Android Automotive OS

A short introduction to Google's AAOS
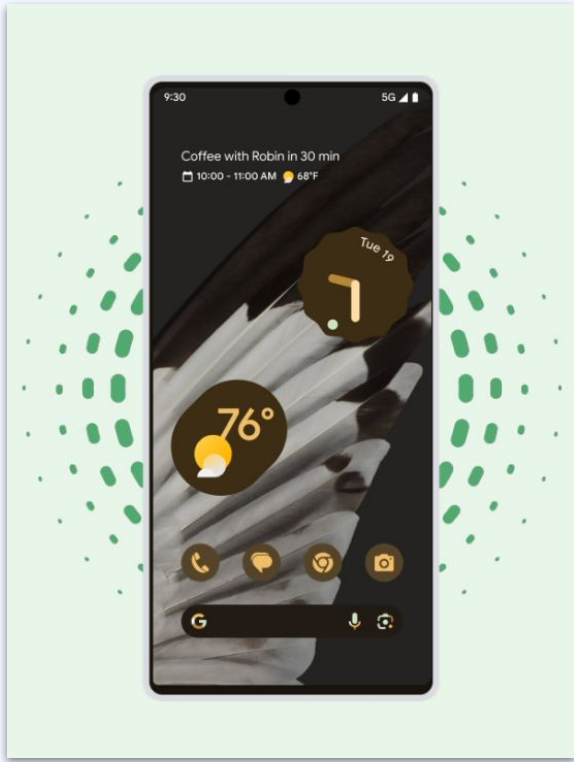
Anna-Lena Marx

March 12th, 2024 · Munich

Anna-Lena Marx

Embedded Systems Developer

- since 2015 with inovex
- has a Master's degree in Embedded Systems
- studies Electrical Engineering as a hobby

Main Topics

- Embedded Systems
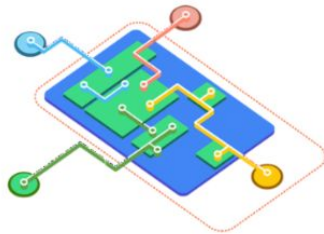- Yocto Linux
- Linux Kernel
- AOSP/AAOS
- IoT

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Android
Open Source Project

Android unites the world. Use the open source Android operating system to power your device.
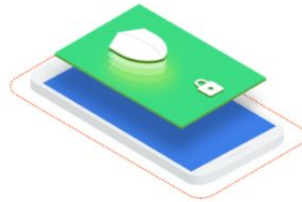
Get source

Search

Interfaces and architecture

Learn how the pieces fit together, from the kernel to the HALs to updatable system components.

Understand architecture

Android security is essential

Find out how the Android security program works and learn how to implement the latest features.

Implement security
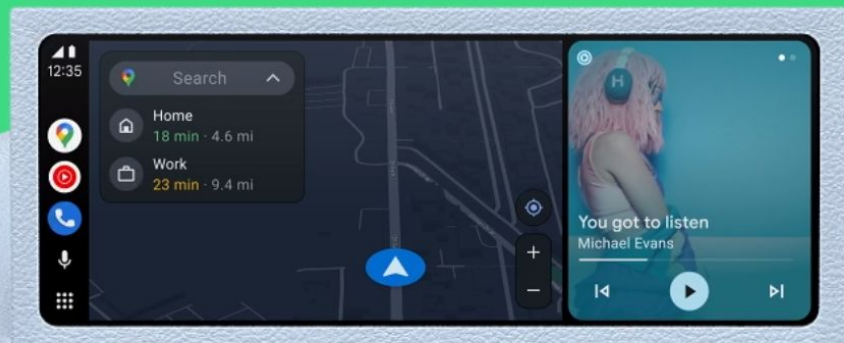
Design compatible devices

Offer consistent experiences across different Android-powered devices for users and app developers.
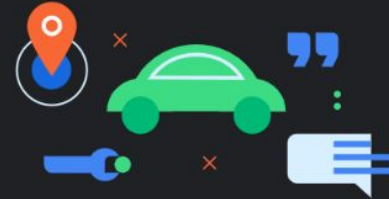
Test devices

https://source.android.com/

Android Automotive

Android Automotive is a full-stack, open source, highly customizable platform running directly on in-vehicle hardware.

