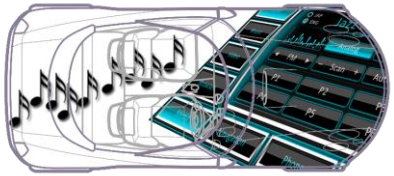
Keeping ahead of Consumers



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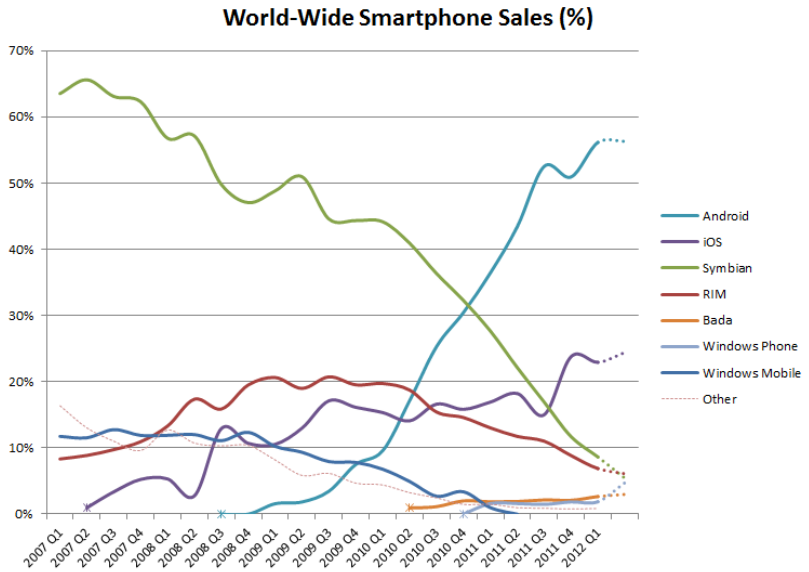
Linux is the registered trademark of Linus Torvalds in the U.S. and other countries.

Smart Phones – consumer growth

- 420m New phones sold in Q2 2012, 154m Smart Phones
- Apple & Samsung account for 83%
- Android has 64% of Smart Phone OS Market



New Car Units..

- USA Market 79% Saturated (2007 peak)
- China market only 7% saturated
- Chinese market 2x USA

- Smartphone : Car Sales ratio 10:1

2011	59,929,016
2010	58,264,852
2009	47,772,598
2008	52,726,117
2007	53,201,346
2006	49,918,578
2005	46,862,978
2004	44,554,268

Source : Worldometers

- Conclusions :

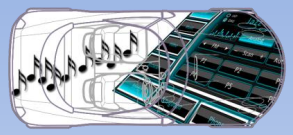
- Plenty of room for growth in automotive globally

