# Automotive Linux, Cybersecurity and Transparency

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Jan 22, 2016
http://she-devel.com/Chaiken_automotive_cybersecurity.pdf

- The Problem(s)
  - -- Legacy designs
  - -- Unclear privacy situation
  - -- DMCA
- Approaches to a Solution
  - -- PKE
  - -- Virtualization
  - -- Architecture-based security
  - -- Open Source

# Ready or not, here come new regulations

Caltrans source link

## Department of Motor Vehicles

## Invitation to Public Workshops on Draft Regulations for Autonomous Vehicles

**The department is seeking public discussion in the following areas:**

- Feedback on specific provisions of the draft regulations
- How the state can best require compliance with transparent and technical safety standards
- Manufacturer certification requirements and how the department can best determine the validity of those certifications

**Workshop Schedules**

**Northern California**
10:00 a.m.
Thursday, January 28, 2016
Harper Alumni Center,
California State University, Sacramento
6000 J Street, Sacramento, CA 95819

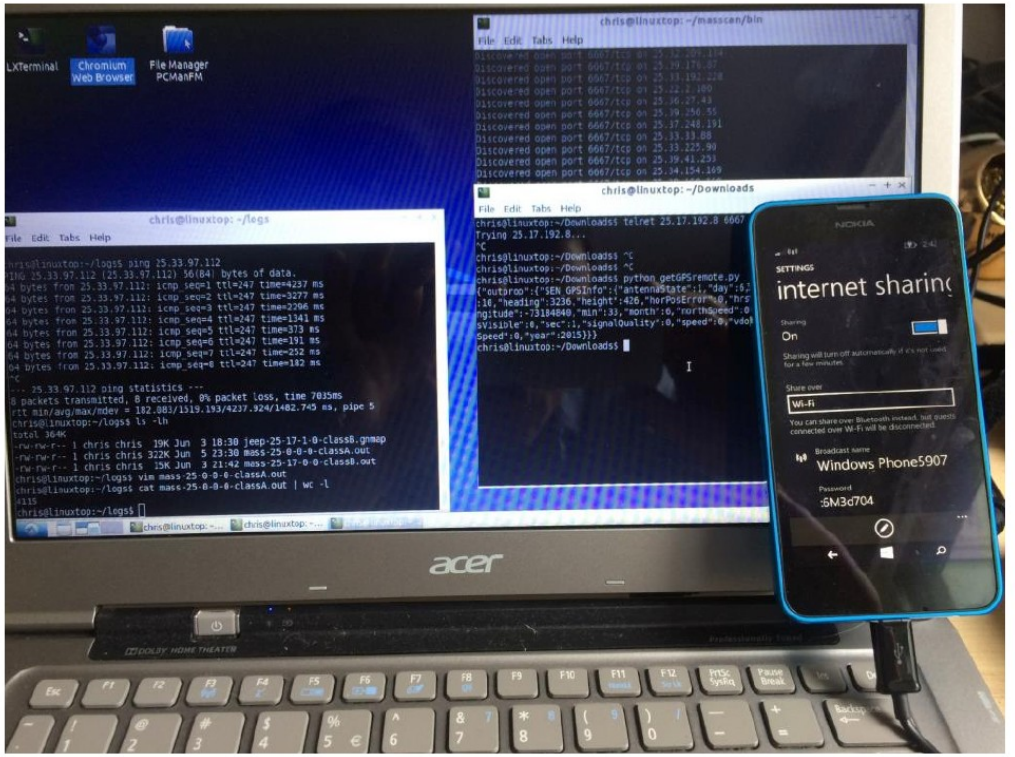
**Southern California**
10:00 a.m.
Tuesday, February 2, 2016
Junipero Serra Building, Carmel Room
320 West 4th Street, Los Angeles, CA 90013

# July 2015: Miller and Valasek “state-sponsored” takedown of Jeep


source: http://illmatics.com/Remote%20Car%20Hacking.pdf

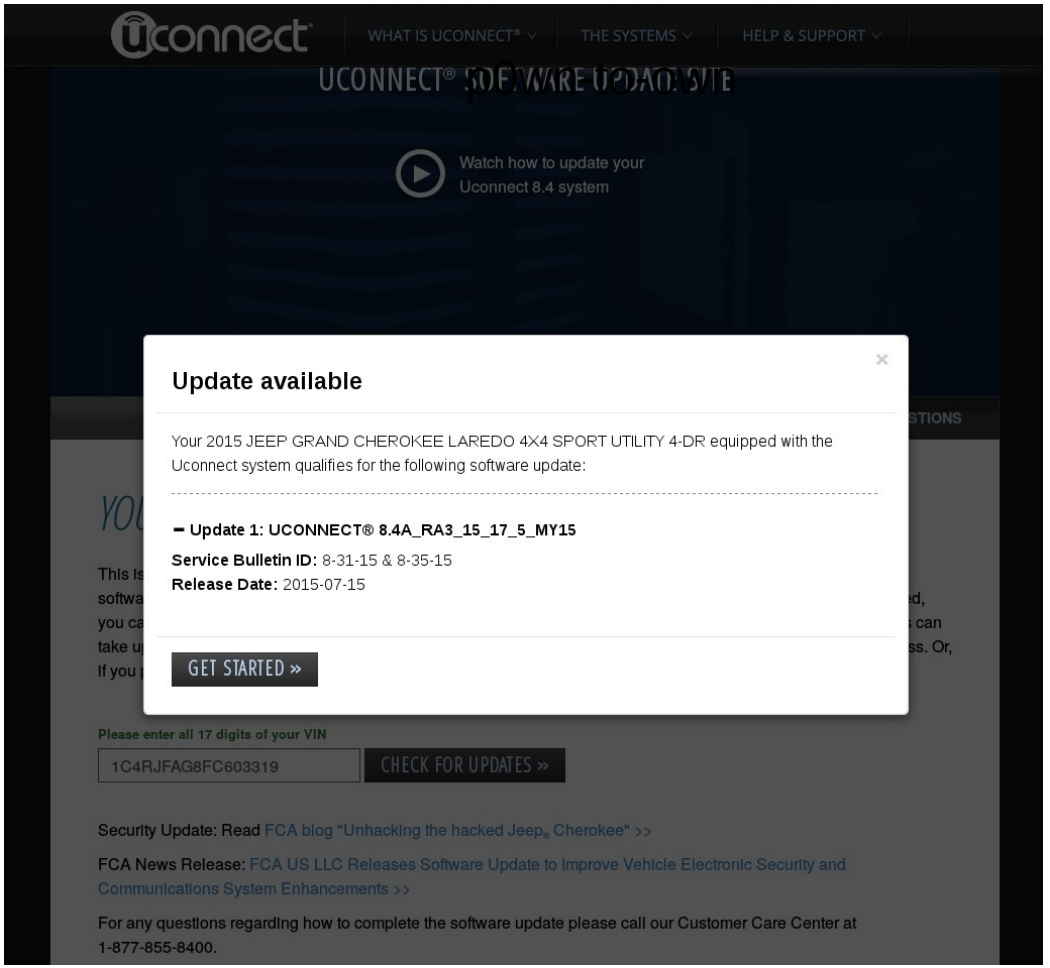
# Miller-Valasek: D-Bus service responding to an open 3G port

"To find vulnerable vehicles you just need to scan on port 6667 from a Sprint device. . . "




```
# netstat
Active Internet connections
Proto Recv-Q Send-Q  Local Address           Forei
tcp        0      0  144-103-28-21.po.65531  68.28
tcp        0     27  144-103-28-21.po.65532  68.28
tcp        0      0  *.6010                  *.*
tcp        0      0  *.2011                  *.*
tcp        0      0  *.6020                  *.*
tcp        0      0  *.2021                  *.*
tcp        0      0  localhost.3128          *.*
tcp        0      0  *.51500                 *.*
tcp        0      0  *.65200                 *.*
tcp        0      0  localhost.4400          localhost.65533
ESTABLISHED
tcp        0      0  localhost.65533         localhost.4400
ESTABLISHED
tcp        0      0  *.4400                  *.*                     LISTEN
tcp        0      0  *.irc                   *.*                     LISTEN
```

# Without Over-the-Air Updates, Jeep is stuck




Dec. 2015 view of Uconnect update

# The Jeep was running QNX

- QNX is outshipping Linux 6:1 say analysts.
- Many automakers plan cars that run Linux:
  - GENIVI members: BMW, FAW, CMC, Great Wall, Honda, Hyundai, JLR, Daimler, Nissan, Peugeot-Citroen, Renault, SAIC, Volvo
  - AGL members: Toyota, JLR, Mitsubishi, Nissan, Honda, Ford, Mazda,Subaru
- So everything's fine, right?

