# Introduction to Embedded System

**Presented By**

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# Agenda

- ✓ **Introduction to Embedded System**
- ✓ **General Characteristics of Embedded System**
- ✓ **Classification of Embedded System**
- ✓ **Essential Components of Embedded System**
- ✓ **Overview of Processors and Hardware Units in an Embedded system**
- ✓ **Application of Embedded System**

# What is a system?

A system is a way of working, organizing or doing one or many tasks according to a fixed plan, program or set of rules.

For example: Watch is a time display system with parts: Hardware, Needles, Battery, Dial, Chassis and Strap.

***Rules***:

- ✓ All needles move clockwise direction.
- ✓ A thin needle rotates every second.
- ✓ A long needle rotates every minute.
- ✓ A short needle rotates every hour.
- ✓ All needles return to the original position after 12 hours.

# Introduction to Embedded System

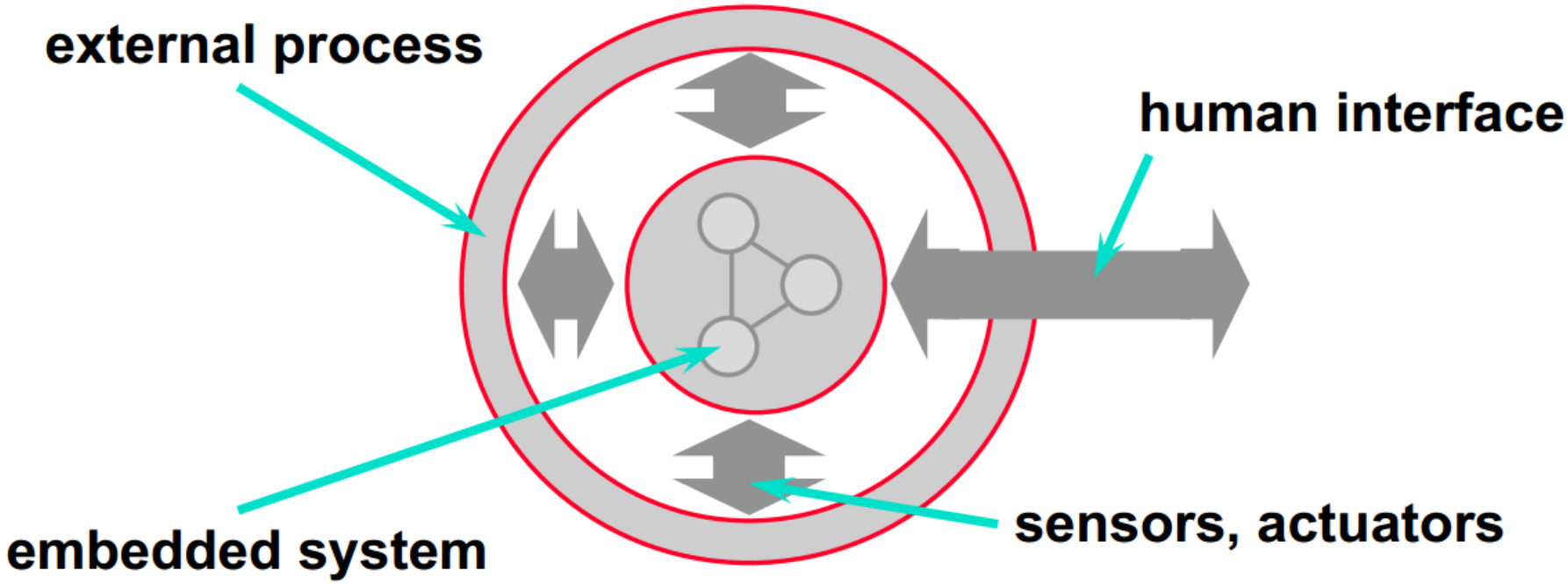
- David E. Simon "People use the term embedded system to mean any computer system hidden in any of these products."

- Todd D. Morton "Embedded Systems are electronic systems that contain a microprocessor or microcontroller, but we do not think of them as computers – the computer is hidden or embedded in the system."

