AECC
AUTOMOTIVE EDGE COMPUTING CONSORTIUM

SBD

BREAKING DOWN THE BARRIERS TO AUTOMOTIVE EDGE ADOPTION

White Paper

Introduction

The upcoming vehicle connectivity evolution will enable the automotive industry to generate and process sensor data from hundreds of millions of vehicles. This will allow a range of vehicle and smart-city services to be consumed locally to where the data was collected. In 2025, there will be at least 400 million connected passenger vehicles on the road, many with potentially high-volume data services competing for processing time and space with new services designed to run in near-real-time (SBD Automotive, 2020). The current cloud-based service model relying on centralized compute and high data volume moving through the network will struggle to support future automotive use cases in this congested environment. Many individual companies or partner-ships are working to find solutions to this future bottleneck issue. The Automotive Edge Computing Consortium (AECC) is trying to build cross-industry collaboration to avoid the proliferation of incompatible data management and service architectures by gathering viewpoints and requirements from across the connected vehicle value chain.

GLOBALLY, THERE WILL BE AT LEAST **400M CONNECTED VEHICLES** ON THE ROAD IN **2025**

GLOBALLY, CONNECTED VEHICLES WILL **SEND UP TO 10 EXABYTES OF DATA PER MONTH** BY 2025

The AECC projects that the global vehicle car parc will send up to 10 Exabytes of data per month by 2025 (AECC, 2020). Fleet vehicles that provide extensive tracking and usage data will form a large part of this data flow. To combat this change in device usage, both within the automotive domain and beyond it, the telecommunications and data handling industries are already deploying localized processing facilities embedded in the wireless network infrastructure with "edge computing" solutions to enable the kind of high-data, real-time, localized services that healthcare, manufacturing, and IoT industries will deploy in the next 5 years. The automotive industry needs to prepare to both use and influence the implementation of this network edge layer with its network and data partners.

Breaking Down the Barriers to Automotive Edge Adoption

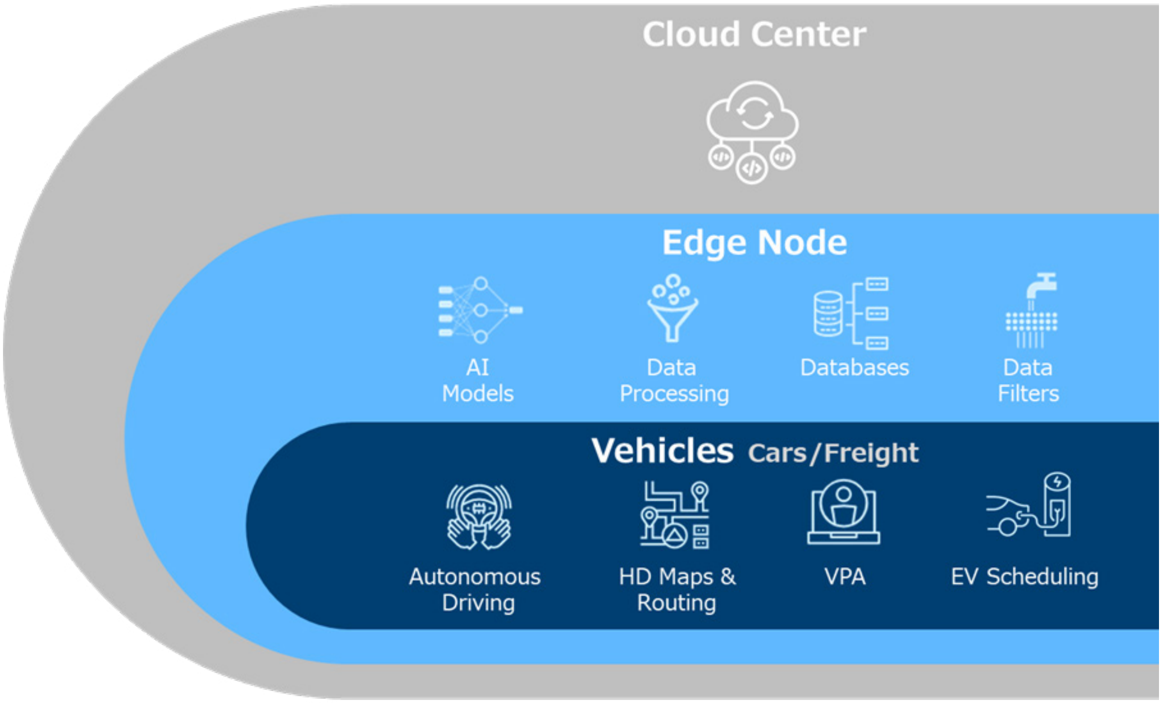
Understanding what "Edge" is and what it offers

