AUTONOMOUS CARS

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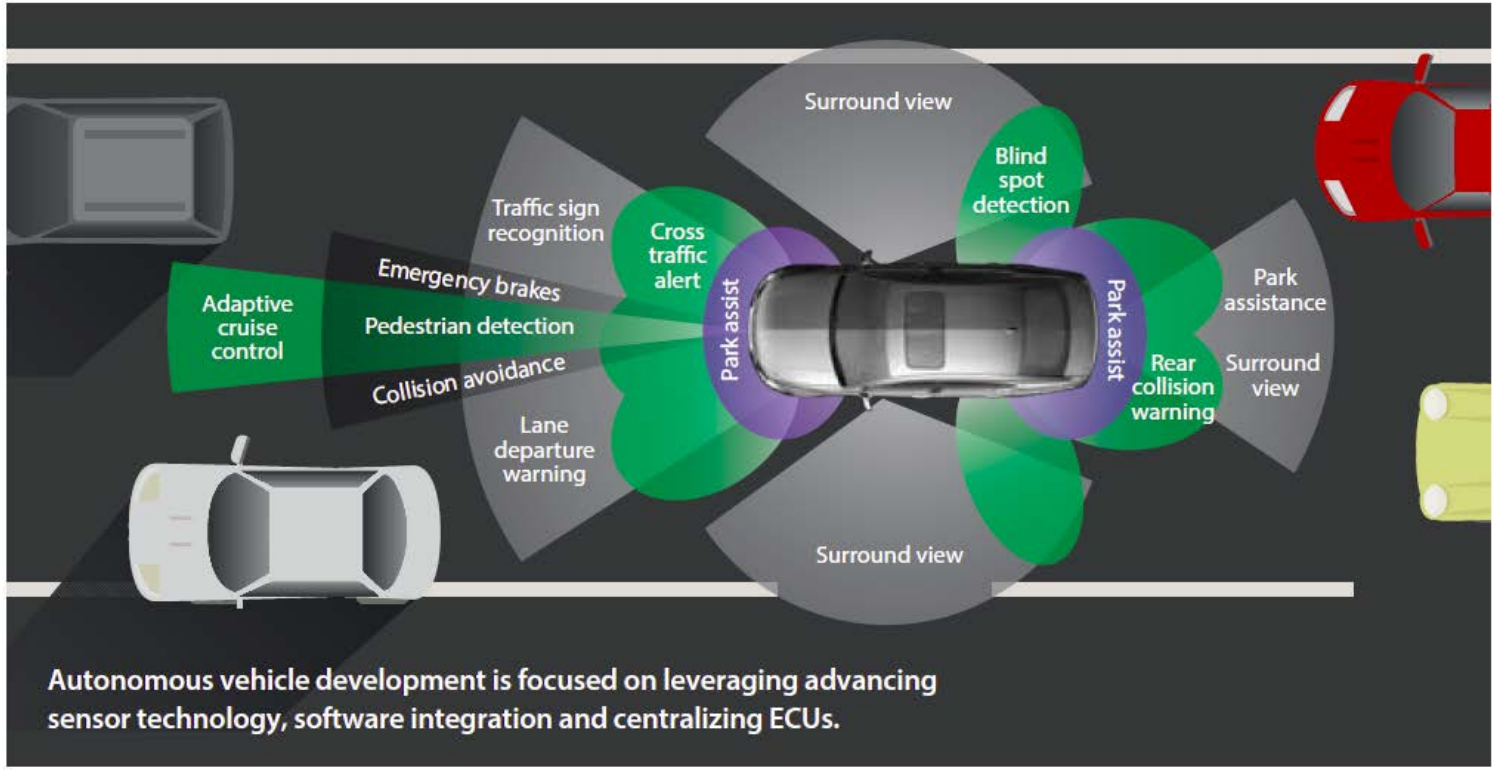
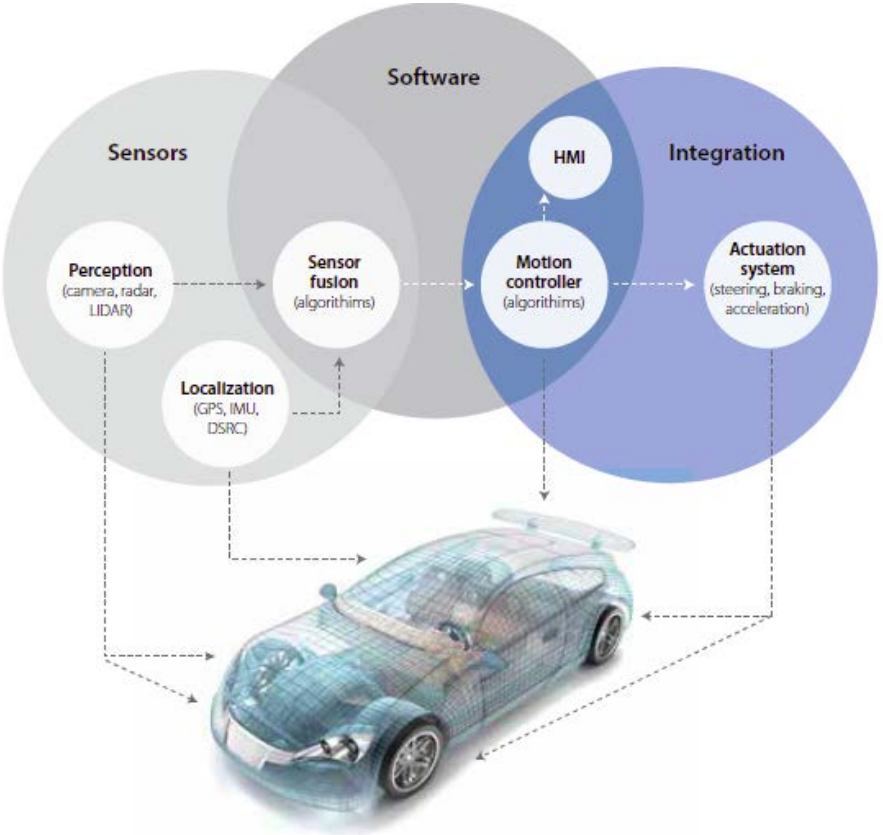
What are autonomous cars?

