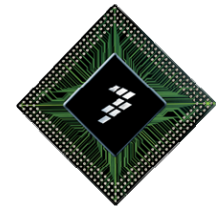June 23, 2010

MCU Products for Auto Applications

FTF-AUT-F0814

Brad Loane

Auto MCU Product Manager – Body Electronics

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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

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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

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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

Freescale Automotive MCU/MPU Cores

Applications (vertical axis)

Performance/Features (horizontal axis)

| S08 (8-bit) | S12(X) (16-bit) | Power Architecture® MPC55xx and MPC56xx (32-bit) | i.MX ARM™ (32-bit) and Power Architecture® MPC52xx, MPC51xx |

Telematics & Infotainment
Navigation
High-performance DIS

Powertrain Electronics
Engine control
Transmission control

Chassis / Safety
Collision avoidance, vehicle dynamics

Central Body Electronics
Body control modules
Gateways
Instrument clusters

General Body Electronics
Door modules, lighting, steering column, sunroof, occupant detection, keyless entry, TPMS

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Body Solutions

Body Systems – Applications Overview

Driver Comfort	Vehicle Networking	Safety Related	Security
► Door Module, Window Lift ► Seat Module ► HVAC ► Electric Roof ► Tailgate	► Central Body Control ► Module ► Central Gateway	► Rain Light Sensor ► Advanced Front Light ► Systems ► Advanced Rear Light ► Systems	► Immobilizer ► Keyless Entry

► 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

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Available

Comfort/Convenience

Gen 1

Gen 2

Gen 3

MPC5668
$z6+z0@116MHz$
2M, Eth, FR, MLB

MPC5510
$z1+z0@80MHz$
FlexRay
512K-1.5M

MPC560xB/C
$z0@64MHz$
128K-1.5M

S12(X)D

S12(X)B
S12C
S12Q

S12XE
128K-1M

S12XS
(no XGATE)
64K-256K

S08D

S08E
S08SG

S12P
32K-128K

Gateway

Central Body

Front/Rear Body

HVAC

Door Modules

Seat Control

Window Lift

Fans/Blowers

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S08/S12 Value Proposition

	Efficient	Family Concept
Reuse	► 16-bit convenience and performance at 8-bit price ►Single wire background debug module with trace ► Mature and optimized CodeWarrior compiler suite including software templates	► Strict compatibility within product families ► IP reuse across S08 and S12 families ► Huge population of engineers familiar with these popular architectures
Smart IP	► CISC architecture offers best in class code density and RAM utilization ► Embedded EEPROM ► I/O w/ slew rate, drive strength and pull-up/downs ► XGATE …	► Integrated port multiplexing enabling hardware and software compatibility between device derivatives and package options

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Automotive S08 Product Portfolio

Flash Memory

CAN, EE High Memory High Pin Count

LIN nodes Range of Peripherals Small footprint

No CAN, No EE Pin Compatible with Dx

SLIC EE

General Purpose Range of Peripherals Higher Pin Counts

"Widgets"

Flash Memory									
128K								Dx128	Dx128
96K								Dx96	Dx96
60K					AW60 Dx60	AW60	Dx60 AW60	Dx60	
48K					AW48 Dx48	AW48	Dx48 AW48	Dx48	
32K	SG32 EL32	SG32 EL32	SG32		AW32 Dx32	AW32	Dx32 AW32	Dx32	
16K	SG16 EL16	SG16 EL16	SG16	AW16A Dx16	AW16A	AW16A Dx16			
		SL16	SL16						
8K	SG8 SL8	SG8	SL8	AW8A	AW8A	AW8A			
4K	QD4 SC4	SG4	SG4						
2K	QD2								

Pin Count: 8, 16, 20, 28, 32, 44, 48, 64, 100

Pin Count

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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 sensoring, 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

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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

Millions units shipped (S12/S12X)

Year	
2008	~110
2007	~118
2006	~90
2005	~65
2004	~40
2003	~22

0 10 20 30 40 50 60 70 80 90 100 110 120

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
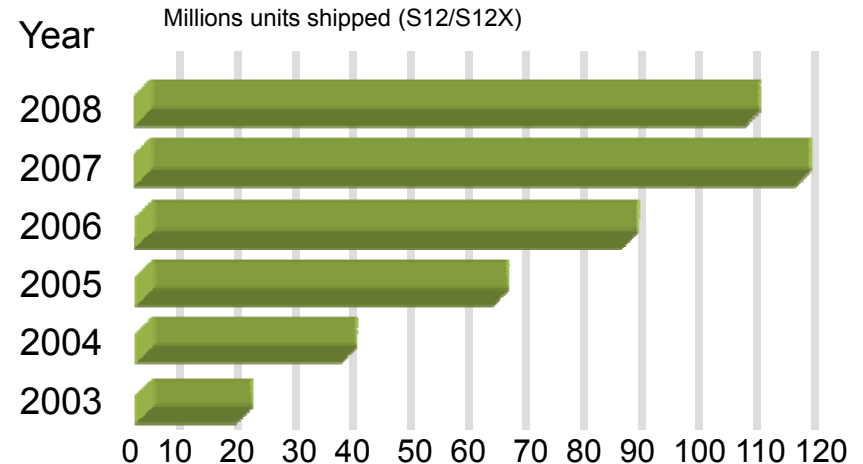
Broad Family of MCU's

