June 23, 2010

MCU Products for Auto Applications

FTF-AUT-F0814

Brad Loane
Auto MCU Product Manager – Body Electronics
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
Body Solutions
## Body Systems – Applications Overview

<table>
<thead>
<tr>
<th>Driver Comfort</th>
<th>Vehicle Networking</th>
<th>Safety Related</th>
<th>Security</th>
</tr>
</thead>
<tbody>
<tr>
<td>▶ Door Module, Window Lift</td>
<td>▶ Central Body Control</td>
<td>▶ Rain Light Sensor</td>
<td>▶ Immobilizer</td>
</tr>
<tr>
<td>▶ Seat Module</td>
<td>▶ Module</td>
<td>▶ Advanced Front Light</td>
<td>▶ Keyless Entry</td>
</tr>
<tr>
<td>▶ HVAC</td>
<td>▶ Central Gateway</td>
<td>▶ Systems</td>
<td></td>
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<tr>
<td>▶ Electric Roof</td>
<td></td>
<td>▶ Advanced Rear Light</td>
<td></td>
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<tr>
<td>▶ Tailgate</td>
<td></td>
<td>▶ Systems</td>
<td></td>
</tr>
</tbody>
</table>

- **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
# S08/S12 Value Proposition

## Efficient

- 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

## Family Concept

- Strict compatibility within product families
- IP reuse across S08 and S12 families
- Huge population of engineers familiar with these popular architectures

## Reuse

- Integrated port multiplexing enabling hardware and software compatibility between device derivatives and package options

## 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 ...

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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
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

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

**High End Gateways Integrated BCM/GTW**

- MPC5668G
  - 2MB Flash, 592KB RAM
  - FlexRay, Ethernet, MediaLB
  - z6+z0 core
  - 116+MHz

- MPC5607B
  - z0 64MHz
  - 1.5M Flash, 96KB RAM
  - 6 CAN, 10 LIN, 6 SPI
  - 100-176 Pin
  - z0 core
  - 64MHz
  - C90 6LM

- MPC5604B/C
  - z0 64MHz
  - 512KB Flash, 48KB RAM
  - 6 CAN, 4 LIN, 3 SPI
  - 100-176 Pin
  - Low End BCM

**High End BCM**

- MPC5602D
  - z0 48MHz
  - 256K Flash, 16KB RAM
  - 1 CAN, 3 LIN, 2 SPI
  - 64-100 Pin
  - Single CAN node BCMs Door/Seat/Window

**Low End BCM**

- MPC5602D
  - z0 48MHz
  - 256K Flash, 16KB RAM
  - 1 CAN, 3 LIN, 2 SPI
  - 64-100 Pin
  - 32-bit Body Family Product Offering

**Sampling**

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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
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
32-Bit Powertrain Overview

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

- z3
  - BRIC
  - @64MHz, 512KB
- z3
  - 2-4cyl
  - @80Mz, 1.5MB
- z4
  - Diesel Gearbox
  - @150Mz, 2 & 4MB
- z7
  - GDI, Diesel
  - @264MHz, 4MB
- 2 x z7
  - 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

Powertrain

Going Green

Known Good Die Available

Gen 1
- Spanish Oak
- Green Oak
- Black Oak
- Silver Oak

Gen 2
- Viper
- Copperhead
- Taipan
- Moccasin
- Coral
- Diamondback

Gen 3 + JDP
- 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

Diesel

GDI

transmission

4cyl emerging

motorbikes

scooters
MPC5674F: 4 MB Engine Controller with FlexRay™

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

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

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

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
- 2 x eDMA 64 & 32ch
- e200z7 superscalar CPU
- FlexRay™ Controller

CROSSBAR SWITCH
- Memory Protection Unit
- 2 x eDMA 64 & 32ch
- 64 ch QUAD ADC
- Interrupt Controller

Power Technology
- e200z7 superscalar CPU
- SPE
- MMU

6x Dec Fil
4x Dec Fil

Timed I/O system
- eMOS 32ch.
- eTPU 32ch.
- eTPU 32ch.
- eTPU 32ch.

