# Automotive Microcontrollers
## based on ARM® Cortex®-M Cores

EUF-ACC-T1574

Nik Croudace | EMEA AMPG Technical Marketing

J U N E . 2 0 1 5



External Use

# Automotive MCUs

## Our Direction

### Industry & Customer Trends

- A **cleaner** world of low emissions and electrified vehicles
- **Autonomously** driven vehicles with advanced active safety
- The **connected** car, part of the global IoT while remaining safe & secure
- **Mobility** for all, growth in emerging nations, with fast to market advanced solutions

### How We Will Meet These Needs

- Powertrain control solutions with integrated motor control and advanced signal processing for the latest hybrid and electric vehicle systems
- Market-leading **SafeAssure** architecture developments for radar, camera and data fusion applications
- Introducing the most advanced **vehicle networking processors** with safety and security architectures integrating the latest encryption and secure vehicle networking protocols
- New hyper-integration **mixed-signal MCUs** for fast time to market. Local applications and solutions labs and low-cost tools to get the new world moving


Powertrain & Hybrid

Advanced Safety

Vehicle Networking

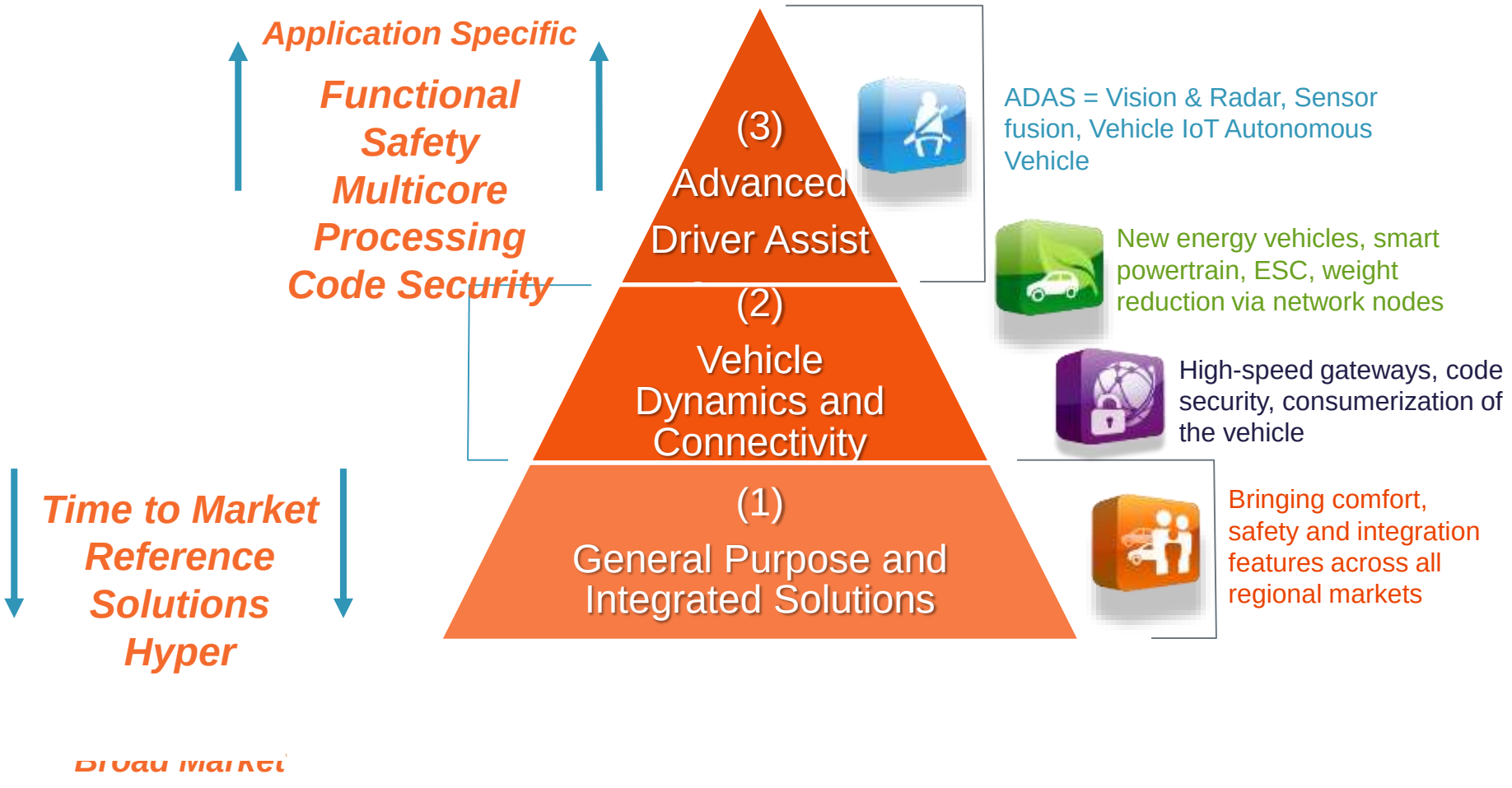
Mobility for All



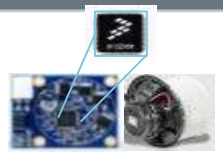
freescale S32 Automotive Processors

SAFE ASSURE by Freescale

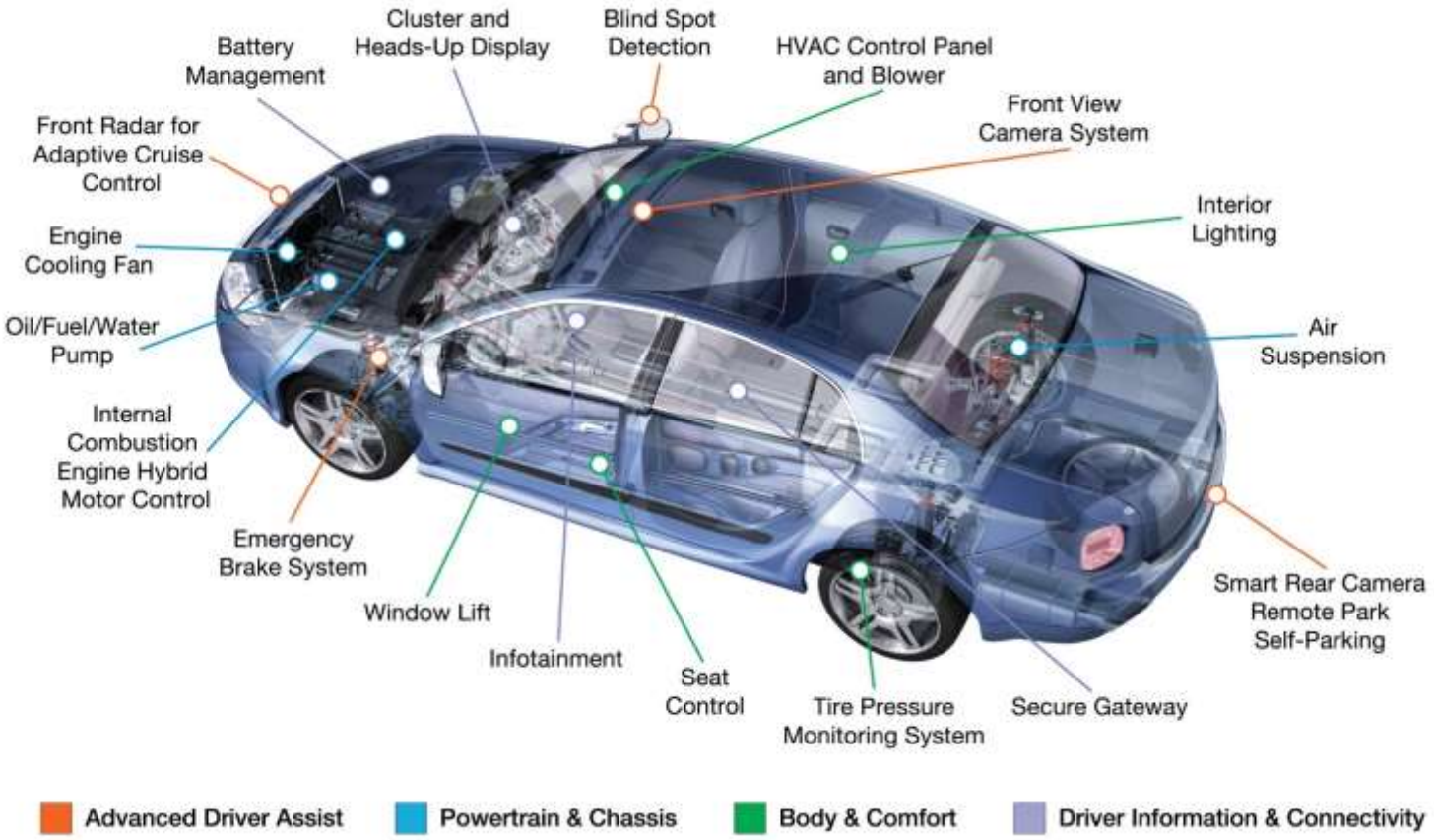
# Automotive Product Lines & Global Megatrends



# Freescale Automotive MCU Focus

| Safer & Autonomous Travel | | A Greener World | Secure Connectivity | Mobility for Everyone | |
|---|---|---|---|---|---|
| Advanced Driver Assistance | | Powertrain | Vehicle Connectivity | Driver Information | Broad Market |
|  |  |  | CAN lin FlexRay Wi Fi Ethernet |  |  |
| Radar | Vision/Fusion | Engine & Motor Control | Advanced Vehicle Networking | Instrument Cluster/ Infotainment | Body & General |
| **Panther/S32R** | **Monitor/S32V** | **Mamba/Cobra/S32P** | **Bolero/Calypso/S32G** | **i.MX** | **S12/KEA/MagniV/S32K** |
| Advanced safety MCU's with integrated high-performance analog and DSP | Multicore MCU with advanced image processing and SW enablement cognivue | Quad-core safety MCUs with advanced timer and instrumentation systems | Advanced MCU with integrated hardware security for high-performance vehicle connectivity | Multicore MCU's with advanced multimedia features and extensive OS support | Broad General Purpose ARM Cortex Solutions and MagniV Analog and power integration for easy solution development. |

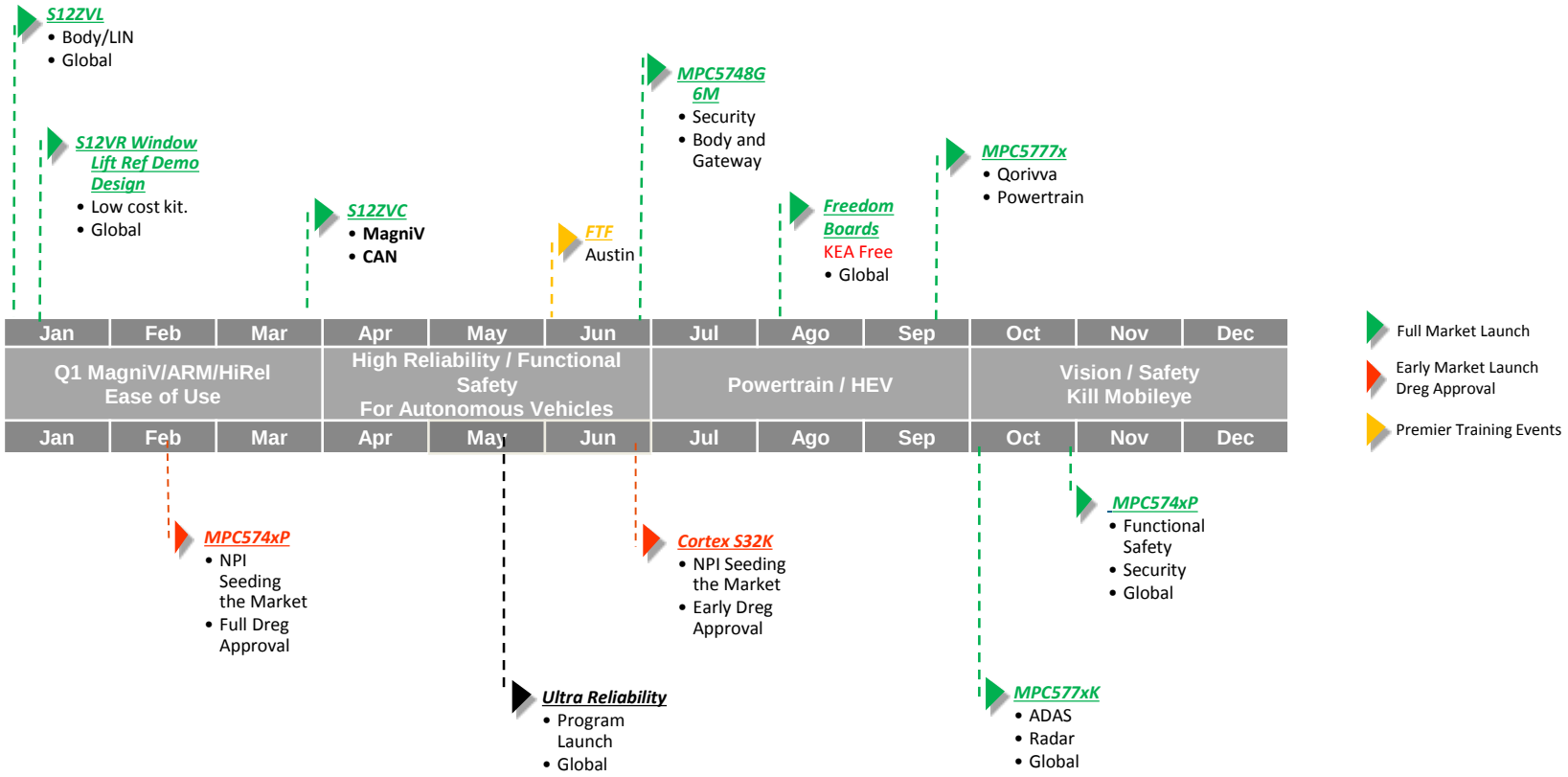
# Where you see Freescale…



# S32K100 Reuse guidelines (3)

Automotive MCUs New Product Introductions

# 2015 Automotive Launch & Activates



# S32K100 Reuse guidelines (3)

Product Introduction - MPC57xx

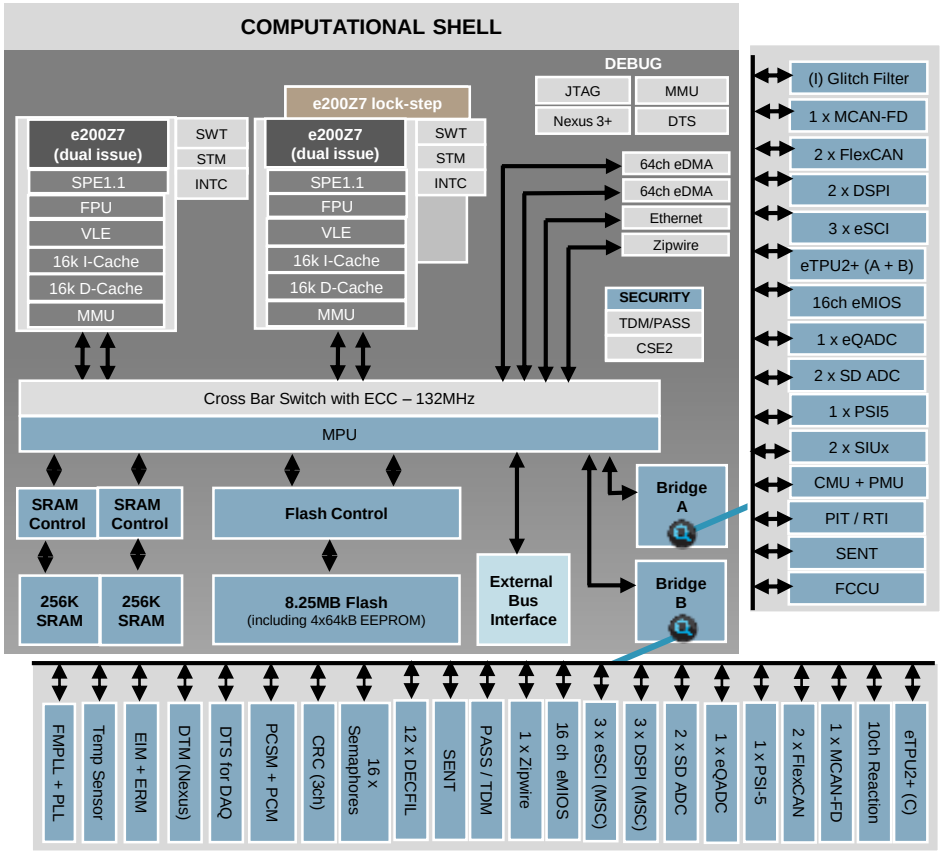
# MPC5777C Block Diagram (Powertrain)

