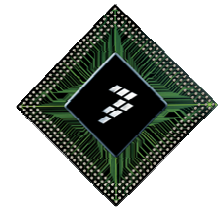


November 10, 2010

# MCU Products for Automotive Applications

AMF-AUT-T0814



## Designing with Freescale Seminars

Toronto

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# Agenda

- ▶ Freescale Auto MCU Overview
  - Vision, Mission and Message
  - Auto Market Segments
- ▶ Auto MCU Solutions
  - Body
  - Powertrain
  - Instrument Cluster/Driver Information Systems (DIS)
  - Safety Applications
- ▶ Enablement
  - Hardware and software
- ▶ Summary

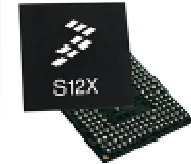
## Our Vision, Mission and Message

- ▶ Freescale Automotive provides enabling technologies that drive next-generation solutions for safer, more fuel-efficient and environmentally friendly vehicles.
- ▶ This is made possible through three **core principles**:

- 1 Our **leadership** in driving innovative technologies for automotive applications
- 2 Our continued efforts to deliver high **quality** products through quality-driven processes
- 3 Our desire to build the **trust** of our customers through “Customer First” initiatives



# Comprehensive 8/16/32-bit Automotive MCU Portfolios



## ► Broad 8/16/32-bit MCU families

- Market-leading architectures (Power Architecture, S12, S08) covering the performance spectrum
- Optimized MCUs for body electronics, safety/chassis, powertrain control and DIS
- Easy migration from 8-bit to 16-bit to 32-bit
- Pin, code and I/O compatibility
- Huge range of flash memory sizes and package options
- Wide variety of peripherals and features

## ► 32-bit and 16-bit leadership

- Power Architecture: de facto standard for powertrain control
- More than 100 million Power Architecture MCUs shipped to date for automotive
- S12: the leading 16-bit automotive MCU architecture
- S12/S12X MCUs shipping at a rate of more than 100 million units per year
- Defect rates of less than 1 ppm

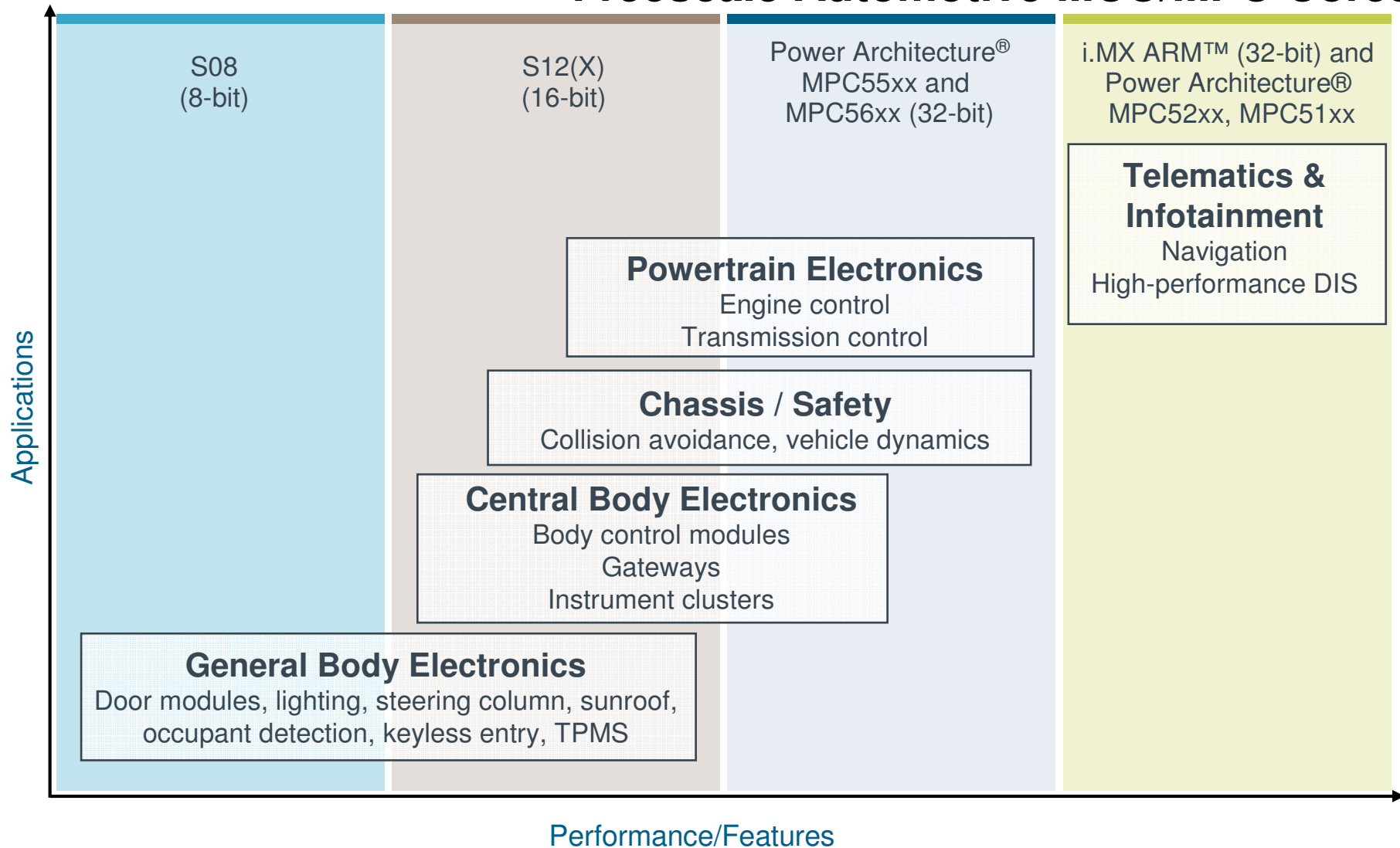
## ► MCU Performance

- Field-proven efficiency in code, processing and low-power consumption
- Exceptional electromagnetic compatibility (EMC) performance / low electromagnetic interference (EMI)

## ► Industry-leading innovations

- First 8-bit MCUs with CAN, electrically erasable programmable read-only memory (EEPROM), flash
- Memory protection unit
- Nonvolatile RAM
- XGATE coprocessor for 16-bit MCUs
- First multicore automotive MCUs (Power Architecture technology)
- First MCUs to integrate FlexRay™ technology

# Freescal Automotive MCU/MPU Cores





## Body Solutions

# Body Systems – Applications Overview

Driver Comfort	Vehicle Networking	Safety Related	Security
<ul style="list-style-type: none"> <li>▶ Door Module, Window Lift</li> <li>▶ Seat Module</li> <li>▶ HVAC</li> <li>▶ Electric Roof</li> <li>▶ Tailgate</li> </ul>	<ul style="list-style-type: none"> <li>▶ Central Body Control Module</li> <li>▶ Central Gateway</li> </ul>	<ul style="list-style-type: none"> <li>▶ Rain Light Sensor</li> <li>▶ Advanced Front Light Systems</li> <li>▶ Advanced Rear Light Systems</li> </ul>	<ul style="list-style-type: none"> <li>▶ Immobilizer</li> <li>▶ Keyless Entry</li> </ul>

- ▶ Body Systems encompass a broad variety of applications inside the cabin
  - OEM value drivers: comfort, safety, security
    - Cost driven
  - Invisible applications: vehicle networking
    - Performance driven
- ▶ Body Systems cover the widest range of performance requirements
  - Small 8-bit controllers
  - General purpose 16-bit controllers
  - 32-bit compute engines
- ▶ Diverting trends
  - Dedicated analog functionality with local compute power: mainly motor control
  - Increasing memory, compute power and networking capability: BCM, gateway

