The Connected Car
Challenging Hardware, Software, Security
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- 20+ Years of Experience in Product Development Engineering, Software Development and System Engineering
- Automotive Industry, Industrial Image Processing, Digital Television, Open Source Consortium Management
- Technical Consulting, Program Management, Technology Research, Strategic Planning
- Cross-functional Team Leadership
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ibeeto

- Consulting for Open Source and Linux
  - Open Source Development Practices
- Training
  - Embedded Linux
  - Yocto Project
- Software Engineering
  - Development Services for Open Source and Linux
  - Specializing in Embedded Systems, IoT, Automotive
Opening Questions

- What do you think the Connected Car is?
- Do you know any Connected Car models?
- What do you expect from a Connected Car?
  - When driving one
  - When being a passenger in one
- What features would you want to buy a Connected Car?
Connected Car

“A connected car is a car that is equipped with Internet access, and usually also with a wireless local network.”

Wikipedia (2014)
Easy enough – or maybe not...
Value Proposition Challenge
Customer Expectations – All I Want...

- **Entertainment**
  - Movies
  - Television
  - Games
  - Music

- **Connectivity**
  - Phone
  - Internet
  - Social Networks

- **Access to**
  - Media on my devices
  - Media on my home entertainment system
  - Media on my cloud services
  - App Store

- **Information**
  - Navigation
  - Traffic Conditions
  - Weather Conditions
  - Voice Mail
  - E-Mail
  - Text Messages

This is a fully featured home entertainment network!
And by the way...

- Fully Customizable
- Large App Store
- Regular Software Updates
- 1 Year Life Cycle
  - < $500

- Fixed Screens
- Limited Applications
- Only Bugfix Updates
- > 10 Life Cycle
  - > $2,000
Complexity Challenge
100+ Million Lines of Code
(in a premium-class car, IEEE Feb. 2009)

70%+ in Infotainment & Telematics

R&D Cost of USD 1 – 10 / LoC
(>enivi, 2010)
Security Challenge
Plenty of Opportunity!
Assessing Threat

**Technical Capabilities**
- Engineering Know-How
- Target Knowledge
- Hardware/Software Tools
- Computation Power

**Operational Capabilities**
- Channel Access
- Field Delivery
- Scale
- Cost
OBD-II and CAN – Freeway to Malware
Over-the-Air Updates

- Built-in ECU Software Installer
- Man-in-the-Middle Attacks
- Gateway Vulnerabilities
- Built-in ECU Software Installer
Smartphones and Mobile Applications

- Trojan Horse in innocuous applications monitoring Bluetooth connections to telematics devices
- Report vehicle information etc to adversary’s servers
- Eavesdrop on driver and passengers using hands-free setup
- Send attack payload via Bluetooth connection
- Widespread app store distribution can have viral effect
In-vehicle WiFi

- Extends beyond vehicle boundaries
- Insufficiently secured WiFi access points allow arbitrary device connections
- Attackers can use it
  - as free of charge hot-spot
  - for access to vehicle data and systems
  - as denial-of-service attack bots or similar
Long-range Wireless Access

- **Broadcast Channels**
  - Digital Radio (HD radio, DAB)
  - RDS
  - GPS
  - Not necessarily for distributing malicious payload but as control channels to trigger attacks.

- **Addressable Channels**
  - Telematics Systems e.g. BMW Assist/Concierge, Ford Sync, GM OnStar, Hyundai BlueLink, Lexus Enform, MB mbrace, Toyota SafetyConnect, etc.
  - Features such as remote door unlocking, remote track and disable, diagnostics, convenience, data access, driving directions and more
  - Accessible over arbitrary distance, two-way channels with high bandwidth, individually addressable
V2X/DSRC/WAVE – A New Hacker Playground

“Defense in Depth” Strategy
PKI with Government CA

Who is to trust?

No hardware binding for protocol security.

IEEE P1556
IEEE P1609
WAVE
DSRC
IEEE 802.11p
User Account Aggregation
Mythbusters

Many eyes find many security issues!

If it is obscure it is more difficult to hack!

Code review may be easy but it requires process diligence.

Software tools such as protocol analyzers, dis-Assemblers, de-compilers etc. provide a high degree of insight.
Ecosystem Challenge
1.2 Billion Annually

80 Million Annually
Where are the Developers?

Affordable Hardware
Open Tools and SDKs
Large Target Market
Open App Store
Low Barrier of Entrance

Proprietary Hardware
Proprietary Software
NDA
Long Time-to-Market
Difficult to Engage
Solution?
Open Infotainment Platform

Built on

TIZEN™

X86 and ARM Hardware Support

VMWare Images

Created through collaboration
Intel, Ixonos, Jaguar Land Rover
Symphony Teleca, TCS

Requirements donated by Toyota,
Denso, Nissan, Jaguar Land Rover
and many more

Enabling Collaboration
Home Screen

- Toolbar for quick access to the main applications
- Settings menu for system setup
- Date and time information
- Info dial with 7 segments to access the major applications: Navigation, Phone, HVAC, Media Player, Dashboard, Smart Device Link
- Center icon to access all installed applications
- Single touch to access any application
HVAC

- Use Cases
  - Max Defrost
  - Fan Speed
  - Air Distribution
  - Temperature Control
  - Air Condition
  - Front Seat Heating
  - Rear Window Heating

- Vehicle integration via Automotive Message Broker (AMB) and CAN bus
Dashboard

- Remaining Battery Level and Mileage Estimate
- Location and Weather Conditions
- Tire Pressure Levels
- Child Lock Activation Status
- Average Energy Consumption
- Controls for Rear-Seat-Entertainment
- Engine Status (when in motion)
Media Player

• Video and Audio Playback
• Integrated browsing of DLNA media containers of DLNA-enabled devices
• Change between DLNA and local content
• Voice recognition from speech API for play, pause, next, previous
WiFi

- Show available WiFi networks by SSID
- Connect to and disconnect from WiFi networks
- Mark WiFi networks for auto-connect when in range
- Connect to hidden WiFi networks
- Enable/disable WiFi tethering
- Indicate connected network
Navigation

- Google Maps
- Text-to-Speech Guidance
News

- Article Summaries
- Full Article Views
- One-finger-touch scrolling
- Data from AppCarousel via jQuery and translated into HTML on the fly
Bluetooth Phone Integration

- Pair Bluetooth Phone
- Retrieve Phonebook
- Make and Receive Phone Calls
- Access Call History
Finger Print Scanning

- Identify users by finger print
- Learn finger prints with an external scanning device
- Recall recorded finger prints
- Delete finger print records
Voice Print

- Identify users by voice
- Record user voice print
- Recall recorded voice prints
- Delete recorded voice prints
Face Recognition

- Identify users by their face
- Learn new face using external cameras
- Recall previously recorded face
- Delete face records
Browser

- Enter text using QWERTY on-screen or external keyboard
- One-touch web links
- Multiple tabs
- Navigation keys
MOST Audio Controls

- Integrated with MOST via AMB
- Sound controls for volume and equalizer
- Balance and fader controls
- Surround sound amplifier and filter controls
Remote Vehicle Interaction (RVI)

- Enable remote access to the vehicle to collect data, verify status, execute actions
- Network and transport agnostic
- Security infrastructure for granular authentication and authorization
Thank You!

Not what you expected? Please let me know now. But I won’t make any promises.
Backup Slides