**Cores & Memory**

- Two independent z7 dual issue computational cores @ 264MHz
  - Cores include VLE, SPE1.1, FPU , MMU
  - 16kB i-cache & 16kB data-cache w/ coherency
- Single z7 lockstep core @ 264MHz (for ISO26262 and ASIL-D)
- Up to 8.25MB Flash RWW w/ ECC including 4 x 64kB EEPROM
- Up to 589kB total SRAM
  - 512kB on chip static RAM w/ECC (up to 48KB standby)
  - 45kB eTPU RAM , 32kB data cache (w/line locking)
- Security
  - PASS and TDM (Tamper Detection)
  - CSE2 (Crypto Services Engine for Encryption & Secure Boot)

**I/O & System**

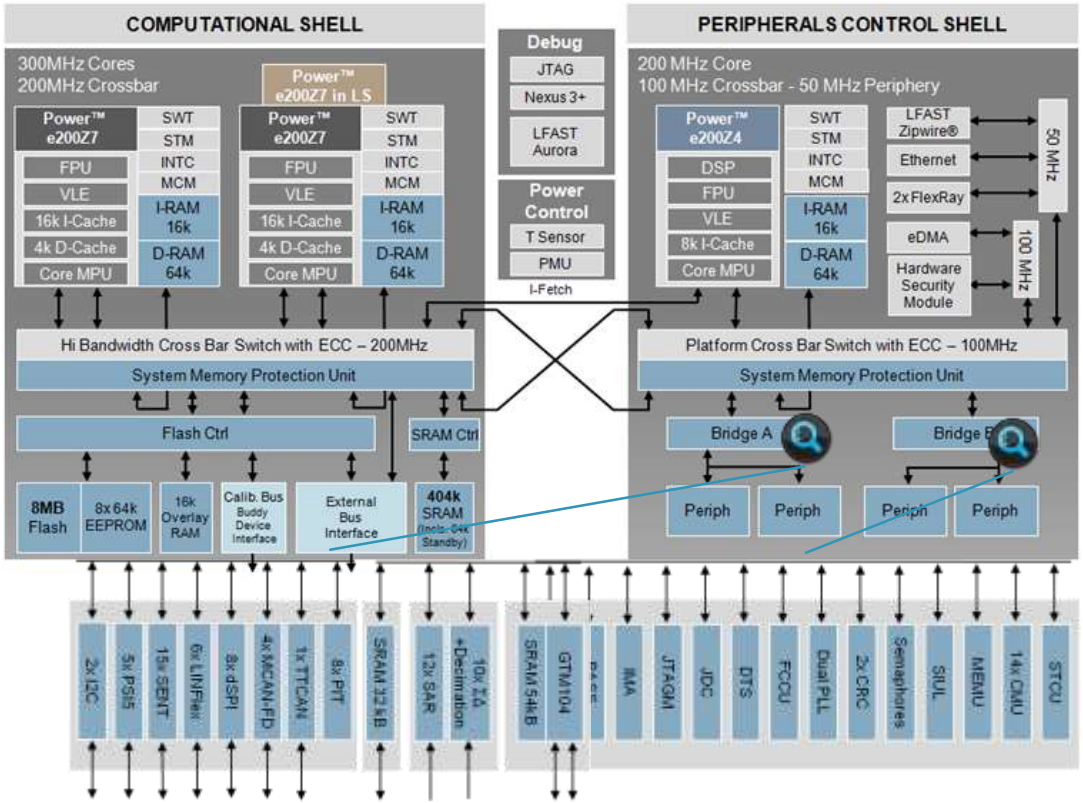
- Up to 70ch eQADC from 4 converters w/12bit resolution
  - On-chip temperature sensor and VGA (x1,x2,x4)
  - 12 x Decimation Filters w/ hardware knock integrators
- 20ch ΣΔ ADC (4 converters w/16bit resolution)
- Timers – up to 128 channels (96ch eTPU2+ and 32ch eMIOS)
- 2 x 64ch eDMA support (128ch total)
- 6 x CAN ports (4 x FlexCAN + 2 x MCAN with Flexible Datarate)
- Ethernet
- DSPI – 5 channels (2 supporting µSec ch.)
- eSCI – 6 channels (2 supporting uSec ch.)
- Reaction module – 10 channels for current control
- Up to 12ch SENT, Zipwire, 2ch PSI-5
- 1 x CRC unit – w/ 3 independent channels,
- 4 x protected port outputs, MPU and MMU
- FMPLL + PLL
- Safety Monitors – e2eECC, CLK, Voltage, Fault Collection



# MPC5777M Block Diagram (Powertrain)

**Key Functional Characteristics**

- Two independent 300 MHz Power Architecture z7 computational cores
  - Single 300 MHz Power Architecture z7 core in delayed lockstep for ASIL-D safety
- Single I/O 200 MHz Power Architecture z4 core
- eDMA controller – 128 channels
- 8M Flash with ECC
- 596k total SRAM with ECC
  - 404k of system RAM (incls. 64k standby)
  - 192k of tightly coupled data RAM
- 10 ΣΔ & 12 SAR converters – 84 channels
- Ethernet (MII/RMII)
- DSPI – 8 channels (3 supporting µSec ch.)
- LINFlex - 6 channels (3 supporting µSec ch.)
- MCAN-FD/TTCAN – 4x modules/1x module
- GTM – 248 timer channels




**Key Electrical Characteristics**

- -40 to +125 °C (ambient)
- 165 °C junction for KGD
- 1.26V Vdd, 5.0V I/O, 5V ADC

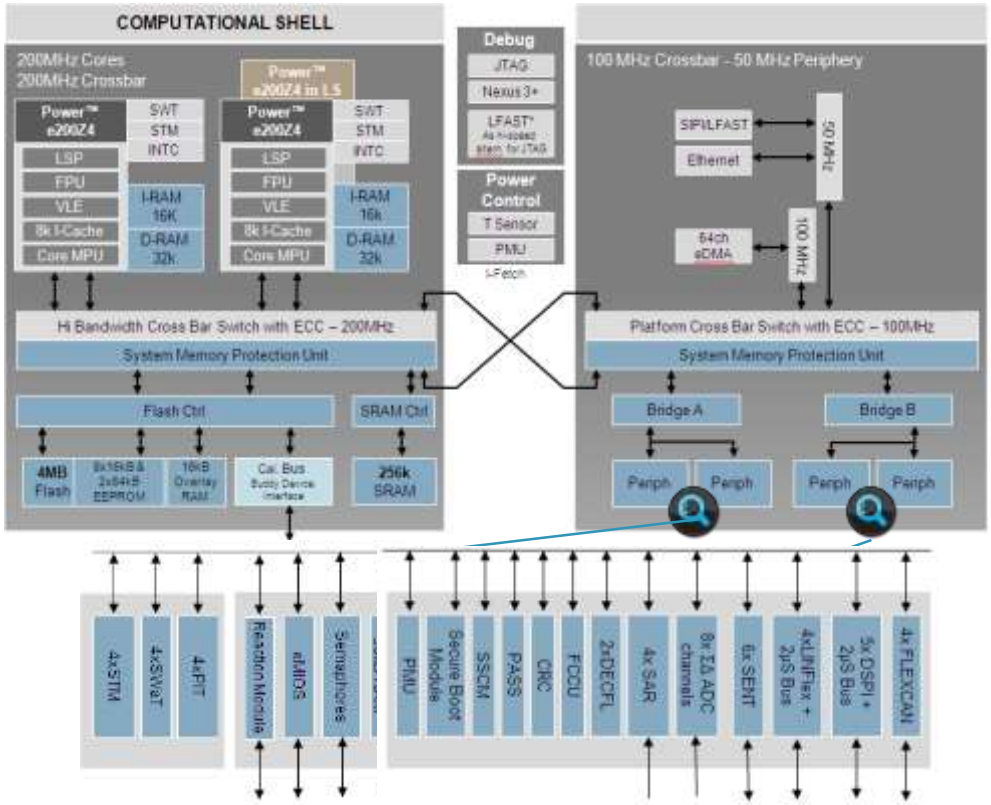
**Package**

- 292 PBGA, 416 PBGA, 512 PBGA
- eCal emulation device for each package

# MPC5746R Block Diagram (Powertrain)

**Key Functional Characteristics**

- Two independent 200 MHz Power Architecture z4 computational cores
  - Single 200 MHz Power Architecture z4 in lockstep
- 4M Flash with ECC
- 320k total SRAM with ECC
  - 256k of system RAM (incls. 32k of standby RAM)
  - 64k of tightly coupled data RAM
- 8 ΣΔ ADC channels, 4 SAR converters
- 50 total ADC channels
- Ethernet MII-lite
- 2 eTPU2+ timers – 64 channels
- 1 eMIOS – 32 channels
- Reaction module – 10 channels
- eDMA controller – 64 channels




**Key Electrical Characteristics**

- Up to 200 MHz operation
- -40 to +125 °C (ambient)
- Single 5v power supply

**Package**

- 176 LQFP, 252 BGA
- 292 BGA eCal package (incls. RAM buddy chip) for emulation/debug
- *LFAST available only on eCAL package

# Todays Demands Integrated Body Control/Gateway

- **Performance through Multicore**
  - Up to three e200 cores built on Power Architecture technology, with up to 160 MHz performance allows for easy division of tasks in an integrated BCM/gateway system
- **Most Diverse Set of Networking Communication**
  - Ethernet with AVB support, FlexRay™, MLB, USB, up to eight CAN with CAN-FD Flexible Data Rate up to 18 LIN, SDIO interface, $I^2S$ all supported on a single-chip solution
- **Flexible Memory Options**
  - Up to 6 MB Flash and 768 KB of embedded SRAM provide suitable storage to maintain the local BCM/gateway application functionality, handle message buffering, and also store additional Flash images for other nodes in the vehicle
- **New Low-Power Unit**
  - Allows for increased functionality in a lower power state, reducing current consumption by over 30% for a typical cyclic wake-up application over previous generation devices
  - Provides a mechanism to bypass entire platform while supporting a smaller set of peripherals (1x CAN, LIN, SPI, ADC, timer, etc.) thereby providing very low power execution modes
- **Analog Comparator**
  - Typical periodic monitoring routines can be fully handled in Standby mode offering a significant improvement in power consumption
- **Pretended Networking Support**
  - Enabled through advanced filtering, wakeup capabilities and CAN availability in low power modes

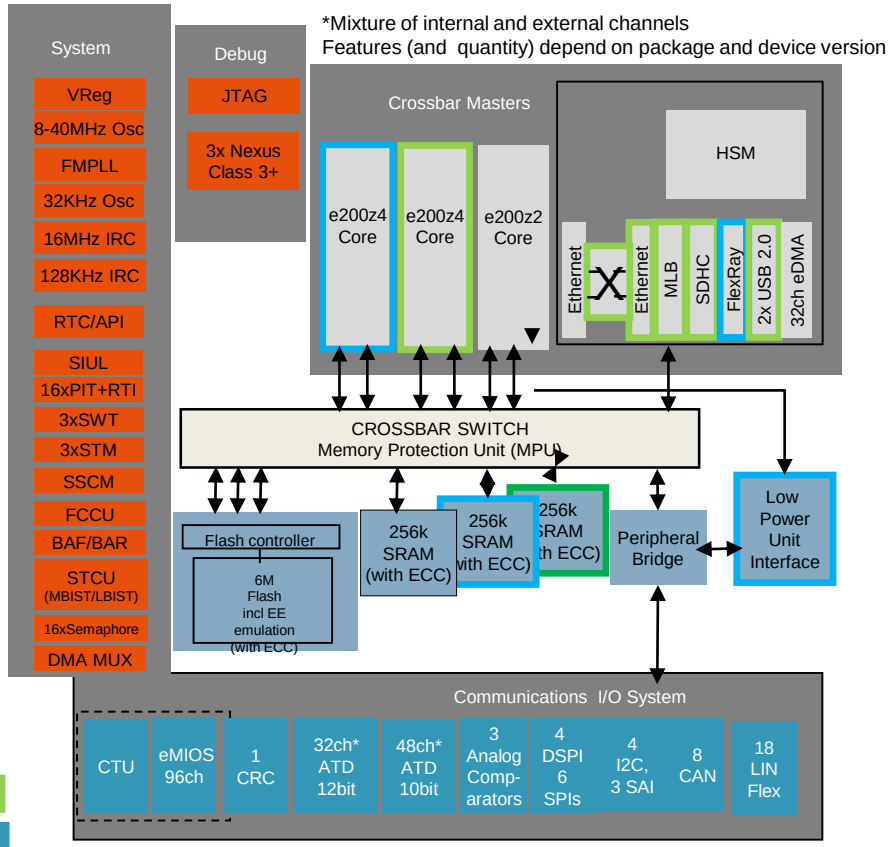
# MPC574xB/D/C/G – Family for High End Gateway/BCM Solution

## Key Characteristics:

- 2x e200z4 + 1x z2 cores, FPU on z4 cores
- 160 MHz max for z4s and 80 MHz on z2
- HSM SecuFamily rity Module option supports both SHE and EVITA low/medium standard
- Media Local Bus supports MOST communication
- 2 x USB 2.0 (1 OTG and 1 Host module) support interfacing to 3G modem and infotainment domain
- 2x Ethernet 10/100 Mbps RMII, MII, +1588, AVB
- Ethernet switch
- CAN module optionally supports CAN FD
- SDHC provides standard SDIO interface
- Low Power Unit provides reduced CAN, LIN, SPI, ADC functionality in low power mode
- Designed to ISO26262 process for use in ASIL B
- -40 to +125C (ambient)
- 3.0V to 5.5V

## Packages:

- 100LQFP, 176 LQFP, 256 BGA, 324 BGA




-C and -G | -G only

| SPC574 | 45/46D | 45B/46B | 45C-48C 46D | 44G-48G |
|---|---|---|---|---|
| Cores | 1 | 1 | 2 | 3 |
| Flash | 2-3M | 2-3M | 2-6M | 3-6M |
| RAM | -384k | -384k | -768k | -768k |
| Eth/FR/ML /SD/USB | 1/0/0/0/0 | 0/1/0/0/0 | 1/1/0/0/0 | 1/1/1/1/2 2/1/1/1/2 |

freescale™

freescale S32 Automotive Processors

SAFE ASSURE™ by Freescale

# Calypso Family Look-up table

| Flash/RAM | Package | | | |
|---|---|---|---|---|
| | 100MAPBGA (11x11mm, 1mm) | 176LQFP-EP (24x24mm, 0.5mm) | 256MAPBGA (17x17mm, 1mm) | 324MAPBGA (19x19mm, 1mm) |
| 6M/768k | | SPC5748G | SPC5748G | SPC5748G |
| 6M/768k | | SPC5748C | SPC5748C | SPC5748C |
| 4M/512k | | SPC5747G | SPC5747G | SPC5747G |
| 4M/768k | | SPC5747C | SPC5747C | SPC5747C |
| 3M/768k | | SPC5746G | SPC5746G | SPC5746G |
| 3M/384k (512k optional) | SPC5746C | SPC5746C | SPC5746C | PPC5746C |
| 3M/384k (512k optional) | SPC5746D | SPC5746D | SPC5746D | |
| 3M/384k (512k optional) | SPC5746B | SPC5746B | SPC5746B | |
| 2M/256k | SPC5745C | SPC5745C | SPC5745C | |
| 2M/256k | SPC5745D | SPC5745D | SPC5745D | |
| 2M/256k | SPC5745B | SPC5745B | SPC5745B | |