A key stumbling block among many in the automotive industry is the misunderstanding that 5G brings all the speed and data volume solutions that connected vehicles need. Edge and 5G are sometimes considered to be part of the same package. Edge, though, is not the same as 5G. The two technologies are complementary – working together to ease their respective workloads and network strains. 5G is a wireless data transfer technology – it improves bandwidth and latency over 4G (without edge processing) through new wireless transmission protocols and technology.

Edge Computing[1] or “edge” improves the latency and workload balancing for 4G and 5G devices by embedding enhanced processing capability into the cellular network infrastructure. **5G technology gets data from one place to another – edge technology does something with that data.**

By 2025, half of all cars driving in the USA will have connected features. None of those vehicles currently have 5G modems (SBD Automotive, 2020). Crucially, edge infrastructure will need to support 4G, 5G, 6G, and beyond if past telecommunications standards trends hold in the future.

Edge solutions offer data aggregation, processing, and sometimes storage near the vehicle. Within a metropolitan environment, such as Los Angeles, Frankfurt, Shanghai, or Paris, dozens of facilities similar to localized cloud data centers handle vast volumes of data to provide services that do not require a centralized database, application, or process.



Edge nodes provide an intermediate data handling option between the vehicle and the cloud

Introducing this intermediate layer brings efficiencies and new opportunities to the devices, the services, and the infrastructure partners. Using these facilities instead of a single or regional cloud facility allows services to react faster by reducing the amount of data that is only needed locally that would otherwise load up the regional or global data pipes and cloud.

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[1] Within the “edge” term, a further opportunity for confusion can arise where some industries or parts of industries now consider “edge” to extend to the IoT devices connected to the wireless network – the so called “device edge”. For clarity, within this discussion, “edge” refers to the network-embedded infrastructure, or “network edge”.

The role of the AECC in pre-competitive collaboration and proof-of-concept (POC)

The AECC's pre-competitive collaboration focuses on helping automotive, telecommunications, and data handling partners develop architecture solutions designed to process **the right data at the right time in the right place** for the complex moving-vehicle environment. The consortium's members include automotive OEMs and Tier 1s, network providers, infrastructure suppliers, as well as edge and cloud solution providers from the USA, Europe, and Asia. These experts pool their ideas, requirements, and system constraints together to create a toolbox that each consortium member can apply to their own edge products and systems.

Gathering requirements and developing use cases helps the industry think about how it can and should manage its workload and data processing needs as edge computing takes off, but collaboration to understand the barriers and solutions is only the beginning. AECC also supports its members to test, refine, and validate these reference use cases by supporting cross-industry POCs to help the cross-industry partners build the architectures they will need to implement a wide range of general automotive and brand-specific services over the next decade and beyond. For example, in 2020, AECC members Toyota and Ericsson collaborated with Vodafone to analyze the impacts of vehicles transitioning from one edge node to another on active services (Muehleisen, 2020). Working together with other members to understand and surmount the core data handling barriers to successful edge adoption, OEMs, infrastructure providers, and service operators can then focus capital investment into building differentiating features, without creating undue dependencies on specific partners.

Enabling the edge for vehicle features

Vehicle and consumer features that rely on the processing of many small data items, or a small number of larger data items, can benefit from the processing speeds, and localization, of edge computing.

