Advantages

- Reliability in portable environments and no noise
  - **No moving parts**
- Faster start up
  - Does not need spin up
- Extremely low read latency
  - No seek time (25 μs (μ =10^{-6}) per page/4KB)
- Deterministic read performance
  - The performance does not depends on the location of data

Disadvantage

- Cost significantly more per unit capacity
  - 3$/GB vs. 0.15$/GB
- Limited number of writes
  - ~100,000 writes
  - high endurance cells may have an 1-5 million
- Performance degrades with time
  - slower write speeds because of the erase blocks becomes larger
- High capacity SSDs may have significant higher power requirements

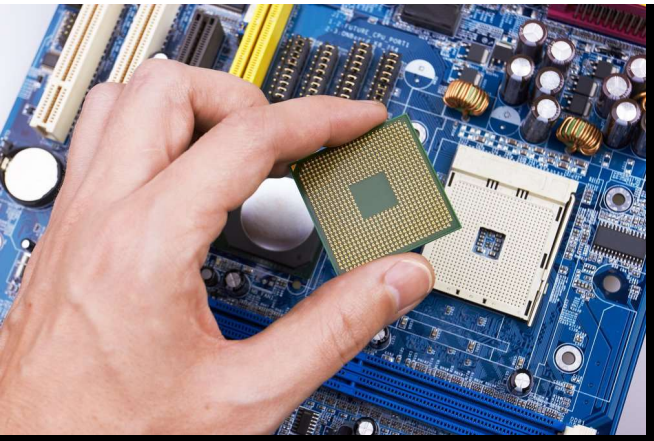
Conclusion

- Although cost prohibitive, for performance applications **SSDs hold a great advantage over platter drives**.
- Common consumer setups take advantage of SSDs for program files while using larger cheaper platter drives to store media and other general storage

  Hybrid drives


Hybrid drive

- **SSDs represent the evolution** toward alleviating the bottleneck that is data storage in present day systems



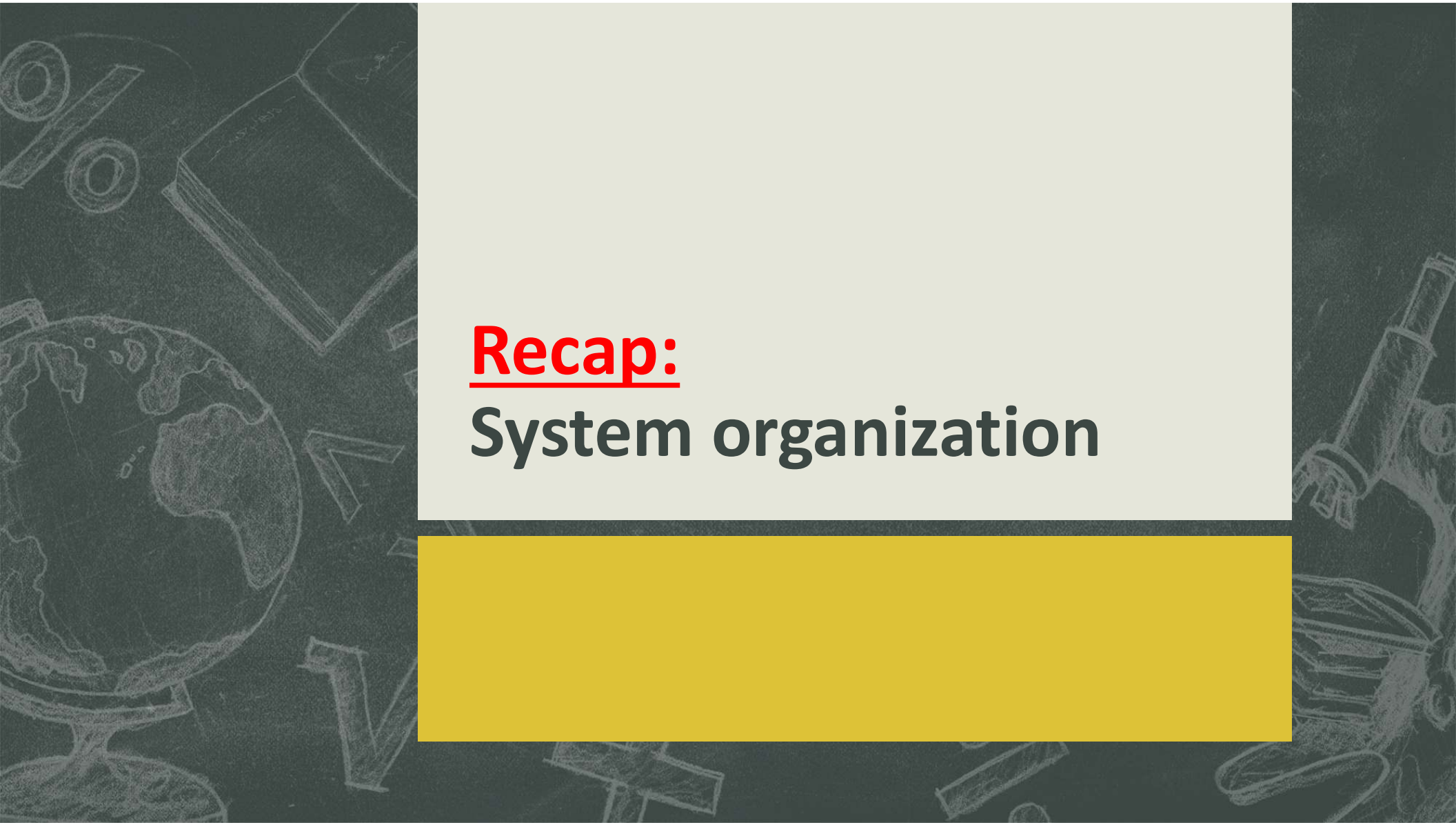
System organization

What's inside?

