KPIT

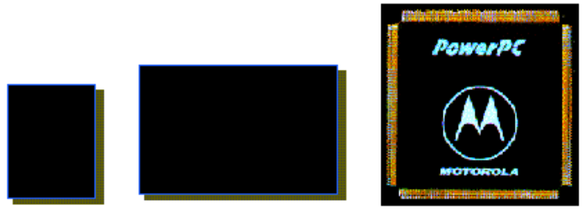
Session-IV
Processors/microcontrollers

Session outline

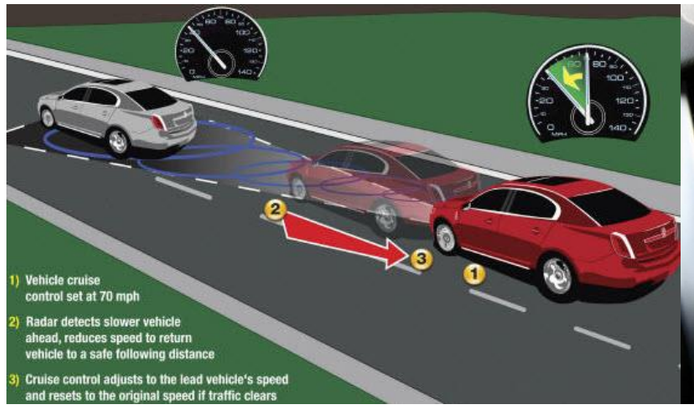
- Role of processors in Automotive systems
- Basic components of microcontrollers/Processors
- Competitive standards of embedded processors in Automotive
- Criteria of choosing processors in Automotive
- Various automotive grade processors as per application requirements

Role of processors in Automotive systems

Some examples where you find processors in a vehicle



- ABS (Antilock Braking Systems), which keeps the wheels from locking up when the driver brakes rapidly or on slippery conditions.
- EDS (Electronic Differential Systems), which allow for different wheel speeds.
- Traction Control Systems, which helps prevent a loss of traction when the engine torque doesn't match road conditions, such as when trying to accelerate on snowy roads.
- Remote controlled door locks and alarms.
- In-car infotainment systems, including GPS and Wi-Fi.
- Adaptive Cruise Control



Basic components of microcontrollers/Processors

Components of Embedded Processors

A microcontroller basically contains one or more following components:

- Central processing unit(CPU)
- Random Access Memory)(RAM)
- Read Only Memory(ROM)
- Input/output ports
- Timers and Counters
- Interrupt Controls
- Analog to digital converters
- Digital to analog converters
- Serial interfacing ports
- Oscillatory circuits

Modern microcontrollers that enhance control of automobiles range from 8-bit to 32-bit Harvard architecture with high-performance, low-cost CPUs and efficient data storage in memory

Feature comparison of 8-bit micro-controllers

Typical features of a modern 8051	Typical features of Arduino Uno
32 input / output lines	23 Input-output lines
Internal data (RAM) memory - 256 bytes	SRAM Data Memory- 2 kbytes.
Internal data (RAM) memory-256 bytes	EEPROM Data Memory- 1 kbytes
Up to 64 kbytes of ROM memory	Flash Program Memory - 32 kbytes.
Three 16-bit timers / counters	Timers: Two 8-bit / One 16-bit.
NA	A/D Converter: 10-bit Six Channel PWM: Six Channels

Major vendors of micro-controllers and hardware

Source: http://www.microcontroller.com/EmbeddedSystems.asp?c=11

Competitive Standards for Automobile Microcontrollers

- Modern microcontrollers that enhance control of automobiles range from 8-bit to 32-bit Harvard architecture with high performance, low cost CPUs and efficient data storage in memory.

- Due to the need for fast throughput alongside the occupation of minimal chip space, the Reduced Instruction Set Computing (RISC) is preferred as industrial CPU standard.

- Current CPUs Ex: Piccolo microcontrollers by Texas Instruments, have an efficient clock speed of up to 60 MHz while processing code in the range of 40 to 60 million instructions per second (MIPS)

Automotive Grade Processors

- What qualifies as extended and high temperatures?