Learn More

Guidelines for Development

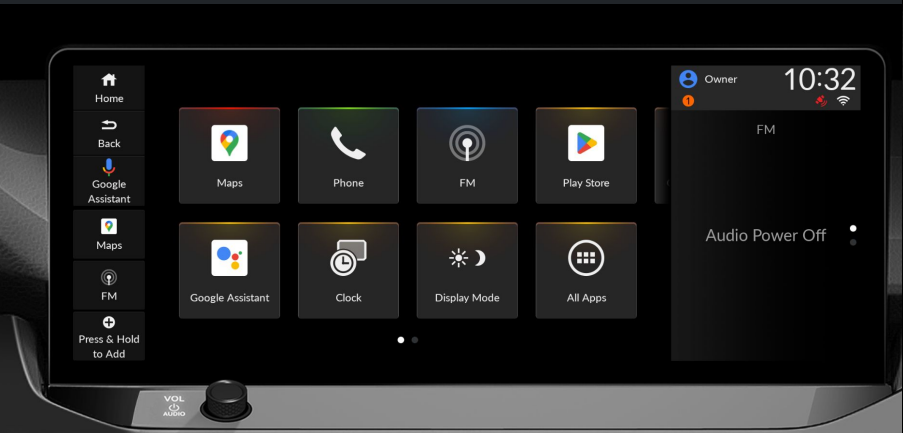Learn about our extensive ecosystem of guidelines specific to the development of Automotive apps.
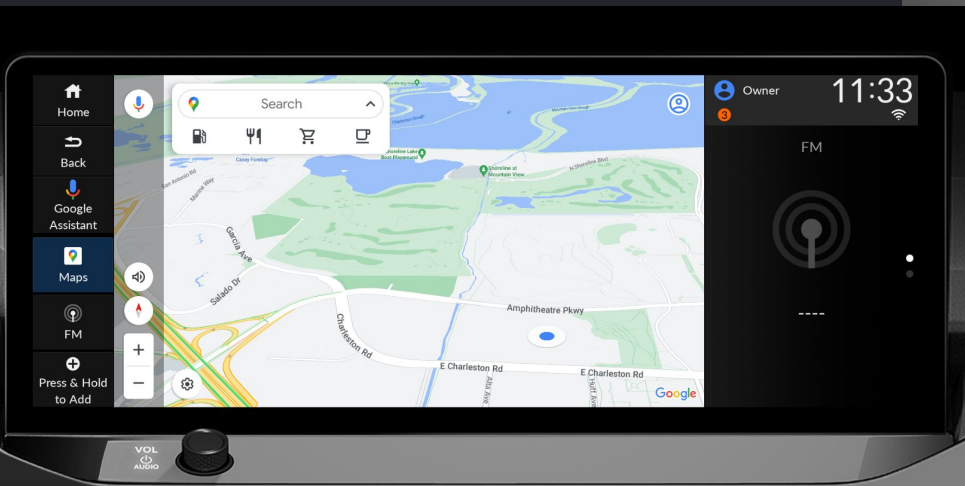
Development Tools

Read about the tools we provide to support your development of AAOS-based apps.

Testing Tools

See the scalable infrastructure and robust set of testing tools we provide so you can maximize your efficiency and ensure compliance.

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Left Top Screen (Maps)

Home
Back
Google Assistant
Maps
FM
Press & Hold to Add

Search

Owner
11:33
FM

Amphitheatre Pkwy
E Charleston Rd
E Charleston Rd
Charleston Rd
Garcia Ave
Salado Dr
Casey Forbay
N San Antonio Rd
N Shoreline Blvd
Shoreline Lake Boat Rental

Google

VOL AUDIO

Left Bottom Screen (Home)

Home
Back
Google Assistant
Maps
FM
Press & Hold to Add

Maps
Phone
FM
Play Store

Google Assistant
Clock
Display Mode
All Apps

Owner
10:32
FM

Audio Power Off

VOL AUDIO

Right Screen (Charge)