1. CPU
2. Memory Hierarchy (volatile memory)
3. Memory Hierarchy (non-volatile memory) / SSD
4. External memory

External devices

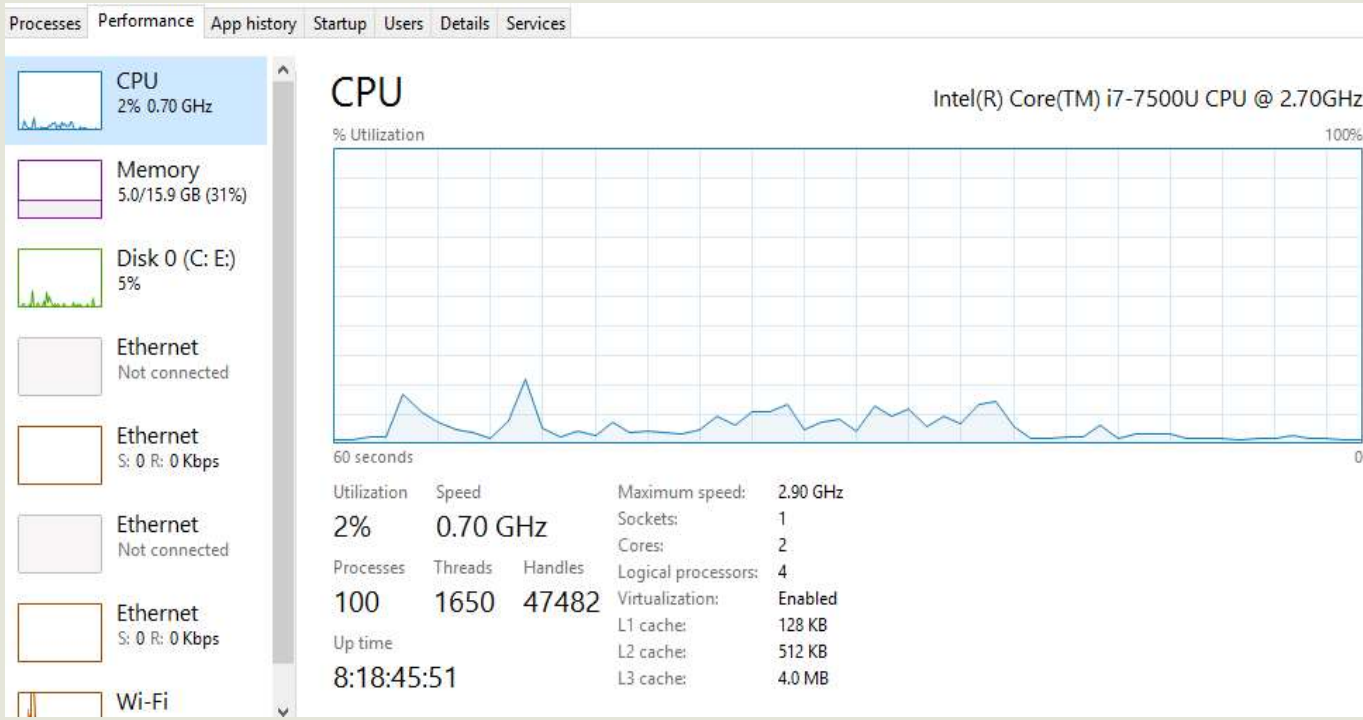
- Flash USB sticks
- External SSD
  - No mechanical part
- External HDD
  - mechanical components



Recap:
System organization

Recap - System Organization

1. **CPU**
    1. **Cores**
    2. **Hyper-threading (**Hyper-threading technology creates two virtual processing cores for each physical core present in a CPU.**)**
    3. **Multi-core** technology adds physical cores
    4. Newer model CPUs are Hyper-Threaded and multi-core (like in the given example)



Recap - System Organization

1. CPU
   1. Cores
   2. Hyper-threading

2. **Memory**
   1. **Cache (volatile)**
   2. **RAM (volatile)**

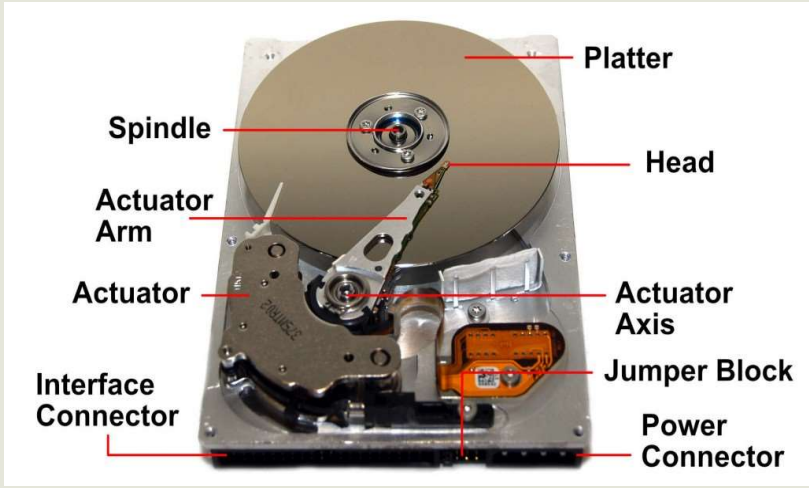
Maximum speed:	2.90 GHz
Sockets:	1
Cores:	2
Logical processors:	4
Virtualization:	Enabled
L1 cache:	128 KB
L2 cache:	512 KB
L3 cache:	4.0 MB

- Cache acts as a buffer between the CPU and main memory. It is used to hold those parts of data and program which are **most frequently used** by CPU.
- Cache temporarily retains recently accessed data in order **to speed up repeated access** to the same data.