- A number of IC vendors use the term “high temperature” to describe a product that operates in ambient temperatures as high as 125°C. Other companies call that “extended temperature,”
- Products that operate over a range of 0° to 70°C or 85°C are considered consumer grade.
- Products that operate over a range of –40° to 85°C are considered industrial grade
- Typical levels above 85°C are 105°, 125°, and 150°C are considered to be High Temperature products
- Automotive-grade or automotive-qualified ICs are generally those that have been tested to the AEC-Q100 set of standards.

AEC-Q100 qualification

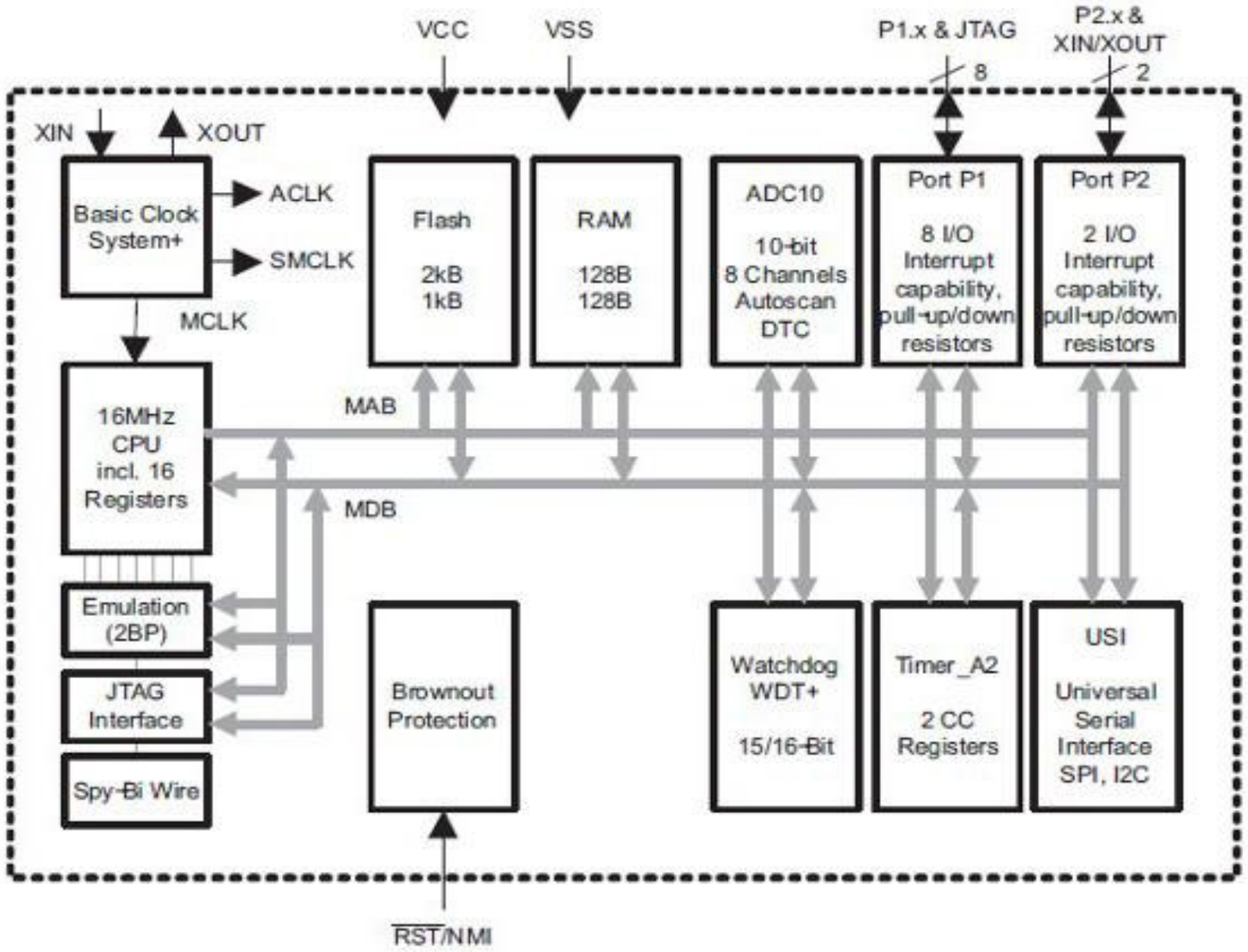
- The Automotive Electronics Council (AEC) was originally created by Chrysler, Ford, and General Motors to establish common standards for part qualification and general system-level quality

