

The future of moving mobility



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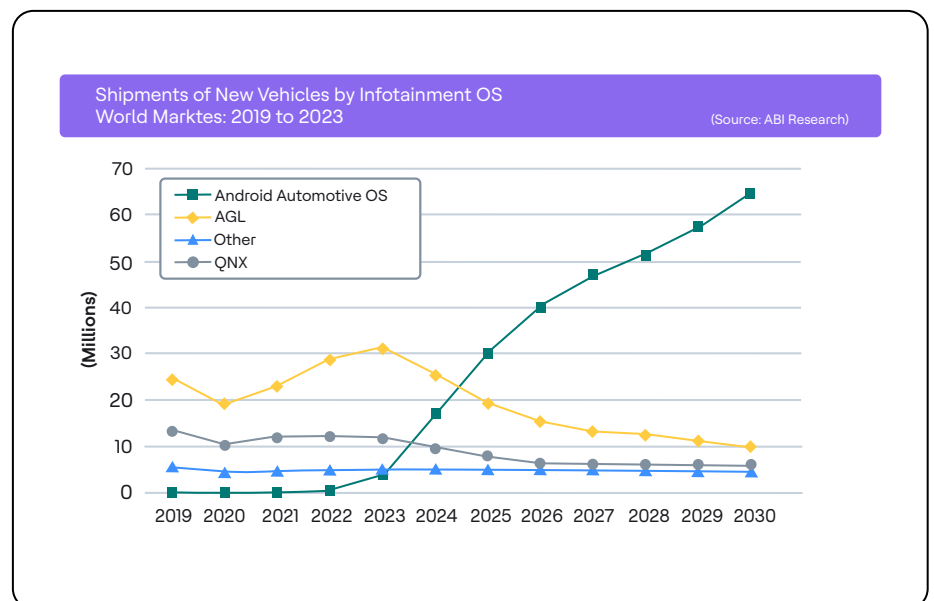
Introduction

Digital transformation of Auto OEMs

Historically, automakers have concentrated on the mechanical aspect of vehicle development. However, the current priority is digital transformation, which is now the primary driver for profitable growth driver in the auto industry. Technology companies are actively engaging in this transition, and the culmination of these synergies promises to revolutionize connectivity, enhancing the comfort level and intelligence of customer experience with In-vehicle infotainment. Google's Android Automotive Operating System (AAOS) is rapidly gaining traction in the infotainment system space, with adoption rates projected to grow exponentially in the next five years. The Google Automotive Services (GAS) suite, built on AAOS and available through a licensing model, enables OEMs to integrate numerous services from Google. This list of services is expected to expand in the coming years. Enabling non-GAS suites on AAOS will explode the potential market for third-party solution providers, creating new revenue streams by connecting multiple service providers.

