Computer Architecture and Organization

CS 115

Lecture 2

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Unit 1: Introduction to Computer Development, Component and Organization

Standard Organization

IEEE
Advancing Technology for Humanity

ISO
International Organization for Standardization

ANSI
American National Standards Institute

IEC
International Electrotechnical Commission

JEDEC

W3C
World Wide Web consortium

RISC-V

PCI SIG

USB
Enabling Connections™


Standard Organization
IEEE Standards
Defines standards for floating-point arithmetic and buses.
ANSI Standards
Defines standards for programming languages and interfaces.
JEDEC Standards
Defines semiconductor standards for memory devices.
Industry Groups
Includes RISC-V, PCI-SIG, and USB-IF for specific industry standards.
ISO Standards
Creates international standards for computer systems and data formats.
IEC Standards
Collaborates with ISO to standardize electronic technologies.
W3C Standards
Sets standards for web technologies.
Made with Napkin

Standard Organization

1. **IEEE** (Institute of Electrical and Electronics Engineers)
2. **ISO** (International Organization for Standardization)
3. **ANSI** (American National Standards Institute)
4. **IEC** (International Electrotechnical Commission)
5. **JEDEC** (Joint Electron Device Engineering Council)
6. **W3C** (World Wide Web Consortium)
7. Industry-specific groups:
    - **RISC-V Foundation** (open standard ISA).
    - **PCI-SIG** (Peripheral Component Interconnect standards).
    - **USB-IF** (USB standards)

Standard Organization

- Standard organizations in computer architecture & organization are needed to ensure **compatibility**, **interoperability**, **portability**, **cost-effectiveness**, and **global communication**, while providing a stable framework for innovation.

Standard Organization

- Why are they needed?

1. **Interoperability**
    - Different hardware and software systems must work together.
    - Example: A program written in C should run on any computer with an ANSI C–compliant compiler.
2. **Compatibility**
    - Standards ensure backward and forward compatibility so older devices or programs can still work with newer ones.
    - Example: USB standards let you plug a flash drive into any computer, regardless of the brand.

Standard Organization

- Why are they needed?

3. **Uniformity in Design**
    - Provides common rules for instruction sets, data formats, and interfaces.
    - Example: IEEE 754 standard for floating-point numbers ensures that "3.14" is represented the same way across Intel, AMD, or ARM processors.
4. **Compatibility**
    - Standards ensure backward and forward compatibility so older devices or programs can still work with newer ones.
    - Example: USB standards let you plug a flash drive into any computer, regardless of the brand.

Standard Organization

- Why are they needed?

5. **Portability**
   - Programs, data, and devices can be used across different systems without rewriting everything.
   - Example: ISO standards for file formats (like JPEG, MP4, PDF) ensure files can open anywhere.
6. **Innovation with Stability**
   - Standards provide a stable foundation, so companies can focus on innovating instead of constantly solving compatibility issues.

Standard Organization

- Why are they needed?

7. **Global Communication & Networking**
    - Standards make worldwide computing possible.
    - Example: Internet protocols (TCP/IP, standardized by IETF/ISO) ensure any two computers can connect across the globe.

Standard Organization

- Standard organizations in computer architecture & organization are needed to ensure **compatibility**, **interoperability**, **portability**, **cost-effectiveness**, and **global communication**, while providing a stable framework for innovation.
- The need for standard organizations in computer architecture & organization comes from the fact that **computers are built by many different manufacturers but must still communicate**, interoperate, and remain compatible.

Standard Organization

- Computer organization refers to the way a **computer's hardware components are structured and interconnected.**
    - This includes the internal and external parts of the computer, such as the CPU, memory, storage, and I/O devices. The organization determines how these components function together to perform tasks.

Standard Organization

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Standard Organization

1. **IEEE** (Institute of Electrical and Electronics Engineers)
   - Defines standards for floating-point arithmetic (IEEE 754), buses (IEEE 488), etc.
2. **ISO** (International Organization for Standardization)
   - Creates international standards for computer systems, data formats, and protocols.
3. **ANSI** (American National Standards Institute)
   - Defines standards for programming languages (e.g., ANSI C) and interfaces.
4. **IEC** (International Electrotechnical Commission)
   - Works with ISO to standardize electronic and computing technologies.


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Standard Organization

5. **JEDEC** (Joint Electron Device Engineering Council)
    - Defines semiconductor standards (RAM, Flash memory).
6. **W3C** (World Wide Web Consortium)
    - Sets standards for web technologies (indirectly part of computer organization at the system level).

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Standard Organization

7. Industry-specific groups:
    - **RISC-V Foundation** (open standard ISA).
        - An organization that manages and promotes the RISC-V (Reduced Instruction Set Computer – V) open standard instruction set architecture (ISA).
    - **PCI-SIG** (Peripheral Component Interconnect standards).
        - An industry consortium that defines and maintains PCI (Peripheral Component Interconnect) standards, including PCI Express (PCIe).
    - **USB-IF** (USB standards)
        - The organization that develops and promotes the USB (Universal Serial Bus) standard.

