High-Speed ADAS Data logging
ADAS definitions

- **ADAS**
  - Advanced Driver Assistance System

- **Level 0: No Automation**
  - Steering or throttle but not both

- **Level 1: Driver Assistance**
  - Steering and Braking and Throttle

- **Level 2: Partial Automation**
  - As above + change lanes in certain circumstances

- **Level 3: Partial Automation**
  - Can self drive without driver input in most conditions

- **Level 4: High Automation**

- **Level 5: Full Automation**
  - No human involvement at all
Level 5: Full Automation

- No human control of a vehicle is needed at all.

- Full automation and vehicles don't need any pedals, steering wheels, or controls for a human to take charge.
ADAS Vehicles

- Westfield POD. Greenwich.
- Uber’s Volvo XC90
- Navya Autonom Cab from France
- Audi A8
New Vehicle Architecture

E-Drive

Autonomous driving

Cloud computing

Connectivity

Security

„ECU less“ age

„Some ECU“ age

„ECU Network“ age
Future ECU Architecture

Cross OEM backend

OEM Backend

Current ECU architecture

Gateway

Vehicle

Powertrain

Chassis

Body

DCU

DCU

DCU

DCU

Powertrain

Energy

Chassis

Infotainment

Automotive Ethernet

5G

Central vehicle access Point

CAN

CAN FD

FlexRay

CAN

LIN
ADAS development – Introduction

“Sense” Sensor ECUs – single or many
- LIDAR
- Radar (SR & LR)
- Ultrasound
- Front Camera
- Side & Reverse (camera/ radar / ultrasound)

“Display & (Re)Act” Signaling & Actuation system ECUs
- Passive: HMI (Cluster)
- Active: Engine & Transmission, Brakes, Steering

“Evaluate & Decide” Data Fusion + ADAS Logic
- Integrated in sensor ECU(s), or
- Dedicated ADAS / autonomous driving processor (hi spec / multicore)

“Virtual” sensors
- Maps (+GPS)
- Car2X
- Road conditions
  - Maps (+GPS)
  - Car2X
  - Road conditions

Virtual sensors
- Maps (+GPS)
- Car2X
- Road conditions
  - Maps (+GPS)
  - Car2X
  - Road conditions
Why?
- Field of view & range of **single** sensor **limited**

How?
- Combine information from multiple sensors to “get a better understanding” of everything around the vehicle

Example: Detection of occluded objects by fusing vision and Car2X (position) information – to better calculate safe vehicle paths
OEM1: Customer Storage for Logging Data

1 PByte Planned: 500 Pbyte

At least 1M km of driving data

( Intel I7 = ~ 0.1 Teraflops )

(Source: INTEL Automotive Division)
New Vehicle Architecture

Impact on: DCU Micro Controller / OS / Bus Interfaces

**Micro Controller**
- Infineon
- ST
- Renesas
- NXP
- NVIDIA
- Mobileye
- Intel

**ECU OS**
- Adaptive
- AUTOSAR
- VxWorks
- QNX
- Linux

**Bus Interfaces**
- CAN
- FlexRay
- CAN FD

**ECU MC-Interfaces:**
- PCIe / USB
- Aurora with up to 25 GBit/s
- Ethernet for MC
- Dynamic Address handling

Eth. => Tap Mode
Logging Concept for ADAS Level 1-2

- Setup: Camera & Radar
- Same Supplier

Data Types:
1. Raw Data: Video / Radar
2. ECU Internal Data: TAPI / XCP

Time-Trigger Start/Stop Synchronisation: ✓
ADAS Logging

Logging Concept for ADAS Level 1-2

- Setup: Camera & Radar
- Different Supplier

Time-Trigger-Start/Stop-Synchronisation?
ADAS Logging

Logging Concept for ADAS Level 3

- Setup: Multi-Sensor & Fusion ECU
- Multi-Supplier

![Diagram of a vehicle with various sensors and a Fusion-ECU](image)

- Front Radar
- Corner Radar
- Front Cam
- Side Lidar
- Rear Cam
- Context Cam
- Fusion-ECU

Log 1, Log 2, Log 3, Log 4, Log 5

Time-Trigger-Start/Stop-Synchronisation ??
ADAS Logging

Logging Concept for ADAS Level 3

- Setup: Multi-Sensor & Fusion ECU
- Multi-Supplier
ADAS Logging Hardware and Software

ADAS Logging, Visualization, Labeling, Analysis Software

ADAS Logging Hardware and Data Logistic

Bus Interfaces: CAN-FD, LIN, FlexRay Auto.Eth. 100/1000BaseT1 (TAP Mode)

Sensor and ADAS Fusion ECU Measurement Hardware
Scalable ADAS Software Concept Based on DHPR Plug-In

ADAS Logging Software

- **ADAS ECU**
- **Vehicle CAM**
- **4 x Context CAM**
- **2 x Lidar**
- **Front Radar**
- **4 x Corner Radar**