## What about . . .

- attaching your phone via USB to a rental car?
- leaving your car at a repair shop overnight?

## How do we . . .

- opt out of automakers' data collection?
- reset a car for sale to factory defaults?

## Should . . .

- an unpatched car fail its safety inspection?
- law enforcement routinely monitor speed data?

We need societal values to inform transportation technological decisions . . . *not* the other way around!

# Safety vs. Security Tradeoffs?


- 2-seconds-to-rear-view-camera NHTSA rule enforces minimum boot time.
- Ill-considered regulations can lead to *less* safety when increased attack surface is factored in.

# Event Data Recorders: NHTSA decision pending

NHTSA
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION

Driving Safety | Vehicle Safety | Research | Data | Laws & Regulations | About NHTSA

- About NHTSA Home
- About the Administrator
- Congressional Testimony
- Jobs at NHTSA
- Speeches, Press Events &

CHAT HELP

## U.S. DOT Proposes Broader Use of Event Data Recorders to Help Improve Vehicle Safety

**NHTSA 46-10**
**Friday, December 7, 2012**
**Contact: Karen Aldana, 202-366-9550**

**Requirement aims to capture valuable safety-related information in seconds before and during a motor vehicle crash**

ELECTRONIC FRONTIER FOUNDATION eff.org

## What is being collected?

- 14 mandatory points + 28 optional
- But that's a floor, not a ceiling
- What else?
  - Location
  - Audio or Video

courtesy
Nate Cardozo,
EFF

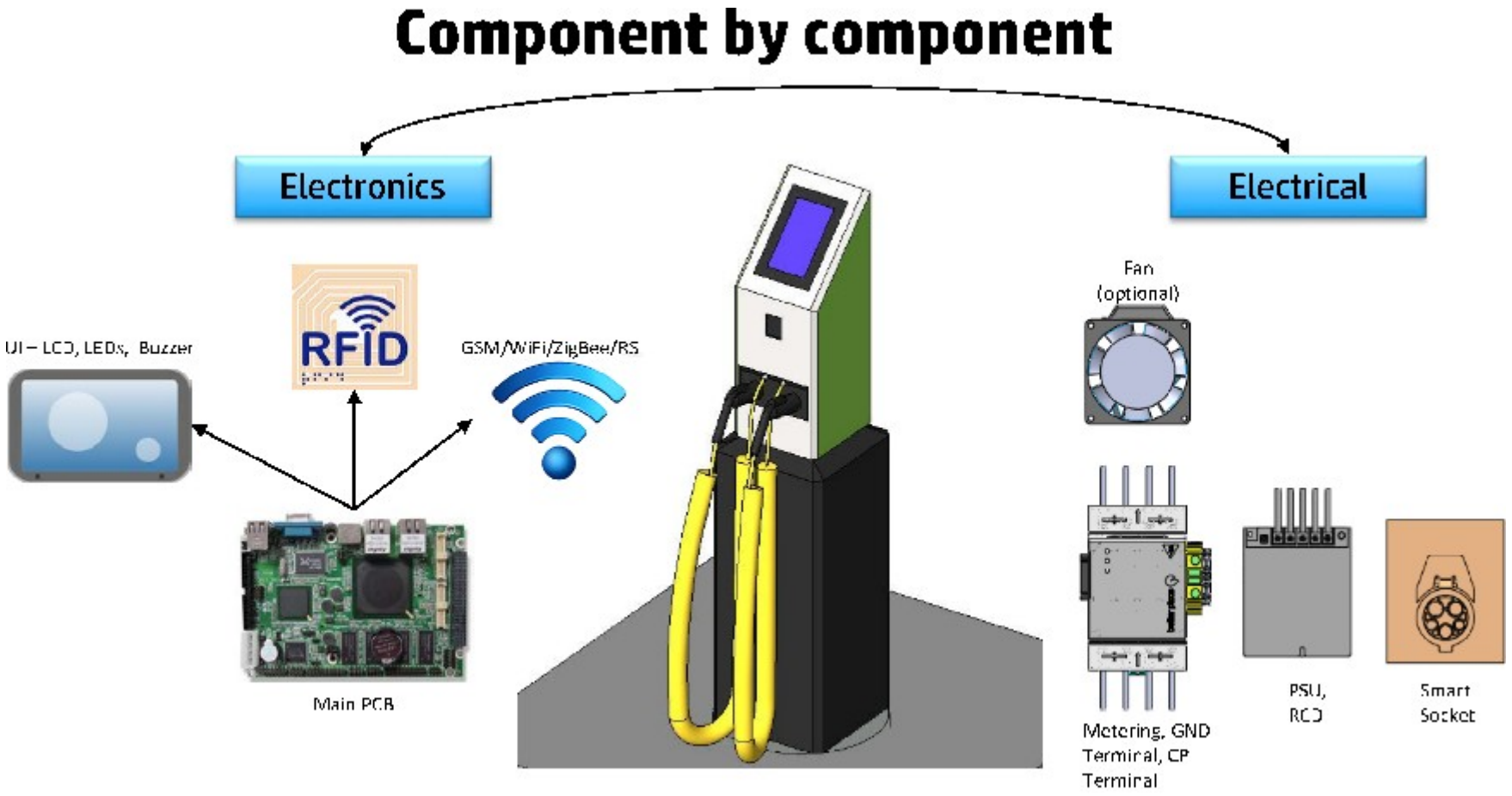

The surest approach to security:
*avoid being an attractive target*


# The ONLY way that payment credentials should be stored in a car


Associating *broad* payment credentials with *embedded* car systems puts lives in danger.

