Introduction to embedded system and Internet of Things

Unit I

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1.1 Embedded System

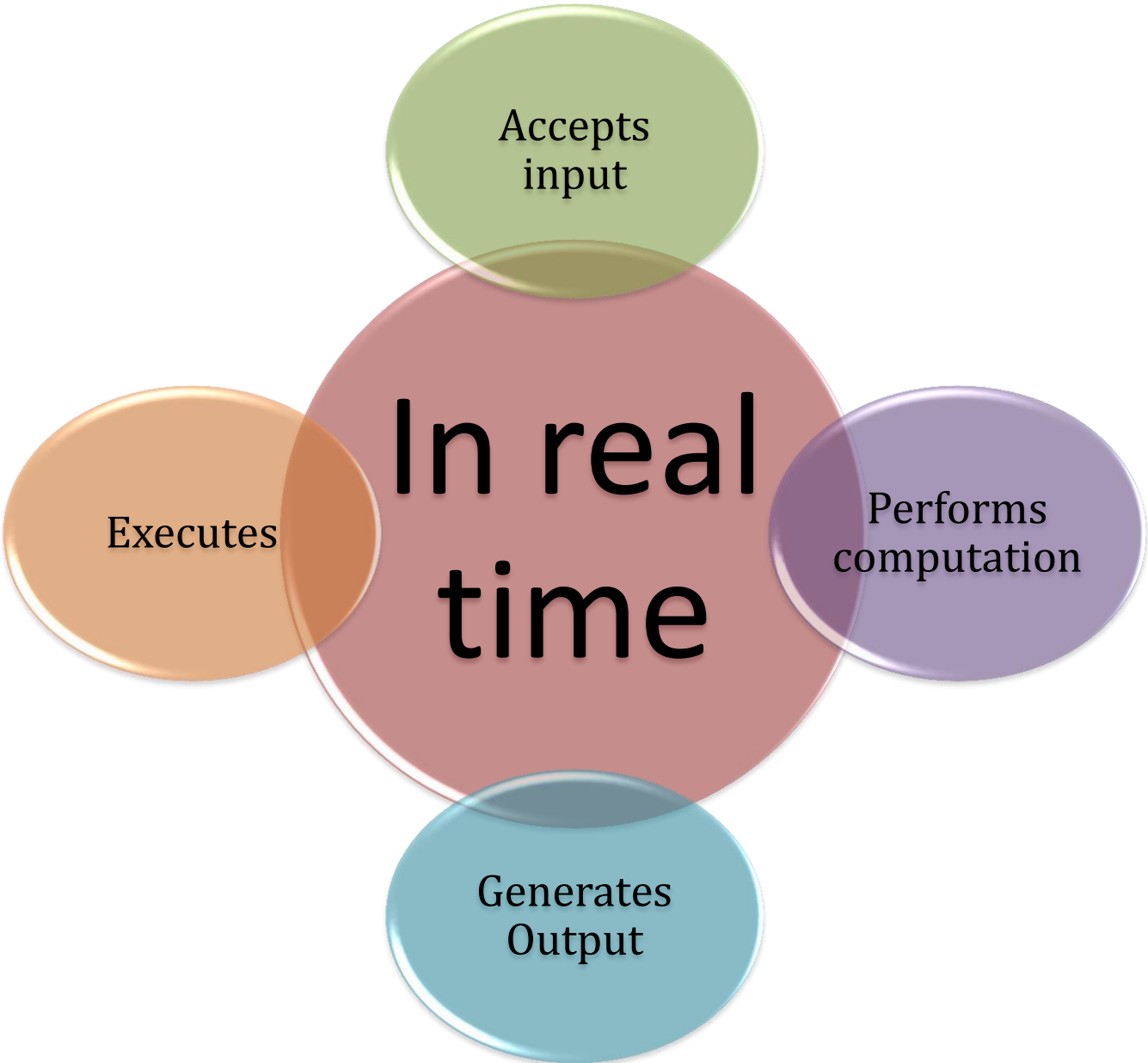
It is an **electronic system which includes a single chip microcomputer(Microcontrollers)** like ARM, Cortex.

It is **configured to perform** certain **dedicated application.**

S/w is **programmed into the on-chip ROM of the microcontroller,** to solve limited range of problems.

The microcontroller is embedded inside the system.

Embedded System…cont



Embedded System…cont

For eg. A typical mobile contains average of 10 microcontrollers

Modern houses approx. 150 microcontrollers per day.