The Von Neumann Model

The Von Neumann Model

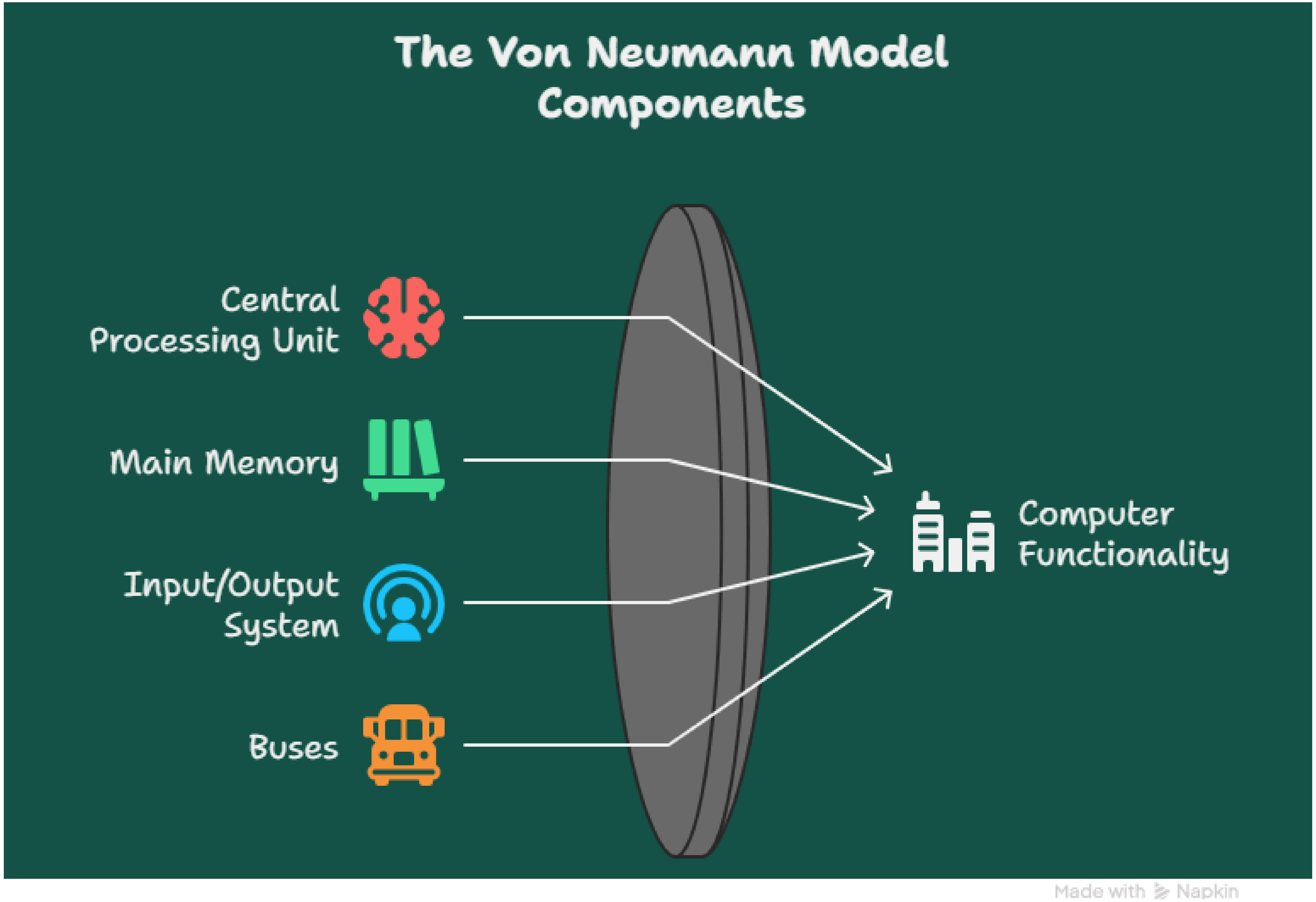
- The Von Neumann model, also known as the **stored-program concept**, is a computer architecture design that has been foundational to the development of almost every modern computer. Its key innovation is the **idea that both a program's instructions and its data are stored in the same memory unit.** This contrasts with earlier architectures that used separate memories for instructions and data.

- John von Neumann's Contribution (1945) – In 1945, he published a famous report called the "**First Draft of a Report on the EDVAC.**"
    - This report outlined the idea of a stored-program computer, which became known as the **Von Neumann architecture.**

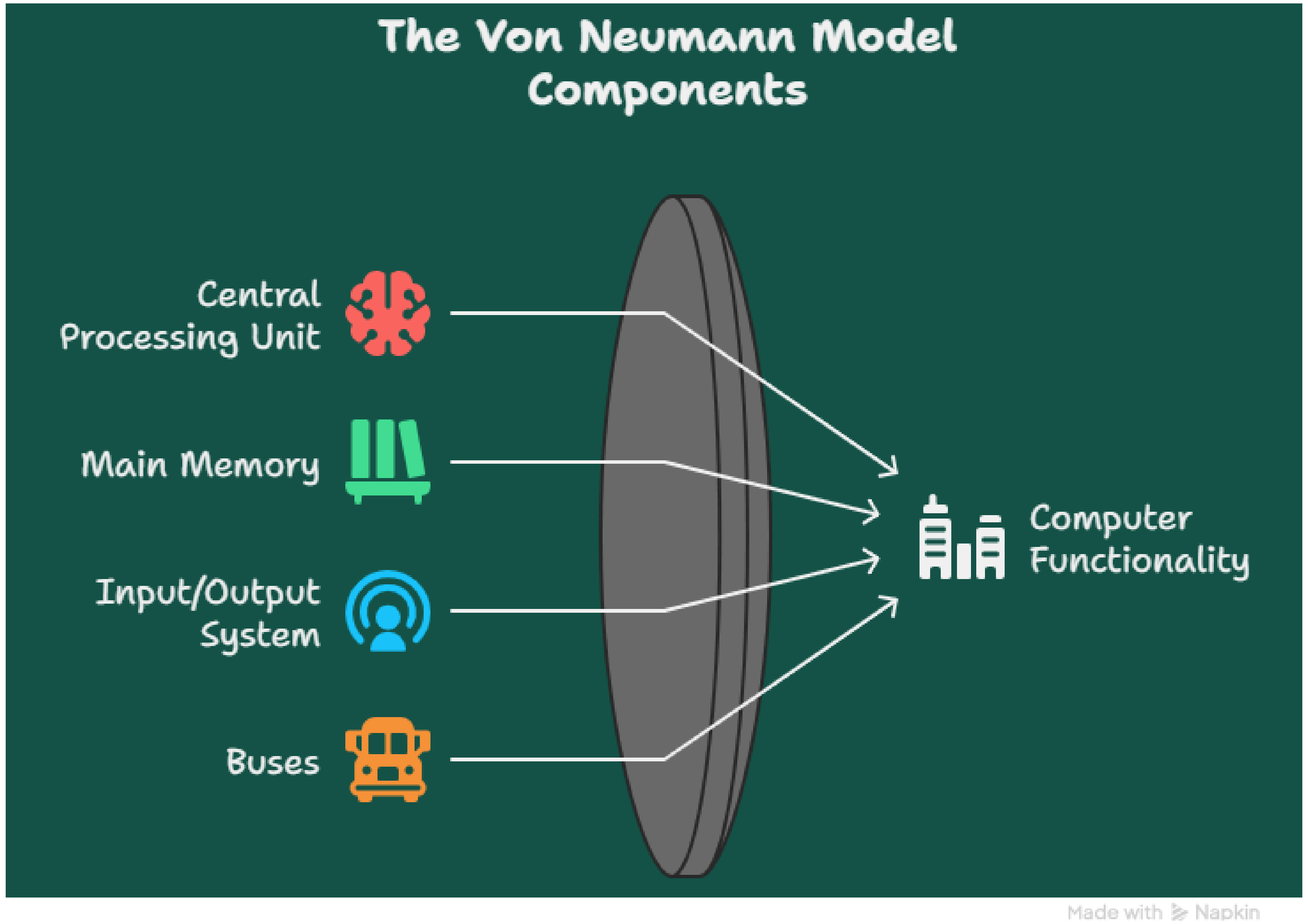
The Von Neumann Model

- The Von Neumann model became the **blueprint for nearly all general-purpose computers.**
- Even today, modern CPUs (Intel, ARM, RISC-V) still follow the basic Von Neumann model, with improvements (like caches, pipelining, parallelism).