# Payment credentials + High Voltage + Connectivity

## What could possibly go wrong?




Ozer Shezaf, http://xiom.com/2013/04/13/who_can_hack_a_plug_the_presentation

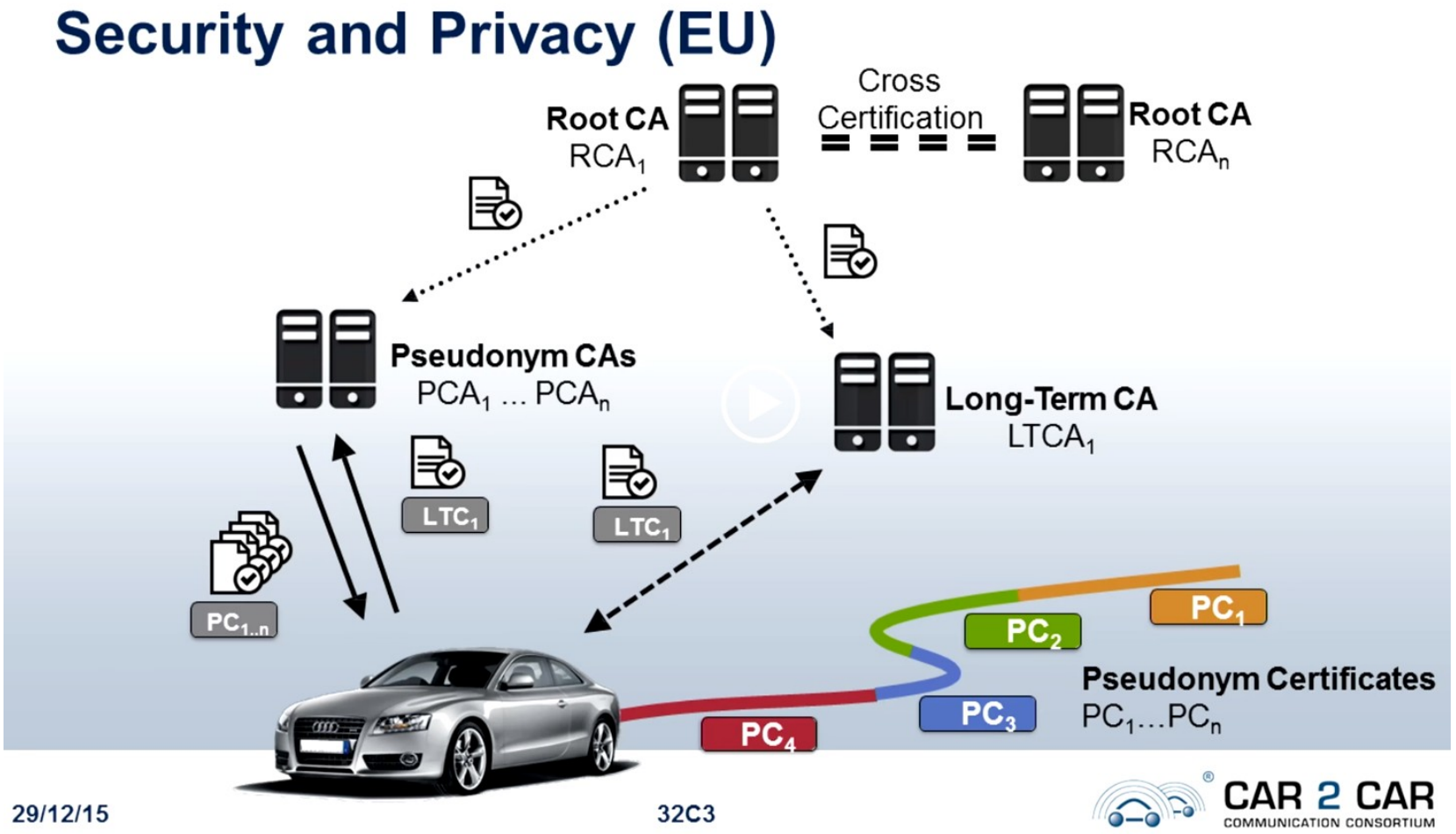
# Security and transparency approaches

# Vinli-Dialexa scan tool architecture

## Securing back end communications

- Each device is issued a private key at manufacture, the public key is sent to the back end along with the device ID
- Each message is signed when it is sent, inside of an HTTPS connection with certificate verification

# Preserving anonymity with PKE is Challenging



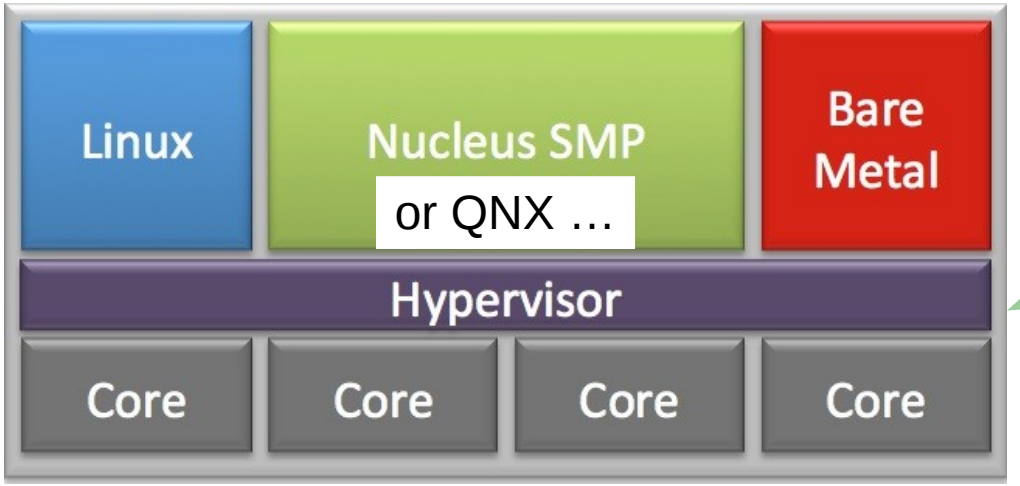

Courtesy B. Lehrmann, 32C3, "Vehicle2Vehicle Communication based on IEEE802.11p"

# Multiple processor cores with multiple OSes

AUTOSAR
Enabling Innovation

Driver Assistance,
Navigation, Entertainment

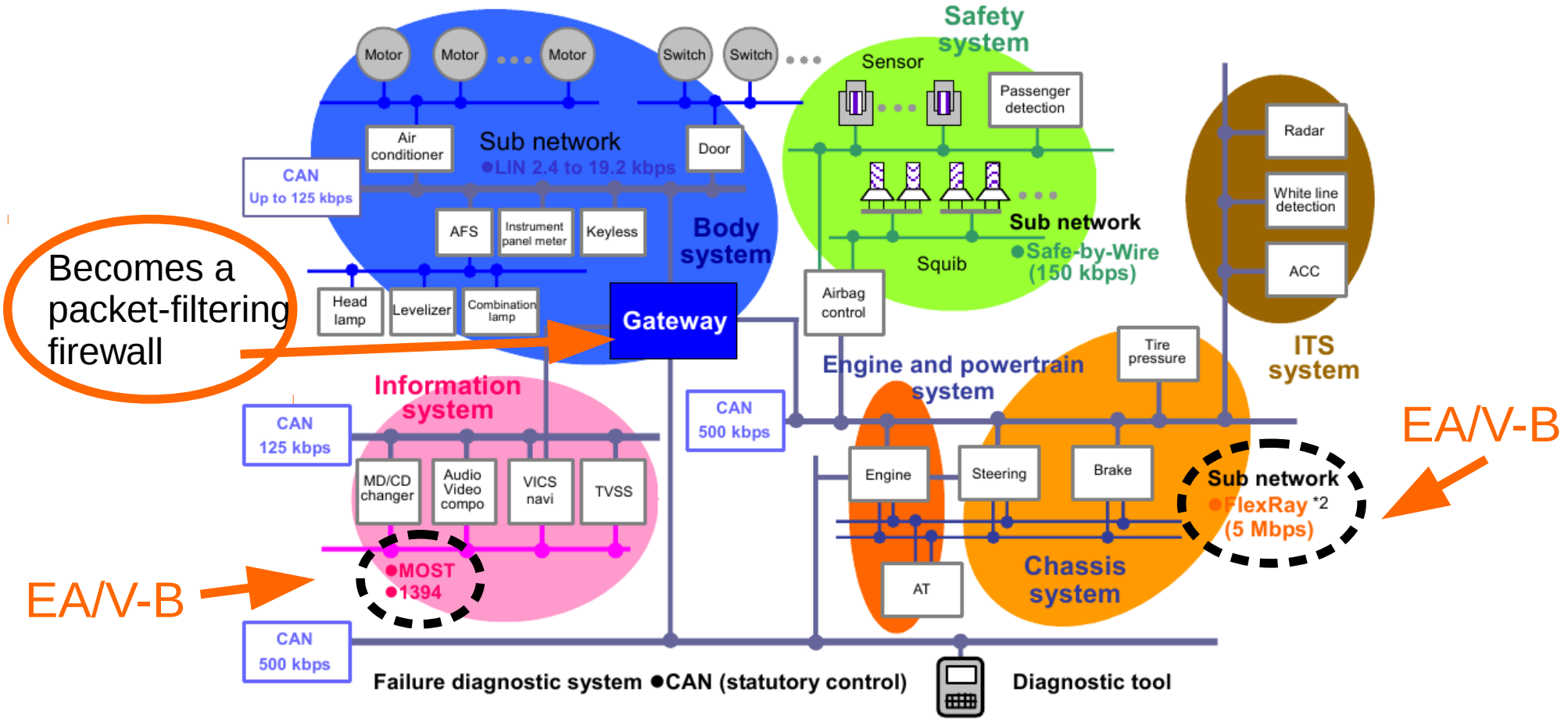
Linux can
be AGL-GENIVI
or Android, or one
core of each




