Embedded Systems summary

Important Comparisons:

Feature	Embedded Systems	General-Purpose Systems
Function	Specific Task	Multiple Tasks
Hardware Cost	Low	High
Power Consumption	Low	High
Examples	Microwave, ATM	Desktop, Laptop

Comparison Table:

Processor Type	Role	Use Case
CPU	Main Control Unit	General Computation
GPU	Graphics & Parallel Tasks	Games, ML, Visualization
DSP	Signal Processing	Audio, Video, Sensors
MCU	Small embedded control tasks	IoT, Automotive

Highlights:

- **CPU Components**: ALU, Registers, Control Unit.
- **Instruction Cycle**: Fetch → Decode → Execute.
- **RISC vs CISC**:
  - RISC: Simple instructions, faster execution, hardware efficiency.
  - CISC: Complex instructions, fewer lines of code, better for compact memory usage.
- **Registers**: Temporary data storage, critical for performance.
- **Flags**: Zero, overflow, and carry flags guide the next instruction.

Architecture Comparison:

Feature	RISC	CISC
Instruction Set	Small & simple	Large & complex
Speed	High	Moderate
Hardware Cost	Lower	Higher
Power Efficiency	Better for embedded	More power-hungry

Clock Source Comparison:

Feature	RC Oscillator	Ceramic Resonator	Crystal Oscillator
Cost	Lowest	Medium	Highest
Accuracy	Low	Moderate	High
Vibration Resistance	High	Low	Low
EMI Resistance	Low	High	High

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- Embedded systems are dedicated computing systems designed to perform specific tasks efficiently.
- These systems often operate under real-time constraints and are optimized for low power consumption and small size.
- The microcontroller is a central component, integrating CPU, memory, and peripherals.
- An RTOS helps manage tasks and timing, ensuring that time-critical operations are executed reliably.

- Microcontrollers are self-contained systems with CPU, memory, and I/O on one chip.
- The Harvard and Von Neumann architectures are key design models.
- Peripheral devices like timers, ADCs, and communication modules are integrated to support specific embedded applications.
- Choosing the right microcontroller depends on the application's requirements for memory, processing power, and peripherals.

- The processor is a crucial component of the computer, responsible for executing instructions and managing data flow. It consists of three main parts that work together to perform computations efficiently.
- Understanding instructions in computing is crucial for executing tasks. It involves learning how to process data, which is fundamental to microprocessor functionality.
- Understanding the difference between hardware types is crucial for optimizing performance and cost. This involves exploring how instructions are processed differently in RISC and CISC architectures.
- The discussion focuses on the components of a computer system, specifically highlighting the role of registers in temporary data storage. Registers are essential for processing instructions and storing data efficiently.
- Understanding memory access and the role of various flags is crucial in computer architecture. Flags like zero and overflow indicate the results of operations and affect subsequent instructions.
- Memory management is crucial for understanding how data is read and written in computer systems. It involves understanding memory locations, address lines, and the types of memory used.

- Embedded C is tailored for programming hardware, enabling interaction with microcontroller peripherals.
- It uses libraries and direct register access to control hardware like LEDs and sensors.
- Understanding memory mapping and port configuration is key to effective embedded programming.
- Compilers and IDEs streamline the development and debugging process.

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