- Tim Wilmshurst
  - "An embedded system is a system whose principal function is not computational, but which is controlled by a computer embedded within it. The computer is likely to be a microprocessor or microcontroller. The word embedded implies that it lies inside the overall system, hidden from view, forming an integral part of greater whole. "
  - "An embedded system is a microcontroller-based, software-driven, reliable, real time control system, autonomous, or human- or network-interactive, operating on diverse physical variables and in diverse environments, and sold into a competitive and cost-conscious market".

# Introduction to Embedded System

- ✓ **Any device that includes a computer but is not itself a general-purpose computer(Mainframe or Desktop).**
- ✓ **Respond to the external events.(e.g. someone pushes an elevator button.)**



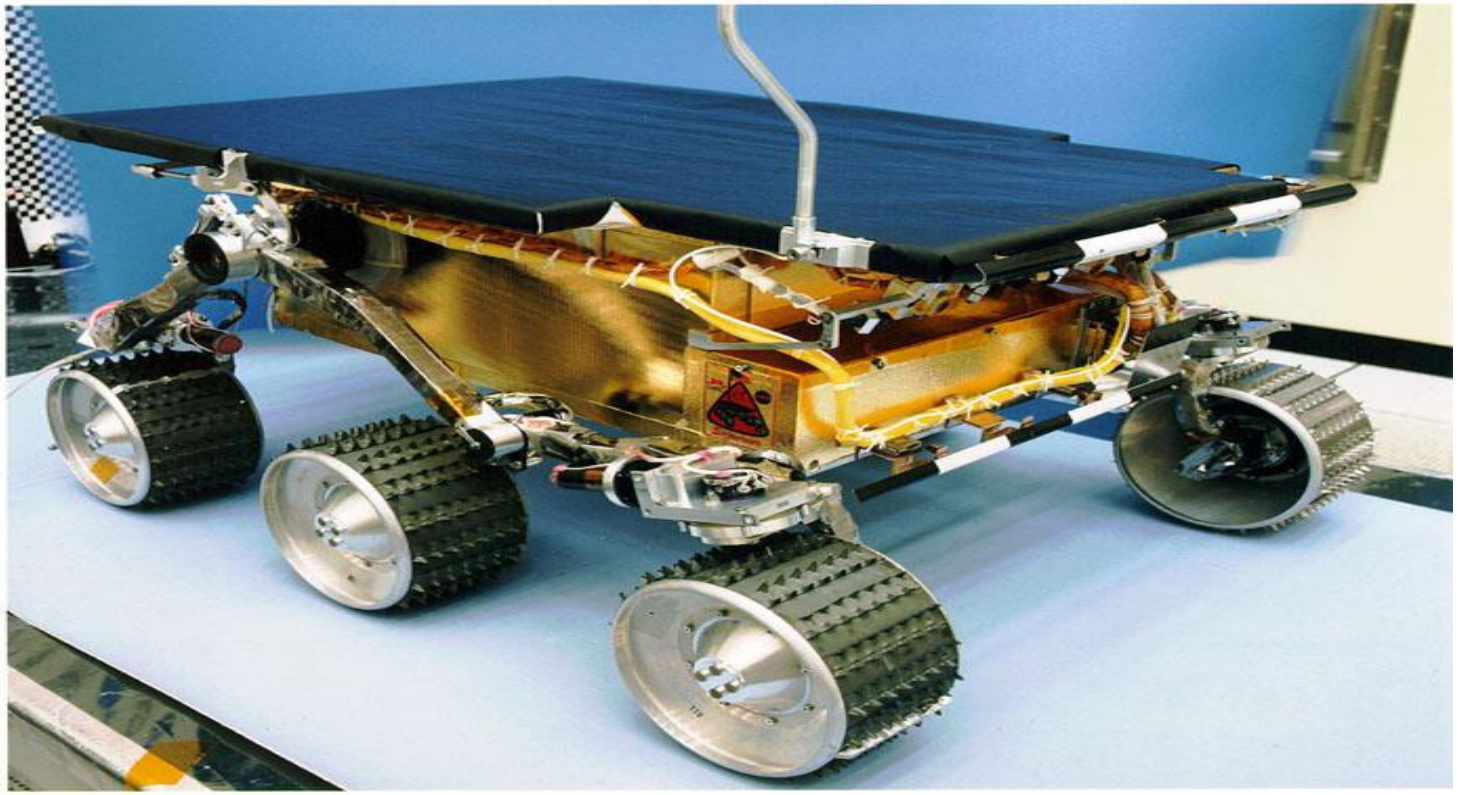
# Introduction to Embedded System

- ✓ **Part of the large system.**
- ✓ **Expected to function without human intervention.**
- ✓ **Their work is subject to deadlines.**
- ✓ **Combination of software and hardware.**
- ✓ **Current ES are Multi-core, Multi-Platform mostly in real time and at Low Power Consumption.**