Available



Comfort/Convenience

## Gen 1

**S12(X)D**

**S12(X)B**

**S12C**

**S12Q**

**S08D**

**S08E**

**S08SG**

## Gen 2

**MPC5510**

*z1+z0@80MHz  
FlexRay  
512K-1.5M*

**S12XE**

*128K-1M*

**S12XS**

*(no XGATE)  
64K-256K*

**S12P**

*32K-128K*

## Gen 3

**MPC5668**

*z6+z0@116MHz  
2M, Eth, FR, MLB*

**MPC560xB/C**

*z0@64MHz  
128K-1.5M*

*Gateway*

*Central Body*

*Front/Rear Body*

*HVAC*

*Door Modules*

*Seat Control*

*Window Lift*

*Fans/Blowers*

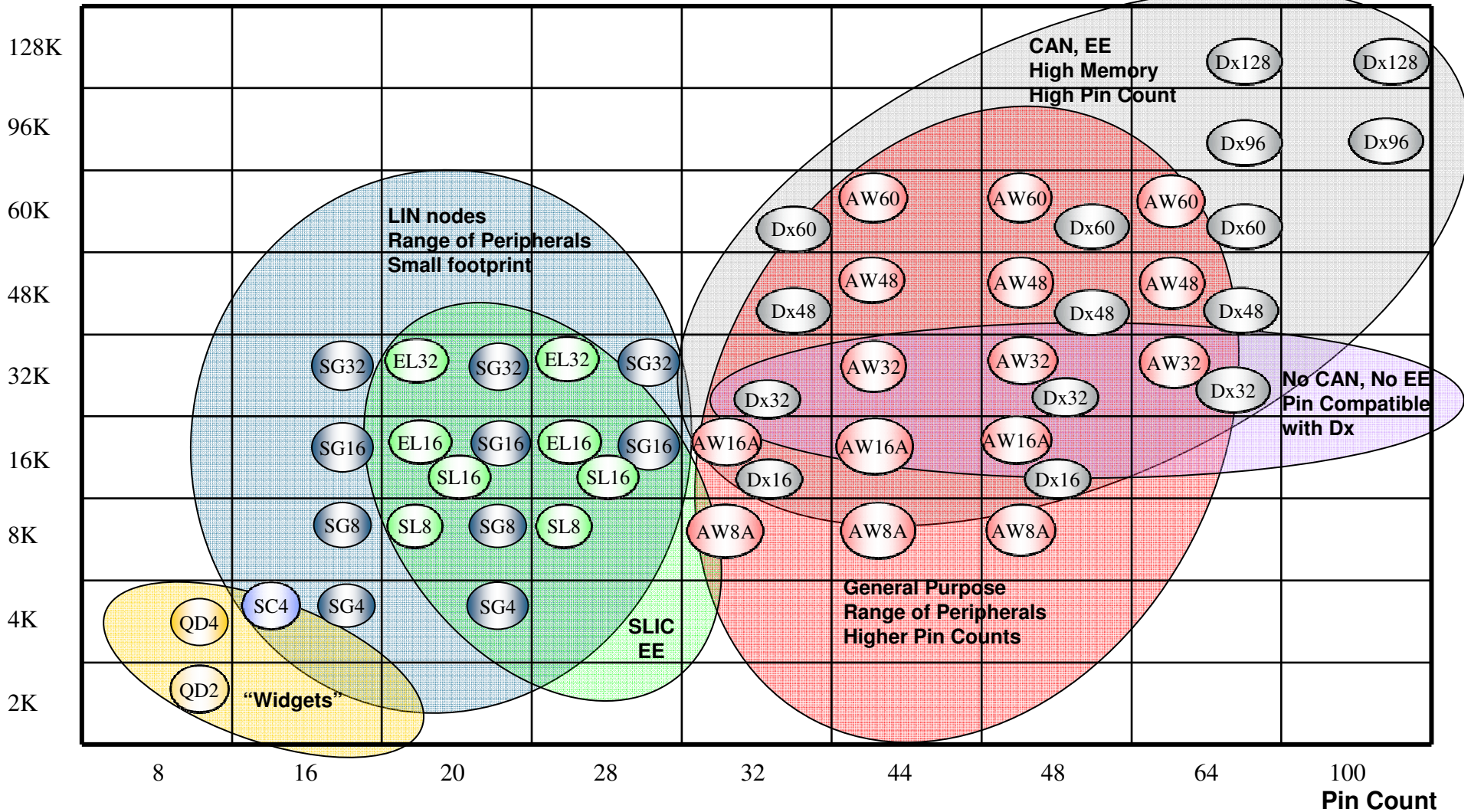


## S08/S12 Value Proposition

	Efficient	Family Concept
<b>Reuse</b>	<ul style="list-style-type: none"> <li>▶ 16-bit convenience and performance at 8-bit price</li> <li>▶ Single wire background debug module with trace</li> <li>▶ Mature and optimized CodeWarrior compiler suite including software templates</li> </ul>	<ul style="list-style-type: none"> <li>▶ Strict compatibility within product families</li> <li>▶ IP reuse across S08 and S12 families</li> <li>▶ Huge population of engineers familiar with these popular architectures</li> </ul>
<b>Smart IP</b>	<ul style="list-style-type: none"> <li>▶ CISC architecture offers best in class code density and RAM utilization</li> <li>▶ Embedded EEPROM</li> <li>▶ I/O w/ slew rate, drive strength and pull-up/downs</li> <li>▶ XGATE ...</li> </ul>	<ul style="list-style-type: none"> <li>▶ Integrated port multiplexing enabling hardware and software compatibility between device derivatives and package options</li> </ul>

# Automotive S08 Product Portfolio

## Flash Memory



# S08 8-bit High Temp Summary

## ► Overview:

- In response to an increase in the automotive market's need for more high temperature 8-bit devices, Freescale has begun efforts to qualify a number of S08 products to temperatures greater than 125 °C.

## ► Customer Drivers:

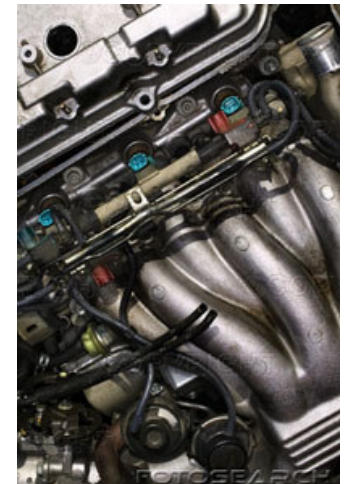
- Electrical replacement of mechanical components in high temperature environments
- Movement of remote electrical components closer to high temp locations
- Increase in use of 8-bit MCUs in the engine compartment
- Synthetic oils which allow for higher motor temperatures

## ► Application Examples:

- Engine watchdogs, oil level sensors, intake manifold control/air intake systems, exhaust system sensing, diesel glow plug, engine/HVAC fan controllers, turbo waste gate, throttle valve control, etc.

## ► S08 High Temp Packaged Qualifications:

- 9S08SG32/16 in a 16/28 TSSOP to 150 °C Ta per AEC Grade 0 Standard
- High temperatures versions of the SG8/4 are being qualified



## S12X The Market Leader

### Quality

- ▶ Shipping at a rate of over 100 Mu per year
- ▶ Defect rate less than 1 ppm

*Your trusted partner in providing quality to the automotive consumer*

### Performance

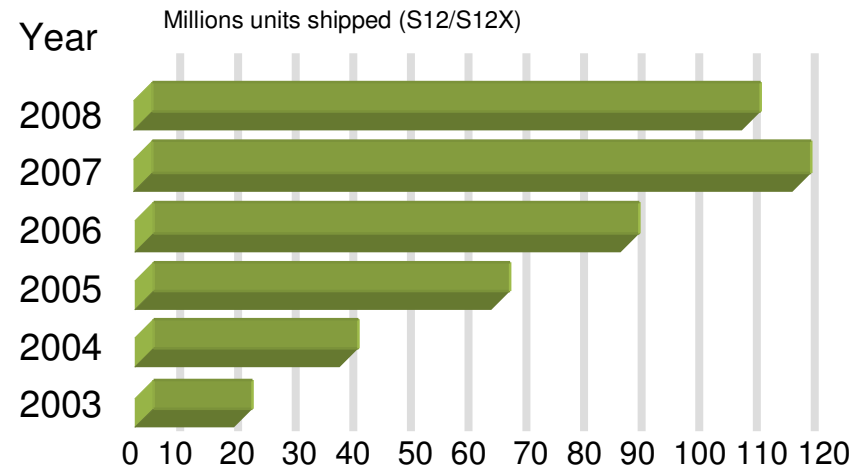
- ▶ Low power and low EMI
- ▶ Field-proven efficiency in code, processing, and power consumption

*Meeting the tough requirements for your new application*

### Industry Leading Innovations

- ▶ XGATE
- ▶ Memory protection unit
- ▶ Emulated EEPROM and Dataflash
- ▶ Embedded FlexRay
- ▶ Many more...