- The AEC-Q100 standard, or more precisely set of standards, defines stress qualification for ICs http://www.aecouncil.com/AECDocuments.html

AEC-Q100 qualification

- The AEC-Q100 qualification documents include some items that apply only to specific types of Ics
- For example, Q100-005 is specifically focused on the endurance of nonvolatile memory in terms of write/erase cycles
- Other Q100 documents apply broadly such as the Q100-001 shear test for wire bonds
- Other specific documents address tolerance to electrostatic discharge, solder-ball shear, and many other potential failure modes

Texas Instruments' 16-bit MSP430



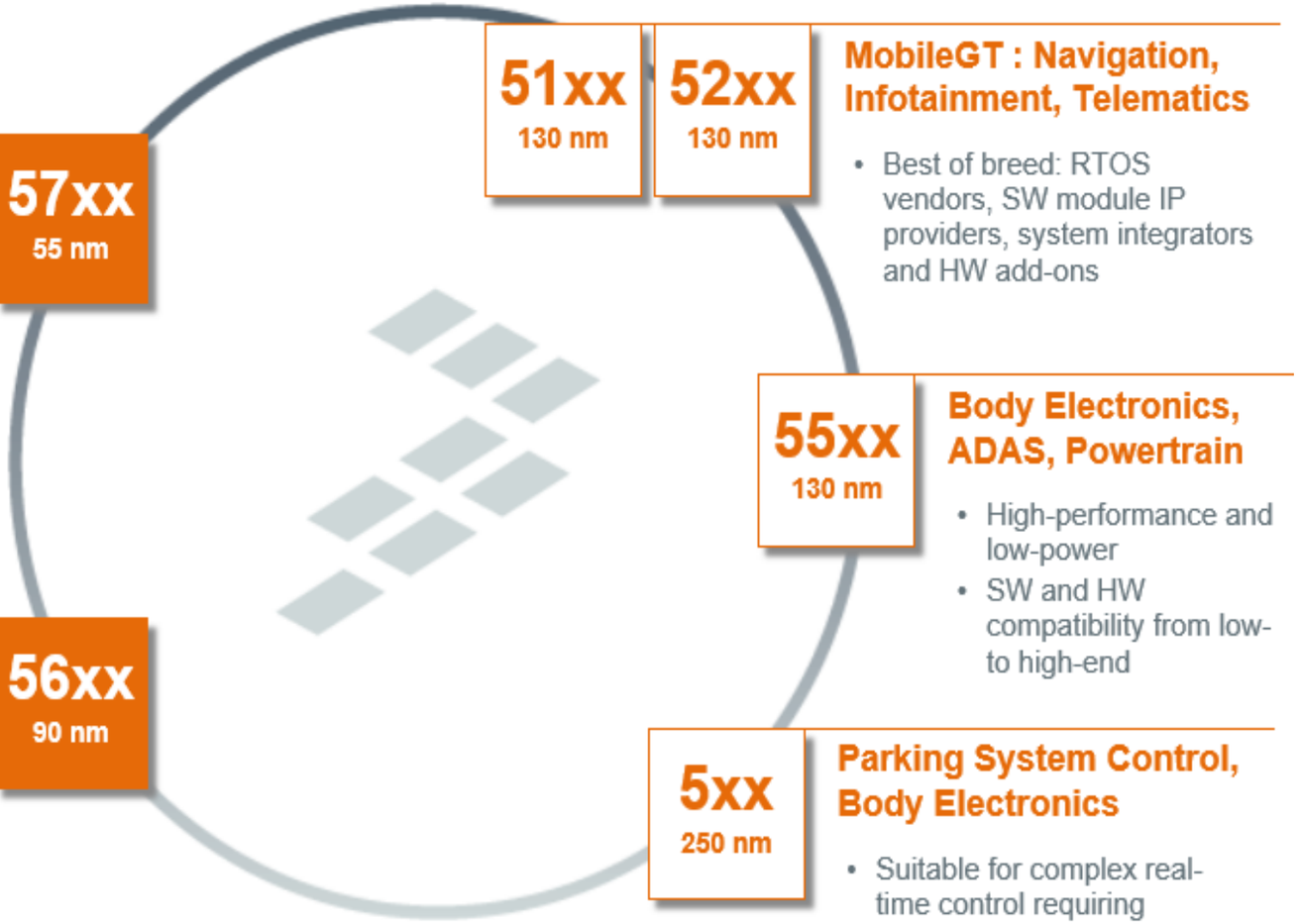
Texas Instruments' 16-bit MSP430

- TI offers the MSP430F20x MCUs specified for operation at a maximum of 85° or 105° C