> IN EUROPE, **FEWER THAN 2%** OF PASSENGER CARS SOLD IN 2032 WILL BE SAE LEVEL 4 AUTONOMOUS

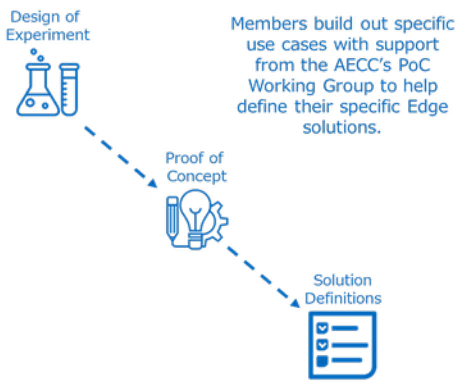
Different vehicle types, local authorities, and OEMs will process data in different layers for different use cases. Some use cases require very high volumes of data from a small number of vehicles to provide a service. Others anticipate small volumes of data from all passing vehicles. Many services involve journey-wide data which will require vehicle information to pass from one edge node to another as a vehicle moves. The AECC is considering use cases with widespread applicability. With an exceptionally small level of Level 4 autonomy among passenger vehicles – contributing fewer than 2% of new car sales in 2032 (SBD Automotive, 2020), the focus on edge for automotive must look away from commercial autonomous vehicles for use cases for volume vehicle usage in the next 10 years. Other examples of local data for local consumption offer ample opportunity to deploy meaningful consumer- and industry-facing services.

Where services are designed to be local – with potentially dozens of edge processing facilities, or nodes, in a single city – service and infrastructure still need to consider the key point of the

Globally, connected vehicles will send up to 10 Exabytes of data per month by 2025.

The adoption of edge technologies in an increasing number of urban areas over the next decade provides a wealth of new opportunities for the automotive industry.

automobile: moving people and goods from one place to another. Services using edge facilities in those vehicles may well need to track efficiently across the network without missing a beat – much like the driver would expect to have a phone call during a journey without any issues as the phone passes among cell towers.



Reducing automotive Edge time-to-market through collaboration and support

AECC's requirements-capture and analysis efforts bring together partners from all the key industries involved in rolling out these future services, to collaboratively discover and surpass barriers to edge adoption that can come from ignoring the impacts of moving vehicles on edge-based functionality.

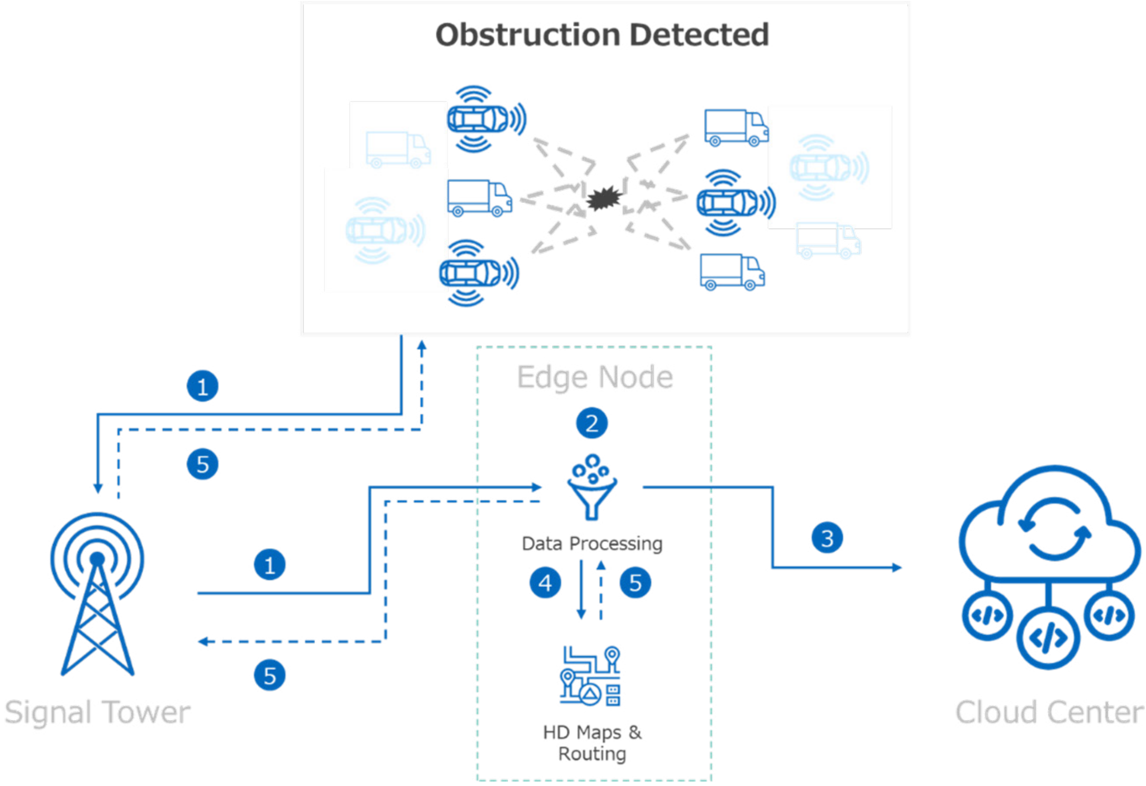
Example High Device / Data Volume Case Cases