- Rate of innovation needs to change

Pecking Order …

OEM

Tier 1



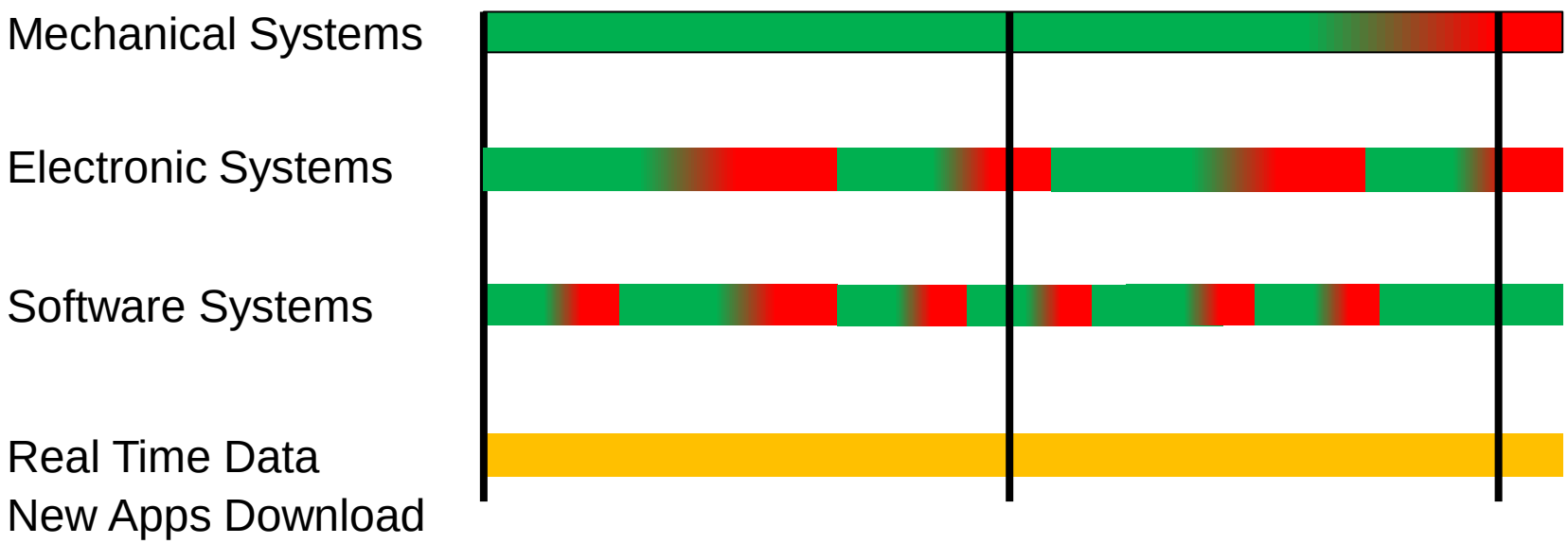
Application Developer

Software Platform Provider

Hardware Platform Provider

Innovation rate has to change

Infotainment System Technology Refresh



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

= Obsolete

= Current

Automotive Design Challenges …

Open Source

Migration to Linux

Best Hardware

Telematics

HMI Performance

Connected Car

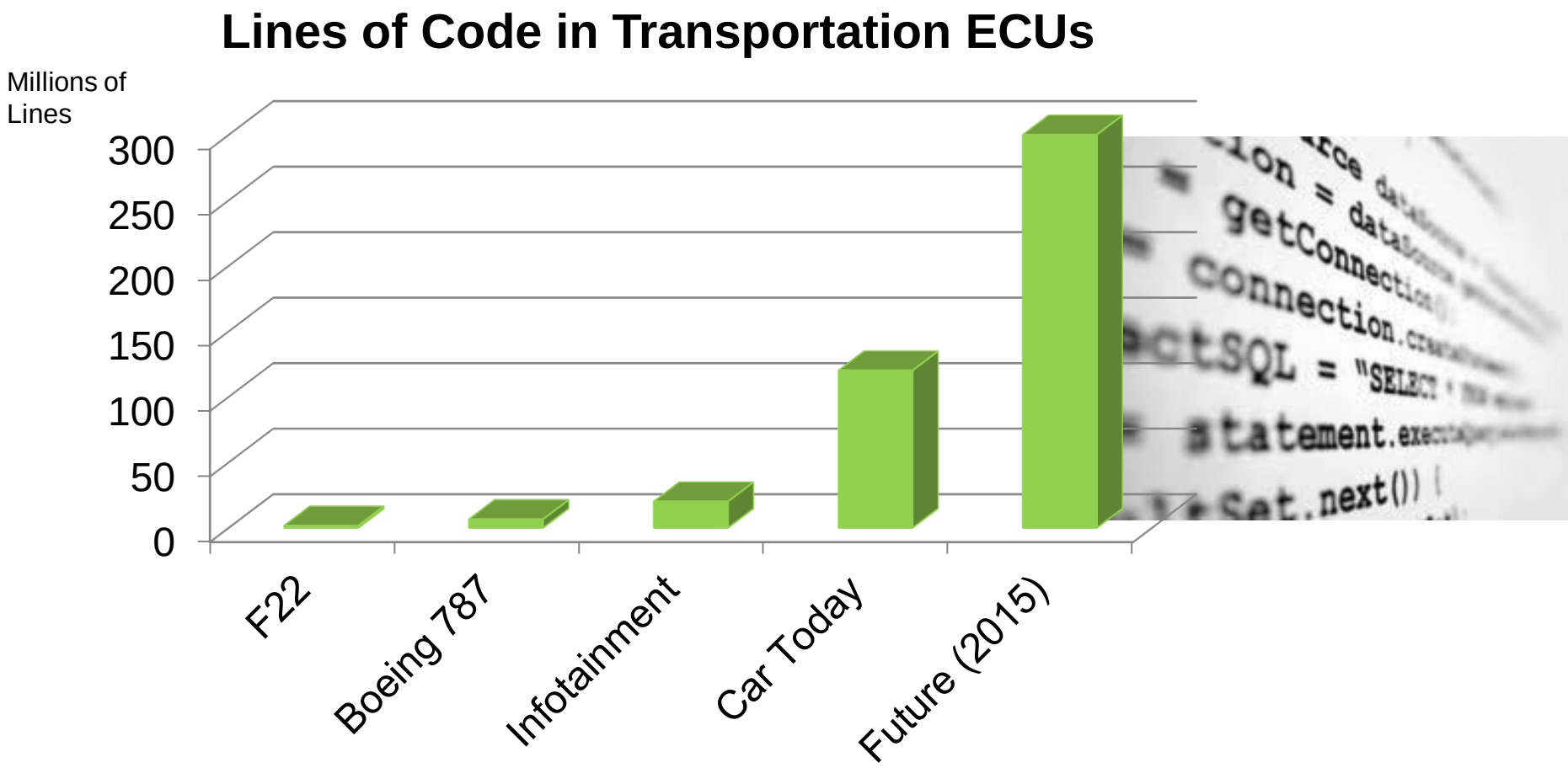
Function Consolidation

Android Support

Multi-Mode User Inputs

Software in Vehicles

Complexity increase is continuous & relentless…



