Vehicle Abstraction in Automotive Grade Linux with Eclipse KUKSA

FOSDEM

February 3, 2024

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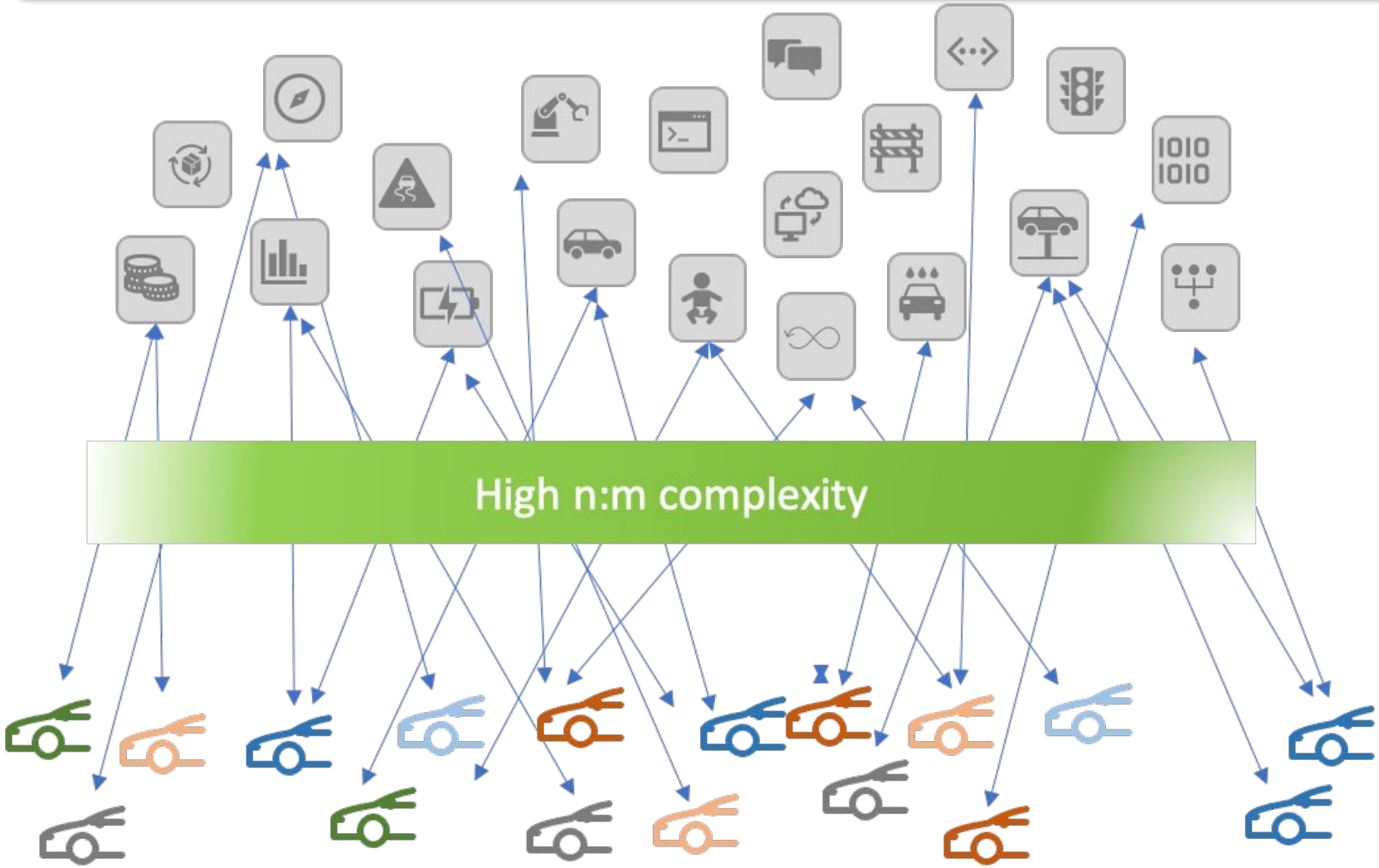
whoami

@ eTAS

2018 → today

How to make application development for vehicles more fun and efficient?

