Embedded Systems and IOT

2025/2026

Lecture 1

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Embedded Systems and IOT

Introduction: Examples

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Introduction cont'd

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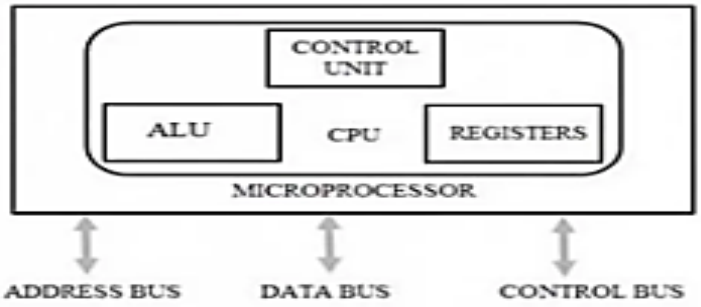
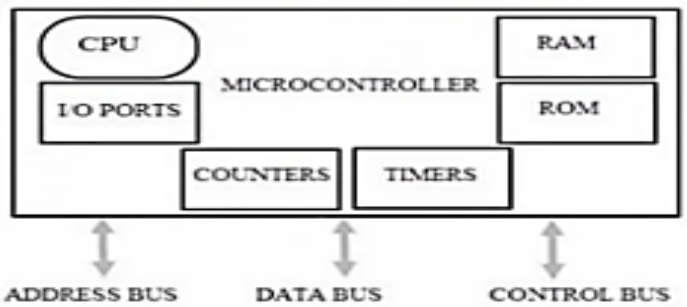
Introduction cont'd

