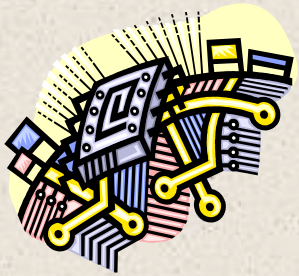
Later Generations

LSI
Large Scale Integration

VLSI
Very Large Scale Integration



Semiconductor Memory
Microprocessors

ULSI
Ultra Large Scale Integration

Semiconductor Memory

In 1970 Fairchild produced the first relatively capacious semiconductor memory

- Chip was about the size of a single core
- Could hold 256 bits of memory
- Non-destructive
- Much faster than core

In 1974 the price per bit of semiconductor memory dropped below the price per bit of core memory

- There has been a continuing and rapid decline in memory cost accompanied by a corresponding increase in physical memory density
- Developments in memory and processor technologies changed the nature of computers in less than a decade

Since 1970 semiconductor memory has been through 13 generations

- Each generation has provided four times the storage density of the previous generation, accompanied by declining cost per bit and declining access time

The Evolution of the Intel x86 Architecture

- Two processor families are the Intel x86 and the ARM architectures
- Current x86 offerings represent the results of decades of design effort on complex instruction set computers (CISCs)
- An alternative approach to processor design is the reduced instruction set computer (RISC)
- ARM architecture is used in a wide variety of embedded systems and is one of the most powerful and best-designed RISC-based systems on the market

Embedded Systems

- The use of electronics and software within a product
- Billions of computer systems are produced each year that are embedded within larger devices
- Today many devices that use electric power have an embedded computing system
- Often embedded systems are tightly coupled to their environment
  - This can give rise to real-time constraints imposed by the need to interact with the environment
    - Constraints such as required speeds of motion, required precision of measurement, and required time durations, dictate the timing of software operations
  - If multiple activities must be managed simultaneously this imposes more complex real-time constraints