An **autonomous car** that is capable of sensing its environment and through advanced driver assistance systems offer improved driving safety and convenience (autonomous vehicles are the technological forerunners of self-driving cars where the steering wheel will disappear completely and the vehicle will do all the driving using the same system of sensors, radar and GPS mapping that autonomous vehicles employ).

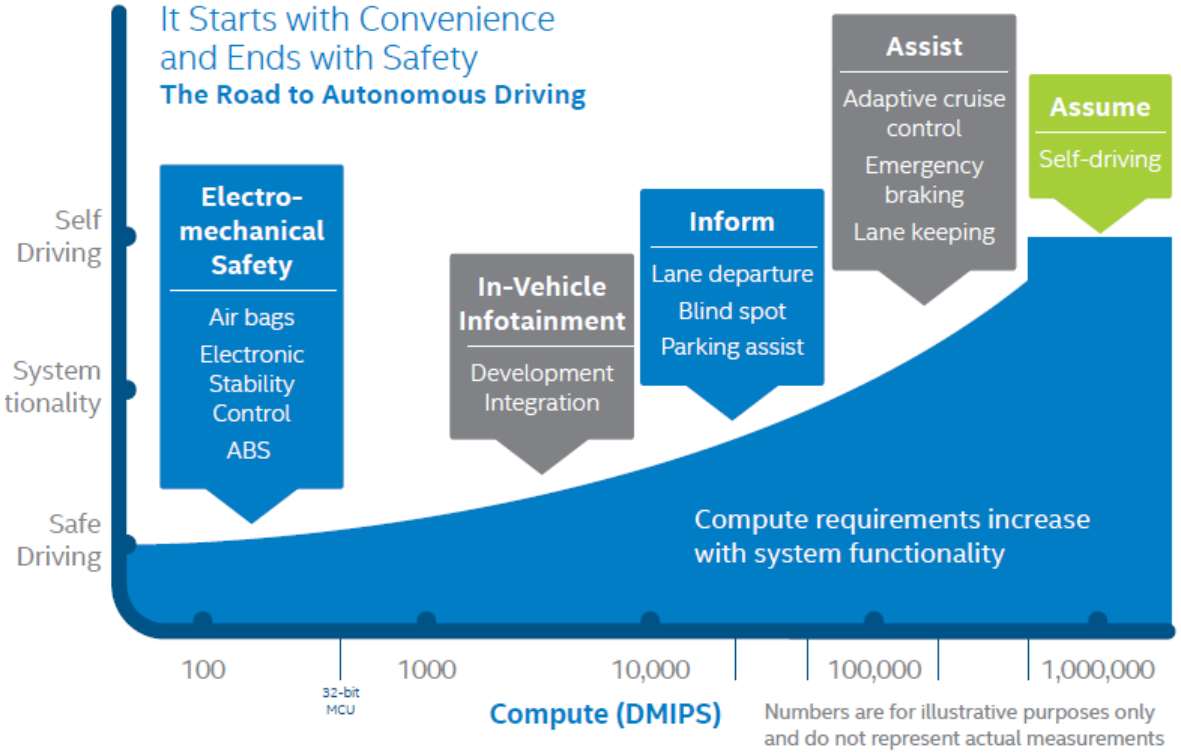


Source: Ricardo - Key Enablers for the Fully Autonomous Vehicle



Increasing demand for compute

SAE level	Name	Narrative Definition	Execution of Steering and Acceleration/ Deceleration	*Monitoring* of Driving Environment	Fallback Performance of *Dynamic Driving Task*	System Capability *(Driving Modes)*
***Human driver* monitors the driving environment**						
0	No Automation	the full-time performance by the *human driver* of all aspects of the *dynamic driving task*, even when enhanced by warning or intervention systems	Human driver	Human driver	Human driver	n/a
1	Driver Assistance	the *driving mode*-specific execution by a driver assistance system of either steering or acceleration/deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	Human driver and system	Human driver	Human driver	Some driving modes
2	Partial Automation	the *driving mode*-specific execution by one or more driver assistance systems of both steering and acceleration/ deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	**System**	Human driver	Human driver	Some driving modes
***Automated driving system* ("system") monitors the driving environment**						
3	Conditional Automation	the *driving mode*-specific performance by an *automated driving system* of all aspects of the dynamic driving task with the expectation that the *human driver* will respond appropriately to a *request to intervene*	System	**System**	Human driver	Some driving modes
4	High Automation	the *driving mode*-specific performance by an automated driving system of all aspects of the *dynamic driving task*, even if a *human driver* does not respond appropriately to a *request to intervene*	System	System	**System**	Some driving modes
5	Full Automation	the full-time performance by an *automated driving system* of all aspects of the *dynamic driving task* under all roadway and environmental conditions that can be managed by a *human driver*	System	System	System	**All driving modes**