Recap - System Organization

1. CPU
   1. Cores
   2. Hyper-threading

2. **Memory**
   1. Cache (volatile)
   2. RAM (volatile)
   3. **HDD**
   4. SSD / External drives
   5. Hybrid Disks

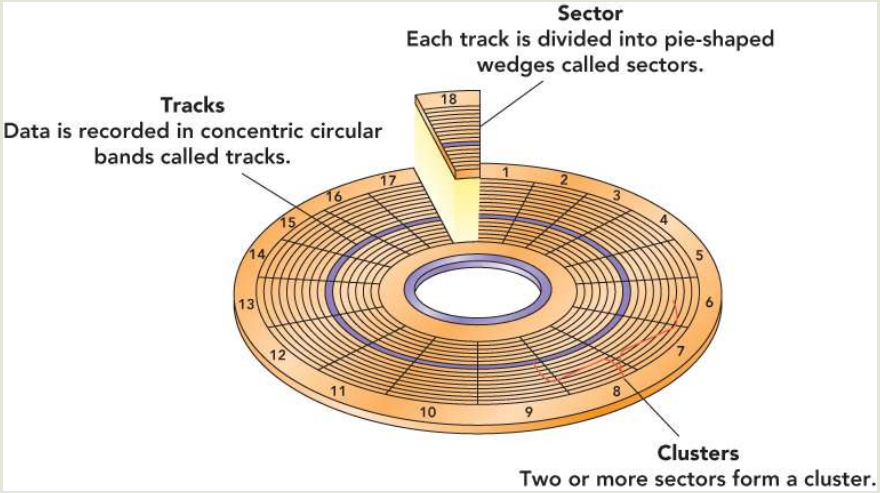


- Rotating Magnetic Media – On a disk called a platter
- Platter rotates several hundred times a second
  - 5400, 7200, 10000, 15000 rpm
- **Disadvantages**
  - Moving parts
  - Latency in reading / writing data

Recap - System Organization

1. CPU
   1. Cores
   2. Hyper-threading

2. **Memory**
   1. Cache (volatile)
   2. RAM (volatile)
   3. **HDD**
   4. SSD / External drives
   5. Hybrid Disks



Capacity = (# bytes/sector) x (avg. # sectors/track) x (# tracks/surface) x (# surfaces/platter) x (# platters/disk)

Example:

- 512 bytes/sector
- 300 sectors/track (on average)
- 20,000 tracks/surface
- 2 surfaces/platter
- 5 platters/disk

Capacity = 512 x 300 x 20000 x 2 x 5

= 30,720,000,00 = **30.72 GB**

Courtesy: Bryant and O'Hallaron

Recap - System Organization

1. CPU
   1. Cores
   2. Hyper-threading

2. **Memory**
   1. Cache (volatile)
   2. RAM (volatile)
   3. HDD
   4. **SSD / External drives**
   5. Hybrid Disks

- **Advantages**
  - Reliability in portable environments and no noise. **(No moving parts)**
  - Faster start up (does not need spin up).
  - Deterministic read performance (The performance does not depends on the location of data).

- **Disadvantages**
  - Cost significantly more per unit capacity (**3$/GB vs. 0.15$/GB**).
  - Limited number of writes **(~100,000 writes**).
  - Performance degrades with time.

Recap - System Organization

1. CPU
   1. Cores
   2. Hyper-threading

2. **Memory**
   1. Cache (volatile)
   2. RAM (volatile)
   3. HDD
   4. SSD / External drives
   5. **Hybrid Disks**


Hybrid drive

Recap - System Organization

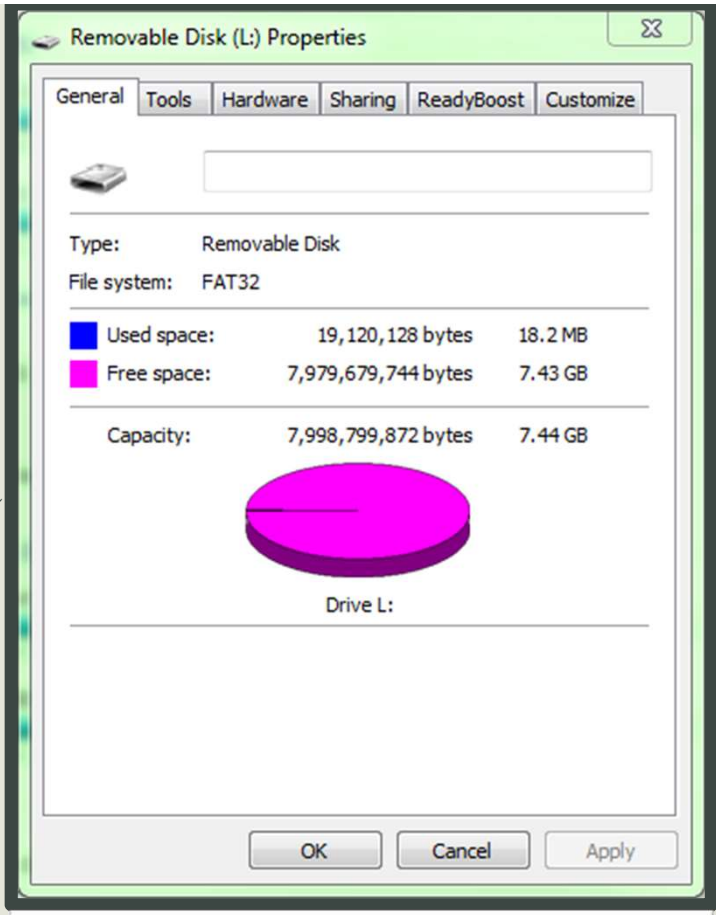
1. CPU
   1. Cores
   2. Hyper-threading
2. Memory
   1. Cache (volatile)
   2. RAM (volatile)
   3. HDD (non-volatile)
   4. SSD / External drives
   5. Hybrid Disks
3. **Memory calculation units / marketing tactics**

Is 2^10 = 10 ^3 ??

