HARDWARE 1

MOTHERBOARD, CPU, COOLING SYSTEM

Computer Motherboard

- A **computer motherboard** is the main circuit board in a computer system that serves as the foundation for all the hardware components.

- It connects the CPU, memory, storage, and other peripherals, allowing them to communicate and function together. Here's a breakdown of its key components and features:

Key Components of a Motherboard

1.Central Processing Unit (CPU) Socket:

1. Holds the processor.

1. The type of socket determines the compatible CPUs (e.g., LGA, PGA, **BGA**).

- **Land Grid Array (LGA)**

    - **Design**: The pins are on the motherboard socket rather than the CPU itself. The CPU has flat contact pads that touch the pins in the socket.

Types of Motherboards

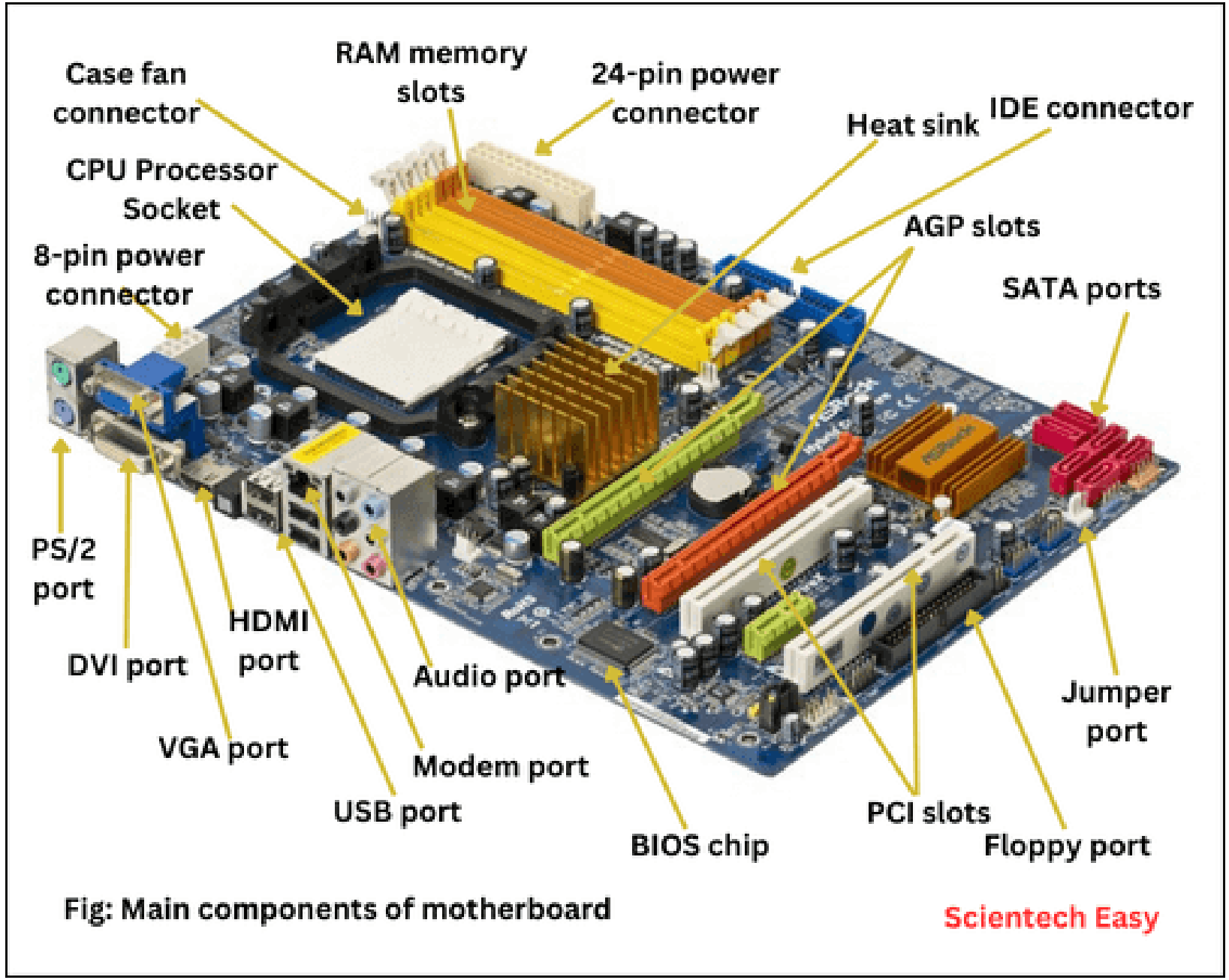
Form Factors:

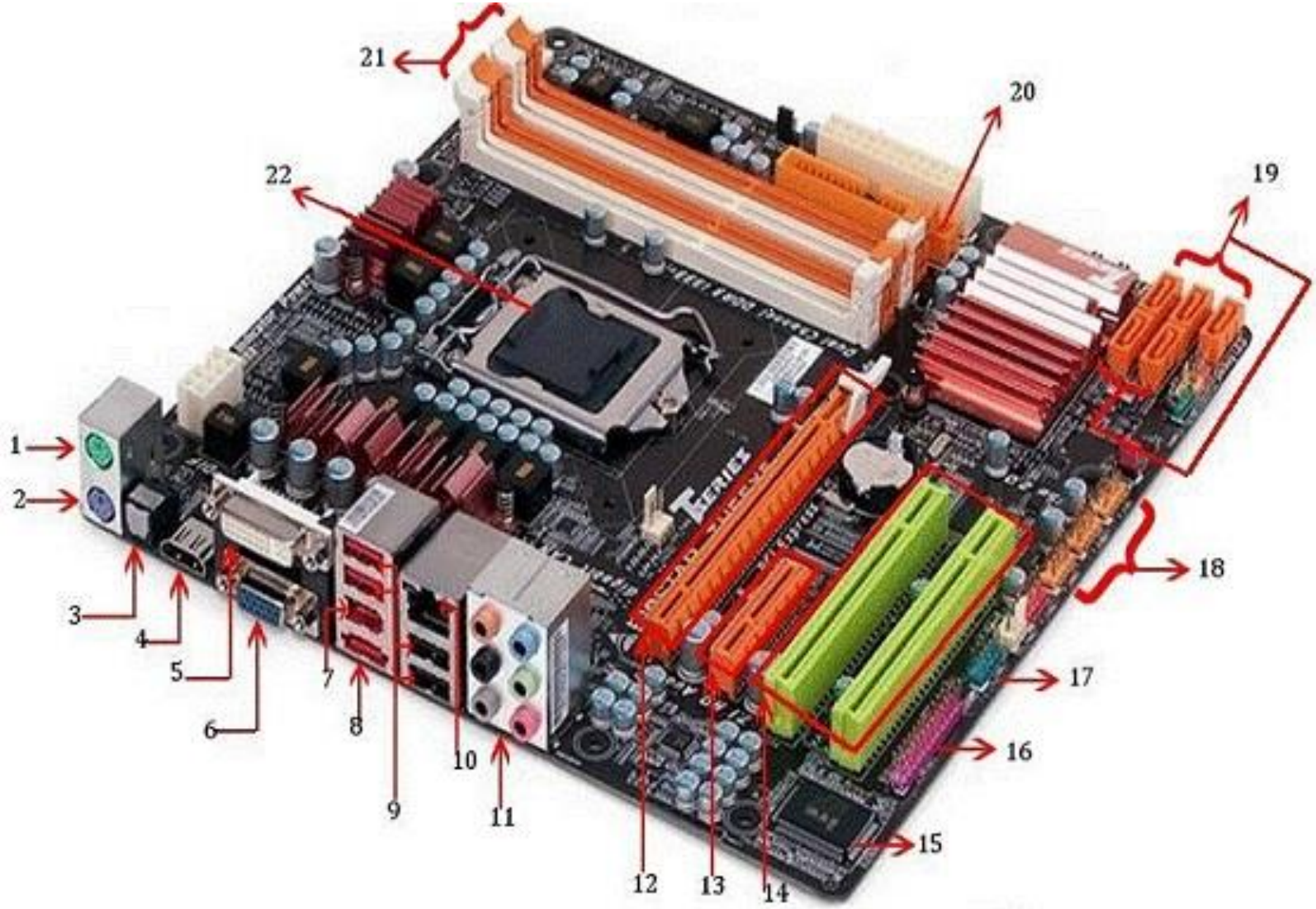
1. **ATX**: Standard size for desktops.
2. **Micro-ATX**: Smaller than ATX, fewer slots.
3. **Mini-ITX**: Compact, often for small builds.
4. **E-ATX**: Extended for high-end systems.

ATX Motherboards

1. **Standard Dimensions**:
    1. Size: **12 x 9.6 inches (305 x 244 mm)**.
    2. Fits in most mid-tower and full-tower cases.

2. **Expansion Capabilities**:
    1. Multiple **PCIe slots** for GPUs, sound cards, or additional peripherals.
    2. Often includes 4 RAM slots, supporting **dual-channel memory** configurations and higher capacities.

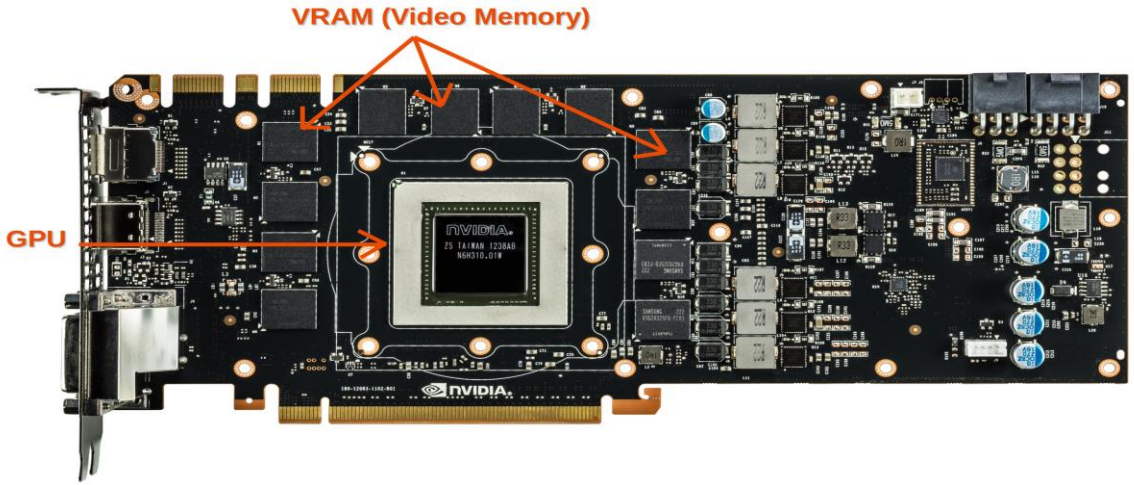

Case fan connector
RAM memory slots
24-pin power connector
Heat sink
IDE connector
CPU Processor Socket
AGP slots
8-pin power connector
SATA ports
PS/2 port
DVI port
HDMI port
Audio port
VGA port
Modem port
USB port
BIOS chip
PCI slots
Floppy port
Jumper port
Fig: Main components of motherboard
Scientech Easy