Dynamic driving task includes the operational (steering, braking, accelerating, monitoring the vehicle and roadway) and tactical (responding to events, determining when to change lanes, turn, use signals, etc.) aspects of the driving task, but not the strategic (determining destinations and waypoints) aspect of the driving task. **Driving mode** is a type of driving scenario with characteristic *dynamic driving task* requirements (e.g., expressway merging, high speed cruising, low speed traffic jam, closed-campus operations, etc.).

Increasing demand for compute

In-car:

- multiple ADAS technologies aggregated into a single system i.e. gather the necessary information about the driver's constantly changing surroundings from numerous sensors and the ability to **"fuse" the data (~1gb/sec) from these various sensors to make safe decisions**.
- Reliability, security, and real-time decision making are non-negotiable necessities, as a fraction of a second can mean the difference between life and death. Therefore, the ability to **effectively execute differing workloads** (e.g. simulation and modelling, big data analytics, machine learning, and visualization workloads) that preserves **compute-power efficiency, architecture scalability, ease of implementation, and functional safety are paramount**. For example, automatically figure out when, how hard, and how fast to brake based on analysis of a range of variables, from the vehicle's speed to the road conditions to surrounding traffic.
- breakthroughs in **artificial intelligence and computer vision**. **Deep-learning based car navigation** is a new work load that is not the same as other high-performance computing workloads. It's driving new architectures that require new approaches."

Increasing demand for compute

V2V and vehicle-to-infrastructure (V2I) communication

- the ability to support an example **of 20,000 autonomous cars may require an exaflop of sustained compute**. This level of supercomputing is needed, considering the network of millions of sensors inside and outside the cars and their interpretation, plus the deep learning needed to constantly stay aware of the world around them and the drivers inside them, and repeatedly pass new models to the cars.

virtual testing and validation- advanced testing and analysis of autonomous vehicle performance.

- A level-4 autonomous vehicle must be able to operate in all driving scenarios, which means **extensive testing** will be required to develop the necessary software to ensure the vehicle responds appropriately, e.g. agent-based modelling (ABM)..