Developing with Drive Playback

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VOLVO

remotiveLabs

Sharing signal data in automotive is complex and hindering collaborations

OEM
Proprietary data

3rd parties/
partners

Background

- VSS removes our proprietary issue with sharing sensor data.
- Faster prototyping and faster to production for Android automotive applications
- Facilitating 3rd party development
- Edge device, model training that eliminates need of sending all sensor data to cloud
- Proprietary free emulator

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android

COVESA

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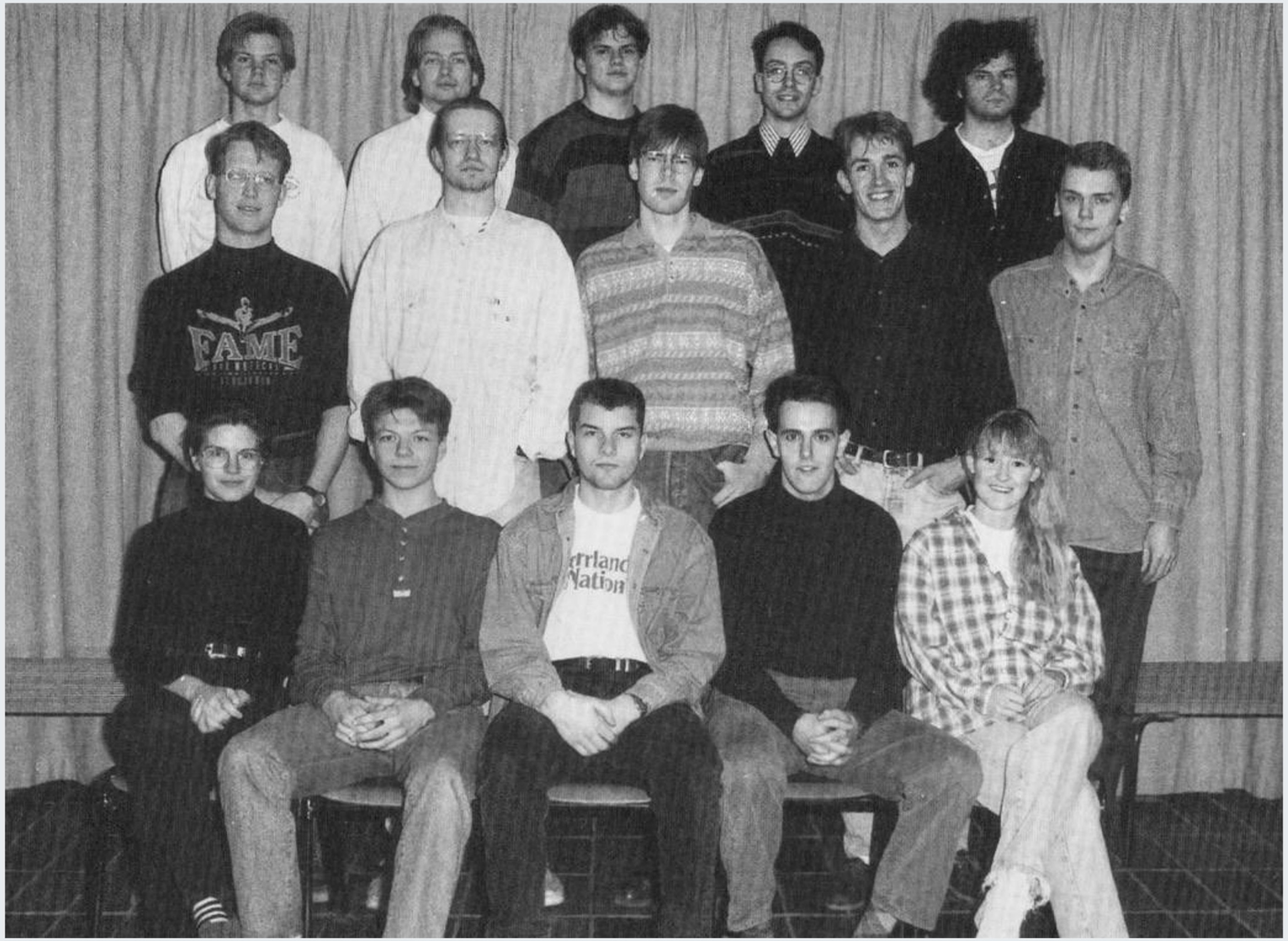
The history
– software in cars

