Infotainment and Telematics Solutions with Renesas R-Car
Course ID: 0C18I

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Andrew Patterson

- Business Development Director for Mentor Graphics embedded division (automotive).
- Over 20 years in Design Automation.
- Specialties include wire harness design, automotive simulation model development, virtual prototyping, and mechatronics.
- Current focus: GENIVI, Infotainment, Electronic Cluster, and Telematics.
- Master’s in Engineering and Electrical Sciences from Cambridge University, UK.
Renesas Technology & Solution Portfolio
Hardware platform - Renesas R-Car

- Sharing basic architecture with mobile application processor
  - Rapid migration of HW requirements from consumer market
- Automotive application family – R-Car
  - Development, function & manufacture to Automotive standards
Automotive Design Challenges ...
Software in Vehicles

Complexity increase is continuous & relentless…

Lines of Code in Transportation ECUs

Millions of Lines

<table>
<thead>
<tr>
<th></th>
<th>F22</th>
<th>Boeing 787</th>
<th>Infotainment</th>
<th>Car Today</th>
<th>Future (2015)</th>
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<td>100</td>
<td>150</td>
<td>200</td>
<td>300</td>
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Solution Components

**HMI**
- 3D Design Tools
- HTML5
- Smart Device Integration

**Applications**
- Demo templates & 3rd-party Alliances

**IVI Foundation**
- Services, Libraries and middleware for Infotainment

**Drivers**
- Board Support Packages

**Linux Kernel**
- GENIVI-compliant Linux, virtualization options

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**Graphics Display**
- 3D, Accelerated
- Hybrid Graphics

**Applications & Functions**
- Building blocks for CAN, AVB, Telematics
- Open API

**Drivers**
- Board Support Packages for Instrument Cluster SoC

**Linux Kernel**
- Multi-domain OS, Virtualization, AUTOSAR
Trends...

- 5 out of 10 top purchase decisions for cars are Infotainment related (GFK Research)
- Value of software and electronics in a car is already 35-40% for a premium car (Spectrum IEEE)
- Smart phone technology is expected, with continuous updates
- Open Source and move to Linux
- Feature-hungry consumers
Car Systems – Innovation Dynamics…

- Mechanical Systems
- Electronic Systems
- Software Systems
- Real Time Data

Product Release: Year 5, Year 10

- Real-time Telematic Data Services
  - Vehicle Position
  - Cloud Access / Connected Car
  - Real time road conditions
  - Vehicle to vehicle warnings

= Obsolete
= Current
Consumer Electronics Influence …

- The SmartPhone Revolution
  - 420m New phones sold globally in Q2 2012
  - Apple & Samsung account for 83%
  - Android has 64% of Smart Phone OS Market in Q2 2012
  - Platform Refresh every 6 months

- The Car is becoming a Consumer Electronic Product
- GENIVI and Automotive Designers need to keep up …
Hardware platform pre-requisites

- High-computing capacity
- GPU / High performance graphics
- Multiple video outputs
- Car standard interfaces — CAN / MOST / AVB etc
The Infotainment System

- **Touch screen, voice, user-controls**

- **Navigation, entertainment, phone apps, mobile office, cloud apps, hot-spot**

- **GENIVI, Open Source, custom**

- **Linux, Android**

- **Device drivers, BSP**

- **Multi-Core, GPU, WiFi, AVB, MOST**
## Instrument Cluster

### Display

- 3D Graphics, shading, glossing, reflections
- Car instrument feeds, cloud data, telematics, diagnostics

### Data

- ECU Feeds
- User Input
- Diagnostics
- AUTOSAR

### Libraries, Services, Middleware

### Operating System

- Mentor Embedded Linux,

### Board Support Package

- Device drivers, SoC Integration

### R-Car Hardware Platform

- Multi-Core CPU, GPU, CAN, Flexray
Why Move to Linux?

- Proprietary 1st generation automotive operating systems now too expensive to maintain and scale up
  - QNX, Windows CE
- Linux is an Industry standard
- GENIVI specifications allow many providers of Linux to create Infotainment platform
  - Mentor, WindRiver, MontaVista, Accenture, KPIT, Renesas, Freescale, ADIT, Canonical, Meego, Intel, Magneti Marelli, Pelagicore, NVidia ....
- Wide choice of hardware platforms (SoC)
Where does GENIVI fit?

