Automotive Market and Industry Update

Steve Nelson
Director, Global Automotive Marketing

FTF-AUT-F0747
Agenda

1. Freescale in Automotive
2. What a Difference a Year Makes
3. Current Market Trends
4. Segment Trends: Body, Chassis/Safety, Powertrain, Driver Information
5. What Does the Future Hold?
6. Conclusion
Freescale Product Portfolio

<table>
<thead>
<tr>
<th>Select Sub-Segments</th>
<th>Industrial</th>
</tr>
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<tbody>
<tr>
<td>Appliance Control</td>
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<td>Home Portable</td>
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<td>Medical</td>
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<td>Smart Meters,</td>
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<td>Smart Grids</td>
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<td>&amp; Drives</td>
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<td>Body &amp; Security</td>
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<td>Powertrain &amp; Hybrid</td>
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<td>Chassis &amp; Safety</td>
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<td>Driver Infotainment</td>
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<td>Networking</td>
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<td>Basestations &amp;</td>
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<td>Controllers</td>
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<td>Routers &amp; Switches</td>
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Select Sub-Segments

<table>
<thead>
<tr>
<th>Consumer</th>
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<tbody>
<tr>
<td>Smart Books</td>
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<tr>
<td>eBooks</td>
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<tr>
<td>RF Remote Controls</td>
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<td>Sensors for Phones &amp; Games</td>
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Automotive Market: Driving Technology Confluence

Automotive
- Safety
- Fuel Economy and Emissions
- Comfort/Entertainment

Networking
- Wireless everywhere
- Broadband expansion
- Ubiquitous Connectivity

Consumer
- Health
- Energy Management
- Home Entertainment

Industrial
- Connectivity
- Medical/TeleHealth
- Smart Grid/Building Control

Going Green
Health & Safety
Net Effect
Technology That Changes the World

No.2 in total auto ICs
No.1 in auto microcontrollers
No.2 in MEMS sensors
### Freescale Automotive—Today’s Innovation

<table>
<thead>
<tr>
<th>Car Model</th>
<th>Freescale Device(s)</th>
<th>Feature</th>
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<td>Chevy Camaro</td>
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<td>Mercedes S Class</td>
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<td>Night Vision</td>
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<td>Aston Martin DB9</td>
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<tr>
<td>BMW X5</td>
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<td>Dynamic Drive</td>
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<tr>
<td>Toyota Prius</td>
<td>DBUS Master/Slave Airbag</td>
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<tr>
<td>Dayun</td>
<td>S12 Fuel Injection</td>
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<td>Peugeot 407</td>
<td>MPC561 ECU</td>
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<td>BMW 7-Series</td>
<td>MPC5567</td>
<td>Body Gateway</td>
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<tr>
<td>Honda Stepwagon</td>
<td>Pictus MCU &amp; Ocotillo Sensor Airbag</td>
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<tr>
<td>Ford Fiesta</td>
<td>S12XHZ Cluster</td>
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<tr>
<td>Chery A516</td>
<td>S12 HVAC, Powertrain</td>
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<td>Ford Fusion</td>
<td>i.MX31 Sync</td>
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<tr>
<td>Mazda Alexa (3)</td>
<td>SPC5565</td>
<td>Start/Stop System</td>
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<tr>
<td>Ducati 696</td>
<td>S12 &amp; Pressure Sensor ECU</td>
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<td>BYD F3</td>
<td>MCU Body, Cluster</td>
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<tr>
<td>Ford F150</td>
<td>SPQ1035 eSwitch Body</td>
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Note: Representative only. All of these products have multiple Freescale devices in many applications.

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Global Auto Production Forecast
(includes light trucks)

What a difference two years makes
- Scrappage rate ~13MU / year
- Industry break even ~10-11MU but not healthy until ~12MU+
- Auto industry employment +15K in 2010, +100K per year 2011-13
What’s Important in Today’s Automotive Market?