# Introduction to Embedded System

- **Examples:**

  **Product: NASA's Mars Sojourner Rover. Microprocessor: Intel 8-bit 80C85, 512 kB of RAM, 176 kb of flash memory, Vxworks operating system, 3- Navigation Cameras.**



# Introduction to Embedded System

- **Examples:**

  **Product: Sony Aibo ERS-110 Robotic Dog. Microprocessor: 64-bit MIPS RISC.**

# General Characteristics of ES

- Single-functioned
  - Executes a single program, repeatedly
- Tightly-constrained
  - Low cost, low power, small, fast, etc.
- Real-time
  - Must compute certain results in real-time without delay.
  - In Hard Real time any delay in deadline could result in a catastrophe.

# General Characteristics of ES Contd.

- Must be Dependable
  - Reliability, Maintainability, Availability, Safety, Security.
- Reactive
  - Continually reacts to changes in the system's environment.
- Sophisticated Functionality
  - Often have to run sophisticated or multiple algorithms for
  - example cellphones, laser printer.

# Classification of ES

- Small Scale ES:
  - Single 8-bit or 16-bit Microcontroller.
  - Little Hardware and Software complexity.
  - They may be battery operated.
  - Usually C may be used to develop such system.
  - Programming Tools:
    - Editor, Assembler and Cross Assembler.
  - Example: Stepper motor controller for a robotics system, Washing system, Computer Mouse, Printer, Scanner, Remote controller etc…

# Classification of ES Contd.

- Medium Scale ES:
  - Single or few 16 or 32-bit microcontrollers or Digital Signal Processors(DSP) or Reduced Instruction Set Computers(RISC).
  - Both Hardware and Software Complexity.
  - Programming tools
    - RTOS, Source Code Engineering tool, Simulator, Debugger and Integrated Development Environment(IDE).
  - Example: Banking systems like ATM and Credit card transactions, Entertainment systems like Video and Music system etc…

# Classification of ES Contd..

- Sophisticated ES:
  - Enormous Hardware and Software complexity.
  - May need scalable processor or configurable processor and programming logic arrays.
  - Constrained by the processing speed available in their hardware units.
  - Example: Real time video processing system, Speech or Multimedia processing system.
  - Programming Tools
    - For these systems may not be readily available at reasonable cost or may not be available at all. A compiler or retargetable compiler might have to be developed for this.

# Essential Components of ES

- Embeds hardware.
  - Processors, Timers, Interrupt Controller, I/O devices, Memories, Ports etc.
- Embeds main application software generally into flash or ROM and the application software performs concurrently the number of tasks.
- Embeds a real time operating system, which supervises the application software tasks running on the hardware and organizes the accesses to the system resources according to priorities and timing constraints of tasks in the system.