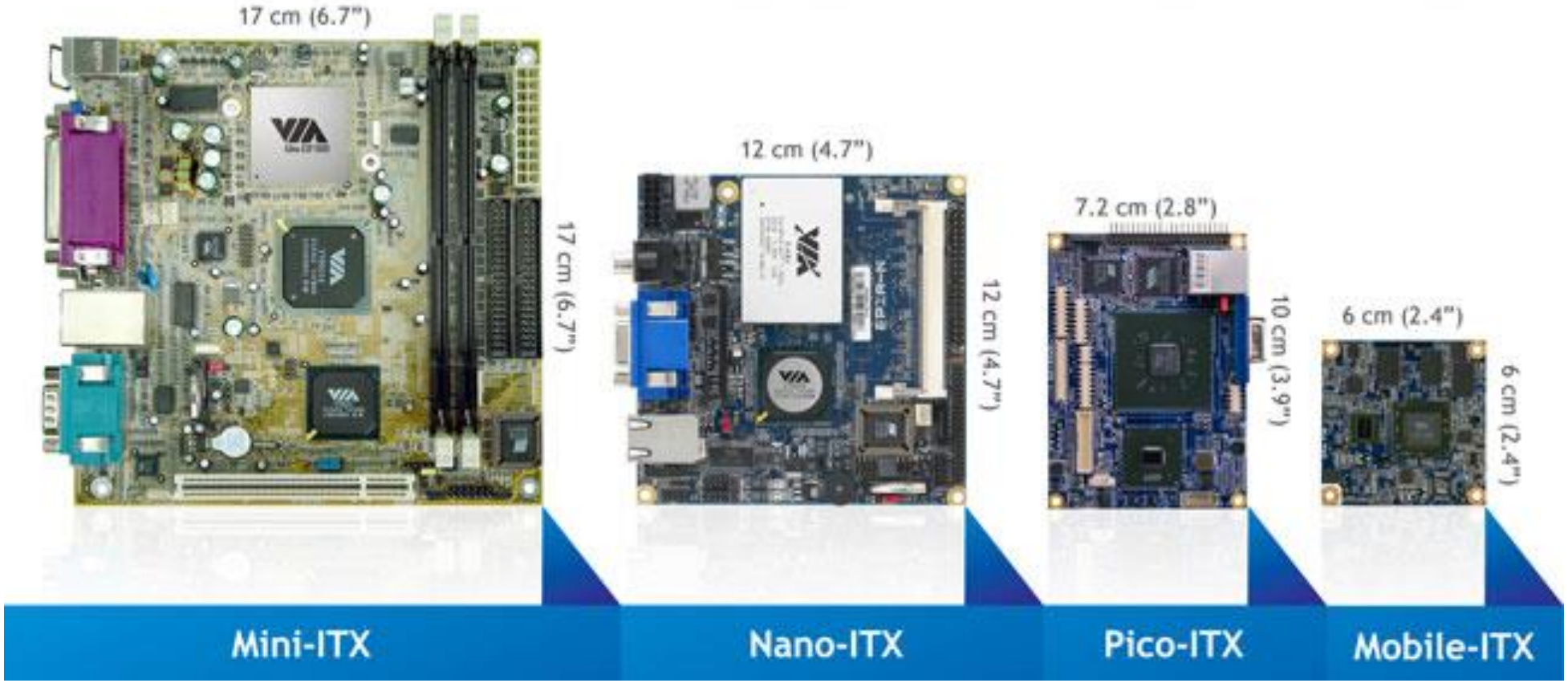
1. PS/2 mouse port
2. PS/2 keyboard port
3. S/PDIF Out port
4. HDMI connector
5. DVI connector
6. VGA port
7. IEEE 1394a (FireWire) port
8. eSATA port
9. USB ports
10. RJ45 port
11. Audio ports
    a. line in (light blue)
    b. line out (lime)
    c. microphone (pink)
    d. side speaker out (gray)
    e. rear speaker out (black)
    f. center/subwoofer (yellow orange)
12. PCI-E x16 slot
13. PCI-E x4 slot
14. PCI slots
15. Super I/O
16. Print Header
17. COM port
18. USB Header
19. 5 SATA2 connectors
20. IDE connector
21. 4 DDR3 DIMM Memory slot
22. CPU

Power Delivery

- 24-pin ATX power connector.
- Dedicated power connectors for the CPU and sometimes the **GPU**.
    - A GPU, or graphics processing unit, is an electronic circuit that processes images and accelerates the rendering of 3D computer graphics



Micro-ATX:


NOV. 2001
MAR. 2003
APR. 2007
MAR. 2004
17 cm (6.7")
17 cm (6.7")
12 cm (4.7")
12 cm (4.7")
7.2 cm (2.8")
10 cm (3.9")
6 cm (2.4")
6 cm (2.4")
Mini-ITX
Nano-ITX
Pico-ITX
Mobile-ITX