► Fun
  • Performance
  • Traffic
  • Driver assistance

► Safe
  • Accident avoidance
  • Occupant protection
  • Reliability

► Sustainable
  • Low impact on the environment
  • Production, use and recycle
“80% percent of innovation is electronic”

“Impossible to comply with regulation without electronic systems”

-Automotive OEM

Electronic cost as % of total car cost

- 1950: 2.5%
- 1960: 5%
- 1970: 10%
- 1980: 15%
- 1990: 22%
- 2000: 30%
- 2005: 35%
- 2010: 50%
- 2030?:

- Advanced Driver Assistance
- Active-Passive Safety
- Green Powertrain
- Radar / Vision
- Telematics
- Infotainment

Electronic cost as % of total car cost:

- Fuel Injection: 35%
- Airbag: 15%
- ABS / ESP: 30%
- Body Electronics: 35%
- Multiplexing: 35%

"80% percent of innovation is electronic"

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-Automotive OEM

"Impossible to comply with regulation without electronic systems"

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Electronics – the Source of Improved Safety

More Cars
Higher Speeds
Higher Density
Fewer Deaths

1959 BelAire vs. 2008 Malibu

Data: Insurance Institute for Highway Safety; iihs.org
“As more electronic sensors and computing capability are incorporated into modern vehicles, the vehicle manufactures now have the technology to enhance safety in a way that was impossible a decade ago. We believe that many of these technologies can detect and compensate for driver errors such as inattention, drowsiness, or driver misjudgment.”

Ronald Medford
Acting Deputy Administrator, NHTSA
May 2009

“A car with a sense of survival”

CNET review of 2011 Infiniti EX
### Common Errors of Older and Younger Drivers

#### Most Common Errors of Older Drivers

- Scans side to side: 86%  
  - Lane Departure Warning
- Scans to rear/head check: 84%  
  - Blind Spot Detection
- Centers car in lane: 49%  
  - Lane Departure Warning
- Safe following distance: 57%  
  - Front Collision Warning, Brake Assist
- Backup up: 69%  
  - Parking Aid, Camera/Radar
- Lane changes: 86%  
  - Lane Departure Warning, Blind Spot Detection
- Speed regulation: 62%  
  - ICC, Front Collision Warning

#### Most Common Errors of Younger Drivers

- Distracted driving
- Speeding
- Following too closely
- Driving drowsy

---

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AAA Foundation for Traffic Safety
% scoring fair or poor on given item

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Future of Safety Systems

► Occupant vs Vehicle Factors: What’s more important?
  • DFSS – factor analysis  135 frontal crashes cases

<table>
<thead>
<tr>
<th>Variable</th>
<th>#1 Influential</th>
<th>#2 influential</th>
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<tbody>
<tr>
<td>Clavicle</td>
<td>Sex + Model Yr.</td>
<td>Weight</td>
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<tr>
<td>All Thoracic</td>
<td>Age</td>
<td>Weight</td>
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<tr>
<td>Upper abdomen</td>
<td>L4 density</td>
<td>Age</td>
</tr>
<tr>
<td>Lower abdomen</td>
<td>Sex + L4 density</td>
<td>Model Year</td>
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<tr>
<td>All spine injury</td>
<td>Pretensioner</td>
<td>Pret + Sex</td>
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<tr>
<td>Thoracic Skeletal + Clavicle</td>
<td>Age</td>
<td>Sex</td>
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<tr>
<td>Th. Org &amp; Vessel + Upp</td>
<td>Delta V + Wt</td>
<td>Delta V</td>
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<tr>
<td>Sum of Skeletal Injury</td>
<td>Age</td>
<td>Sex</td>
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<tr>
<td>Sum of Organ Injury</td>
<td>L4 density</td>
<td>Weight</td>
</tr>
</tbody>
</table>

• Occupant factor most influential for **8 of 9** injury outcome measures and second most influential in **7 of 9**.

► Cars must adapt safety systems based on human factors

► Adoption of EDR and Telematics can provide estimates of injuries to emergency personnel *before* they arrive at a crash.
Collision Warning and Avoidance

► Lane departure warning/prevention systems could prevent/mitigate up to 483,000 crashes per year, including 87,000 non-fatal injury and 10,345 fatal crashes

► Forward collision warning/mitigation systems could potentially prevent or reduce the severity of 2.3 million crashes in the United States each year, including 1.4 million front-to-rear crashes.
  • These improvements could prevent up to 210,000 non-fatal injury crashes and 7,166 fatal crashes each year.

► Blind spot detection/warning and emergency brake assist could prevent 457,000 and 417,000 crashes per year, respectively.

► One second of notification can eliminate 90% of front end collisions

Source: Insurance Institute for Highway Safety
Issues: Fundamentally the Same

► Increasing world wide population

► Increasing energy usage and shortage of oil

► Increasing World Mobility

► Too much Greenhouse Gas emissions
New Idea?

