Challenges and Technologies
The Human Friendly Vehicle in 2030 and Beyond

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Agenda

- Growth of Automotive Electronics
- Advanced Vehicle Architecture
- Sustainable Mobility
- Managed Infrastructure
- Summary

Fun, Safe, and Sustainable Transportation
Global leadership in Embedded Processing and Connectivity Solutions

#1 in RF for Wireless Infrastructure

Nearly 7 of every 10 mobile phone calls are made using Freescale Base Station Products

#1 Supplier of Automotive ICs

1 of every 2 new cars worldwide are powered by Freescale Technology

#1 in Communications Processors

Have shipped more than 185 million communications processor units

#2 Supplier of Microcontrollers

Shipped 18 Microcontrollers every second in 2008

Shipped 9 Industrial microcontrollers every second in 2008
$5.2B Revenues (2008)
- 30% automotive
- No.1 automotive semiconductor supplier for more than 30 years

No.1 in total auto ICs
No.1 in auto microcontrollers
No.2 in MEMS sensors
Human Friendly Vehicle

► Fun
  • Performance
  • Traffic
  • Driver assistance

► Safe
  • Accident avoidance
  • Occupant protection
  • Reliability

► Sustainable
  • Low impact on the environment
  • Production, use and recycle
The Financial Crisis is Not Changing the Fundamental Issues

- Increasing world wide population
- Increasing energy usage and shortage of oil
- Increasing World Mobility
- Too much Greenhouse Gas emissions

This is Why We Are Here
### The Case for Electronics

<table>
<thead>
<tr>
<th></th>
<th>1983 BMW 323i</th>
<th>2006 BMW 325i</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel consumption</td>
<td>10.31/100 km</td>
<td>8.4/100 km</td>
</tr>
<tr>
<td>Acceleration</td>
<td>9.2 s</td>
<td>7.0 s</td>
</tr>
<tr>
<td>Emission</td>
<td>ECE R15-04</td>
<td>EU 4</td>
</tr>
<tr>
<td>Aerodynamic Resistance</td>
<td>0.40 x 1.85 m²</td>
<td>0.29 x 2.15 m²</td>
</tr>
<tr>
<td>Weight</td>
<td>1080 kg</td>
<td>1490 kg</td>
</tr>
<tr>
<td>Power</td>
<td>102 kW</td>
<td>160 kW</td>
</tr>
<tr>
<td>Engine torque</td>
<td>205 Nm</td>
<td>250 Nm</td>
</tr>
</tbody>
</table>

Source: BMW Presentation, FTF Orlando, 2008, Dr. Michael Wurtenburger
Automotive Electronic Content Growth

“80% percent of innovation is electronic”
“Impossible to comply with regulation without electronic systems”
-Automotive OEM

Electronic cost as % of total car cost


2005: 30%
2010: 35%

Sources: Bosch, PSA, Freescale Strategy

The Road Ahead

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

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

• Consumer awareness, legislation and competitive differentiation join forces driving electronic content

Airbag
ABS / ESP
Body Electronics
Multiplexing

“80% percent of innovation is electronic”
“Impossible to comply with regulation without electronic systems”
-Automotive OEM

Electronic Fuel Injection

50%

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Automotive Semiconductors in 2030

► Process node trails ‘industry leading’ by ~7 years and ~ 5 nodes
  • Volume production today mostly on 180nm
  • Ramping 90nm, development on 65nm
  • Analog further behind

► Trends / Issues
  • Redundant/Parallel architectures
  • Application specific vs. generic MPU
  • Dedicated hardware
  • Power consumption at smaller nodes

The industry has traditionally found a way around technical hurdles!
Advanced Vehicle Architecture
Vehicle Architecture: Today’s Global Basic Vehicle

- Immobilizer
- Body Controller
- Instrument Cluster
- Engine Management
- Radio
- Airbag
- Anti-lock Braking