The Von Neumann Model



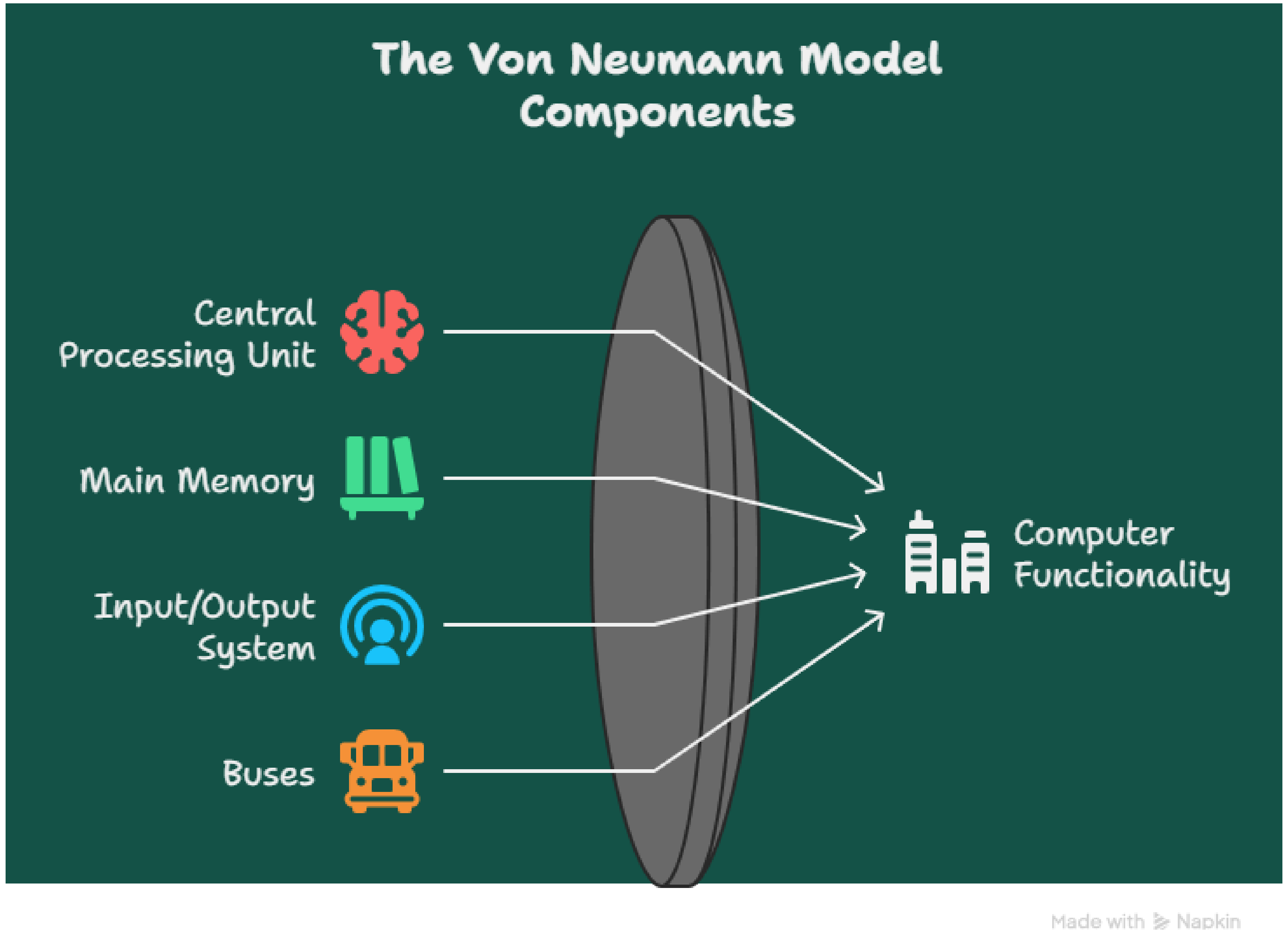
The Von Neumann Model



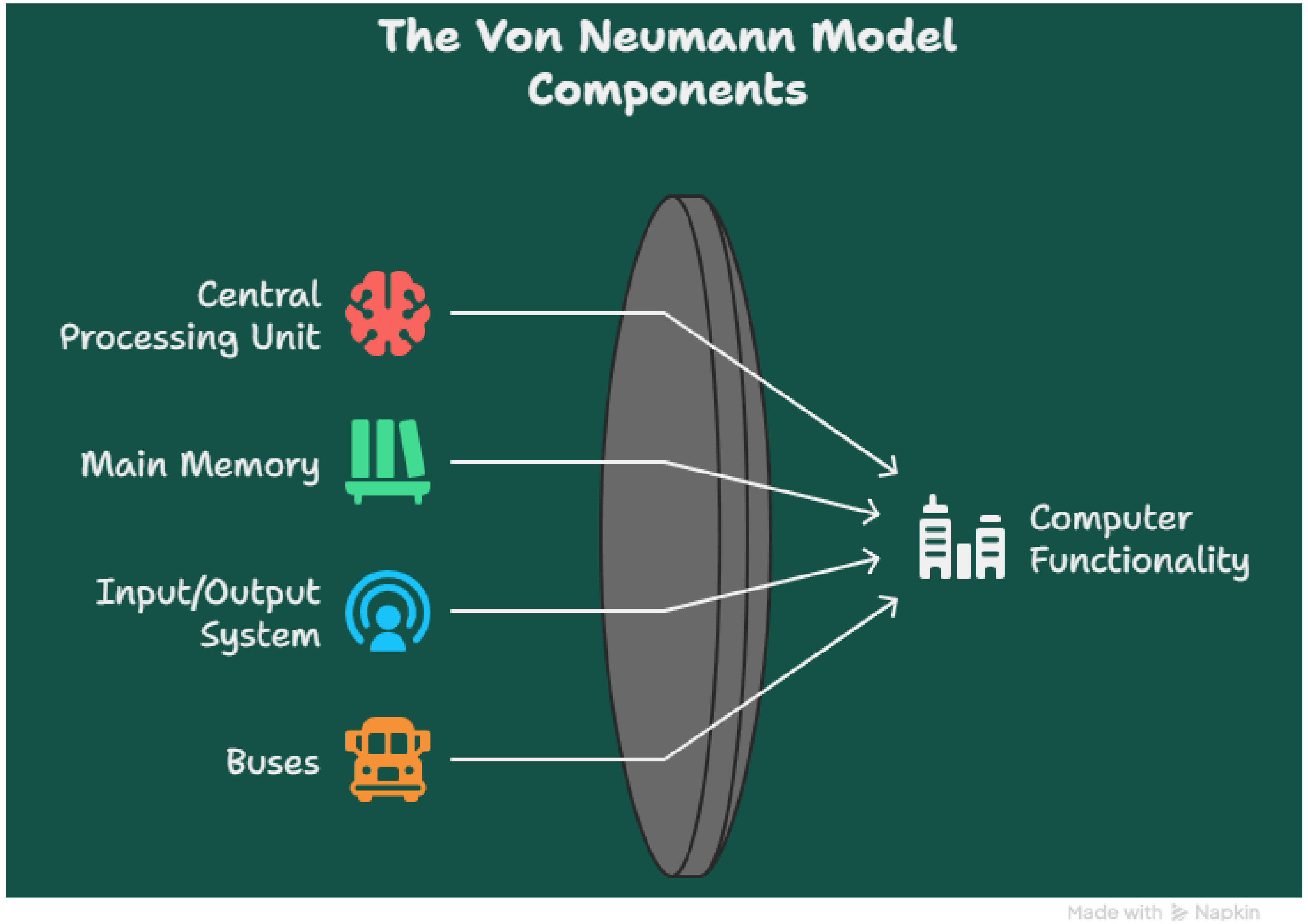
1. **Central Processing Unit (CPU):** This is the "brain" of the computer, responsible for executing instructions. The CPU is composed of the:
    - **Arithmetic Logic Unit (ALU):** Performs arithmetic operations (like addition, subtraction) and logical operations (like AND, OR).
    - **Control Unit (CU):** Fetches instructions from memory, decodes them, and controls the flow of data within the CPU.
    - **Registers:** Small, fast memory locations within the CPU used to hold temporary data and instructions during processing.