8 GB (Gigabyte)

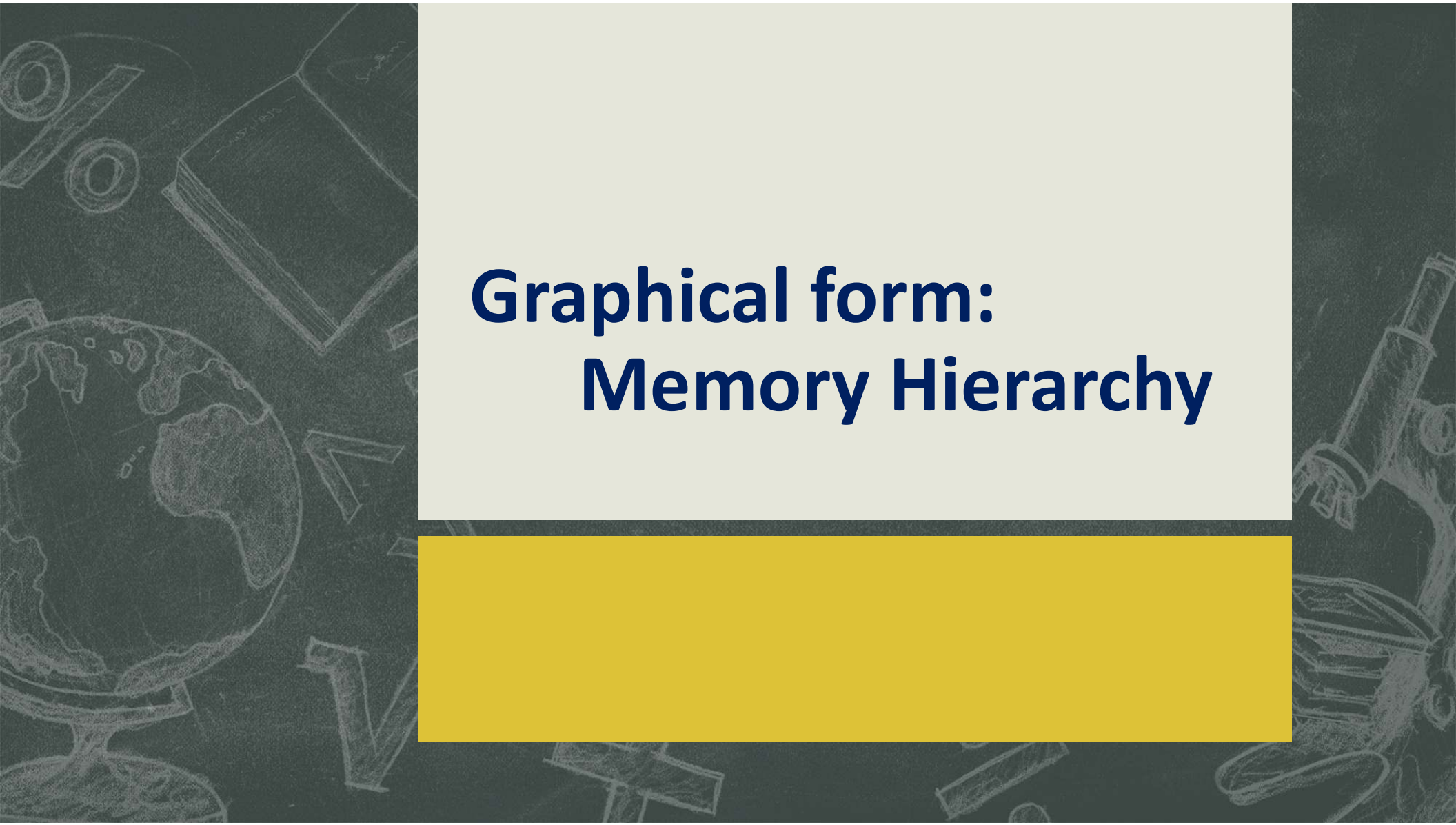
8 x 1000 x 1000 x 1000

Kilo Mega Giga



8000000000 ÷ 1024 ÷ 1024 ÷ 1024 =

7.450580596923828125