Ferdinand Porsche, an employee of Jacob Lohner & Co. in Vienna, Austria developed a drive system based on fitting an electric motor to each front wheel without transmissions (hub mounted).

Vehicles of this type were known as Lohner-Porsches and were sold in 1898-1906.

Since gasoline automobiles are being made more complicated every year, and still many inherent difficulties not yet overcome, and with the cost of gasoline advancing, I am forcibly convinced that with the recent improvement in storage batteries the Electric Automobile will largely supersede the gas cars.
Global Regulations Drive Innovation and Content

The new CAFE standards must **achieve by 2016 a combined average** fuel-economy standard of 35.5 mpg—39 mpg for cars and 30 mpg for light trucks and SUVs—a **40 percent improvement** over current standards.

Emission standards are being adopted in China by the State Environmental Protection Administration (SEPA). Chinese standards are **based on European regulations**.

Focus investment area-HEV and Fuel Cell.

Japan' emissions standards in 2009 with further limits about NOx and PM to a level in-between the US 2010 and Euro 5 requirements.

**Euro 6 standards** effective from fall 2014, with a target to reach 95g CO2 by 2020.
EV/PHEV Business Dimensions

Infrastructure & Power Requirements

- Charging infrastructure
  - @ Home
  - @ Public areas
  - @ Work
- Normal & Rapid charge options

Product Development

- Powertrain technology
- Chassis & body technology
- Energy storage technology
- High performance @ reasonable cost

Business Model Innovations

- Alliance of OEM & key component suppliers
- Linkage between Government policy, Energy suppliers, Key technology innovators critical for success
- Taxes
Influences

- **Location**: 80% of Americans drive <50 miles, 70% of Europeans drive < 25 miles.
- **Application**: EV / Hybrid for city, high efficiency combustion engines for highway/commercial.
- **Cost**: Upfront cost tolerance vs. life cycle consumer benefits.

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**Daily usage pattern**

- **Short**: < 25 mls
- **Medium**: 25 - 75 mls
- **Long**: > 100 mls

**Vehicle size / weight**

- **Small**: Electric Car (partially with range extender)
- **Medium**: Plug-in Hybrid
- **Large**: Hybrid
- **High-efficiency combustion engine**: Range extender and Fuel cell (long term)

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**WSJ: Electric cars Fall Short in Mini Test, “most significant effect on range is interior temperature”** 6/3/10

Source: Bain
Efficiency Requires Improvements in Many Areas

Prediction
- Driver behavior
- Route topology
- Weather
- Managed Infrastructure

Powertrain
- Hi Precision/Direct Injection
- Single/Multiple Turbo
- Improved Transmissions
- Start/Stop
- Mild/Full Hybrid
- EV

Resistance
- Rolling Resistance
- Light Weight Materials
- Cable harnesses
- Reduced Hydraulics
- Increased Electrification
- Active Aerodynamics

Energy Sources
- Bio Diesel
- Gasoline
- Natural Gas
- Alternative Fuels
- Hydrogen
- Electric
Legislation Drives MCU Powertrain

EURO III
- 16bit based injection systems

EURO IV
- 32bit CPU
- 80 MIPS
- 36K SRAM
- 1M Flash

EURO V
- Port fuel injection
- Flexfuel

Euro V
- Combined engine & transmission

CAFÉ
- GDI
- High pressure Common rail

EURO VI
- Hybrid, car electrification
- Valvetronic
- HCCI

MCU Requirement Evolution
- 32bit CPU
- 200 MIPS
- 64K SRAM
- 2M Flash

- 600 MIPS
- 256K SRAM
- 4M Flash
- dual eTPU

- ~1000 MIPS
- 384K SRAM
- 6M Flash
- dual eTPU2

- ~1500 MIPS
- 512K SRAM
- 8M Flash
- quad ATS
- low power

Regulation Evolution → Electrification

Instrument Clusters
Critical Branding and Differentiation Point
Information Explosion or Driver Overload?