► 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

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32-bit Body Family Value Proposition

	Scalability	**Low-power**
Power Architecture	► Compatible e200 core platform from z0 @ 64 MHz to z4 @ 120 + MHz ► Crossbar architecture to increase data throughput ► Dual core options ► Strong ecosystem	► Multiple low-power modes cutting power to selected areas of the MCU ► Use of second core to manage low-power modes
Advanced peripherals	► Very flexible eDMA saves CPU load and removes bottlenecks ► Cross Triggering Unit adapts to all types of load diagnostic schemes ► LINFlex, FlexCAN, FlexRay, Ethernet, MediaLB, CSE….	► Configurable wake-up events ► Multiple internal oscillator options

32-bit Body Family Product Offering

Sampling
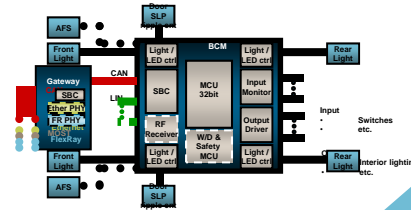
High End Gateways
Integrated BCM/GTW

MPC5668G
2MB Flash, 592KB RAM
FlexRay, Ethernet,
MediaLB

z6+z0 core
116+MHz
C90 6LM

z0 core
64MHz
C90 4LM
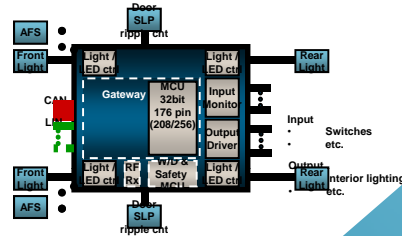
High End BCM

MPC5607B
z0 64MHz
1.5M Flash, 96KB RAM
6 CAN, 10 LIN, 6 SPI
100-176 Pin

Low End BCM

MPC5604B/C
z0 64MHz
512KB Flash, 48KB RAM
6 CAN, 4 LIN, 3 SPI
100-144 Pin

Single CAN node BCMs
Door/Seat/Window

MPC5602D
z0 48MHz
256K Flash, 16KB RAM
1 CAN, 3 LIN, 2 SPI
64-100 Pin

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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

208 MAPBGA
17 mm x 17 mm
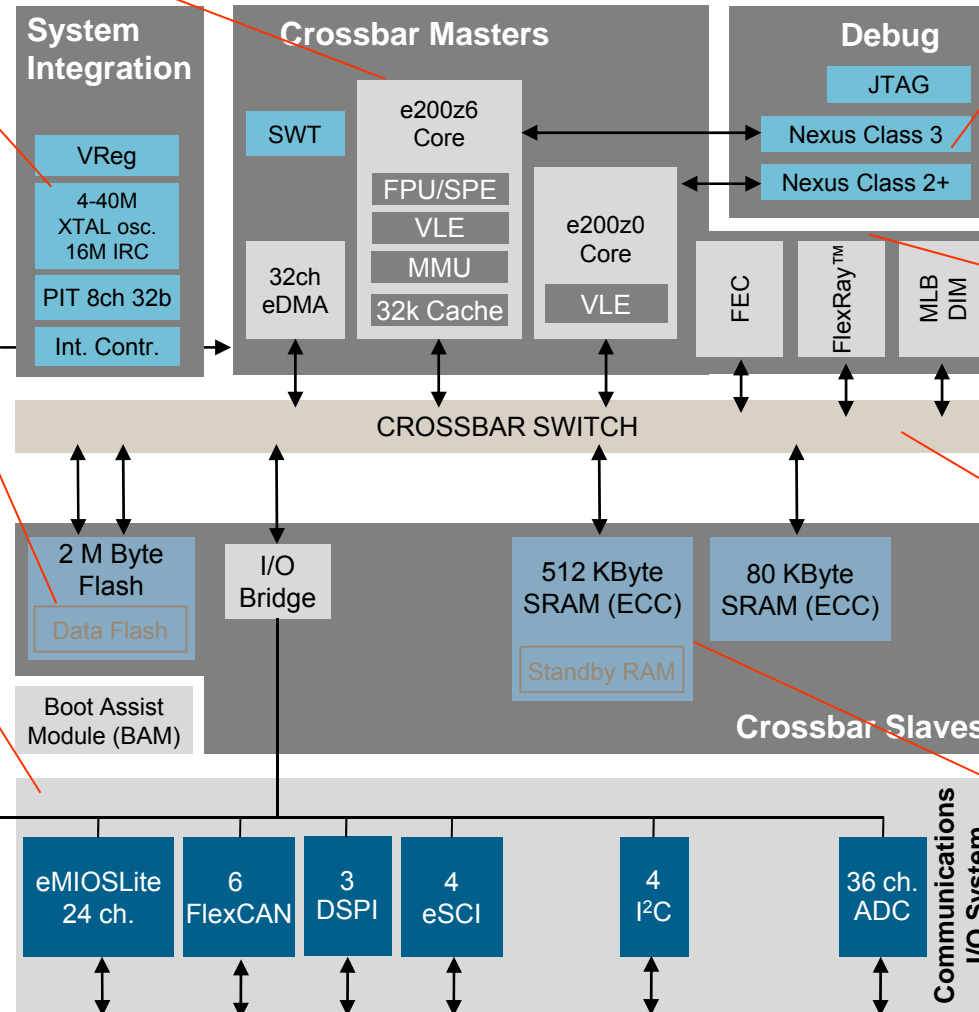
Multi-core Debug
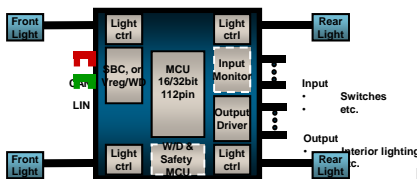- Two separate Nexus modules to allow parallel "real-time" debug of 2 cores
- One single interface