- ABS
- Airbags
- Vehicle Dynamics

Starting end 1980s /early 1990s

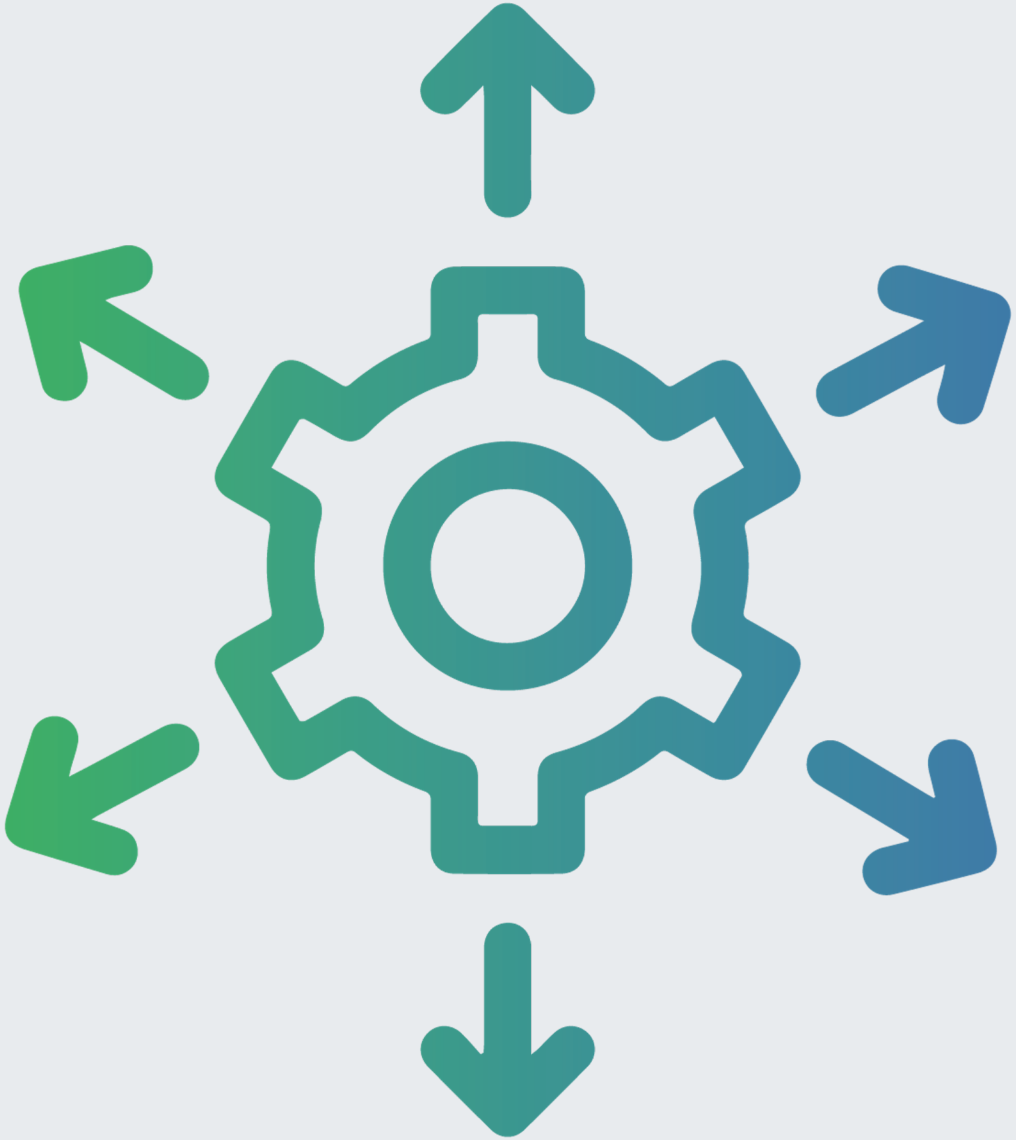


And this is how future engineers looked like back then

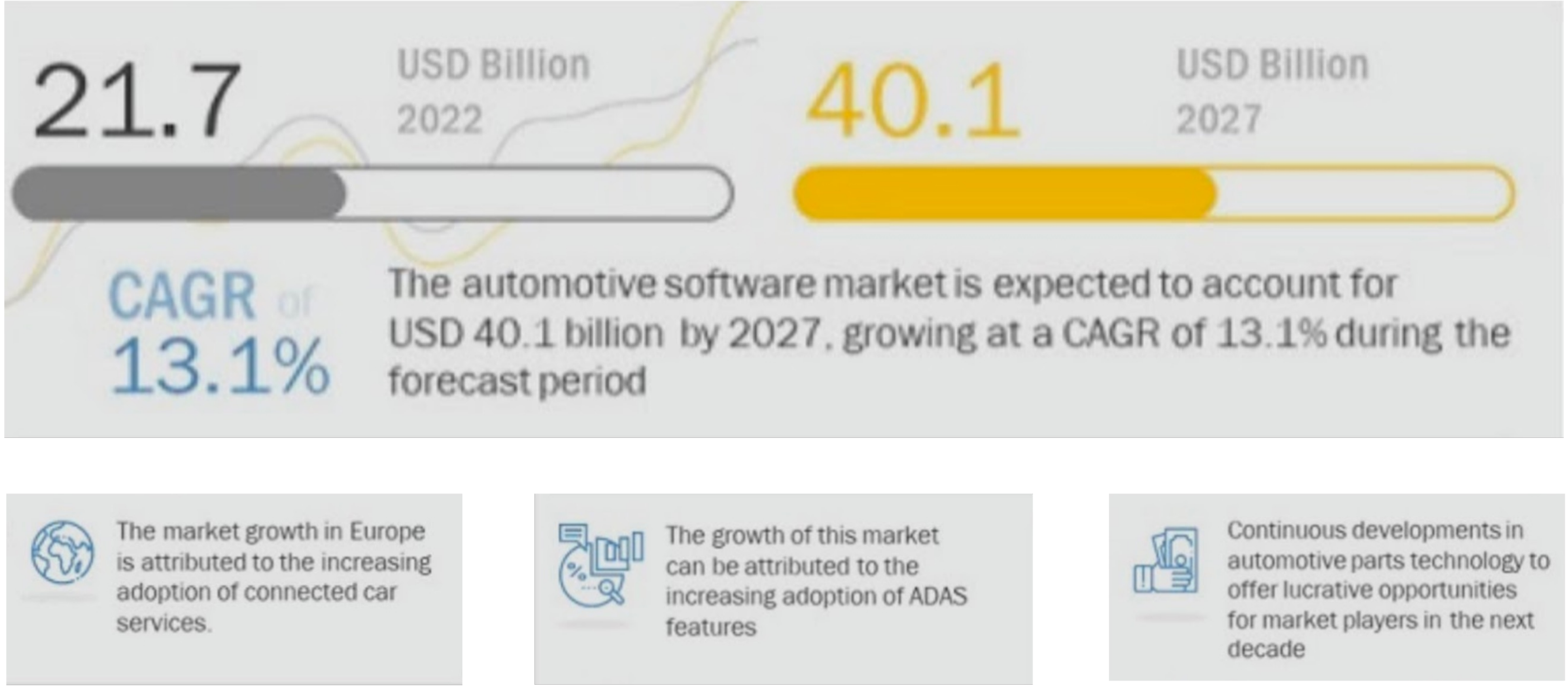
The present

- SW a main differentiator
- Driver in megatrends

Software is everywhere



Outlook on the automotive software market



21.7 USD Billion 2022

40.1 USD Billion 2027

CAGR of 13.1%

The automotive software market is expected to account for USD 40.1 billion by 2027, growing at a CAGR of 13.1% during the forecast period

The market growth in Europe is attributed to the increasing adoption of connected car services.

The growth of this market can be attributed to the increasing adoption of ADAS features

Continuous developments in automotive parts technology to offer lucrative opportunities for market players in the next decade

Source: Market reports

The complexity growth ≈ 300 percent

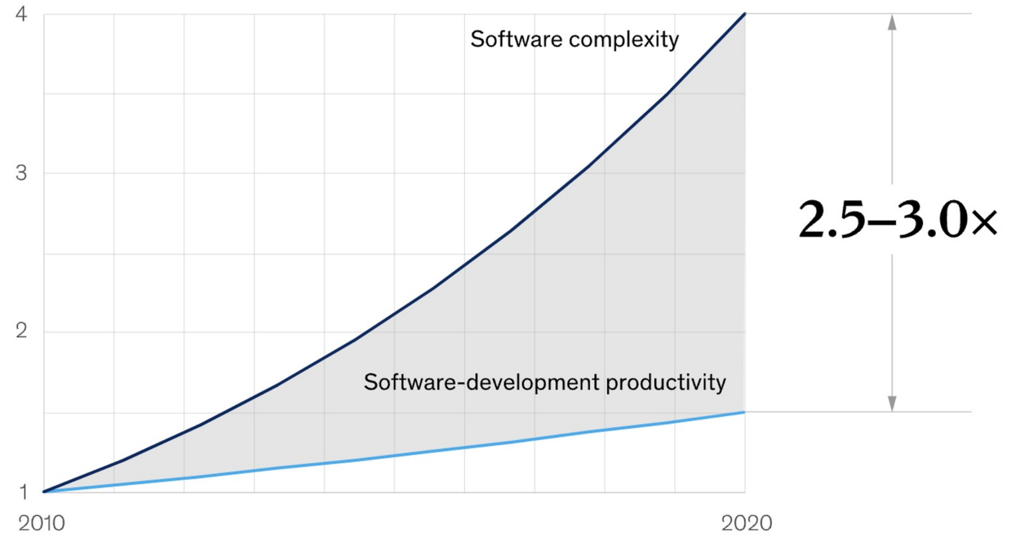
Every vehicle has:

- *100 control units*
- *+1000 software components*
- *+10,000 signals exchanged between subsystems*

*All to be **designed, developed, integrated, tested, and validated** to work individually as well as in conjunction with each other.*

Growth in software complexity more than doubles the growth in software-development productivity.

