Android & IVI systems
February 15th, 2012
Diego Buffa, System Engineer
Agenda

- IVI OS overview and trends
- Open Source OS, why?
- Is it really applicable to IVI?
- Theory to concrete example
- Example to demo
Automotive system software overview

Core Auto Systems
- Powertrain systems
- Chassis & Safety
- ADAS & Driver Assist
- Body systems
- Comfort & Convenience

Infotainment Systems
- Audio systems
- Navigation systems
- Rear/front-seat entertainment
- Mobile device connections
- Telematics systems

Others?

QNX
- Apps software interface
- Reference platform
- Used by most OEMs
- 2002 deployment

Microsoft Auto
- Apps software interface
- Software standards
- Fiat, Ford, Hyundai/Kia
- 2006 deployment

AUTOSAR
- Apps software interface
- Software standards
- Multiple MCUs
- 2009-10 deployment

GENIVI
- Apps software interface
- Software standards
- BMW, GM, PSA, Renault
- 2012-13 deployment

Android
- Apps software interface
- Software standards
- Conti auto platform
- 2012-13 deployment
Illustration: IVI OS adoption direction

Closed proprietary OS

Open-source, Linux based OS

Pure RTOS

Time
Why go open source?

1. Innovation speed
2. Ecosystem support
3. Cost
Why Android for a IVI system?

Finger-friendly

Ecosystem

Openness

And…?
Look & Feel

Mobile

• Designed for mobile users

IVI

• Designed for drivers
• UI need to be simple, straightforward, distinguishable at the first glance
• Branding control
## Voice Support

<table>
<thead>
<tr>
<th>Mobile</th>
<th>IVI</th>
</tr>
</thead>
</table>
| • Voice search | • Voice command of basic functionality:  
  - placing/receiving a call  
  - controlling the navigation system  
  - controlling FM Radio/CD  
  - Text to Speech conversion of SMS/Email  
  - Noise cancellation |

---

*Speak now*

*Google search*

*Cancel*
## External Storage

<table>
<thead>
<tr>
<th>Mobile</th>
<th>IVI</th>
</tr>
</thead>
</table>
| • SD Card supported | • Usually, need to support a SD Card and a USB disk  
• Framework need to be changed for media access on an extra external storage |
iPod Support

Mobile

- iPod...?

IVI

- iPod management/indexing with the Apple Authentication algorithm
- Media Player support for iPod
- Video Player support for iPod
# Boot-up time optimization

<table>
<thead>
<tr>
<th>Mobile</th>
<th>IVI</th>
</tr>
</thead>
<tbody>
<tr>
<td>• About 45 seconds</td>
<td>• For cold boot, ~ 10 seconds is target</td>
</tr>
<tr>
<td></td>
<td>• For warm boot, the unit need to be fully operational within 2 - 3 seconds</td>
</tr>
<tr>
<td></td>
<td>• Can be achieved using the CPU's suspend mode at the expense of approx 2mA extra backup current</td>
</tr>
</tbody>
</table>
Power Management

**Mobile**

- The primary goal is to save the power consumption

- Applications and services request CPU/screen resources

**IVI**

- The primary goal is to ensure stability and usability when system is on

- To support “instant-on”
# Audio Management

<table>
<thead>
<tr>
<th>Mobile</th>
<th>IVI</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Audio routing designed for mobile phones</td>
<td>• Audio priority definition for BT HFP, Multimedia playback and Navigation</td>
</tr>
<tr>
<td>• No dedicated streaming channels for Navigation</td>
<td>• Need to define new Android steam type (Navigation, FM Radio, external sources...) and then connect them to the hardware channel</td>
</tr>
</tbody>
</table>
## Bluetooth management

<table>
<thead>
<tr>
<th></th>
<th>Mobile</th>
<th>IVI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• PBAP, designed to be the source</td>
<td>• PBAP, designed to be the receiver</td>
</tr>
<tr>
<td></td>
<td>• HFP, designed to be the audio gateway</td>
<td>• HFP, designed to be the Hand-free unit</td>
</tr>
<tr>
<td></td>
<td>• A2DP, designed to be the source</td>
<td>• A2DP, designed to be the receiver</td>
</tr>
</tbody>
</table>