Challenge: No standardized signals



Pain Points:

- Portability
- Scalability
- Maintenance

Leading to high complexity and data silos

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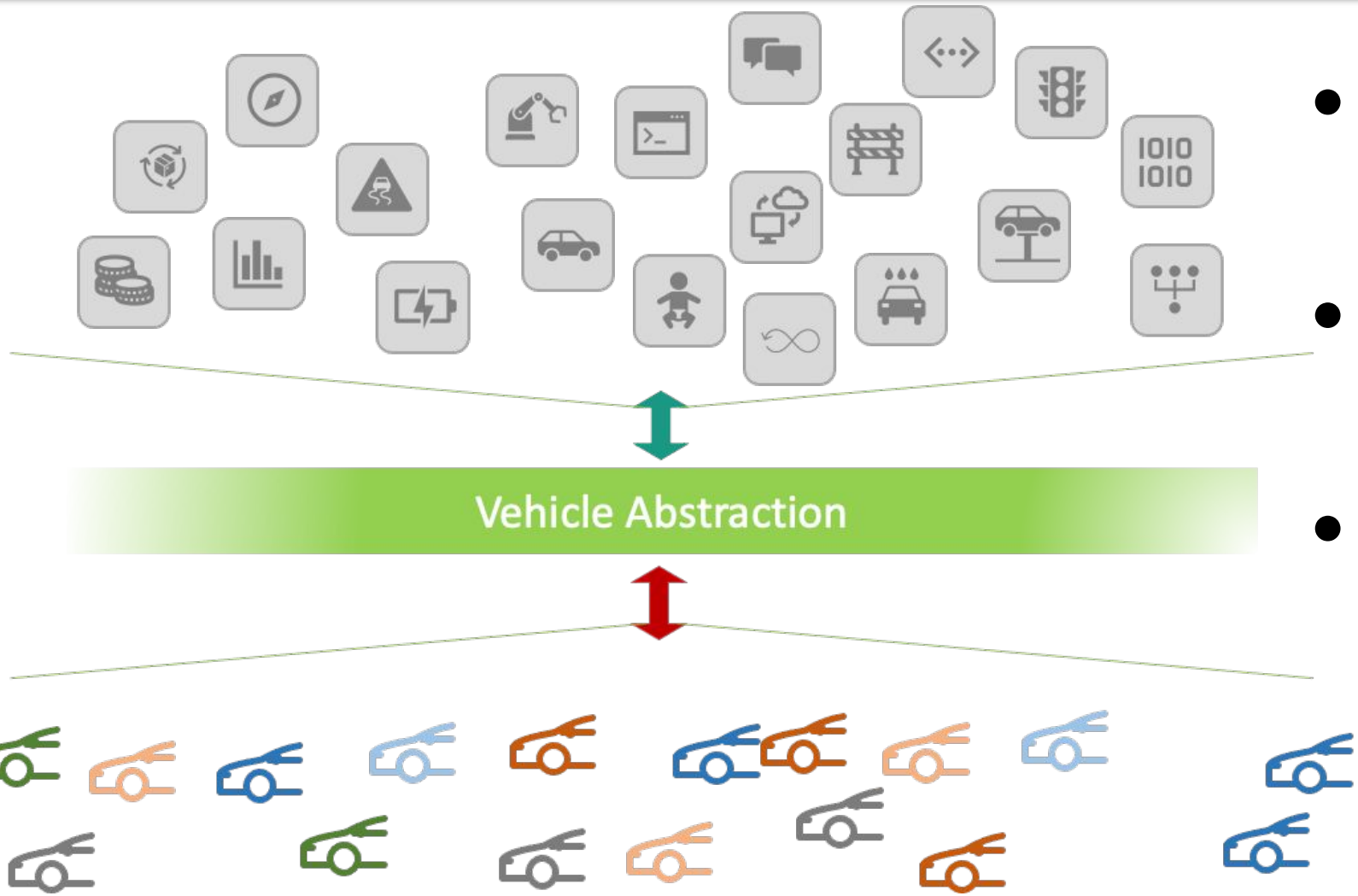
SDV Eclipse Software Defined Vehicle