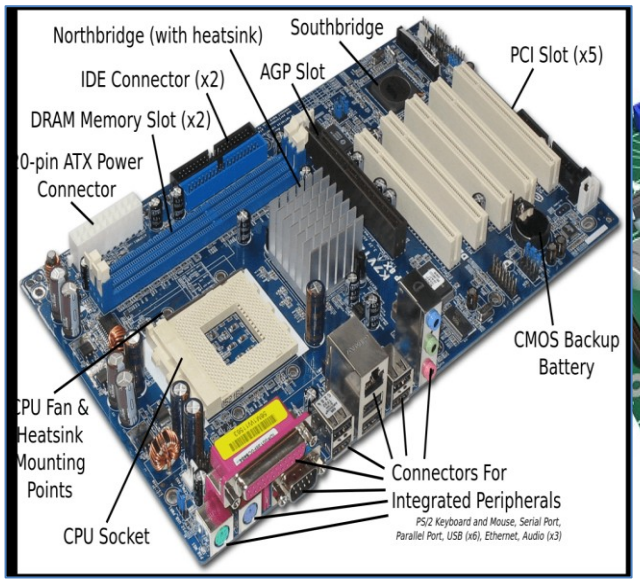
Computer Architecture

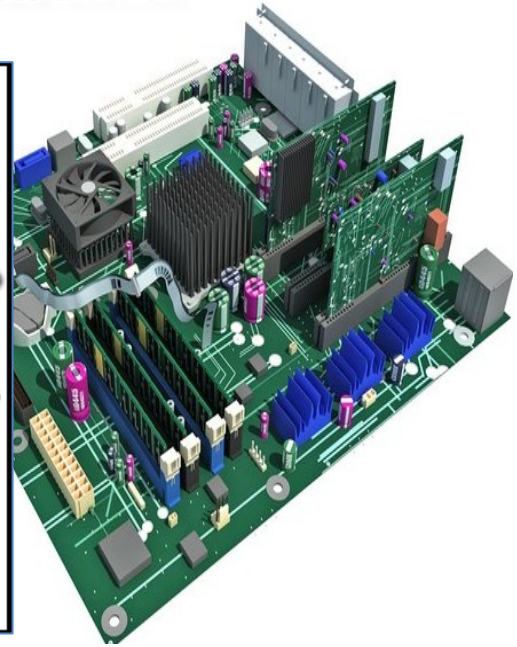
Microprocessor

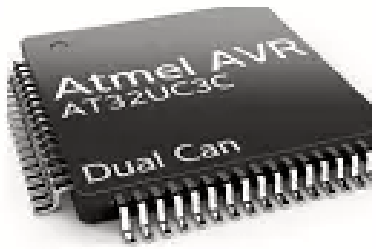


Microcontroller

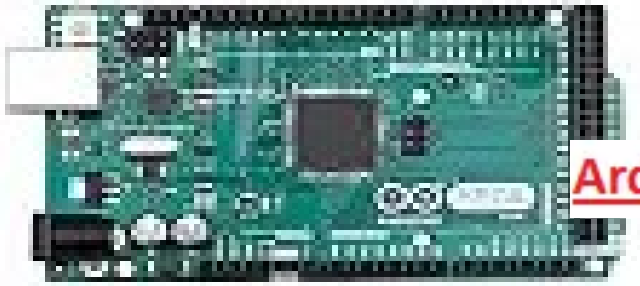








Atmel AVR PIC 18F877A



Arduino

Introduction cont'd

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Feature	Microprocessor	Microcontroller
Functionality	Primarily designed for general-purpose computing, handling complex tasks.	Specialized for embedded systems, typically for specific applications or tasks.
Integration	Central Processing Unit (CPU) is the primary focus, with external components added as needed.	Integrated CPU, memory, and peripherals on a single chip.
Purpose	Used in computers, workstations, servers, and high-level computing applications.	Designed for embedded systems, consumer electronics, and specific control applications.
Cost	Tends to be more expensive due to higher processing power and general-purpose nature.	Often more cost-effective, tailored to specific applications, and includes necessary components.
Power Consumption	May consume more power due to higher processing capabilities.	Typically designed for low-power consumption, suitable for battery-powered applications.
Memory	External memory is required for program storage and data handling.	Often includes built-in Flash memory for program storage and RAM for data handling.
Peripheral Support	Limited on-chip peripherals; external components added as needed.	Integrates a variety of on-chip peripherals like timers, ADC, GPIO, and communication interfaces.
Complexity	Generally more complex due to broader functionality.	Simpler design, focused on specific tasks, reducing overall complexity.
Examples	Intel Core series, AMD Ryzen series.	PIC Microcontrollers, AVR Microcontrollers, ARM Cortex-M series.
Application Examples	Personal computers, servers, high-level computing systems.	Embedded systems, IoT devices, consumer electronics, control systems.
Development Environment	Typically uses high-level programming languages.	Often programmed in lower-level languages for resource efficiency.
Real-Time Operation	May not be optimized for real-time operation.	Often designed with real-time capabilities for control applications.
Clock Speed	Generally operates at higher clock speeds.	Operates at moderate to lower clock speeds depending on the application.

