Infotainment and Telematics Solutions with Renesas R-Car
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>
</tr>
</thead>
<tbody>
<tr>
<td>Millions</td>
<td>0</td>
<td>20</td>
<td>40</td>
<td>80</td>
<td>250</td>
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</table>

getConnection()

connection.createStatement().

execute('SELECT * FROM next()')
**Solution Components**

### Infotainment
- **HMI**
  - 3D Design Tools
  - HTML5
  - Smart Device Integration
- **Applications**
  - Demo templates & 3\(^{rd}\)-party Alliances
- **IVI Foundation**
  - Services, Libraries and middleware for Infotainment
- **Drivers**
  - Board Support Packages
- **Linux Kernel**
  - GENIVI-compliant Linux, virtualization options

### Telematics
- **Linux Kernel**
  - Multi-domain OS, Virtualization, AUTOSAR
- **Drivers**
  - Board Support Packages for Instrument Cluster SoC
- **Applications & Functions**
  - Building blocks for CAN, AVB, Telematics
  - Open API
- **Graphics Display**
  - 3D, Accelerated
  - Hybrid Graphics

### Cluster
- **Graphics Display**
- **Applications & Functions**
- **Drivers**
- **Linux Kernel**
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**

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

![Chart showing the lifecycle of different car systems](chart.png)

- **Red** = Obsolete
- **Green** = Current

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**Legend:**
- **Red** = Obsolete
- **Green** = 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

- **Data**
  - Car instrument feeds, cloud data, telematics, diagnostics
  - Mentor Embedded Linux,
  - Device drivers, SoC Integration
  - Multi-Core CPU, GPU, CAN, Flexray

- **Libraries, Services, Middleware**

- **Operating System**

- **Board Support Package**

- **R-Car Hardware Platform**
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 Cancelation 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
- gypsy

### 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
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?

![Smart Phone Link](image1.jpg)

![Integrated SIM Card](image2.jpg)
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
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
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>Against</td>
</tr>
<tr>
<td>- Scalable to multiple domains on a single hardware platform</td>
<td>- Cost / proprietary licensed software solution</td>
</tr>
<tr>
<td>- Faster boot-up time</td>
<td>- Substantial porting effort for device drivers</td>
</tr>
<tr>
<td></td>
<td>- Boot-up time : Need to wait for Linux host</td>
</tr>
<tr>
<td></td>
<td>- Less domain isolation</td>
</tr>
</tbody>
</table>

- Available as part of Mentor GENIVI Linux
- Lower Cost
- HMI Integration easier to manage
- Solutions in place for Android and AUTOSAR

■ Virtualization software can also be used to provide multiple OS domains (Hypervisors)
■ Alternative to Linux Containers
Linux Container (LXC) Architecture

Common HMI

Graphics Layer Management

Android Apps

Android OS

Linux Container

Mentor IVI Linux OS / LXC Resource Management

IIVI Stack

Networking

Navigation

Entertainment

Mobile Office

Hardware Layer

Multi-Core CPU

GPU
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

HyperVisor

Hypervisor Partner

SoC
- ARM Multi-core CPU
- GPU, Peripherals

Android Apps.

Android OS

Common HMI

[Android OS]

[Android Apps.]

[Networking]

[Navigation]

[Entertainment]

[Mobile Office]

[Graphics Layer Management]
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
AUTOSAR Co-Host

- Host AUTOSAR environment on IVI or Cluster hardware
- Mentor (or partner) AUTOSAR V4

![AUTOSAR Co-Host Diagram]

- 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

Development Tools
- IDE
- Compiler
- Debugger
- Profiler
- IS Simulator

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

Hardware Target

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
Questions?