KUKSA

Solution: Vehicle Abstraction



- Portability:
  “Write once, run everywhere”
- Scalability:
  “Attract 3rd party developers”
- Maintenance:
  “Realize Synergies”

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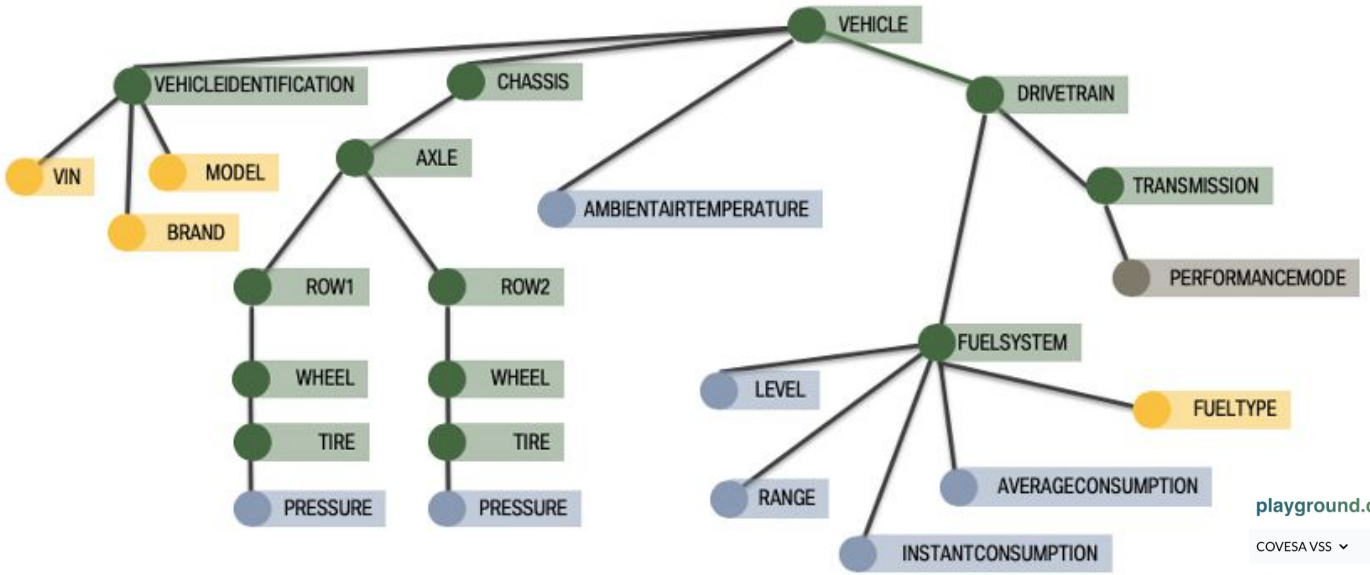
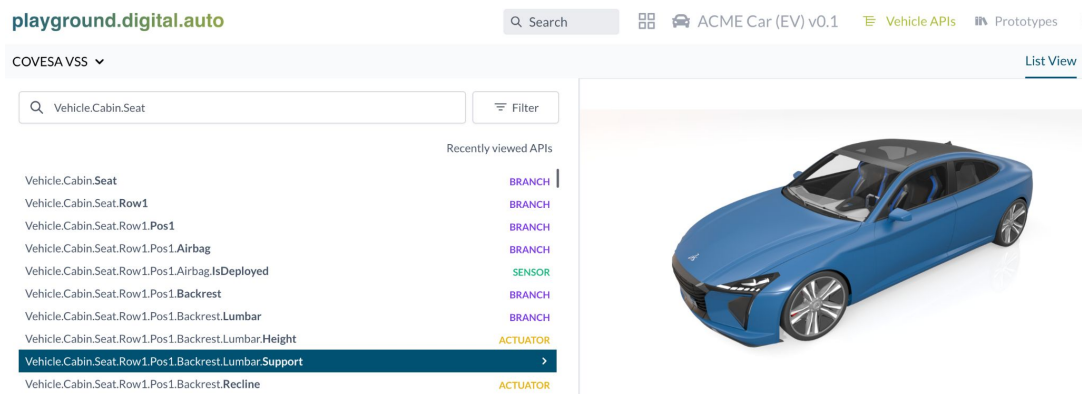
COVESA Vehicle Signal Specification