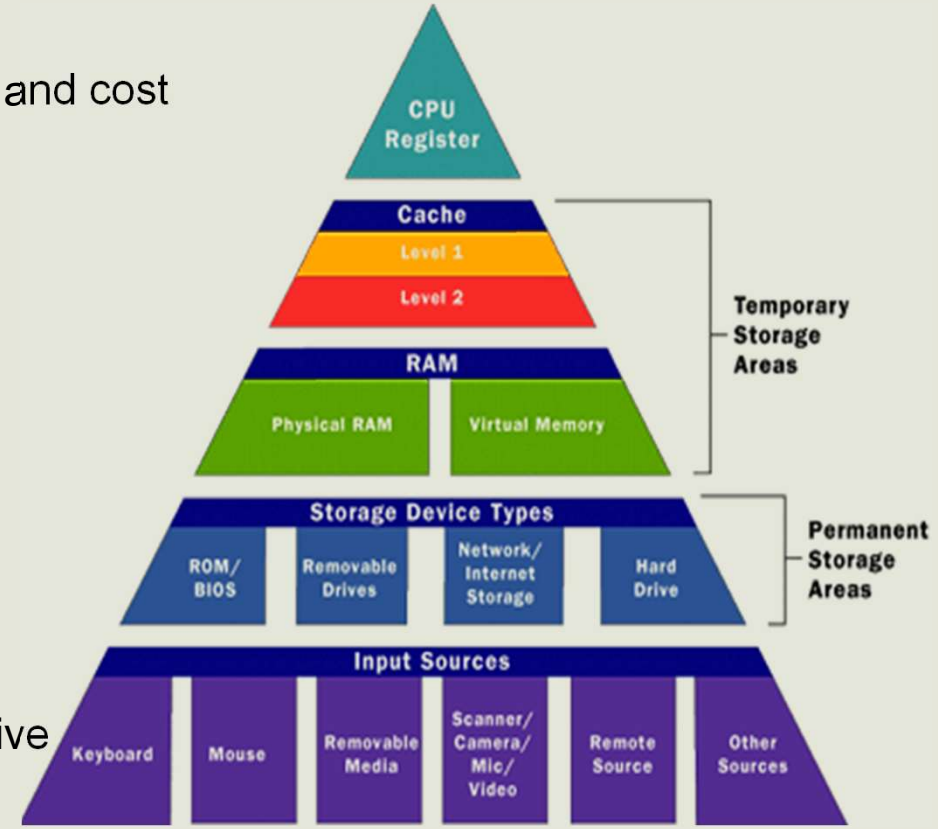


Graphical form: Memory Hierarchy

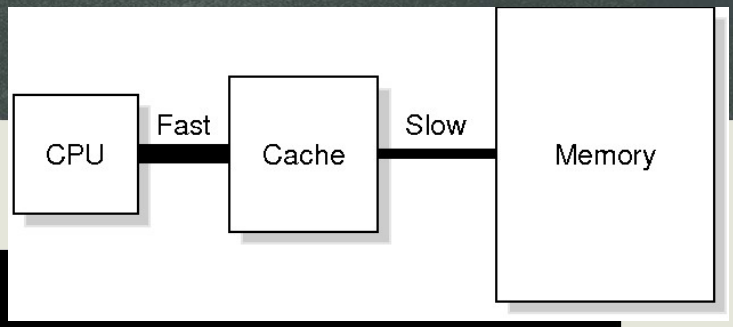
Memory Hierarchy