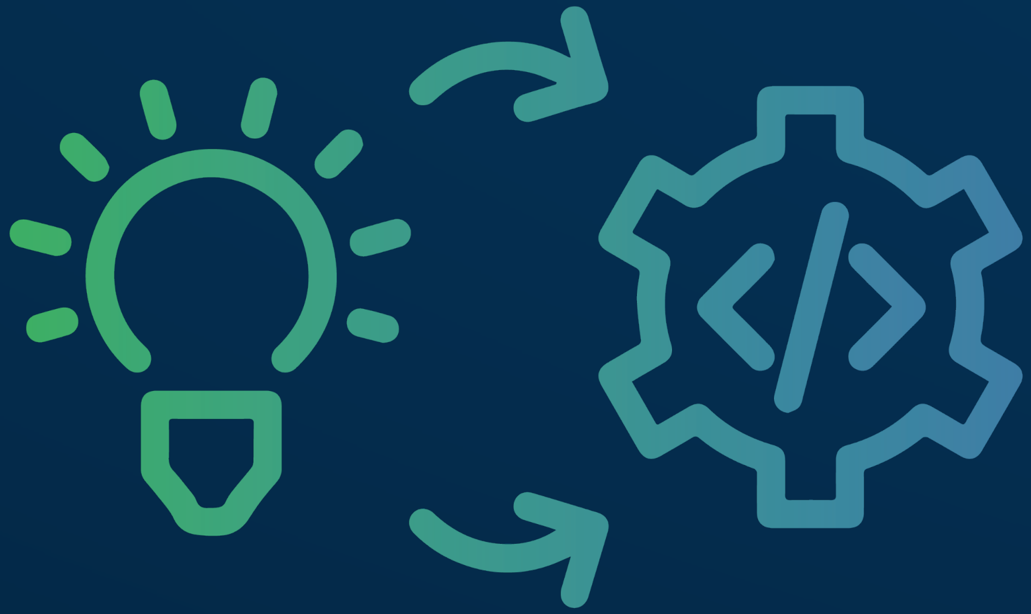
Relative growth over time, for automotive features, indexed, 1 = 2010