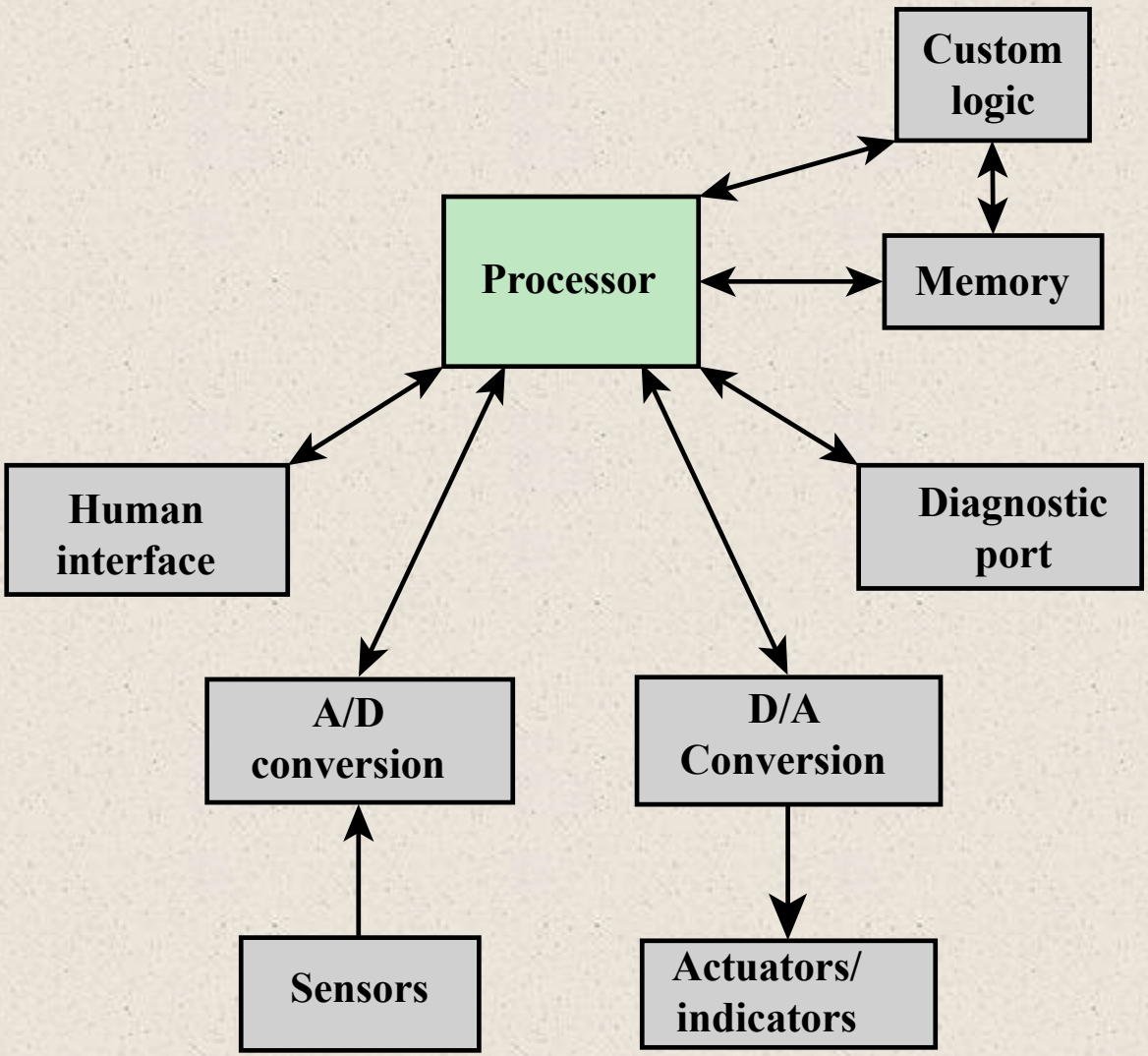


Figure 1.14 Possible Organization of an Embedded System

Embedded Operating Systems

Application Processors versus Dedicated Processors

- There are two general approaches to developing an embedded operating system (OS):
  - Take an existing OS and adapt it for the embedded application
  - Design and implement an OS intended solely for embedded use

- Application processors
  - Defined by the processor's ability to execute complex operating systems
  - General-purpose in nature
  - An example is the smartphone – the embedded system is designed to support numerous apps and perform a wide variety of functions

- Dedicated processor
  - Is dedicated to one or a small number of specific tasks required by the host device
  - Because such an embedded system is dedicated to a specific task or tasks, the processor and associated components can be engineered to reduce size and cost