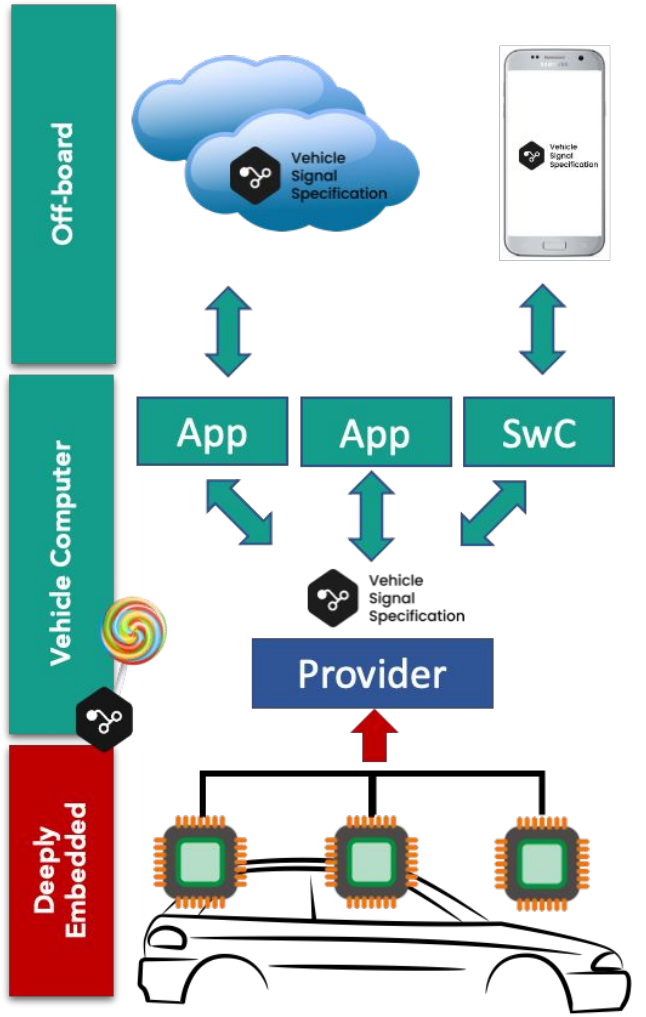
https://digitalauto.netlify.app/




```
- Drivetrain.Transmission.Speed:
  type: sensor
  datatype: uint16
  unit: km/h
  min: 0
  max: 300
  description: The vehicle speed, as measured by the drivetrain.
```

Source: https://covesa.github.io/vehicle_signal_specification/introduction/overview/