The AECC's technical requirements work to maximize the collection, processing, and consumption, of local data for forward-thinking automotive edge cases – such as autonomous driving, high-definition mapping & routing, and virtual personal assistants (VPA). Where data collection, filtering, or processing is only needed locally, it makes more sense to implement edge processing at the edge than in the cloud (which typically handles such tasks on a national or global scale).

High **Device** Volume Example: Road-health Assessment Service	High **Data** Volume Example: Incident Assessment Service
All passing vehicles on a section of road can transmit 1KB of vibration data and low-resolution imaging to an edge node to calculate a continuous road-health assessment for a service which alerts road users and authorities of dangerous debris or surface conditions. This detail and volume of data is of little relevance anywhere beyond that locale and would provide limited value for transmission, processing, and storage on a cloud basis.	Following heavy braking, 32 megabytes of video/camera data from six vehicles are processed at an edge node to quickly provide an incident assessment – this information can then be forwarded to traffic management and emergency services if needed. The combined data from these vehicles crosses privacy boundaries, but local anonymized automated use and disposal to determine response levels without reference to personal data such as license plates or people seen in images respects privacy to provide a localized service based on intermittent, high data volumes.

Two example services for Edge deployment

HD mapping interfaces and real-time updates offer a core edge-based automotive service. Taking the Road-health Assessment scenario above, services based on the edge detect and analyze road obstructions from vehicle sensor data and support local distribution of that information via the live HD map service. The figure below illustrates the example in more detail.



HD mapping use case example: Obstruction Analysis via Edge Computing

The first step in this process is for vehicle systems that already collect data from the vehicle's cameras, radar, and vibration sensors to continuously provide some of this data to the edge service. Second, by analyzing the continuous data feed, the service can build a detailed profile of an obstruction, including its size, type (e.g., debris or pothole), and level of risk to drivers. The service notifies local authorities of the obstruction (step 3) and provides the obstruction detail to a local HD map data service (step 4). The local map service updates its data and then provides that to all nearby vehicles (step 5), notifying them of the obstruction ahead.

How does this process work?

The vehicle's cameras and sensors are always on and, by default, detect obstructions for the immediate journey needs of the vehicle. This continuous operation means that the vehicles' sensors can generate large volumes of data, including data related to road obstructions. The vehicle sends data to the off-board service for further processing, filtering, and analysis. Today's cloud-based world is ill-suited for such localized services, requiring all such functionality in a country or region to compete for bandwidth and capacity.

Why off-board?

Many vehicles will not have the necessary sensor and processing capabilities to develop a detailed, 3D description of a road obstruction, especially a dynamic one such as slowly moving debris or a pedestrian. Even those vehicles which can create such an image will only generate static data – once the vehicle moves past, any information the vehicle has communicated becomes static with the final readings. However, an off-board service can collect large volumes of sensor data across multiple vehicles to produce an image from this data that can change as each new vehicle in the area sends new data about it. The processing capabilities of an off-board service share this dynamic description with local authorities and real-time HD map services.

Why edge and not cloud?