- AEC-Q100 qualification will only be to the 105°C temperature level identified in AEC-Q100 as Grade 2. That means these MCUs will not be used in the engine compartment

- But the MCUs will be used in cabin applications ranging from lighting control to HVAC control to remote keyless entry systems

Qorivva 32-bit Microcontrollers



51xx
130 nm

52xx
130 nm

MobileGT : Navigation, Infotainment, Telematics

- Best of breed: RTOS vendors, SW module IP providers, system integrators and HW add-ons

55xx
130 nm

Body Electronics, ADAS, Powertrain

- High-performance and low-power
- SW and HW compatibility from low- to high-end

5xx
250 nm

Parking System Control, Body Electronics

- Suitable for complex real-time control requiring computationally complex algorithms

57xx
55 nm

Powertrain, Body Control, ADAS

- Single to multicore
- Functional Safety compliance to standards such as ISO 26262

56xx
90 nm

Wide Range Auto Applications

- Single to dual core
- Functional Safety compliance to standards such as ISO 26262

freescale

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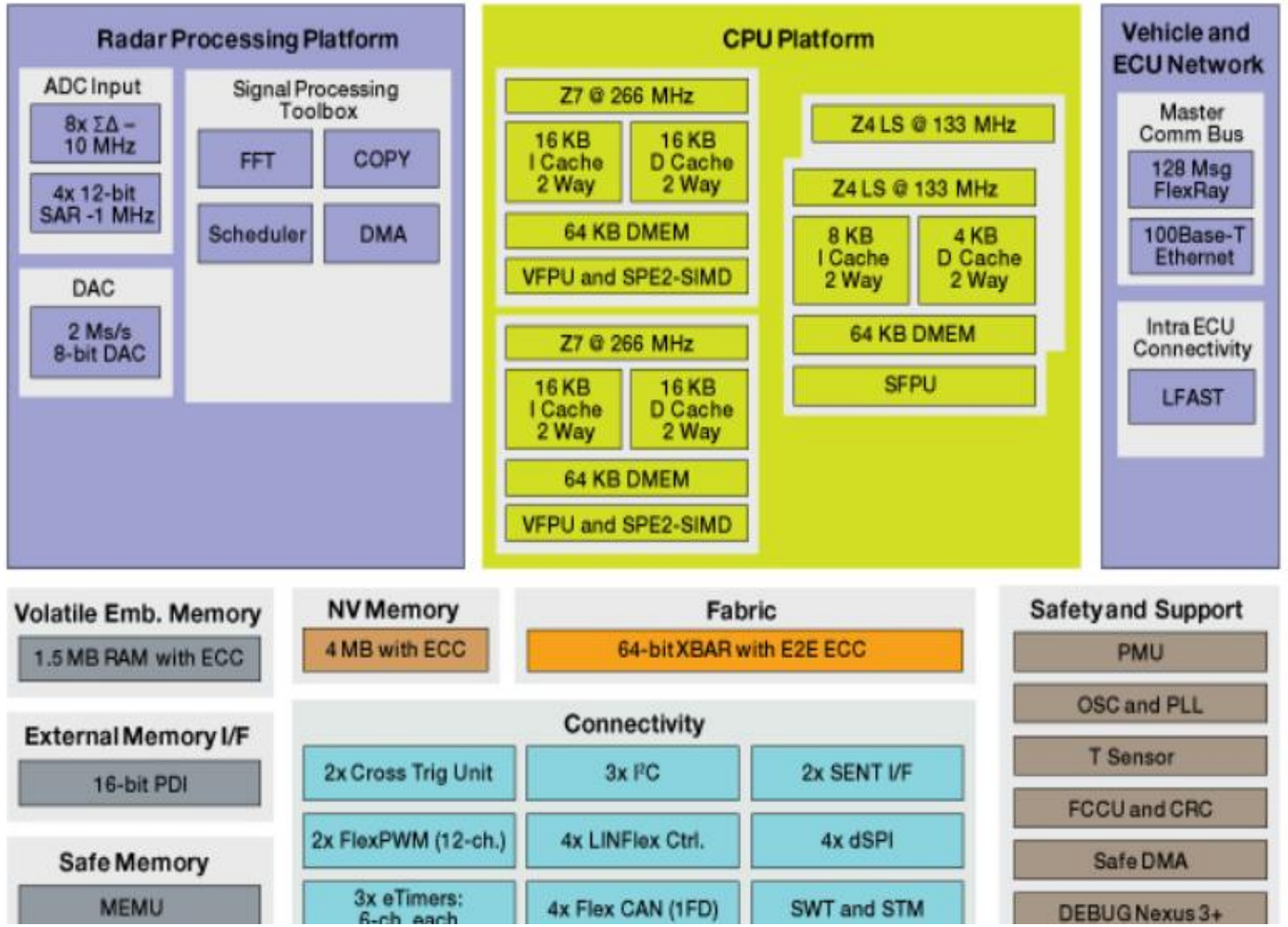
Qorivva MPC55xx