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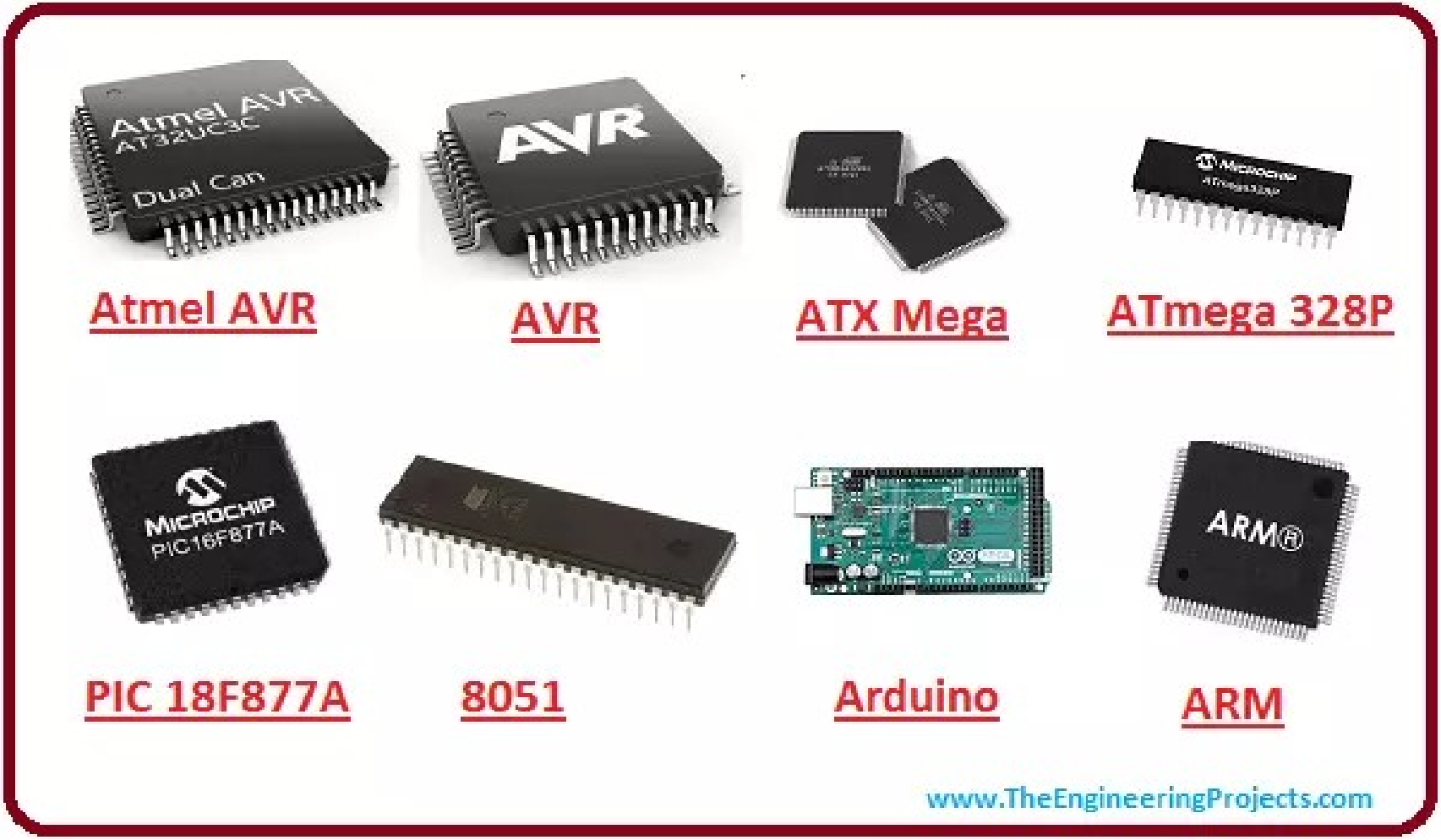
Introduction cont'd



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Introduction cont'd

Comparison of 8051, PIC, And ARM Microcontrollers

Feature	8051 Microcontrollers	PIC Microcontrollers	ARM Microcontrollers
Architecture	Harvard, 8-bit,RSIC	Modified Harvard, 8-bit/16-bit,RSIC	RISC, 32-bit/64-bit
Instruction Set	Simple 8-bit instruction set	Diverse set for 8-bit/16-bit	RISC-based instruction set
Memory	Limited on-chip memory • **Program Memory (Flash):** 4 KB • **Data Memory (RAM):** 128 bytes	Varied configurations (RAM, Flash, EEPROM) PIC16F877 • **Program Memory (Flash):** 14 KB • **Data Memory (RAM):** 368 bytes • **EEPROM:** 256 bytes	Larger on-chip memory (Flash, RAM) LPC2148 • **Program Memory (Flash):** 512 KB • **Data Memory (RAM):** 32 KB
Peripheral Integration	Basic set of peripherals • UART • Timers/Counters	Rich set of integrated peripherals • Analog-to-Digital Converter (ADC) • Parallel Slave Port (PSP) for parallel communication • Capture/Compare/PWM (CCP) modules	Versatile, wide range of peripherals • **CAN** (Controller Area Network) • **USB** (Universal Serial Bus) • **JTAG** (Joint Test Action Group) - for debugging
Power Consumption	Generally low power consumption	Designed for power efficiency	Varied power options
Applications	Simple embedded systems, home appliances	Consumer electronics, automotive, industrial control	IoT devices, high-performance computing
Manufacturer	Various manufacturers • Intel • Atmel (now a part of Microchip Technology) • NXP Semiconductors • Silicon Labs	Microchip Technology	Various manufacturers (ARM Holdings licenses the architecture) • **STMicroelectronics** • Texas Instruments • NXP (Philips) • Atmel
Example ICs	AT89C51, AT89S52, AT89C2051	**PIC16F877A**, PIC18F4550, **PIC32MX** series	ARM Cortex-M series (e.g., Cortex-M0, **Cortex-M3(LPC2148)** Cortex-M4)
Advantages	Educationally established	Rich peripherals for diversity.	Versatile, scalable, high processing power.