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

Pre-requisite : Getting Connected

Smart Phone Link

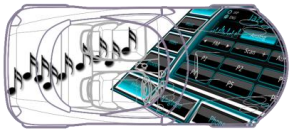
Integrated SIM Card

Make use of existing phone	Need additional data plan
Familiar apps	Dedicated Infotainment apps
Phone contact list	Duplicated data
Includes navigation, maps	Tidier
Entertainment, song list	Better signal?

Connected Smart Phone

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

Solution Components



Infotainment

Telematics

Cluster

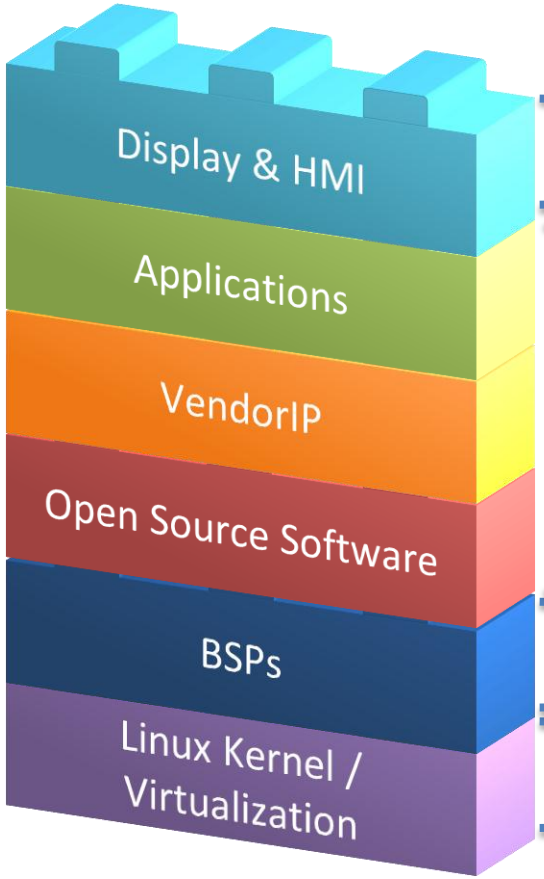
HMI
- 3D Design Tools
- HTML5
- Smart Device Integration