Colour Coding:

- Triple Core, Ethernet, FR, USB, SDHC, (optional HSM, 2nd Ethernet + switch)
- Dual Core, Ethernet, FR (optional HSM, 2nd Ethernet + switch)
- Single Core, Ethernet, (optional HSM)
- Single Core, FR, (optional HSM)
- Debug device for SPC5745B/C/D and SPC5746B/C/D - not for production

# SPC574xP Introduction

## Key Technical Characteristics

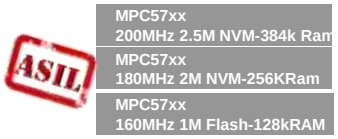
- Dual Core Qorivva up to 200MHz with Local memory (64KB)
- 1M > 2.5 MB Embedded Flash with EE emulation – up to 384KB SRAM
- Delayed lock-step architecture for ASIL-D
- Developed according to ISO26262 Standard
- Option for Extended temperature up to 165C Tj

## Integration and Peripherals

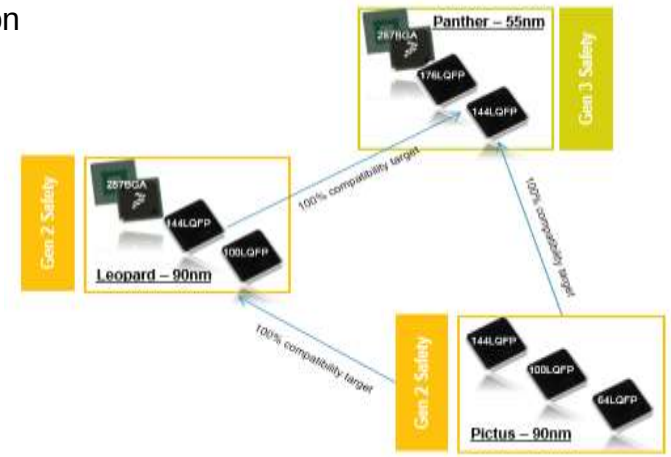
- Maximum compatibility to MPC5643L (pin compatible in 144LQFP)
- Supporting up to 2 motors (4 SAR A/D 1Msample)
- Inter-processor high speed serial I/F (SIPI) – Up to 300Mbaud
- New Sensor I/F: SENT for Chassis
- Ethernet 10/100
- 4x multi-chip DSPI for ASIC communication

## Package: LQFP with option for MAPBGA

- 144LQFP, 257 MAPBGA




**MPC57xx**
- Up to 200MHz
- Dual Core – LS only
- Functional Safety –Asil D
- Up to 2.5M flash
- Up to 384k SRAM
- 144-176EP-QFP & 257BGA




**Strong Intra Node scalability & Compatibility**
- Pin Level
- Source/Binary level
- Package Continuum

**100% pin-compatibility target between 144LQFP (Leopard to Panther and Pictus.**

- Recompilation will be required (new features, new safety concept & new IPs)

- AUTOSAR availability on Leopard/Panther plus same periphery for easier migration

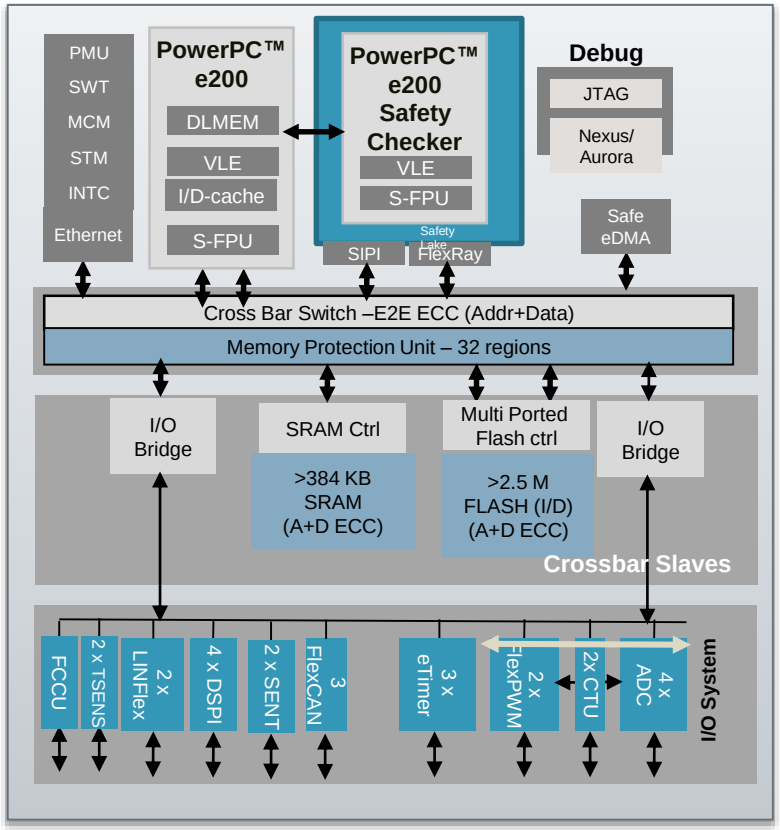
# SPC5744P 2.5 MB

**Core**
- Dual up to 200 MHz PowerTM ISA e200 zen4 core ( Z420)
- 32 bit Reg File, 64 bit BIU with E2E ECC,
- 64kB RAM of D-LMEM with MPU for fast context switch + local data
- 8KB 2-way I-cache / 4KB 2-way D-Cache
- 1x Scalar FPU (compiler supported) per core
- Safety enhanced Cores – VLE only
- No Signal processing unit extension + NO MMU
- Delayed Lock Step configuration only

**Memory**
- 2.5 MBytes NVM with ECC (with add. Safety measure for address).
- 64kB EEE (Data Flash) available incl. ECC
- Up to 384 Kbyte global system SRAM with ECC (Addr + Data)

**I/O**
- 3 x FlexCAN (64+2x32 message buffers)
- 1 x FlexRay (Dual Channel 64 msg. buffers)
- 2 x LINFlex (Uart/Lin protocol driver)
- 4 x DSPI (4 cs each)
- 2x FlexPWM (2x 12ch for 2 independent Motors Controlled)
- 3 x eTimer modules (18 channel total)
- 4 x SAR ADC – 1MS/s target 5V input capable
- 2 x Cross-triggering unit for motor control automatism
- 2x SENT
- Ethernet (257BGA only)

**System**
- Interprocessor I/F SIPI (– approx 300Mbaud)
- Safe DMA
- Fault Collection unit, WDG, T-sens, & CRC computing unit
- Nexus debug interface – Aurora
- Dual-PLL (Peripheral + System Core)
- 3.3 V Single supply: internal regulator with external power stage or External supply
- 3.3 V I/Os (ADC 5 V capable)
- 144 LQFP / 257 MAPBGA 0.8 mm pitch
- Tj = 150°C . Extended Temperature at 165”C Option (separate P/N)



# Automotive Software (MCAL/OS)

# Software…What is the demands in Automotive?

Mars Curiosity Rover
5MLoC

Android
11.8 MLoC

F-35 Joint Strike Fighter
23.5 MLoC

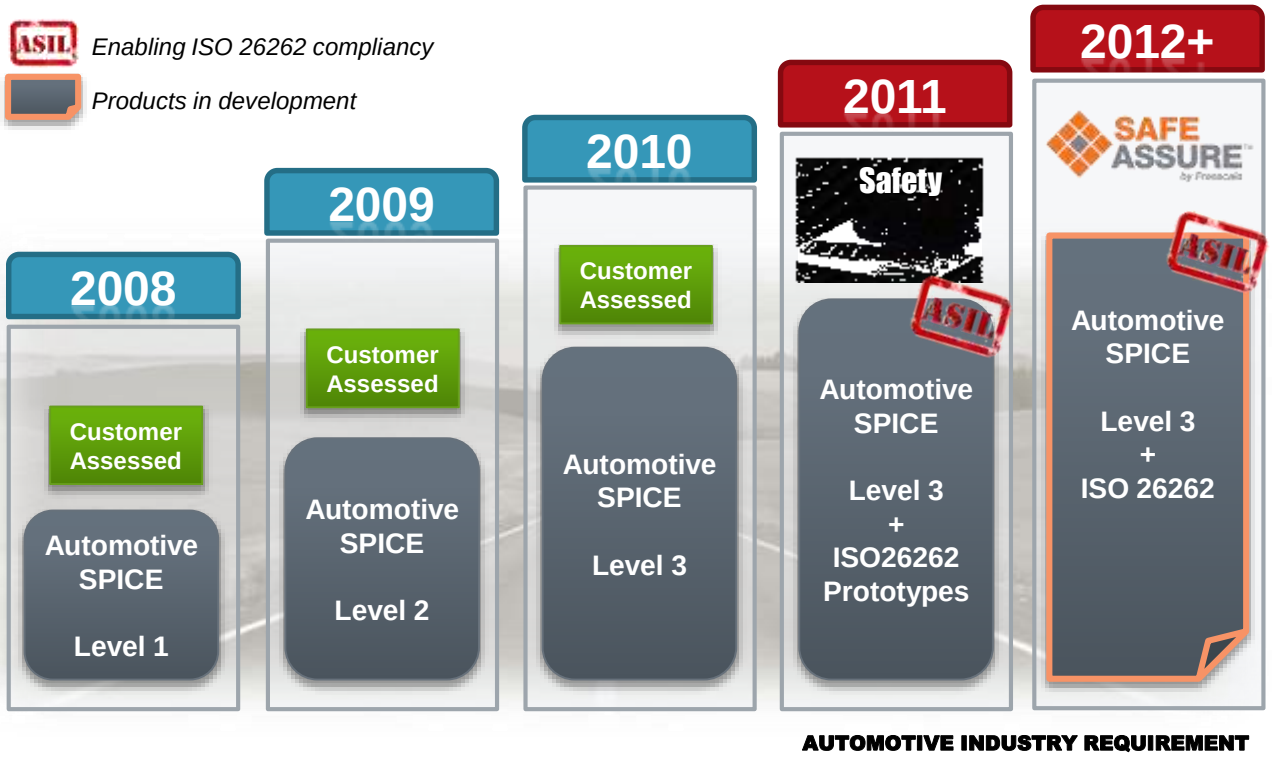
Mercedes S Class
~100MLoC

More than first perceive..?

Market leading EcoSystems…
MCAL/OS ASILD / SIL3 and beyond.

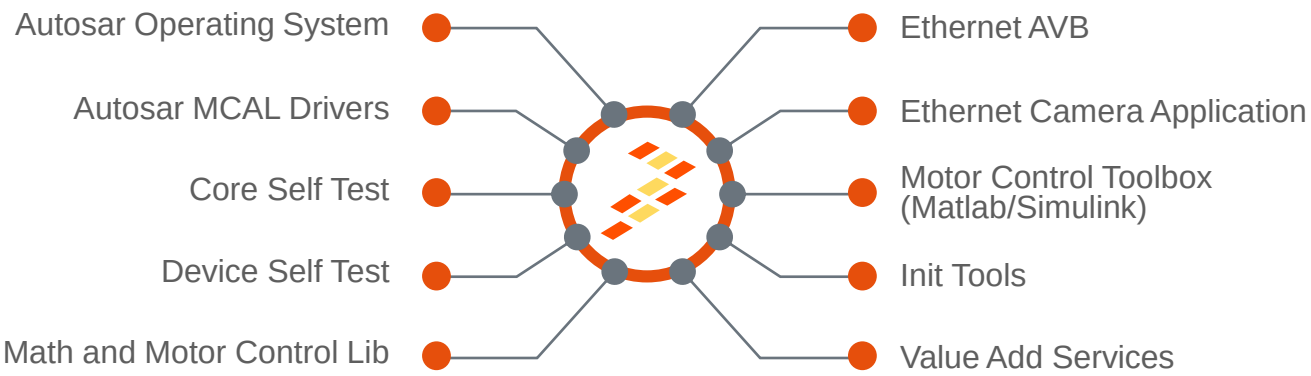
http://spectrum.ieee.org/green-tech/advanced-cars/this-car-runs-on-code
http://www.informationisbeautiful.net/visualizations/million-lines-of-code/

# Auto SW Development Process Evolution



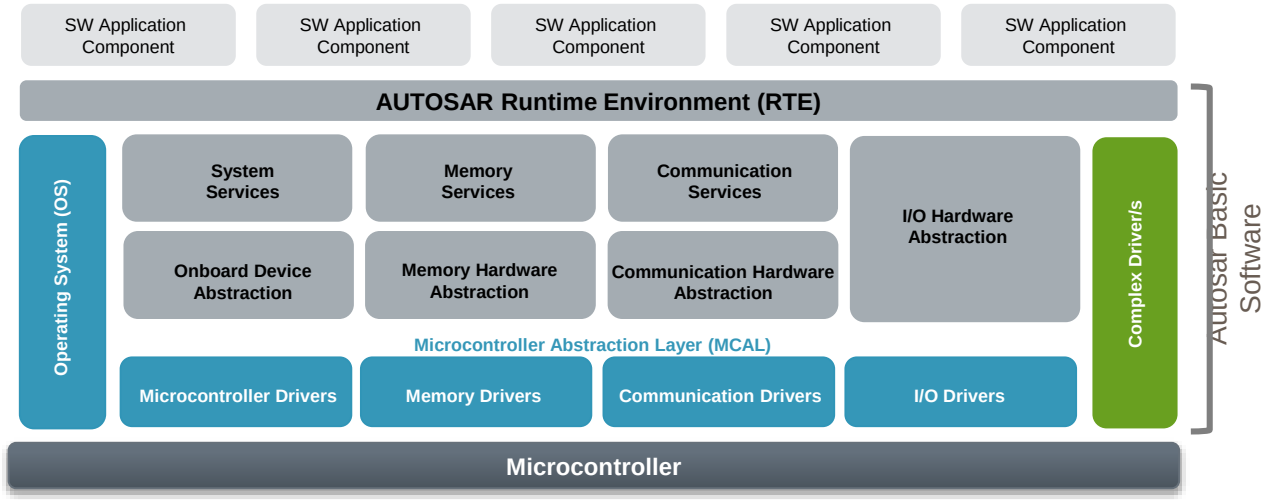
# Freescale Automotive Software

## Areas of Activities



# Autosar Basic Software

- **Freescale Standard Products** (shaded blue below) - MCAL (source code), OS (source code) and Config Tool (executable) for MCAL and OS.
- **Partner Products** (Elektrobit, Vector, KPIT, etc.) – The rest of AUTOSAR basic software as needed & Integration Services (FSL IP + Partner IP + Customer IP)
- **Complex Drivers** (shaded green below) – custom software offered by Freescale Consulting & Professional Engineering Services



# AUTOSAR Software Release Framework - Overview

### Early Access Release – EAR (Lead customers only)

- Includes a subset of MCAL Drivers with limited testing coverage
- No Quality Documentation

### BETA Release (all customers)

- Includes all MCAL Drivers (Feature Complete) fully verified and documented
- Includes Integration Testing
- No Quality Documentation

### Release to Market Candidate – RTMC (all customers)

- Beta criteria +
- 100% Decision Coverage for one configuration
- No open S1 and S2 defects