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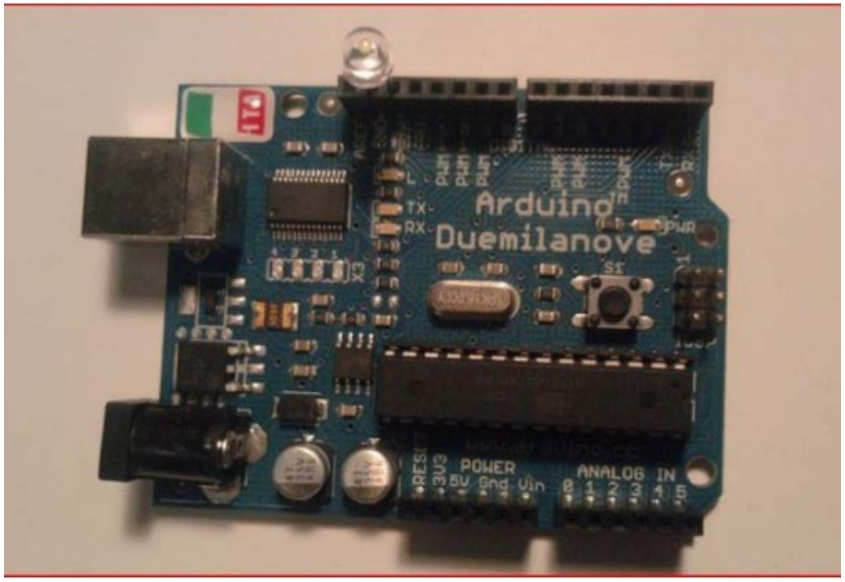
Introduction cont'd



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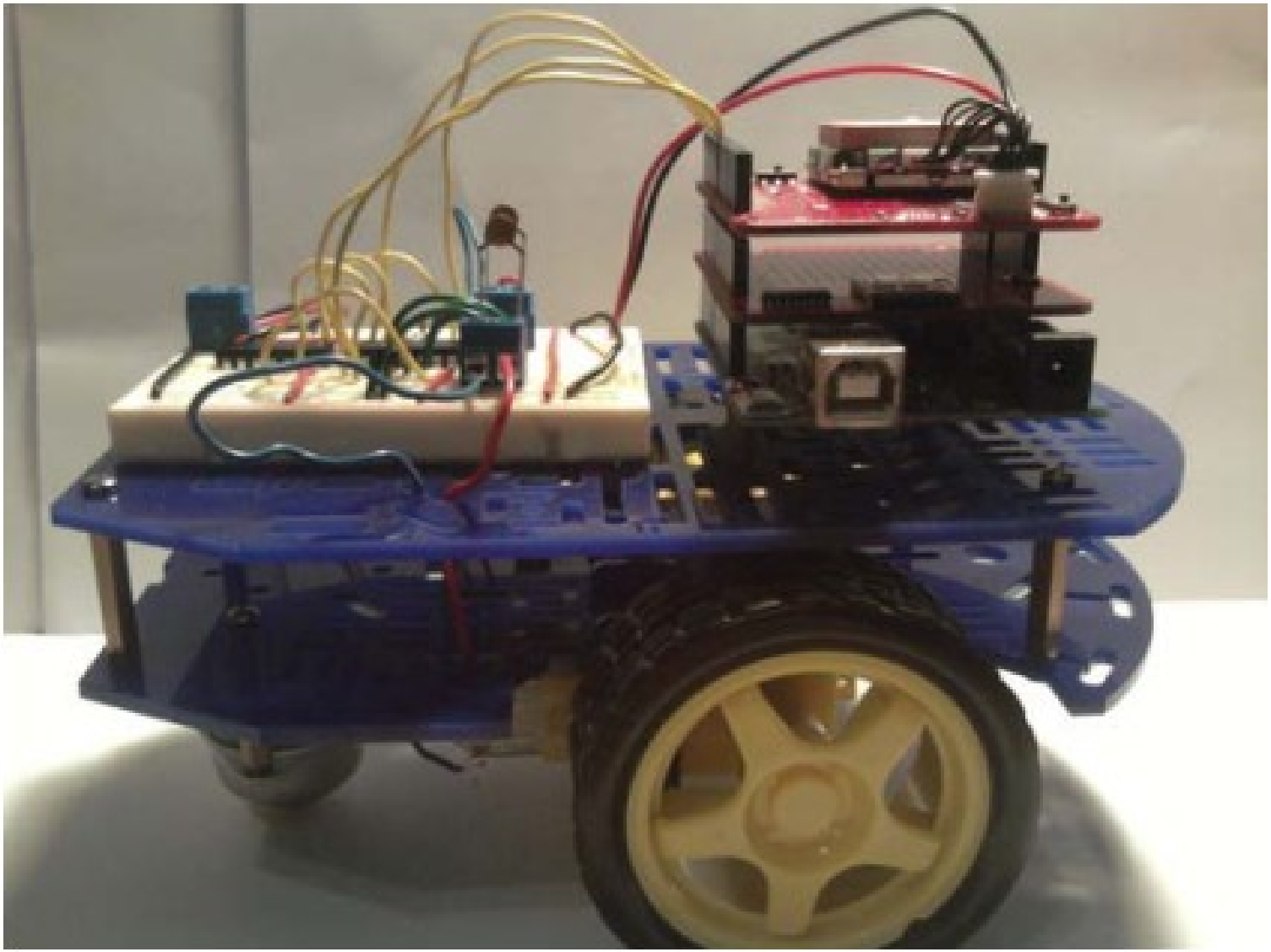