*Freescale continues to set the standard in 16-bit innovations*



### Broad Family of MCU's

- ▶ Pin, code, and I/O compatible
- ▶ Many package options
- ▶ Huge range of sizes- 32K-1M flash
- ▶ Range of features

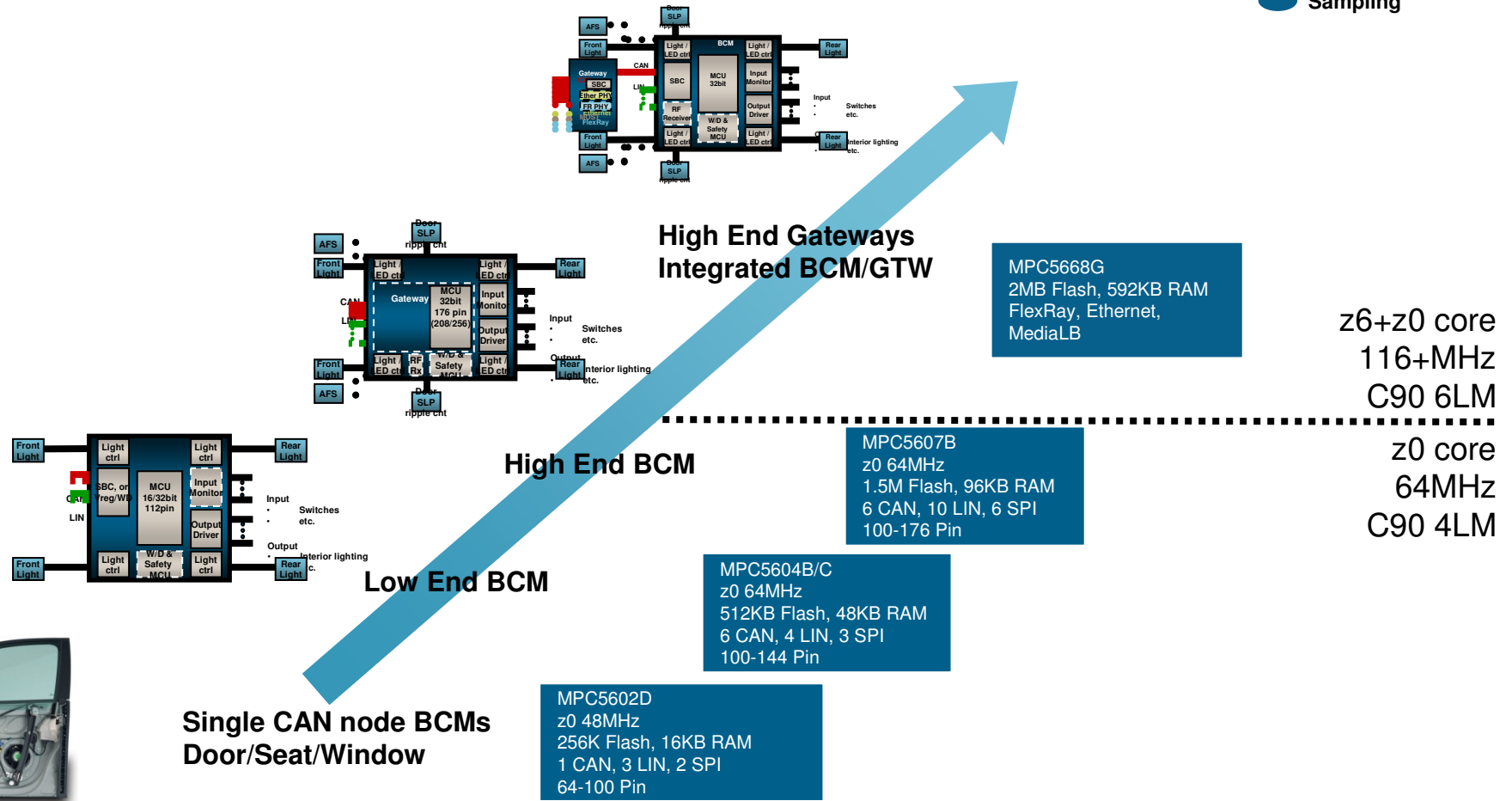
*S12X MCUs adapt with changing application requirements*

## 32-bit Body Family Value Proposition

	Scalability	Low-power
<b>Power Architecture</b>	<ul style="list-style-type: none"> <li>▶ Compatible e200 core platform from z0 @ 64 MHz to z4 @ 120 + MHz</li> <li>▶ Crossbar architecture to increase data throughput</li> <li>▶ Dual core options</li> <li>▶ Strong ecosystem</li> </ul>	<ul style="list-style-type: none"> <li>▶ Multiple low-power modes cutting power to selected areas of the MCU</li> <li>▶ Use of second core to manage low-power modes</li> </ul>
<b>Advanced peripherals</b>	<ul style="list-style-type: none"> <li>▶ Very flexible eDMA saves CPU load and removes bottlenecks</li> <li>▶ Cross Triggering Unit adapts to all types of load diagnostic schemes</li> <li>▶ LINFlex, FlexCAN, FlexRay, Ethernet, MediaLB, CSE....</li> </ul>	<ul style="list-style-type: none"> <li>▶ Configurable wake-up events</li> <li>▶ Multiple internal oscillator options</li> </ul>

# 32-bit Body Family Product Offering

● Sampling



Because of an order from the United States International Trade Commission, BGA-packaged product lines and part numbers indicated here currently are not available from Freescale for import or sale in the United States prior to September 2010: MPC5604B in 208 BGA package

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# MPC5668G/E – The Ultimate Gateway