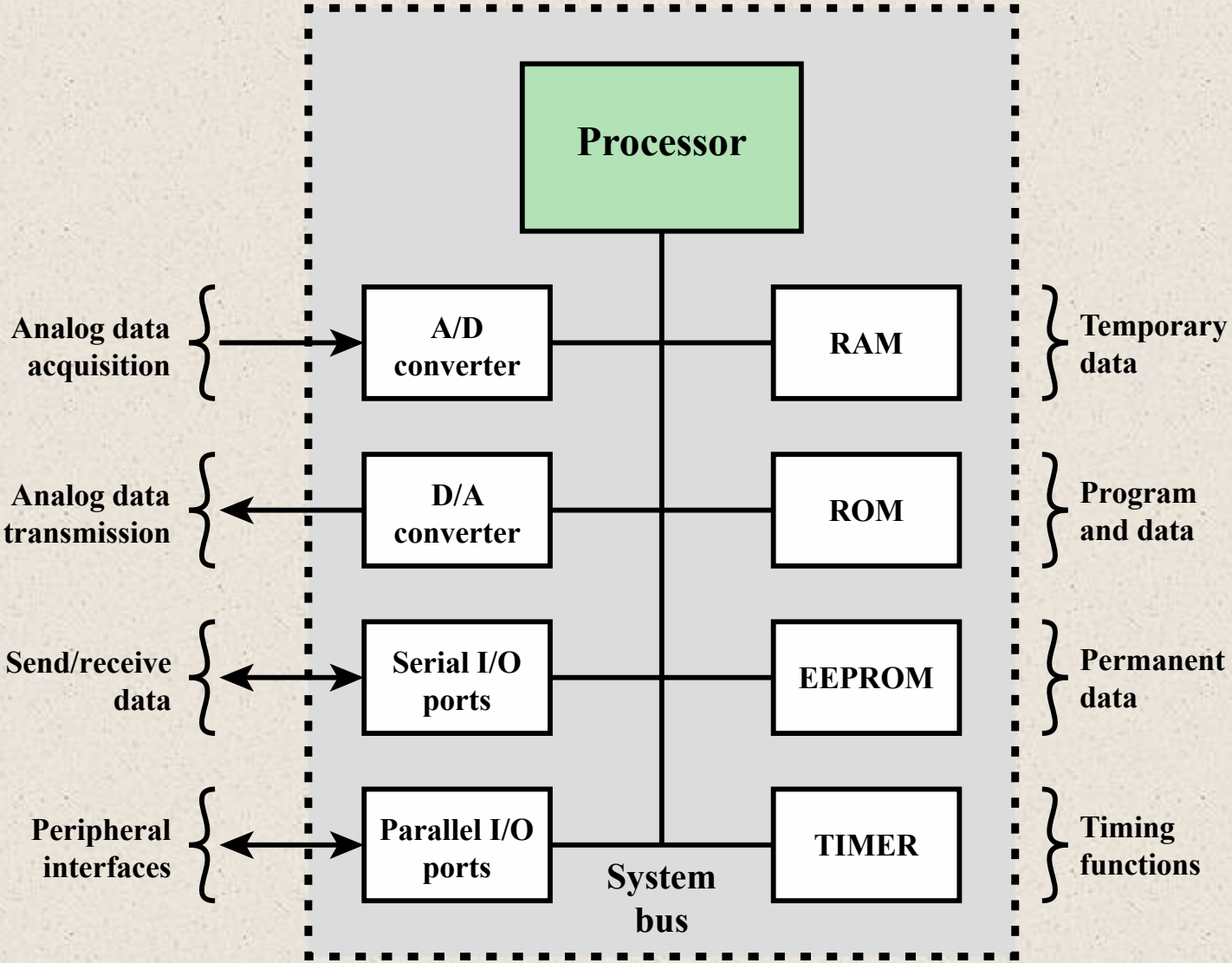
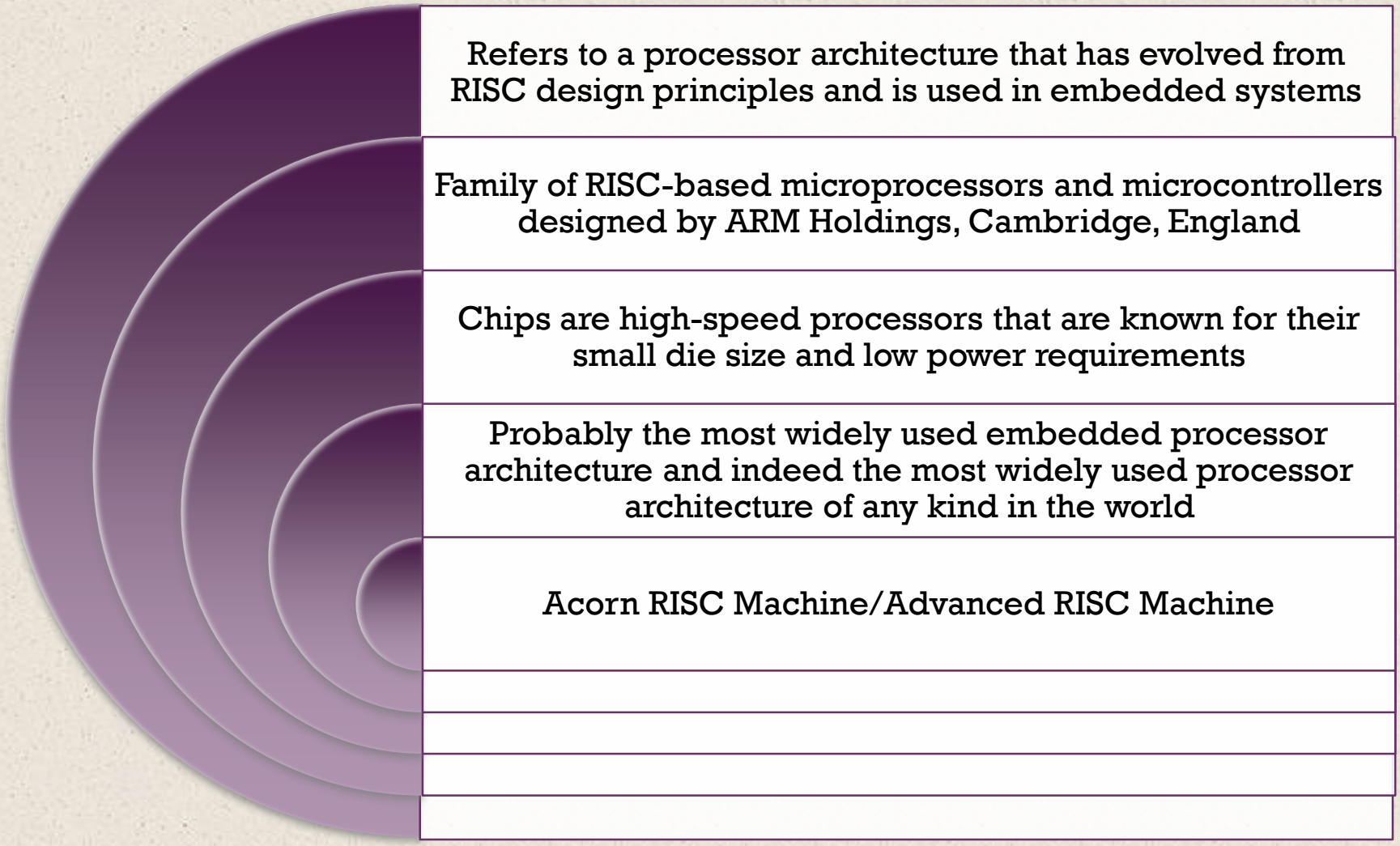


Figure 1.15 Typical Microcontroller Chip Elements

Deeply Embedded Systems

- Subset of embedded systems
- Has a processor whose behavior is difficult to observe both by the programmer and the user
- Uses a microcontroller rather than a microprocessor
- Is not programmable once the program logic for the device has been burned into ROM
- Has no interaction with a user
- Dedicated, single-purpose devices that detect something in the environment, perform a basic level of processing, and then do something with the results
- Often have wireless capability and appear in networked configurations, such as networks of sensors deployed over a large area
- Typically have extreme resource constraints in terms of memory, processor size, time, and power consumption

ARM



ARM Products