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



Graphics Display
- 3D, Accelerated
- Hybrid Graphics

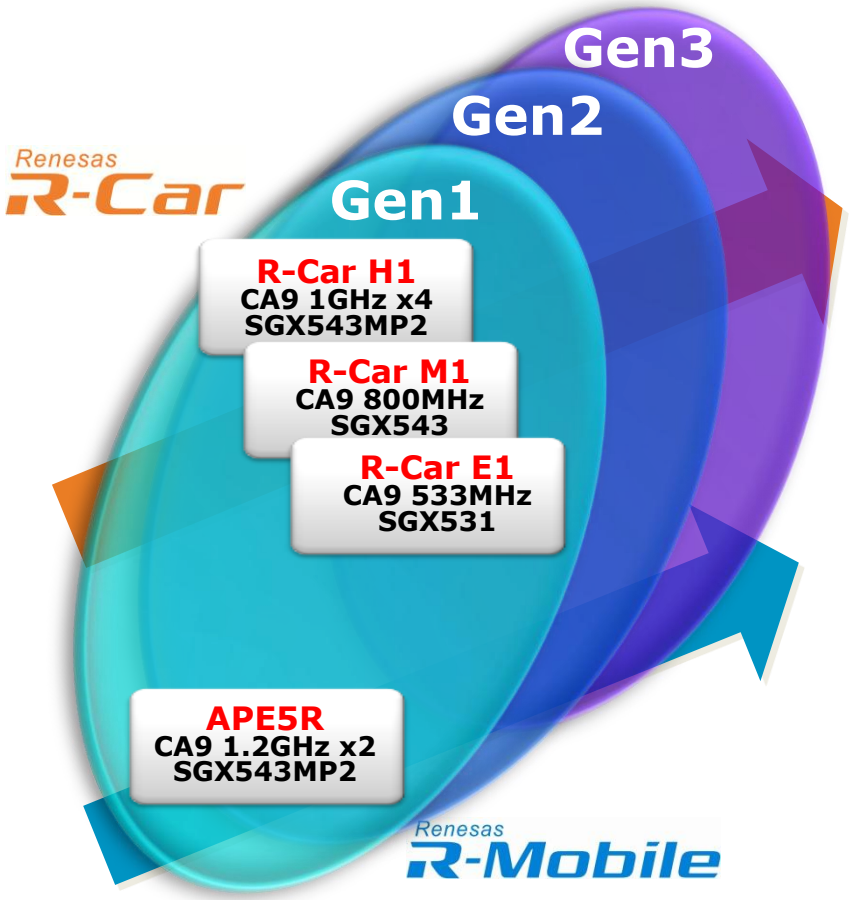
Applications & Functions
- Building blocks for CAN, AVB, Telematics
- Open API

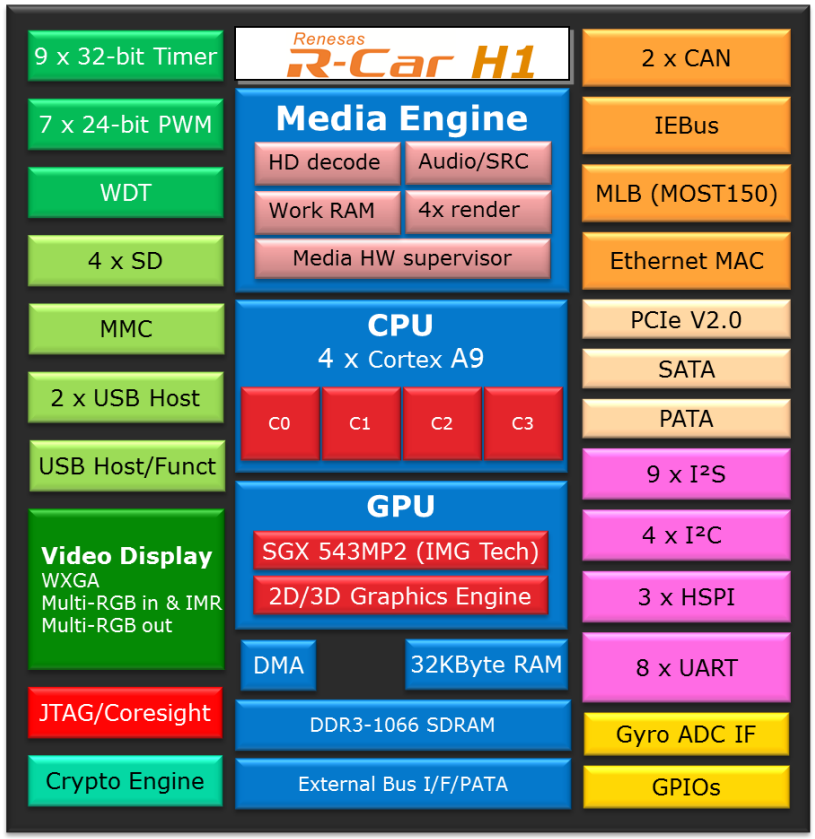
Drivers
- Board Support Packages for Instrument Cluster SoC