![Bluetooth logo]
FM/AM Radio

Mobile

• No FM/AM radio

IVI

• FM/AM receiver and transmitter
• New APIs of framework
• A FM/AM Radio application
# Hardware Diagnose Application

<table>
<thead>
<tr>
<th>Mobile</th>
<th>IVI</th>
</tr>
</thead>
</table>
| • Function does not exist | • To ensure safety and usability  
• Provides a set of functions helping to diagnose hardware failure: display, memory, storage, sensor, GPS… |
**Navigation Software Integration**

<table>
<thead>
<tr>
<th>Mobile</th>
<th>IVI</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Can have a navigation application</td>
<td>• Need to be integrated into system</td>
</tr>
<tr>
<td></td>
<td>• Part of UI/UX</td>
</tr>
<tr>
<td></td>
<td>• Can be manipulated through voice interface</td>
</tr>
</tbody>
</table>
Rear camera

**Mobile**

- Used for taking pictures or remote monitor

**IVI**

- Make sure you do not hit your dog when driving backwards
- Need to be available in 2 seconds once the car started
# LBS services application

<table>
<thead>
<tr>
<th>Mobile</th>
<th>IVI</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Google Maps</td>
<td>• Emergency Call</td>
</tr>
<tr>
<td>• Applications downloaded from Market</td>
<td>• Roadside Assistance</td>
</tr>
<tr>
<td></td>
<td>• Information Sending on Fleet and Asset Manager request</td>
</tr>
<tr>
<td></td>
<td>• Vehicle Tracking</td>
</tr>
<tr>
<td></td>
<td>• Mobility Services</td>
</tr>
</tbody>
</table>

- [Image of Google Maps application]
- [Image of a woman making a call by the roadside]
## Security

<table>
<thead>
<tr>
<th>Mobile</th>
<th>IVI</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Basic security mode to isolate applications from one another</td>
<td>• Need to provide a solution to segregate a downloaded service or application and the basis software of the platform</td>
</tr>
<tr>
<td>• Users be aware of the permissions requested before installing a new application</td>
<td>• Protecting the CAN/MOST access from malicious attacks</td>
</tr>
</tbody>
</table>

### Diagram
- basis services or applications
- Downloaded applications
Global open source choices (no RTOS)

Or both simultaneously on a multicore and/or hypervisor based system
## GENIVI vs. Android: Focus Areas

### GENIVI
- Focus on Automotive by OEMs, Tier1 and Tier 2s
- Managed by GENIVI alliance
- HMI and application store by OEM or Tier1
- HMI focus on non Driver Distraction

### Android
- Focus on Mobile Phone and Tablet Market
- Led by Google
- Application Store > 400,000 apps for Handsets and Tablets
- Attractive touchscreen based HMI
### GENIVI vs. Android: Other considerations

<table>
<thead>
<tr>
<th>GENIVI</th>
<th>Android</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open Source based on standard Linux distribution</td>
<td>Open Source based on Linux kernel and Google middleware</td>
</tr>
<tr>
<td>GPL and LGPL (v2.0)</td>
<td>Apache like license</td>
</tr>
<tr>
<td>Consideration for early use cases</td>
<td>Focus on connectivity and OTA updates</td>
</tr>
<tr>
<td>RAM &amp; CPU footprint optimized for automotive</td>
<td>Java applications driving CPU &amp; RAM requirements</td>
</tr>
<tr>
<td>Development environment through OSVs</td>
<td>Rich SDK development environment</td>
</tr>
</tbody>
</table>

© 2011 Wind River. All Rights Reserved.
GENIVI/Android: Combinations possible

Virtualized model uses Wind River Hypervisor to isolate Android and Linux environments.

Embedding model uses Linux Control Groups to isolate Android and Linux applications. Both use a common OS framework.
Android for IVI market growth

Where is the data?

