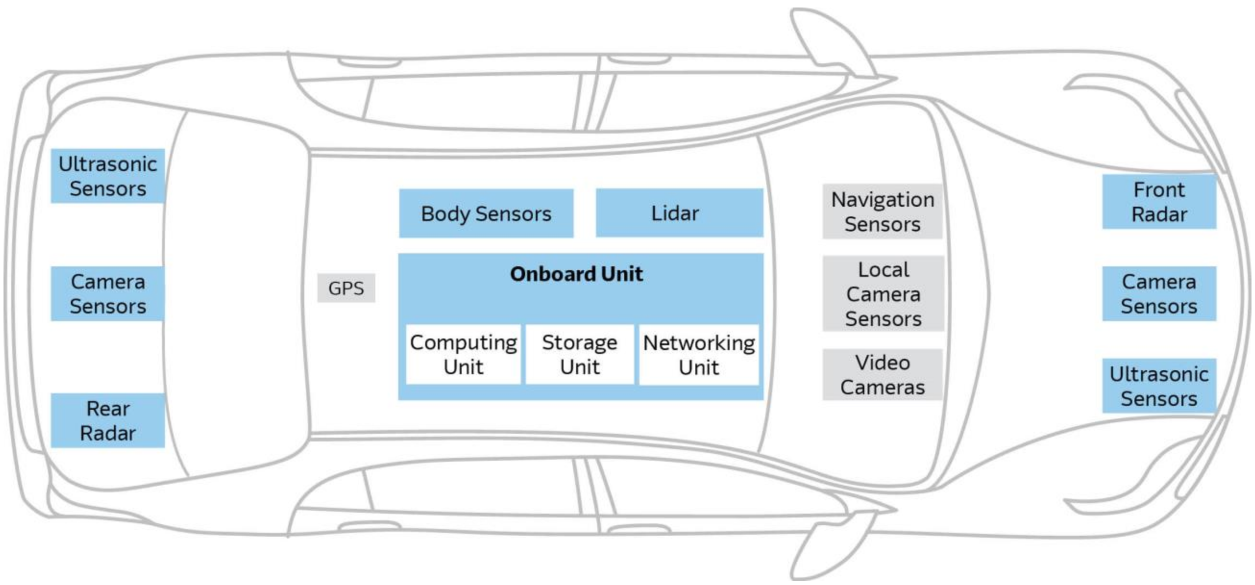
Edge Computing for Autonomous Vehicles: A Look into Use Cases and Network Architecture for Connected Vehicles

Of the trends currently driving transformation in the automotive industry, at the forefront is the shift from more traditional technology to highly intelligent data-lead systems. The trend is directly related to connected vehicles and the growing popularity of self-driving cars, together with other smart city infrastructure, both gathering and generating a wealth of real-time data for artificial intelligence algorithms to leverage.

Today, newly manufactured cars are fitted with hundreds of sensors that constantly share data related to location, entertainment, environmental conditions, vehicle operation, and driving behavior as frequently as several times per second, generating immense volumes of data. According to a McKinsey estimate, connected cars create up to 25 gigabytes of data per hour.



The enormous amount of data generated by vehicles is supported by a combination of data processing and controls, sensors, artificial intelligence, and 5G, all enabled by edge computing infrastructures. The continued evolution of these integrated technologies is the catalyst for new business models and use cases. It can also enhance road safety and create more intelligent user-led driving experiences. Related technologies include:

1. **Sensor fusion and value aggregation**: Vehicle sensors generate a large volume of data. While most data can be processed on board, certain applications push content to the cloud. However, leveraging edge computing limits the need to move data externally, reducing both transmission costs and minimizing sensitive data leaving the vehicle.

2. **Advanced Driver Assist Systems (ADAS) for increased vehicle safety:** ADAS enables pedestrian detection, automatic emergency braking, and blind spot detection. It uses radar/Lidar/camera sensors on powerful edge computing systems to support real-time vision coprocessing and sensor fusion subsystems.

3. **V2X protocols for enhanced connected car ecosystem:** Vehicle-to-everything (V2X) connection allows vehicles to speak both to each and surrounding infrastructure. V2X relies on edge computing and 5G networks for data exchange between vehicles and servers with protocols requiring access to edge-based IoT devices.

4. **Authentication for data privacy:** Vehicle data breaches and transmission errors can compromise vehicle and occupant safety; hence data privacy is critical. Safeguarding against hacking can be achieved with robust edge infrastructure and high-speed, secure connectivity. Using edge servers facilitates real-time authentication, however specific communication protocol must be established and authenticated between the host and server to maximize safety and minimize latency.

5. **Intuitive Infotainment systems for enhanced user experience:** Customer purchasing decisions are greatly influenced by the quality of the vehicle infotainment with both drivers and passengers seeking intuitive experiences. Edge computing is again responsible for meeting such expectations by reducing latency to deliver real-time personalization, music, and video streaming, plus seamless software updates.