- Eco-driving
- Display & Management of Hybrid/Electric Vehicle Battery Charging
- Advanced Speech Recognition for destination entry and music search
- "Skinnable" User Interface
- Traffic Sign Recognition
- Location-based Services
- Digital Radio & Traffic Information
- Night Vision Camera
- Connectivity to portable device and WAN
- Diagnostics and remote support
- User Interface for Car system control
- Manage Connection to Smart Meter for battery charging
- Map Data as sensor to Powertrain
- Panoramic Parking assist camera
- Applications downloaded from "Apps Store"
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Future Architecture Challenges

► Power
  • Customers requesting 50% reduction in power over existing architecture while increasing complexity

► Performance
  • Customers requesting up to x5 performance over existing architecture

► Functional Safety
  • Compliance to IEC61508 and ISO26262 standards

► Lower Cost of Ownership
  • Lower ASPs!!!
  • Reduced development costs
  • Faster time to market
Future Vehicle Architectural Trends

Today

Distributed Electronic Control Units

One ECU per mechanical function - Connected by multiple CAN and LIN interfaces

- Number of ECUs increases with the addition of features and vehicle options.
- High systems and software complexity.
- Difficult integration

Future

Distributed Computing

Major computing nodes on a high performance network organized by “domains” which control “zones”

- High performance multi-core domain controllers with guaranteed safety and security of operation.
- Lower performance but highly integrated Zones with direct actuator control.
- Standardized software and OS to ease integration
Prediction is a Critical Component

Energy Management with Prediction

- Topology
- Traffic Conditions
- Weather / Temperature
- Traffic Signals / State
- Hybrid Energy Usage

All constantly transmitted
to the car’s
Energy Management System
Aging Population

- **Improved Navigation**
  - Intelligent / Safe routing
  - Out of Area notification

- **Driver Capability and Skill**
  - Alertness
  - Safety event reporting
    - Lane departure
    - Over/Under speed limit

- **Medical Condition Awareness**
  - Automatic notification
  - Autonomous operation in medical emergency
  - Integrated medical sensing

*Diagnostic Steering Wheel*
Personal Freedom vs. Efficiency

► Daily Commute Scenario
  • Submitted daily commute plan
  • Trip logistics transmitted to the car from central auto management
  • Departure time
  • Routing and speed
  • Parking slot

► Issues
  • Ad-Hoc driving
  • Biology breaks
  • Essence of personal transportation
Extension of your ‘Virtual Self’

- Car Configuration
- Personal and Business Content
- Real time interaction with the outside world
- Personal Privacy?
<table>
<thead>
<tr>
<th>Criteria</th>
<th>Unit</th>
<th>USA</th>
<th>EU27</th>
<th>Japan</th>
<th>Total or Avg.</th>
<th>Brazil</th>
<th>Russia</th>
<th>India</th>
<th>China</th>
<th>Total or Avg.</th>
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<td>491</td>
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<td>Land area</td>
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<td>9.1</td>
<td>4.3</td>
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<td>5454</td>
<td>1196</td>
<td>13115</td>
<td>1751</td>
<td>933</td>
<td>3316</td>
<td>1930</td>
<td>7930</td>
<td>0.60</td>
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<tr>
<td>Car park</td>
<td>Mio of cars</td>
<td>240</td>
<td>250</td>
<td>61</td>
<td>551</td>
<td>24</td>
<td>38</td>
<td>13</td>
<td>37</td>
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<tr>
<td>Car density</td>
<td># cars per 1000 hab.</td>
<td>782</td>
<td>509</td>
<td>480</td>
<td>596</td>
<td>123</td>
<td>268</td>
<td>11</td>
<td>27</td>
<td>39</td>
<td>0.07</td>
</tr>
<tr>
<td>Car density</td>
<td># cars per km of road</td>
<td>37</td>
<td>46</td>
<td>51</td>
<td>42</td>
<td>14</td>
<td>40</td>
<td>4</td>
<td>19</td>
<td>14</td>
<td>0.33</td>
</tr>
</tbody>
</table>

Source: US Central Intelligence Agency – CIA, world fact book

Developed Infrastructure for Transportation Management will be Critical
Smart Highways Tomorrow: Vehicle – Road Network

- Sensor / Radar / Camera networks
- Vehicle – Road / Vehicle – Vehicle Communications
- Automated driving
- Predictive safety
- Platoon: Increased traffic density at higher speeds
Prediction – Critical Factor in Next Generation Transportation

Safety – milliseconds save lives, collision avoidance, post crash
Efficiency – routing, navigation, consumption
Driver Information – driver decisions
Our Common Goals

ZERO

- Emissions
- Fatalities
- Defects

Electronics are imperative to balancing increasing individual transportation and reducing fuel cost, emissions and casualties.

Consumer awareness, legislation and competitive differentiation join forces driving automotive electronics
Automotive Solutions: Helping you with System Solutions

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