The main advantage of edge computing over the cloud is its focus on local data and local processing. By handling data locally (rather than on a larger scale via the cloud), it can be processed, filtered, and aggregated quickly. The data is not competing on the wired network or the cloud platforms with similar services for other locations, regional media, fleet management, or national map processing, so this kind of scenario gets to its processor faster, gets processed faster, and is turned into an outcome faster.

The edge's focus on handling data locally also means that this data can be used more securely. Local data filtering and processing without leaving national borders or storage in a national database, means that personally identifiable information, such as a license plate number or photograph, will never go to the cloud where it is potentially accessible.

The data volume for services with continuous sensor data input can also put a strain on the network and cloud infrastructure. Network backhaul and potentially global cables already transmit vast amounts of data to cloud facilities. Globally, connected vehicles will generate up to 10 Exabytes per month by 2025 (AECC, 2020). Uploading that quantity of data to cloud facilities potentially degrades the anticipated automotive services as well as all the other services that use that infrastructure. Cloud processing of national or global sensor data on this scale could also place severe processing, cooling, and electricity strains on the cloud infrastructure.

Service beneficiaries & value

The beneficiaries of an off-board service for HD mapping range from on-road users to local road authorities. HD map providers, for example, can benefit from a streamlined work process. Subscribing to an obstruction analysis service reduces the pressure on providers to handle the process of collecting and processing vehicle data through their own cloud servers. Likewise, it also means that the provider will not have to develop their own edge systems to carry out this process either.

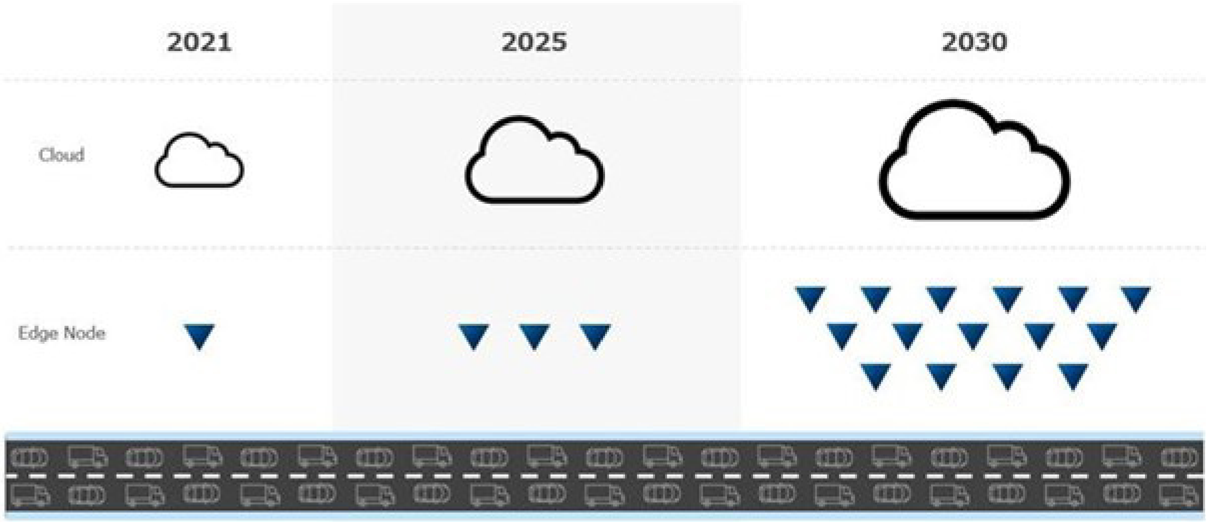
Vehicle manufacturers and fleet providers can similarly experience the streamlined workflow that comes from using an off-board service, removing the need to build, implement, and maintain their own individual service to gather and process large volumes of data.

Users of HD Mapping systems, such as OEMs and consumers, can benefit from a fast turnaround in map detail for dangerous obstructions – a key requirement in the move towards greater vehicle autonomy. This means HD map users receive data about hazardous road obstructions prior to encountering them, allowing vehicles to replan the lane or road selection safely.