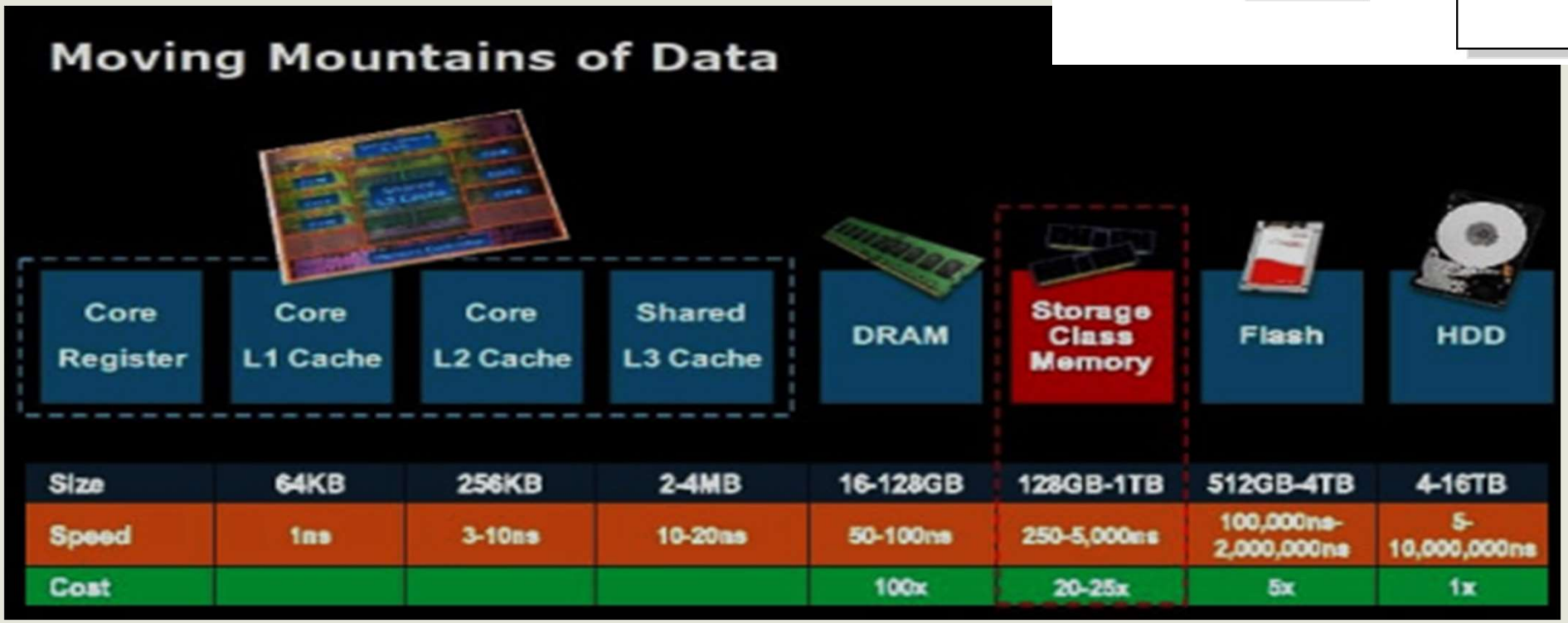
Increasing performance and cost

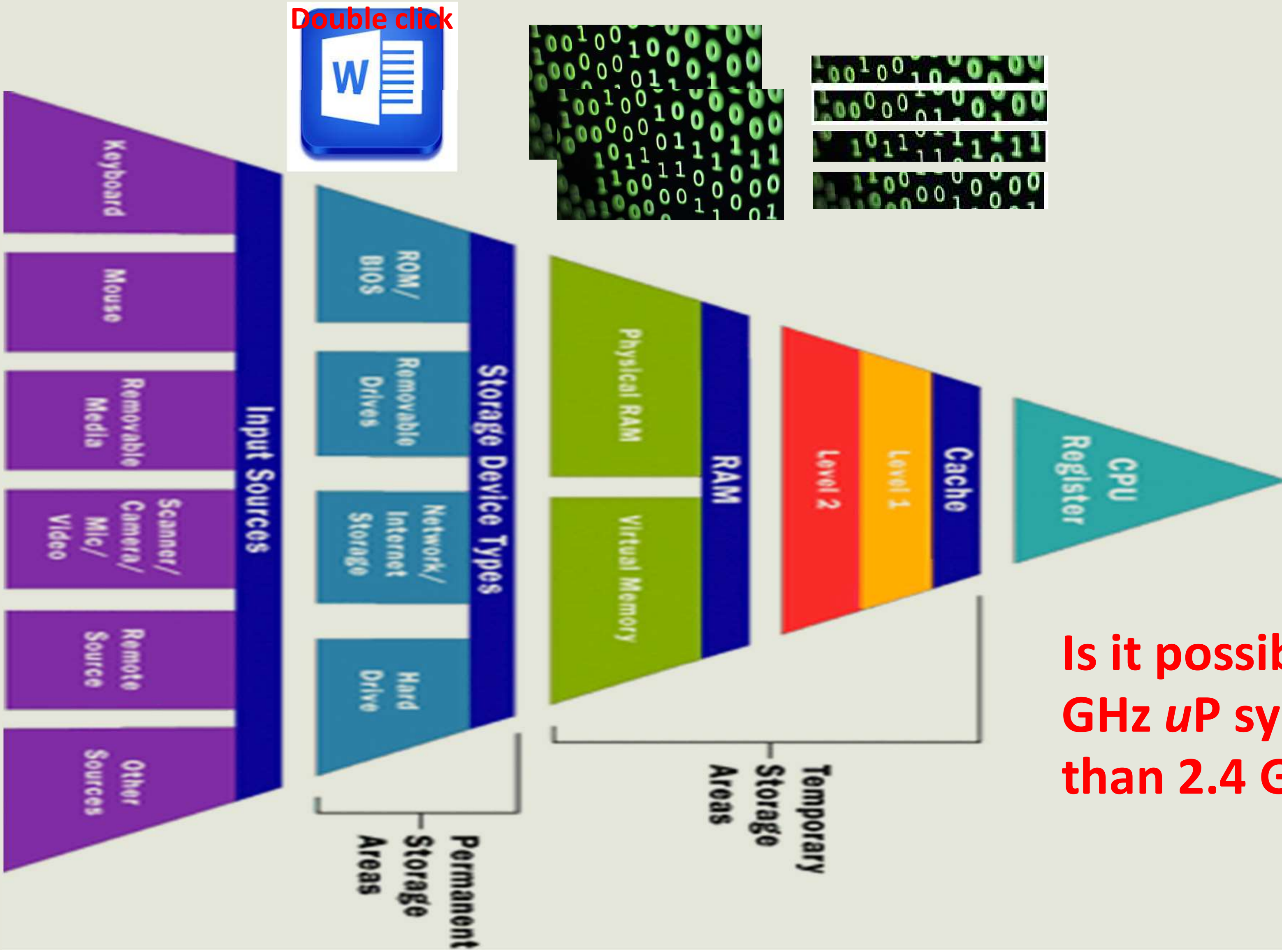
Slow and inexpensive



Flow of data