- The Qorivva MPC55xx family, built on Power Architecture® technology, comprises 32-bit MCU devices designed for engine management, advanced driver assistance, central body, and gateway applications.
- The Qorivva MPC55xx offers significant benefits to automotive designers, including:
- Software and hardware compatibility from low- to high-end
- Scalability among different core versions and product features
- Builds upon embedded flash experience implemented in a high density floating-gate technology
- Unmatched efficiency - parallel processing in conjunction with sc 

eral sets
- Leverages Power Architecture tools and software ecosystem

MPC577XK for ADAS



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MPC577XK for ADAS

- The Qorivva MPC577xK family of 32-bit MCUs, built on Power Architecture® technology, provides high levels of digital and analog integration and performance within a single chip for next-generation radar-based advanced driver assistance systems (ADAS)

- The MPC577xK family removes the need for additional external components to the MCU, that are typically used in existing radar systems, such as an FPGA, ADC, DAC and SRAM thus reducing the overall number of components within the system, the size of the PCB and the complexity of software

- The MPC577xK MCU family when combined with the MR2001 77 GHz packaged radar front-end chipset offers a complete system level radar solution for ADAS applications such as adaptive cruise control, emergency braking systems and blind-spot detection. Qorivva MPC577xK MCUs are SafeAssure functional safety solutions.