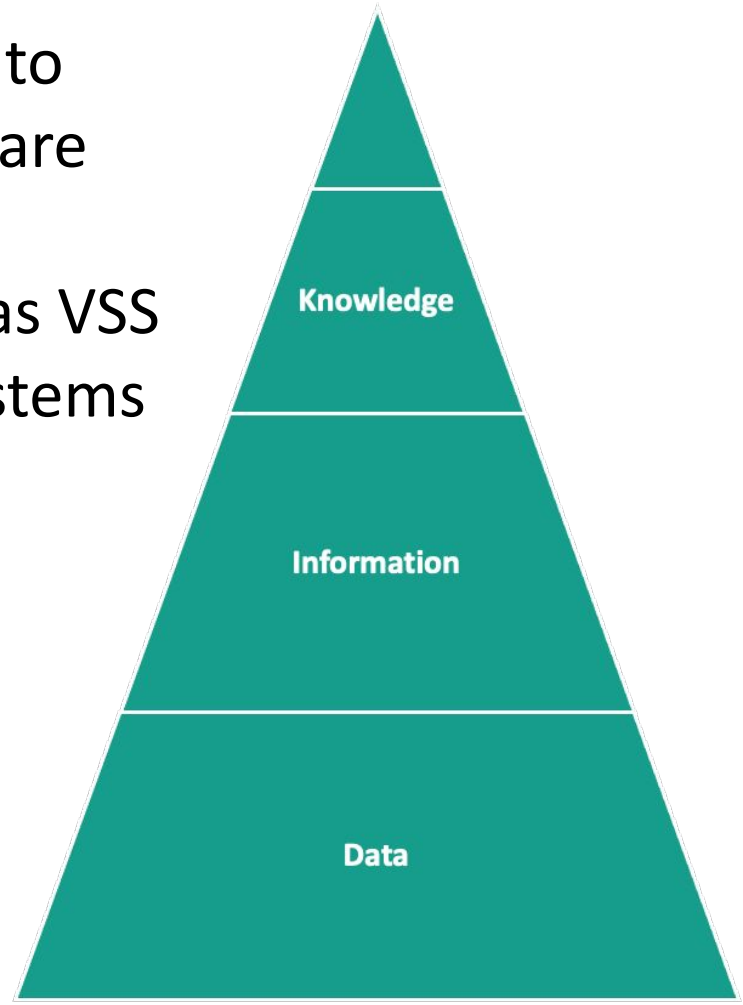
KUKSA.val



- Vehicle Computer as place to decouple hard- from software (SDV)
- Add an API to access data as VSS from deeply embedded systems

This is

KUKSA.val



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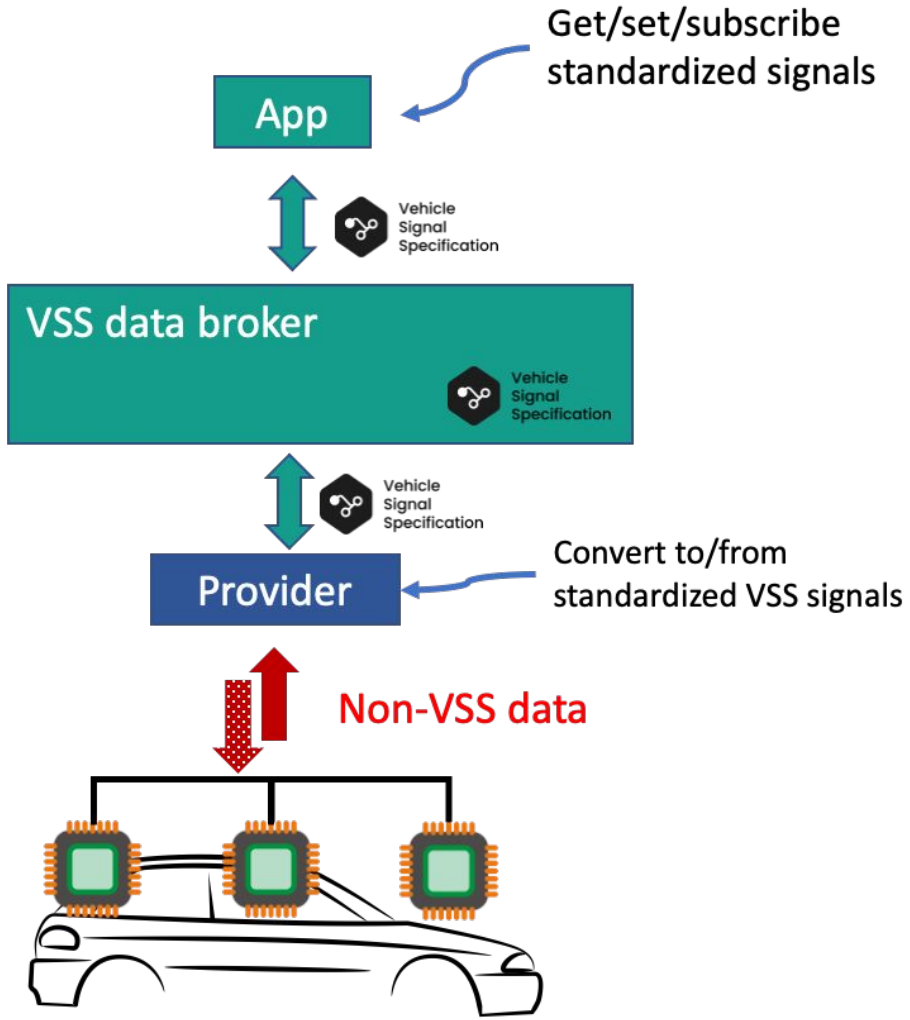
KUKSA.val Scope