Connected vehicle service

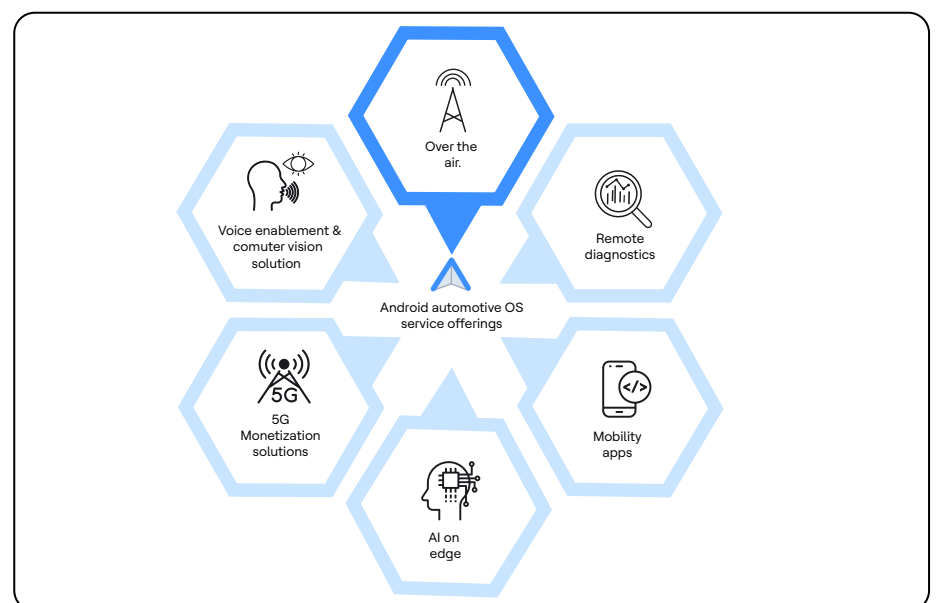
With Google Maps, Google Assistant and the Google Play Store, GAS offers extensive possibilities for connecting a moving vehicle with user data and preferences to a wide range of services, thereby generating new revenue streams. This distinct advantage of AAOS poses a significant threat to the existing infotainment OS. Gartner predicts that by 2028, 70% of vehicles will use Android OS. Analysts believe AAOS is poised to become the leader in the future infotainment space. Currently, the cost of GAS licensing restricts its availability to high-end vehicles. However, the adoption of AAOS is inevitable. The quest for alternative solutions to implement AAOS without GAS opens a massive opportunity for third-party In-Vehicle Infotainment (IVI) solution providers. This whitepaper will explore AAOS's immense potential to enable a new world of vehicle-connected services that will transform the entire automotive industry.



AAOS and its potential

A broad spectrum of service ecosystem

Connected vehicles can open significant opportunities for third-party IVI solution providers. Hands-free tasks such as climate control, music streaming, messaging, navigation, media playback via phone and car-optimized app downloading are now integral to IVI offerings. Furthermore, rear-seat entertainment like Live TV and on-demand video are becoming standard in IVI offerings. One distinct advantage Google offers is its robust navigation solution, supported by a vast user base and real-time content. For car OEMs, adopting an alternative solution would require a considerable leap. Although TomTom provides a substantial alternative, navigation solution providers must enhance User Experience (UX) and incorporate user collaborations and contributions to compete with Google's current offerings. A powerful System-on-Chips (SoCs) with Android Automotive OS compatibility from the semiconductor suppliers will significantly accelerate AAOS adoption, facilitating faster deployment of connected vehicle service applications. The potential of 5G and AI technologies using computer vision and natural language processing in autonomous vehicles will unlock new monetization opportunities for car OEMs and service providers. Platforms like AAOS will enable quick time to market. Let's explore the key areas where there will be an explosion of market adoption.



Over-the-air (OTA)

The development of next-generation trusted platforms for connected cars has two major function categories: remote operations and DATA SDK. Over-the-air (OTA) upgrades for car OEMs will be a significant factor as they enhance user experience and ensure timely upgrades without losing logistic efforts. Gartner predicts automakers will generate new revenue streams after vehicle sales by offering capability upgrades through

OTA. As the entire OS with a new set of loaded apps and features upgrade through OTA, it will be a game changer for the car OEMs to innovate new business use cases and user experience applications that can be loaded onto the user dashboards. In 2022, Volvo announced that it would upgrade the AAOS version through OTA, and they have planned their transition into AAOS by 2027. HCLTech's integrated service offering brings together product engineering expertise to design, develop and test the TCU and ECU components of the OTA update client. This includes integrating the client with the server and complying with standards such as MISRA, ISO26262, AUTOSAR and more.

Mobility apps

Car OEMs have traditionally been hesitant to share vehicle data with Google. However, their growing willingness to adopt Google's standalone operating system with vehicle-specific play stores marks a significant breakthrough. This shift enables OEMs to explore new monetization models and allows multiple third-party applications to roll out various business models, enhancing comfort and lifestyle. Google's extensive customer base and deep understanding of customer preference, combined with vehicle data, can unlock unprecedented business opportunities.

5G solutions

The low latency, high location accuracy and extensive bandwidth of the 5G network will significantly enhance the potential of Google's AAOS in connected vehicles. While telemetry and IVI are prominent use cases for 5G, combining vast data intelligence from vehicles and intricate user data from Google's analytics capabilities can exponentially increase business potential. For example, a family encountering sudden lousy weather on a trip could receive real-time suggestions for alternative plans based on their preferences, weather, traffic and availability, creating a breakthrough driving experience.

