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
Freescale Automotive MCU/MPU Cores

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

**Performance/Features**
- **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

**Telematics & Infotainment**
- Navigation
- High-performance DIS
Body Solutions
Body Systems – Applications Overview

**Driver Comfort**
- Door Module, Window Lift
- Seat Module
- HVAC
- Electric Roof
- Tailgate

**Vehicle Networking**
- Central Body Control Module
- Central Gateway

**Safety Related**
- Rain Light Sensor
- Advanced Front Light Systems
- Advanced Rear Light Systems

**Security**
- 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
Body Roadmap

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

- 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

<table>
<thead>
<tr>
<th>Feature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single wire background debug module with trace</td>
</tr>
<tr>
<td>Mature and optimized CodeWarrior compiler suite including software templates</td>
</tr>
</tbody>
</table>

### Smart IP

<table>
<thead>
<tr>
<th>Feature</th>
</tr>
</thead>
<tbody>
<tr>
<td>CISC architecture offers best in class code density and RAM utilization</td>
</tr>
<tr>
<td>Embedded EEPROM</td>
</tr>
<tr>
<td>I/O w/ slew rate, drive strength and pull-up/downs</td>
</tr>
<tr>
<td>XGATE …</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Feature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integrated port multiplexing enabling hardware and software compatibility between device derivatives and package options</td>
</tr>
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</table>
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
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

S12X The Market Leader

<table>
<thead>
<tr>
<th>Year</th>
<th>Millions units shipped (S12/S12X)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td></td>
</tr>
<tr>
<td>2007</td>
<td></td>
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<tr>
<td>2006</td>
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<td>2005</td>
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<td>2004</td>
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<td>2003</td>
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</table>

Freescale continues to set the standard in 16-bit innovations

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### 32-bit Body Family Value Proposition

<table>
<thead>
<tr>
<th><strong>Scalability</strong></th>
<th><strong>Low-power</strong></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>
</tbody>
</table>

### Power Architecture
- Crossbar architecture to increase data throughput
- Dual core options
- Strong ecosystem

### 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

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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
- Low End BCM
  - MPC5604B/C
    - z0 64MHz
    - 512KB Flash, 48KB RAM
    - 6 CAN, 4 LIN, 3 SPI
    - 100-144 Pin
- 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
  - MPC5602D
  - z0 48MHz
  - 256K Flash, 16KB RAM
  - 1 CAN, 3 LIN, 2 SPI
  - 64-100 Pin
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

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

Crossbar Masters
- SWT
- e200z6 Core
- FPU/SPE
- VLE
- MMU
- 32k Cache
- e200z0 Core
- VLE

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

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

Communications
- I/O System

- eMIOSLite
  - 24 ch.
- 6 FlexCAN
- 3 DSPi
- 4 eSCI
- 4 I^2C
- 36 ch. ADC

Boot Assist Module (BAM)

Crossbar Slaves

- 2 M Byte Flash
- Data Flash
- I/O Bridge
- 512 KByte SRAM (ECC)
- 80 KByte SRAM (ECC)
- Standby RAM

- FlexRay™
- MLB
- DIM

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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
32-Bit Powertrain Overview

same instruction set / memory map / interrupt map / software

- **z3**
  - BRIC
  - @64MHz, 512KB
  - Diesel

- **z3**
  - 2-4cyl
  - @80Mz, 1.5MB

- **z4**
  - Diesel Gearbox
  - @150Mz, 2 & 4MB

- **z7**
  - GDI, Diesel
  - @264MHz, 4MB

- **2 x z7**
  - 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
**MPC5674F: 4 MB Engine Controller with FlexRay™**

- **System integration**
  - VReg
  - Osc/PLL
  - Interrupt Controller
- **Data and Instruction System**
  - 2 x eDMA
  - 64 & 32ch
- **FlexRay™ Controller**
  - 64 ch

**Debug**
- JTAG
- Nexus
- IEEE
- ISTO
- 5001-2003

**Power Technology**
- e200z7 superscalar CPU
- SPE
- MMU

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

- **Debug**
  - JTAG

- **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**

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Cluster/DIS Solutions
Freescale Instrument Cluster Value Proposition

Complete family of solutions from basic to premium line

- Basic / LCD Only
- Low End Cluster
- Mid-line Hybrid Cluster
- High-line Hybrid Cluster
- Fully Reconfigurable Cluster

- S08
- S12
- S12X
- Power e200z0
- Power e200z4
- LMX

- 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

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

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
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

Low-Line

Gauges + Low-Res LCD Single-chip

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

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

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The MPC5606S Hybrid Cluster SoC:

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

**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
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/DDR2 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

**Audio Connectivity**
- GUI Support
- Bluetooth Hands-free, A2DP

**i.MX351**
- ARM1136, 532 MHz
- 2xCAN, MLB, Audio
- DDR2, USB Phy x2

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

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

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Safety Solutions
### 32-bit MCU Roadmap – Safety Critical Applications

<table>
<thead>
<tr>
<th>Model</th>
<th>Tech.</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>MPC55xx</td>
<td>90nm</td>
<td>e200z1 – e200z6, e200z0 optional 48-66-80-132MHz</td>
</tr>
<tr>
<td></td>
<td></td>
<td>MPC5567 - dual core (eTPU) 2M Flash, 80 KB RAM MPU, CAN, FlexRay</td>
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<tr>
<td></td>
<td></td>
<td>MPC5561 - single core 1M Flash, 192 KB RAM MPU, CAN, FlexRay</td>
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<tr>
<td></td>
<td></td>
<td>MPC5516 - dual core 1M Flash, 64KB RAM MPU, CAN, FlexRay</td>
</tr>
<tr>
<td></td>
<td></td>
<td>MPC5514 - dual core 512k Flash, 64KB RAM MPU, CAN, FlexRay</td>
</tr>
<tr>
<td></td>
<td>130nm</td>
<td>MPC5560xP - single core 512KB+64kB Flash, 40 KB RAM, MPU,FCU, CTU, CAN, FlexRay</td>
</tr>
<tr>
<td></td>
<td></td>
<td>MPC560xP - single core 384KB+64kB Flash, 32 KB RAM, MPU,FCU, CTU, CAN</td>
</tr>
<tr>
<td></td>
<td></td>
<td>MPC560xP - single core 256KB+64kB Flash, 20 KB RAM CTU, CAN</td>
</tr>
<tr>
<td></td>
<td></td>
<td>MPC560xP - single core 192KB+64kB Flash, 12 KB RAM CTU, CAN</td>
</tr>
<tr>
<td>MPC5561</td>
<td></td>
<td>1M Flash, 64KB RAM MPU, CAN, FlexRay</td>
</tr>
<tr>
<td>MPC564xL</td>
<td>90nm</td>
<td>E200z4d dual issue I/D cache eDMA, MMU, FPU &amp; SPE 64-80-120MHz</td>
</tr>
<tr>
<td></td>
<td></td>
<td>MPC564xL – dual core 1M Flash, 128kB RAM FCCU,MPU,CTU,CAN,FlexRay</td>
</tr>
</tbody>
</table>

**Technology Nodes:**
- 130nm
- 90nm

**Production and Committed:**
- 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

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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