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

System Integration
- VReg
- 4-40M XTAL osc. 16M IRC
- PIT 8ch 32b
- Int. Contr.

Crossbar Masters
- SWT
- 32ch eDMA
- e200z6 Core
  - FPU/SPE
  - VLE
  - MMU
  - 32k Cache
- e200z0 Core
  - VLE
- FEC
- FlexRay™
- MLB DIM

Debug
- JTAG
- Nexus Class 3
- Nexus Class 2+

CROSSBAR SWITCH

Crossbar Slaves
- 2 M Byte Flash
  - Data Flash
- I/O Bridge
- 512 KByte SRAM (ECC)
  - Standby RAM
- 80 KByte SRAM (ECC)
- Boot Assist Module (BAM)

Communications I/O System
- eMIOSLite 24 ch.
- 6 FlexCAN
- 3 DSPI
- 4 eSCI
- 4 I²C
- 36 ch. ADC

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Powertrain Solutions

Freescale'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

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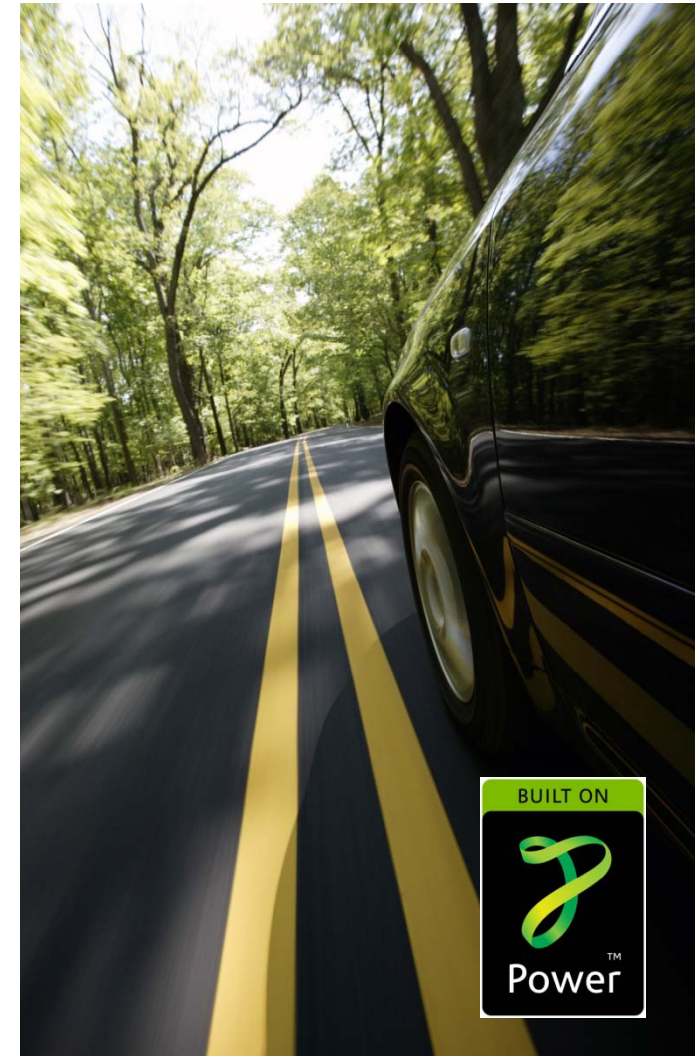
32-Bit Powertrain Overview

same instruction set / memory map / interrupt map / software
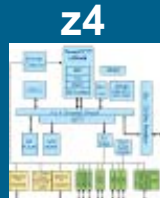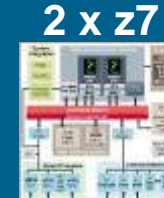
z3	z3	z4	z7	2 x z7
BRIC	*2-4cyl*	*Diesel Gearbox*	*GDI, Diesel*	*Hybrid HCCI*
@64MHz, 512KB	@80Mz, 1.5MB	@150Mz, 2 & 4MB	@264MHz, 4MB	Multi-core (New)