Remote diagnostics and maintenance

Although remote diagnostics and maintenance are crucial for customer satisfaction, their adoption could be faster. In-vehicle connectivity, ADAS and communication with external devices have enhanced safety but have yet to be fully monetized. Google's AAOS, in conjunction with 5G, can integrate user patterns and vehicle data to provide real-time insights into predictive maintenance needs. This approach enables OEMs to accurately assess system malfunctions based on vehicle usage history, optimize warehouse management and inform future model designs. Machine learning models could enable advanced AI solutions for remote diagnostics, improving inventory management and maintenance precision.

Computer vision and NLP solutions

Car OEMs have profoundly utilized computer vision for a 360-degree view, automated parking support and numerous automation, all critical for developing self-driving cars. Integrating vehicle data from OEMs with Google's vast user data combined with 5G enablement will enable real-time information for various GenAI solutions. Hands-free operation is a critical feature in vehicles and provides the best-in-class NLP solutions that car OEMs can rely on for their worldwide rollouts.

A compelling use case could be a computer vision model detecting drowsiness, suggesting a nearby break option using 5G location accuracy. The NLP model enables them to explore menu options and book their choice via voice command, completing the payment seamlessly. Such scenarios enhance user experience and open monetization opportunities for multiple industry players through the car's Play Store. This evolution could render smartphones redundant, positioning intelligent In-vehicles at the forefront.

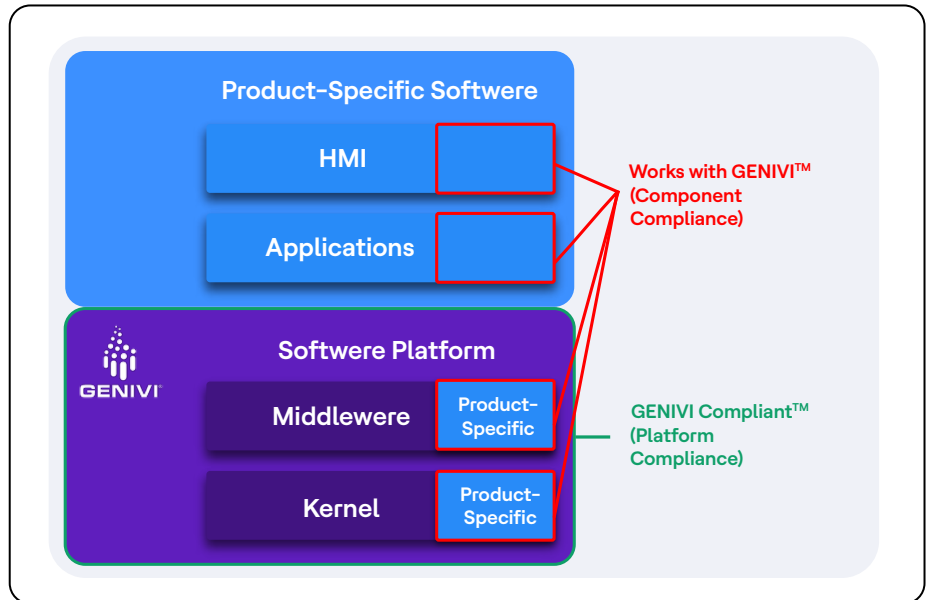
AI on Edge

The high accuracy requirements of computer vision for autonomous vehicles make Edge AI an advantageous solution due to its processing and inference capabilities. The advancement in IVI and AAOS enables embedded AI to develop a new set of business models and promotions. Practical applications include non-invasive methods of detecting body temperature and ensuring contactless authentication at entry gates during a pandemic, measuring the emotional stability of customers at banks or insurance offices, and identifying impatient travelers to mitigate potential security or medical threats. A car rental company could use these technologies to ensure the safety of both customers and drivers by measuring the emotional quotient, which is an undisputed safety feature in many countries. In sizeable earth-moving equipment, a 360-degree view with an auto alert on human intervention or any obstacle will vastly improve safety at construction sites and the ease of operating these earth movers. Truck fleets, which can be tracked with the precise 5G technology aided by Google's navigation and fleet operators' real-time priority, can be well managed with AAOS enablement in IVI systems.