**PC1**
- CANape
- XCP Recorder
- Bus Interface
- Time Sync Trigger Handling

**Vehicle CAM1 DHPR**

**Reference CAM DHPR**

**Lidar1 DHPR**

**PC2**
- Eth.

- **Radar1 DHPR**
- **Radar2 DHPR**

**Multi-bus:**
- CAN-FD
- LIN
- FlexRay
- Auto.Eth

- **GPS UTC support**
- **gPTP timesync**
ADAS Logging Software

4 in 1 Use Case: Logging / Visualization / Labeling / Data Analysis

- Logging Mode: Simple control mobile UI
- Engineer Mode: Visualization & Calibration GUI
- Labeling
- Data Analysis

High-End Logging System
ADAS Logging Software

Visualization: Map, Video View, Bird-Eye View, 3D Scene View
ADAS Logging Software

Visualization: Vehicle / Reference-CAM Calibration

- 4 x CAM
- 4:1 Video Encoder with H.264 hardware compression
- 1 Gb/Eth

- Image Base Camera Calibration
- Calibration quality coverage
- Test object

CANape
Labeling with CANape Panel

- In case of 2 test driver: Online labeling via CANape Panel
- Automatic datamining can be used on labeling output
Automated Data Analysis

Data Analysis: Data Management System

- **Data Storage:**
  - Local database (on premises)
  - Vector Cloud

- Signal & object oriented data
- Link to raw data
Automated Data Analysis

Data Analysis: Datamining Workflow

Select Function or Simulink.dll

Execute datamining
Generate hits

PDF Report
ADAS Logging Hardware

**ADAS Logging System with Integrated CAN / LIN / FlexRay channel**

**Brick/Brick+ System**
- Complex ADAS Setups
- Up to 10 Gb/s Brick
- Outlook
  - Up to 16 Gb/s Brick+
- 2 x 10 GbE Connector RJ45
- GPS (position and time)
- Storage Raid (up to 32 TB)
- Optional: 2 x PCIe extension

**Outlook:** Brick LE System
- Single sensor, Auto.Eth
- Up to 4 Gb/s Brick LE
- 2 x 10 GbE Connector RJ45
- GPS (position and time)
- PCIe Storage (up to 8 TB)
- 1 x PCIe extension
ADAS Logging Hardware

Data Logistic

Docking Station

Thunderbolt

HDD Storage

10 Gb/Eth

Storage Server

Outlook: Programmable Copy Station

Move out Storage Bay
ADAS Logging Hardware

Bus-Interfaces: 100/1000BaseT1

- **VN5640** 12+4 Channel
  - 6 x / 3 x TAP 100BaseT1
  - 6 x / 3 x TAP 100/1000BaseT1
  - 4 x 1000BaseTx

- **PC connection: USB3.0**

- **Outlook:** **VN5240** = 12 * 100/1000BaseT1
  - PC connection 10 Gb/Eth + 10 Gb/Eth cascading port

- **12 + 4 x Debug Interfaces**
- **LIDAR, Low-end Fusion-ECU & Radar**

**Brick-LE example setup with 24 x Auto-Eth**
ADAS Logging Hardware

ADAS Fusion-ECU Combined PCIe + IFX Aurora POD Approach

ECU Interfaces:
- uC: DAP2 / Aurora
- DAS Concept for dynamic address
- uP PCIe
- 5 x CAN-FD / 1 x FR A/B
- 1 x 100BaseT1 Auto.Eth.

1 x 2.5 Gbit/s Aurora/DAP2
5 Gbit PCIe
5 GB/s HSSL2 Cable
1 x 100 BaseT1
1 x 100BaseT1
1 x FR A+B
5 x CAN-FD
5 x CAN-FD
SGMI Eth. #
ADAS Logging Hardware

Radar ECU Measurement: XCP and Radar Raw Data

- Radar ECU
  - CPU0
  - CPU1
  - CPU2
- VX1438 POD
  - 2,5 Gbit AURORA
  - 4 x 400 Mbit RIF Interface
- VX1135 Base Module
  - FFT, classification, detection, tracking >> calculation
  - HSSL2 Cable up to 8m
- Radar Raw Data >>
- 2 x 1 Gbit Eth.
- CANape
  - 4 x 400 Mbit RIF Interface
  - 2,5 Gbit AURORA
Video Logging Setup: Raw Data + TAPI + CAN-FD/Auto.Eth

**ADAS Logging Hardware**

**Vehicle-Camera**
- Camera-Imager
- MIPI-CSI2
- MIPI-Bridge
- MobilEye EyeQ4
- Eth.
- uC

**Debugg-Extension**
- Serializer
- FPD-LinkIII (LVDS standard)

**Connectors**
- CAN-FD
- Auto. Eth.
- USB 3.0

**TAPI DHPR**
- Video + TAPI Data
- Online data validation

**ADAS ECU**
Outlook VX1161: Flexible Multi-Interface Device

- Up to ECU 6 x Interface Modules
  - POD: Serial / HSSL / HSSL2
  - Video
  - Bus Interface: CAN / FlexRay

- Switch Module
  - 2 x 10 Gb
  - 4 x 100/1000BaseTx or 100BaseT1

- Example Setup1
  1 x Front Radar / 2 x Corner Radar / 1 x Quad-Video / 6 x CAN+1 FR
  24 x Auto.Eth

- Example Setup2
  1 x Front Radar / 4 x Corner Radar / 1 x Fusion-ECU / 6 x CAN+1 FR
  24 x Auto.Eth

Cabling:
3 x 10 Gb Eth.
For more information about Vector and our products please visit

www.vector.com

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