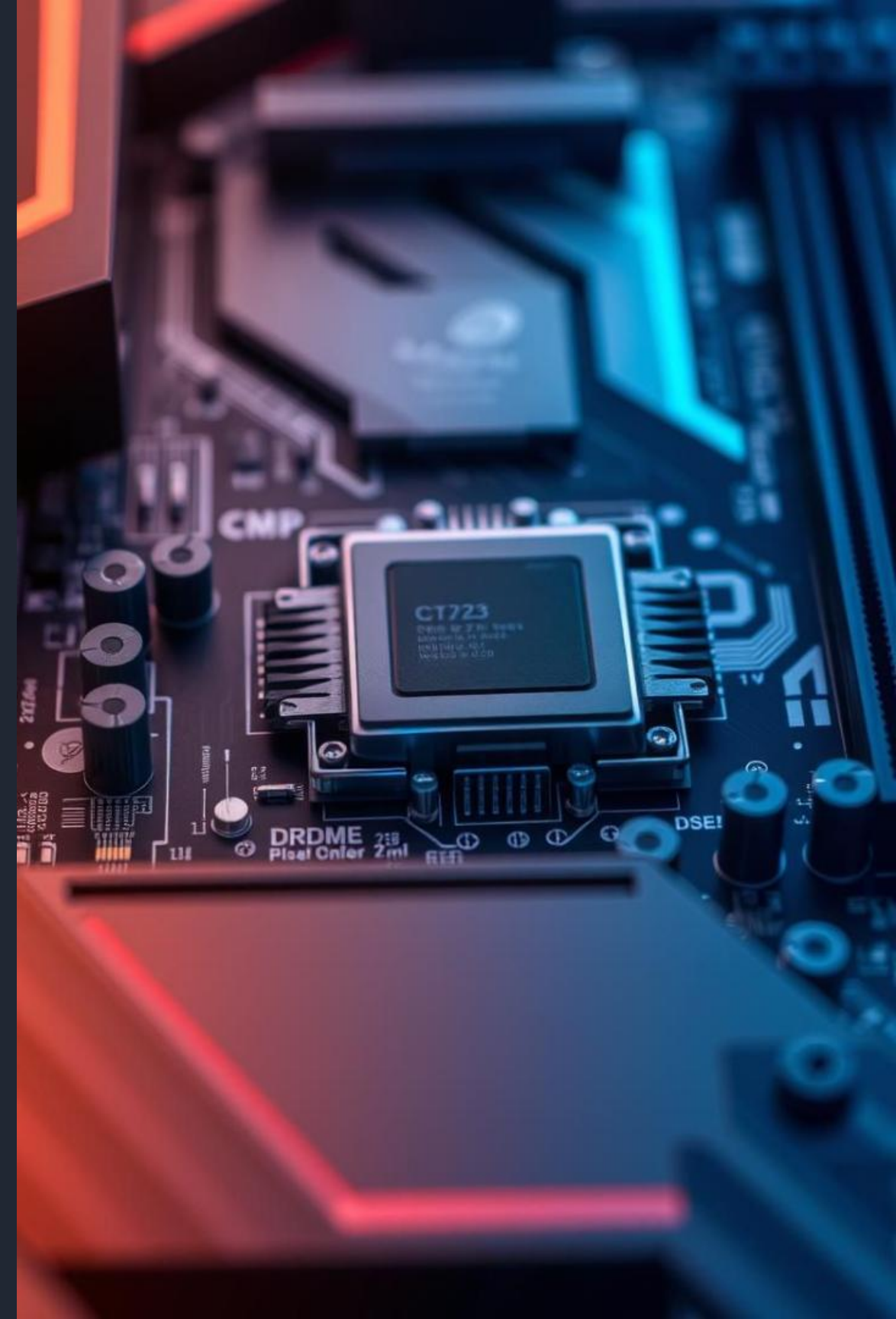


Computer Architecture and Hardware: Foundations of Computing

Explore the core of every computing device. It is essential for understanding performance, efficiency, and limitations. From smartphones to supercomputers, computer architecture provides a common foundation.