## 250+ DMIPS

e200z6 @ 116 MHz  
e200z0 @ 64 MHz

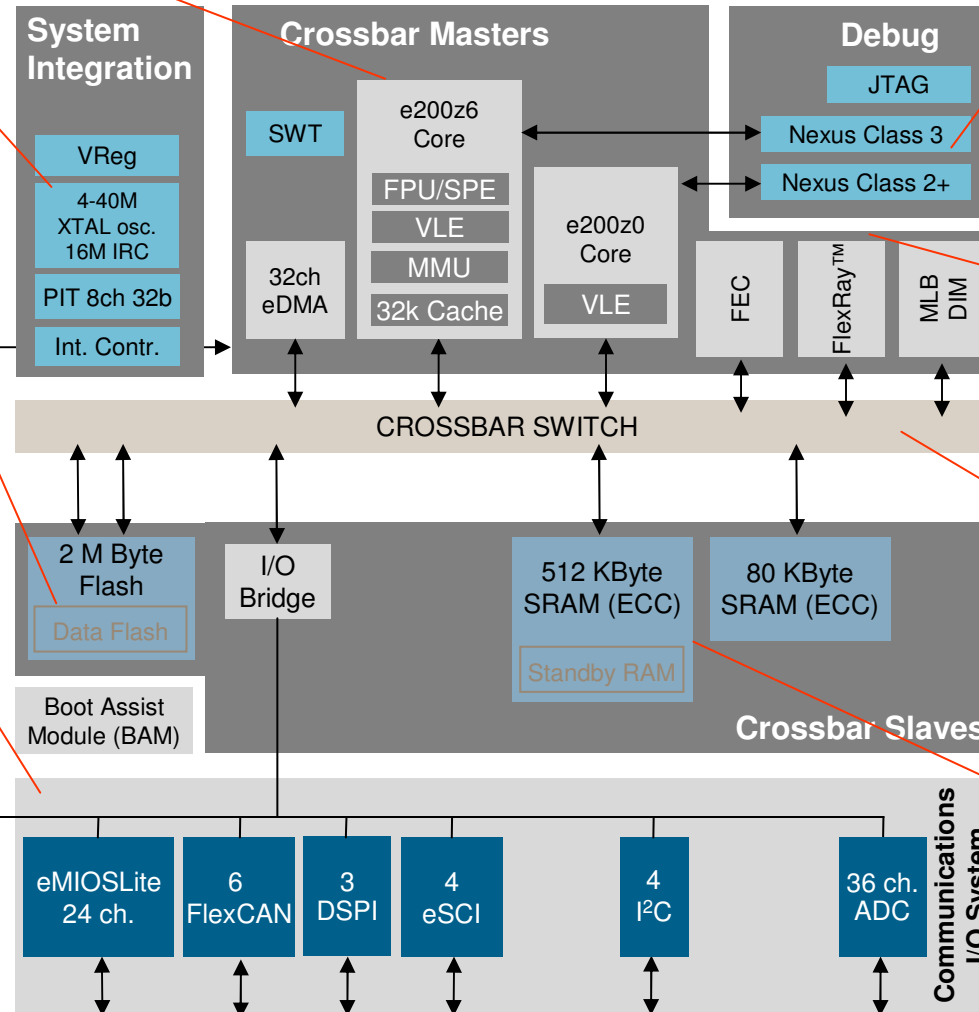
## Low-power

Internal oscillators to support parking modes and fast wake-up capabilities

## 2 MB Flash

Includes small sectors and read-while-write capability for data storage

## Small footprint



## Multi-core Debug

- Two separate Nexus modules to allow parallel “real-time” debug of 2 cores
- One single interface

## Ethernet, FlexRay™, MediaLocalBus

All available on one single chip

## Crossbar

Allows parallel accesses to on-chip resources for maximum system performance

## 592 KB SRAM

Removes the need for external RAM chip and associated EMC issues

Because of an order from the United States International Trade Commission, BGA-packaged product lines and part numbers indicated here currently are not available from Freescale for import or sale in the United States prior to September 2010: MPC5668G and MPC5668E

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# Powertrain Solutions



# Freescal's Powertrain Overview

## ► Freescale technology

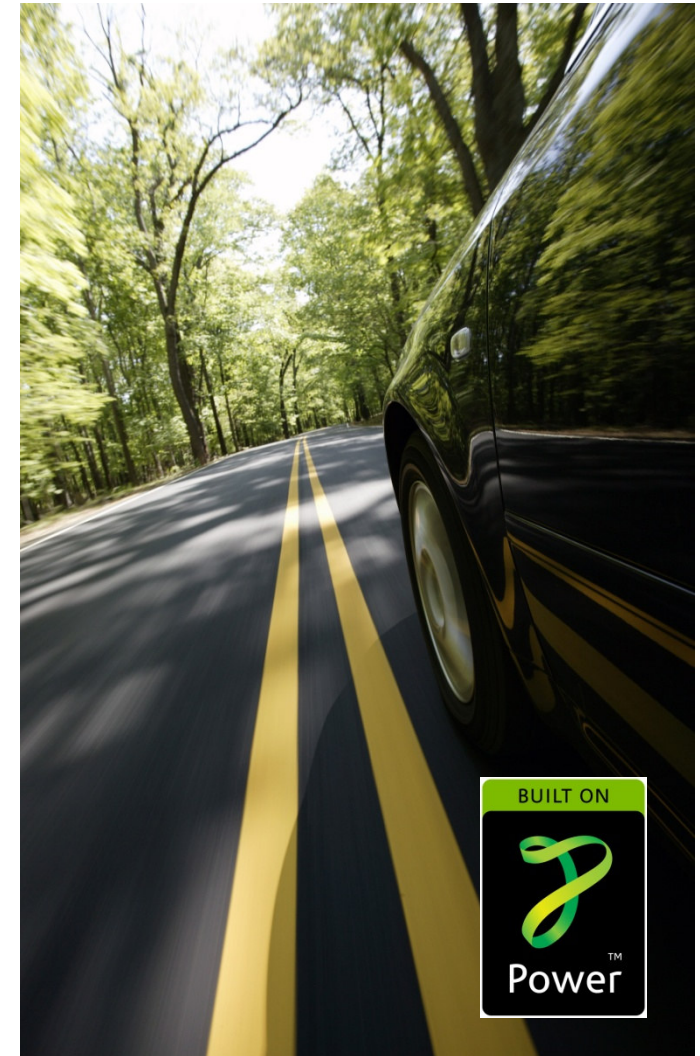
- Sampling on 90 nm technology and developing on next node technology
- Offering 10x increase in MCU performance compared to today's typical engine controllers
- Delivering the highest performance MCU for engine management with more than 600 DMIPS benchmarked at 264 MHz

## ► Superior quality

- Bringing the industry's first 0 ppm product on esys
- Using best practices such as DFT, DFM and zero defect processes
- Enabling OEMs to offer "lifetime powertrain warranties"

## ► 30-year powertrain leadership

- Market leader with nearly 50% market share in 32-bit engine control
- Industry leader in driving advanced powertrain solutions
- MPC5674F enables "green engines," such as direct injection for gasoline and diesel engines for 4-8 cylinders
- MPC5674F jointly developed with leading OEMs and Tier 1 suppliers; awarded advanced "Clean Diesel" platform business



# 32-Bit Powertrain Overview

*same instruction set / memory map / interrupt map / software*



**BRIC**

@64MHz, 512KB



**2-4cyl**

@80Mz, 1.5MB



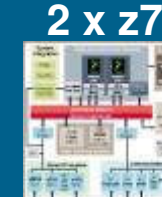
**Diesel  
Gearbox**

@150Mz, 2 & 4MB



**GDI,  
Diesel**

@264MHz, 4MB



**Hybrid  
HCCI**

Multi-core (New)

## ► Time to market reduced

- Modular cores to match engine requirements
  - w/ DSP, FPU, cache, larger pre-fetch buffers
  - w/ Single and Dual-Core options
- Software enablement package
- Maximize Development reuse

## ► Development Cost and Resource reduction (*economies of scale*)

- Common architecture and platform development
- Key IPs implementation to lower system cost as such as decimation filter, reaction channel and knock detection
- Same core & tools from BRICs to GDI engines
- Software tool re-use