9:44

Drive   Assist   Charge   More

%
Error

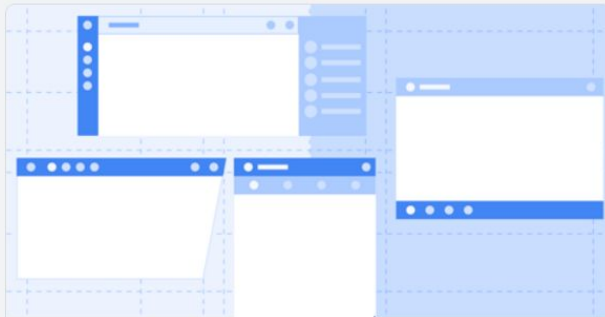Charge limit %   40   50   60   70   80   90   100
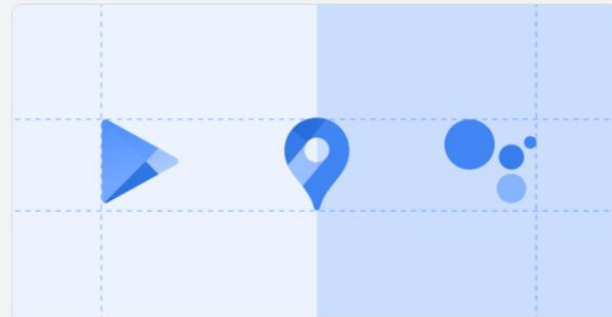
─   +

Android Auto

Android Auto provides users of Android phones with an app experience designed for cars. If a car's head unit supports Android Auto, users can access apps directly on their car's display by connecting their phone.

App developers can support Android Auto by adding services to their phone apps. Android Auto then uses those services to display an interface designed to work well on the screen configurations of all compatible cars.

Android Automotive OS (AAOS)

AAOS is an infotainment system built into vehicles by car makers. Android apps that support AAOS requirements can be downloaded from the Google Play Store to any car manufactured by a Google Automotive Services (GAS) partner. Instead of using a particular phone app, users install a version of the app that is designed for cars directly onto the head unit.

Google Automotive Services (GAS)

Car makers who wish to provide Google services such as Maps, Play Store, Assistant, and so on can work directly with Google to support GAS. GAS consists of software built on top of Android Automotive OS for the purpose of delivering such services.

https://developers.google.com/cars

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The Android Open Source Project

Two levels of compatibility:

AOSP compatibility
defined by
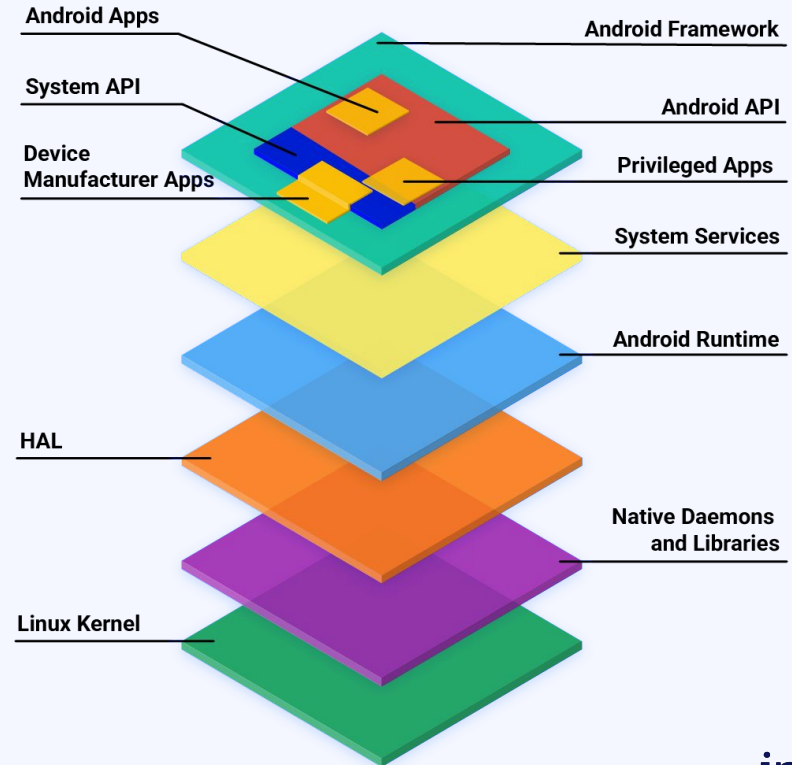Compatibility Definition Document (CDD)