Foundational Concepts: Instruction Set Architecture (ISA)

The ISA Defined

The Instruction Set Architecture (ISA) serves as the interface between hardware and software.

It defines instructions, data types, addressing modes, and memory architecture.

Examples of ISAs

- x86-64 (Intel, AMD)
- ARM (mobile devices)
- RISC-V (open standard)

Key Elements

- Instruction format
- Registers
- Memory model

Key Architectural Elements: CPU Structure



ALU

Arithmetic Logic Unit performs arithmetic and logical operations.



Control Unit

Fetches, decodes, and controls instruction execution.



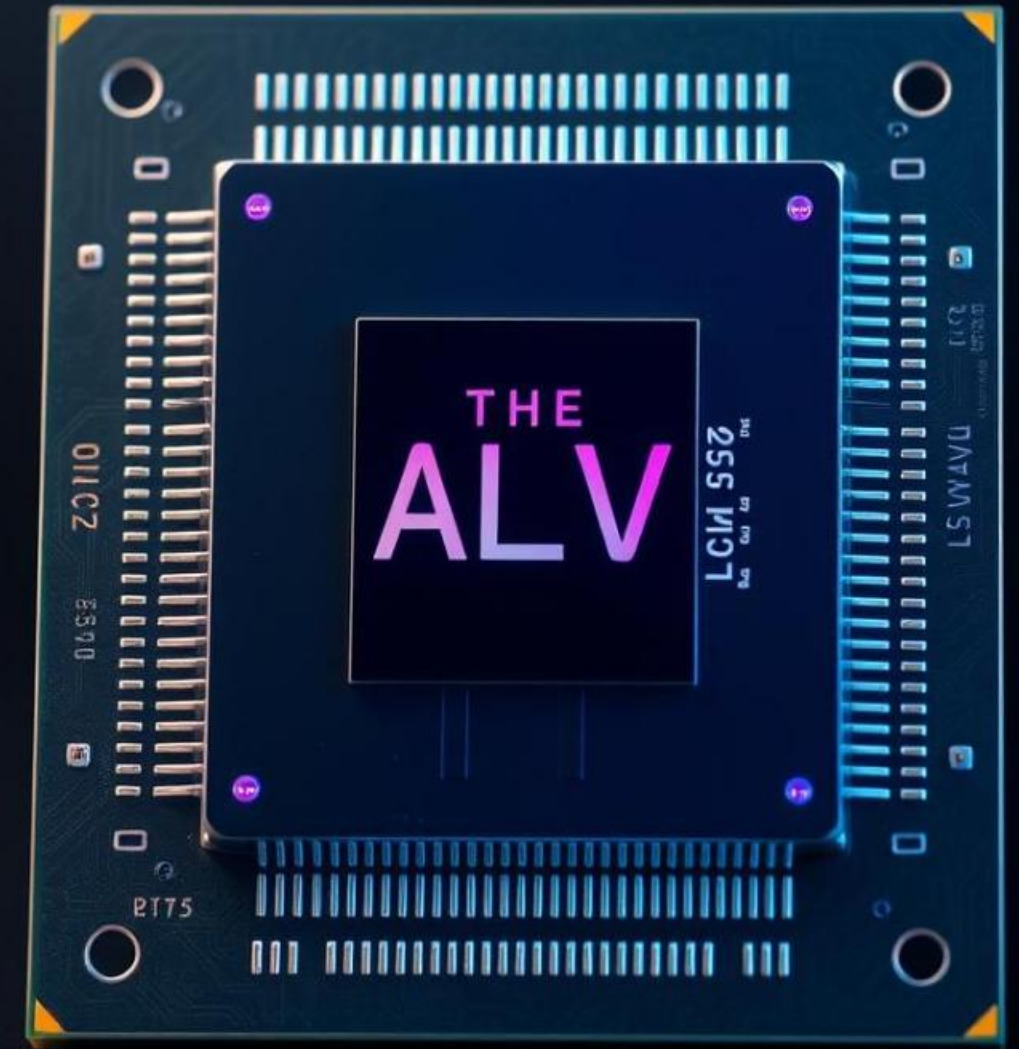
Registers

Small, fast storage locations within the CPU.