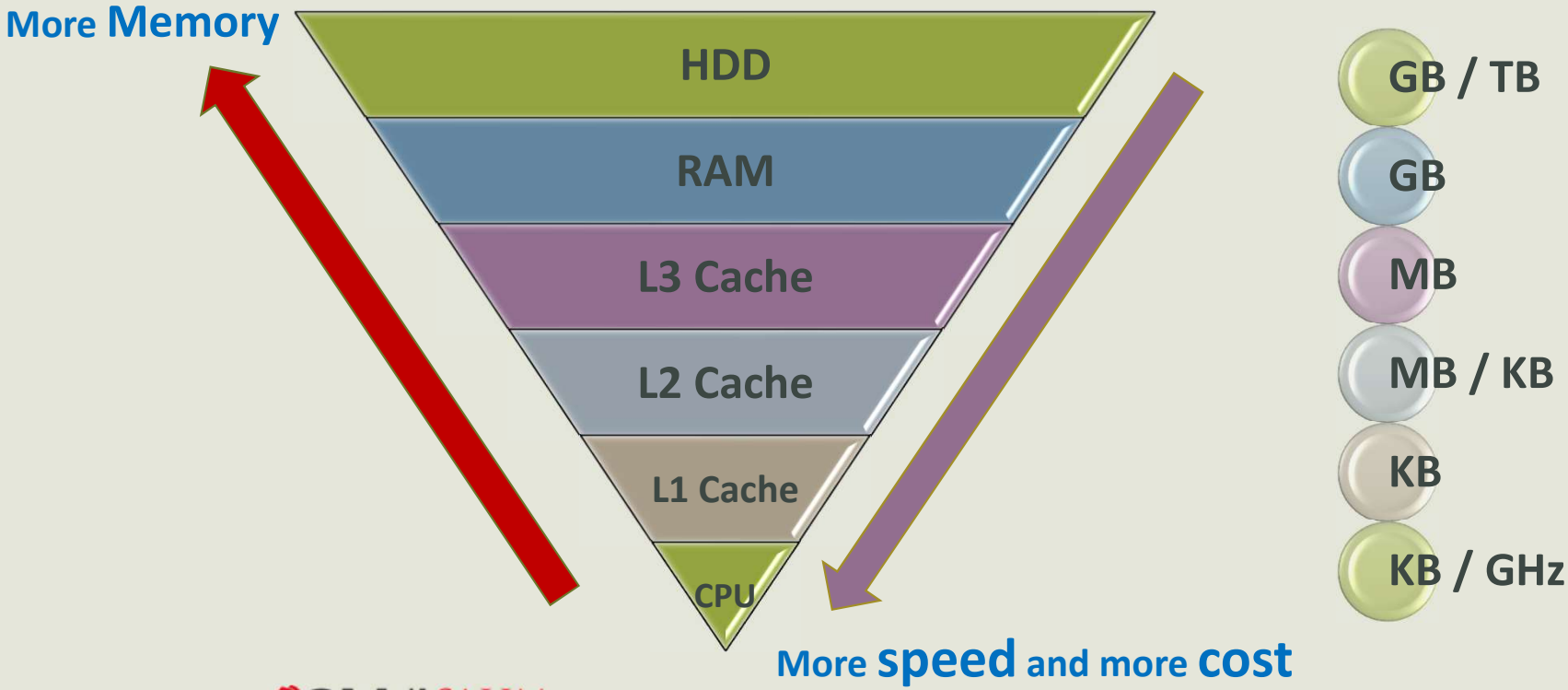


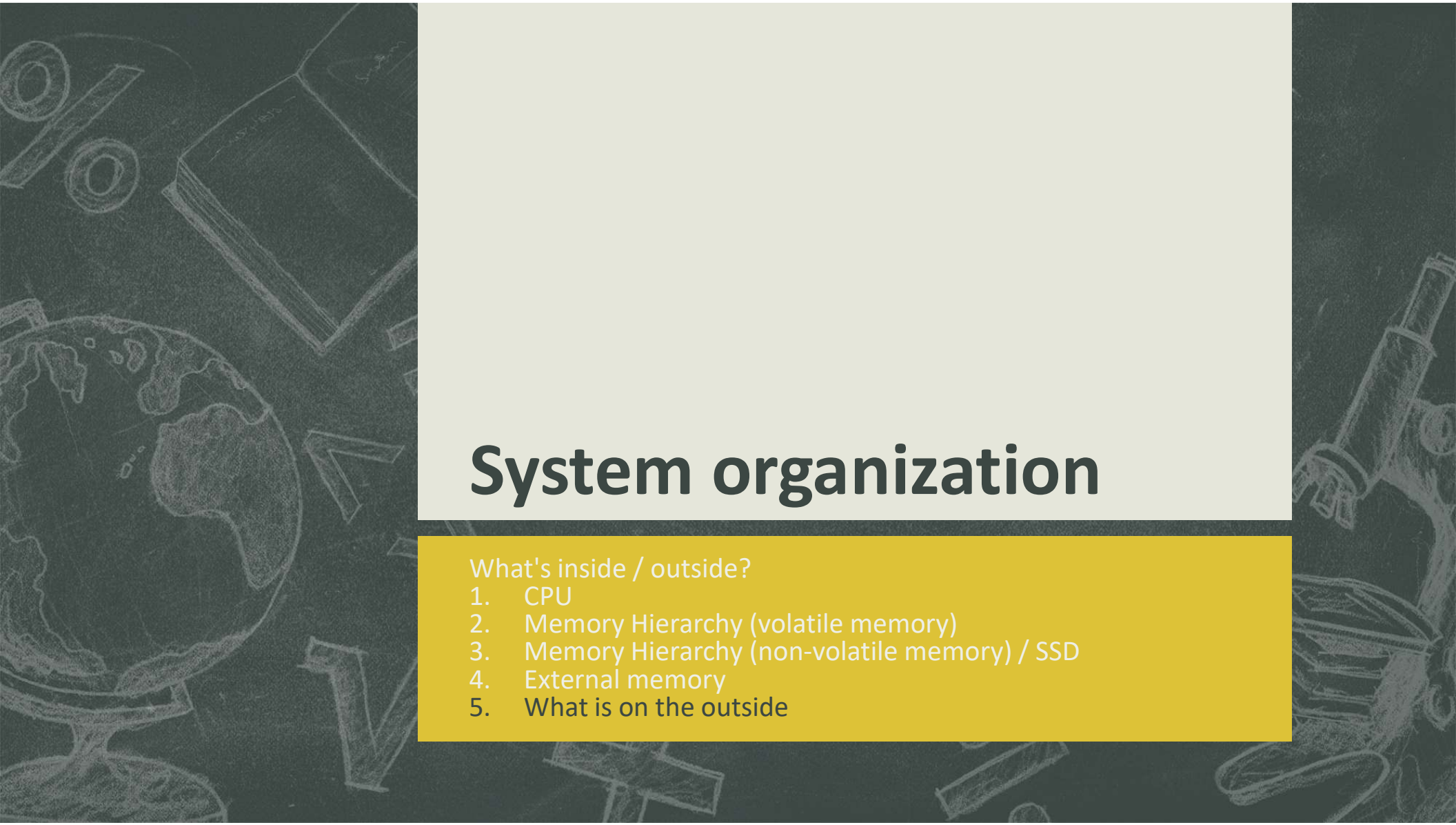


Is it possible to have 3 GHz *u*P system slower than 2.4 GHz *u*P system?