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Introduction cont'd

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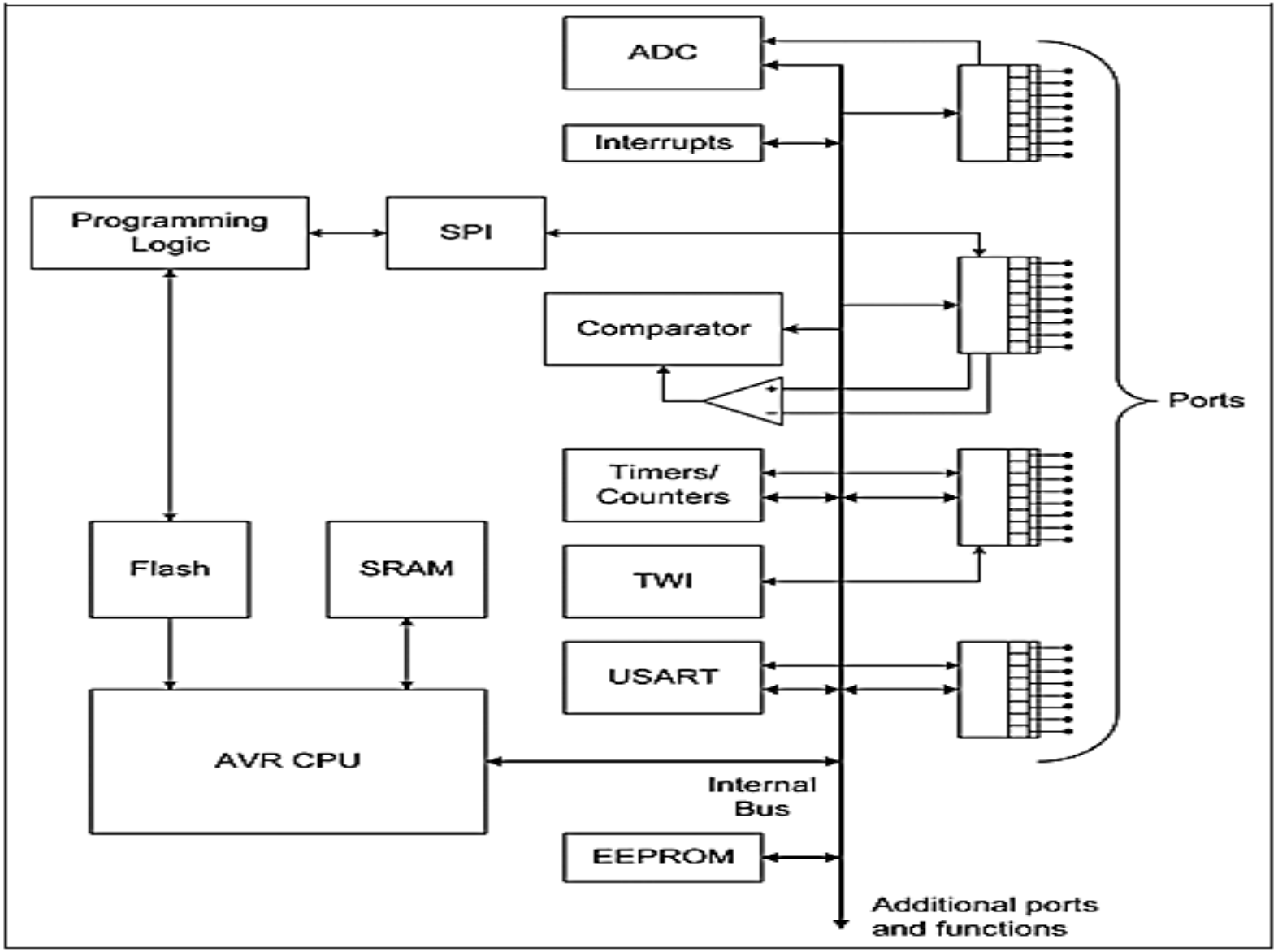
Introduction: Generic AVR microcontroller block diagram