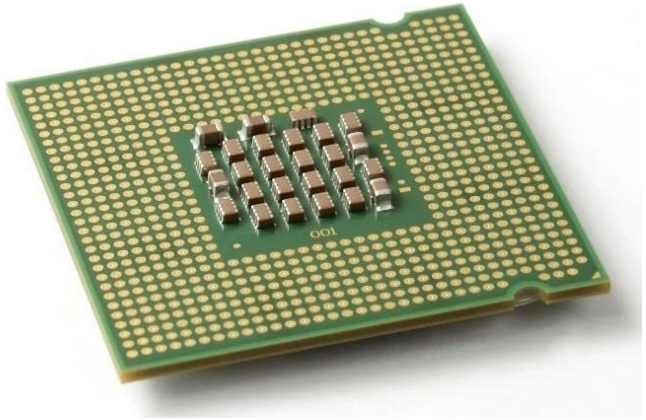
Feature	ATX	Micro-ATX	Mini-ITX
Size	12 x 9.6 in	9.6 x 9.6 in	**6.7 x 6.7 in**
RAM Slots	Typically 4	2-4	**2**
PCIe Slots	Multiple	Fewer	**Usually 1**
Expandability	High	Moderate	**Low**
Use Case	**General Purpose**	**Budget Builds**	**Compact PCs**

CPU SOCKETS

- **LGA (Land Grid Array)** and **PGA (Pin Grid Array)** are two types of socket and packaging technologies for connecting CPUs to motherboards

- **Land Grid Array (LGA)**
  - **Design**: The pins are on the motherboard socket rather than the CPU itself. The CPU has flat contact pads that touch the pins in the socket

- **Pin Grid Array (PGA)**
  - **Design**: The CPU has pins on its underside that fit into holes in the motherboard socket.



LGA

PGA


AMD
RYZEN
AMD Ryzen 9 7950X3D
INTEL CORE™ i9
i9-14900K
SRN48
X333P762

Key Functions of a CPU

- **Fetch**: Retrieves instructions from the computer's memory.
- **Decode**: Interprets the instructions to determine what actions are required.
- **Execute**: Performs the necessary operations, such as arithmetic calculations, logic comparisons, or data transfers.
- **Store**: Writes the result of its operations back into memory.

Main Components of the CPU:

1. **Arithmetic Logic Unit (ALU)**:

   Handles arithmetic (addition, subtraction, etc.) and logical (AND, OR, NOT, etc.) operations.

2. **Control Unit (CU)**:

   Directs the operation of the CPU by telling other components and peripherals what to do.

   Manages the flow of data between the CPU, memory, and input/output devices.

Main Components of the CPU:

3. **Registers**:

   Small, high-speed storage locations inside the CPU used to hold temporary data, instructions, or addresses.

4. **Cache**:

   A small amount of high-speed memory located within or close to the CPU to store frequently accessed data and instructions, speeding up processing.

Key Performance Metrics:

- **Clock Speed** (GHz): Indicates how many cycles the CPU can execute per second. Higher speeds generally mean faster performance.

- **Core Count**: Determines how many processes can run simultaneously.

- A clock cycle is the time it takes for the CPU to complete one basic operation, such as fetching an instruction or performing a calculation.

- The clock rate indicates how many of these cycles occur in one second.

- **Example**:
  - A CPU with a clock rate of **3.0 GHz** performs 3 billion cycles per second.

- **Thread Count**: Reflects the number of tasks the CPU can handle at once, influenced by hyper-threading technology.

Hyper-Threading Technology is a hardware innovation that allows more than one thread to run on each core. More threads means more work can be done in parallel

- **Instruction Set Architecture (ISA)**: Defines the set of instructions the CPU can execute (e.g., x86, ARM).

- **Cache Size**: Affects how quickly the CPU can access frequently used data.

Types of CPU Cache

Cache (Level 1):

1. **Location**: Closest to the CPU cores.
2. **Size**: Smallest (16 KB to 128 KB per core, typically).
3. **Speed**: Fastest among cache levels.
4. **Function**: Stores critical data and instructions the CPU is actively working on.

L2 Cache (Level 2):

1. **Location**: Located on the CPU chip but slightly farther from cores.
2. **Size**: Larger than L1 (128 KB to 1 MB per core).
3. **Speed**: Slower than L1 but faster than L3.
4. **Function**: Stores data not immediately required but likely to be reused soon.