Source: Numetrics

McKinsey & Company

Optimize for iteration speed

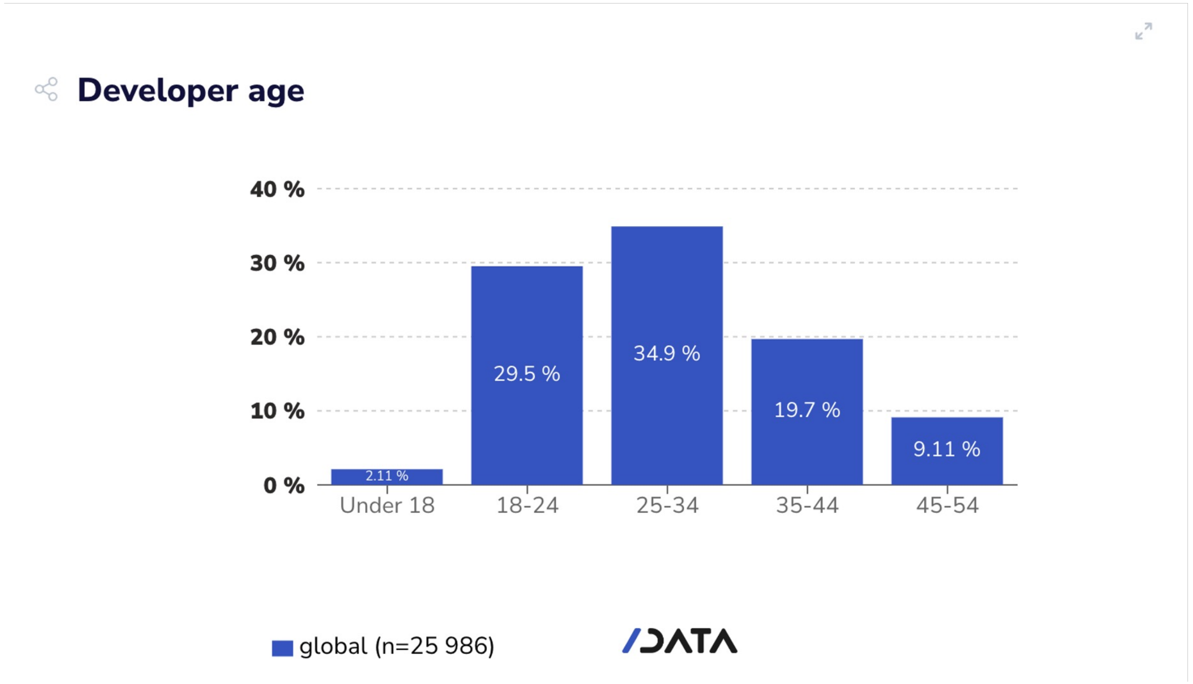


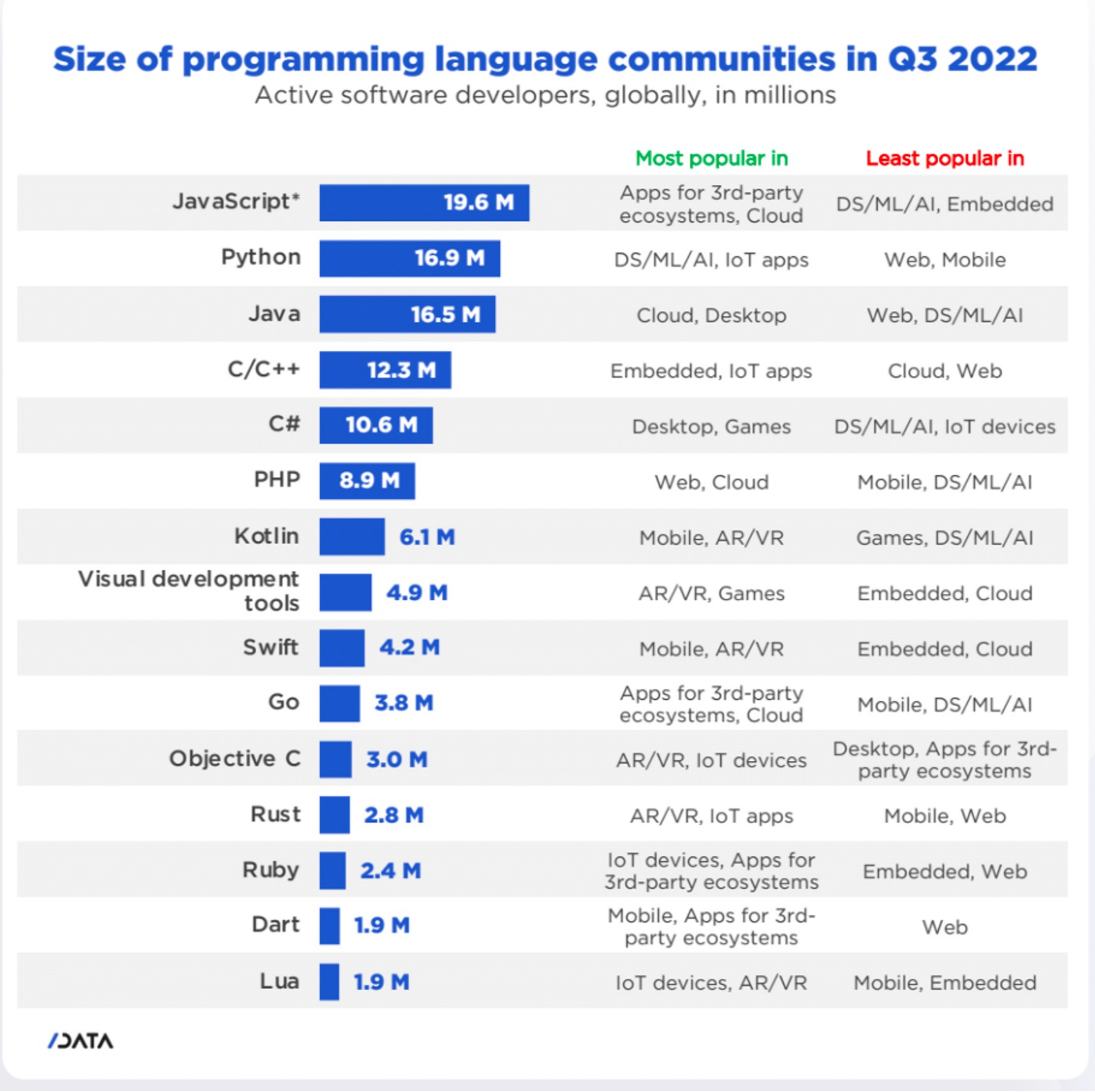
What Makes A Good Engineering Culture
by Edmond Lau

Quick iteration speed increases work motivation and excitement. Infrastructural and ***bureaucratic barriers to deploying code and launching features*** *are some of the most common and frustrating reasons that engineers cite during interviews for why they're leaving their current companies.*

To get stuff done - attract software developers

Developer Nation report: **33.6 million** active software developers worldwide





Size of programming language communities in Q3 2022

Active software developers, globally, in millions

		Most popular in	Least popular in
JavaScript*	19.6 M	Apps for 3rd-party ecosystems, Cloud	DS/ML/AI, Embedded
Python	16.9 M	DS/ML/AI, IoT apps	Web, Mobile
Java	16.5 M	Cloud, Desktop	Web, DS/ML/AI
C/C++	12.3 M	Embedded, IoT apps	Cloud, Web
C#	10.6 M	Desktop, Games	DS/ML/AI, IoT devices
PHP	8.9 M	Web, Cloud	Mobile, DS/ML/AI
Kotlin	6.1 M	Mobile, AR/VR	Games, DS/ML/AI
Visual development tools	4.9 M	AR/VR, Games	Embedded, Cloud
Swift	4.2 M	Mobile, AR/VR	Embedded, Cloud
Go	3.8 M	Apps for 3rd-party ecosystems, Cloud	Mobile, DS/ML/AI
Objective C	3.0 M	AR/VR, IoT devices	Desktop, Apps for 3rd-party ecosystems
Rust	2.8 M	AR/VR, IoT apps	Mobile, Web
Ruby	2.4 M	IoT devices, Apps for 3rd-party ecosystems	Embedded, Web
Dart	1.9 M	Mobile, Apps for 3rd-party ecosystems	Web
Lua	1.9 M	IoT devices, AR/VR	Mobile, Embedded

/DATA

Software ownership is crucial

Increase speed and reduce risk

With an iterative way of working

Innovate & realize new ideas

With the right people

Software-centric development

With seamless collaboration

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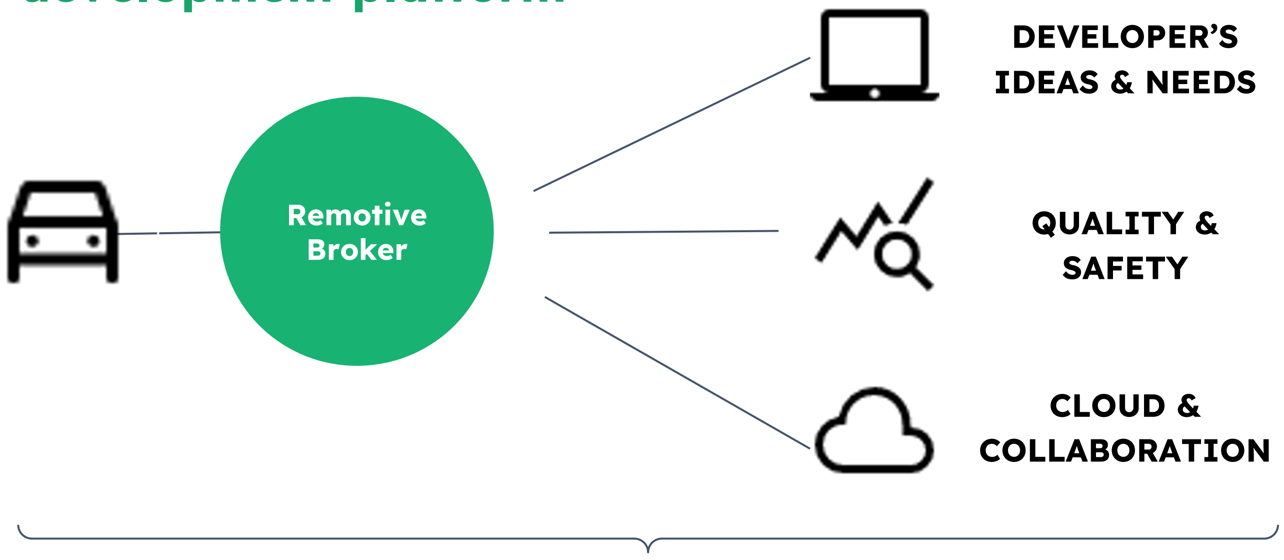
Agile, flexible & lightweight development platform