Android compatibility
CDD plus
- Vendor Software Requirements (VSR)
- Vendor Test Suite (VTS)
- Compatibility Test Suite (CTS)

Additional step:
Licensing Google Mobile Services (GMS)
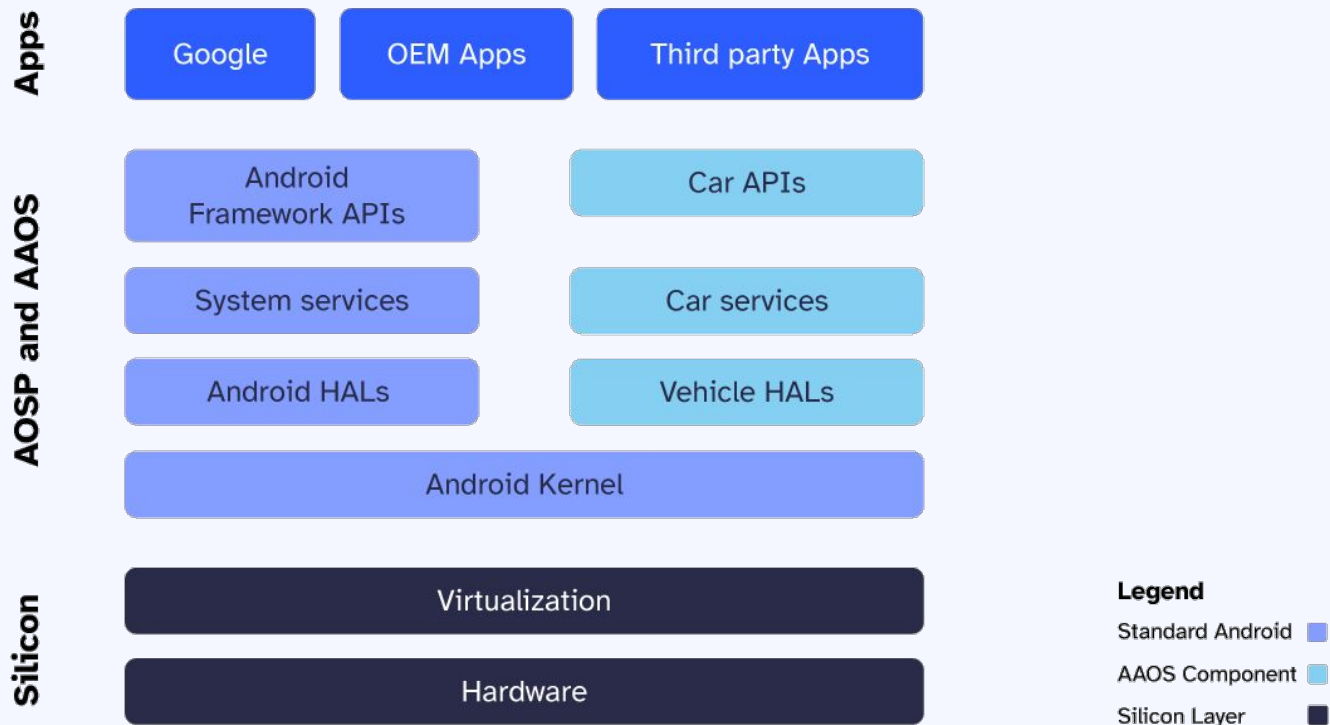- Google Apps (Youtube, Maps, Gmail etc.)

Android Apps
System API
Device Manufacturer Apps

Android Framework
Android API
Privileged Apps
System Services
Android Runtime
HAL
Native Daemons and Libraries
Linux Kernel

https://source.android.com/docs/core/architecture

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It's already there!