CAN
Proprietary Communication

= Optional
Vehicle Architecture:
2009 Architectural Leader

- Immobilizer
- RKE and TPMS Rx
- Instrument Cluster
- Radio
- Nav
- Engine Management

Body Controller / Gateway:
- Seat modules
- Alarm
- Rear module
- HVAC
- Blower
- Door module
- Rear Lighting
- Sunroof
- Lighting L
- Lighting R
- Temp
- Wipers
- Battery management
- SJB
- Blind Spot Detection
- Anti-lock Braking
- Sensor cluster
- Airbag
- Occupant Classification
- Driver Seat Belt Pretent.
- Pass. Seat Belt Pretent.
- Integrated Chassis Management
- NOX
- 4x4
- Park Assist
- Park Assist

- Amplifier
- Video
- Video
- Glow Plug
- Cooling Fan
- Fuel Pump
- Transmission
- Active Steering
- Suspension
- Suspension
- Suspension
- Park Assist
- Adaptive Cruise Ctrl

- CAN
- Diagnostic CAN
- LIN
- FlexRay
- MOST
Why is This important?

► Networked systems increase in capability as the number of nodes increases
► New features are enabled
► Balance complexity for the average consumer
► Risk being too ‘clever’
  • System operates as designed but incorrectly programmed or operated
  • Remote system programming will be required

• Limit top speed
• Prevents deactivation safety systems
• Limits audio sound level
• Set a speed alert chime
• Mutes the audio system if the seat belts are not buckled
• Warns of a low fuel sooner
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*
Sustainable Mobility
Efficiency Requires Improvements in Many Areas

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

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

**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
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
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
Future Communications Scenarios
- Car to Car
- Car to Infrastructure

Capabilities
- Advanced Safety
- Accident avoidance / prediction
- Dynamic re-routing
- Surface conditions
- Road maintenance

Desired Benefits
- Driver awareness / impairment / ability
- Green Driving behavior

Automobiles with limited capability must be able to co-exist with advanced platforms
Active Safety and Driver Interaction

► Collision Detection
  • Radar
  • Car2Car
  • GPS
  • Car2Infrastructure

► Response
  • Wheel shake
  • Audible/Visible
  • Braking/Turning

► Returning control to the driver
  • Determine that danger has passed

Cars safe enough to build using less sturdy materials
Managed Infrastructure
## Western Hemisphere vs. BRIC

<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>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td>Mio hab</td>
<td>307</td>
<td>491</td>
<td>127</td>
<td>925</td>
<td>198</td>
<td>140</td>
<td>1166</td>
<td>1338</td>
<td>2842</td>
<td>3.07</td>
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<tr>
<td>GDP per capita</td>
<td>US$</td>
<td>$47,000</td>
<td>$33,400</td>
<td>$34,200</td>
<td>$38,024</td>
<td>$10,100</td>
<td>$15,800</td>
<td>$2,800</td>
<td>$6,000</td>
<td>$5456</td>
<td>0.14</td>
</tr>
<tr>
<td>Land area</td>
<td>Mio sq km</td>
<td>9.1</td>
<td>4.3</td>
<td>0.374</td>
<td>13.774</td>
<td>8.4</td>
<td>16.9</td>
<td>2.9</td>
<td>9.3</td>
<td>37.5</td>
<td>2.72</td>
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<tr>
<td>Total road</td>
<td>‘000s of km</td>
<td>6465</td>
<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>
</tr>
<tr>
<td>Car parc</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>
<td>111</td>
<td>0.20</td>
</tr>
<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
Managed Infrastructure

- Segregation of common platforms
- Smoothing of vehicle flow
- Active lane management

Embedded Energy
Advanced Infrastructure and Telematics

Extension of your ‘Virtual Self’

- Car Configuration
- Personal and Business Content
- Real time interaction with the outside world
- Personal Privacy?
Summary

- Incremental progress on multiple fronts
- Critical mass of key technologies
- Ultimate reliability of hardware and software
- Changes in consumer behavior
- Roll of government regulation

The processing power will be available!