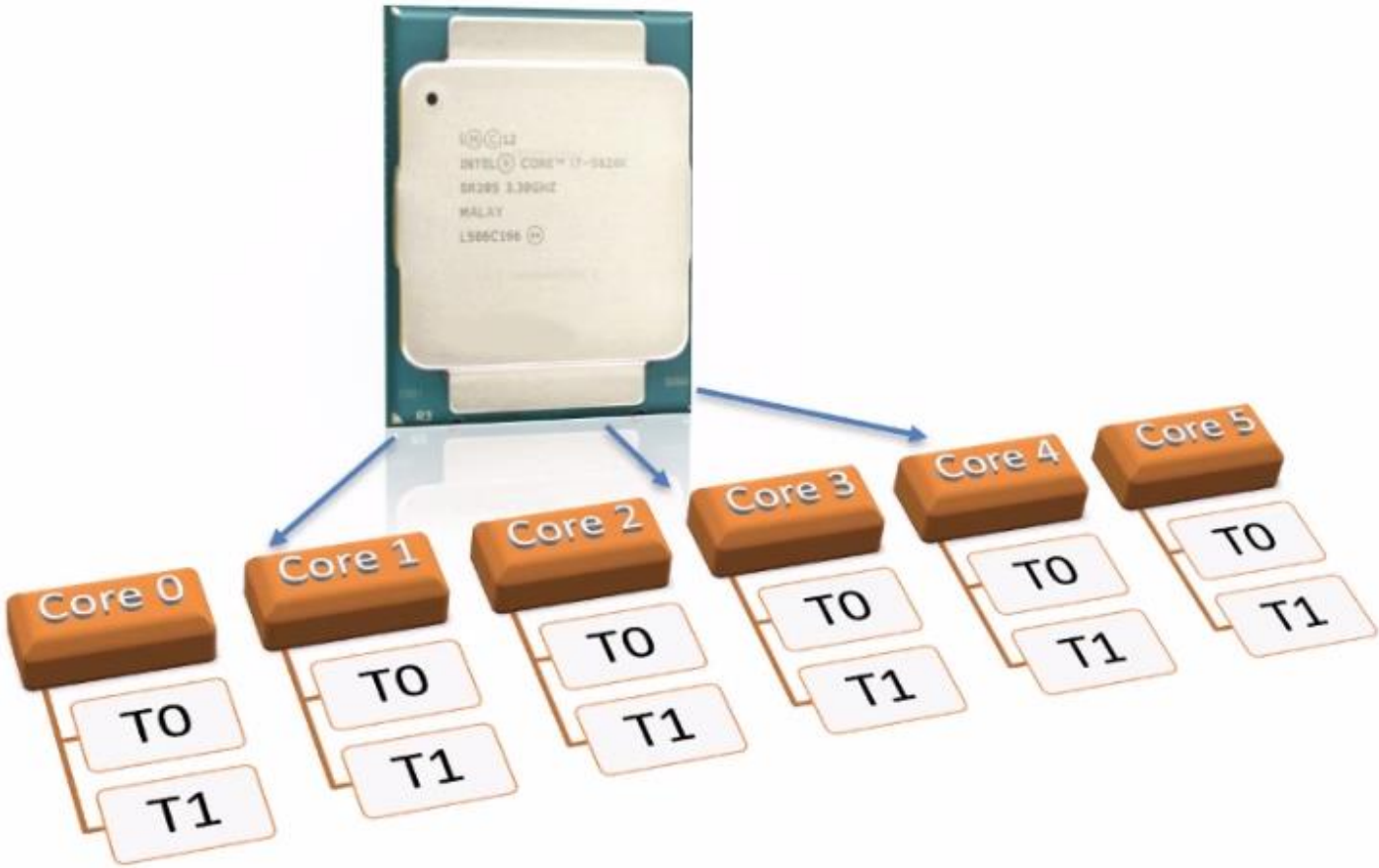
L3 Cache (Level 3):

1. **Location**: Shared across all cores on the CPU.
2. **Size**: Largest (2 MB to 64 MB, depending on the processor).
3. **Speed**: Slower than L1 and L2 but still much faster than RAM.
4. **Function**: Acts as a buffer to reduce memory bottlenecks.

How CPU Cache Works

- When the CPU needs data, it first checks the **L1 cache**.
- If the data is not found (cache miss), it moves to the **L2 cache**, then **L3 cache**, and finally to the **RAM**.
- The hierarchy ensures that most operations are performed with the fastest available data.