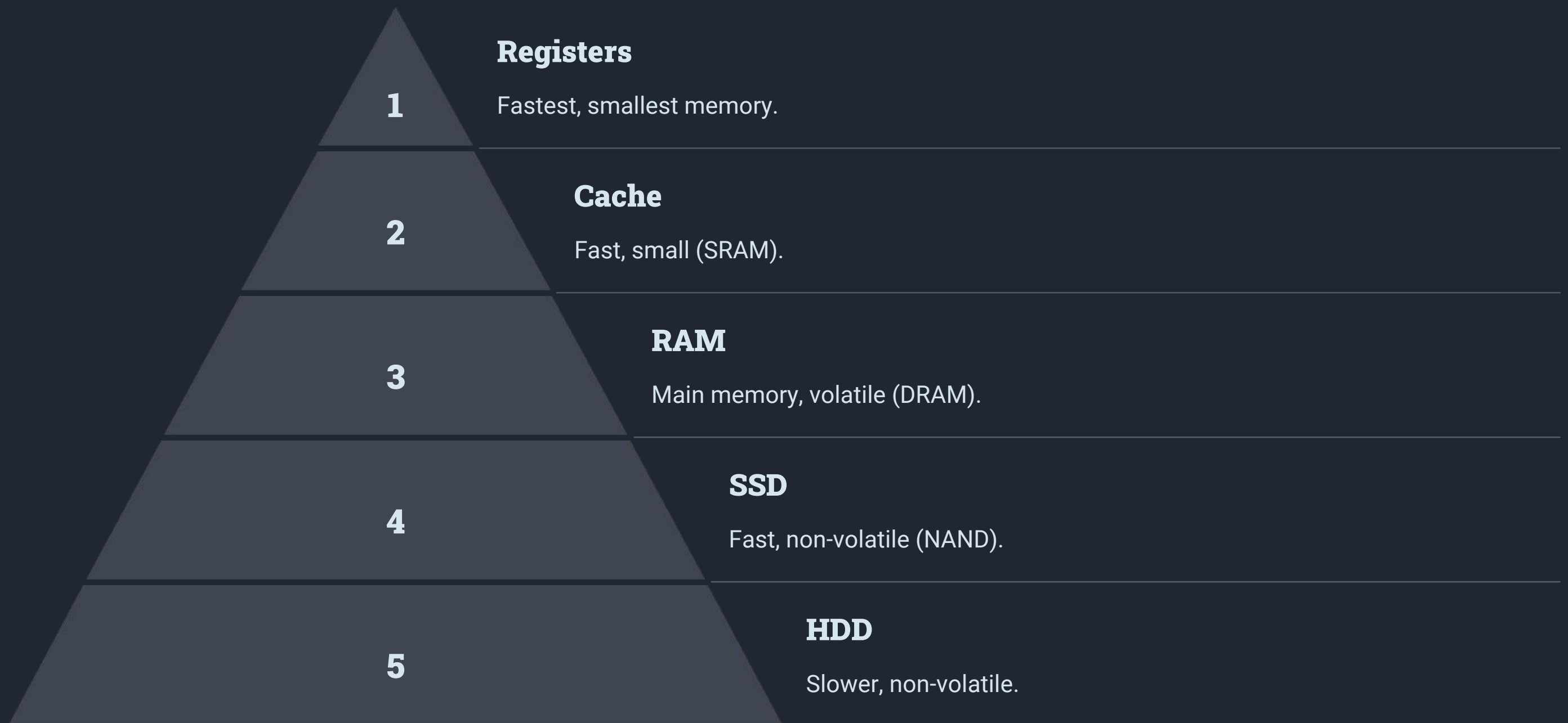


Cache

High-speed memory for frequently accessed data.



Memory Hierarchy: From Registers to Storage



Input/Output (I/O) Systems: Connecting to the World

Interfaces

Connect the computer to external devices.