► **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

Powertrain

🌐 Going Green

🟧 **Known Good Die Available**

Available | **In Development**

Gen 3 + JDP

Gen 2

Gen 1

high precision DI

Hybrid

fuel cell

transmission

4cyl, emerging

motorbikes

scooters

Gen 1	Gen 2	Gen 3 + JDP
	Viper	MPC5674F 4M, 264MHz 256k SRAM
	Copperhead	MPC5673F 3M, 264MHz 192k SRAM
Spanish Oak	Taipan	
	Moccasin	
Green Oak	Coral	
Black Oak	Diamondback	MPC5634M 1.5M, 80MHz 94k SRAM
Silver Oak		MPC5633M 1M, 64MHz 64k SRAM
	Sailfish	MPC5632M 768k, 48MHz 48k SRAM
HC11	Hatchfish	

Diesel

GDI

transmission

4cyl emerging

motorbikes

scooters

performance

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MPC5674F: 4 MB Engine Controller with FlexRay™

Power Technology e200z7 superscalar CPU
SPE
MMU

600 DMIPS from 264 MHz core, integrated DSP allowing users to create 'virtual sensors'

4x Dec Fil
64 ch QUAD ADC

Only quadruple ADC on market, with built-in filtering system allows cost reduction of PCB

timed I/O system
eMIOS 32ch.
eTPU 32ch.
6K data 24K code RAM
eTPU 32ch.

Most precise engine timers available, control fuel delivery & improve gas mileage

4MB Flash w/ ECC
256kB SRAM w/ ECC (32kB S/B)

Largest program memory for market space helps with autocoding; zero defect technology on all memories

System integration
VReg
Osc/PLL
Interrupt Controller

Data and Instruction System
BUILT ON Power
e200z7 superscalar CPU
2 x eDMA 64 & 32ch
FlexRay™ Controller

Debug
JTAG
Nexus IEEE ISTO 5001-2003

CROSSBAR SWITCH
Memory Protection Unit

I/O Bridge
SIU

main memory system
4 MB Flash w/ECC
256kB SRAM w/ECC (32kB S/B)

I/O Bridge

EDB development & calibration bus

Boot Assist Module (BAM)

timed I/O system
eMIOS 32ch.
eTPU 32ch.
6kB data 24kB code RAM
eTPU 32ch.

communications
4x FlexCAN
3x eSCI
4x DSPI
4x Dec Fil
64 ch QUAD ADCi

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Cluster/DIS Solutions

Freescale Instrument Cluster Value Proposition

Complete family of solutions from basic to premium line

S08	Basic / LCD Only	S12 S12X	Low End Cluster	Power e200z0	Mid-line Hybrid Cluster	Power e200z4	High-line Hybrid Cluster	i.MX	Fully Reconfigurable Cluster

Up to 40 MHz, 32KB   **Up to 50 MHz, 64-512KB**   **64 MHz, 1-2MB**   **125 MHz, 2MB**   **Up to 800 MHz, 2 GPUs**

►Time to market reduced

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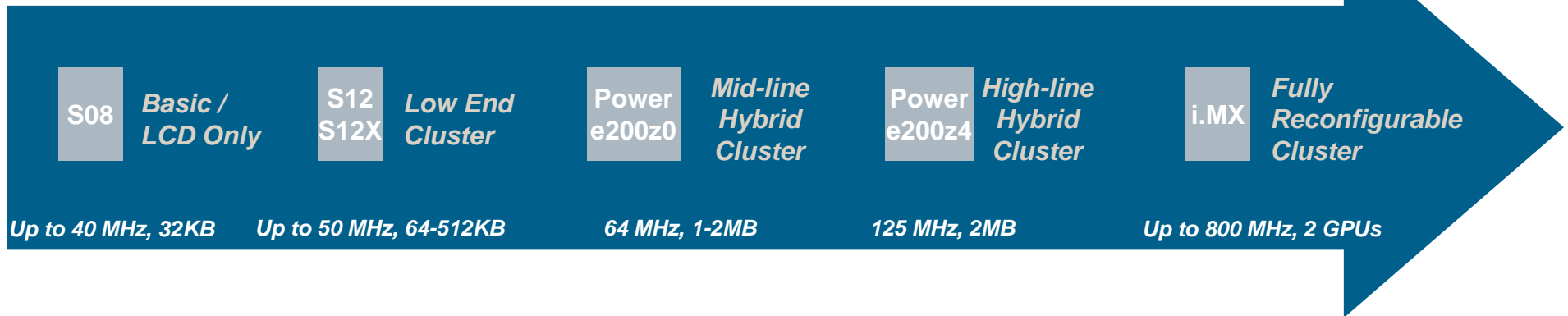- Software enablement package
- Graphics tools and ecosystem
- Industry standard graphics APIs