The Von Neumann Model

2. **Main Memory:** This is where both program instructions and data are stored. The CPU can access any location in main memory directly and quickly.
3. **Input/Output (I/O) System:** This handles the communication between the computer and the outside world, including devices like keyboards, monitors, and storage drives.



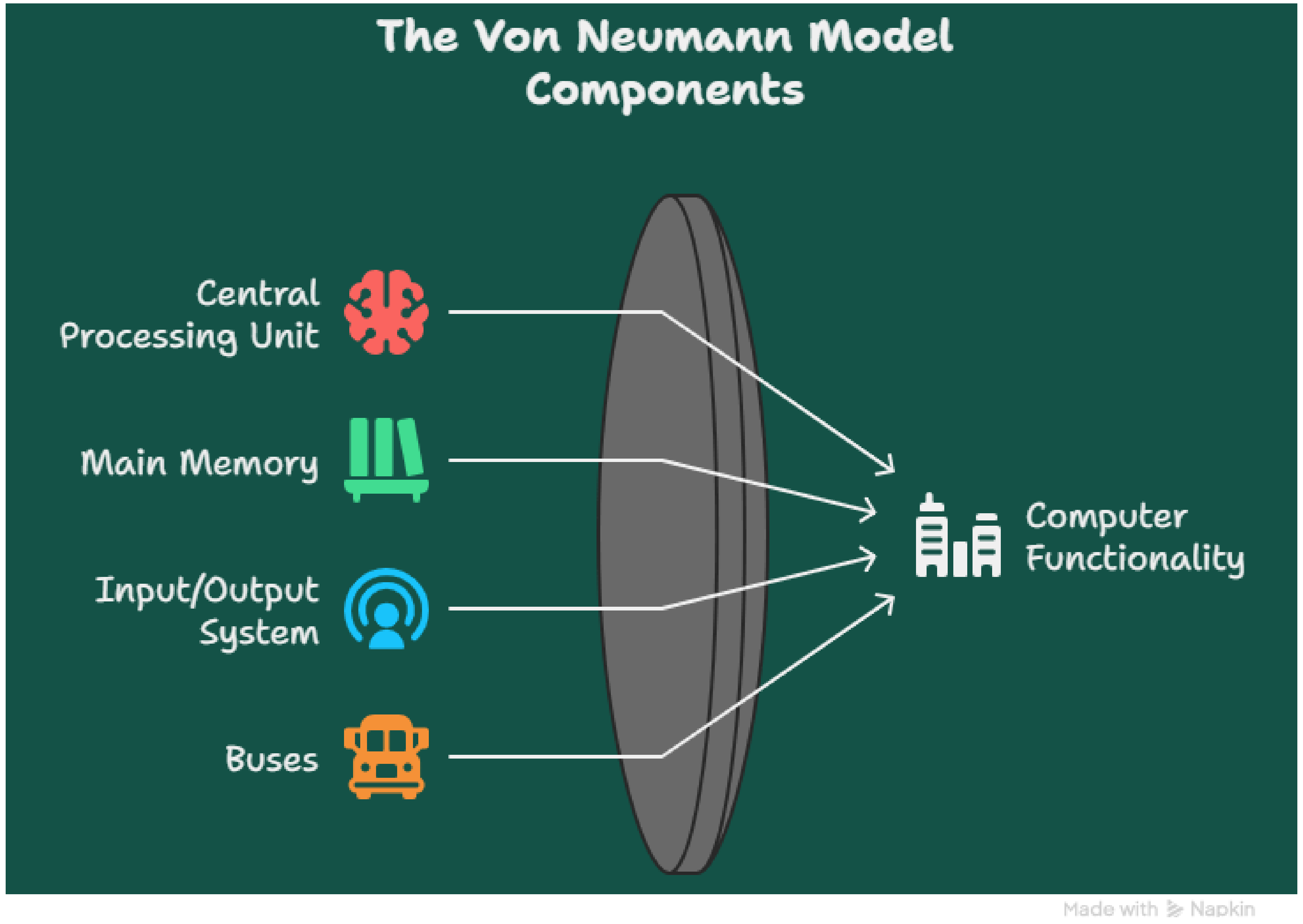
The Von Neumann Model



4. **Buses:** These are the physical pathways or wires that connect the different components, allowing them to communicate. There are typically three main types:

- **Data Bus:** Carries data between the components.
- **Address Bus:** Carries the memory address of the data being accessed.
- **Control Bus:** Carries control signals to manage the flow of information.