Remotive Broker

DEVELOPER'S IDEAS & NEEDS

QUALITY & SAFETY

CLOUD & COLLABORATION

Process, language & hardware agnostic

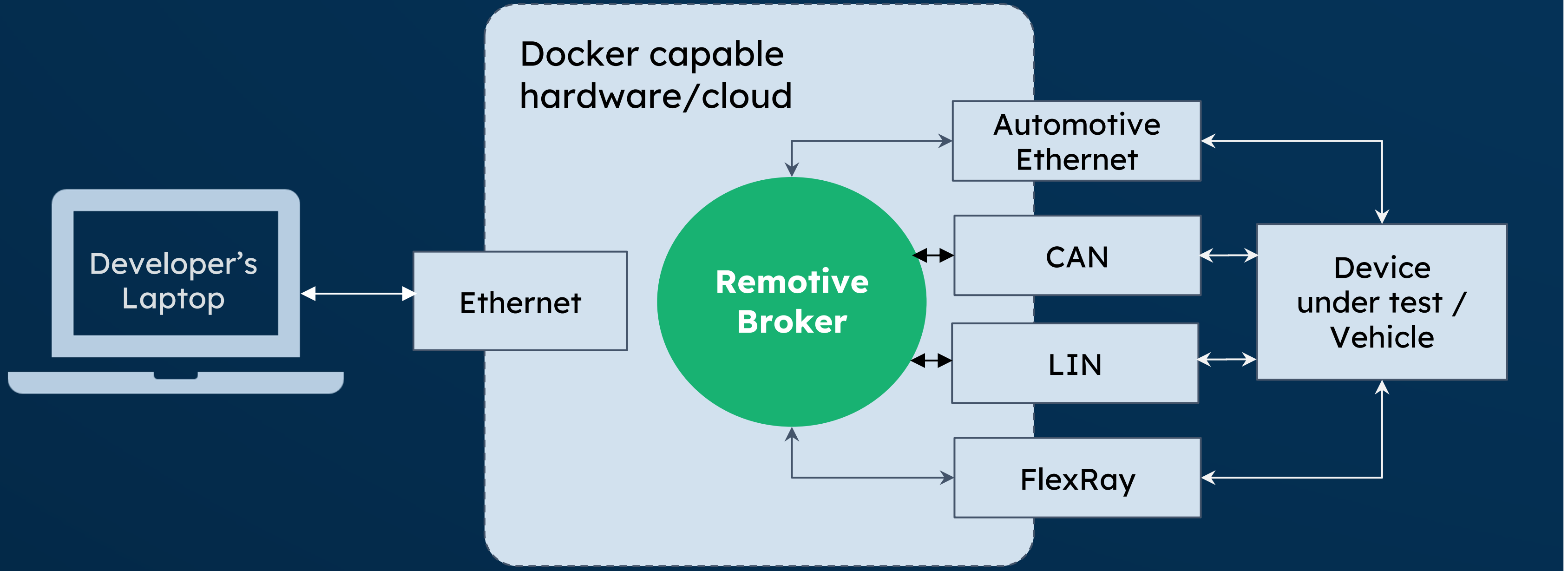
Business drivers

Innovation speed

Software ownership

Best practices & partner up

RemotiveBroker (a.k.a software ECU)
- the core component and data aggregator



Protocols and features

Supports gRPC
Use the programming language of your choice including Python, Rust, C++ etc.

Supported network protocols
CAN (.dbc), SocketCAN, FlexRay (fibex /arxml), LIN (.ldf), UDP arxml, LDF.

Record and playback
Easy to record signals - replay locally or in the cloud

Remote access
Access the product from anywhere over the Internet

Hardware of your choice

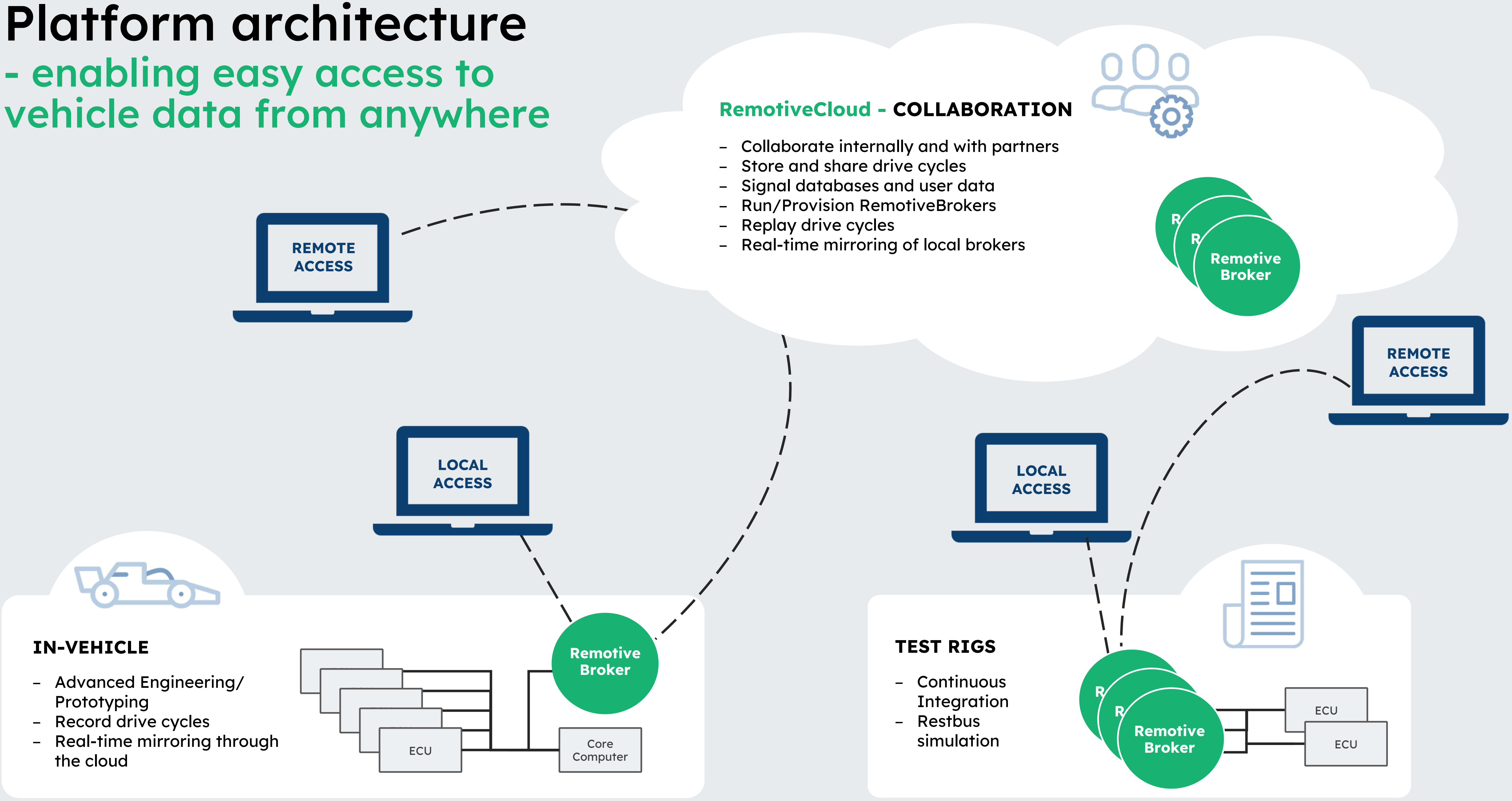
Any Linux/Docker-capable HW
Just download the Docker-image, e.g. to development PC or Nvidia Drive