### Customer Compiler Tests (no new release)

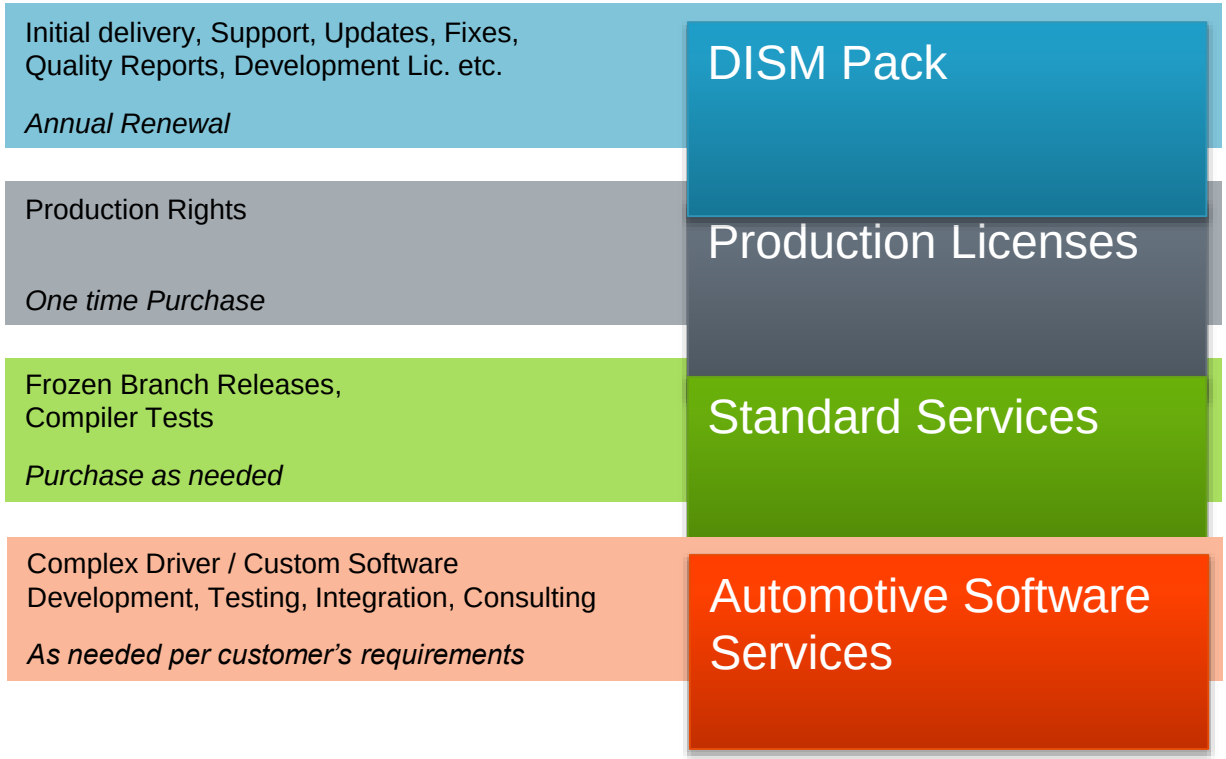
- Specific for the provided customer compiler version and settings
- Production Approval and starting point for frozen branch support - if required by customer

| | | EAR | Beta | RTM-C |
|---|---|---|---|---|
| **Content** | Product scope | subset of MCAL drivers | full set of MCAL drivers | full set of MCAL drivers |
| **Documentation** | Technical | subset of user documentation | full user documentation | full user documentation |
| | Quality docs | no | no | Complete quality package |
| **Testing** | Used HW | first samples | unqualified samples | qual-intent samples |
| | Test coverage | limited test coverage | all drivers fully verified, 100% of tests successfully executed | all drivers fully verified, 100% of tests successfully executed[1)] |
| | Decision coverage goal | no | 90% DC for one configuration | 100% DC for one configuration |
| | Extended testing | no | includes integration testing | includes integration testing & EPD testing |
| **Feature coverage** | | partial feature coverage | 100% coverage of defined features | 100% coverage of defined features |
| **Release criteria** | Error Status | | No open S1 defects | No open S1 & S2 defects |

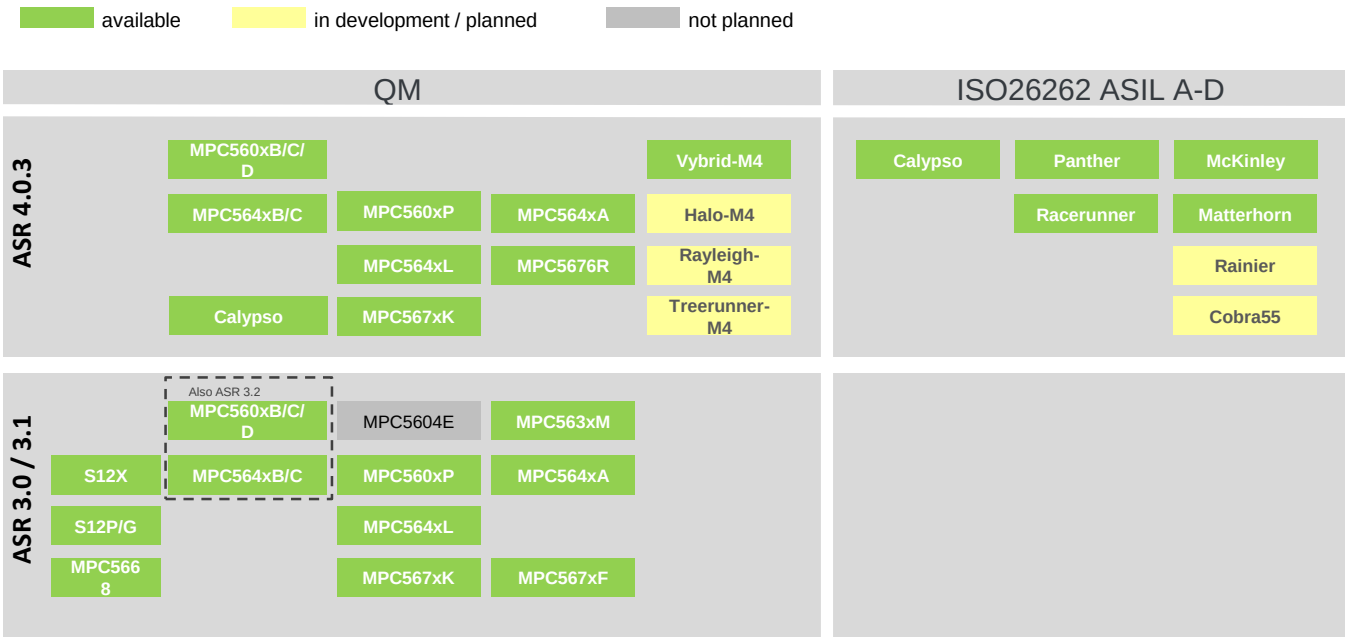
[1)] During Beta and RTMC release work, tests are added:
- To cover additional features / functionality requested after BETA release
- As test suite is continously extended and improved over time