- Traditional Android market research:
  - Smart phones (CAGR 37%) – acc. RBC Dominion Securities Inc.
  - Tablets (CAGR 65%) – acc. To IDC
  - Digital TV plus set up boxes (CAGR 79%) – acc. MarketResearch.com

- Informal market momentum data
  - A number of publicly announced systems/concepts
  - 300+ attendees @ GENIVI Android workgroup meeting
  - Wind River winning Android IVI projects worldwide
In-market: Android Production IVI system

- Roewe 350 running Android 2.1 (China)
  - SAIC (Shanghai Automotive Industry Corporation)
  - Real time traffic reports, web access, chat online
  - Texting, email, GPS, agenda
  - Stock market graphs
  - Using Inkanet cellular network
In-market: Android After Market IVI system

- Dynavin E46 Navigation system for BMW Aftermarket
  - Single DIN mounting chassis
  - OEM bezel to allow a "OEM" look
  - Motorized touchscreen multimedia AV player
  - OSD touchscreen function
  - SD card slot and mini-USB port
  - Full iPod function control
  - 45Watts x 4 sound output
  - Electronic and mechanical Anti-Shock System
  - Video system: Auto ,NTSC and PAL TV receiver function with PAL;PAL N;PAL M;NTSC and SECAM
  - Screen: 7-inch Digital LCD (16:9)
  - Horizontal resolution: 800x480
  - Four preset EQ settings
  - Rear monitor video output (rear camera not included)
  - 4-CH RCA line out for headrest monitor
  - 30 FM/AM preset stations (AM 12 /FM 18)
  - Full-function remote control
  - Built-in Bluetooth function
  - Built-in Navigation(GPS)system
  - Built-in RDS function
  - Running Android 2.2
Concepts: Android Production IVI system

- Saab’s “IQon” [General Motors, concept]
  - On Saab 9-5 series
  - 3G cellular connection
  - Intends to make the API available for developers
    - Telematics: 500 signals from car sensors (speed, location, direction of travel, yaw, steering wheel angle, engine RPM and torque, inside/outside temps, barometric pressure, and the sun’s position)
    - New apps will be “vetted” by Saab and released in the Saab IQon store

- Continental “AutoLinQ” (USA, concept)
  - 3G cellular connection
  - Listen to streaming music, download Twitter feed
  - InRIX’s Traffic Pro system predicts traffic and changes route
  - Take any signal from the CAN bus (throttle position or engine speed) and use as input. Track data and post to Facebook.
  - NAVTEQ Network for Developers
Future play: Android for E-Car IVI systems

- **Tesla (USA, concept)**
  - 17” NVIDIA Infotainment system
  - Cell, navigation, etc.
  - Android marketplace apps

- **Tieto (Concept Car)**
  - Electric car
  - Tablet computer
  - Dynamic battery management app
  - Directions towards the next available charging station
  - Car-sharing related information
  - Install private apps
  - **Links the vehicle to the cloud with a front-end client while the application logic runs on a remote server in the cloud**
  - Using TI hardware dual core
MirrorLink/Terminal Mode

Bridging mobile device and automotive system
Mobile automotive applications

1. Standard with many automotive OEM brands

2. Apple and Android focus
   - Legacy mobile OS support is slim

3. ‘1.0’ release use cases
   - Security
   - HVAC
   - LBS
   - SNS integration
   - Production system only

CONTROL & COMMUNICATION
Automotive applications (US)

- Chevrolet’s MyLink [General Motors]
  - In Equinox and Volt cars
  - Apps stored on tethered iPhone, Blackberry or Android device
  - Pandora and Stitcher apps present
  - OnStar system
  - Mobile app allows:
    - Remotely start vehicle
    - Monitor charge
    - Lock/unlock doors
    - Control temperature
    - Honk horn and flash lights
Automotive applications (Europe)

- **BMW connected**
  - Last mile navigation
  - Board Computer
  - Calendar usable in car
  - Internet radio
  - News

- **BMW Blog**

- **My BMW Remote (+Assist)**
  - Remote door lock/unlock
  - On/off independent car heater
  - Horn blow
  - Flash light
  - Google local search + transfer
  - Vehicle finder (LBS integration)
Automotive applications for E-cars

- **Nissan Leaf (USA)**
  - Electric car
  - Application for Android platform
  - Start charging car
  - Check the status of the battery
  - Find out the estimated driving range
  - Launch the HVAC controls before the driver gets in the car
Conclusions: Android for IVI

- Merging world, keeping specificity
- Benefits from mobile world
- Several systems in the market already
- Helping in costs and timeframe
- Ecosystem