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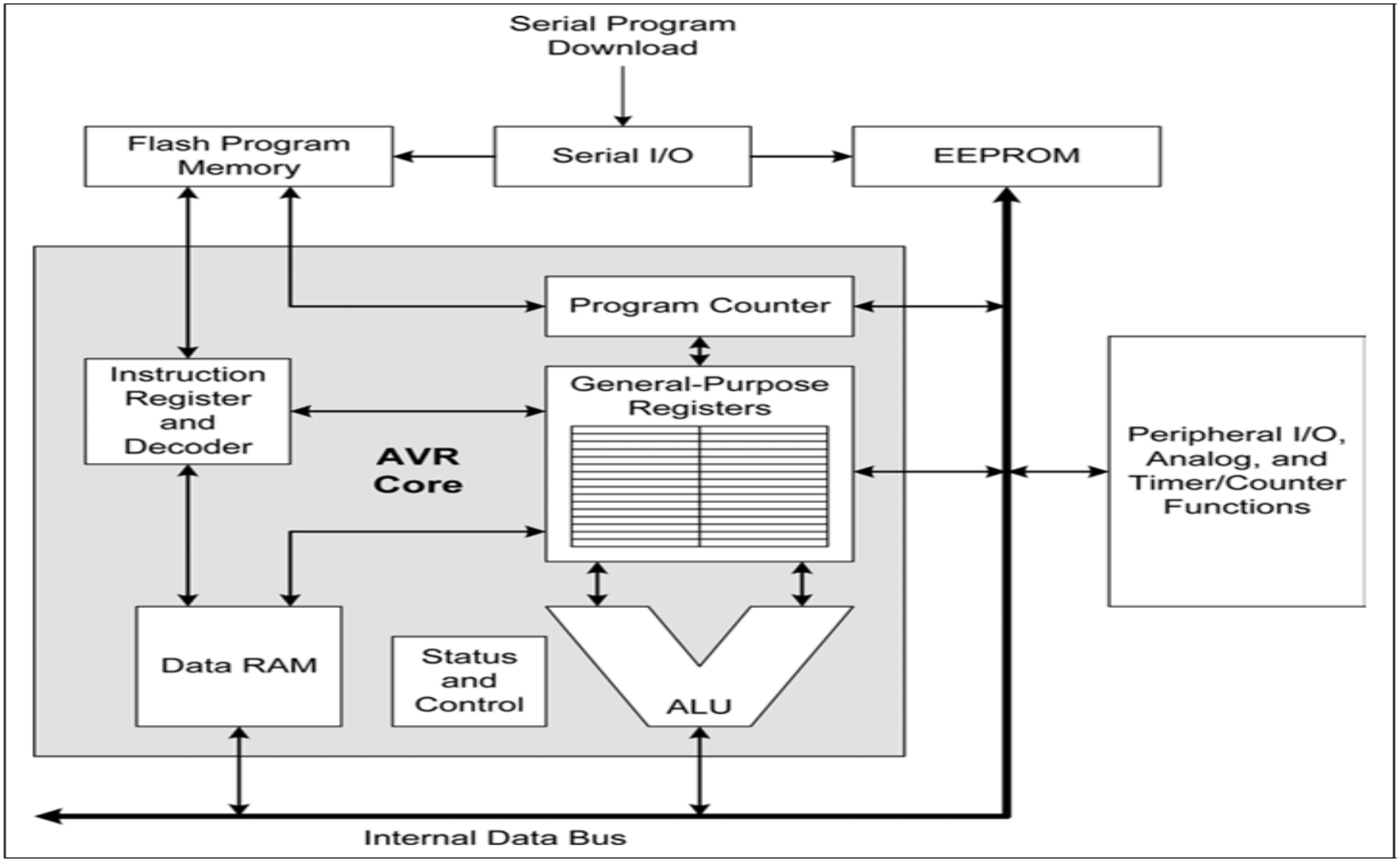
Introduction: AVR CPU block diagram