# Freescale Automotive Software Business Model

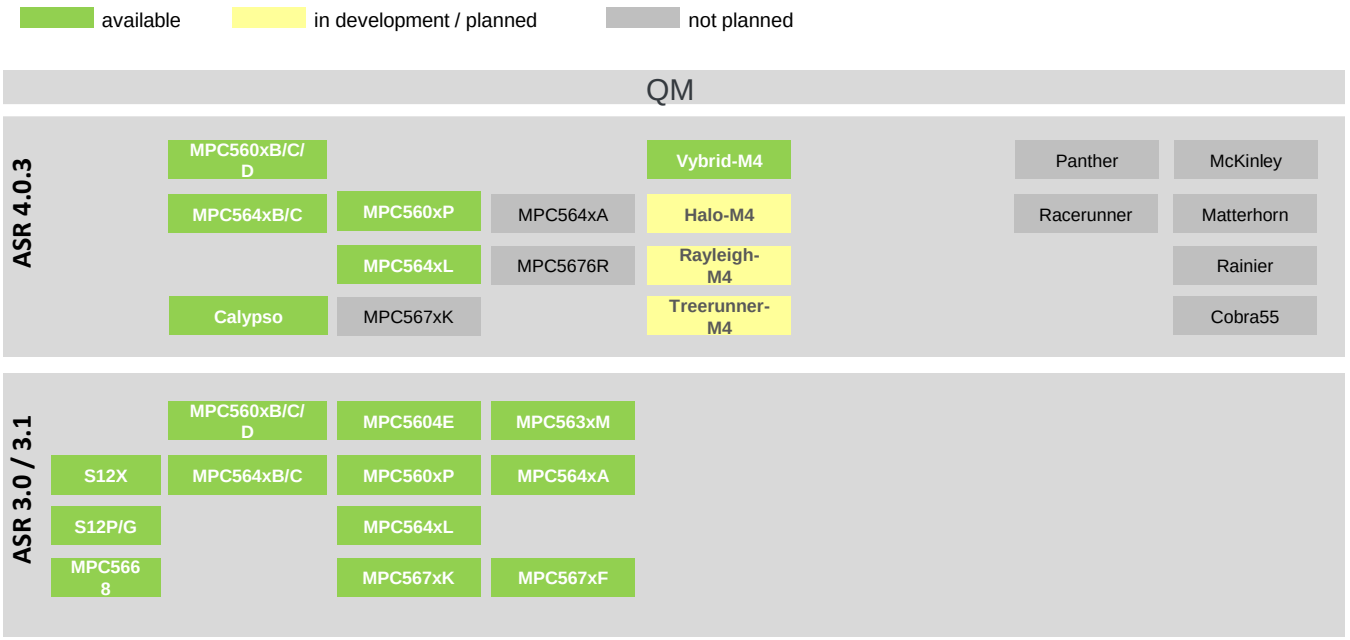
**Four Components:**



# AUTOSAR MCAL Availability Matrix

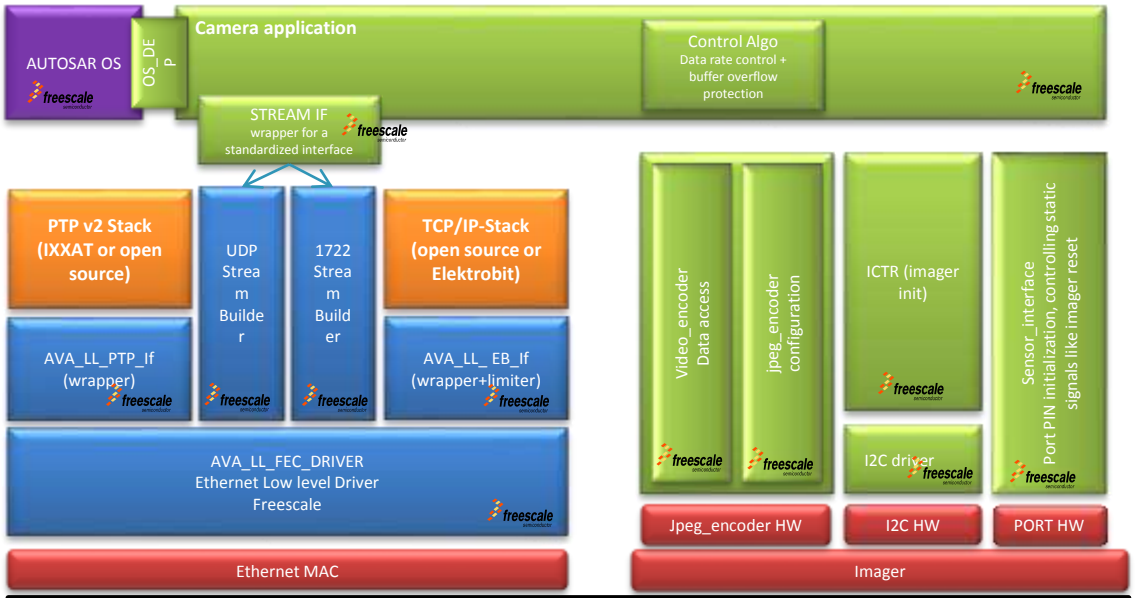


# AUTOSAR OS Availability Matrix

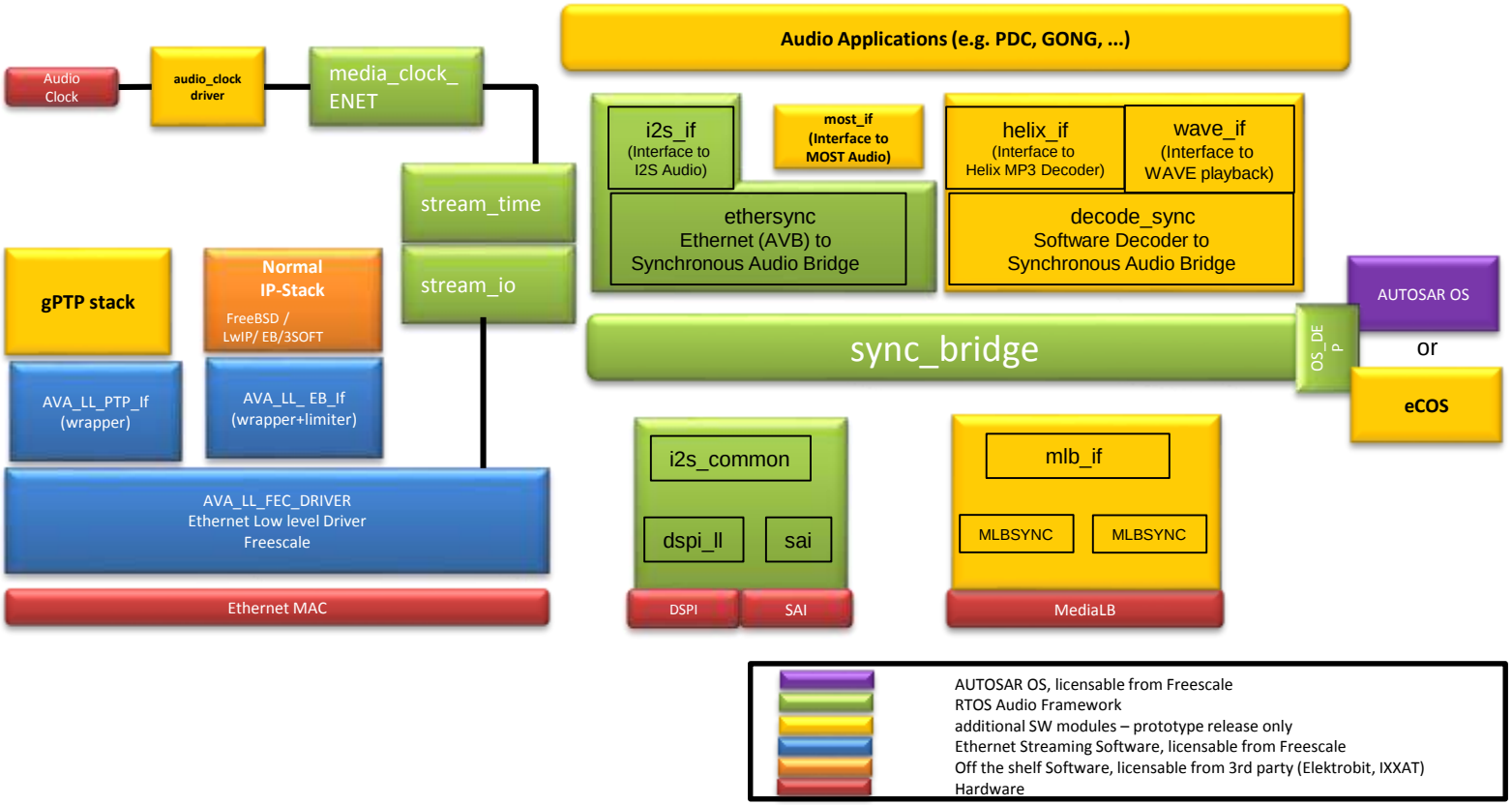


# Freescale Software for Surround Camera Systems

Target: Salsa



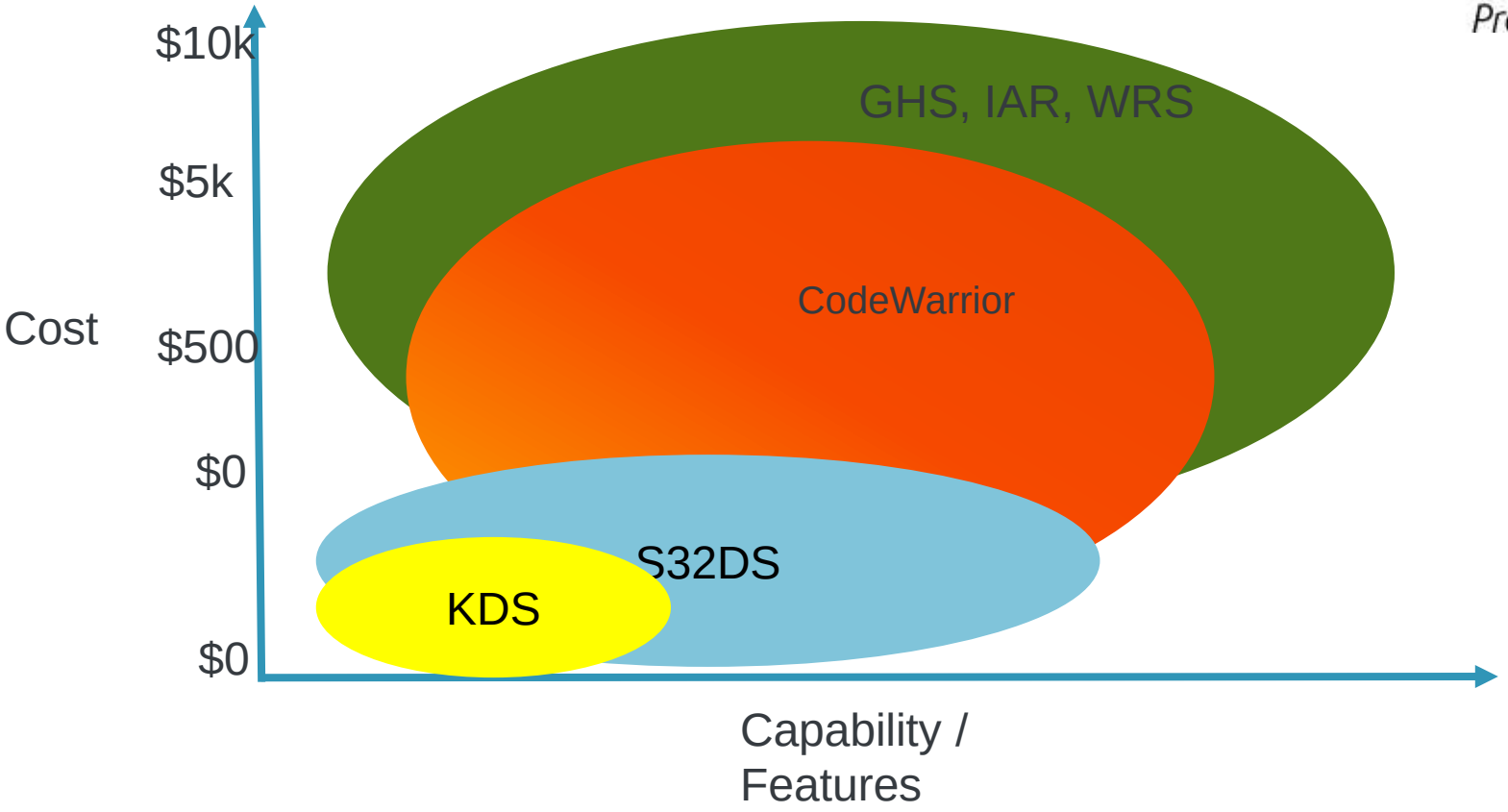
# Freescale RTOS Ethernet Audio Framework



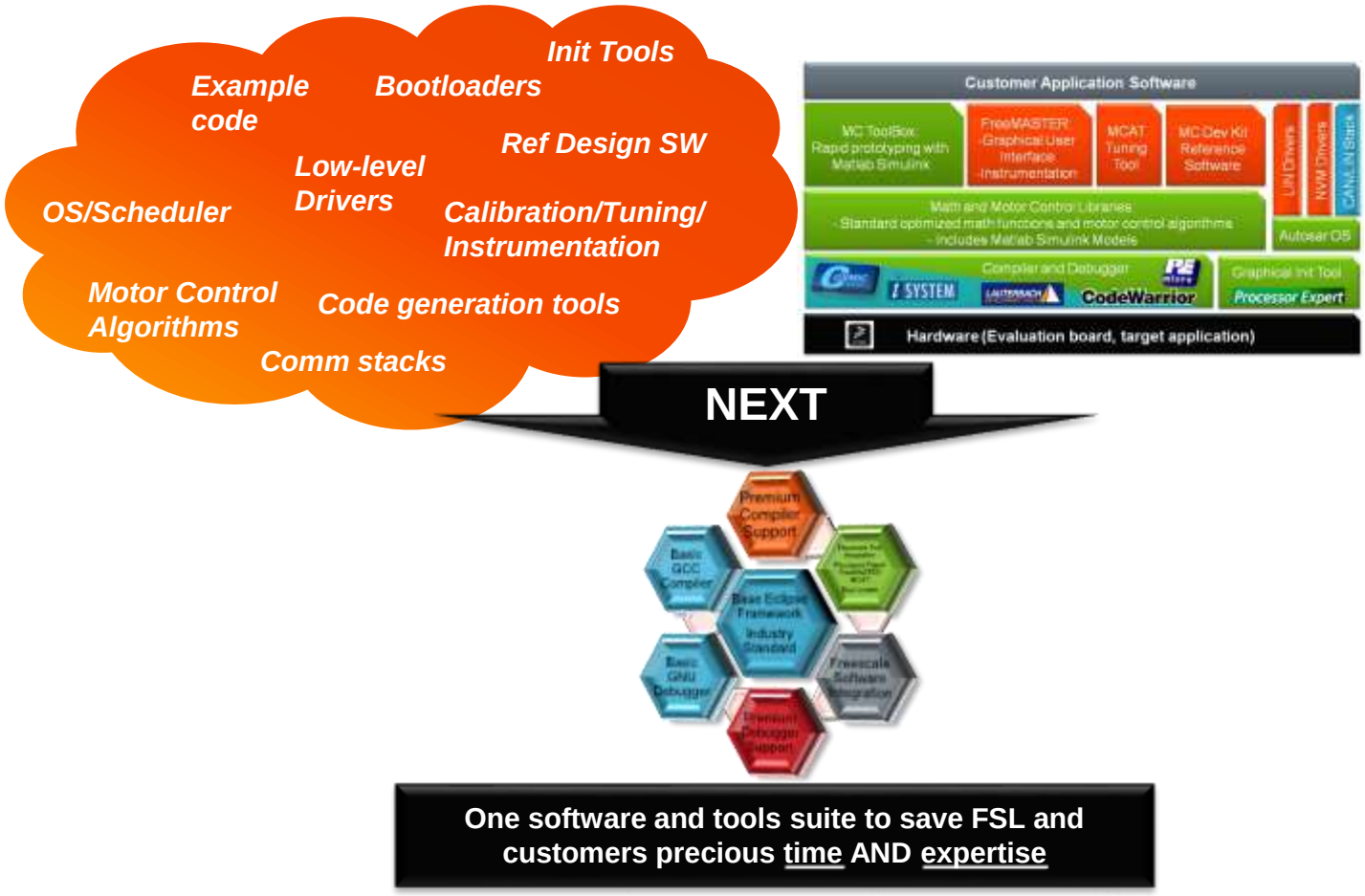
# Introduction New S32DS SW Ecosystem

# Performance Map

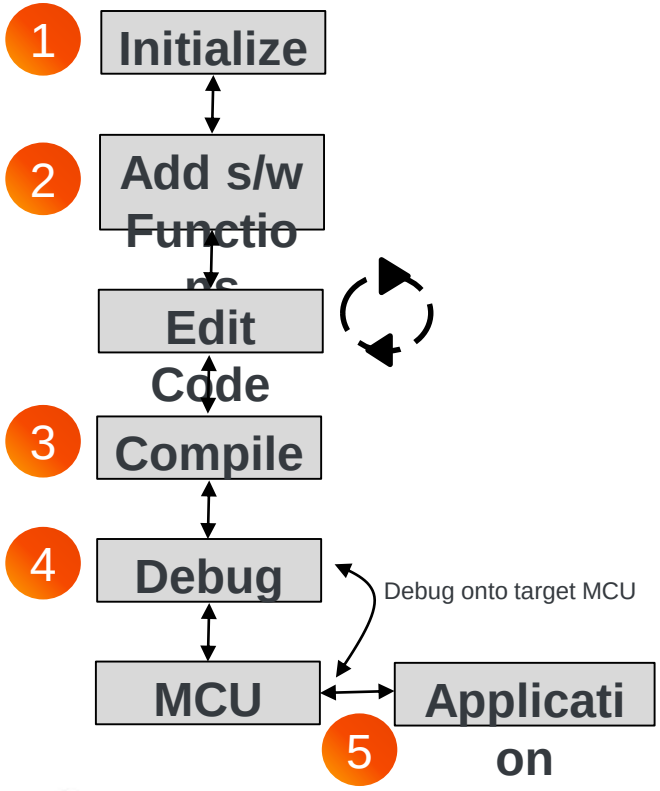
freescale
S32 Automotive Processors



# The Vision


Init Tools
Example code
Bootloaders
Ref Design SW
Low-level Drivers
OS/Scheduler
Calibration/Tuning/ Instrumentation
Motor Control Algorithms
Code generation tools
Comm stacks
Customer Application Software
MC ToolBox: Rapid prototyping with Matlab Simulink
FreeMASTER: Graphical User Interface Instrumentation
MCAT Tuning Tool
MC Dev Kit Reference Software
LIN Drivers
NVM Drivers
CAN/LIN Stack
Math and Motor Control Libraries - Standard optimized math functions and motor control algorithms - Includes Matlab Simulink Models
Autosar OS
Compiler and Debugger
CodeWarrior
Graphical Init Tool
Processor Expert
Hardware (Evaluation board, target application)
NEXT
Premium Compiler Support
Basic GCC Compiler
Base Eclipse Framework
Industry Standard
Freescale Software Integration
Basic GNU Debugger
Premium Debugger Support
One software and tools suite to save FSL and customers precious time AND expertise

# S32 Design Studio: Simple 5 Step Software Development




freescale S32 Automotive Processors

1. **Initialize**
   - Initialize Pin muxing (Pin Wizard)
   - Init tools (Processor Expert)
2. **Add Plug-ins** *(no separate downloads)*
   - SDK (low-level drivers)
   - MCAT (motor control tool)
   - Self-Test
   - AUTOSAR (MCAL & OS)
   - FreeMASTER
   - Bootloader
3. **Compile**
   - GCC, GHS, IAR, Keil, CW, others…
4. **Debug MCU**
   - GDB, Lauterbach, iSystems, others…
5. **MCU now contains application**

# S32 Design Studio: What it IS and IS NOT

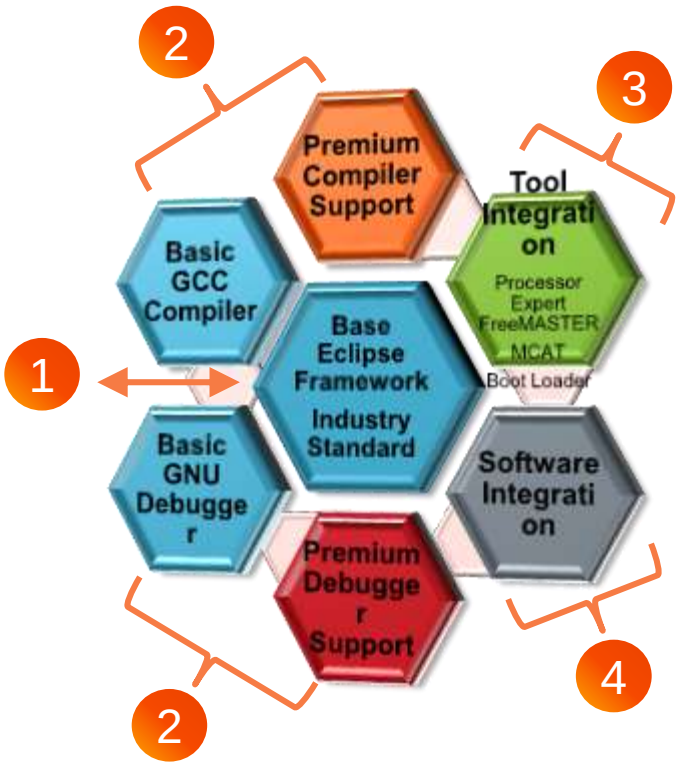
**IS**

- More Features than KDS
- Low-cost/No-cost Software Development Tool Strategy
  - Low-Cost to develop and maintain
  - No-Cost to our customers
- GCC Base Compiler Performance
- Intended to complement and enable 3rd Party Partner Tools (Compilers & Debuggers)
- Support for Premium compilers addressing Automotive Safety Requirements
- Integration of Freescale software in easy to use environment for application development

**IS NOT**

- KDS Equivalent
- AUTOSAR software
- CodeWarrior Replacement
- Premium Tool Replacement (w/ Advanced Debugging, Best in class code performance, etc…)

# S32 Design Studio: 4 Step Software Overview



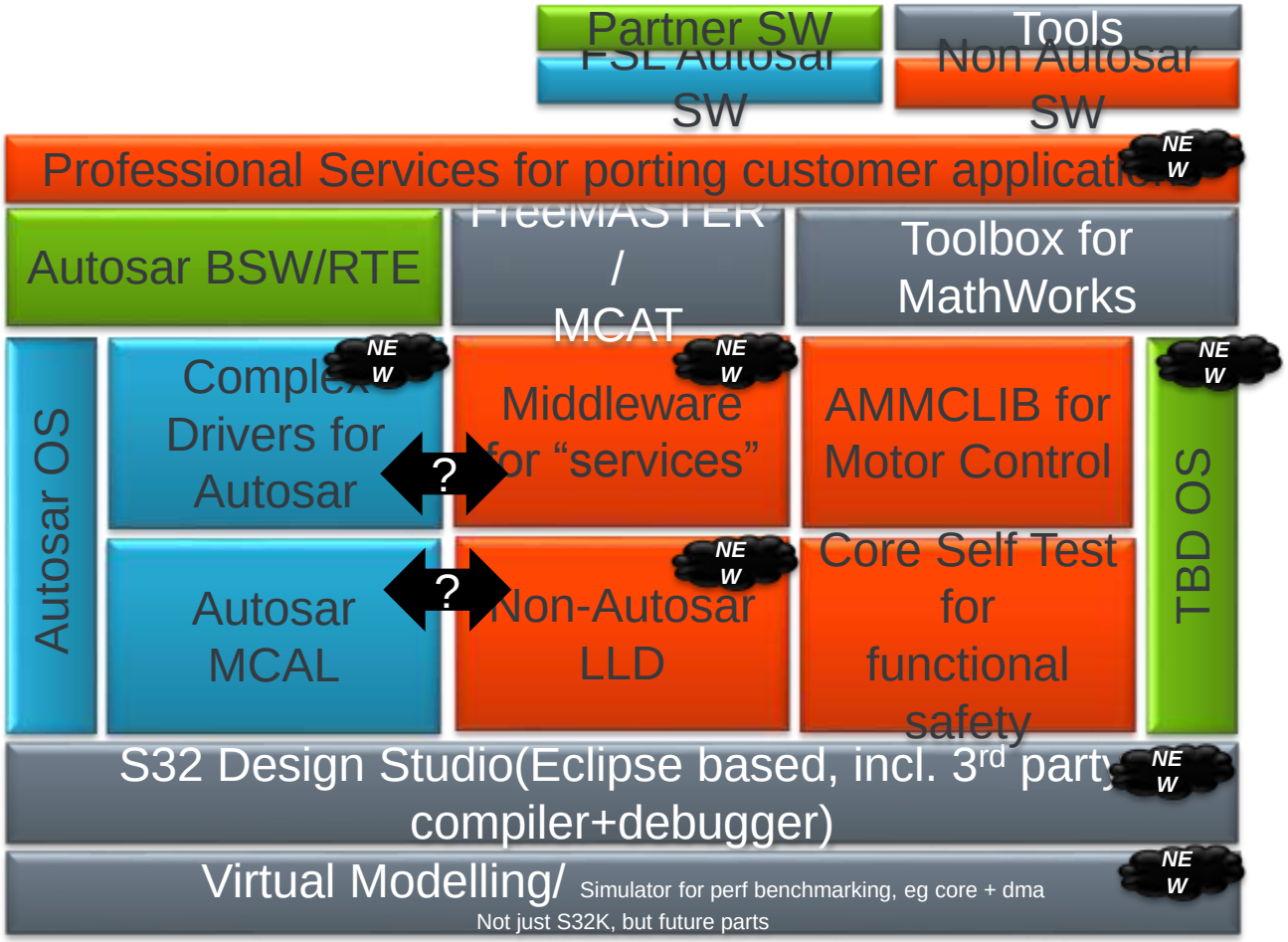

1
- **Create a new S32DS Project**
- Select MCU and target package

2
- Select **Compiler**
  - GCC or 3rd party Premium Compiler
- Select **Debugger**
  - Basic GNU or 3rd party Premium Debugger

