Agenda

- New In-Car Architectures
  - Evolving Architectures
  - Connectivity Middleware

- Autonomous Use cases
  - Connectivity Middleware requirement for Autonomous

- Inter-ECU communication

- Infotainment Use cases
  - Media Sharing over Ethernet
  - Remote Peripheral Access over Ethernet

- AllGo Ethernet Connectivity Middleware Portfolio
New In-Car Architectures

WHY New Architectures are Required?

• ECU in a Car are increasing

• Sensors with high bandwidth for Autonomous

• As a result Traffic Congestion in current architectures

Traditional In-Car Architecture

• ECUs are clustered based on the application

• Central Gateway to do heterogeneous communication translation

• High communication load occurs on Central gateway
New In-Car Architectures

**OBSERVATION:** In these evolving Architectures
- Ethernet is the preferred choice for backbone
- QoS required for data transmitted over the Ethernet backbone
- Backbone network should be Reliable and Fail Safe.

**DOMAIN ARCHITECTURE**
- ECU
- Actuator/Sensor
- Clustering based on physical placement of ECUs
- Congestion in Central gateway reduced
- Scalable: Any additional function to be adapted only into the functional domain

**ZONAL ARCHITECTURE**
- Zonal Gateway
- Actuator/Sensor
- Clustering based on physical placement of ECUs
- Processing moved to a Central Entity
- Flexibility: Integration of a new function by adding peripheral to the zone controller
What is a Connectivity Middleware:

The Communication Framework with the necessary protocols and standards required for reliable data transfer between the ECUs to realize the different Automotive use cases.

What Follows:

We will look at the different use cases of Autonomous and Infotainment with the New Architectures

Look at the Connectivity and Communication Requirements and Middleware solutions
Sensor Fusion: 
Sensor fusion is combining of sensor data or data obtained from different sensor sources so that the resulting information has less uncertainty than would be possible when these sources were used individually.

- Low latency
- Robust communication mechanism required
- Sensor data to be synchronized
- Sensor data to arrive at Low latency
Connectivity Requirements: Central Compute Module

Multi Processor System

Ethernet or PCIe Connectivity

Requires Very High bandwidth data sharing with low latency

CENTRAL COMPUTE MODULE

SENSOR FUSION

Camera Processing Core

Lidar/Radar Processing Core

Safety Processor

ETHERNET/PCIe

ETHERNET/PCIe
WHY ROS2?
- Defacto standard Robotics SDK
- Solves common and recurring challenges
  - Transferring large amounts of sensor data to multicore computers for processing,
  - Sending processed info to multiple actuators
- Complete ecosystem of tools, such as visualization, simulation, build tools
- Used by almost all autonomous companies in R & D
- Agnostic of Transport (PCIe/Shared Memory/Ethernet)

WHY TSN?
- TSN brings in Precise, Reliable and Synchronized Clock
- Traffic Shaping algorithms to ensure Low Latency
- Frame Elimination and Replication (802.1CB) for Reliable transport of Sensor Data.
Inter-ECU communication over TSN

CAN to ETHERNET

- New Architectures will still have ECUs with traditional connectivity like CAN.
- ECUs will need to send out time critical periodic data or Inter-ECU control data.
- Low latency CAN to Ethernet translation middleware required.
- IEEE 1722 (AVTP Control Streams) one option to do the CAN to Ethernet Translation.

Over TSN

- Ethernet QoS provided by TSN traffic required for reliable Low latency communication between ECUs.
- TSN Frame Replication and Elimination standards for reliable connectivity through redundant paths.
- Gateways act as Proxy TSN Endpoints for these ECUs connected over CAN.
New In-Car Architectures: Media Over Ethernet

Key Requirements
• Time Synchronization between Devices
• Dedicated Bandwidth for Media Streams to avoid packet drops
• Low Latency – Prioritization of A/V streams over Best effort traffic
• Real time A/V Streaming protocol
New In-Car Architectures: Media Over Ethernet

Ethernet AVB

- Transport of Time Sensitive Audio and Video over Ethernet
- Time Synchronization (802.1AS), Credit Based Traffic Shaper (802.1Qav), AVTP transport (IEEE 1722), Bandwidth Reservation (802.1Qat) implemented as part of AVB.

RTP over AVB

- RTP transport instead of AVTP with AVB
- Easier Integration into the existing RTP based Systems
- Based on IEEE 1733 (RTP over AVB) standard.
IVI is a separate ECU and iPhone connected over a USB Media Hub to do Carplay

IVI may be connected to cluster to share some meta data to be shared on Cluster or to stream maps

IVI will have built in WiFi which may be used for Wireless Carplay

IVI Display
New Architecture: Infotainment Connection Topology

Central Compute Module may run IVI and Cluster functions in a Zonal Architecture

Dedicated lengthy wires from Central compute to Displays needed.
Can the Displays be connected over Ethernet?

Smart Antenna may have the WiFi module
Can the IVI function on the Central compute remotely access the WiFi module on the smart antenna?

Dedicated Lengthy USB cables needed to connect the Media Hub to the Central Compute
Can the Media hub be accessed over Ethernet?
AllGo Device Virtualizer (DeVit) – Peripherals Over Ethernet

- AllGo’s Device Virtualizer (DeVit) Technology to access Devices connected to Remote Peripheral Interfaces over Ethernet
- Devices Connected to Interfaces like USB, SDIO, Display Port, HDMI are remotely accessed over Ethernet
- Remote ports appear as virtual ports on the Host. Higher layers are not aware that the port is remote
- Integrated with TSN to guarantee Quality of Service over Ethernet.
Ethernet Technologies Summary

- **Communication Middleware**
  - ROS2
  - DDS
  - IEEE 1722 AVTP
  - IEEE 1733 for RTP
  - RTP Server/Client
  - SOME/IP

- **ETHERNET AVB/TSN**
  - Traffic Shaper
  - Time Sync gPTP
  - Stream Bandwidth Reservation
  - Redundancy and Reliability

- **TCP**
- **IP**

- **IEEE Ethernet MAC + VLAN (802.1Q)**

- **Automotive Ethernet Physical Layer**

- **Diagnostics**
  - UDS
  - DoIP

- **DeVit:** Peripheral Over Ethernet

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Thank you!

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