- Open Source Project at Eclipse Foundation under Apache 2.0
- “In-Vehicle digital twin” based on VSS
- Only provide current and target view (no history data)
- VSS providers to transform data to VSS

Data Broker:

- Written in Rust
- < 4MB statically compiled
- language agnostic interface (gRPC): Get, Set, Subscribe

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Let’s get to the news

- KUKSA Android SDK released
- Vehicle Mock Service Available
- Leda on AGL

KUKSA Android SDK

- SDK for Android to communicate with KUKSA.val Data Broker
  - Available in Maven Central as org.eclipse.kuksa.kuksa-sdk

- Released Example Companion Application based on SDK to F-Droid Store

F-Droid

Source: https://f-droid.org/

Vehicle Mock Service

- Mock vehicle behavior:
  - Example: move current value for 10 seconds to target after it has been set
- Python script accepting behavior definition in the form of specific `mock.py`
- https://github.com/eclipse/kuksa.val.services/tree/main/mock_service

mock.py - Example

```
mock_datapoint(
    path="Vehicle.Cabin.Seat.Row1.DriverSide.Position",
    initial_value=0,
    behaviors=[
    create_behavior(
        trigger=create_event_trigger(EventType.ACTUATOR_TARGET),
        action=create_animation_action(
        duration=10.0,
        values=["$self", "$event.value"],
        ),
    )
    ],
)
```

Sneak Preview: Eclipse Leda on AGL

whoami #2

- Linux user/developer since 1994
- Embedded Linux developer since 2000
- Principal Software Engineer at Konsulko Group since 2014
- Working on AGL on contract since 2016
  - Yocto Project maintenance
  - Demo development, integration, and maintenance

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Automotive Grade Linux

- A collaborative open source project that is bringing together automakers, suppliers, and technology companies to build a Linux-based, open software platform for automotive applications
- Founded in 2014
- Currently over 150 members
  - 10 major OEMs and many Tier 1 and Tier 2 suppliers
- Code first model (as opposed to specification driven)
- Used in production vehicles from Toyota and Subaru
- https://www.automotivelinux.org/

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AGL Provides…

- A base automotive oriented Linux distribution built with Yocto Project (https://www.yoctoproject.org/)
- Goal of providing 70-80% of the base platform for production
- Focus was initially on in vehicle infotainment (IVI) targets
- Expansion into instrument cluster (IC) and telematics based on member interest
- Expert groups for various areas of interest, with open biweekly meetings
- Biannual releases (nominally February & August)

KUKSA.val in AGL?

- Up until 2020, a lot of AGL development went into a demonstration application framework
  - Included CAN and higher level signal abstraction APIs
- Members indicated they were not interested in further effort going into the application framework
  - OEMs already have frameworks in hand
- AGL shifted towards a bit more of a FOSS technology demonstrator model for its integration demos
- The timing aligned well with respect to the releases of VSS and KUKSA.val

KUKSA.val in AGL? (cont)

- KUKSA.val server was initially added in the Marlin (13.0) release in March 2022
  - Replacement for previous agl-service-can-low-level and agl-service-signal-composer
- A BitBake recipe to build the server (and now databroker) is carried in the meta-agl-demo layer
  - Custom AGL VSS generated by applying overlay vspec file on top of base VSS
- The CAN feeder is also built and packaged with a BitBake recipe in meta-agl-demo
  - Uses CAN database (DBC) file with minimal "agl-vcar" CAN signal definitions

KUKSA.val Integration in AGL

- Magic Marlin (13.0) - Spring 2022
  - KUKSA.val 0.2.1 integrated
  - VSS 2.2
  - Using C++ server with VIS WebSocket API
  - kuksa-dbc-feeder CAN feeder for demos
- Nifty Needlefish (14.0) - Summer 2022
  - Upgraded to KUKSA.val 0.2.5 and VSS 3.0
- Optimistic Octopus (15.0) - Spring 2023
  - Upgraded to KUKSA.val 0.3.1 and VSS 3.1.1
  - Switch to using vspec overlay with vss-tools