# Overview of Processors in ES

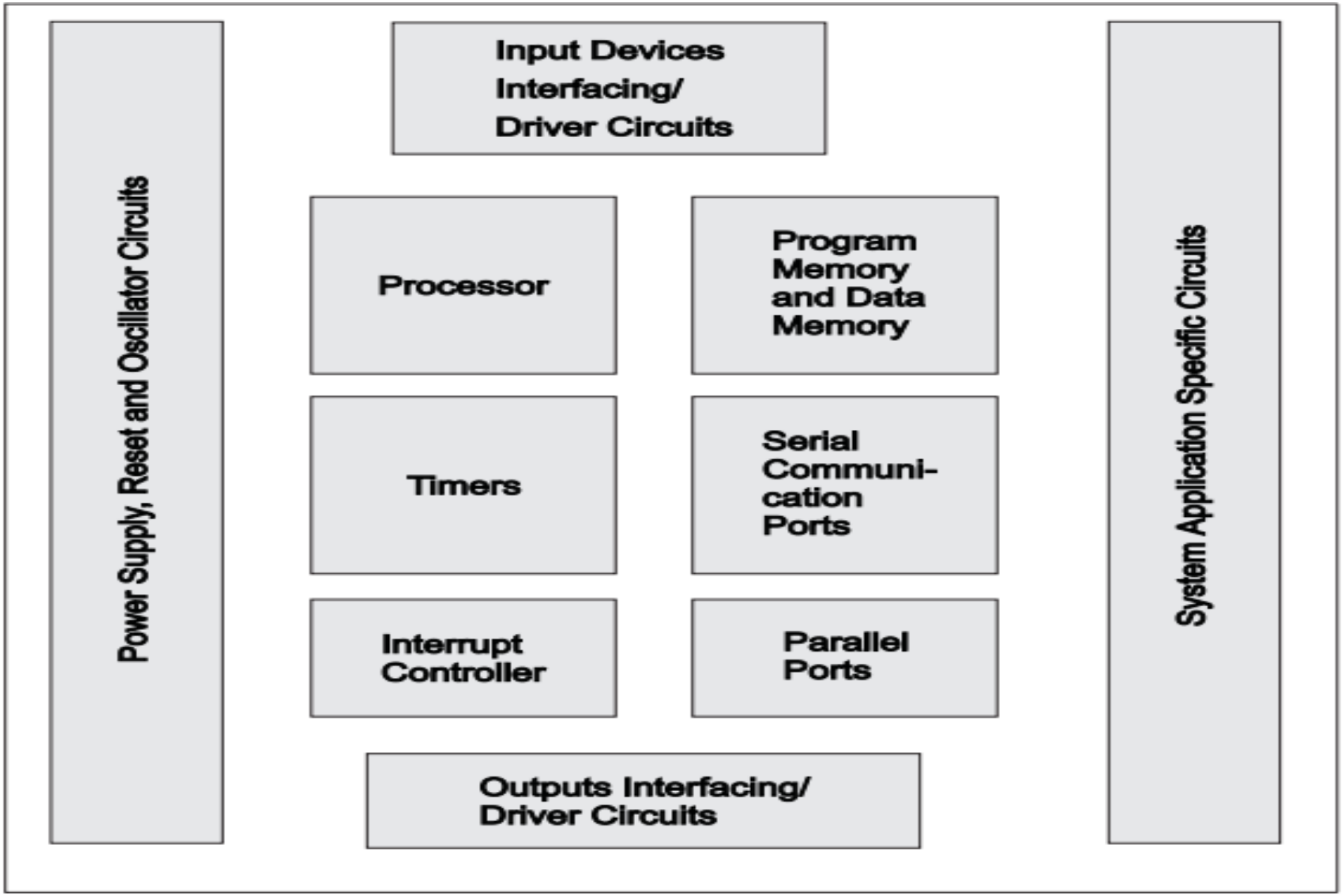
- General Purpose Processor
  - Microprocessor
    - Intel : 8085, 8086, 80186, 80188, 80286,80386
    - Motorola: 6800, 6809, G3, G4,G5
  - Microcontroller
    - Intel: 8032, 8051, 8052
    - PIC: 8-bit PIC 16, PIC18, 16-bit DSPIC33/PIC24
    - Motorola: 6811
  - Embedded Processor
    - AndeScore N9/10/12, ARM 7/9/11, Intel i960, AMD 29050.
  - Digital Signal Processor
    - PAC, TMS32oCXX, SHARC, Motorola 5600XX.

# Overview of Processors in ES Contd..

- Application-Specific Processor:
  - Dedicated to specific tasks like image compression and provides faster solution.
  - Used as an additional processing unit for running the application in place of using embedded software.
  - Example: IIM7100, W3100A.

- Single-Purpose Processor
  - Digital circuit designed to execute only a single program.
  - Contains only the components to execute a single program.
  - No program memory.
  - Example: coprocessor, accelerator or peripheral.

# Hardware Units in Embedded System



# Application of ES

- ✓ Automotive Electronics
- ✓ Aircraft Electronics
- ✓ Trains
- ✓ Telecommunication
- ✓ Medical Systems
- ✓ Military Applications
- ✓ Authentication Systems
- ✓ Consumer Electronics e.g MP3 Audio, digital Camera, home electronics etc.
- ✓ Robotics etc…