Apps

| Google | OEM Apps | Third party Apps |

AOSP and AAOS

Android Framework APIs	Car APIs
System services	Car services
Android HALs	Vehicle HALs
Android Kernel	

Silicon

| Virtualization |
| Hardware |

Legend

Standard Android
AAOS Component
Silicon Layer

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Car

Links ▾

AAOS

Source code for Android Automotive OS.

Structure

Load more

⌃ **Files and Directories**

📁 FrameworkPackageStubs/	📁 car-evs-helper-lib/	📁 car-maps-placeholder/	📁 cpp/	📁 packages/	📁 tests/
📁 apex_car_framework/	📁 car-helper-lib/	📁 car-test-lib/	📁 data/	📁 procfs-inspector/	📁 tools/
📁 car-admin-ui-lib/	📁 car-lib/	📁 car-usb-handler/	📁 experimental/	📁 service/	📁 vehicle-hal-support-lib/
📁 car-builtin-lib/	📁 car-lib-module/	📁 car_product/	📁 obd2-lib/	📁 service-builtin/	

📄 .clang-format	📄 Android.mk	📄 CleanSpec.mk	📄 OWNERS_networking	📄 README.md
📄 .gitignore	📄 CPPLINT.cfg	📄 OWNERS	📄 PREUPLOAD.cfg	📄 TEST_MAPPING

Structure

```
car_product/          - AAOS product
car-builtin-lib/      - A helper library for CarService to access hidden
                        framework APIs
car-lib/              - Car API
car-lib-module/       - Car API module
cpp/                  - Native services
experimental/         - Experimental Car API and services
packages/             - Apps and services for cars
service/              - Car service module
service-builint       - Platform builtin component that runs CarService module
tests/                - Tests and sample apps
tools/                - Helper scripts
```

C++

Native (C++) code format is required to be compatible with .clang-format file. The formatter is already integrated to `repo` tool. To run manually, use:

```
git clang-format --style=file --extension='h,cpp,cc' HEAD~
```

Note that clang-format is *not* desirable for Android java files. Therefore the command line above is limited to specific extensions.

Debugging CarService

Dumpsys and car shell can be useful when debugging CarService integration issues.

dumpsys

```
adb shell dumpsys car_service # to dump all car service information
adb shell dumpsys car_service --services [service name] # to dump a specific service information
adb shell dumpsys car_service --list # get list of available services
```

Dumpsys for CarService includes the following (more information is availble in dumpsys, below are just highlights):

platform/superproject/main ▾ ❯ ▦ main ▾ ❯ hardware/interfaces/automotive

Files   Outline

Repository root

▾ 📁 interfaces
  ▸ apexkey
  ▸ atrace
  ▸ audio
  ▸ authsecret
  ▾ **automotive**
    ▸ audiocontrol
    ▸ can
    ▸ evs
    ▸ ivn_android_device
    ▸ occupant_awareness
    ▸ remoteaccess
    ▸ sv
    ▸ vehicle
    📄 OWNERS
    📄 README.md
    📄 TEST_MAPPING

automotive

Links ▾

Autmotive HALs

Overview:

The automotive HAL tree is used by Android Automotive to discover and operate hardware specific to a car.

The HALs are not (yet) frozen, as the HAL definition is expected to evolve between Android releases.

˄   **Files and Directories**

📁 audiocontrol/   📁 evs/   📁 occupant_awareness/   📁 sv/
📁 can/   📁 ivn_android_device/   📁 remoteaccess/   📁 vehicle/

📄 OWNERS   📄 README.md   📄 TEST_MAPPING

14

Files   Outline

Repository root

▼ 📁 interfaces
  ▸ apexkey
  ▸ atrace
  ▸ audio
  ▸ authsecret
  ▼ automotive
    ▸ audiocontrol
    ▼ can
      ▼ 1.0
        ▸ default
        ▸ hidl-utils
        ▸ tools
        ▸ vts
        📄 Android.bp
        📄 ICanBus.hal
        📄 ICanController.hal
        📄 ICanErrorListener.hal