KUKSA.val Integration in AGL (cont)

- Prickly Pike (16.0) - Summer 2023
  - Still using KUKSA.val 0.3.1
  - Databroker included in images for evaluation and testing
    - Using Rust 1.68 mixin layer for Yocto kirkstone
- Quirky Quillback (17.0) - Spring 2024
  - KUKSA.val 0.4.2 and VSS 4.0
    - 0.4.2 released by community to get a working RISC-V build of the databroker
  - Fully switched over to the databroker
    - Rust 1.70 mixin layer for Yocto kirkstone recently published

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VSS Applications in AGL

- Pure VSS signal observers
  - e.g. IC dashboard applications
  - Read "sensors" in VSS terminology
- VSS signal actors
  - e.g. services like agl-service-hvac
  - Implement "actuators" in VSS terminology
- Some applications also set actuators
  - HVAC, audio controls, navigation, etc.

Demo services

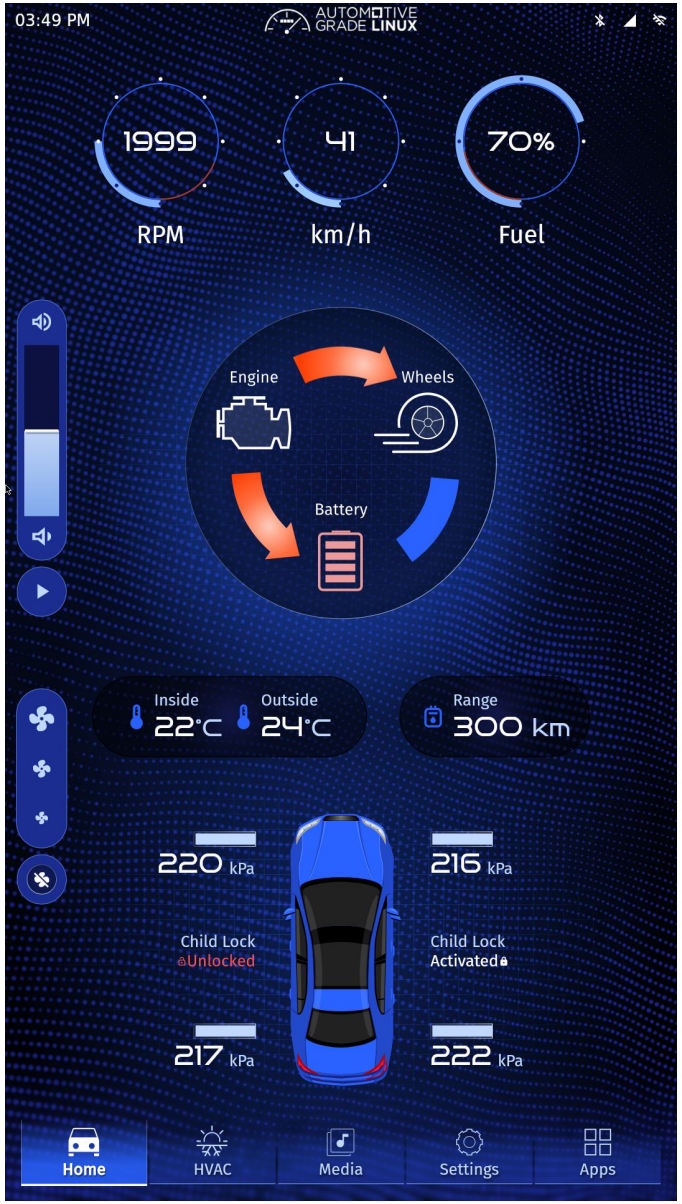
- agl-service-hvac
  - Listens to fan speed and temperature actuator signals
  - Pushes fan speed updates to HVAC controller via CAN
  - Pushes temperature updates to LEDs in demo unit via GPIO
- agl-service-audiomixer
  - Listens to VSS volume and some AGL custom audio control actuator signals
  - Pushes changes to WirePlumber

