieved
- Level 5 in testing
- History since 1939
- Roadmap 2025

**ANY QUESTIONS
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