1.0   Links ▾

^   **Files and Directories**

📁 default/   📁 hidl-utils/   📁 tools/   📁 vts/

📄 Android.bp   📄 ICanController.hal   📄 ICanMessageListener.hal   📄 types.hal
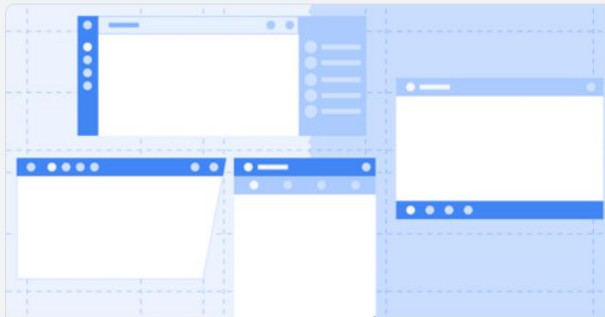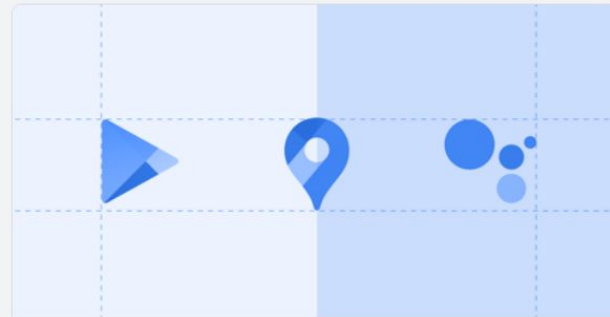📄 ICanBus.hal   📄 ICanErrorListener.hal   📄 ICloseHandle.hal

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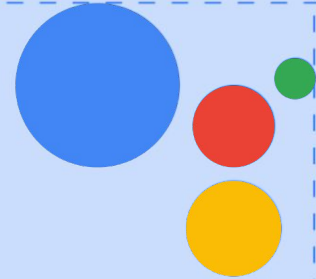Car makers who wish to provide Google services such as Maps, Play Store, Assistant, and so on can work directly with Google to support GAS. GAS consists of software built on top of Android Automotive OS for the purpose of delivering such services.

https://developers.google.com/cars

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Google Play

Google Maps

Google Assistant

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Why is AAOS interesting for car manufacturers?

Android is an ECOSYSTEM

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AAOS is a platform to build vehicles

Matured code infrastructure of the AOSP

- graphics, video and media support
- connectivity stack
  - WiFi
  - Bluetooth
  - cellular
- security mechanisms
  - verified boot
  - SELinux
  - app isolation – secure runtime for untrusted apps
- updates mechanism

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AAOS is familiar to app developers and users

Matured application development ecosystem

- an UI/UX concept people are already familiar with
  - platform focuses on UX!

- well-known app developer ecosystem
  - standardized **APIs** with a good abstraction level
  - extensive set of system and third-party **libraries**
  - pretty good and in depth **documentation**
  - large eco system of existing apps
  - lots of *good* Android **app developers**

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… and it's open

There are alternatives to the Google Automotive Services

- Automotive focused app stores

- Navigation providers

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Android Automotive OS with Google Automotive Services

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Only Android Automotive OS
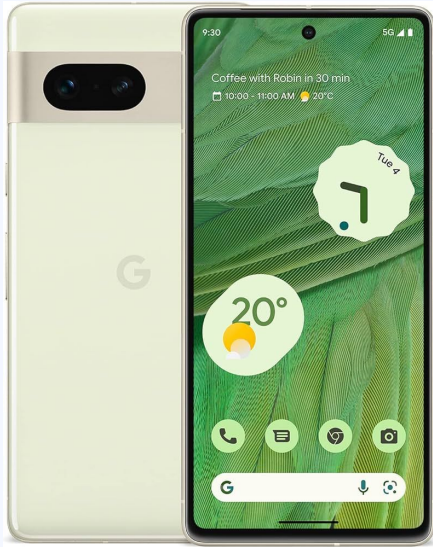
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- lifes 5-6 years as a maximum
- typical Google support range:
  ~ 2-3 years