Multicore Technologies

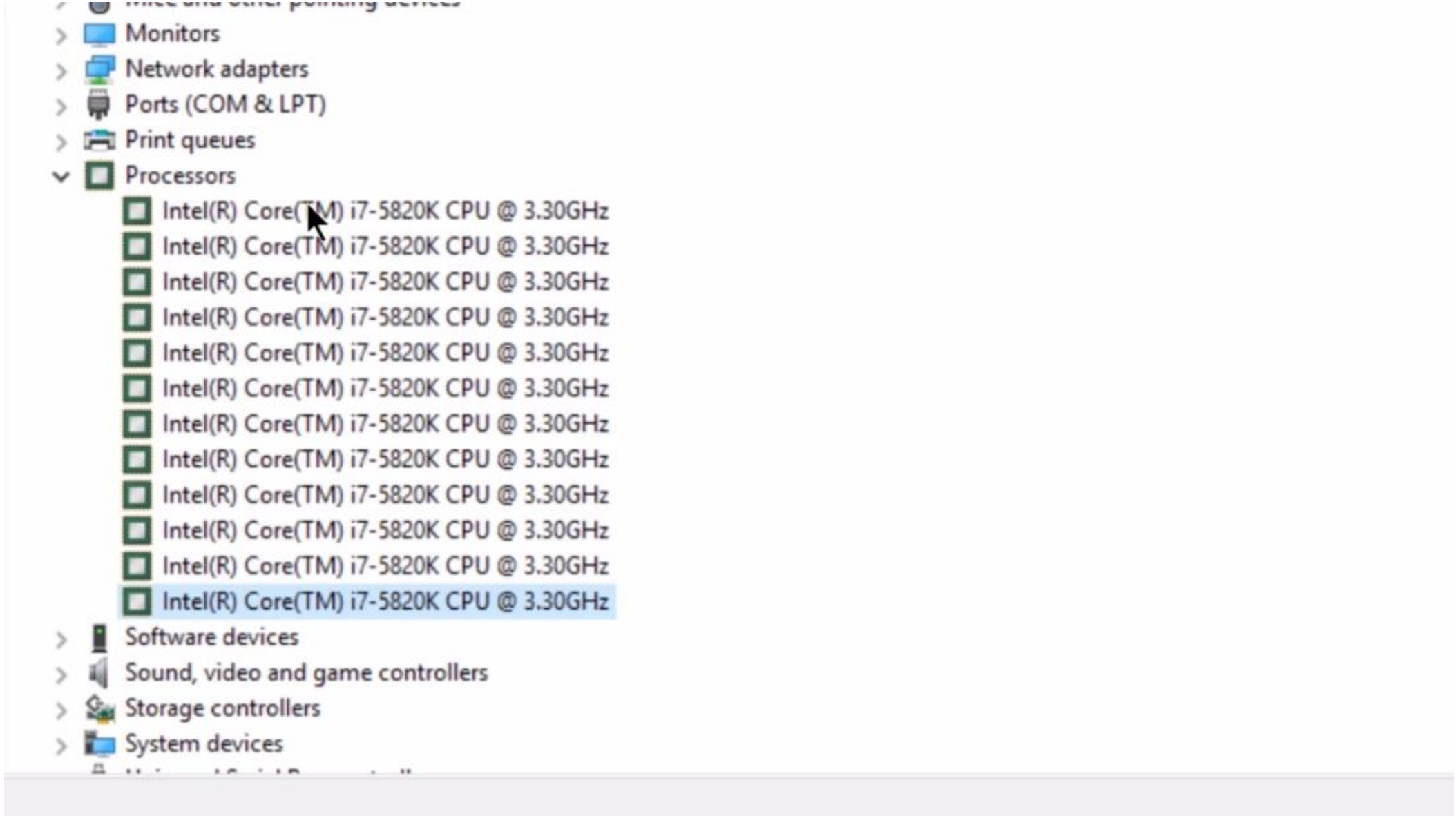


Multicore

When a CPU physically contains two or more processor cores.

It's common to see 2, 4, 6, or 8 cores in a single CPU.

Used together with Hyper-Threading.