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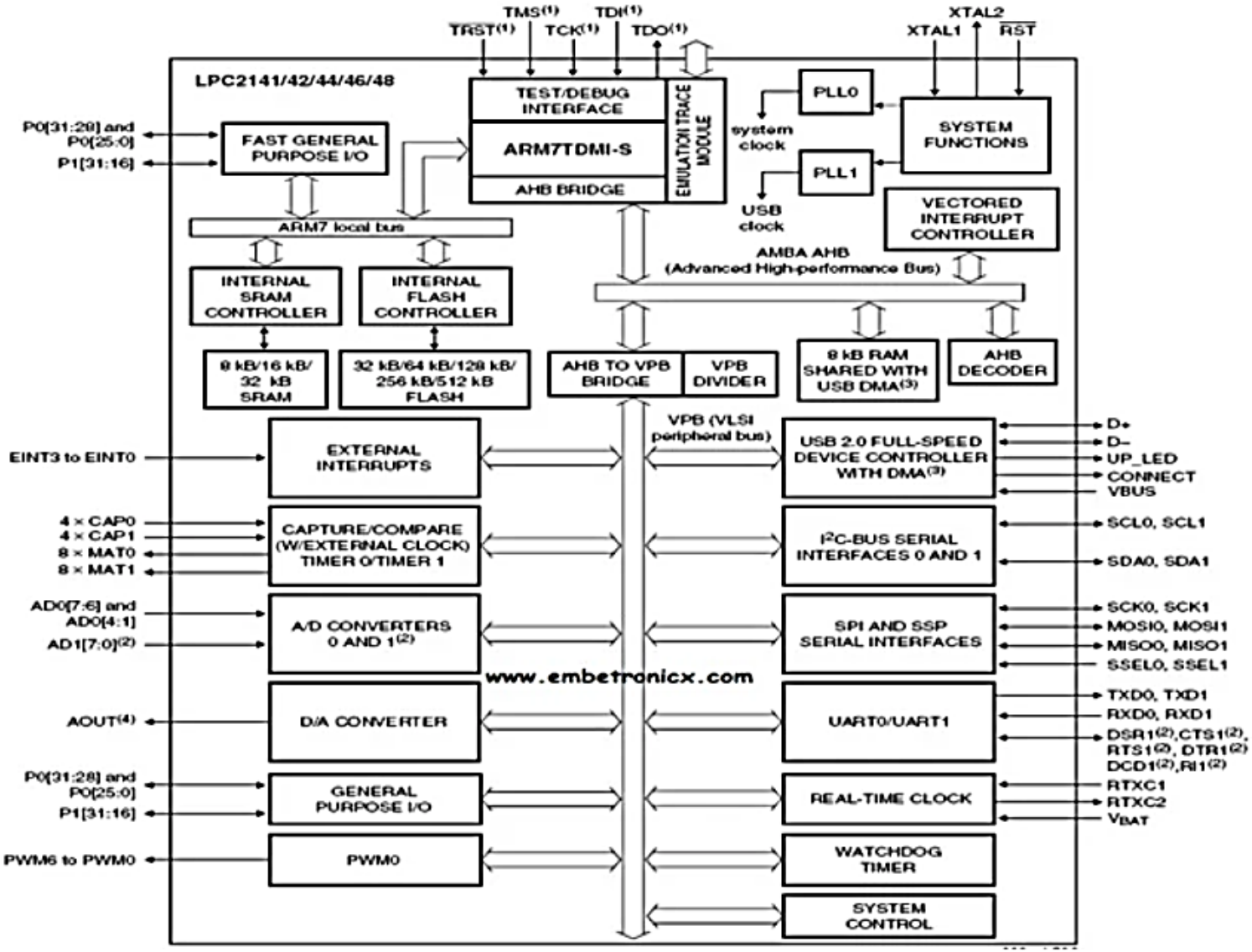
Introduction: ARM microcontroller block diagram



Questions

THANK YOU