►Lowest system cost for low- and mid-line

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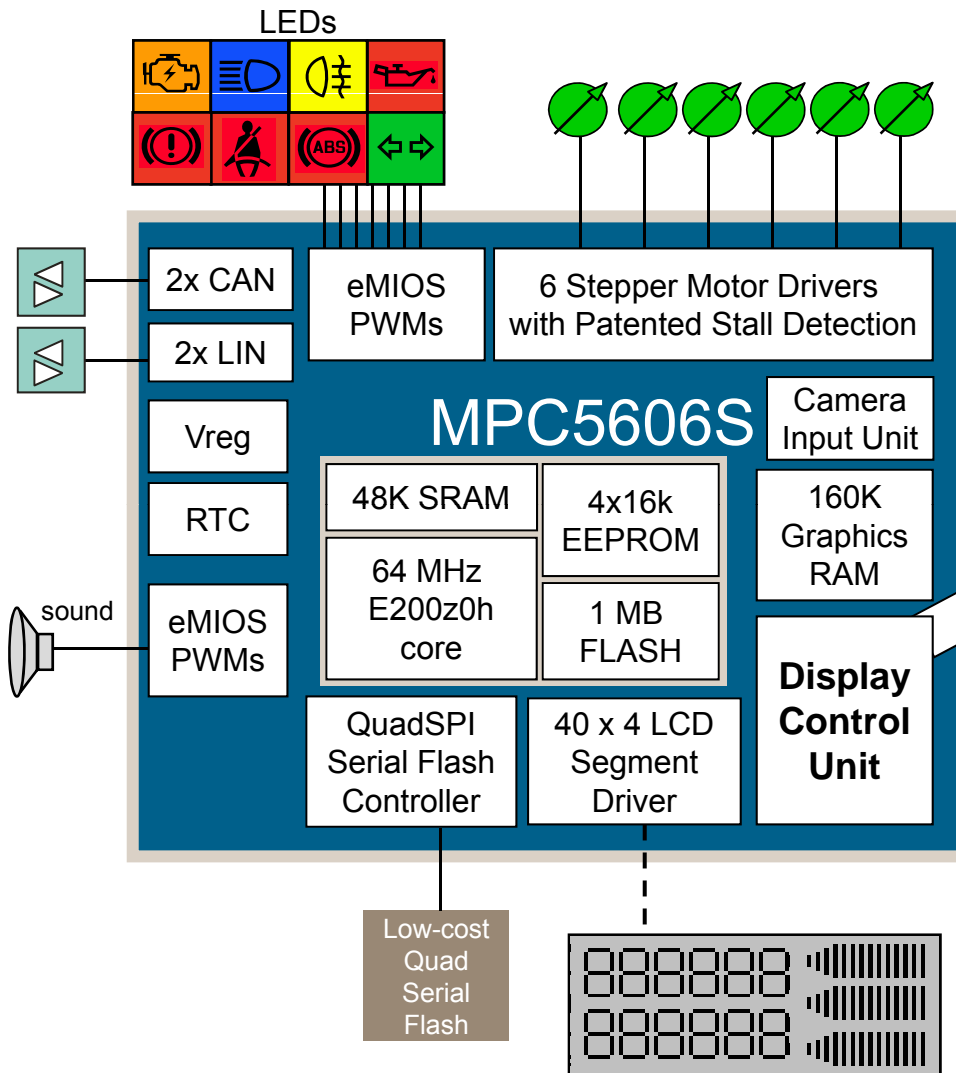- Innovative LCD display controller for lowest possible RAM requirements

►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

Premium Line

Fully
Reconfigurable
Cluster
3D GFX
MPU+GPU

5121e
32-bit MPU, 400MHz
OpenGL-ES 1.1
OpenVG1.0

i.MX51
32-bit MPU, 600MHz
OpenGL|ES 1.1 & 2.0
OpenVG1.1

i.MX53
32-bit MPU, 800MHz
OpenGL|ES1.1 & 2.0
OpenVG1.1

Mid-/high-Line

Gauges +
Hi-Res
Color LCD
2D GFX
Single-chip

MPC560xS
32-bit MCU, 64MHz
6x Stepper Drives
DCU

Low-Line

Gauges +
Low-Res LCD
Single-chip

S12XHZ
16-bit MCU, 40MHz
4x Stepper Drives
Xgate for TFT drive

16-bit MCU, 32MHz
4x Stepper Drives
Segment LCD

S12HZ
16-bit MCU, 20MHz
4x Stepper Drives
Segment LCD

S12HY
16-bit MCU, 32MHz
4x Stepper Drives
Segment LCD

Basic/Motorcycle Clusters

Gauges +
Basic LCD
Single-chip

S08LG32
8-bit MCU
PWMs for Gauges
Segment LCD

Production

Committed

2010

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The MPC5606S Hybrid Cluster SoC:

LEDs

2x CAN

2x LIN

Vreg

RTC

sound

eMIOS PWMs

eMIOS PWMs

6 Stepper Motor Drivers with Patented Stall Detection

MPC5606S

48K SRAM

4x16k EEPROM

64 MHz E200z0h core

1 MB FLASH

Camera Input Unit

160K Graphics RAM

Display Control Unit

QuadSPI Serial Flash Controller

40 x 4 LCD Segment Driver

Low-cost Quad Serial Flash

Tuesday March 15th   16:22   6°C

Freescale st.