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

4x FlexCAN
3x eSCI
4x DSPI
4x Dec Fil

64 ch QUAD ADC

Debug
- JTAG
- Nexus IEEE ISTO 5001-2003

EDB development & calibration bus

Boot Assist Module (BAM)

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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
  - Up to 40 MHz, 32KB

- **S12**: Mid-line
  - Up to 50 MHz, 64-512KB

- **S12X**: Low End Cluster
  - 64 MHz, 1-2MB

- **Power e200z0**: Hybrid Cluster
  - 125 MHz, 2MB

- **Power e200z4**: High-line Hybrid Cluster
  - Up to 800 MHz, 2 GPUs

- **iMX**: Fully Reconfigurable Cluster

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

Low-Line
- Gauges + Low-Res LCD
  - Single-chip
  - 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

2010
The MPC5606S Hybrid Cluster SoC:

- LEDs
- 2x CAN
- 2x LIN
- Vreg
- RTC
- 6 Stepper Motor Drivers with Patented Stall Detection
- Camera Input Unit
- 160K Graphics RAM
- Display Control Unit
- QuadSPI Serial Flash Controller
- 40 x 4 LCD Segment Driver
- 48K SRAM
- 64 MHz E200z0h core
- 4x16k EEPROM
- 1 MB FLASH
- Low-cost Quad Serial Flash

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**
- Cortex A8, 600 MHz
- OpenGL ES 2.0
- OpenVG 1.1
- mDDR/DDDR2 200
- USB Phy

**i.MX514**
- 720p Video Dec

**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

**Steering**
- Electric power steering
- Active front steering
- Steering torque sensors

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

**EM braking recuperation**

**Passive Safety**
- Front airbag
- Side airbag
- Seatbelt pretensioner

**Suspension**
- Semi active suspension
- Fully active suspension

**Network Effects**

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

**Camera parking aid**
- MAP sensors

**Safety controller**
# 32-bit MCU Roadmap – Safety Critical Applications

<table>
<thead>
<tr>
<th>MPC55xx</th>
<th>MPC560xP</th>
<th>MPC564xL</th>
</tr>
</thead>
<tbody>
<tr>
<td>e200z1 – e200z6</td>
<td>e200z0h single issue</td>
<td>E200z4d dual issue</td>
</tr>
<tr>
<td>e200z0 optional</td>
<td>eDMA</td>
<td>I/D cache</td>
</tr>
<tr>
<td>48-66-80-132MHz</td>
<td>64MHz</td>
<td>eDMA, MMU, FPU &amp; SPE</td>
</tr>
<tr>
<td></td>
<td></td>
<td>64-80-120MHz</td>
</tr>
<tr>
<td>MPC5567 - dual core</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2M Flash, 80 KB RAM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MPU, CAN, FlexRay</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MPC5561 - single core</td>
<td></td>
<td></td>
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<tr>
<td>1M Flash, 192 KB RAM</td>
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<td></td>
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<tr>
<td>MPU, CAN, FlexRay</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MPC5516 - dual core</td>
<td></td>
<td></td>
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<tr>
<td>1M Flash, 64K RAM</td>
<td></td>
<td></td>
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<tr>
<td>MPU, CAN, FlexRay</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MPC5514 - dual core</td>
<td></td>
<td></td>
</tr>
<tr>
<td>512k Flash, 64KB RAM</td>
<td></td>
<td></td>
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<tr>
<td>MPU, CAN, FlexRay</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>MPC560xP</th>
<th>MPC564xL</th>
</tr>
</thead>
<tbody>
<tr>
<td>single core</td>
<td>dual core</td>
</tr>
<tr>
<td>512KB+64kB Flash, 40 KB RAM,</td>
<td>1M Flash, 128KB RAM</td>
</tr>
<tr>
<td>MPU, FCU, CTU, CAN</td>
<td></td>
</tr>
<tr>
<td>MPC560xP</td>
<td></td>
</tr>
<tr>
<td>single core</td>
<td></td>
</tr>
<tr>
<td>384KB+64kB Flash, 32 KB RAM,</td>
<td></td>
</tr>
<tr>
<td>MPU, FCU, CTU, CAN</td>
<td></td>
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<tr>
<td>MPC560xP</td>
<td></td>
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<tr>
<td>single core</td>
<td></td>
</tr>
<tr>
<td>256KB+64kB Flash, 20 KB RAM,</td>
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<tr>
<td>CTU, CAN</td>
<td></td>
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<tr>
<td>MPC560xP</td>
<td></td>
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<tr>
<td>single core</td>
<td></td>
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<tr>
<td>192KB+64KB Flash, 12 KB RAM,</td>
<td></td>
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<tr>
<td>CTU, CAN</td>
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</tbody>
</table>

**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**
- ECC

**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

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

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

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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)