Local road authorities benefit from the level of detail provided by the service about the obstruction, particularly about its size and how dangerous it is for drivers. Such information allows the authorities to quickly enable automated or semi-automated mitigation prioritization and repair scheduling.

Preparing Infrastructure & Service Partners for The Future of Automotive Edge Computing

Before 2030, vehicles will move along multiple edge nodes in a single urban journey. Most edge service use cases, however, will anticipate a ratio of one device (i.e. a vehicle) to one node. The AECC's use cases help infrastructure and service providers plan for use cases in which processing moves in conjunction with the vehicle.



Edge nodes will proliferate in number, where cloud centers will increase in capacity

IN 2019, LCVs TOTALED 4.2 MILLION IN USMCA AND 2.3 MILLION IN EUROPE

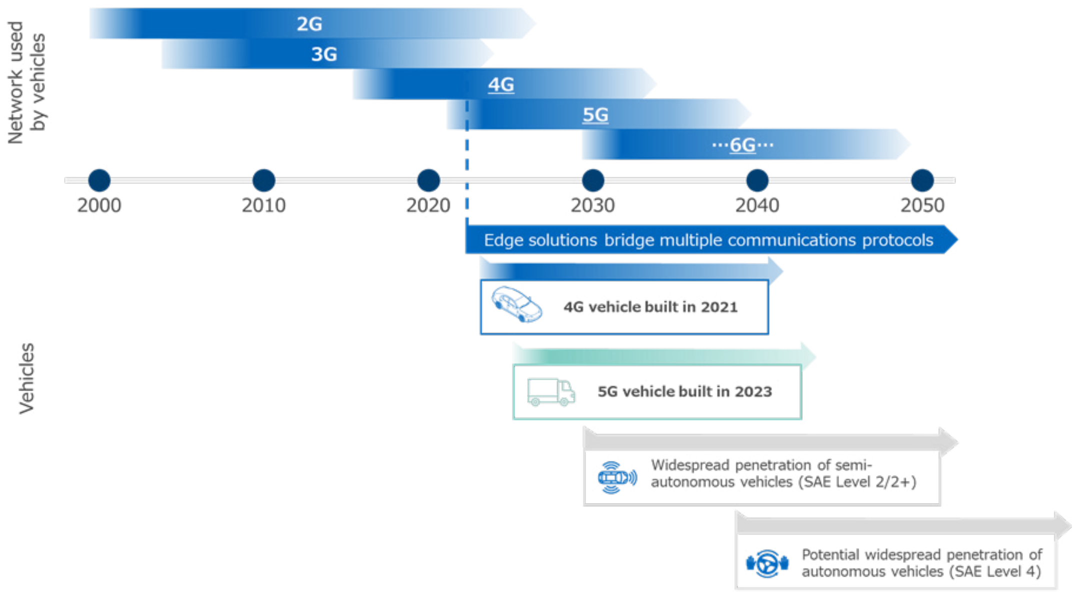
Currently, OEMs utilize a handful of private and hosted platforms which operate regionally or globally. Between now and 2030, minimal growth is expected for these platforms, with relatively few more to be added by the end of the decade. Instead, cloud providers may add more capacity to the platforms already in place. However, edge deployment will see a much greater expansion. In larger cities, the edge typically operates across 1-6 nodes per provider. In megacities, such as Frankfurt and Tokyo, this increases to 6-20 nodes. By 2025, this figure is set to increase to 10-20 per metropolis and several dozen operating in megacities around the world. By 2030, the number of edge facilities in urban and high-traffic areas will be sufficient to ensure that a fleet delivery vehicle will pass among dozens of nodes daily and a typical 45-minute commute will involve at least a handful of edge nodes. With several million connected commercial vehicles entering the market each year (6.5 million in USMCA + Europe in 2019) (SBD Automotive, 2020), potentially communicating and driving for 8+ hours daily, fleet vehicles will significantly contribute to the need for new edge use cases.

The adoption of edge technologies in an increasing number of urban areas over the next decade provides a wealth of new opportunities for the automotive industry. Therefore, all parties in the industry need to understand its existing use cases and how those use cases will develop alongside edge technology.