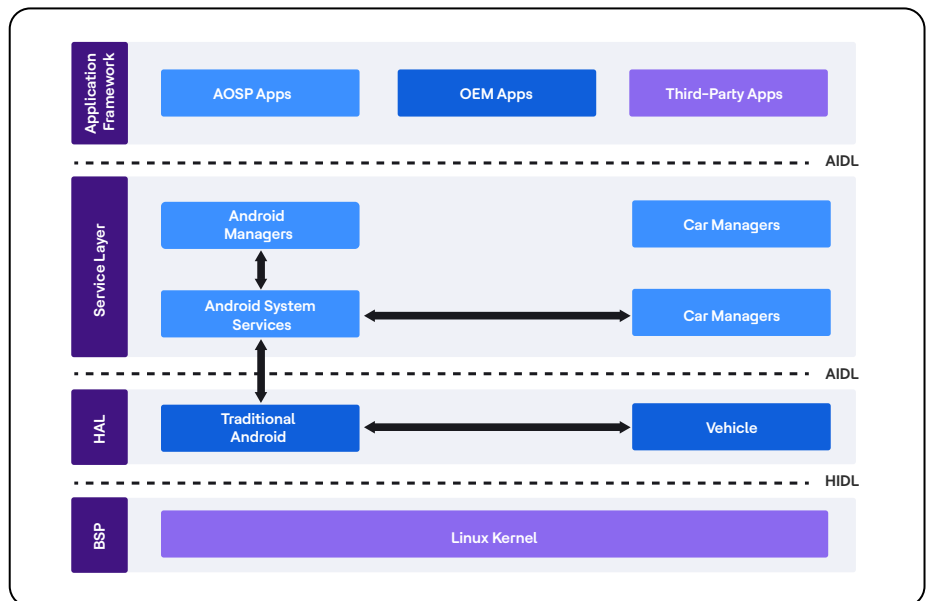
OEMs' journey towards adopting AAOS

The GENIVI Alliance, established in an early 2009, is a non-profit consortium of over 180 automotive industry companies dedicated to promoting collaboration and deployment of open-source software in the automotive electronics business, particularly infotainment. This initiative aimed to simplify and reduce the costs associated with developing, testing, deploying and supporting IVI products and services. A notable goal was to create a platform comprising of about 5% self-developed code, with the remainder being adopted or adapted from existing Open Source Software (OSS) projects.

In October 2021, the GENIVI rebranded as the Connected Vehicle Systems Alliance (COVESA). The primary objective of COVESA is to establish a standardized common software platform for developing IVI systems. By identifying and implementing non-differentiating functionalities common to all IVI systems, the GENIVI platform packages operating system and middleware components but lacks a complete IVI environment. This approach enables manufacturers to concentrate resources on developing higher-level components, such as the application layer and Human Machine Interface (HMI), instead of the base system.