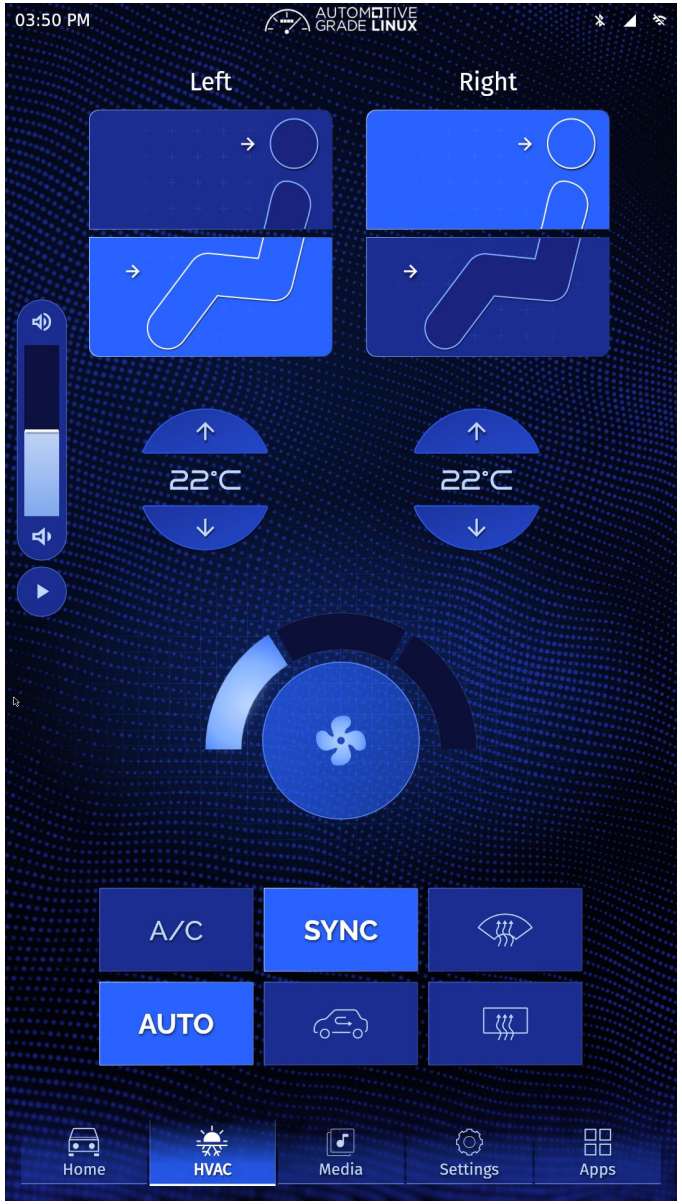
Qt Demo Applications

- VSS signal using applications:
  - Homescreen
  - Dashboard
  - IC dashboard
  - HVAC
  - Navigation
- Client code is abstracted in Qt library (libqtappfw-vehicle-signals) to reduce code duplication
  - Originally VIS WebSocket based, now gRPC with databroker

Flutter Demo Applications

- VSS signal using applications:
  - Homescreen
    - Combines dashboard, HVAC, media, etc. into a unified application a bit more realistic with respect to current OEM designs
    - UI designed for AGL by ICS for CES 2024
  - IC dashboard
- Client code is currently duplicated in each application, but is not large
- Some potential for switching to using a wrapped non-Dart gRPC implementation, e.g. Rust's tonic
  - Toyota has indicated they do something along these lines





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More information

- Vehicle Abstraction with Eclipse Kuksa and Eclipse Velocitas - Sven Erik Jeroschewski, Bosch Digital

  https://static.sched.com/hosted_files/aglammspring2023/5c/VehicleAbstractionwithEclipseKuksaandEclipseVelocitas.pdf

  https://www.youtube.com/watch?v=LHJnBKb1Ta8

- Vehicle Signaling Specification and KUKSA.val in AGL

  https://static.sched.com/hosted_files/aglammspring2023/8f/VSS%20and%20KUKSA.val%20in%20AGL.pdf

  https://www.youtube.com/watch?v=RhSocQDu_DY

- AGL table in AW building on Sunday!

Want to start hacking? Join us @

Questions?