# Powertrain Roadmap

Available In Development

## Powertrain

Going Green

Known Good Die Available

### Gen 3 + JDP

### Gen 2

Viper

Copperhead

Taipan

Moccasin

Coral

Diamondback

Sailfish

Hatchfish

### Gen 1

Spanish Oak

Green Oak

Black Oak

Silver Oak

HC11

MPC5674F

4M, 264MHz  
256k SRAM

MPC5673F

3M, 264MHz  
192k SRAM

MPC5634M

1.5M, 80MHz  
94k SRAM

MPC5633M

1M, 64MHz  
64k SRAM

MPC5632M

768k, 48MHz  
48k SRAM

high precision DI

Hybrid

fuel cell

transmission

4cyl, emerging

motorbikes

scooters

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## Slide 19

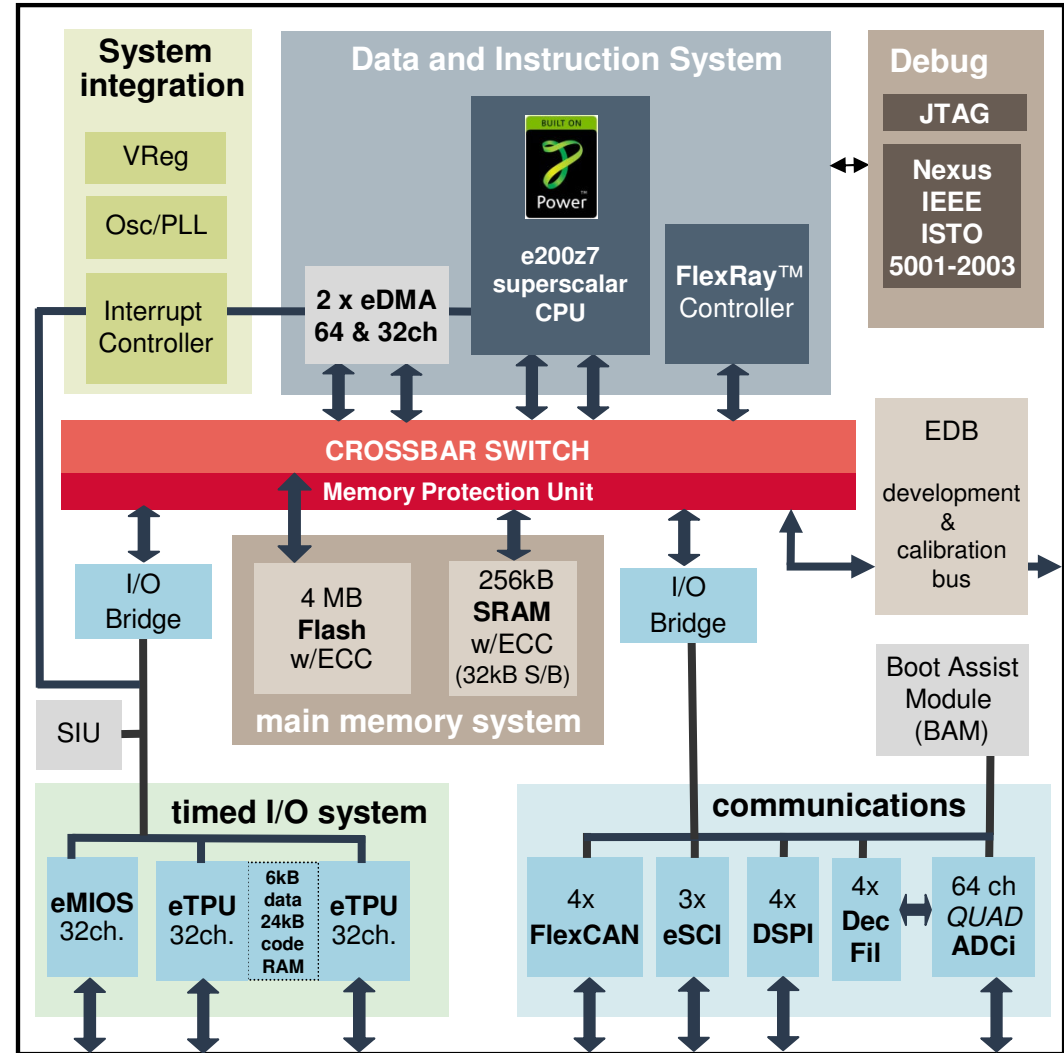
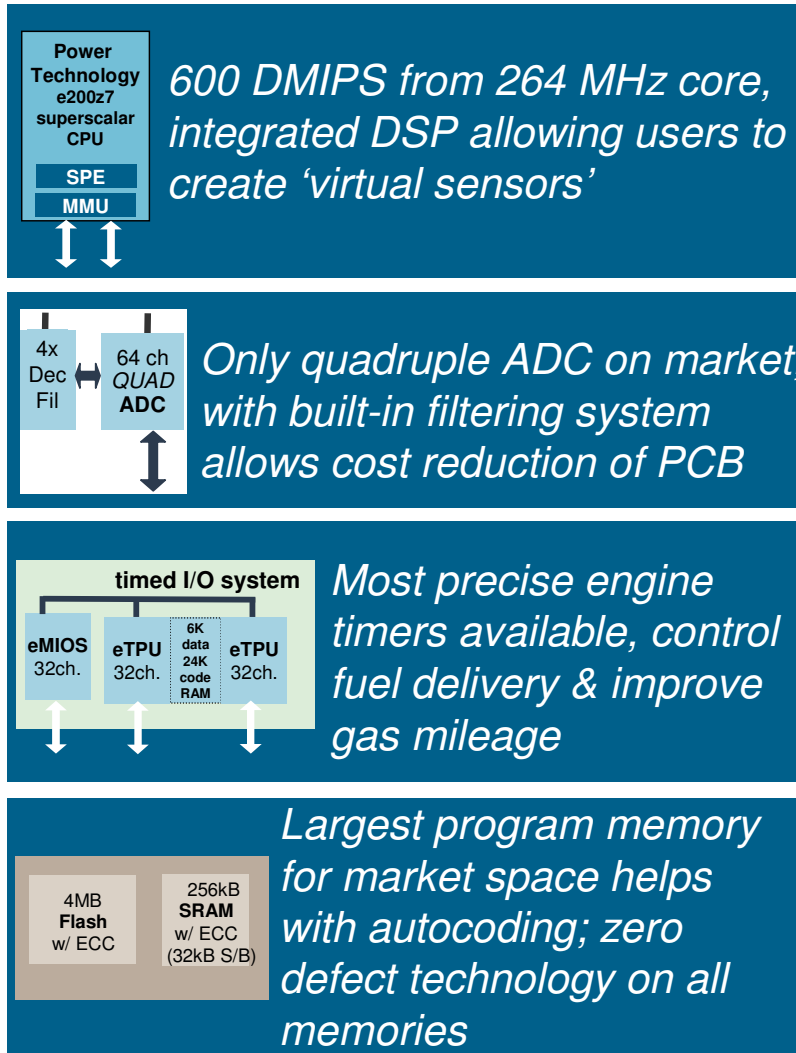
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**KAL1**

Cannot have code names. Must have product names. Please change.

rm027c, 5/12/2010

# MPC5674F: 4 MB Engine Controller with FlexRay™



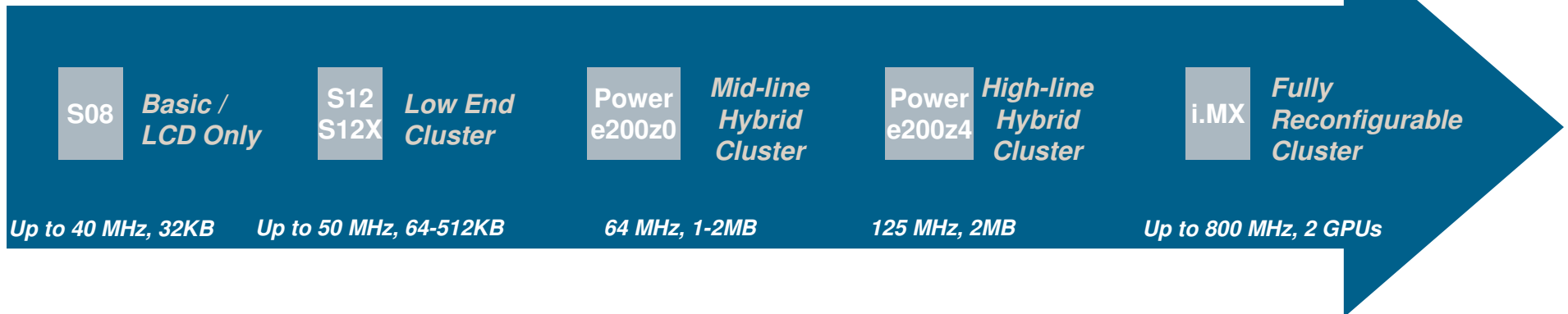




## Cluster/DIS Solutions

# Freescal Instrument Cluster Value Proposition

*Complete family of solutions from basic to premium line*



## ► Time to market reduced

- Reference designs
- Software enablement package
- Graphics tools and ecosystem
- Industry standard graphics APIs