Host Mobility
Preconfigured
- HMX
- MX-4 T30 FR

RemotiveBox
Raspberry Pi + CAN shield

Platform architecture

- enabling easy access to vehicle data from anywhere



RemotiveCloud - COLLABORATION

- Collaborate internally and with partners
- Store and share drive cycles
- Signal databases and user data
- Run/Provision RemotiveBrokers
- Replay drive cycles
- Real-time mirroring of local brokers

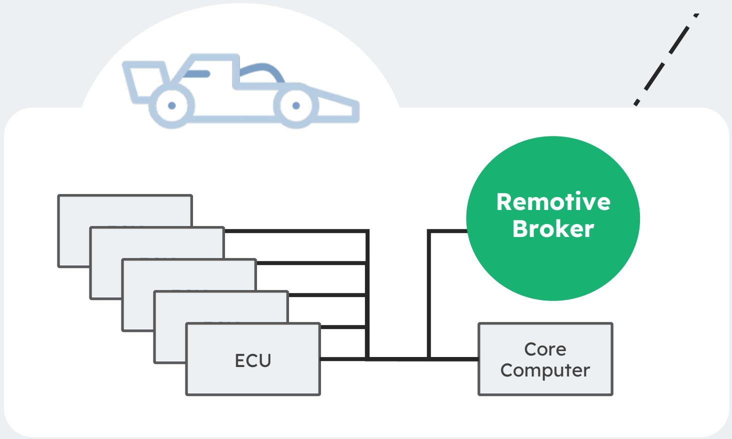
IN-VEHICLE

- Advanced Engineering/ Prototyping
- Record drive cycles
- Real-time mirroring through the cloud

TEST RIGS

- Continuous Integration
- Restbus simulation

Solution overview

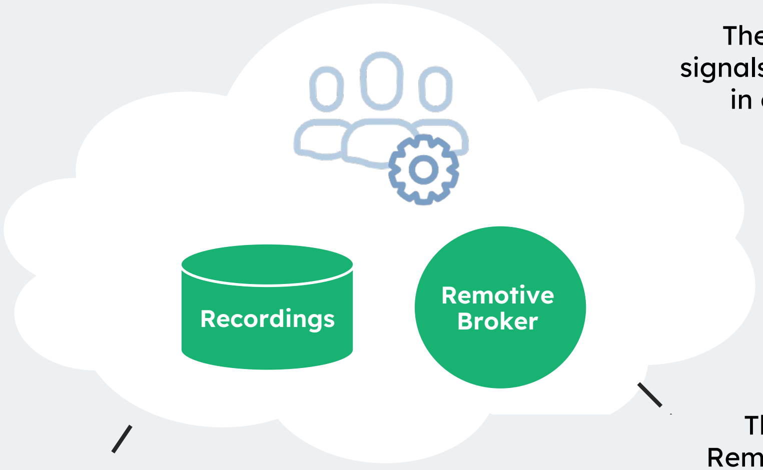


1. RECORD DRIVE CYCLES

A RemotiveBroker records drive cycles scenarios including potential errors in any vehicle, that could be a mule in early stage development

2. UPLOAD DRIVE CYCLES

The recorded drive cycles are uploaded and stored in the cloud

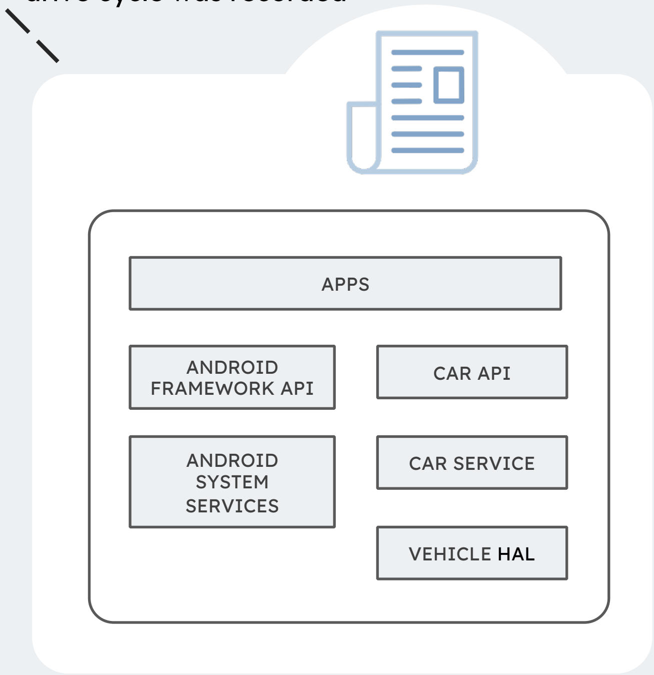


3. FILTER AND SHARE

The relevant signal set is filtered out and signals are renamed according to COVESA VSS in order to hide proprietary information