Monitors
Network adapters
Ports (COM & LPT)
Print queues
Processors
Intel(R) Core(TM) i7-5820K CPU @ 3.30GHz
Intel(R) Core(TM) i7-5820K CPU @ 3.30GHz
Intel(R) Core(TM) i7-5820K CPU @ 3.30GHz
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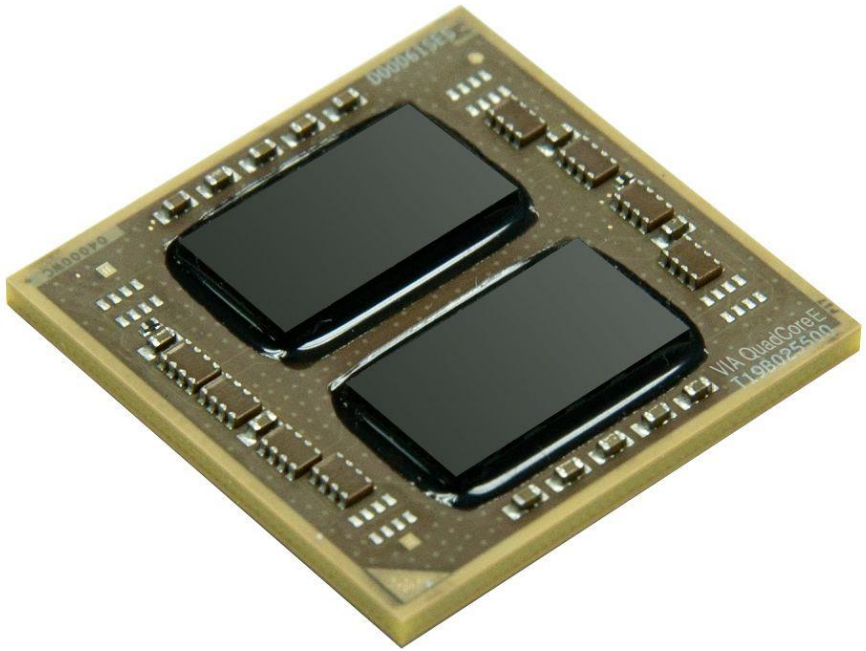
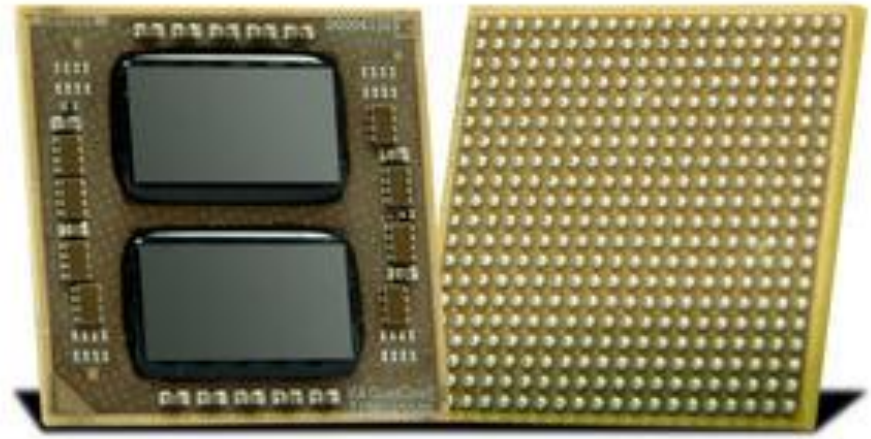
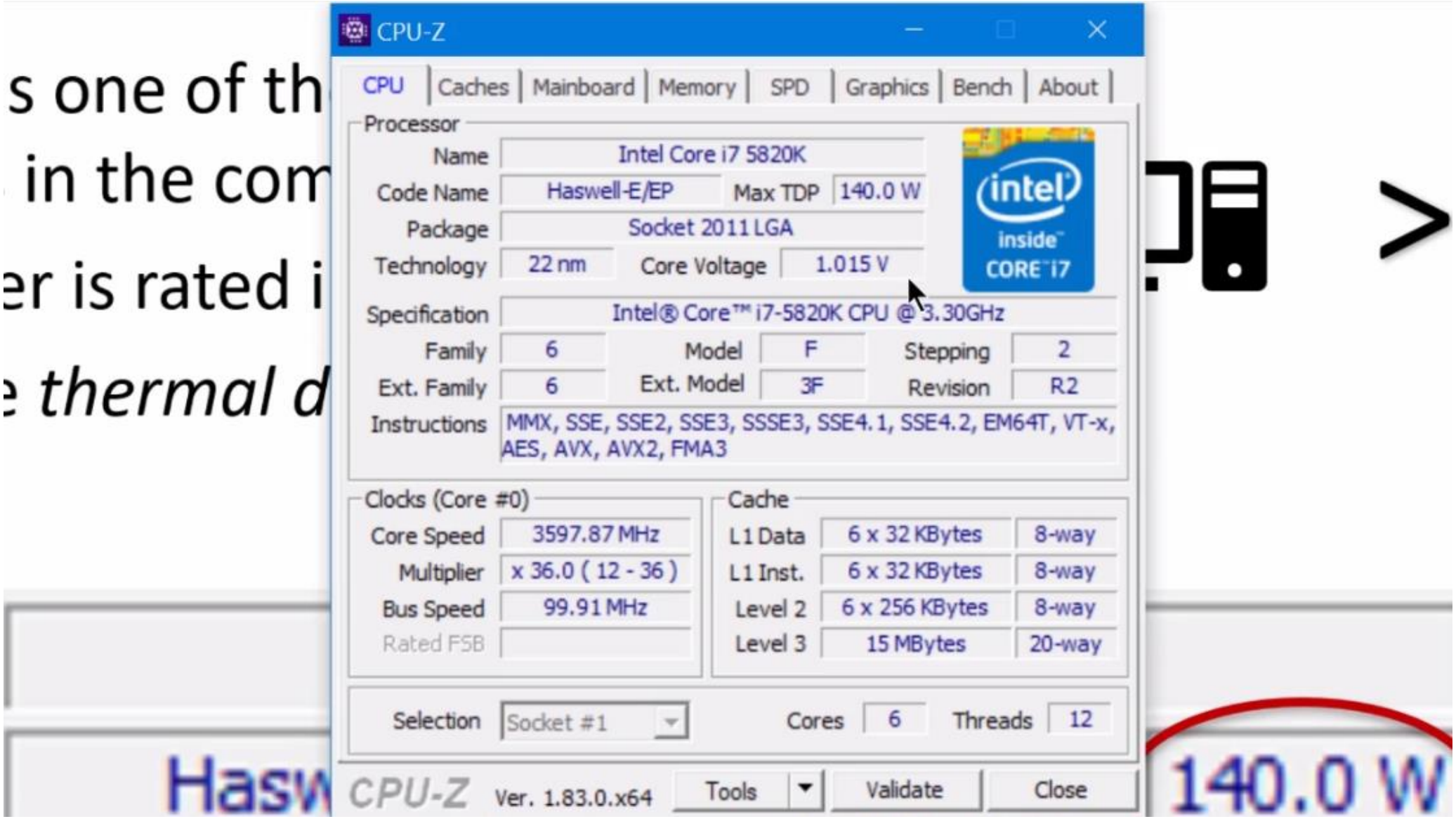
Intel(R) Core(TM) i7-5820K CPU @ 3.30GHz
Software devices
Sound, video and game controllers
Storage controllers
System devices


VIA QuadCore E
T1908025S00



- The CPU is one of the largest power consumers in the computer.
- CPU power is rated in watts.
- This is the *thermal design power* (TDP).

Intel Core i7 5820K		
Haswell-E/EP	Max TDP	140.0 W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CPU-Z
CPU
Caches
Mainboard
Memory
SPD
Graphics
Bench
About
Processor
Name
Intel Core i7 5820K
Code Name
Haswell-E/EP
Max TDP
140.0 W
Package
Socket 2011 LGA
Technology
22 nm
Core Voltage
1.015 V
intel
inside
CORE i7
Specification
Intel® Core™ i7-5820K CPU @ 3.30GHz
Family
6
Model
F
Stepping
2
Ext. Family
6
Ext. Model
3F
Revision
R2
Instructions
MMX, SSE, SSE2, SSE3, SSSE3, SSE4.1, SSE4.2, EM64T, VT-x, AES, AVX, AVX2, FMA3
Clocks (Core #0)
Core Speed
3597.87 MHz
Multiplier
x 36.0 (12 - 36)
Bus Speed
99.91 MHz
Rated FSB
Cache
L1 Data
6 x 32 KBytes
8-way
L1 Inst.
6 x 32 KBytes
8-way
Level 2
6 x 256 KBytes
8-way
Level 3
15 MBytes
20-way
Selection
Socket #1
Cores
6
Threads
12
CPU-Z
Ver. 1.83.0.x64
Tools
Validate
Close
Hasw
140.0 W