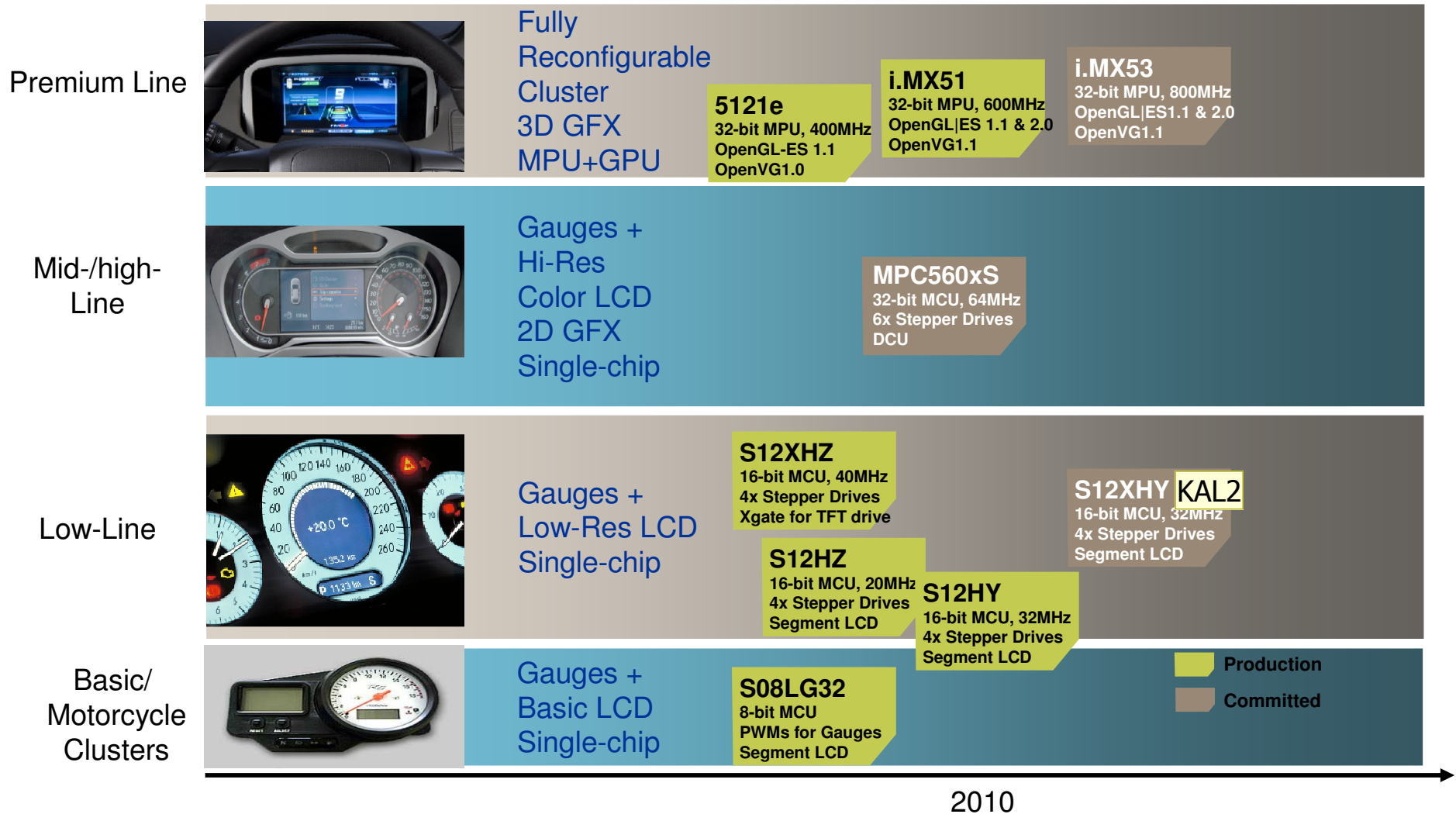
## ► Lowest system cost for low- and mid-line

- All peripherals integrated on MCUs
- QFP packages enable 2-layer PCBs
- Innovative LCD display controller for lowest possible RAM requirements

## ► Performance

- Highest performance MPU for automotive graphics
  - Up to 1600 MIPS @ 800 MHz
- Up to 2 Graphics Accelerators
  - Up to 400 Mpixel/s raw performance
  - Supports warping for Head Up Display
  - Native rendering of true-type fonts and vector paths

# Automotive Instrument Cluster Roadmap







## Slide 23

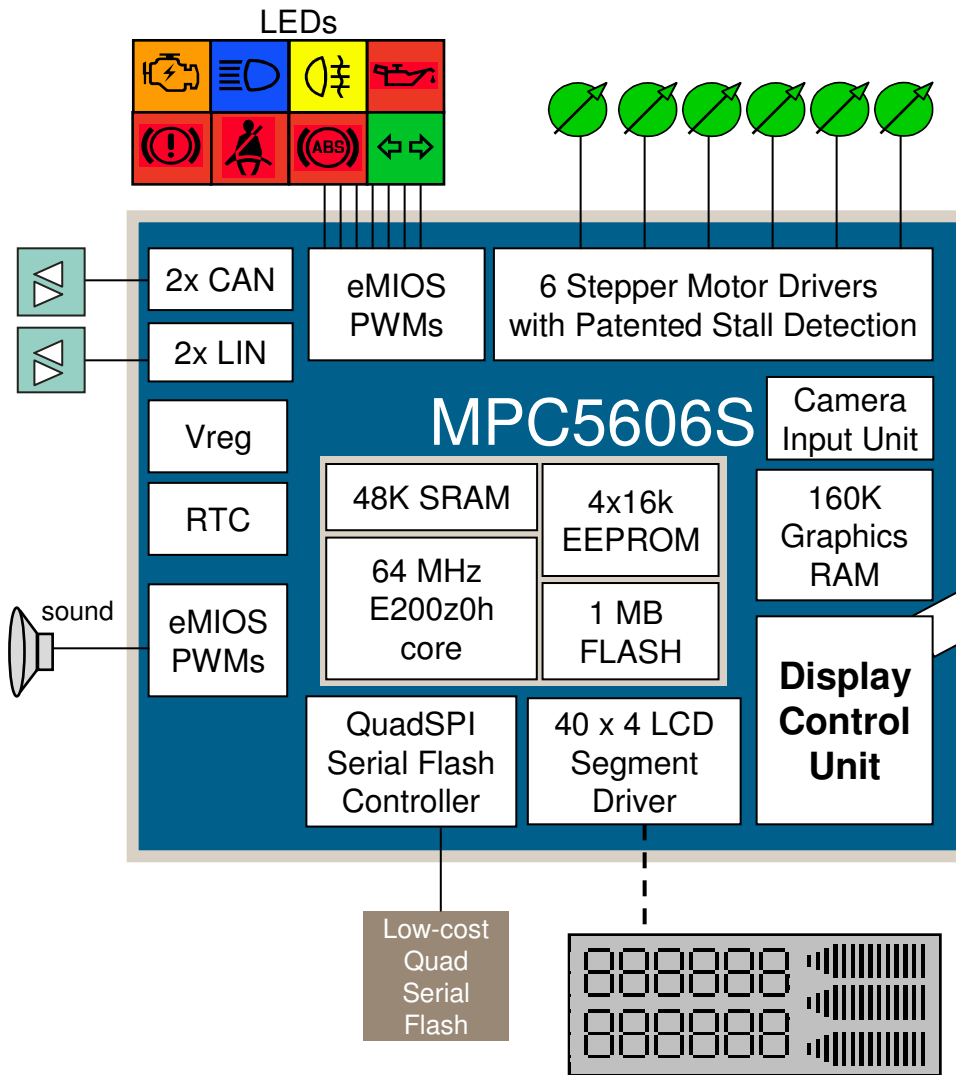
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**KAL2**

We haven't announced the XHY yet. Maybe we can just take the name off of it?

rm027c, 5/12/2010

# The MPC5606S Hybrid Cluster SoC:



## TFT DISPLAY

DCU on MPC5606S can drive up to 480x272 LCD with no external RAM

- ▶ Cost efficient
- ▶ Low memory requirement
- ▶ Optimized for GUI and advanced OSD
- ▶ Safety feature to enable safety related display content

## DIS Applications

### ▶ Audio Connectivity and Telematics

- Compressed Audio playback from storage devices and personal media players
- High-speed CD ripping (encode) to USB, SD/MMC or HDD for virtual CD changer
- Audio processing and wireless for hands-free telephony
- Speech Recognition for controls



### ▶ A/V Connectivity and Navigation

- Features above plus high resolution displays
- Map display & route calculation
- Video decode (software and/or hardware)
- Sophisticated graphics (hardware accelerated)