The Von Neumann Model



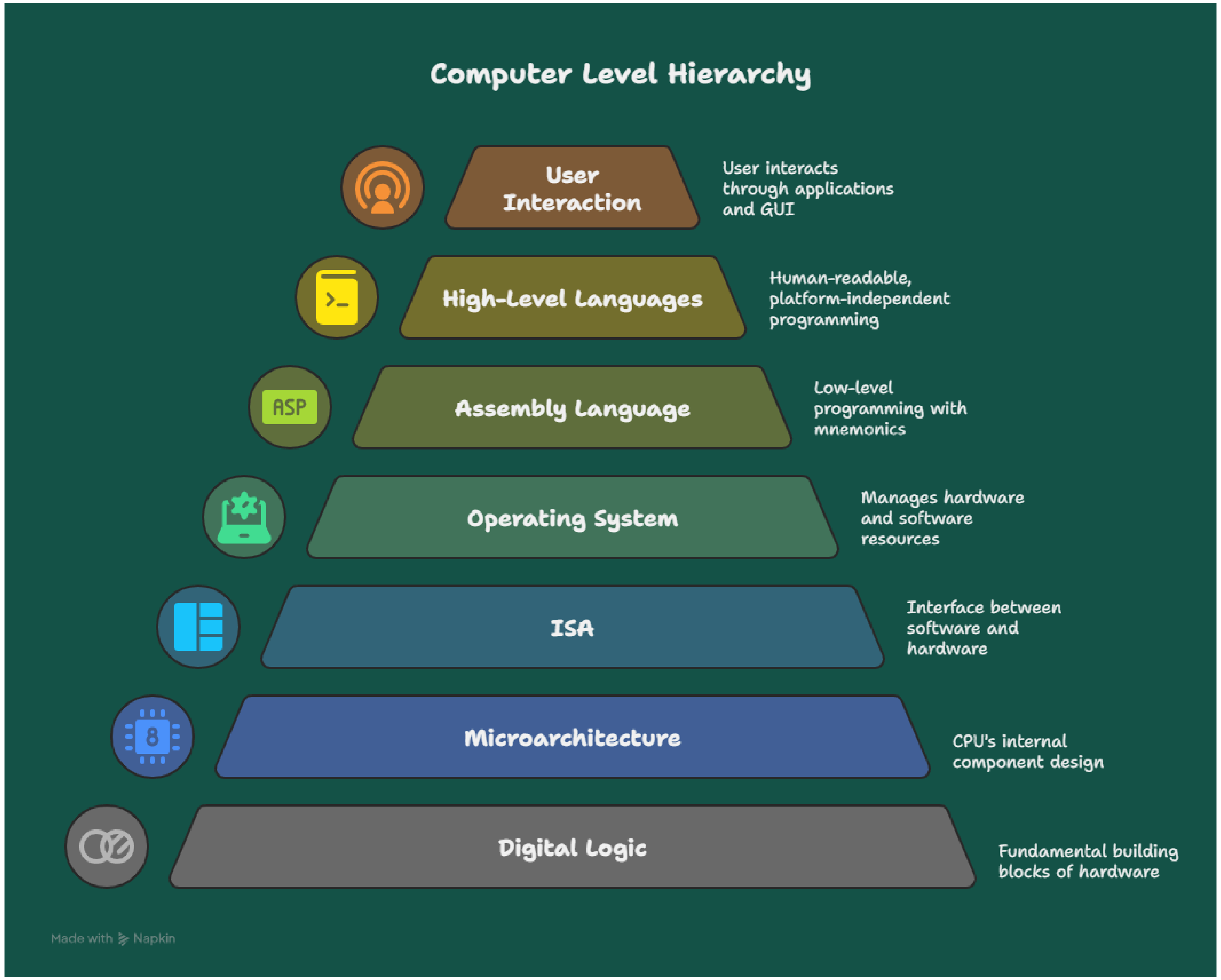
- The model operates in a cyclical manner known as the fetch-decode-execute cycle. The CPU fetches an instruction from memory, decodes it to understand what to do, and then executes the instruction, often involving data from memory.
- A key limitation of this model is the Von Neumann bottleneck, where the CPU's processing speed is often limited by the rate at which data can be transferred to and from memory via the single shared bus.

The Computer Level Hierarchy

The Computer Level Hierarchy

- Computers operate through a series of **abstraction layers**, often visualized as a hierarchy.
- Each level in the hierarchy performs a specific set of tasks and hides the complexity of the levels below it.