Proprietary
or Xen

Courtesy Mentor Automotive

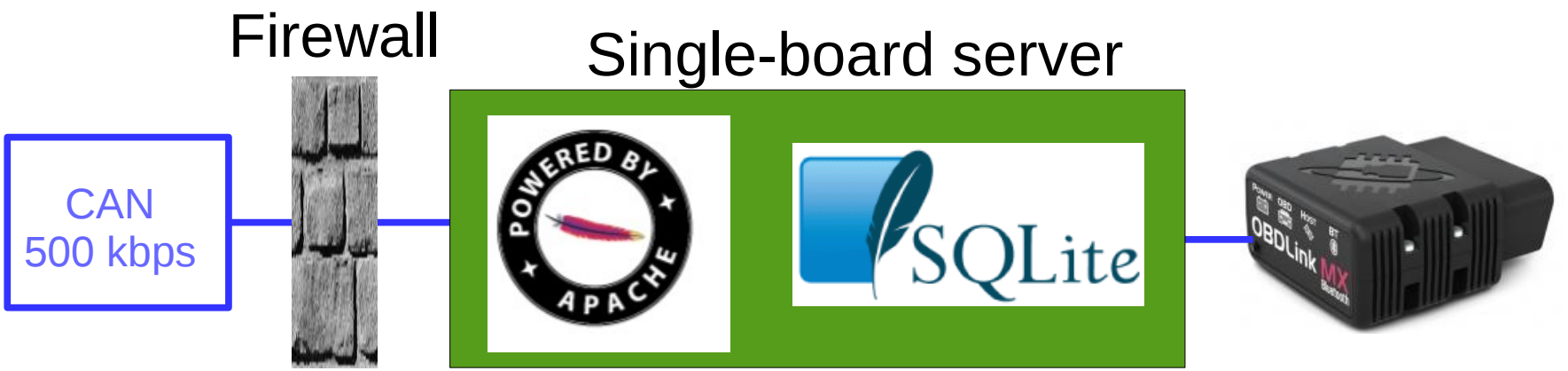
# Automotive LAN, 2025






Ethernet A/V-B (audio-video bridging) will displace FlexRay and MOST

# *Proposal*: scantool connection via DB only



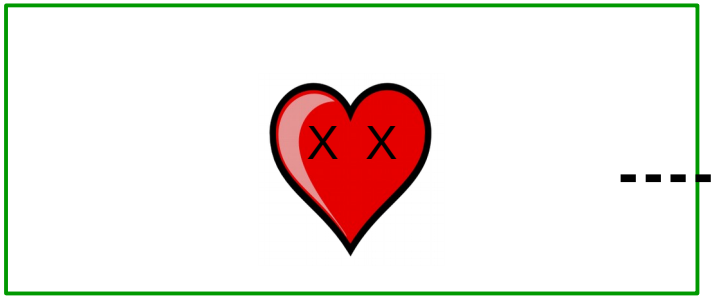

Get rid of *hard* connections to CAN from passenger cabin.