ACC
TRIP
NAVI
TEL
ECO

250m

T1 12189,6 km   P R N D Dm   000'2181 km

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

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▶ ## 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

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

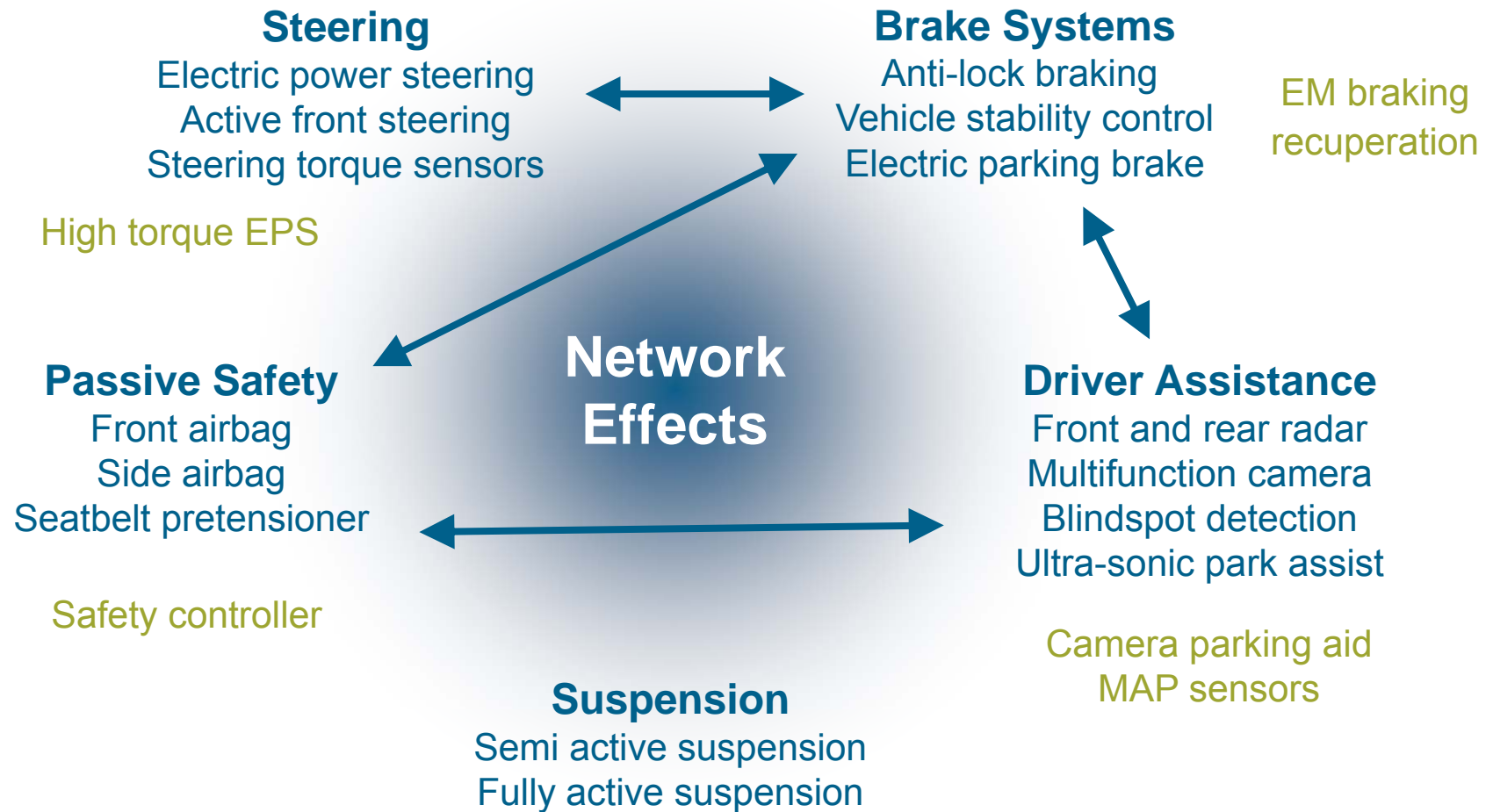**i.MX255**
- WVGA Touchscreen
- Camera

i.MX251
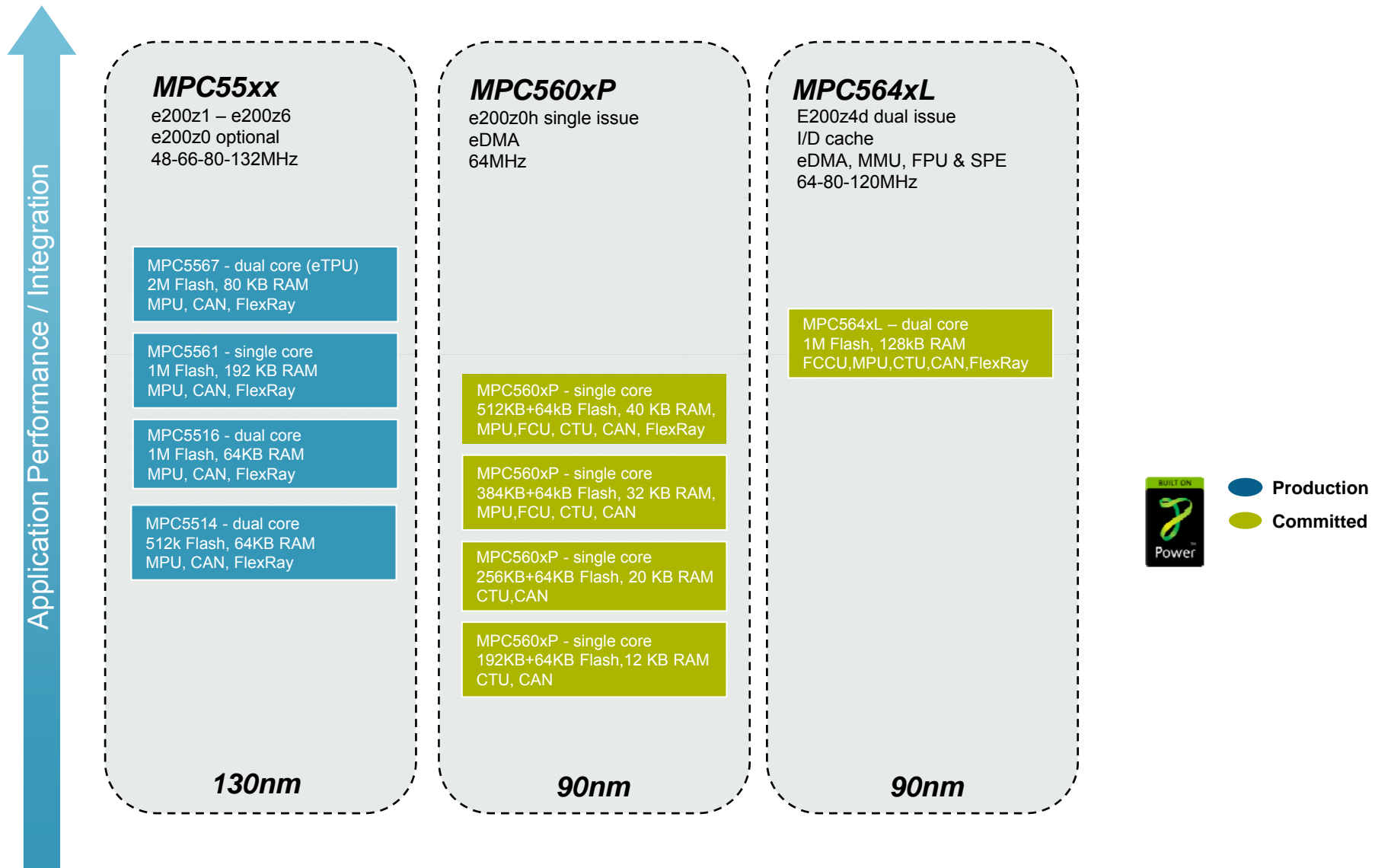- ARM926, 400 MHz
- 2xCAN, Ethernet
- USB Phy, Audio, DDR2

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Safety Solutions

Chassis & Safety Application Space

Steering
Electric power steering
Active front steering
Steering torque sensors

High torque EPS

Brake Systems
Anti-lock braking
Vehicle stability control
Electric parking brake

EM braking recuperation

Network Effects

Passive Safety
Front airbag
Side airbag
Seatbelt pretensioner

Safety controller

Driver Assistance
Front and rear radar
Multifunction camera
Blindspot detection
Ultra-sonic park assist

Camera parking aid
MAP sensors

Suspension
Semi active suspension
Fully active suspension

32-bit MCU Roadmap – Safety Critical Applications

Application Performance / Integration ↑

MPC55xx
e200z1 – e200z6
e200z0 optional
48-66-80-132MHz

> **MPC5567** - dual core (eTPU)
> 2M Flash, 80 KB RAM
> MPU, CAN, FlexRay

> **MPC5561** - single core
> 1M Flash, 192 KB RAM
> MPU, CAN, FlexRay

> **MPC5516** - dual core
> 1M Flash, 64KB RAM
> MPU, CAN, FlexRay

> **MPC5514** - dual core
> 512k Flash, 64KB RAM
> MPU, CAN, FlexRay

130nm

MPC560xP
e200z0h single issue
eDMA
64MHz

> **MPC560xP** - single core
> 512KB+64kB Flash, 40 KB RAM,
> MPU,FCU, CTU, CAN, FlexRay

