

## Motivation and Task

- Modern Software Defined Vehicles (SDVs) require unifying sensor data from heterogeneous sources.
- Current systems lack standardized, real-time abstraction layers.

## Concept

- The system introduces a layered abstraction pipeline for sensor data in SDVs.
- Raw data from sensors is transmitted using Data Distribution Service (DDS) or Zenoh into a shared topic space.
- A Middleware-to-Kuksa Bridge receives this data, maps it to VSS signals, and publishes it to the Kuksa Databroker.

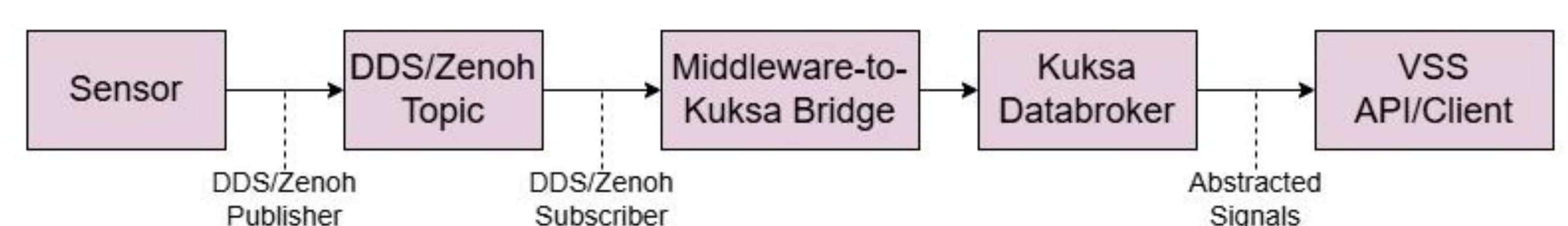
## Prototype

- Developed two parallel pipelines on Raspberry Pi and Laptop to capture real-time camera data.
- Used **Fast DDS** (C++) on the Pi and **Zenoh** (Python) on the laptop to publish raw sensor signals.
- Implemented middleware bridges to decode and map these raw signals to **VSS** format before publishing them to **Kuksa Databroker**.
- The bridge publishes signals to the Kuksa Databroker using **gRPC**-based communication, ensuring low-latency and structured signal transfer.
- Applications such as YOLO object detection accessed the VSS signals for real-time use.

## Result

- Achieved real-time abstraction and publishing of sensor data into VSS format with minimal latency (**average end-to-end latency ~102ms**).
- Verified **cross-platform synchronization**: Raspberry Pi and Laptop pipelines both produced consistent signal values in Kuksa.
- Demonstrated successful application layer integration using YOLO-based object detection and API-driven access.

- Problem:** In SDVs, sensor data is generated in diverse formats across vendors and platforms, lacking semantic consistency.
- Solution:** Use middleware and Vehicle Signal Specification (VSS) to abstract and unify sensor data for seamless system integration.



- Applications or clients access the abstracted VSS signals via the Kuksa Databroker, using a lightweight gRPC interface for efficient and scalable communication.