# Linux kernel's watchdog timer guards against intrusion-caused slowdown

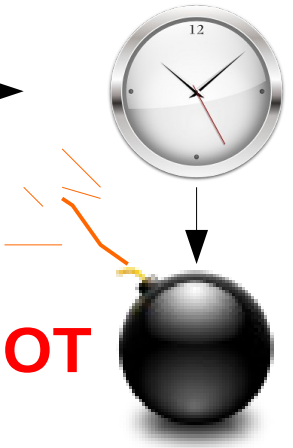

/dev/watchdog

***Must hit critical time window***

Critical application,
normal state

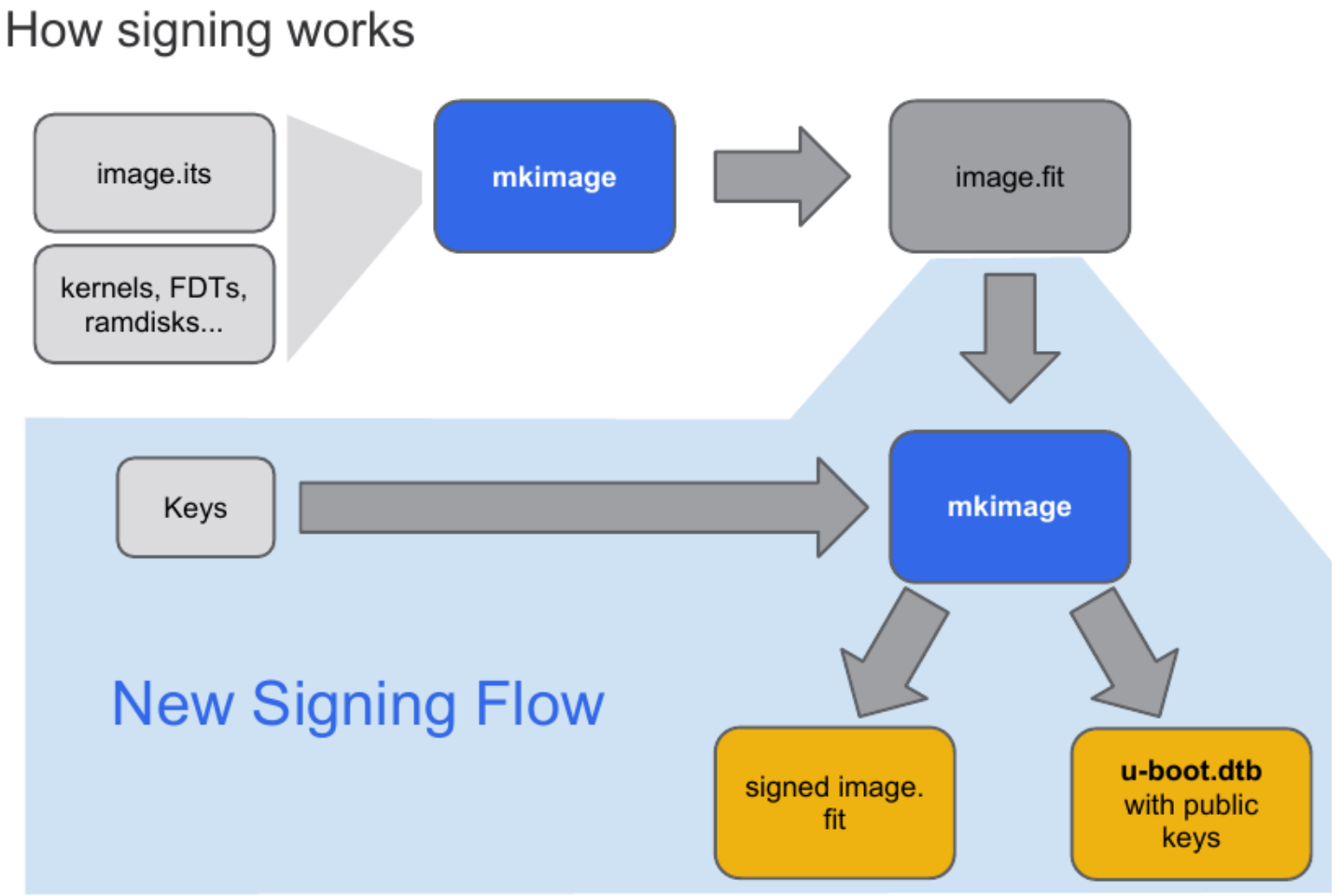



/dev/watchdog

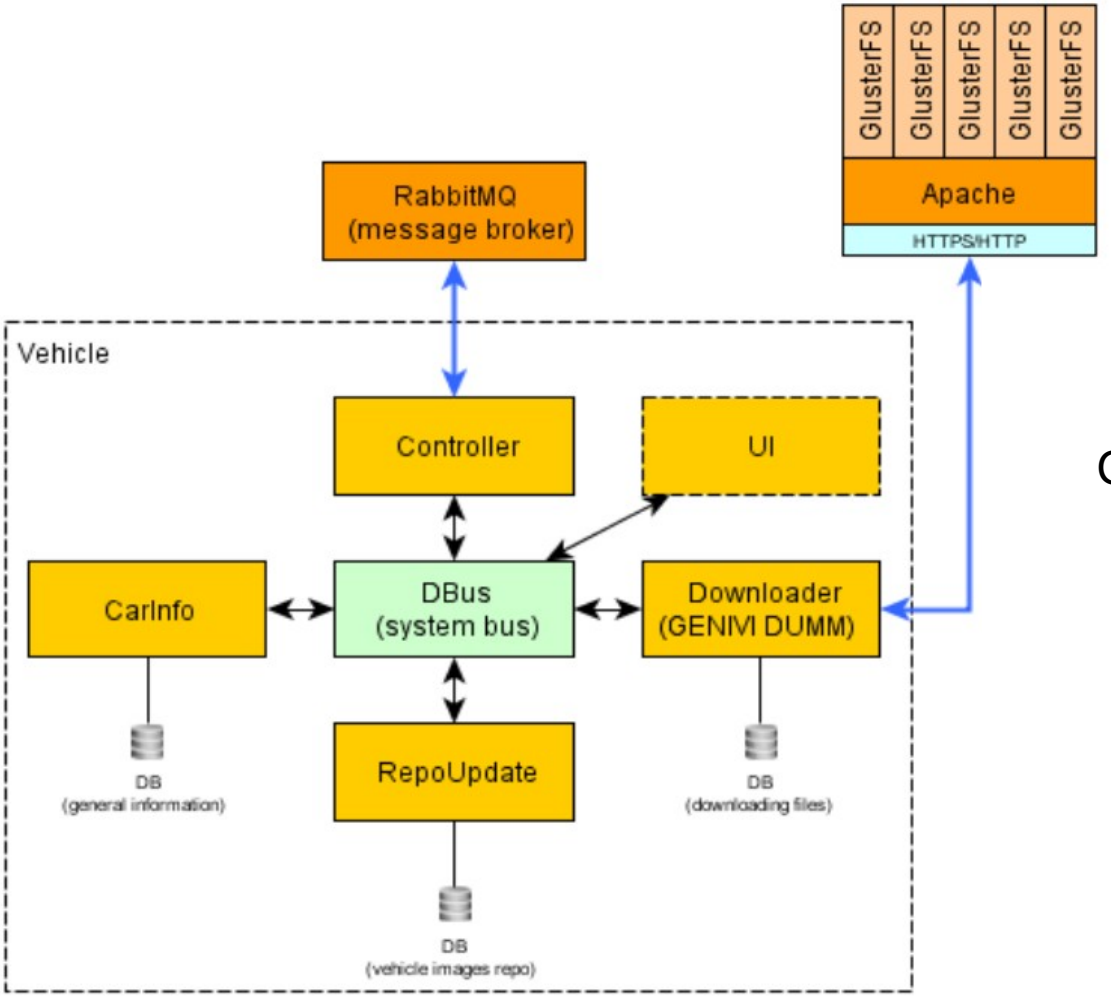



Critical application,
failed state; ***or simple slowdown***

# Industry Best Practice: ChromiumOS's Verified Boot




Balances security with software freedom.


Courtesy
GENIVI
and
Arynga

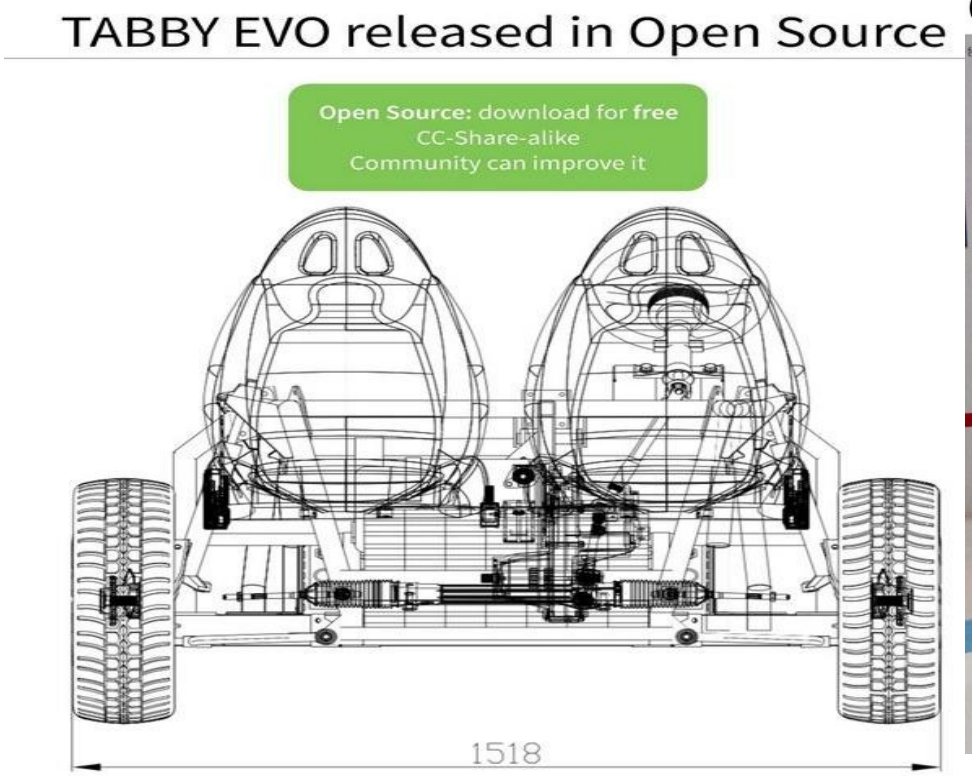
OCTOBER 27, 2015 | BY PARKER HIGGINS AND MITCH STOLTZ AND KIT WALSH AND CORYNNE MCSHERRY

## Victory for Users: Librarian of Congress Renews and Expands Protections for Fair Uses


EFF wins automotive DMCA Section 1201 exemption

32c3 2015: F. Domcke reverse-engineers the VW-diesel cheat

# Most exciting development of 2015: OSVehicle




# Summary

- Adding capability and automation inevitably increases 'attack surface.'
- The FCA-Harman-Sprint installation did not follow best practices.
- The industry as a whole is moving to OTA.
- Considerable open-source activity is underway.
- Traditional Linux security considerations apply equally to cars.