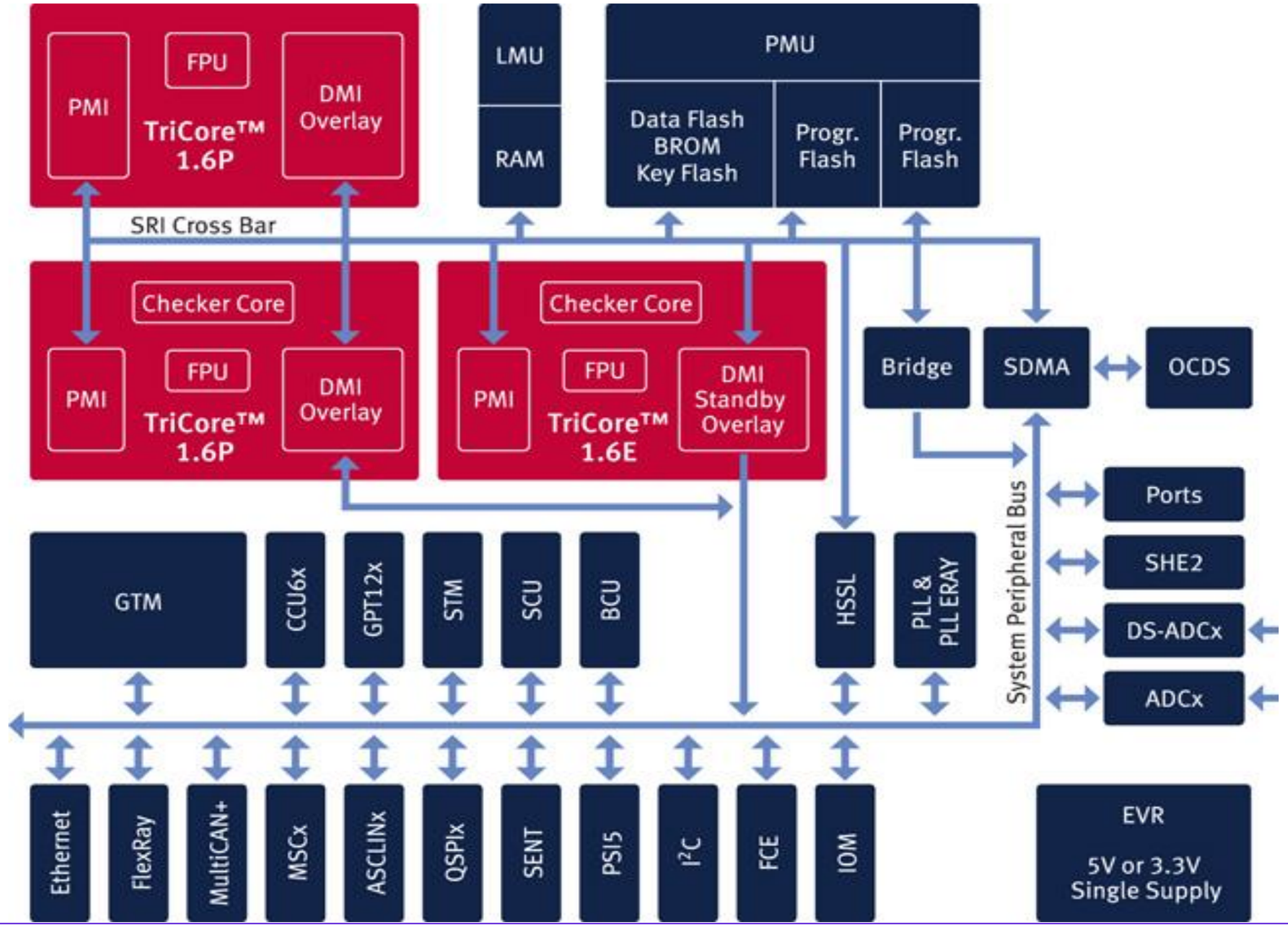
AURIX from Infineon

- AURIX™ is Infineon’s brand new family of microcontrollers serving exactly the needs of the automotive industry in terms of performance and safety

- Its innovative multicore architecture, based on up to three independent 32-bit TriCore™ CPUs, has been designed to meet the highest safety standards while increasing the performance at the same time

- Using the AURIX™ platform, automotive developers will be able to control powertrain, body, safety and ADAS applications with one single MCU platform

Tricore Architecture



Criteria for choosing processors in Automotive

- How much RAM or nonvolatile memory is required?

Storing lots of data is critical for some applications, especially those that have automobile presets, such as seats, steering and radio. Simple switch applications, such as lighting, are not RAM or memory intensive.

- RAM becomes critical when several communication busses are required.
- What is the minimum number of I/O required?

General purpose I/Os are valuable for handling simplistic functions, such as turning things on/off or getting readings from a signal. They give you flexibility to adapt to the needs of an application.

- What peripherals are necessary?

For more complex applications, “smart” peripherals (e.g., eTPU, eMIOS+CTU, XGATE, DMA), which allow more of the CPU bandwidth to be used for the application rather than be used up by repetitive tasks.

For less complex applications (e.g., dimmer switch) a lower-end microcontroller with single channel 8-bit conversion ADC might be suitable.

Criteria for choosing processors in Automotive

- Is Low power or performance is the criteria?
- Some applications have higher requirements for processing, such as airbags and engine control. In these two examples, it is mission critical that an airbag deploy at a precise time and that all parts of an engine maintain synchronization. So, high bus speeds are required to allow quick or complex burst of data to flow without failure.

- Other applications are non-mission critical and can operate with a greater tolerance for error, such as seating and mirrors. In these cases, a lower bus speed will probably be suitable and operating at low power will be the priority.