> **MPC560xP** - single core
> 384KB+64kB Flash, 32 KB RAM,
> MPU,FCU, CTU, CAN

> **MPC560xP** - single core
> 256KB+64KB Flash, 20 KB RAM
> CTU,CAN

> **MPC560xP** - single core
> 192KB+64KB Flash,12 KB RAM
> CTU, CAN

90nm

MPC564xL
E200z4d dual issue
I/D cache
eDMA, MMU, FPU & SPE
64-80-120MHz

> **MPC564xL** – dual core
> 1M Flash, 128kB RAM
> FCCU,MPU,CTU,CAN,FlexRay

90nm

● **Production**
● **Committed**

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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*
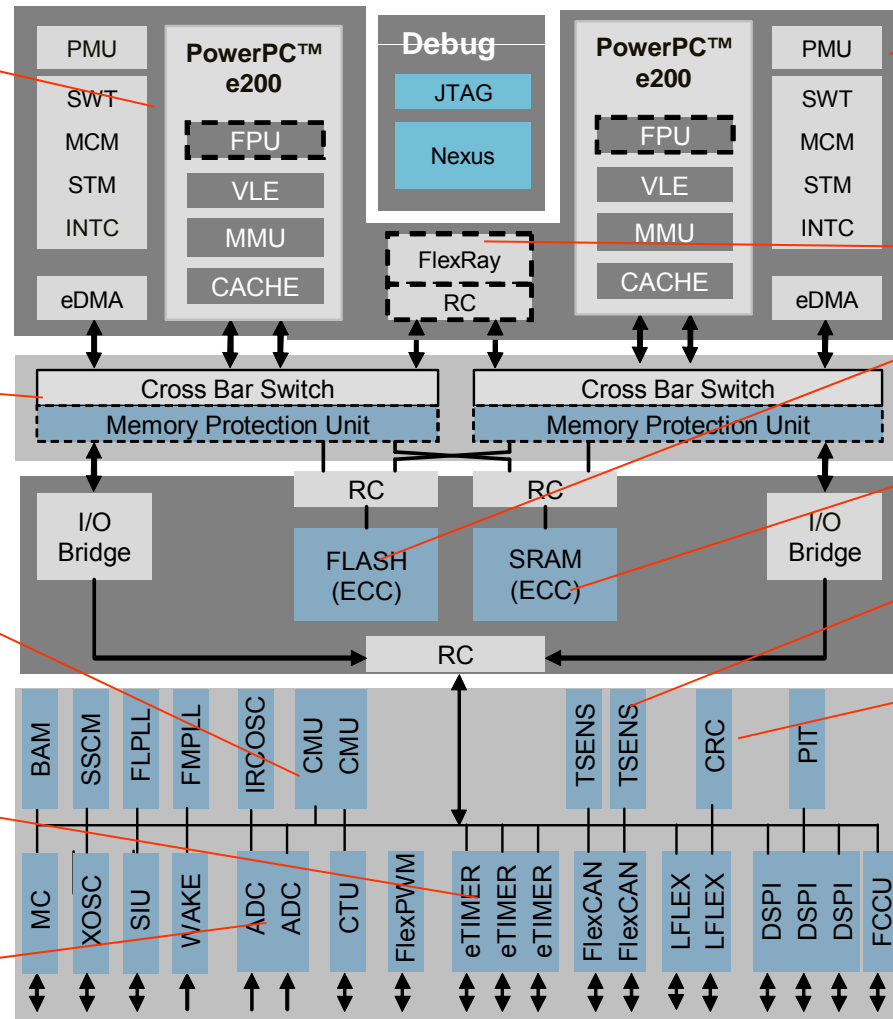- *RC Units at Gates to non redundant sphere*

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™

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

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)

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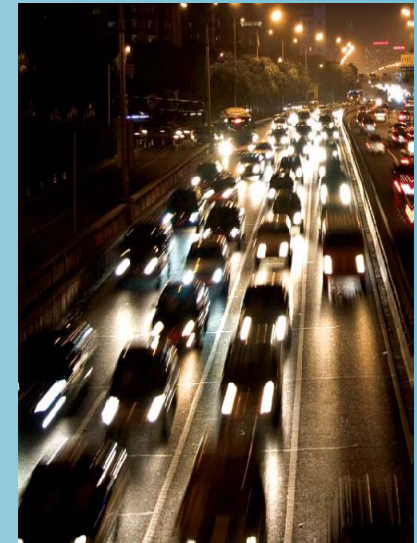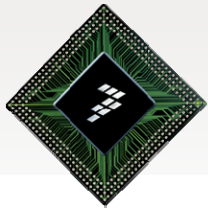
Freescale Product Longevity Program

► 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

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