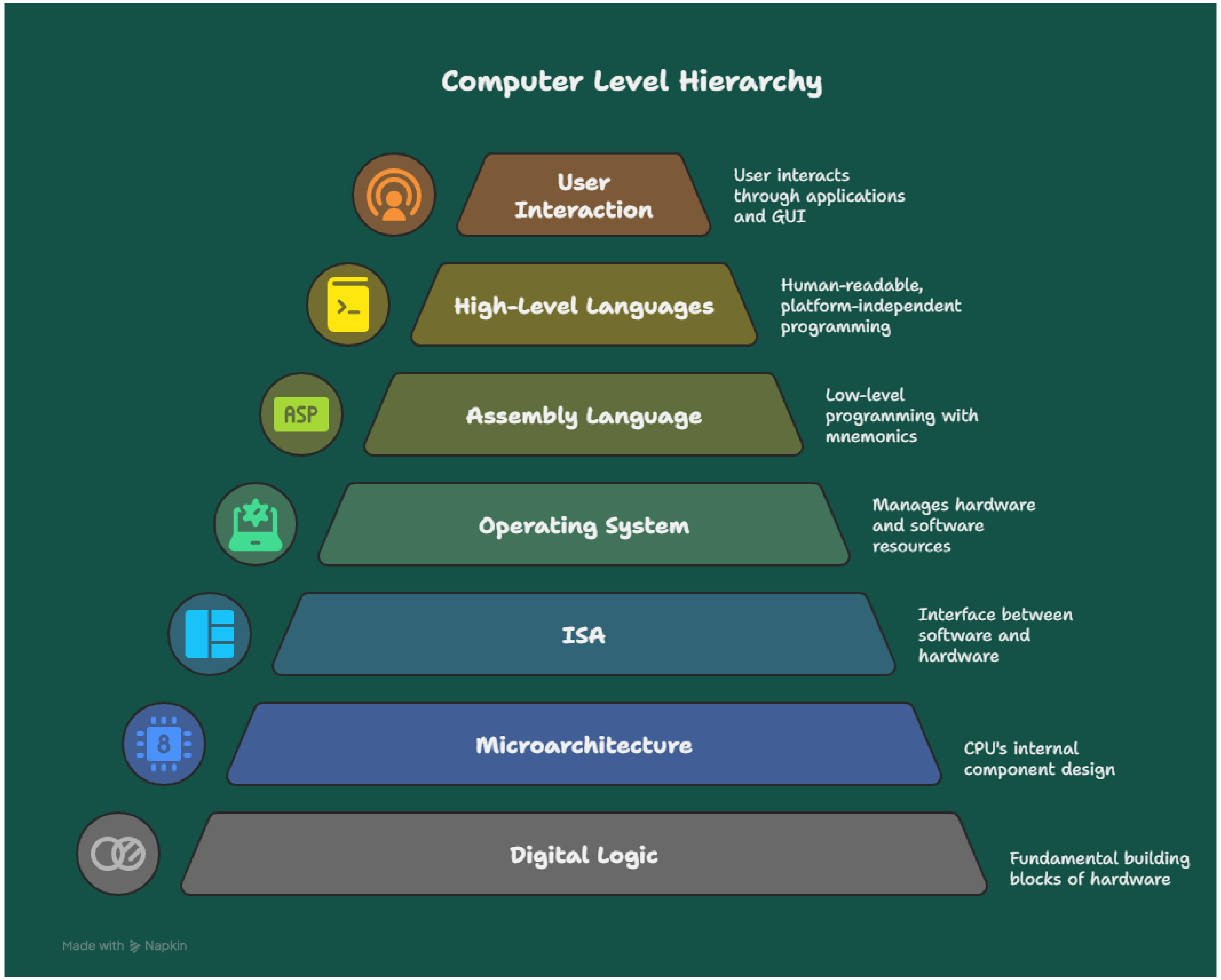
The Computer Level Hierarchy



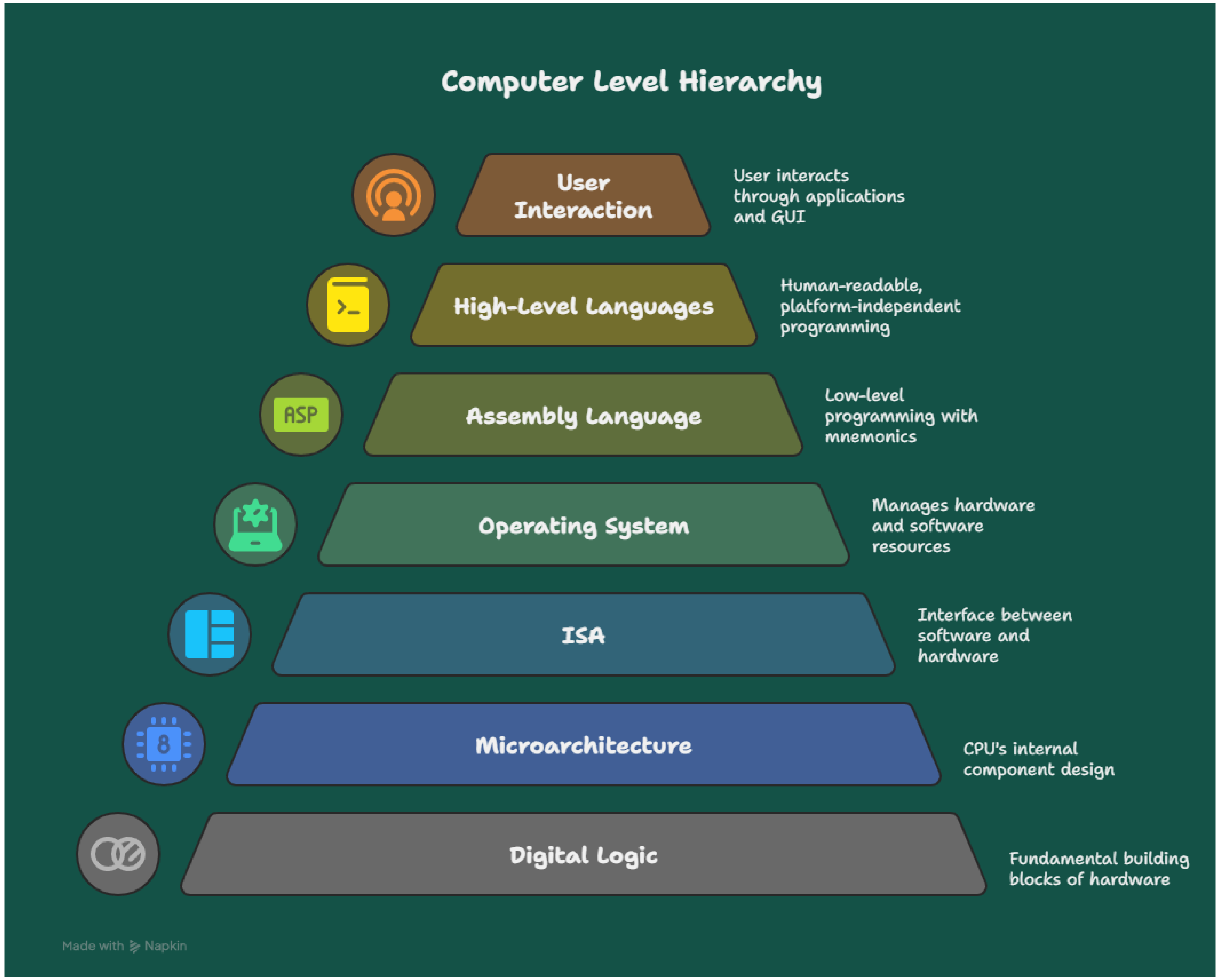
- **Level 6: The User Level:** At this highest level, the user interacts with the computer through applications and the **graphical user interface (GUI).**
- They don't need to know anything about how the computer works internally to perform tasks like browsing the web or using a word processor.

The Computer Level Hierarchy

- **Level 5: High-Level Language Level:** Programmers write code in high-level languages like Python, Java, or C++.
- These languages use human-readable syntax and are platform-independent.
- An interpreter or compiler translates this code into machine-executable instructions.