3
- Select **Integration tools**
  - Processor Expert
  - Bootloader
  - FreeMASTER GUI
  - Motor Control Tool (MCAT)

4
- Select **Software Integration**
  - Math & Motor Control Library (MMCL)
  - S32K SDK
  - Core Self-Test functions
  - Touch sensing library

# Software and Tools Offering



# S32DS Timing & Schedules: Power Architecture (and legacy)

| | Release | 2015 | | | | | | | | | | | | 2016 | | | | 2017 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 |
| Power Arch. | Beta Release | | | | | ◆ | | | | | | | | | | | | | | | |
| | v1.0 Release<br>GCC 4.9 for z2 / z4 / z7 support<br>P&E Debug | | | | | | | ▲ | | | | | | | | | | | | | |
| | Service Pack Update | | | | | | | | | ◆ | ◆ | ◆ | ◆ | | | | | | | | |
| | v1.1 Release<br>AMMCLib Plug-in<br>PD1 Debugger Plug-in Support<br>PD2 Debugger Plug-in Support<br>PC1 Compiler Plug-in Support | | | | | | | | | | | | | ▲ | | | | | | | |
| | **Products** | 2015 | | | | | | | | | | | | 2016 | | | | 2017 | | | |
| | | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 |
| S32DS for Power Arch. (and Legacy) | Matterhorn (MPC5777M) | | | | | | | ● | | | | | | | | | | | | | |
| | Panther | | | | | | | ● | | | | | | | | | | | | | |
| | Calypso 3M | | | | | | | ● | | | | | | | | | | | | | |
| | RaceRunner | | | | | | | ● | | | | | | | | | | | | | |
| | Calypso 6M | | | | | | | ● | | | | | | | | | | | | | |
| | Cobra55 (MPC5777C) | | | | | | | | | ● | | | | | | | | | | | |
| | Rainier (MPC5746R) | | | | | | | | | | ● | | | | | | | | | | |
| | Calypso 6M | | | | | | | | | | | ● | | | | | | | | | |
| | Panther Cut2.1b | | | | | | | | | | | | ● | | | | | | | | |

▲ Major Release/Production Release

◆ Product Update Ltd New Feature

◆ Maintenance Update Release

◆ Developers Release

◆ Beta Release

# S32DS Timing & Schedules: ARM®

| | Release | 2015 | | | | | | | | | | | | 2016 | | | | 2017 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 |
| ARM | **Beta Release**<br>Alpha SP for SW team (KFA512 v1.0) | | | | ◆ | | | | | | | | | | | | | | | | |
| | **v1.0 Release**<br>GCC 4.9 for M0+, M4<br>P&E Debug, Segger Debug | | | | | | ▲ | | | | | | | | | | | | | | |
| | **Service Pack Update (KFA512 Final SP)** | | | | | | | | ◆ | | | | | | | | | | | | |
| | **v1.1 Release**<br>Pin Muxing KFA<br>S32V/KFA Support Added<br>KDS Import for KEA<br>GCC 4.9<br>P&E Debug, Segger | | | | | | | | | ▲ | | | | | | | | | | | |
| | **v1.2 Release**<br>AMMC Library<br>PC1 Plug-in<br>PC2 Plug-in<br>FreeMaster<br>PD1 Debugger Plug-in<br>PD2 Debugger Plug-in<br>Boot loader | | | | | | | | | | | | | ▲ | | | | | | | |

| | Products | 2015 | | | | | | | | | | | | 2016 | | | | 2017 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 |
| S32DS for ARM | KEA128 | | | | ● | | ● | | | ● | | | | ● | | | | | | | |
| | KEA64 | | | | ● | | ● | | | ● | | | | ● | | | | | | | |
| | KEA32 | | | | ● | | ● | | | ● | | | | ● | | | | | | | |
| | S32K1x (KFA512) *Alpha SP | | | | ● | | ● | | | ● | | | | ● | | | | | | | |
| | S32K1x (KFA256) | | | | | | | | ● | ● | | | | ● | | | | | | | |
| | S32V234 | | | | | | | | | ● | | | | ● | | | | | | | |

▲ Major Release

◆ Customer driven Production Release

◆ Maintenance Update Release

◆ Developers Release

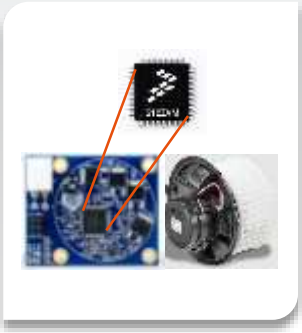
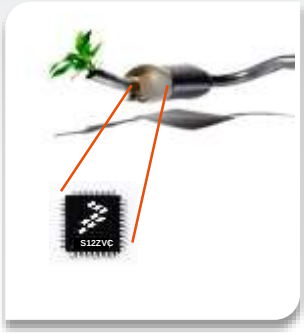
◆ Beta Release

# S32K100 Reuse guidelines (3)

Product Introduction - MagniV

# S12 MagniV: Integration Beyond the MCU

Our **S12 MagniV** portfolio simplifies system design with the integration on High-Voltage (HV) analog features onto MCUs for automotive applications

| MM912/S12VR<br>Window Lift | S12ZVM<br>BLDC Motor Control | S12ZVC<br>Small CAN nodes | S12ZVL<br>LIN Nodes |
|---|---|---|---|
|  |  |  |  |

- **Reduced PCB Space**
- **Reduced Bill of Material**
- **Improved manufacturing efficiency**
- **Simplified development**

# S12 MagniV Benefits

**S12 MagniV** solutions deliver optimal **system cost** **and** **physical footprint** for sensor and actuator applications.

## Reduced PCB Space
Up to 30%

## Improved manufacturing efficiency
Replacing typically 3 IC by 1 MagniV reduces assembly and test cost while quality improves

## Reduced Bill Of Material (BOM)
Fewer components to purchase, handle, store and qualify

## Simplified motor control that speeds up time-to-market
Save up to 6 months on development, validation and ISO26262 implementation
- Abstract the complexity of 3-phase motor control software development
- Production ready Automotive quality SW and Tools
- SafeAssure program

# Market Trends – Sensor and Actuators

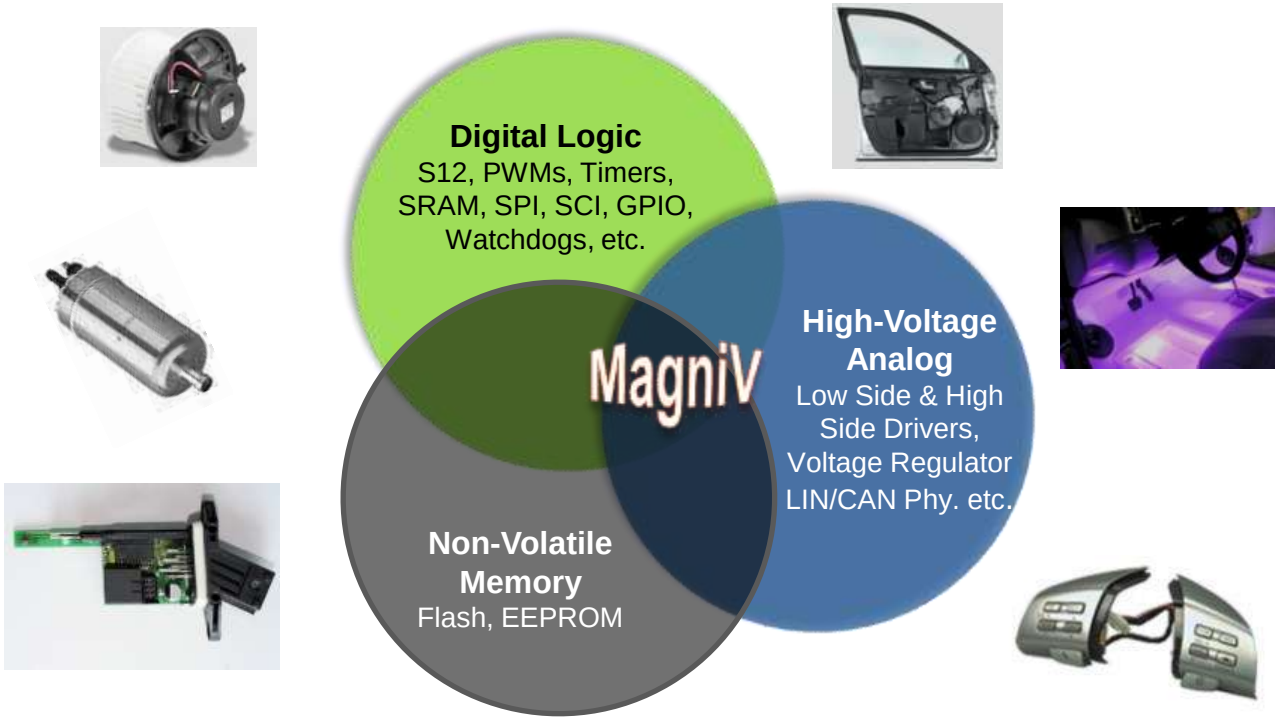
- **Reduction of power consumption**
  - LIN to reduce **cables** weight
  - **Smarter** motor control techniques
  - **Smarter** and **more** sensors

- **Reduction of physical size**
  - Electro-mechanical **integration**
  - **High temperature** >125°C Ta

LOCAL INTERCONNECT NETWORK

- **High Growth**
  - Driven by affordability of **LIN**
  - Driven by **comfort and convenience** features

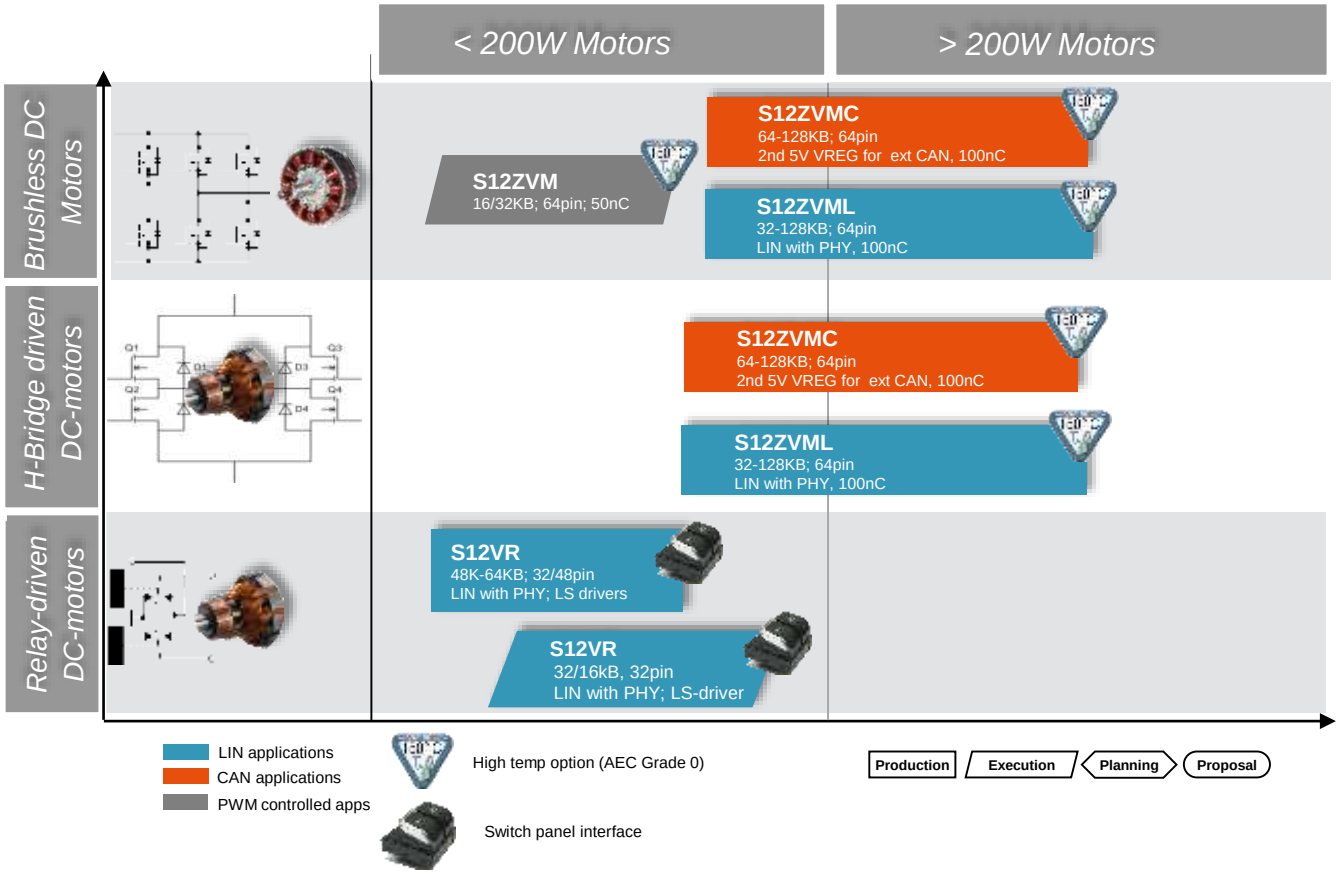
# A Technology Sweetspot for Sensor and Actuators




**Existing**
**Low Leakage 180nm CMOS+NVM**

**40V UHV Devices**

# Motor Control Solutions



# SafeAssure™ Program Applied to S12 MagniV

**Safety Hardware**
Common safe hardware platform for application software:
✓ Voltage/clocks monitoring
✓ Memories w/ error correction
✓ Window Watchdog...