Linux Kernel
- Multi-domain OS, Virtualization, AUTOSAR

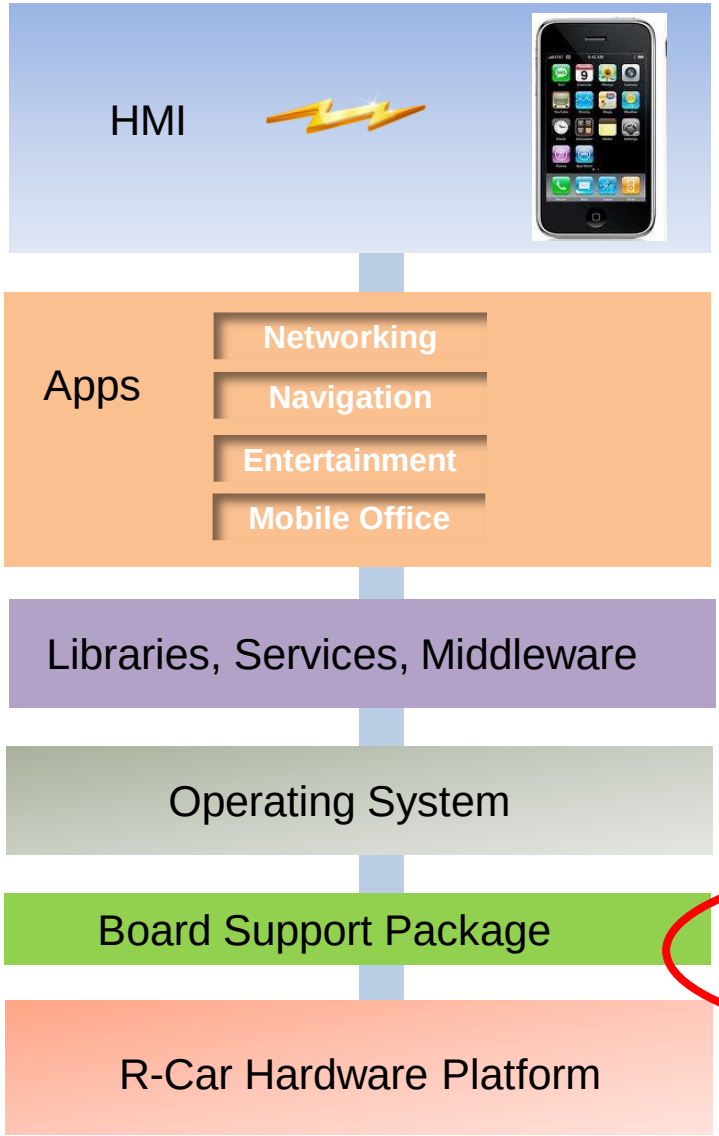
Hardware platform - Renesas R-Car

- 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





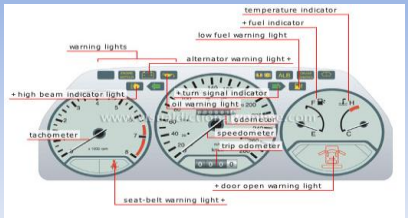
The Infotainment System



- **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

ECU Feeds

User Input

Diagnostics

AUTOSAR

- **Car instrument feeds, Cloud Data, Telematics, diagnostics**

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
- Linux is an Industry standard
- GENIVI Alliance established to standardize industry Infotainment Platform
  - Reduce OEM costs
  - Tier 1 Transparency
- Multiple CPU Architectures

Infotainment Linux : GENIVI 2 and GENIVI 3

GENIVI

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

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
- quota
- udev
- usb-utils
- libmtp
- File Server
- Indexing Engine
- MTP Library
- Systemd

OS kernel, drivers and libraries

ARM Cortex Processors
Intel Atom Processors

Linux
GNU libc

Beyond GENIVI

- GENIVI is not universally accepted…
- Current specification is not a complete solution
- Human Machine Interface – HMI
- Hardware Platform and software drivers
- IVI Applications and Integration work
- Testing
- Design Tool Support
- Services