4. REPLAY DRIVE CYCLE

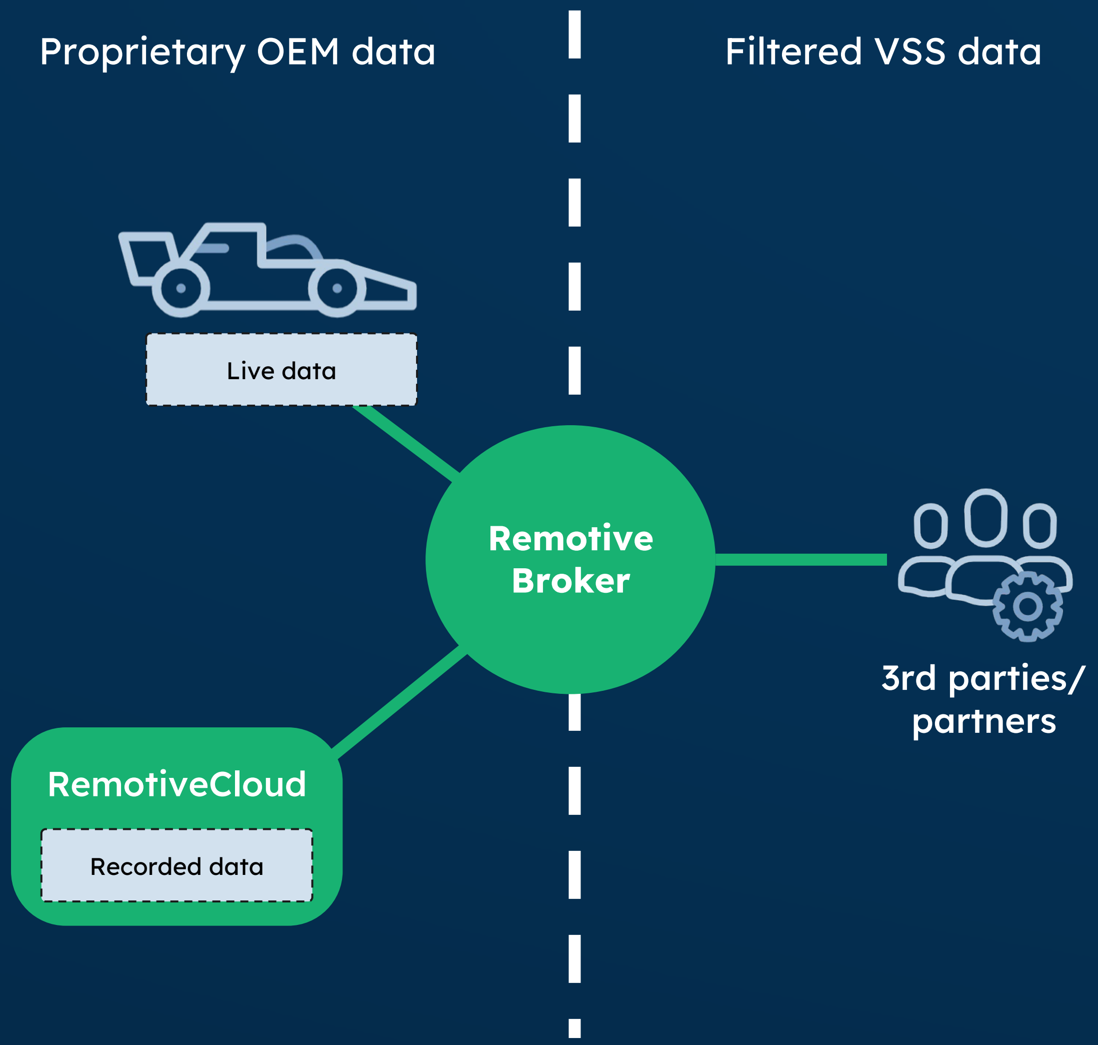
The custom Vehicle HAL connects to the RemotiveCloud and starts the playback of the drive cycle; with the result that the AAOS stack thinks it is running in the vehicle where the drive cycle was recorded



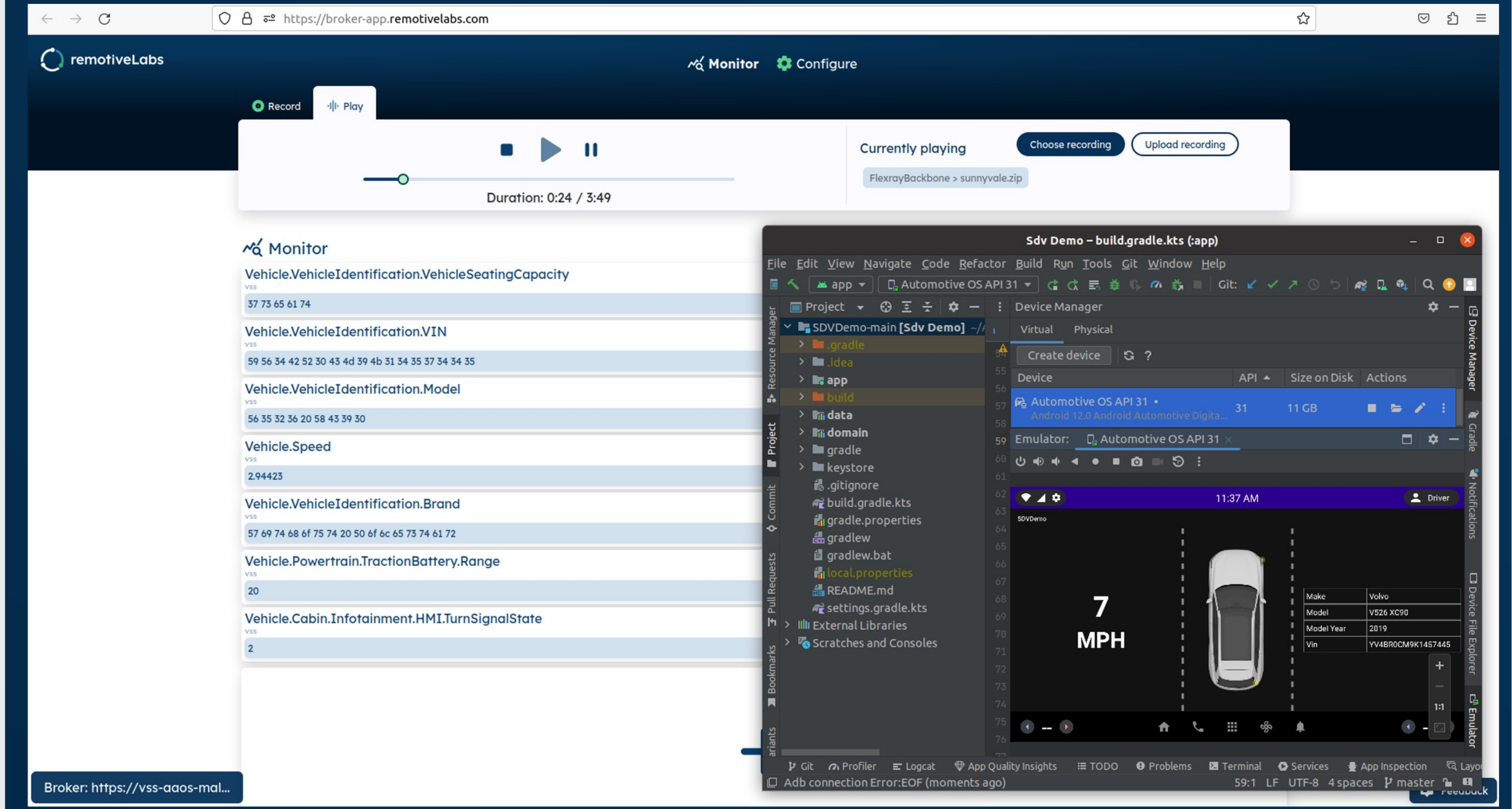
Case study: COVESA & VSS

Share signals according to VSS

- No issue with different naming conventions
- OEMs choose exactly what to share
- Collaborate, innovate & get stuff done!