**Safety Process**
✓ISO26262 development process for most products
✓Safety-Element-Out-Of-Context


**Safety Support**
✓ FIT rates
✓ Dynamic FMEDA
✓ Safety manual
✓ Technical support as required

**Safety Software**
S12Z core self-test available to complement the built-in hardware safety features

| Product families | Part Codenames | Development Process | FMEDA Report Availability | Dependant Failure Analysis | Safety Manual | Core Self test and User Guide |
|---|---|---|---|---|---|---|
| **S12VR** | Tomar | Standard | Upon request | Yes | No | No |
| **S12VR** | Tomarino | Standard | Upon request | | | |
| **S12ZVM** | Carcassonne | Standard | yes | | Yes (www) | Yes |
| **S12ZVM** | Obidos | ISO 26262 | Q4 2014 | | | |
| **S12ZVH** | Lumen2W | Standard | Upon request | | | |
| **S12ZVH** | Lumen4W | Standard | Upon request | | | |
| **S12ZVL** | Knox | ISO 26262 | yes | | | |
| **S12ZVC** | Hearst | ISO 26262 | yes | | | |

# S12 MagniV - Product Specific Benefits

| | | S12VR Tomar/Tomarino | S12ZVM | S12ZVL Knox |
|---|---|---|---|---|
| **Product specific benefits** | Bill of material reduction | LIN phy<br>VREG + Vsense<br>2xLS for relays<br>2xHS | LIN phy<br>VREG + Vsense<br>Gate Driver<br>2xOp-amps | LIN phy<br>VREG + Vsense |
| | PCB Space | 2-3cm2 | 4-6cm2 | 1-2cm2 |
| | Manufacturing cost | - Fewer components to mount (pick & place)<br>- Less testing required for individual ICs | | |
| **General benefits** | Quality | - Proven high volume LL18 base technology<br>- Fewer solder joints → fewer points of failure | | |
| | Logistics | - Fewer parts to qualify, source, store, track, etc… | | |

# Hardware Tools Overview

| Type | Evaluation Board | Motor Control Development Kit | Mini Eval Board |
|---|---|---|---|
| |  |  |  |
| Purpose | Evaluation and software development for either CAN or LIN target device | Spin a BLDC motors within minutes, for demo and training purposes | Low cost and small 5x9cm board for evaluation and training purposes. |
| HW Features | - LIN and CAN interfaces<br>- Onboard BDM-to-USB<br>- SCI-to-USB interface for Freemaster<br>- Hall sensor interface<br>- Resolver interface<br>- **6 N-channel FET with 10-15A drive capability** | - **S12ZVML12EVBLIN with pre-programmed S12ZVML128 part**<br>- **BLDC motor with Hall-effect sensors mounted on plexiglas**<br>- **PMSM version will also be available** | - S12ZVML128 part soldered<br>- LIN connector<br>- Onboard BDM-to-USB debug interface<br>- **6 N-channel FET with 5-8A drive capability** |
| Software Package | MTRCKTSBNZVM128_SW | MTRCKTSBNZVM128_SW | MTRCKTSBNZVM128_SW |
| Availability | Prototypes now (XS12ZVMx12EVB) | Now for BLDC<br>e/o Q1 14 for PMSM | Orderable in March 14<br>First shipments mid April 14 |
| Partnumbers | S12ZVML12EVBLIN<br>S12ZVML12EVBCAN | MTRCKTSBNZVM128<br>www.freescale.com/AutoMCDevKits | S12ZVML-MINIBRD<br>www.freescale.com/S12ZVML-MINIBRD |
| Price | $349 | $789 | $69 |

# Freescale S12ZVH Enablement

- Development Boards
  - TRK-S12ZVH128
  - TRK-S12ZVHY64
  - TRK-S12ZVFP64


- S12ZVH Reference Designs
  - (Available on request)

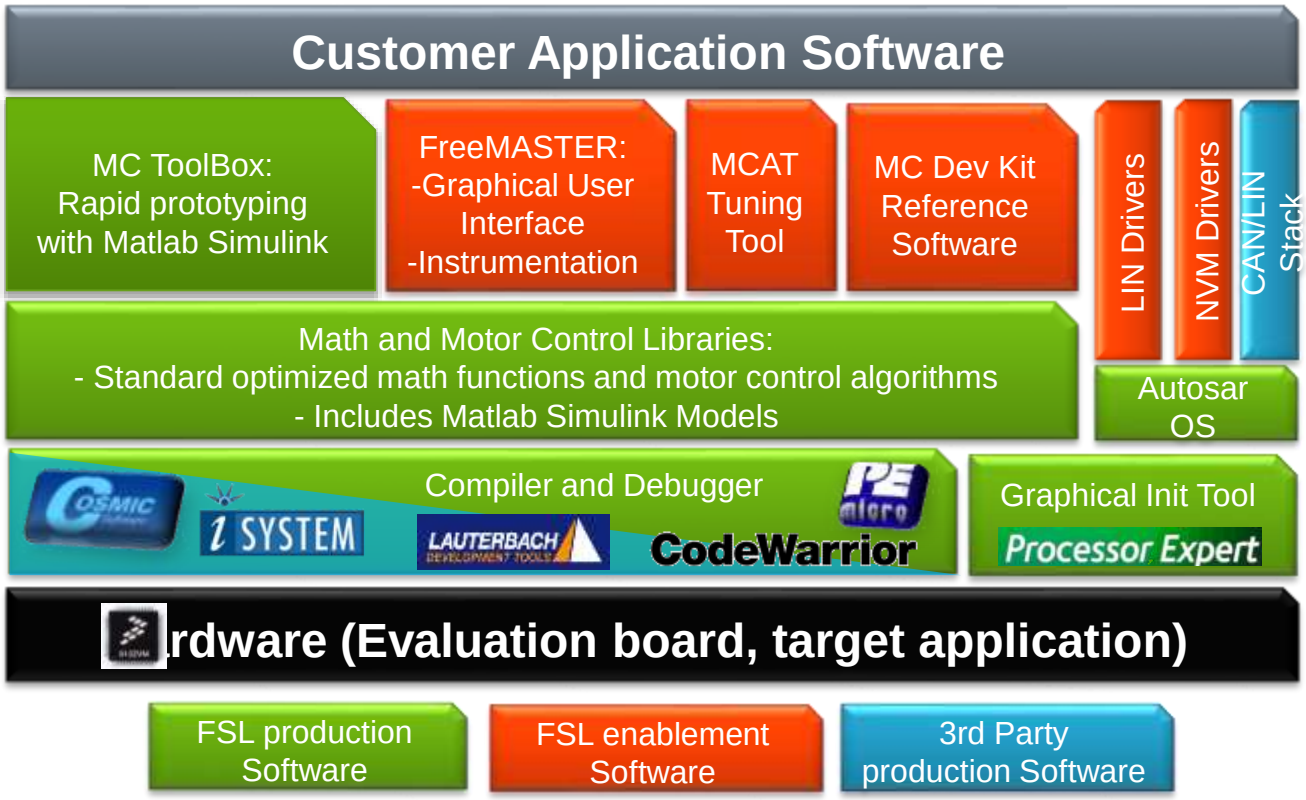
S12ZVH-REF-V1

S12ZVHY-REF-V1

# Development Tools Ecosystem

- **Compilers**
  - CodeWarrior S12Z rev. 10.3 and newer
  - Cosmic
- **IDE**
  - CodeWarrior 10.3
  - Cosmic Zap
  - eclipse
- **Programmers**
  - P&E PROGS12Z
  - Cyclone Pro Programmer
- **Debugger**
  - CW & P&E S12Z Debugger
  - Cosmic Zap Debugger
  - iSYSTEM winIDEA
- **Support Tools:**
  - Make utility – cygwin
  - FreeMASTER run time debugger and for instrumentation/calibration

# Ecosystem – The Complete Solution



# S12 MagniV Benefits

**S12 MagniV** solutions deliver optimal **system cost** **and** **physical footprint** for sensor and actuator applications.

- **Reduced PCB Space**
  Up to 30%
- **Improved manufacturing efficiency**
  Replacing typically 3 IC by 1 MagniV reduces assembly and test cost while quality improves
- **Reduced Bill Of Material (BOM)**
  Fewer components to purchase, handle, store and qualify
- **Simplified motor control that speeds up time-to-market**
  Save up to 6 months on development, validation and ISO26262 implementation
  • Abstract the complexity of 3-phase motor control software development
  • Production ready Automotive quality SW and Tools
  • SafeAssure program

# S32K100 Reuse guidelines (3)

Product Introduction – Kinetis EA Family

# Why Cortex M0+ Series for Automotive General Purpose

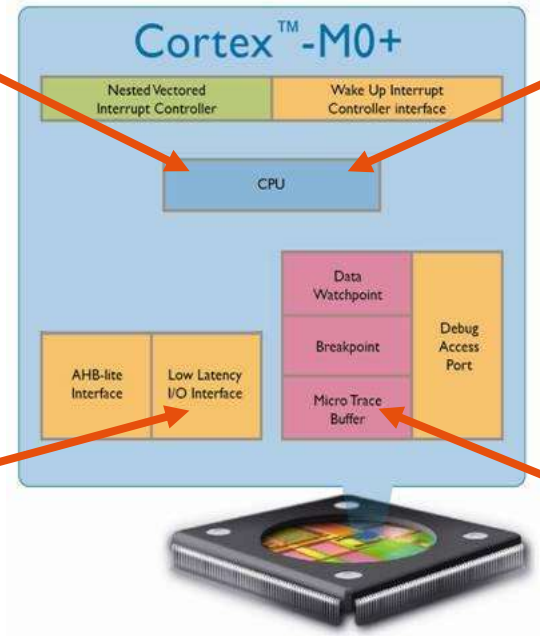
## Built on the ARM® Cortex® M0+ Processor

### Energy Efficiency

- 2-stage pipeline – reduced cycles per instruction (CPI) enabling faster branch instruction and ISR entry
- Program memory access on alternate cycles

### Single-Cycle I/O Port

- 50% higher GPIO toggling frequency than standard I/O
- Improves reaction time to external events allowing bit-banding and software protocol emulation
- Save precious cycles, e.g. set faster peripherals for low-power access
- Access GPIO/peripherals while processor fetches the next instruction




### Processing

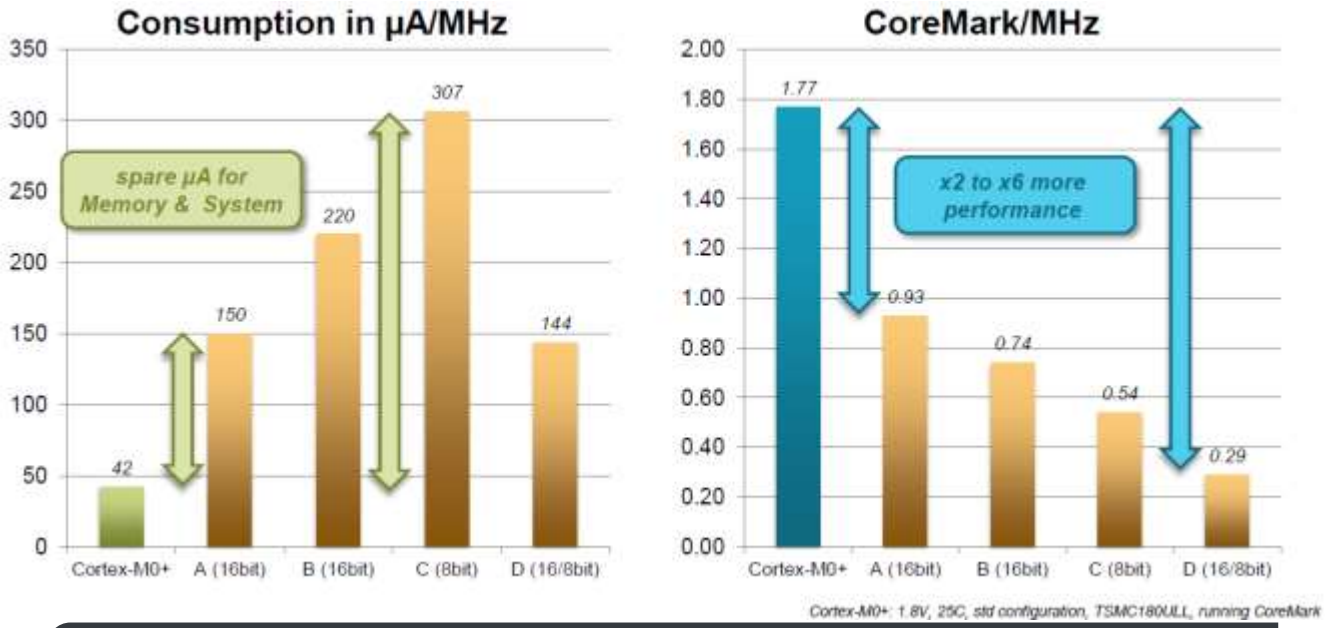
- Only 56 Instructions, mostly coded on 16-bit. Option for fast MUL 32x32 bit in 1 cycle
- Cortex-M0/3/4 compatible
- Best-in-class code density – reduced cost, power consumption and pin-count

### Micro Trace Buffer

- Powerful, lightweight trace solution enabling fast debug
- Non-intrusive – trace information stored in small area of MCU SRAM (size defined by programmer)
- Trace read over Serial Wire /JTAG (CPU stopped)

# Kinetis EA Benchmark

## Performance & power consumption advantage



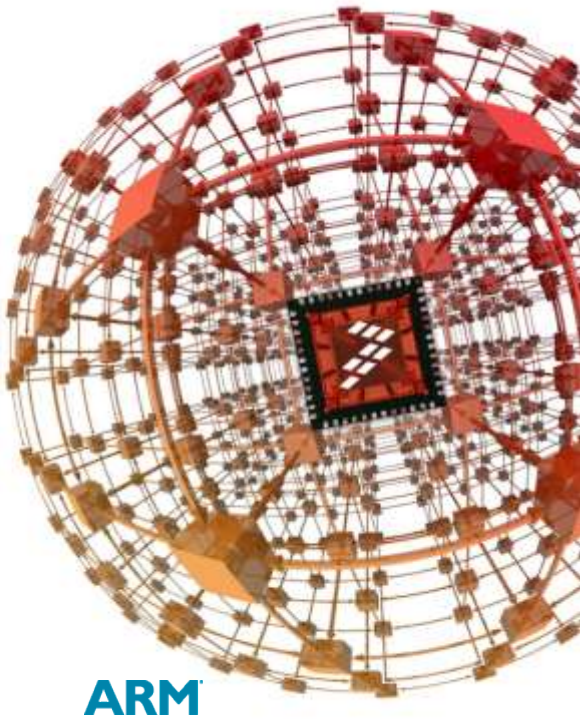

**Stop mode current 1uA**
**M0+ 0.95 DMIPS per MHz**

ARM

# Kinetis EA Series MCUs : ARM-Based 32-bit MCUs for Challenging Environments

**KEA Series MCUs: 32-bit ARM-based MCUs for Automotive**

- Based on a 32-bit ARM Cortex®-M0+ 48MHz core which equals high performance with ultra-low power
- 8K to 128K embedded flash, pin-to-pin compatible
- **AEC-Q100 qualified, -40°C to 125°C**
- **Enhanced ESD/EMC (6kV HBM)**
- **Automotive connectivity: CAN, LIN (UART), SPI and $I^2C$**
- **Automotive IPs: 12-bit ADC, ACMP, Timers (FTM, PWM, PIT, PWT, RTC)**
- $V_{DD}$ = 2.7 - 5.5 V, 3.3 V or 5 V convenience

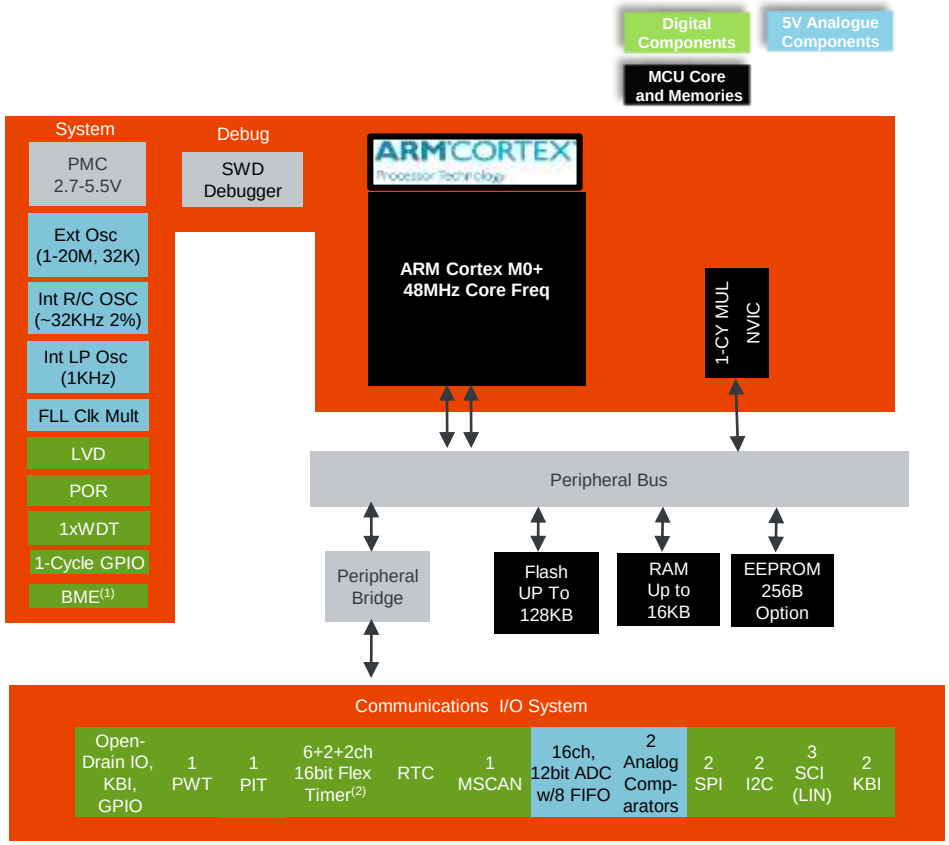



**Start Your Design Easily Today!**

- **Most complete MCU + development environment**
- **24-hours to prototype, 2 months to production grade**
- Samples and Evaluation Boards (8K to 128KB)
- **Fully Qualified and Released.**