Open Source software platform for Infotainment Systems Developers

Goals:

– Reduce Costs
– Make Tier 1 development more transparent
– Contributions from many expert sources

170 Corporate Members
Many projects underway
Infotainment Linux: GENIVI 2 and GENIVI 3

Audio
- ALSA
- PulseAudio
- AudioManager
- Echo Cancellation Engine
- Noise Reduction Engine

Graphics
- X.Org
- Layer Management
- Chromium / Webkit
- Graphics Backend
- Open GL-ES
- Qt Core

Multimedia
- GStreamer
- GStreamer Framework, Base plugins
- Tracker
- Telephony Stack

Speech
- Festival
- Pocketsphinx
- Speech Engine

CE-device
- CE Device Manager

External Access
- HTTP Server
- lighttpd
- lighttpd-mod-webdav

Connectivity
- Wireless Tools
- Wpa supplicant
- ConnMan
- BlueZ

Positioning
- gpsy
- Personal Information Management
- SyncEvolution

Package Management
- opkg

Networking
- dhcp
- libcurl
- nfs-utils
- ntp

Security
- ecryptfs-utils
- gnupg2
- openssl

System Infrastructure
- d-bus
- sqlite
- qt-core
- fuse
- Gettext
- Indexing Engine
- MTP Library
- Systemd

OS kernel, drivers and libraries
- ARM Cortex Processors
- Intel Atom Processors
- Linux
- GNU libc

Device Management
- CE Device Manager

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What is the status today?

GENIVI processes are slow
- Founded in 2009
- GENIVI 3.0 now announced

Solution is incomplete

Designed by Committee...

Much left to do by implementers and integrators

Only 3 OEMs involved (BMW, PSA, JLR)

European-centric
What is Outside GENIVI?

- Human Machine Interface – HMI
- User Applications
- Hardware Platform and software drivers (BSPs)
- Other domains
  - Android, AutoSAR, ADAS
- System Integration and Test
- Design Tool Support
- Services
Pre-requisite: Getting Connected

### Smart Phone Link
- Make use of existing phone
- Familiar apps
- Phone contact list
- Includes navigation, maps
- Entertainment, song list

### Integrated SIM Card
- Need additional data plan
- Dedicated Infotainment apps
- Duplicated data
- Tidier
- Better signal?
How to get In-Vehicle Android….

- Phone Link
  - Link SmartPhone to IVI Head Unit
  - Run approved phone apps on Head Unit

- Embedded Android
  - Linux Container
  - Virtualization Solutions
**Connected Smart Phone**

- MirrorLink (CCC) Solution
  - Vehicle Hot Spot
  - Internet Access
  - Phone App access
- Selected Apps on IVI head unit
- USB, Bluetooth, OpenVNC

**IVI Stack**

- Networking
- Navigation
- Entertainment
- Mobile Office
- Speech Engine
  - Audio
  - Telephony
  - Cloud
Telematics Services – driving growth

- Collision notification
- Insurance
- Stolen vehicle
- In-car services, concierge, streaming
- Eco-driving services
- Real-time cloud data: traffic, weather, road ahead
- Car-Car communication
- Driverless car
- Diagnostics and servicing
Infotainment Design and Architecture

Andrew Patterson
Business Development Director
Embedded Automotive
Complex Supply Chain

OEM

Tier 1

Application Developer

Software Platform Provider

Hardware Platform Provider
Embedded Software Design Process

- Requirement Definition
- Test Scripts
- Calibration
- Final Test
- System in Loop
- Prototype in Loop
- Design Implementation
- Integration, Test
- Prototype Development
- Initial POC
- H/W Model in Loop
- S/W Model in Loop

OEM

Tier 1

Tier 1
Multiple Domain Options

- R-Car has processing capability for multiple domains
  - Reduce component count
  - Easier maintenance
  - Simplified wire harness
- Candidates for combination:
  - Instrument cluster
  - Telematics
  - Infotainment
  - ADAS
  - AUTOSAR
  - Android
Virtualization or Containers?