Automotive Edge Computing: Today and Tomorrow

As edge technologies continue to develop alongside 5G to expand automotive off-board processing opportunities for increasingly autonomous vehicles, the scope of the edge and its uses within automotive is set to play a significant role in vehicle functionality.

However, network technologies and infrastructure continue to develop. Automotive edge solution and service designers need to look beyond data transmission methods to the infrastructure involved in processing and managing this data. Globally, 69% of passenger cars sold this year will have a modem (SBD Automotive, 2020). A very small minority of these cars will have an embedded 5G modem at purchase time.



Automotive edge solutions need to bridge multiple cellular standards and vehicle technologies

The typical lifetime of a passenger vehicle is approximately 20 years, with a potentially shorter expectation for Light Commercial Vehicles. Telecommunication standard generations (such as 3G, 4G, or 5G) average fewer than 10 years of primacy. The IoT legacy duration of each generation is dependent on the uptake of devices, the standard's technology overlap with the next generation, and the difficulty of replacing device connections. As such, to keep up with changing telecommunication protocols, it is imperative that the solutions developed today facilitate equal support for 4G, 5G, and 6G over the lifetime of cars manufactured this year.

Some OEMs, fleet owners, or individuals may replace connectivity modules, but in most cases that is unlikely. Therefore, AECC focuses on ensuring that the data processing and management architecture for its use cases are as applicable in 2038 as they are in 2028.

Conclusion

The advent of edge computing creates a world of new opportunities for the automotive, telecommunications, and data handling industries. The increase in vehicle sensor deployment and data will increase the level of on-vehicle computing power for some, but not all vehicles. The increase in vehicle connectivity will increase the level of off-board service availability for nearly all vehicles in major automotive markets. Combined, the increase in sensor data and vehicle connectivity creates a tension between on-device processing and cloud service delivery, which other industries will meet by implementing edge-based service solutions. Within the Automotive industry, those solutions have the added complexity of moving devices and lifespans that outlive the telecommunications standard in place when a car leaves the factory.

The AECC hopes to bring together the right people to develop long-term solutions to help the automotive industry process its data in the right place at the right time.

References

AECC. (2020, July 15). Driving Data to the Edge: The challenge of Traffic Distribution.

Muehleisen, M. (2020). Automotive Trials for Make-Before-Break 5G Edge Cloud Handover. *CLEEN2020workshop*. 5G PPP. Retrieved from https://5g-ppp.eu/wp-content/uploads/2020/07/Maciej-Keynote-CLEEN-Workshop-Published.pdf

SBD Automotive. (2020). ADAS & Autonomy Forecast. SBD Automotive.

SBD Automotive. (2020). Global Connected Car Forecast. SBD Automotive.

SBD Automotive. (2020). OEM Fleet Management Solutions and Value Chains. SBD Automotive.

About the AECC

The Automotive Edge Computing Consortium (AECC) is an association of cross-industry, global leaders working to explore the rapidly evolving and important data and communications needs involved in instrumenting billions of vehicles worldwide. The AECC's goal is to find more efficient ways to support the high-volume data and intelligent services needed for distributed computing and network architecture and infrastructure. The AECC's members are key players in the automotive, high-speed mobile network, edge computing, wireless technology, distributed computing, and artificial intelligence markets.

If you would like to learn more, visit AECC.org or contact the AECC here.

About SBD Automotive

SBD Automotive is a global consultancy firm specializing in automotive technologies. For over 20 years, our independent research, insight, and consultancy has been helping vehicle manufacturers and their partners to create smarter, more secure, better connected, and increasingly autonomous cars. With a reputation for robust data and expert advice, as well as an ability to attract and retain the industry's most talented specialists, SBD Automotive operates a network of local offices in key automotive hubs, including the UK, Japan, USA, Germany, China, and India.

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AUTOMOTIVE EDGE COMPUTING CONSORTIUM

Webinar: Breaking Down the Barriers to Automotive Edge Adoption

Join **Kurt Dusterhoff** of SBD Automotive and a panel of experts from AECC, including **Christer Boberg, Roger Berg** & **Said Tabet,** as we break down the barriers to automotive edge adoption

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