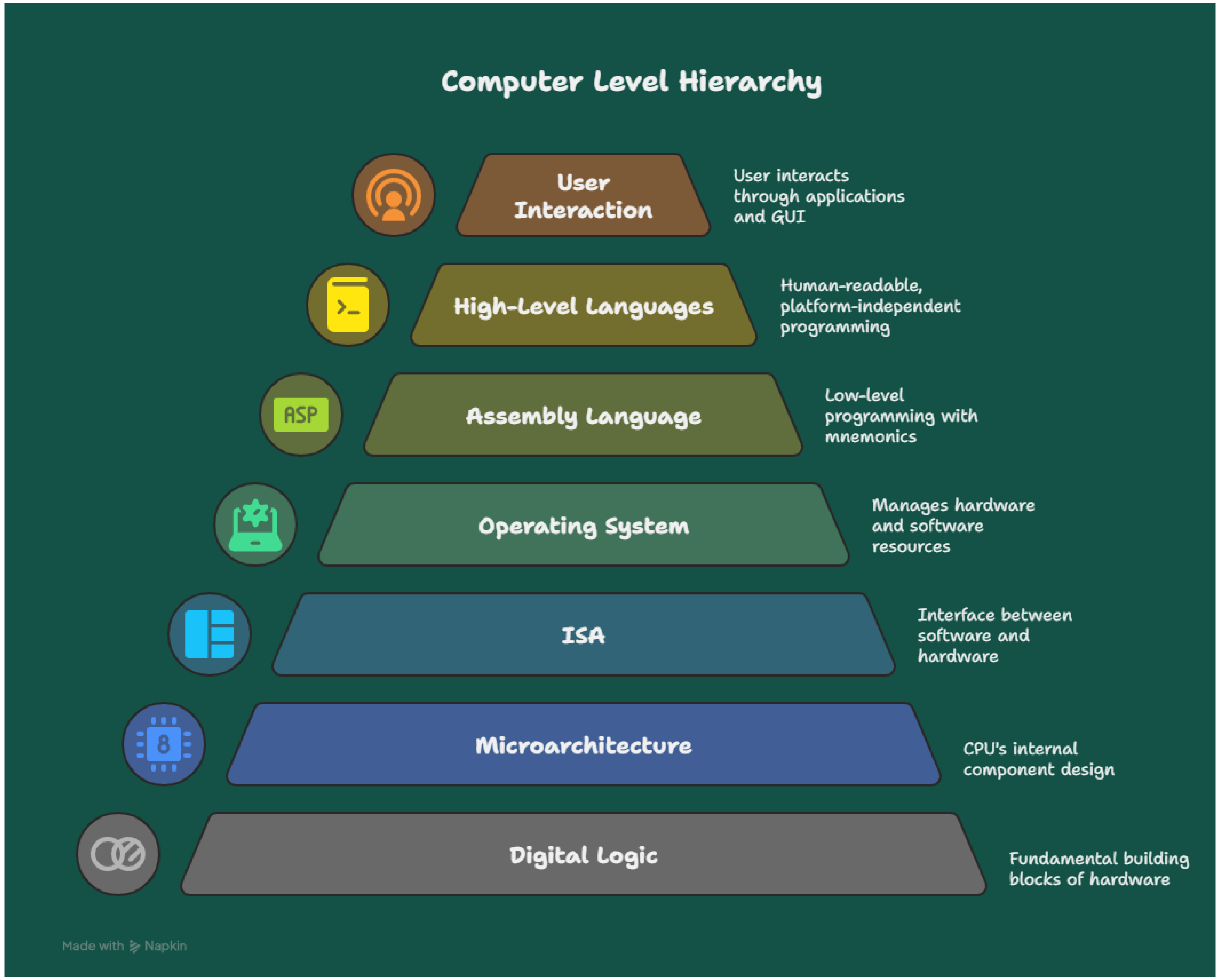
The Computer Level Hierarchy



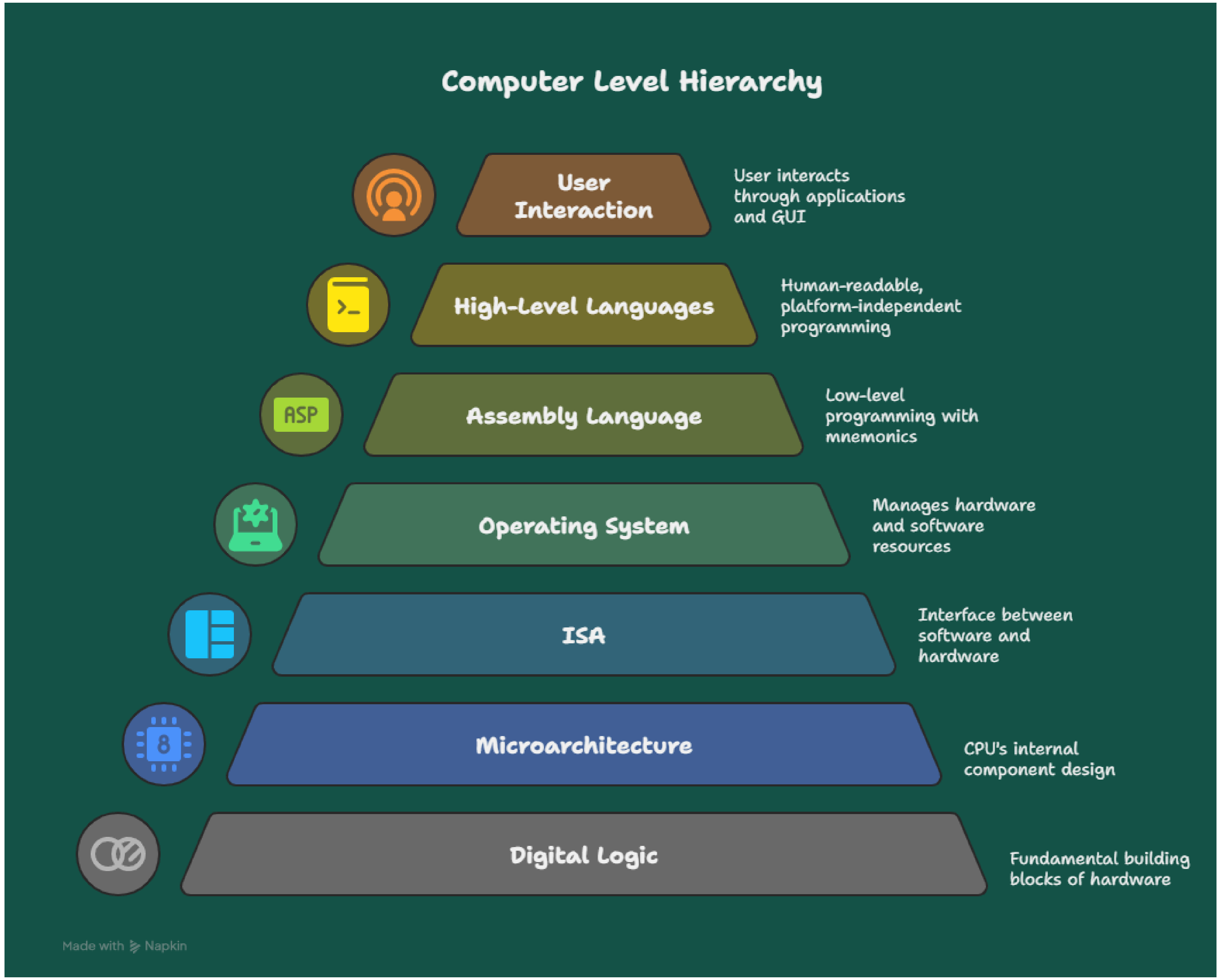
- **Level 4: Assembly Language Level:** This is a low-level programming language that is a step above machine code. It uses mnemonics (e.g., ADD, MOV) to represent machine instructions. Each assembly instruction corresponds to a single machine instruction.

The Computer Level Hierarchy

- **Level 3: Operating System Level:** This is the software that manages all the computer's hardware and software resources.
- It provides services to applications, manages memory, schedules processes, and handles input/output operations.