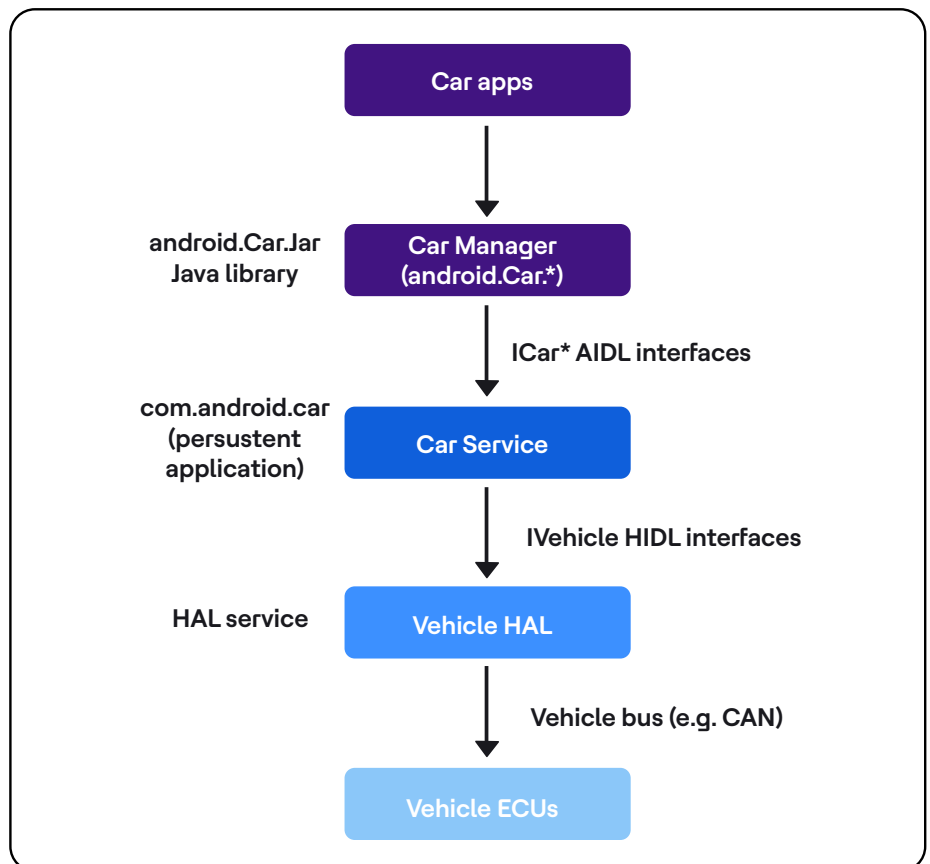
Android Automotive OS operates independently within vehicles and is based on the AAOS, part of the Android Open-Source Project (AOSP). This open-source nature allows third parties to create an IVI product. The GAS Android Automotive infotainment system allows third-party apps available on the Google Play Store. Non-GAS Android Automotive infotainment users can also support third-party apps, provided they are pre-approved and pre-loaded by the car manufacturer.



The codebase in AOSP is relatively minimal, featuring a primary home screen and a few 'demo quality' apps for functions like music and heating controls. This means that auto manufacturers must undertake significant development work to produce a viable product. The use of GAS is a controversial issue. OEMs need to share proprietary vehicle data with Google, potentially losing their competitive edge in monetizing the data. This requirement poses significant concerns regarding data privacy and control.

Android implementation uses a framework-binder IPC for inter-process communication. OEMs must implement the interfaces in the hardware drivers defined by the Android Hardware Abstraction Layer (HAL). Android HAL is the user space C/C++ library layer, unlike the device driver residing in the Android Linux kernel. Apps and system services will require HAL to interact with kernel device drivers. Android inks the HAL API dynamically as needed. Interestingly, Android Device's OEMs often want to use proprietary hardware and associated software drivers. So, putting driver implementation in user space HAL relieves them from releasing their source code.

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The Android for Cars App Library is a set of Jetpack libraries that enable developers to build apps for use in vehicles. It provides a templated framework that provides driving-optimized user interfaces while also adapting to car hardware configurations (for example, input methods, screen sizes and aspect ratios).

Conclusion

Eventually, cars will become moving mobility in operation and revolutionize the world. With the constant evolution of connected vehicle service, new business models and increasing monetization opportunities, a new world of services centered around the drivers and passengers in a moving car will emerge through the 5G adoption, AI adoption, OTA and remote diagnostics services. With its superior navigation and AI assistants, Google will unearth massive potential with its vast customer base and customer data will only see increased adoption, which has transformed the world.

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Narayanan is a part of HCLTech' s ERS vertical and he is responsible for designing and delivering solutions to address HCLTech' s clients in multiple verticals to build solutions in the Android Auto ecosystem from HCLTech India. For over two decades in Japan, Narayanan has been involved in developing various solutions in the parking system industry, Printing Industry and IOT/AI enablement of consumer electronics products in his 24+ years at HCLTech.

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