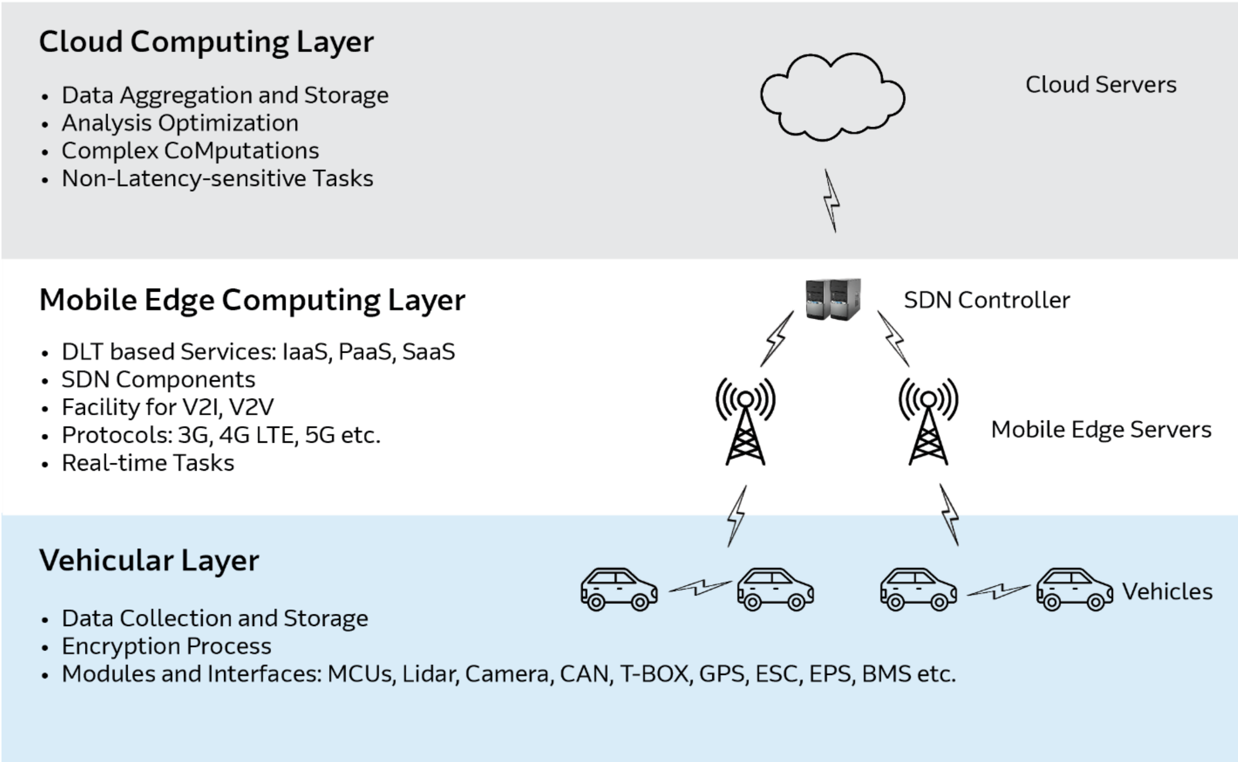
6. **Adaptive & predictive vehicle maintenance:** Edge infrastructure allows machine learning (ML) and artificial intelligence (AI) to be used to develop predictive maintenance schedules as part of vehicle after-sales service. It further facilitates remote software updates and improvements without the need to take the car to a service center.

7. **Smart Home and Vehicle Integration for self-parking:** Integrating the smart home and car allows one to communicate with the other through compute power at the edge. For example, those with home valet parking can leave their vehicle in the driveway, allowing the car to park itself in the garage. Through this intelligence, cars can also synch with the owner’s calendar and drive themselves out of the garage ready for the scheduled departure.

8. **Generic Rules and Machine Learning-based Monitoring and Alerting:** Such intelligence allows fleet managers to set up rules to efficiently run operations. A rule may categorize a car as “unavailable” around the time it is due for a service, triggering an alert. The role of edge computing here is to process sensor data on board and assess pre-set rules using ML algorithms, avoiding the need to access the cloud. The cloud, however, can be leveraged to train and sharpen the ML algorithms or initially define rules to then push to the edge when updates are made.

Network Architecture

According to Navigant Research, 94.7 million vehicles with self-driving capabilities will be sold annually by 2035. This phenomenal growth of intelligent, connected vehicles generates staggering amounts of data that require robust infrastructure and a solid safeguard framework, supported by a plethora of technologies from big data and AI to cloud and edge computing. This network architecture and its various layers are what make it all possible.



The Cloud Layer: is where enormous volumes of data are stored, aggregated, and processed. It is also here that more complex computation takes place. The cloud is ideal for longer-term storage in which latency is not critical to applications

The Mobile Edge Computing (MEC) Layer: sits between the cloud and vehicular layer ensuring data exchange and extending cloud capabilities, moving them closer to the edge. Information on road infrastructure, pedestrians, other vehicles, and the external environment are shared here together with data caching and computation functions. The combination of MEC and AI/ML allows vehicles to access real-time information on their surroundings, decreasing latency and reducing data traffic congestion which is critical to safety.

The Vehicular Layer: refers to communications between the vehicle and objects, people, or infrastructure in its immediate vicinity. Intelligent connected vehicles (ICVs) collect data from onboard and surrounding sensors, cameras, radar, Lidar, GPS, etc sending data to the MEC layer to feed various vehicle intelligence services including environmental and traffic conditions. Data exchange is made possible via the 5G network and communication with onboard wireless devices. As an example, the integrated vehicle radar can slow the vehicle automatically upon sensing traffic build-up.

Summary

A new era of user-centric mobility is upon us with intelligent vehicles and surroundings now hyper-connected and expected to provide a safer and unprecedented driver/passenger experience. This is driving the automotive industry to evolve rapidly and expand into previously un-navigated areas of technology and data. Whatever network layer you operate in or provide solutions for, Arrow has the expertise and experience to support you in delivering safe, efficient, connected, autonomous solutions for intelligent automotive applications. We help you bring together the right technology, backed by a global infrastructure network to differentiate you from the competition and provide solutions for the future of mobility.

References

- A Survey on Vehicular Edge Computing: Architecture, Applications, Technical Issues, and Future Directions
- Self-driving vehicles (SDVS) & Geo-information