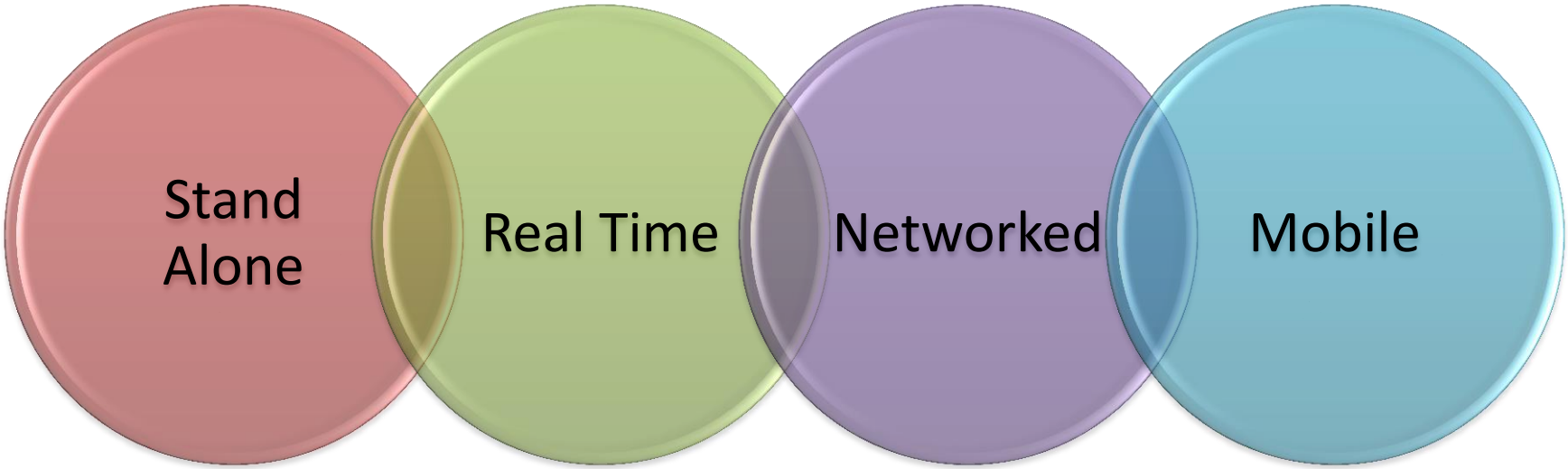
Embedded system generally covers every branch from day-to-day science and technology like communication, military, medical, consumer, machine control.

Eg. Cell phone, Digital camera , microwave, MP3 player, Automobile Anti braking system.

1.2 Characteristics of Embedded System

- Speed (bytes/sec) : should be high.
- Power(watts) : Low power tolerance
- Size and weight : Small size and low weight
- Accuracy(0.9999) : Must be very accurate
- Adaptability : High adaptability and accessibility
- Reliability : Must be reliable for a longer period of time

Categories of Embedded System



Stand Alone System

Works by itself : self-contained device

Does not require any host system like computer

Takes digital/ analog input , calibrates , converts and processes the data and outputs the resulting data to its attached o/p device

Eg : MP3 players, digital cameras, Video game consoles, Microwave oven

Real Time Systems

System which strictly follows time deadline for completion of task is real time system

Two types of Real Time Systems Exist

- Soft : Violation of time constraint just degrades quality of the system but the system continues to work
- Hard : Violation of time causes critical failure and loss of life or property damage.

Soft Real System Examples

Hard Real Time

Delayed alarm during gas leakage

Failure in RADAR functioning

Deadline in missile control

Networked System

Related to n/w interface to access resources

Connected n/w may be LAN , WAN and connection can be wired or wireless

Eg : Home security system

Mobile Systems

- MP3 players, Mobiles, Cellphones, PDAs, Digital cameras which have the limitation of memory

ARM Processor & Its Architecture

ARM PROCESSOR[1]

- The **ARM processor** is a 32-bit RISC processor
- It is built using the reduced instruction set computer (RISC) instruction set architecture (ISA).
- ARM processors are microprocessors and are widely used in many of the mobile phones sold each year, as many as 98% of mobile phones. They are also used in personal digital assistants (PDA), digital media and music layers, hand-held gaming systems, calculators, and even computer hard drives.

TimeLine of ARM

- 1985: Acorn Computer Group manufactured the first commercial RISC microprocessor.
- 1990: Acorn and Apple participation leads to the founding of Advanced RISC Machines (A.R.M.).
- 1991: ARM6, First embeddable RISC microprocessor.
- 1992 – 1994: Various companies use ARM (Sharp, Samsung), while in 1993 ARM7, the first multimedia microprocessor was introduced.