# References


- Smart Automotive special issue of Telematics Wire
- Nate Willis, “Linux and the Automotive Security Lab”
- “Dieselgate” and V2V communication talks at 32c3 2015
- EPIC “Internet of Cars” Congressional testimony, 11/18/2015
- “Vehicle Forensics” SchmooCon 2014
- “Remote Vehicle Interaction,” AGL meeting, 9/2015
- Ethernet A/V-B: Junko Yoshida, EE Times
- Automotive Grade Linux and GENIVI
- General Motors' kernel source
- Freenode #automotive IRC
- I Am the Cavalry Five Star Automotive Cyber Safety Framework

# Acknowledgements

Thanks to the following people for comments on, contributions to or support of (but not endorsement of) this presentation:

Dan Bartz, Mike Linksvayer, Roni Michaels, Linda Campbell, Charlie Vogelheim, Nate Cardozo, Andre Nakkurth, Julian Palau, Vinli, IBM Enterprise Security

# extra slides

# Hardware-level security on a device

- x86: TPM, IMA . . .
- ARM: Cortex-R, TrustZone
- Both ARM and x86 solutions have some Linux driver support

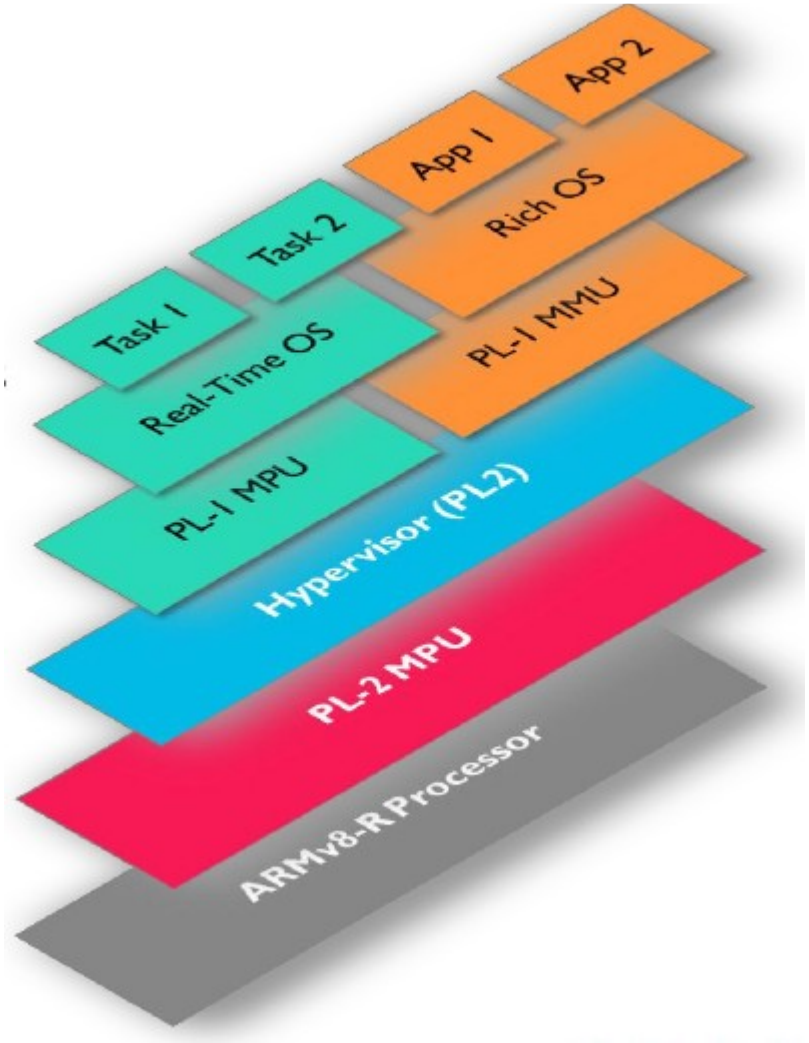
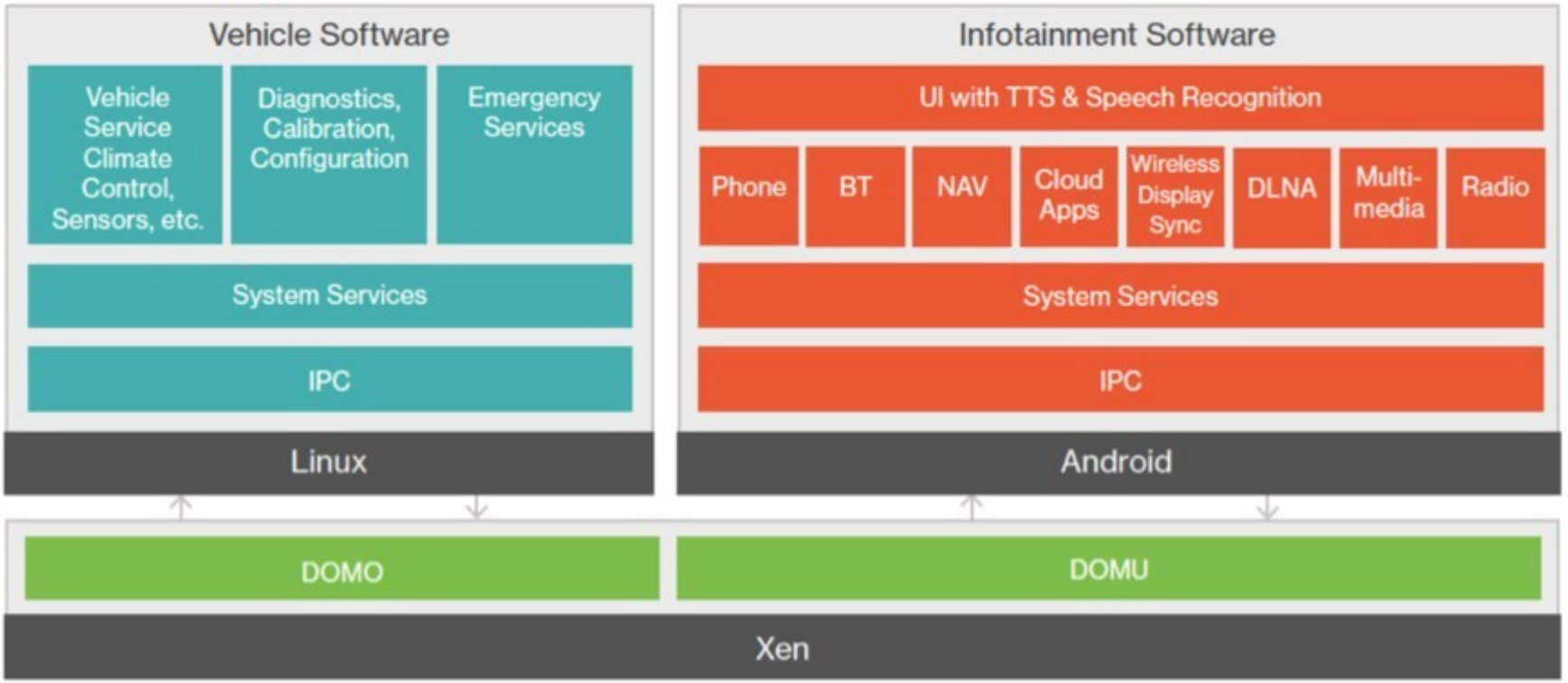



Image courtesy Chris Turner, ARM

# Familiar problems, familiar solutions




DOM0 and DOMU run on different cores of a processor.