### ▶ High-end Instrument Clusters

- Fully reconfigurable using one or two LCDs
- OpenVG and OpenGL ES graphical APIs



# Automotive DIS Processor Roadmap

## ICs Available

High-end Navigation  
High-end Speech Recognition  
HD Video Decode  
Multiple Displays

### i.MX516

- 720p Video Dec

### i.MX514

- Cortex A8, 600 MHz
- OpenGL ES 2.0
- OpenVG 1.1
- mDDR/DDR2 200
- USB Phy



Entry to Mid-level Navigation  
Advanced Audio Connectivity  
Mid-Level Voice Recognition  
Sophisticated GUI

### i.MX356

- OpenVG 1.1

### i.MX355

- WVGA
- Camera Input

### i.MX351

- ARM1136, 532 MHz
- 2xCAN, MLB, Audio
- DDR2, USB Phy x2



Audio Connectivity  
GUI Support  
Bluetooth Hands-free, A2DP

### i.MX255

- WVGA Touchscreen
- Camera

### i.MX251

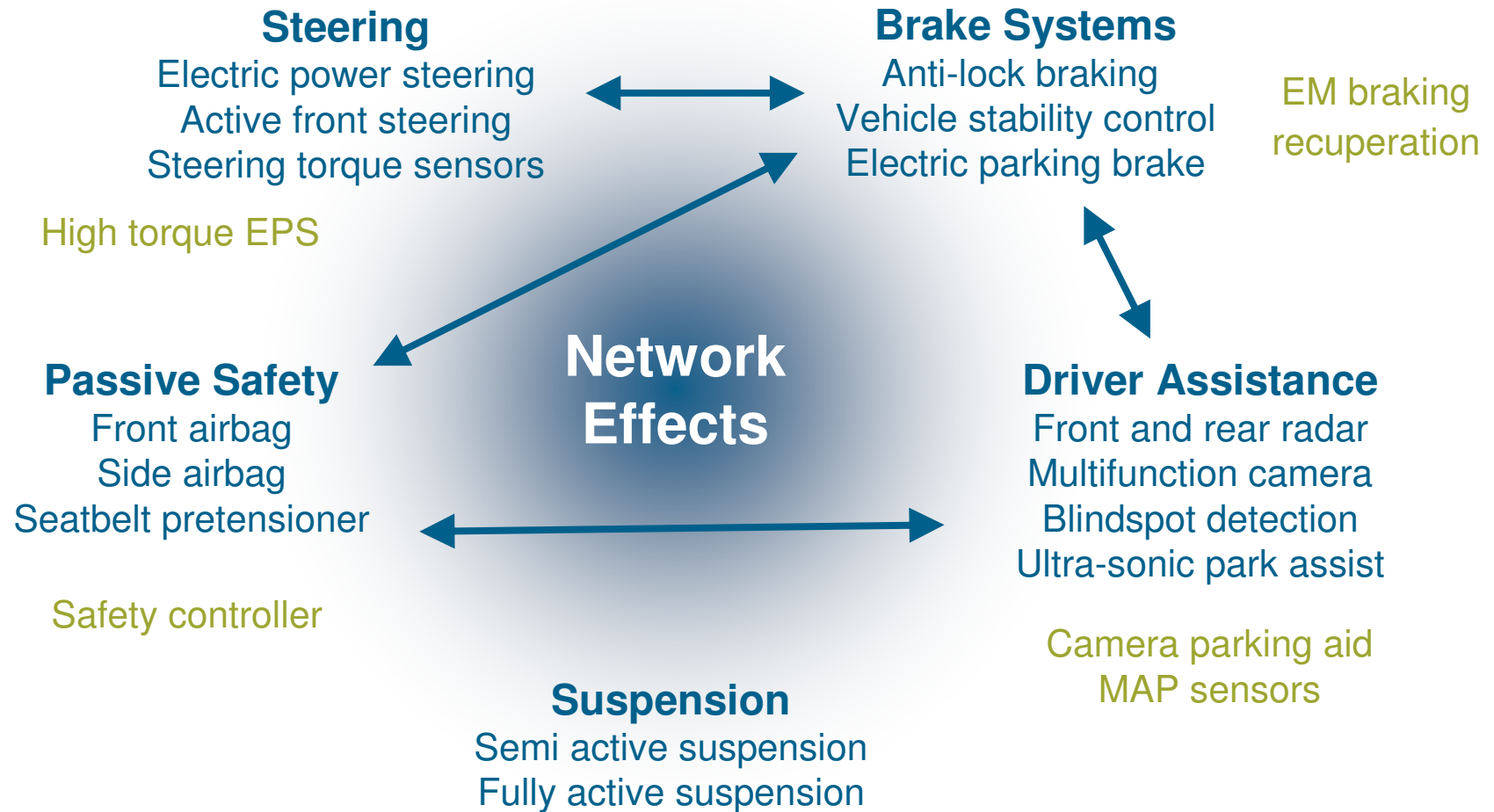
- ARM926, 400 MHz
- 2xCAN, Ethernet
- USB Phy, Audio, DDR2





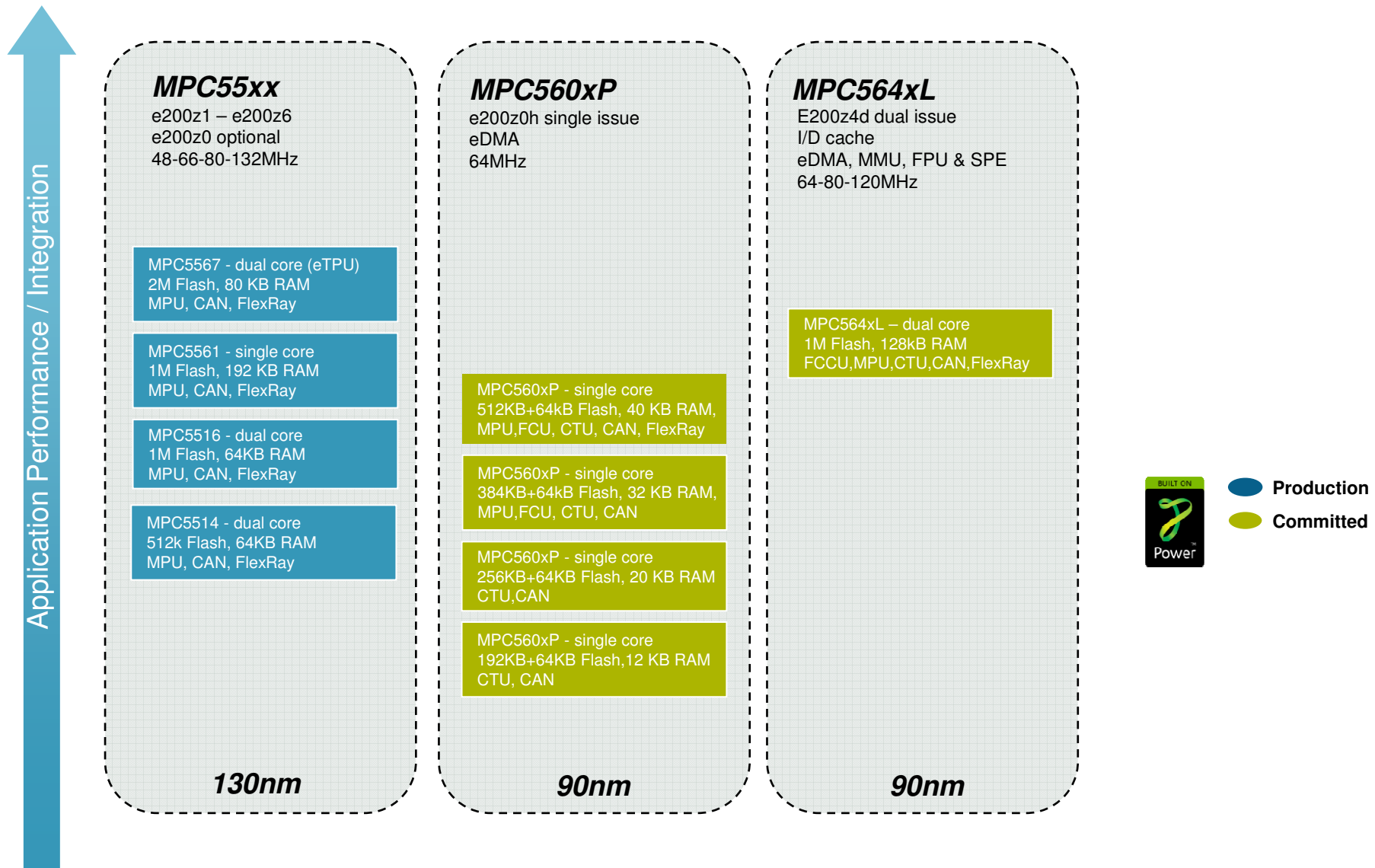
# Safety Solutions

# Chassis & Safety Application Space





# 32-bit MCU Roadmap – Safety Critical Applications



# MPC564xL Family – Key Benefits

## ► Higher Performance

- Up to **25% more performance** - e200z4 dual issue core architecture provides 2.31 DMIPS/MHz intrinsic performance
- **SIMD and floating point unit** - provides DSP capabilities
- Small instruction cache - boosts performance for localized motor control code