ARM Architecture

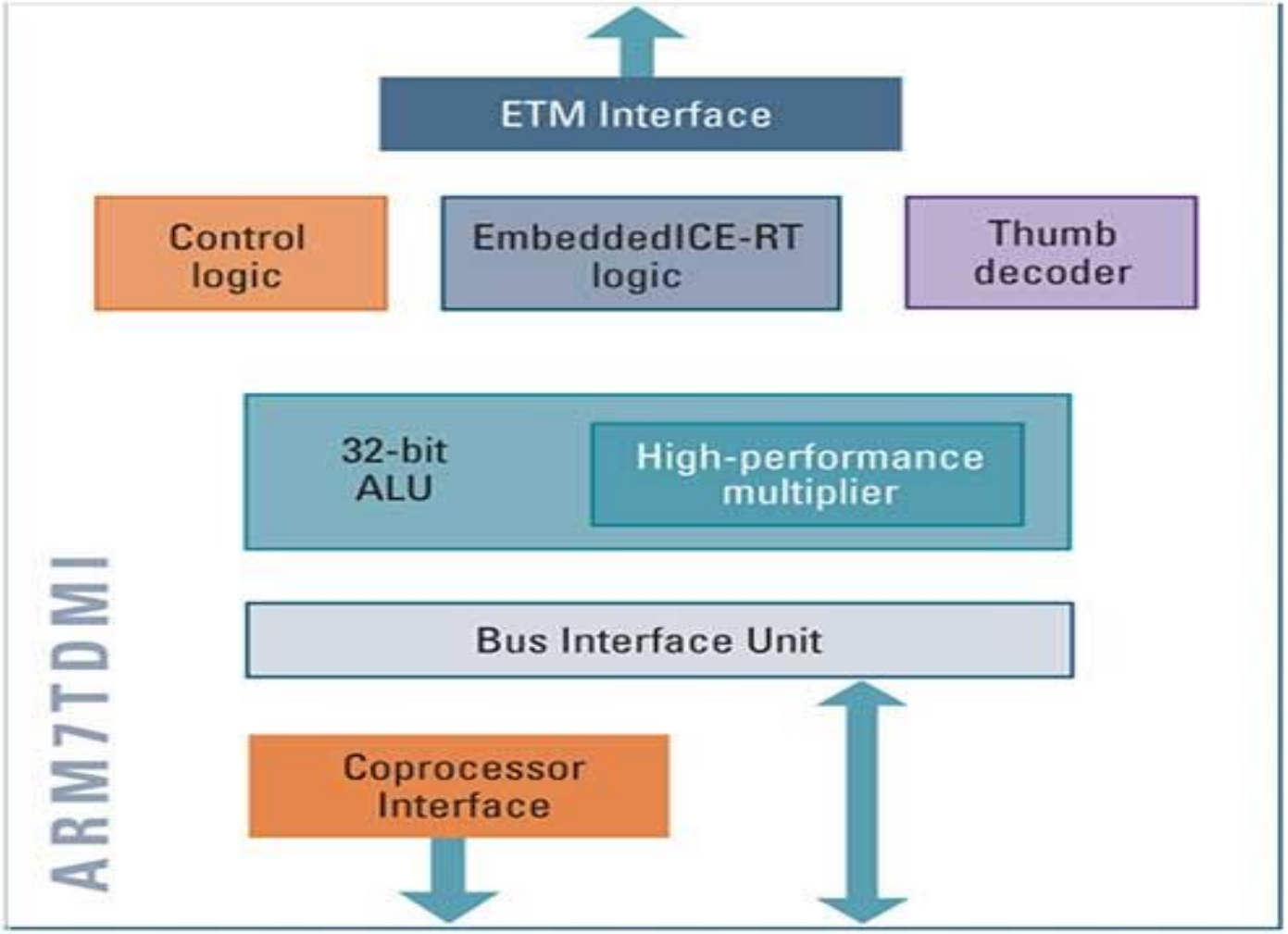
- ARM machines have a 32 bit Reduced Instruction Set Computer (RISC) **Load Store Architecture**.
- The **direct manipulation of memory isn't possible** in this architecture and is **done through the use of registers.**
- The instruction set offers many conditional and other varieties of operations with the primary focus being on **reducing the number of cycles per instruction** featuring mostly single cycle operations.

ARM Architecture….Contd[2]

The main Features of **ARM7** is,

- 32/16-bit **RISC architecture.**
- 32-bit ARM instruction set for maximum performance and flexibility.
- **16-bit Thumb instruction set** for increased code density.
- Unified bus interface**, 32-bit data bus carries both instructions and data.**
- **Three-stage pipeline : FETCH, DECODE and EXECUTE.**
- **32-bit ALU.**
- Very small die size and low power consumption.
- Fully static operation.
- Coprocessor interface.
- Extensive debug facilities (Embedded ICE debug unit accessible via JTAG interface unit) **: that allows programs to be downloaded and fully debugged in-system.**

ARM Architecture



ARM Architecture….Contd

- Control over both the Arithmetic Logic Unit (ALU) and shifter in most data-processing instructions to maximize the use of an ALU and a shifter.
- Auto-increment and auto-decrement addressing modes to optimize program loops.
- Load and Store Multiple instructions to maximize data throughput.
- Conditional execution of almost all instructions to maximize execution throughput

- ARM has 31 general-purpose 32-bit registers, At any one time, 16 of these registers are visible
- These registers are used by all unprivileged code.**(User mode Registers) i.e** less access to memory and coprocessor

Privileged execution modes

- **Fast interrupt processing mode** Used when processor receives an interrupt signal from the designated fast interrupt source.
- **Normal interrupt processing mode**: When processor receives an interrupt signal from any other interrupt source.
- **Software interrupt mode** : When the processor encounters a software interrupt instruction.
- **Undefined instruction mode** :When the processor attempts to execute an instruction that is supported neither by the main integer core nor by one of the coprocessors.
- **System mode** is used for running privileged operating system tasks.
- **Abort mode** is : When memory fault exists

Reference

[1] https:// www. computerhope.com /jargon /a/ arm.htm

[2] https://www.pantechsolutions.net/microcontroller-tutorials/getting-started-with-arm-architecture