Summary

Memory hierarchy: speed, space and cost tradeoff





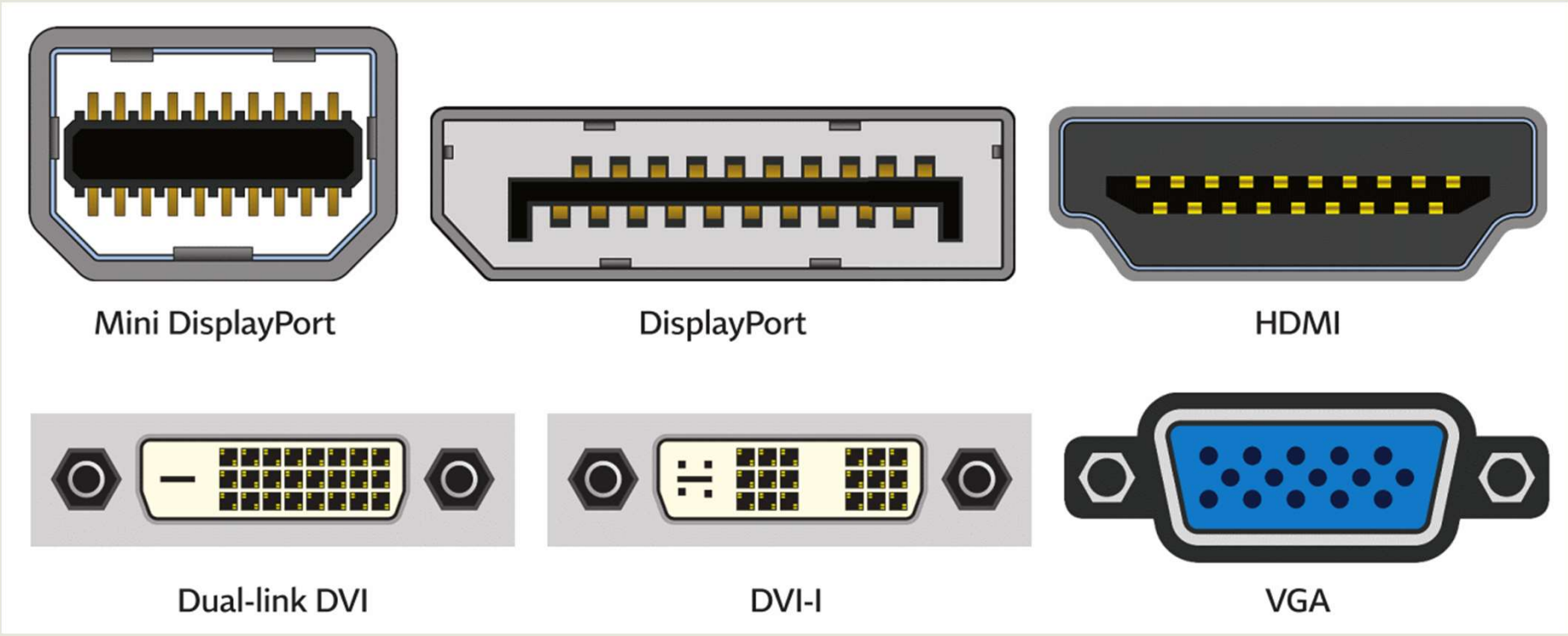
System organization

What's inside / outside?

1. CPU
2. Memory Hierarchy (volatile memory)
3. Memory Hierarchy (non-volatile memory) / SSD
4. External memory
5. What is on the outside

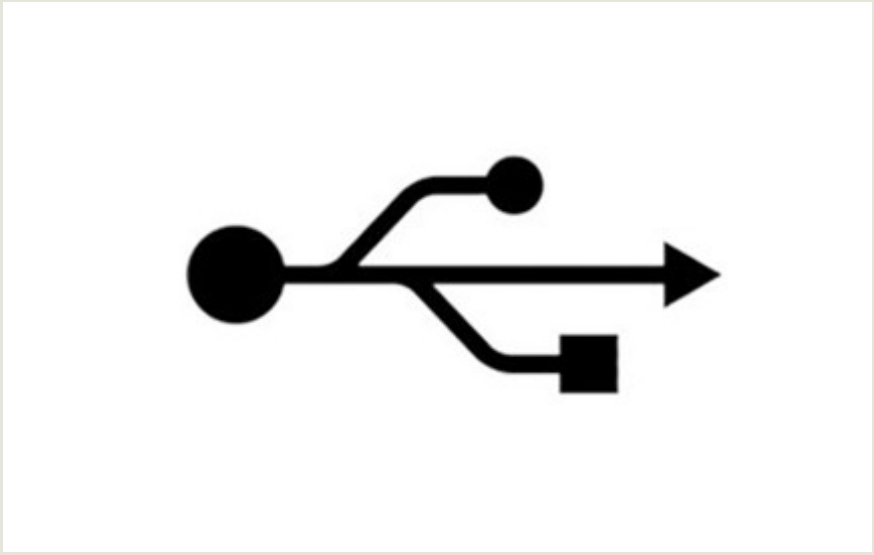
What is on the outside

What is on the outside:
Display connectors



What is on the outside:
USB connector

- You can connect whole range of devices using USB port:
  - Printer
  - Scanner
  - Camera
  - External disk
  - USB Fan / bulb
  - Mouse
  - Keyboard
  - .
  - .



What is on the outside:

USB connector

Wireless connectivity

Wifi

- Short for

  ***wi**reless **fi**delity.*

- It is a wireless technology that uses radio frequency to transmit data through the air.
- Wi-Fi is based on the 802.11 standard:
  - 802.11a (54 Mbps, more flexible, less interference)
  - 802.11b (11 Mbps)
  - 802.11g (54 Mbps)

Wireless connectivity

- **Bluetooth** is an open standard for **short-range** digital radio to interconnect a variety of devices
  - PC / Laptops
  - PDA
  - Printers / cameras / Smart phones
  - etc

- Bluetooth Special Interest Group (SIG)
  - Founded in Spring 1998, by Ericsson, Intel, IBM, Nokia, Toshiba
  - Now more than 2000 organizations joint the SIG

Bluetooth, Why?

•The name 'Bluetooth' was named after 10th century Viking king in Denmark Harald Bluetooth who united and controlled Denmark and Norway.

•The name was adopted because Bluetooth wireless technology is expected to unify the telecommunications and computing industries

Wireless connectivity

- Research area
  - Security (concern for both BT and wifi)
- BT Good for short transfers, but has
  - limitations on file size
  - limitations on distance
- WIFI disadvantages
  - Power consumption
  - Interference with devices operating in same freq. spectrum

Inspiring Stories – Computers changing lives


End