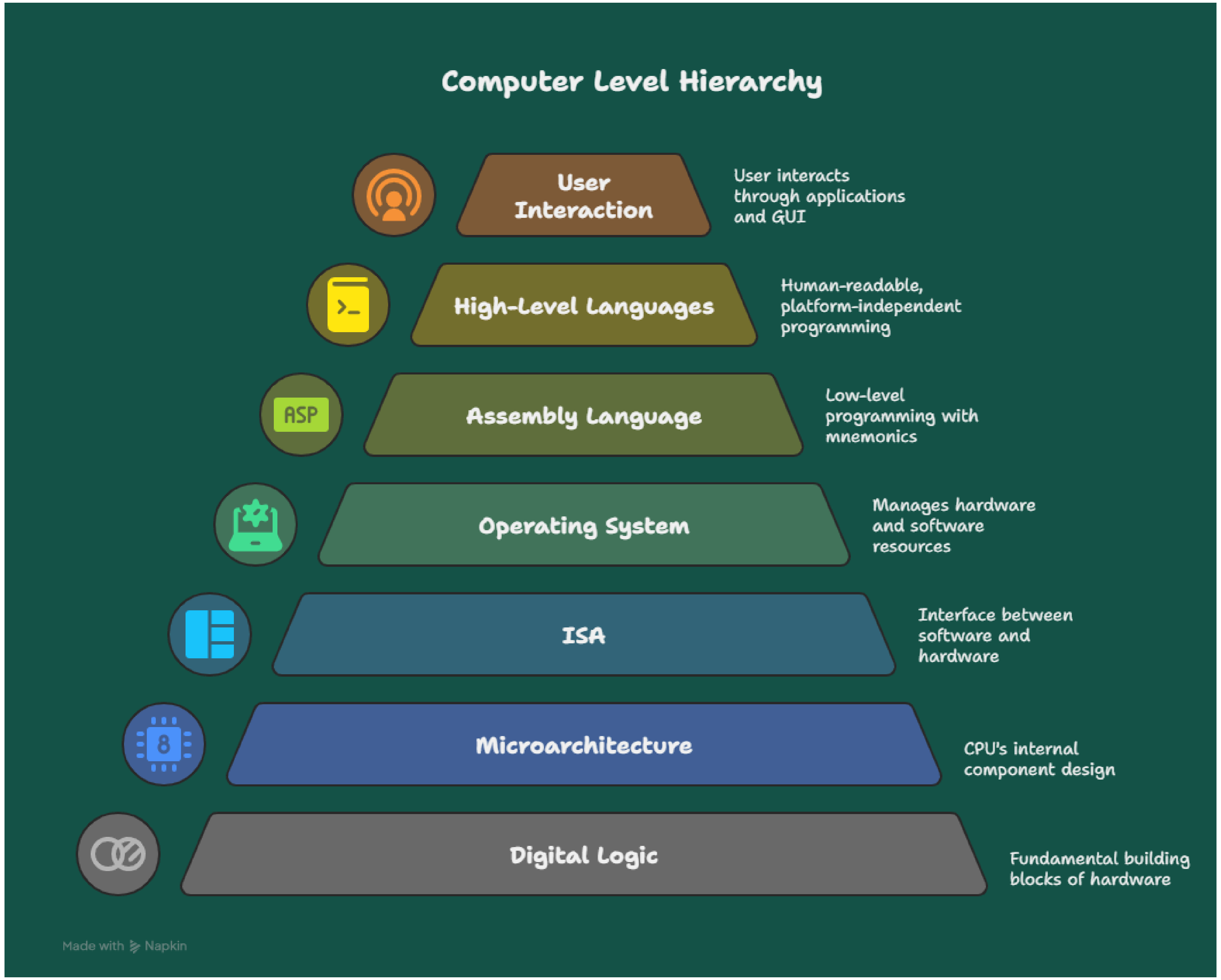
The Computer Level Hierarchy



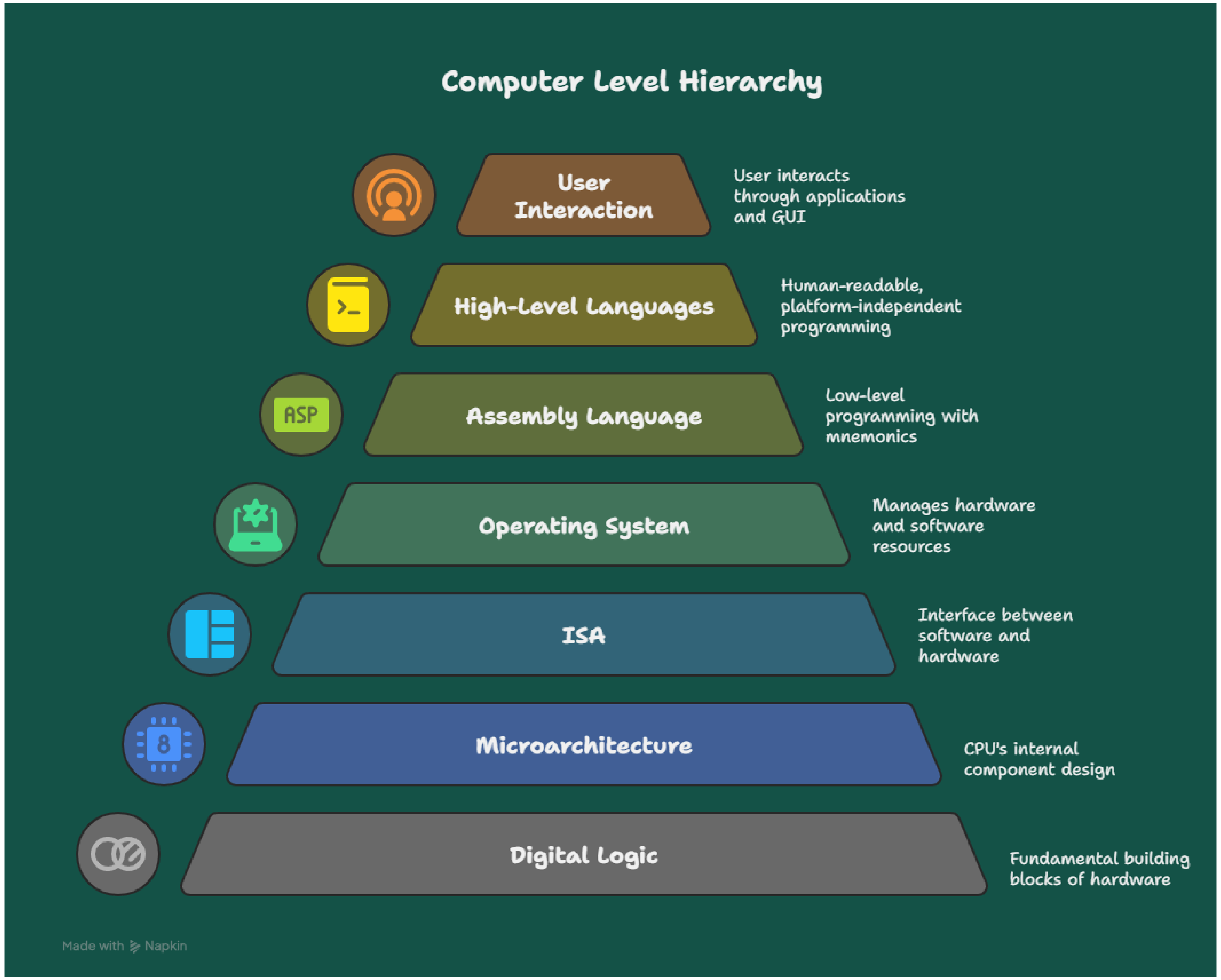
- **Level 2: Instruction Set Architecture (ISA) Level:** This is the interface between the software and the hardware.
- It defines the set of instructions that the processor can execute, the data types it can handle, and the memory addressing modes.
- **This is where architecture and organization meet.**

The Computer Level Hierarchy

- **Level 1: Microarchitecture Level:** Also known as the control level, this level implements the ISA.
- It includes the design of the CPU's internal components, such as the arithmetic logic unit (ALU), registers, and the control unit.



The Computer Level Hierarchy



- **Level 0: Digital Logic Level:** This is the lowest level of the hierarchy, composed of digital logic gates (AND, OR, NOT) and circuits.
- These gates are built from transistors and form the fundamental building blocks of the computer's hardware.

End of Presentation

Questions…?