Futuristic Automotive Software Architecture
Microservices, Orchestration and Networked Hardware

Anil Dhonde, Ethernovia Inc.

IEEE SA Ethernet & IP @ Automotive Technology Day
São Paulo, Brazil
September 2023
Agenda

• Key Concepts
• Ethernet Today
• Futuristic Software Architecture
• DevOps
• Pros and Cons
• Future Work
Traditional Monolithic SW Arch

- Tightly Coupled Architecture
  - Applications chained to HW
- One SW Image
  - Single Build
  - Build/Test for every change
  - Major Release/Update
OEM Software Supply Chain

- OEMs offload SW to Tier 1’s
- Multiple SW suppliers
  - Different platforms
  - Different architectures
- Painful integration
  - Test, Release, Update
Monolithic -> Microservices

- Loosely coupled
- Network comm
  - Microservices
  - Applications
- Location Freedom
- Design breakdown
- Independent Lifecycle
  - Build, Release, Update
Containers

- Containers Manage
  - Microservices
  - Applications
- Platform independence
- Libraries and services, ex: network
- Build Once, Run Anywhere
Orchestrator

- Manage Containers @ Run Time
- Configuration, Lifecycle
- Load Balancing
- Redundancy, Fault recovery
- Routing services
OEM's Software Destiny

• Software is the Differentiator of the future
• OEMs want to build Software applications in-house
  • Some OEMs have already setup up software entities
• OEMs will need full control over the Software destiny
Ethernet Today

• Due to the ongoing work in IEEE802.1 TSN group, Automotive Ethernet is now:
  • Time Bound
  • Deterministic
  • Reliable

... hence, we can deploy a Software Architecture with Ethernet as the key enabler!
Futuristic Architecture
Architecture: In-Vehicle Cloud

- Container Application
- ECU
- ECU
- In-Vehicle Cloud
- Container Microservice
- ECU
- ECU
- HW API
- Hardware

- Ethernet Network Link
- Non-Ethernet Link
Almost Endless Possibilities
Networked Hardware

- Containers
- Applications
- ECU
- Orchestration
- In-Vehicle Cloud
- Containers
- Microservices
- Applications
- Hardware
- Non-Ethernet Link
- Ethernet Network Link
Ethernet Ubiquity

- ECU
- Ethernet Switch
- Non-Ethernet Network
  CAN, CSI2, ...

Hardware Sensor
Hardware Camera
Hardware Ex: Camera

Core
Aggregation
Edge

Ethernet Port
Ethernet Network Link
Non-Ethernet Link
Independent Stacks

- Software
  - Applications
  - Containers
  - Microservices
  - HW APIs

- Hardware
  - Core
  - Aggregation
  - Edge
DevOps
Development & Operations
Traditional

Hardware Req/Dev: 3 years
Software Dev: 1 year

Future

Hardware Req/Dev: 3 years
Software Dev: Decouple, HW Agnostic

Save 2 years!
Dev and Ops

Source: https://commons.wikimedia.org/w/index.php?curid=51215412
Dev: Virtual or Networked HW

- Orchestration
- ECU

- In-Vehicle Cloud
  - Container
    - Application
    - ECU
  - Container
    - Microservice
    - ECU

- Digital Twin
  - ECU
  - HW API
    - Hardware
  - ECU
  - HW APIs
    - Hardware

- Networked Physical Hardware

- Ethernet Network Link
- Non-Ethernet Link
Ops: Networked Physical HW
Mix Of Enterprise and In-Vehicle Cloud
Pros and Cons
Pros: Dev

• Complexity breakdown
• Scalability
• Independence: Processing platform, Hardware and Topology
• Agile: Move away from Waterfall, Shift Left (Early Validation)
• Supplier friendly development
• Enhancement and Future revenue streams
• Hybrid possibilities: “Move” ECUs to the Cloud
Pros: Ops

• Time to market
• Load Balancing
• Failure Detection, Isolation and Recovery
• Lifecycle/Updates: CI/CD
• Canary deployment
• Policing
Cons

• Cultural shift, steep learning curve
• Validation: Limit endless possibilities
• Overhead: Processing, Memory
• Legacy hardware integration
• Compatibility
Summary

• Monolithic SW is difficult to Develop and Deploy
• Ethernet allows Breaking Down the Monolith
• Futuristic Software Architecture
  • Endless Possibilities
  • Ethernet Uniquity
  • Networked Hardware
• Benefits for DevOps
• Mix of Enterprise and In-Vehicle Cloud
Future Work

• Lightweight Containers and Orchestrators
• Networked Hardware and Standardization of APIs
• Safety, Reliability and Security needs a modern approach
Concluding Thoughts

Software: Think Cloud First.
Hardware: Ethernet Ubiquity.
Thank You