CPU COOLING SYSTEM

- A CPU cooling system removes heat from the CPU and redistributes it away from the hardware. The most popular methods for cooling a CPU are air cooling and liquid cooling, but there are other options as well:

Air cooling and Liquid cooling

Air cooling

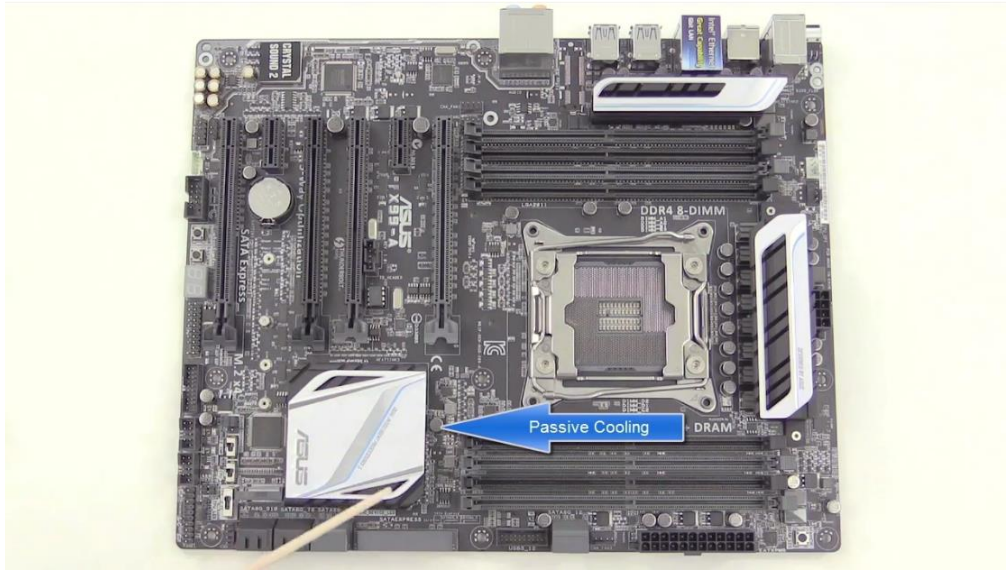
- Uses a heat sink and fan to move air across the heat sink and away from the CPU.

Liquid cooling

- Uses a coolant, usually water or a specialized liquid, to absorb heat from the CPU and move it to a radiator where fans remove it. Liquid cooling is often quieter than air cooling

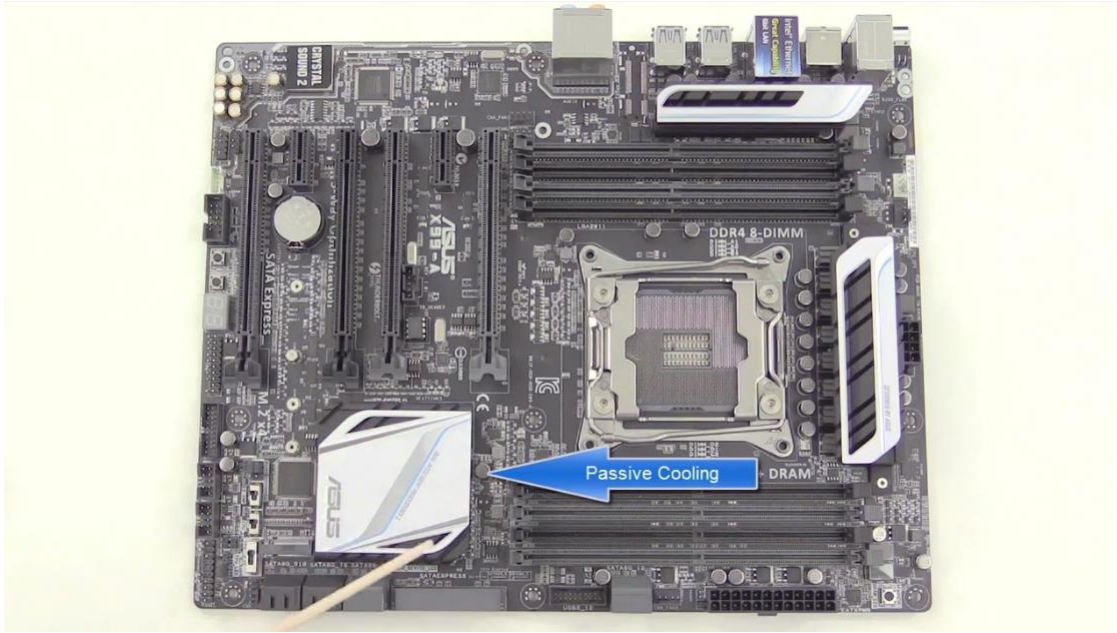
Passive Cooling

- Passive cooling dissipates heat without using moving parts like fans. Instead, it relies on components like heatsinks and thermal conductivity to transfer heat away from the CPU into the surrounding environment.



Active Cooling

- Active cooling uses fans or liquid cooling systems to actively remove heat from the CPU, enhancing heat dissipation and maintaining lower temperatures.



Feature	Passive Cooling	Active Cooling
Components	Heatsinks, thermal paste	**Fans, liquid cooling systems**
Noise	Silent	**Can produce noise**
Efficiency	Limited	**High**
Maintenance	Low	**Moderate to high**
Power Usage	None	**Requires power**
Use Cases	**Low-power systems**	**High-performance systems**