Global Logic: http://tinyurl.com/ojnrbr2

# Driver drowsiness detection has great potential, but . . .

## INTERIOR MONITORING WITH ACTIVE PERSONALIZATION

**Interior Monitoring:**

Monitor the driver's gaze direction, attention, drowsiness and emotion using a 2.3 mp camera module with IR illumination connected to FPGA processing FC.

- Camera Point Tracking Algorithms
  - Gaze Direction
  - Eye Closure
  - Blink Rate
  - Head Tracking
  - Yawn Detection
  - Emotion Recognition
- Holistic HMI

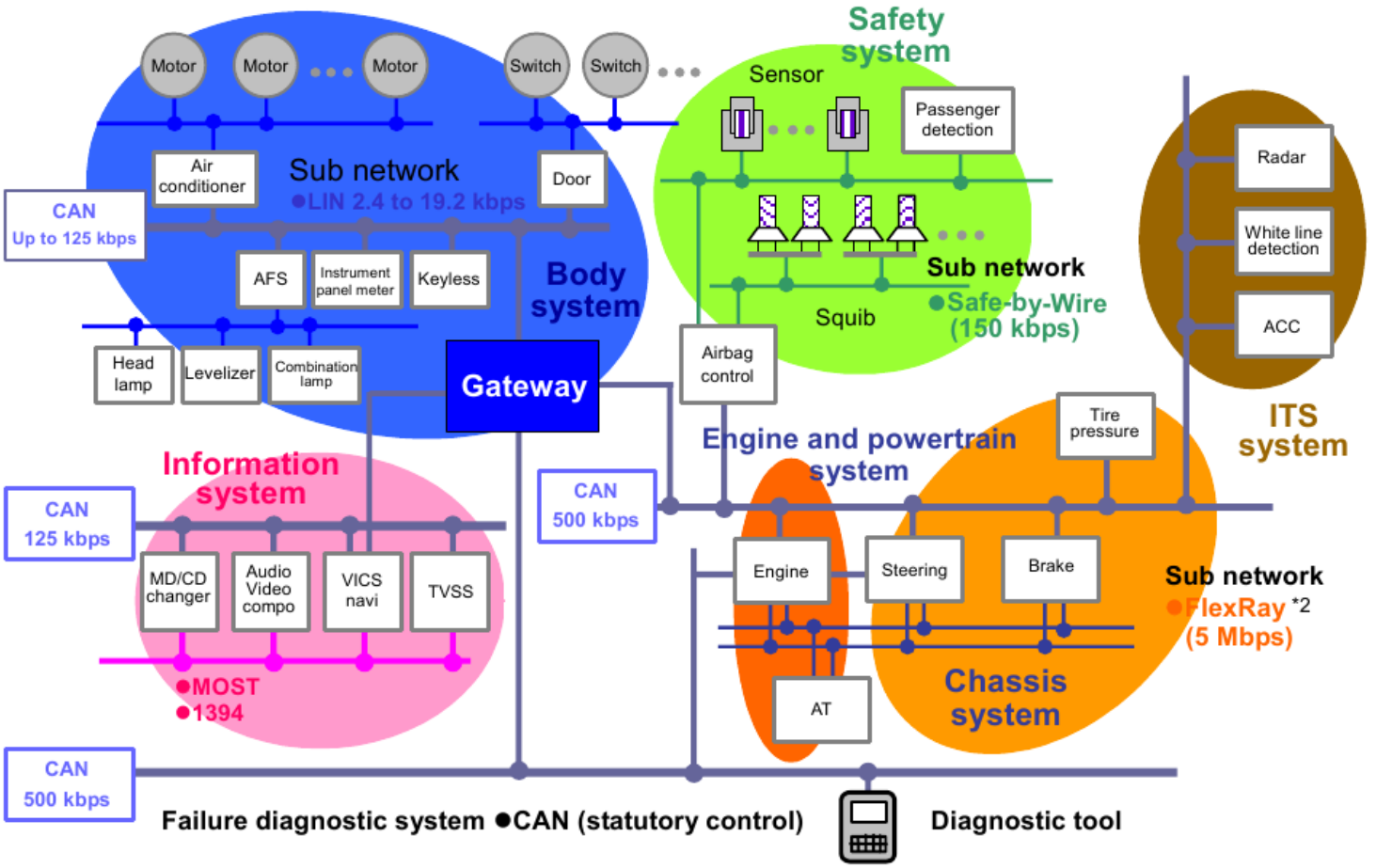
**Active Personalization:**

Vehicle preferences and customization is saved and automatically set when system identifies driver.

- **For Fun:**
  - Personal Profile
  - Mobile, Infotainment and Comfort Presets
  - Seat and Climate Presets
  - Recommended Routes
  - Better Routing and Incentives
  - Text, Email and Social Reader