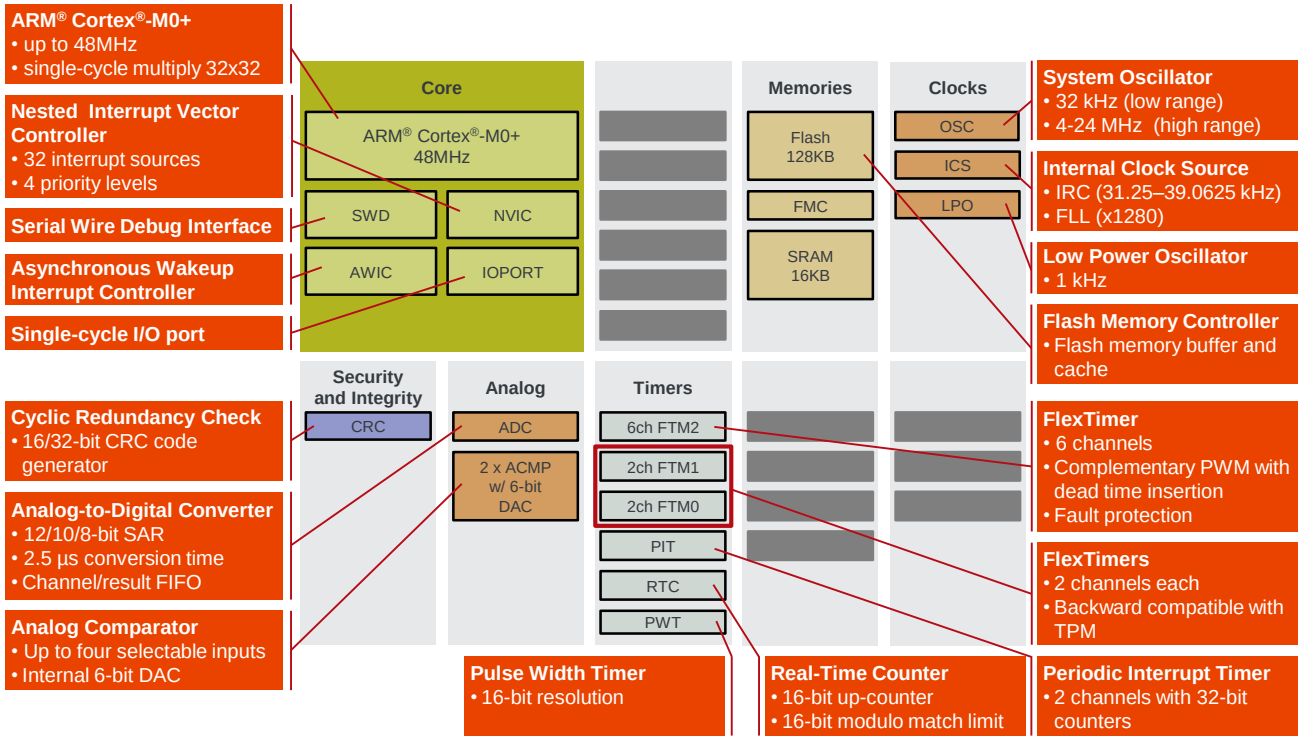
# Kinetis EA128 Block Diagram

- **Applications:**
  - Automotive general purpose
- **Operating Characteristics:**
  - Voltage range: 2.7 to 5.5 V
  - Temperature range: -40 to 125°C
- **Key Features:**
  - ARM Cortex M0+ core 48MHz
  - Up to 128K embedded flash
  - Up to 16K RAM
  - External OSC + internal ICS for clock
  - System functions: LVD, WDG, CRC, LP modes
  - Communication: SPI, SCI, IIC, CAN
  - Timers: FTM, PWM, PIT, PWT, RTC
  - 12bit ADC and ACMP
- **Packages:**
  - 16TSSOP, 24QFN, 32/ 64/ 80LQFP
  - Pin compatible within KEA family

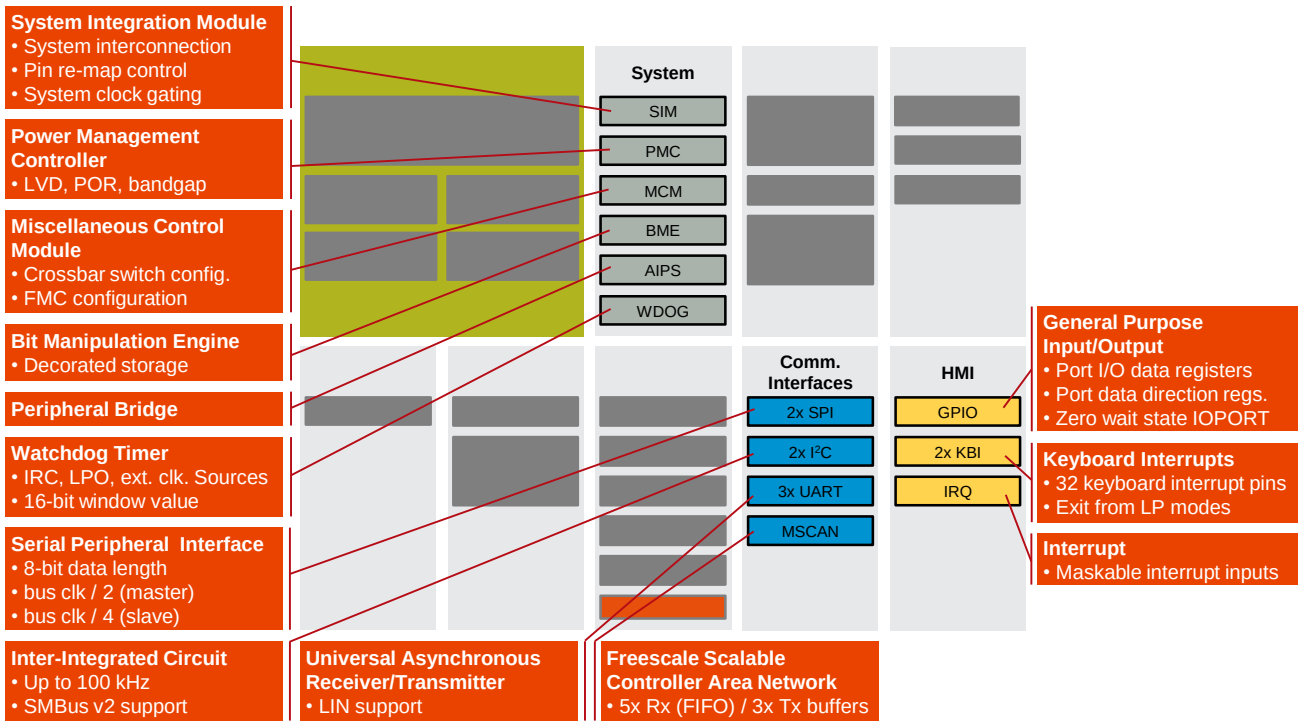



(1) Support bit operation in RAM
(2) Faster timer running 2 x core clock

# Kinetis EA128 Block Diagrams Details



# Kinetis EA128 Block Diagrams Details (Continued)



# Kinetis EA Series Comparison Table

- KEA has at least the same overall quality level as existing 0.25um 16-bit Auto MCU and 0.18um 8-bit Auto MCU, but notably higher performance and richer enablement's.
- KEA has perfect runway to S32K M4/M0+ Core series solutions with even greater Low-Power enablement, system enhancements and wider memories options.

| | Features | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Flash | RAM | EE PROM | Freq | MS CAN | SCI | SPI | ATD | PWT | Flex-Tim | ACMP | IIC | GPIO | Packages |
| KEAZN8 | 8K | 1K | emulate | 48MHz | 0 | 1 | 1 | 12c12b | 1 | 6c+2c 16b | 2 | 1 | Up to 22 | 16 TSSOP/ 24 QFN |
| KEAZN16 | 16K | 2K | 256B | 40MHz | 0 | 3 | 2 | 16c12b | NA | 6c+2c+2c 16b | 2 | 2 | Up to 57 | 32/64 LQFP |
| KEAZN32 | 32K | 4K | 256B | 40MHz | 0 | 3 | 2 | 16c12b | NA | 6c+2c+2c 16b | 2 | 2 | Up to 57 | 32/64 LQFP |
| KEAZN64 | 64K | 4K | 256B | 40MHz | 0 | 3 | 2 | 16c12b | NA | 6c+2c+2c 16b | 2 | 2 | Up to 57 | 32/64 LQFP |
| KEAZ64 | 64K | 8K | emulate | 48MHz | 1 | 3 | 2 | 16c12b | 1 | 6c+2c+2c 16b | 2 | 2 | Up to 71 | 64/80 LQFP |
| KEAZ128 | 128K | 16K | emulate | 48MHz | 1 | 3 | 2 | 16c12b | 1 | 6c+2c+2c 16b | 2 | 2 | Up to 71 | 64/80 LQFP |

# Kinetis EA/S32K100 Automotive Series has true Scalability

- Migration across the Cortex Series:
- Higher performance: core and peripherals
- Improved security & safety
- Save development cost and time with pin compatibility, SW and tool re-use

| Flash | Pin Count | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 16 | 24 | 32 | 64 | 80 | 100 | 144 | 176 |
| 2M | | | | | | S32K147* | S32K147 | S32K147 |
| 1M | | | | | S32K146* | S32K146 | S32K146 | S32K146* |
| 512K | | | | S32K144 | S32K144* | S32K144 | S32K144* | |
| 256K | | | | S32K142 | S32K142* | S32K142 | | |
| 128K | | | KEAZ128* | KEAZ128/ S32K141 | KEA128/ S32K141* | S32K141 | | |
| 64K | | | KEAZN64 | KEAZ(N)64 | KEAZ64 | | | |
| 32K | | | KEAZN32 | KEAZN32 | | | | |
| 16K | | | KEAZN16 | KEAZN16 | | | | |
| 8K | KEAZN8 | KEAZN8 | | | | | | |

# Kinetis EA MCUs Easy Enablement:
## Rapid Prototyping for Quality Software Development

### Freescale Library and Tool:

- Automotive Math and Motor Control Library for Cortex M0+
- Motor Control Application Tuning (MCAT) tool
- FreeMASTER

### IDE Debugger/Compiler

- CodeWarrior 10.6, Processor Expert integrated
- S32-DS IDE
- IAR
- Keil
- Cosmic IDE for Kinetis ARM MCUs

### Operating Systems:

- MQX Lite

### Drivers

- Split Gate Flash Driver Software for Kinetis EA Series MCU
- Flash driver for EEPROM emulation
- LIN driver
- CAN driver
- Other peripherals and IO drivers
- Optional Autosar MCAL and Vector Driver

### Debugger Interface

- P&E Micro: Umultilink

# Kinetis EA MCU Low Cost StarterTRAK Boards

## TRK-KEA8

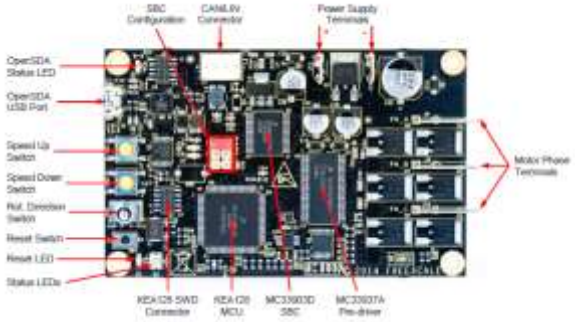
- KEA8 MCU in a 24 QFN package
- On-board openSDA debugging and programming circuit using K20 MCU
- LIN communications interface
- Analog interface with potentiometer
- High efficiency LEDs
- SCI serial communication interface

## TRK-KEA64

- KEA64 MCU in a 64 LQFP package
- On-board openSDA debugging and programming circuit using the K20 MCU
- LIN communications interface
- Analog interface with potentiometer
- High efficiency LEDs
- SCI serial communication interface

## TRK-KEA128

- KEA128 MCU in a 80 LQFP package
- On-board openSDA debugging and programming circuit using K20 MCU
- LIN communications interface
- Analog interface with potentiometer
- High efficiency LEDs
- SCI serial communication interface
- CAN communications interface



# Motor Control Reference Design Overview

## Highlights

- Based on the Kinetis KEAZ128 32-bit ARM Cortex-M0+ automotive MCU
- Motor control solution for 12 V automotive systems 3-phase sensorless brushless DC (BLDC)
- Hardware solution consists of the KEAZ128 MCU, MC33903 SBC and MC33937A 3-phase FET pre-driver
- LIN & CAN connectivity support

## Integrated Software

- Automotive Math and Motor Control Library set for ARM Cortex-M0+, Application Software
- Application data visualization and control with FreeMASTER run-time debugging tool included
- Motor Control Application Tuning (MCAT) tool allows run-time tuning of the application parameters included

# Kinetis EA MCUs Key differentiators…

- **Complete enablement to save development cost & time**
  - Massive options of development tools, SW and HW references
  - Complete ARM ecosystem
- **Super scalable product family**
  - 8K to 2M embedded flash, pin to pin compatible
  - Save HW&SW porting effort
- **Automotive grade Quality**
  - AEC Q100 certificated, Proven automotive IP on board, Enhanced EMC/ESD performance
- **High Performance**
  - 32-bit ARM ® M0+ core, compared with 8/16bit core in similar flash size devices

- **Low power consumption**
  - M0+ core optimized for low power
  - Chip level low power design
- **Advanced automotive connectivity**
  - Plenty of automotive peripherals including CAN, LIN(SCI), SPI, IIC etc
- **Wide operating range**
  - Vdd = 2.7 - 5.5V, 3.3V or 5V convenience
  - Ta = -40C to 125C
- **Ideal for vast number of automotive applications**

freescale S32 Automotive Processors

# Kinetis EA MCUs Key differentiators…

KEA MCU is cost-effective auto-grade scalable 32-bit product family with complete ARM ecosystem for a wide range of automotive applications

Customers can start design easily today for fast prototyping!

**Complete enablement to save development cost & time**

- Massive options of development tools, SW and HW references
- Complete ARM ecosystem

**Super scalable product family**

- 8K to 2M embedded flash, pin to pin compatible
- Save HW & SW porting effort

**Automotive grade Quality**

- AEC Q100 certificated, Proven automotive IP on board, Enhanced EMC/ESD performance

**High Performance**

- 32-bit ARM Cortex-M0+ core, compared with 8-/16-bit core in similar flash size devices

**Low-power consumption**

- Cortex-M0+ core optimized for low-power
- Chip level low-power design

**Advanced automotive connectivity**

- Plenty of automotive peripherals including CAN, LIN(SCI), SPI, IIC etc

**Wide operating range**

- Vdd = 2.7 - 5.5V, 3.3V or 5V convenience
- Ta = -40C to 125C

**Ideal for vast number of automotive applications**

**High-performance platforms: Safety and Security**

- SW friendly flexible architecture for broad market appeal
- CPU bandwidth/DMA/FPU /Low power/CAN-FD/ Ethernet/USB/ISO26262
- HW Security…

**Reduce R&D effort/Time-to-Market**

- Complete enablement with tools and software ecosystem
- Expand software offering into higher levels of abstraction / model-based design

**Future-proof your design**

- See software as an investment, not a cost
- Scalability through portfolio


Secure, embedded processing solutions for the
Internet of Tomorrow.


www.Freescale.com