Demo - introduction



Duration: 0:24 / 3:49

Monitor

Vehicle.VehicleIdentification.VehicleSeatingCapacity
vss
37 73 65 61 74

Vehicle.VehicleIdentification.VIN
vss
59 56 34 42 52 30 43 4d 39 4b 31 34 35 37 34 34 35

Vehicle.VehicleIdentification.Model
vss
56 35 32 36 20 58 43 39 30

Vehicle.Speed
vss
2.94423

Vehicle.VehicleIdentification.Brand
vss
57 69 74 68 6f 75 74 20 50 6f 6c 65 73 74 61 72

Vehicle.Powertrain.TractionBattery.Range
vss
20

Vehicle.Cabin.Infotainment.HMI.TurnSignalState
vss
2

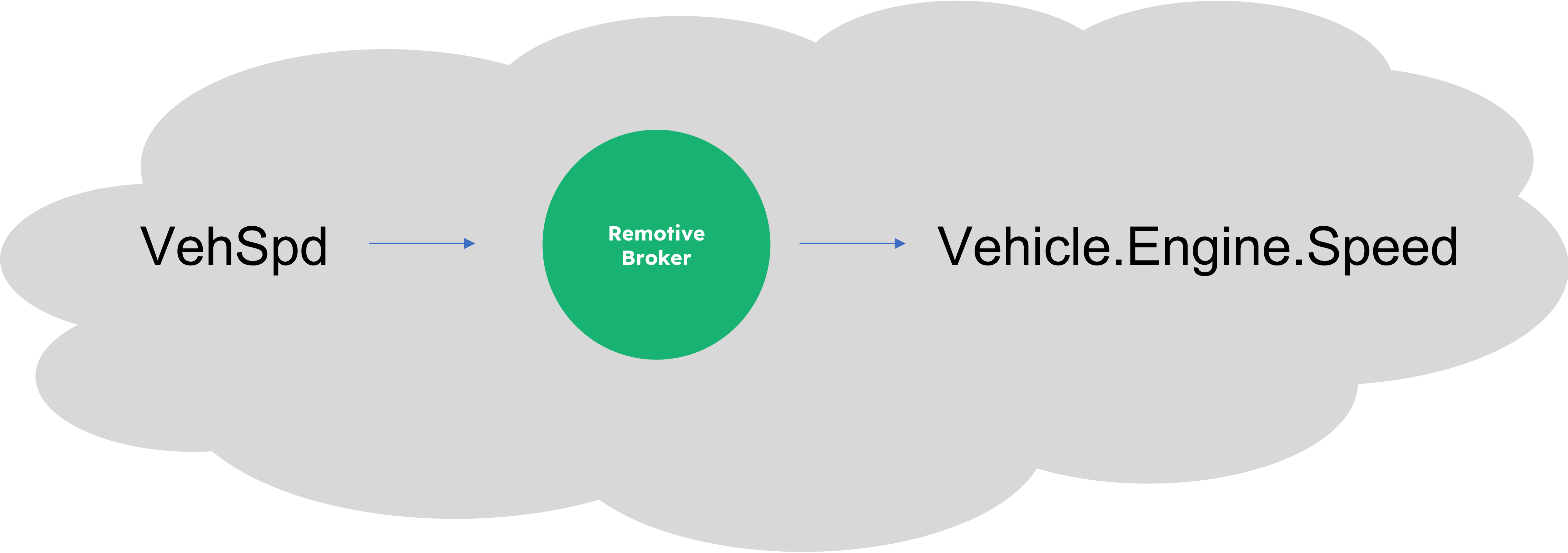
Make	Volvo
Model	V526 XC90
Model Year	2019
Vin	YV4BR0CM9K1457445

Adb connection Error:EOF (moments ago)

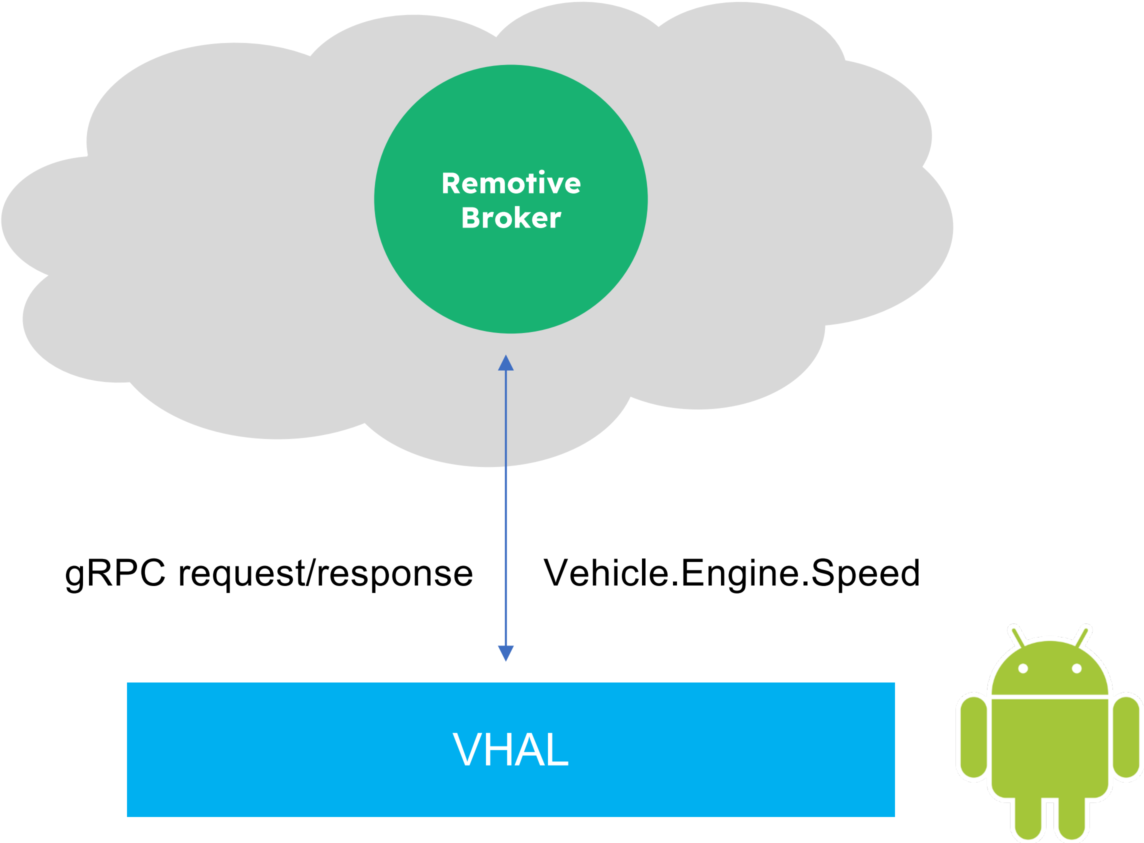
VehSpd

90
km/h
488
VOLVO
200 m
Aschebergsgatan
Then
Google
Forever
Anna's Phone
Strong signal
22°
22°

Recorded data becomes VSS



gRPC is used to interface the RemotiveLabs platform



Conclusions…

```
package com.android.data.repository

import android.car.Car
import android.car.VehiclePropertyIds
import android.car.hardware.CarPropertyValue
import android.car.hardware.property.CarPropertyManager
…
override fun getCarSpeed(): Flow<Speed> {
        return speedFlow
   }
```

Overall conclusion

- Collaborate - use standardised signal names VSS so it gets easier to work together
- Innovate - everybody that needs should have access to data to try ideas
- Get stuff done - enable partners to do application development

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