Source: Key Safety Systems

# Automotive LAN, 2015





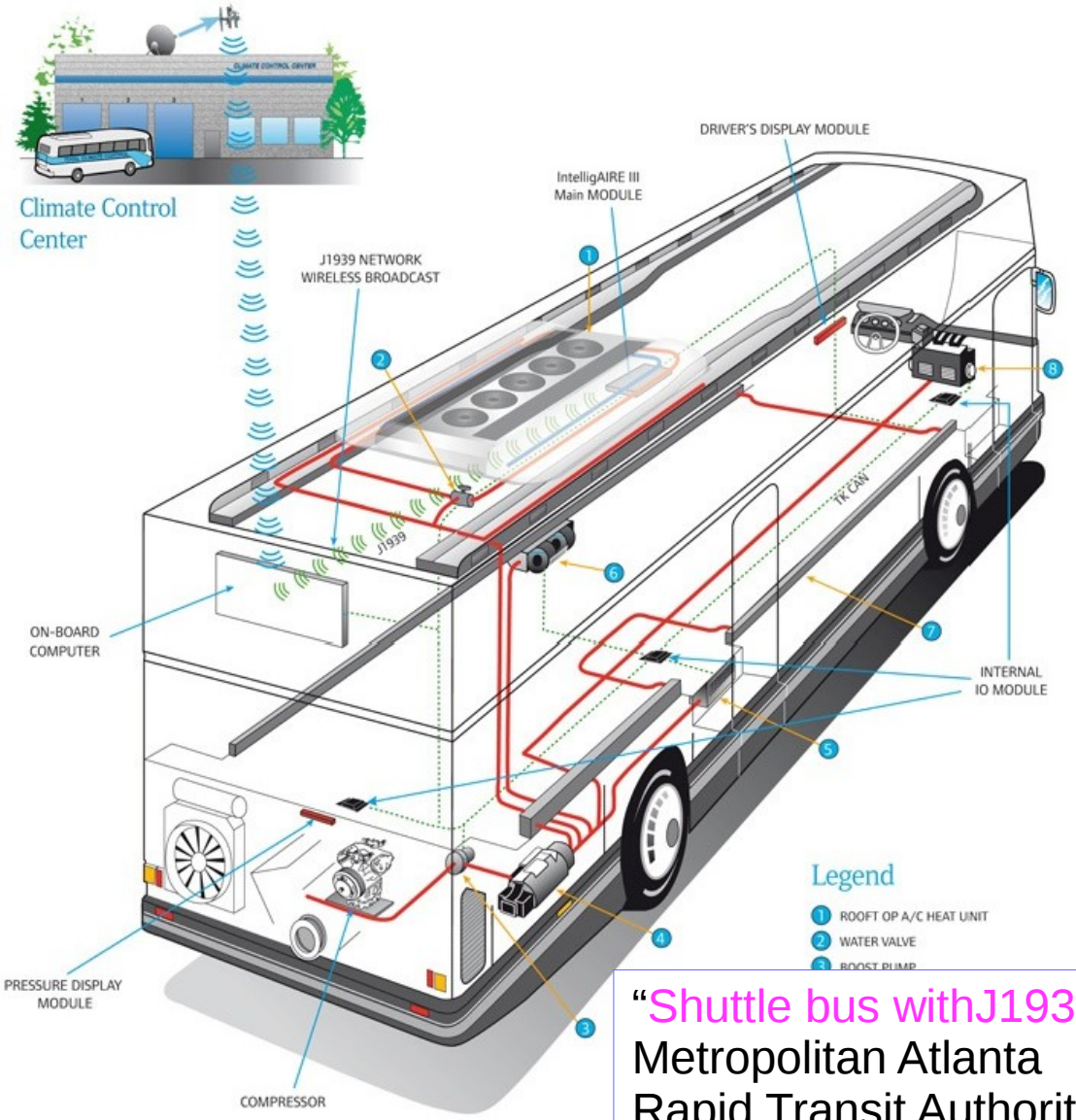

>100 microprocessors on MOST, CAN-FD, LIN, FlexRay networks

# GPS Spoofing: Qihoo at Defcon

## Try to spoof cars

- Demo video: The car, BYD Qin,was located in a lake center.

# Connectivity may be a bad choice




"Shuttle bus withJ1939 air conditioning," Metropolitan Atlanta Rapid Transit Authority, http://can-newsletter.org

The "Thermo King Intelligaire III"

# Ambient Insecurity: the Internet of Threats

"Alternative Web browser-based user interface allows remote programming and status observation"
(Safetran Cobalt brochure)

Background: Thinking Highways

# Open Street Map and Ubuntu uNav


H/T Linux Unplugged Episode 115

# Automotive pen-testing

Security conference

Save as PDF

## *Tesla only partially hacked*

**Last week's Syscan-360 Security Conference in Beijing (China) posed a challenge: a prize of US$ 10 000 was announced for anyone who managed to hack a Tesla. The prize money went unclaimed - none of the participants managed to meet all specifications set by the organizers.**

ACCORDING TO THE SOUTH CHINA MORNING POST, 10 600 yuan were awarded to a white hat hackers team from Zhejiang University, which managed to exploit a "flow design flaw" of the Tesla model S to access the car's CAN network. They could "unlock the vehicle, sound the horn, and flash the lights, and open the sunroof." All this was achieved while the car was in motion, but no team managed to hack the engine during the set timeframe.

CAN Industry Association newsletter, July 24, 2014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GM embraces white-hat hackers with public vulnerability disclosure program
First major automaker (aside from Tesla) to issue guidelines promising not to sue researchers.
by Sean Gallagher - Jan 8, 2016 7:44am PST
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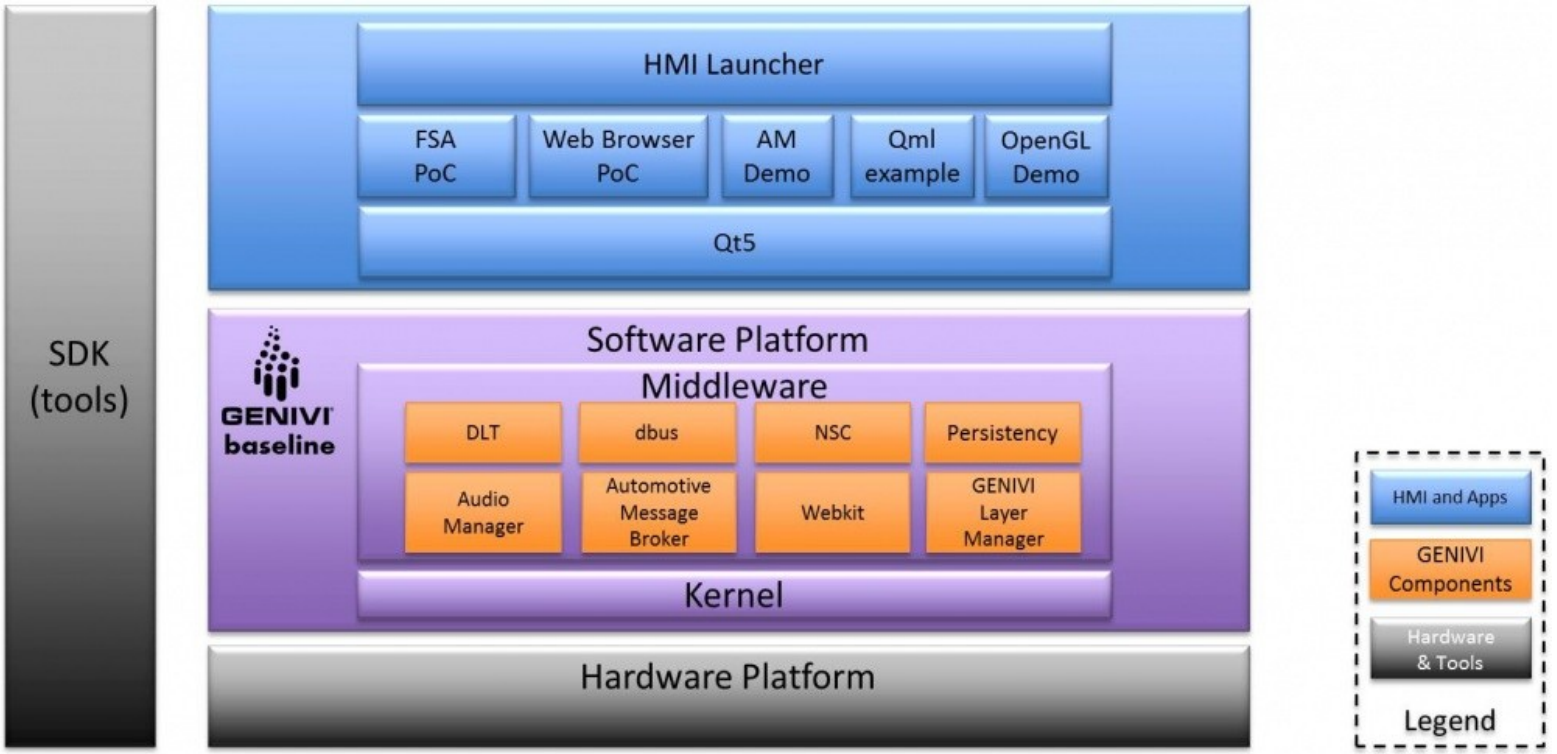
# Auto Security Products & Solutions

| | Security Function | Company/Product |
|---|---|---|
| Cyber-Security Services | ▸Security risk assessment<br>▸Penetration testing<br>▸Vulnerability assessment | ▸Cisco OpSec<br>▸IOActive<br>▸Many others |
| Hardware Security | ▸Cryptographic processing<br>▸Secure microprocessor | ▸Freescale microcomputers<br>▸TI and others |
| Hypervisor Software | ▸Protect at software boot-up<br>▸OS & software isolation | ▸OpenSynergy, Mentor Graphics<br>▸Green Hills & others |
| Over-the-air SW Update | ▸Remote software update with built-in security | ▸Arynga<br>▸Redbend |
| Apps Security Framework | ▸Security framework for connected car apps | ▸Secunet Application Control Unit<br>▸Others expected |

Courtesy of IHS and E. Juliussen

# GENIVI Demo Platform




Qemu image plus BSPs for RPi, Minnowboard, Nvidia Jetson and Renesas R-Car

# A typical automotive data center

Source: RTKL blog

# Chaos Computer Club 2012 video

Christie Dudley, Santa Clara University Law School


http://tinyurl.com/crbazg9