Advances and challenges in remote configuration of connected cars

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Orchestrating a brighter world

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1. Self-introduction
1. Self-introduction

Stefan Aust

- Expert in communication and standardization.
- Working in the automotive embedded systems
  - Car gateways
  - AVB and TSN
  - Linux OS
2. Motivation

The connected car
The vehicular target system

Power Train
- Engine control
- HEV/EV motor
- Transmission

Chassis
- Steering/EPS
- Brake/ABS
- Chassis control

Safety
- Airbag
- Safety control

ADAS
- Collision warning
- Parking assistant

Networking
- CAN
- LIN
- FlexRay
- Ethernet
- AVB/TSN
- Bluetooth

IVI
- Car audio
- Connectivity
- Navigation
- Entertainment
- ITS/GPS

Automotive networks: CAN, FlexRay, LIN, MOST, Ethernet
Software-car and the need for up-to-date software

I) Automotive service
- Over-the-air (OTA)
- Secure OTA
- Firmware OTA (FOTA)
- Service platform

II) Automotive IoT access
- Car-GW
- IEEE 802.11p
- D2D/LTE
- Connected car

Connected vehicles on road

- 2015: 50 Million
- 2020: >250 Million

Software effort
- 100 Mil LoC
- 6 Mil LoC

Software costs
- 100%
- 40%
3. Remote configuration
The car gateway

Target: -connected car
-new GW design

RP 3 = Raspberry Pi3
AGL = Automotive Grade Linux
CAN = Controller Access Network
Software OTA (SOTA)

Update strategies
- Master/Slave
- Bootloader
- Secure roll-back
- Secure home/public WLAN/LTE

Watching Automotive Grade Linux (AGL)
- Implementation of OTA features
- Implementation of security features
- Open source/collaboration

PoC
- Remote configuration setup
- Security features
- Presentation to car OEMs

OTA strategies

Watching Automotive Grade Linux (AGL)

Sec. OTA server

Sec. SW diff.

Sec. OTA client

Home/public

3G/LTE/Wi-Fi

SOTA infrastructure

Userspace A (running)

Userspace B

Kernel

Bootsloader
OTA client/server architecture

OTA Server
- Authentication
- Web server
- OTA protocol
- OTA server

Admin Browser

Maintenance

OTA client
- HMI
- SW loading manager
- OTA client
- Authentication

Vehicle/Fleet
4. Car Gateway (Proof of Concept)
Gateway architecture (OTA client)

**LinkBird-MX + Raspberry Pi 3**
- Adding required functions if LinkBird does not allow it.
- AGL offers snapshots for Raspberry Pi 3

- **LinkBird-MX** (MIPS, 64bit, Microprocessor)
- **Raspberry Pi 3** (AGL, Ubuntu, IVI, server/client)

- MOST/CAN/Ether/Serial, Wi-Fi
- Ethernet
- System Interface
- OTA protocol/Remote Vehicular Interaction (RVI)

**OTA client**
- ECU/MCU/xCU
- Admin
- OTA server
- Client identification, SW upload

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SW platform: Automotive Grade Linux (AGL)

**Car software:**
- EU AUTOSAR
- Japan GENIVI
- AGL

One platform for all ECUs, OTA, services

**Open source**

Supporter:
- Japanese OEM, car maker

**Tizen OS + GENIVI** → AGL 2.0 (Blowfish)

**Raspberry Pi3**
- CAN, MOST, GPS, serial
- USB
- HDMI
- Ethernet port

**AGL Raspberry Pi 3 support**


**Supporter:**
- GENIVI
- AGL Raspberry Pi 3 support

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Automotive Grade Linux (AGL) - Advantages

AGL

- An open source Linux distribution for car OEMs
- Has many supporters
  - Toyota, Honda, Mazda
  - Denso
  - Fujitsu
  - Panasonic
- Open source of core features
  - Communication
  - IVI
  - Browser
- Allows distinct implementations
  - Competitive
  - Less time-consuming

https://www.automotivellinux.org/

Automotive Linux Summit (ALS 2016)
PoC with AGL software

RP3 = Raspberry Pi3
AGL = Automotive Grade Linux
HVAC = Heating Ventilation and Air-Conditioning
Remote configuration: OTA client/server communication

Image Name: Linux-4.4.16
Image Type: ARM Linux Kernel
Checksum ..OK
Loading Kernel ..OK
Starting kernel ..
Automotive Grade Linux 3.0.0
RaspberryPi3 login:__

RP3=Raspberry Pi3

OTA client (RP3)

OTA client

OTA server

Config.

Terra-term

Transmit delay
0 msec/char 0 msec/line

Port: COM10
Baud rate: 115200
Data: 8 bit
Parity: none
Stop: 1 bit
Flow control: none

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OTA and remote OTA server communication

OTA Server

Remote update

Server comm.

$W$ update

ACK

Internet/LAN

Application

Software update accomplished

AGL kernel modification

AGL software

Software update accomplished
Challenges in remote configuration: HW/SW dependencies

- There may be dependencies given by the target platform architecture
- CPU/MIPS
- Kernel version
- Outdated drivers/libraries
- Boot-loader
- Hardware interfaces (J-TAG/boot-loader/flashing).
- Need for entire HW/SW sources/knowledge when using OTA.

Example architecture:
OTA prototype realization - Discussion

Software
- AGL is helpful to realize remote configuration of hardware components.
- Clear strategy in case of SW roll-back is required.
- Specification of API /client GUI need further development.

Hardware
- Significant slow-down in project realization when HW dependencies exist.
- GW hardware is different and need different remote update strategies.
- Deep understanding of the hardware architecture is essential and all source code need to be available, e.g., boot-loader, kernel updates, etc.
5. Conclusions
Conclusions

There is an increased need for connected vehicles and remote configuration of car software.

- Increased of software recall can be solved by over-the-air (OTA) communication.

Automotive Grade Linux aims to modernize and prepare the connected car with flexible, scalable and secure remote configuration.

- AGL supports OTA and remote configuration of IVI systems.

Open source projects will help the adoption of OTA technology in automotive markets.

- However, a strong hardware/software dependency can be challenging.
Thank you!

Questions & Answers