- average lifetime: 18 years

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2014

Lebensdauer in Jahren

Volkswagen	Honda, Mitsubishi	Toyota, BMW, Audi, Volvo, Mercedes	Opel, Nissan, Skoda, Renault	Durchschnitt	Seat, Citroen, Suzuki, Ford, Mazda	Daihatsu, Fiat, Hyundai	Alfa Romeo, Lancia, Kia
26	22	19	18	18	17	16	14

https://de.statista.com/statistik/daten/studie/316498/umfrage/lebensdauer-von-autos-deutschland/
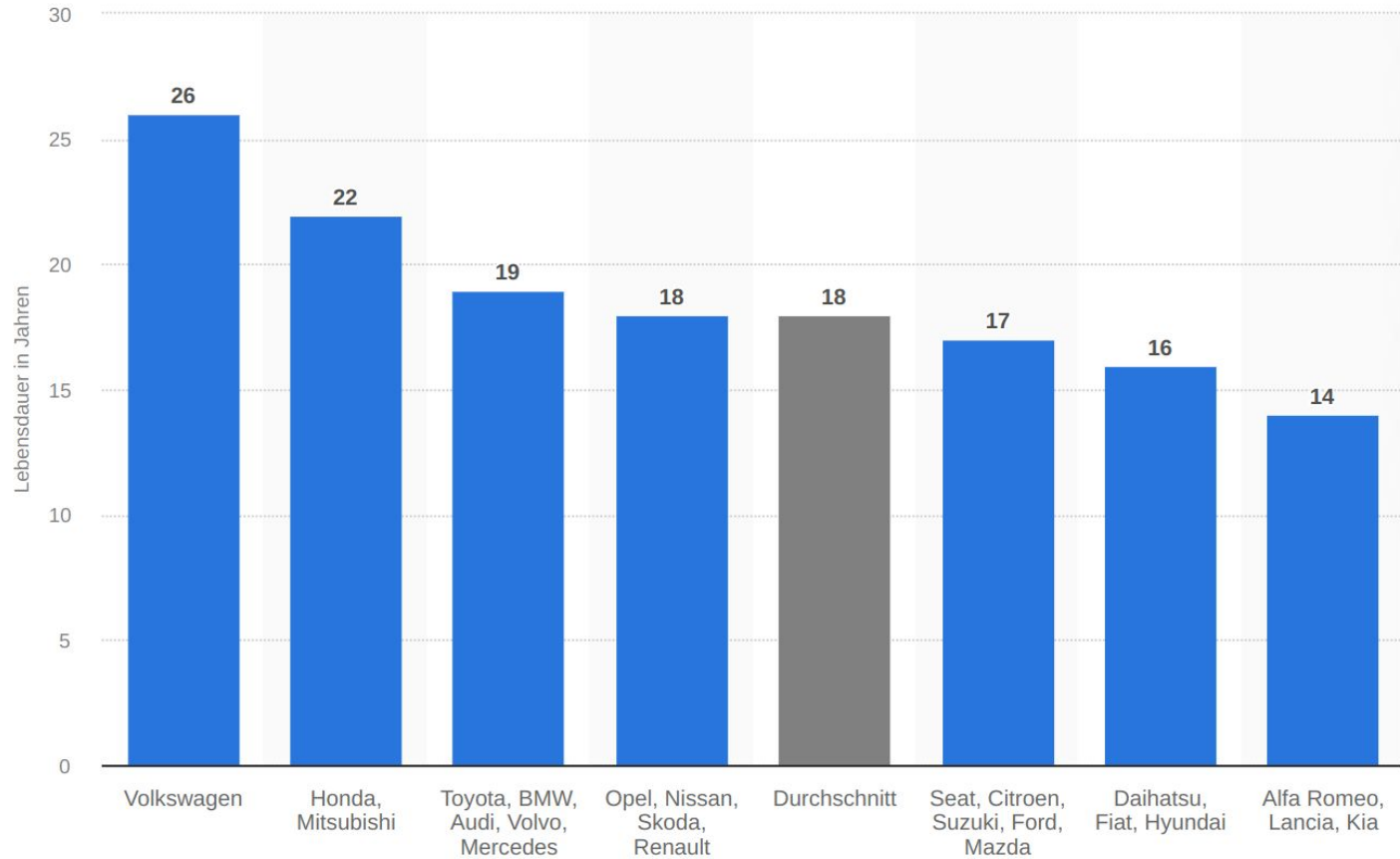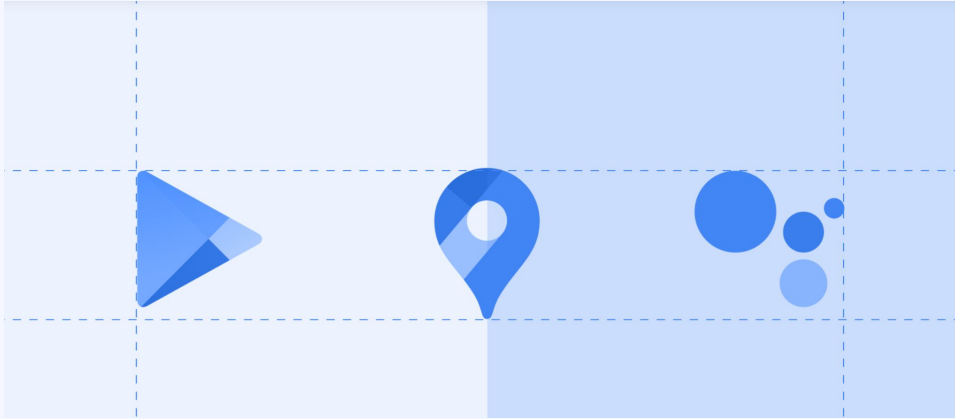
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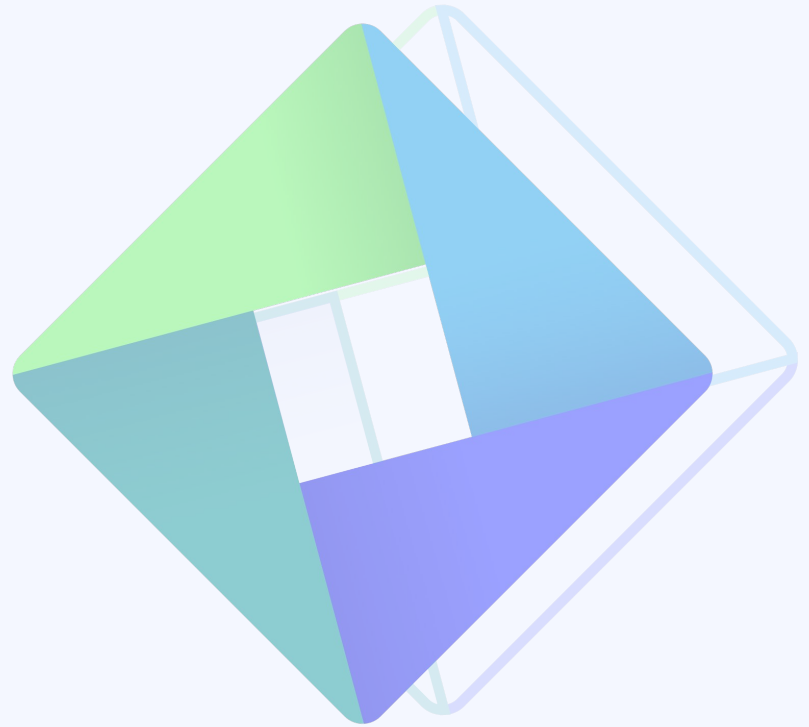
Google Automotive Services

vs.

Third-Party Providers

And where do the necessary AOSP devs come from?

Let's discuss!

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Embedded Systems Dev

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Further Reading

- [What is Android Automotive?](#)
- [A perspective on Android Automotive (AAOS) from an Android TV guy](#)
- [Android Automotive, the Real Android Fragmentation](#)
- [The state of Android Automotive in 2024](#)

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