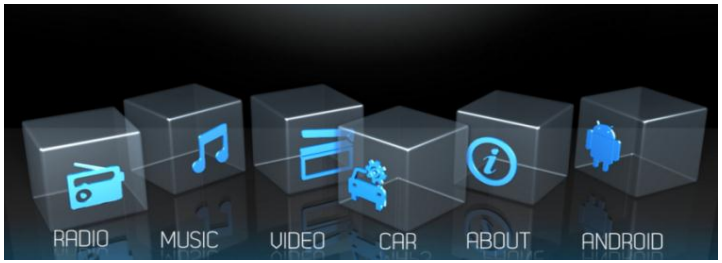
Design agility: New GENIVI Baselines every 6 months

Multiple Domain Options

- R-Car has processing capability for multiple domains
  - Improved flexibility
  - Escape from ‘one box – one function’
  - Simplified vehicle architecture
- Candidates for combination :
  - Instrument Cluster
  - Telematics
  - Infotainment
  - ADAS
  - AUTOSAR
  - Android

Android Guest OS via Hypervisor

Common HMI



Graphics Layer Management

IVI Stack
- Networking
- Navigation
- Entertainment
- Mobile Office

Android Apps.

Linux OS

Android OS

HyperVisor

Hypervisor Partner

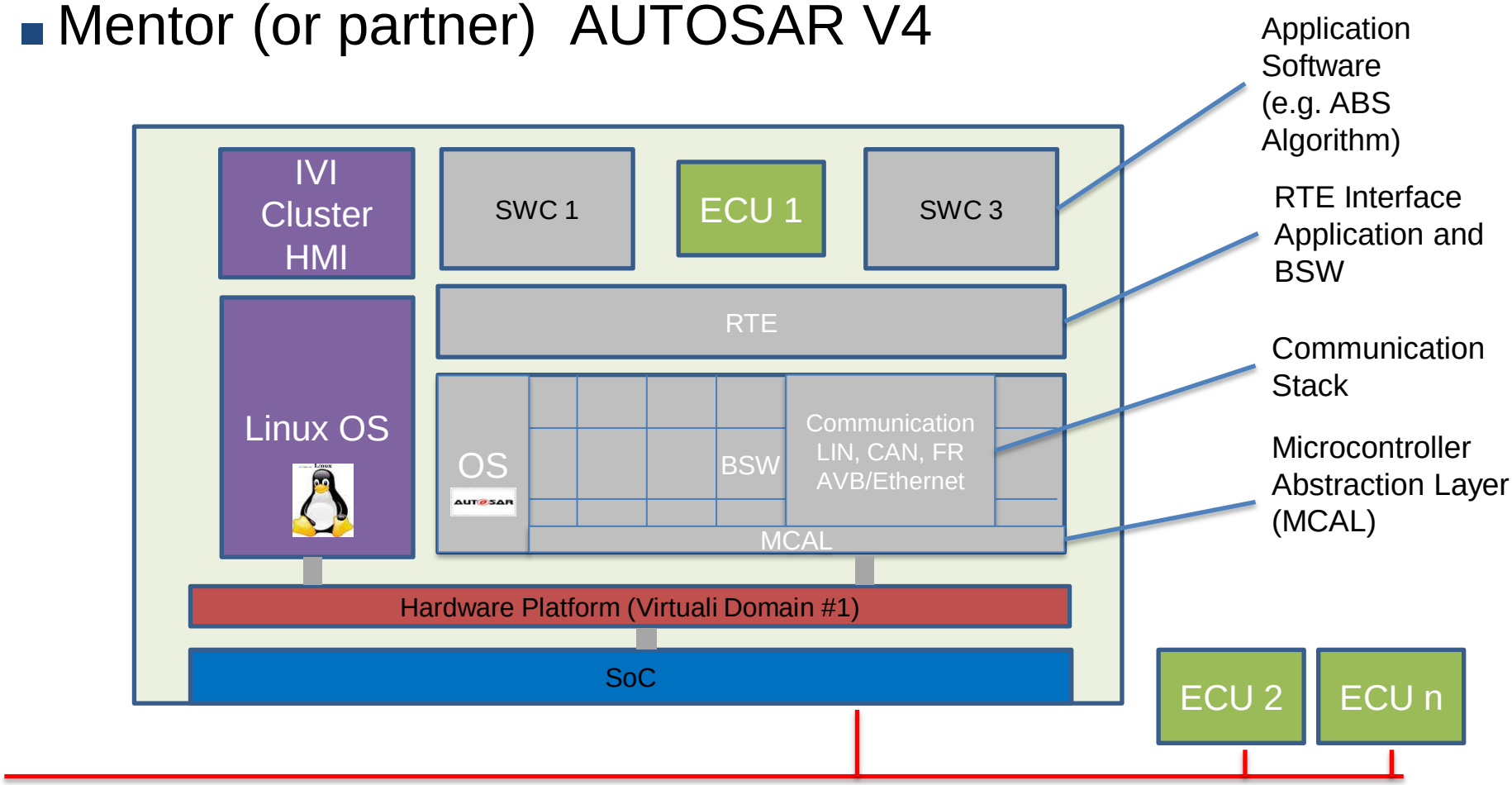
SoC

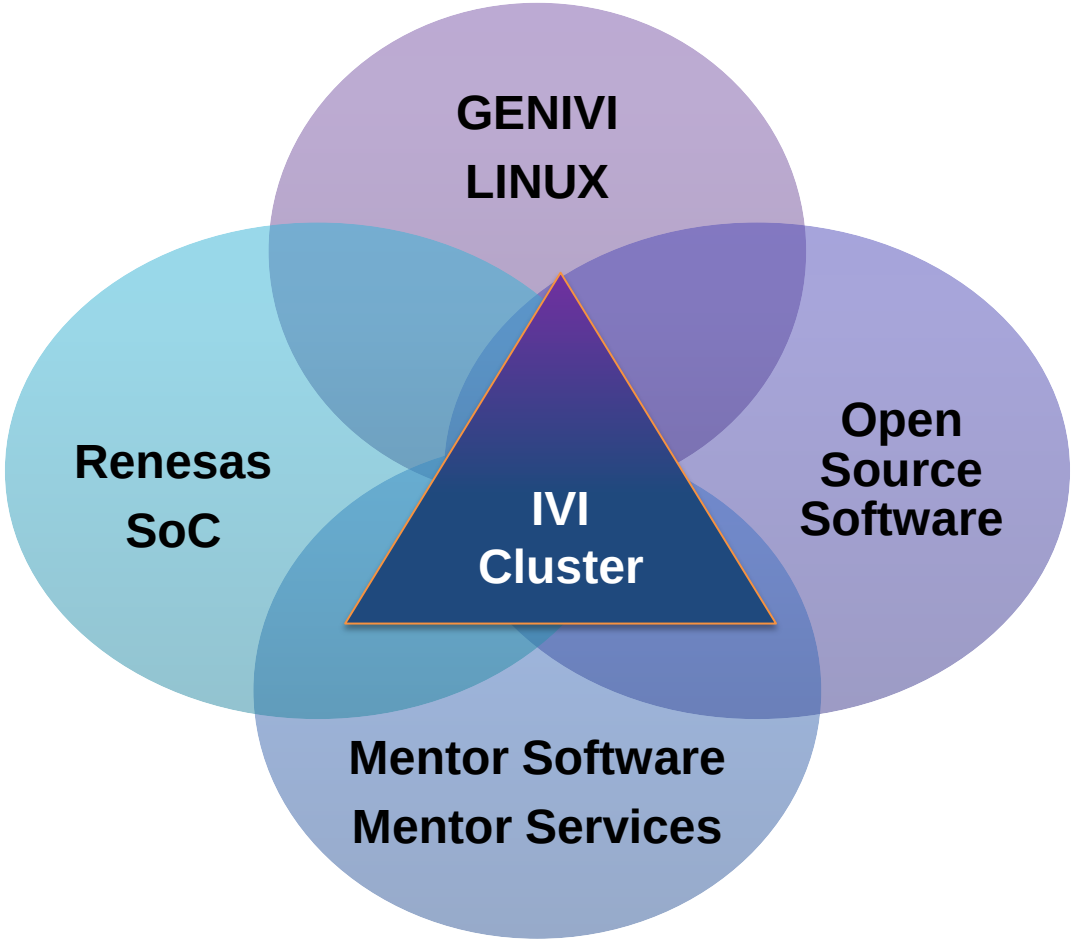
ARM Multi-core CPU

GPU, Peripherals

AUTOSAR Co-Host

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



Bus : CAN, LIN, FlexRay, AVB, MOST

Integration – the way forward