- Virtualization software can also be used to provide multiple OS domains (Hypervisors)
- Alternative to Linux Containers

<table>
<thead>
<tr>
<th>Hypervisor Virtualization</th>
<th>Linux Container</th>
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<tbody>
<tr>
<td>For</td>
<td></td>
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<tr>
<td>- Scalable to multiple domains on a single hardware platform</td>
<td>- Available as part of Mentor GENIVI Linux</td>
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<tr>
<td>- Faster boot-up time</td>
<td>- Lower Cost</td>
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<td>- HMI Integration easier to manage</td>
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<tr>
<td></td>
<td>- Solutions in place for Android and AUTOSAR</td>
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<tr>
<td>Against</td>
<td></td>
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<tr>
<td>- Cost / proprietary licensed software solution</td>
<td>- Boot-up time : Need to wait for Linux host</td>
</tr>
<tr>
<td>- Substantial porting effort for device drivers</td>
<td>- Less domain isolation</td>
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Linux Container (LXC) Architecture

Common HMI

Android Apps

Android OS

Linux Container

IVI Stack
- Networking
- Navigation
- Entertainment
- Mobile Office

Mentor IVI Linux OS / LXC Resource Management

Hardware Layer
- Multi-Core CPU
- GPU

Graphics Layer Management
Benefits of Android in Linux Container

- Run Android apps inside a GENIVI-Compliant Infotainment System
- Avoid purchase of Hypervisor technology
- Ready-made integration with Mentor GENIVI Linux
- No virtualization development effort
- Overall reduced cost
- Will run on lower-spec hardware platform
Android Guest OS via Hypervisor

Common HMI

Graphics Layer Management

IVI Stack
- Networking
- Navigation
- Entertainment
- Mobile Office

Linux OS

Android Apps.

Android OS

HyperVisor

Hypervisor Partner

SoC
- ARM Multi-core CPU
- GPU, Peripherals
Features of Hypervisor solution

- SoC hardware resources shared between two or more operating systems
  - Multi-core CPU, GPU, audio, network
- Independent reboot / fast boot options
  - ADAS, system start-up
- Low overhead ( < 2% CPU)
- Privileges management / security
Host AUTOSAR environment on IVI or Cluster hardware

Mentor (or partner) AUTOSAR V4

- **IVI Cluster HMI**
- **SWC 1**
- **ECU 1**
- **SWC 3**
- **RTE**
- **OS**
- **BSW**
- **Communication LIN, CAN, FR AVB/Ethernet**
- **MCAL**
- **Hardware Platform (Virtuali Domain #1)**
- **SoC**

**Application Software** (e.g. ABS Algorithm)
**RTE Interface Application and BSW**
**Communication Stack**
**Microcontroller Abstraction Layer (MCAL)**

**Bus:** CAN, LIN, FlexRay, AVB, MOST
Design Tools and Services

Andrew Patterson
Business Development Director
Embedded Automotive
Embedded Tools for IVI Design

Optional Tools
- Static Analysis
- Code Coverage
- Traceability
- Verification
- Virtual Platform

Run-Time IVI Software
- HMI
- Applications
- Middleware & User Space
- Linux Kernel
- Board Support Package

Integration Services

Source Code
- IDE
- Compiler
- Debugger
- Profiler
- IS Simulator

Source Control

IVI APPS

Hardware Target

Serial (ethernet, usb, etc)

Optional Tools

Development Tools

Run-Time IVI Software

Integration Services

Optional Tools

Development Tools

Run-Time IVI Software

Integration Services

Optional Tools

Development Tools

Run-Time IVI Software

Integration Services
Real / Virtual System Analyzer

- Optimize performance for bare-metal, Linux, Hypervisor etc.
- Easily visualize data with timeline synchronized views
- Extract CPU usage and kernel events, view locking patterns, find memory leaks and more!
- Integrate custom analysis of your own time-stamped data streams
- Analyze behavior and improve performance on multi-core systems
Integration – the way forward

- GENIVI LINUX
- Open Source Software
- Mentor Software
- Mentor Services
- Alliances

IVI Cluster
Questions?
Please Provide Your Feedback...

Please utilize the ‘Guidebook’ application to leave feedback

or

Ask me for the paper feedback form for you to use...