## ► Peripherals for complex motor control

- **Cross triggering unit** – coordinates ADC, timer and PWM generation and minimizes CPU interrupt load
- **High precision A/D conversion** – 12-bit resolution ADC with TUE +/-2 LSB

## ► Turn key solution for IEC61508 SIL3 certification

- **Fault collection and control unit** – offers a systematic approach to fault detection and control and
- **Safe peripherals** - safety concept generic to electric motor control without specificities on the usage and control method
- **Two modes of operation** - Decoupled Parallel Mode (DPM as known from MPC551x) & statically configurable Lockstep Mode (LSM)



# MPC5643L Safety Elements – Module View

## Sphere of Replication:

- replicated e200Core
- replicated eDMA
- redundant INTC, SWT, etc
- redundant MMU
- RC Units at Gates to non redundant sphere

## XBAR + MPU:

- redundant
- RC Units at Gates to non redundant sphere

## Clock Monitoring

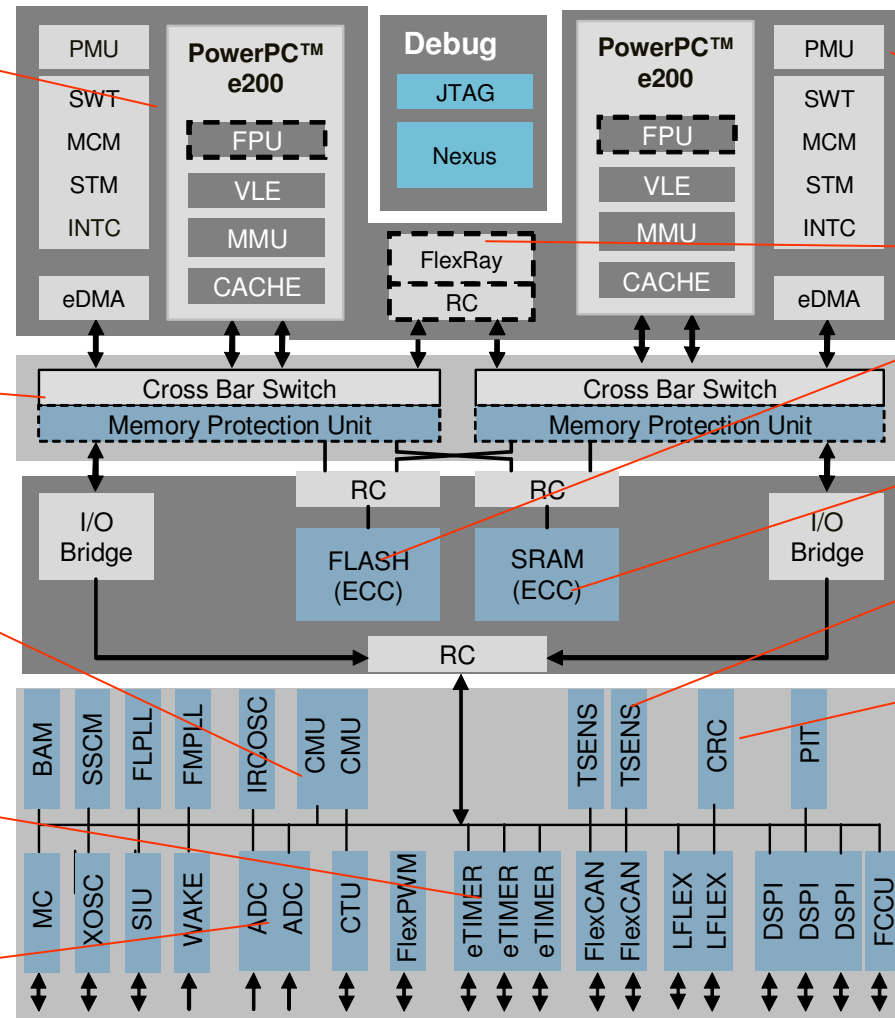
- detects and mitigates clock disturbances
- PLL

## Timer

- eTimer0 channels "isolated"

## ADC

- on line assisted hardware BIST



## PMU

- internal Vreg
- redundant Vmonitor

## FlexRay

## Flash

- ECC

## RAM

- ECC

## Temperature Sensor

- redundant

## CRC Unit

- application signature

## Fault Collection Unit

- detects when errors have occurred
- indicates error to external
- independent of software operation

# Comprehensive Ecosystem

## Development Tools

- Comprehensive selection from Freescale and third parties
- Multi-core support
- “Vertical” calibration solution
- mobileGT™

**CodeWarrior**

## Processor Architecture Partnerships

- STMicroelectronics for 32-bit Power Architecture
- Common process/flash development



**FlexRay™**

## Run-time Software

- AUTOSAR
- Drivers
- Signal processing library
- Motor control library

## Auto labs

- Global systems support: China, Germany, Japan, Korea, US
- Modeling consulting services

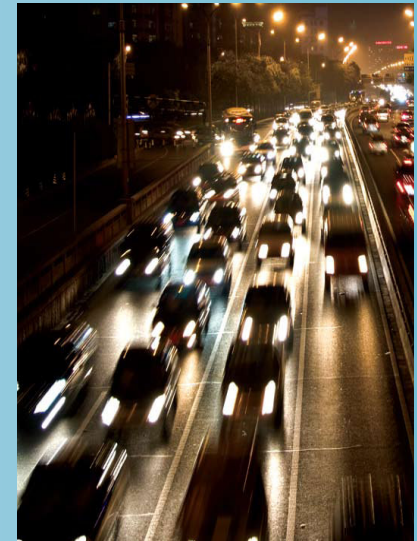
## Communication Standards

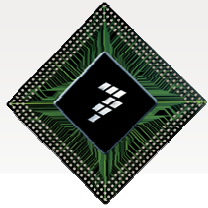
- Founding member of FlexRay™ and LIN consortia
- Automotive Electronics Workshop Participation for Japan Ministry of Economy, Trade and Industry



## ► Why choose Freescale as your Auto MCU supplier?

- Consistent focus on automotive business
  - Large automotive portfolio
  - Comprehensive roadmap (90 nm and beyond)
- Efficient Power Architecture
  - Parallel processing
  - Code density
  - Low power
- Scalability through many peripherals, package and memory options
- Consistent delivery on leading auto technology and new products
- Supported by a vast network of existing ecosystem (Tools & Software)





## Freescale Product Longevity Program

- ▶ The embedded market needs **long-term product support**
- ▶ Freescale has a longstanding track record of **providing long-term production support** for our products
- ▶ Freescale offers a **formal product longevity program** for the market segments we serve
  - For the automotive and medical segments, Freescale will make a broad range of program devices available for a minimum of **15 years**
  - For all other market segments in which Freescale participates, Freescale will make a broad range of devices available for a minimum of **10 years**
  - **Life cycles** begin at the time of launch
- ▶ A list of participating **Freescale products** is available at: [www.freescale.com/productlongevity](http://www.freescale.com/productlongevity)