- USB
- PCIe
- SATA
- Ethernet

I/O Controllers

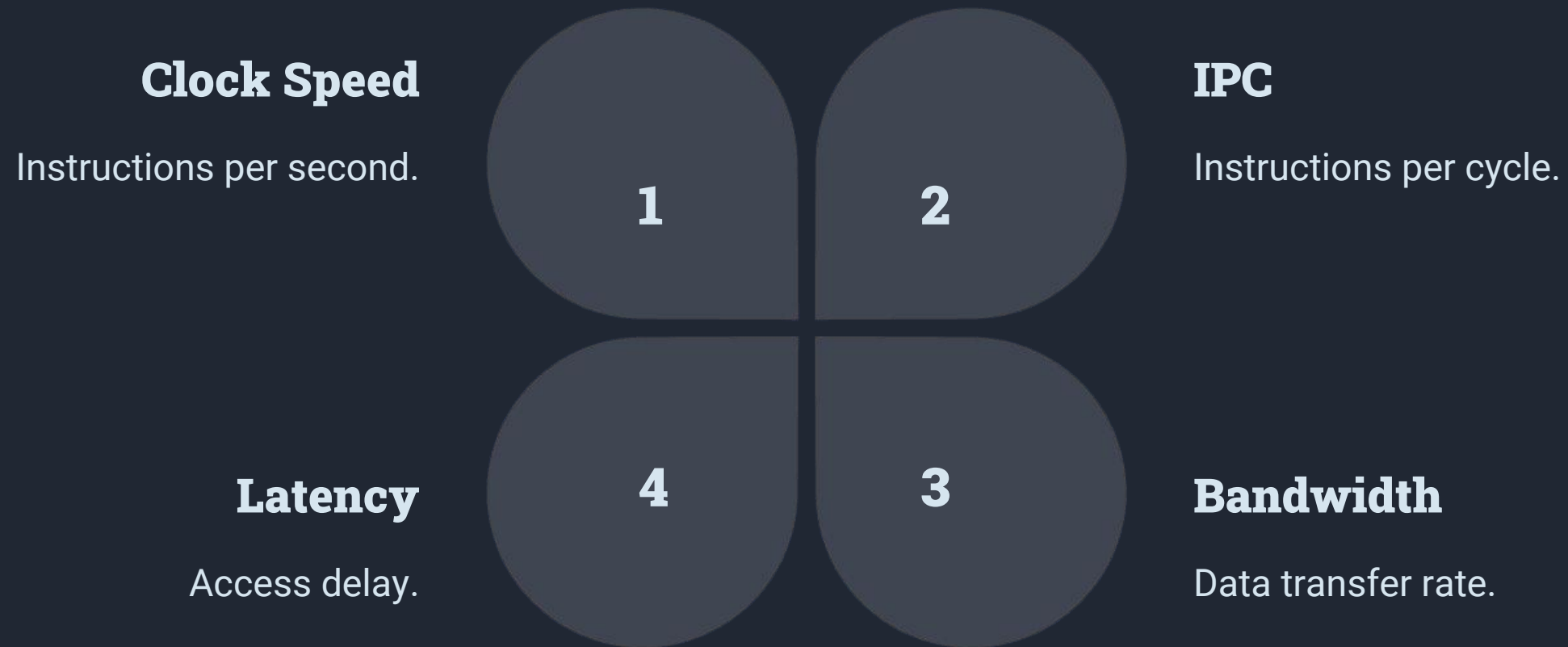
Manage data transfer between devices and memory.

DMA

Direct Memory Access allows devices to access memory directly.



Performance Metrics and Optimization



Parallel and Distributed Computing

1

Parallel

Multiple cores on one machine working on same problem.

2

Distributed

Multiple computers working together over a network.

3

GPU Computing

Using GPUs for general-purpose computation.



Future Trends in Computer Architecture

Quantum Computing

Qubits and quantum gates for complex problems.

Neuromorphic

Mimicking the human brain.

3D Stacking

Vertical integration for density.

