PARALLEL & DISTRIBUTED COMPUTING

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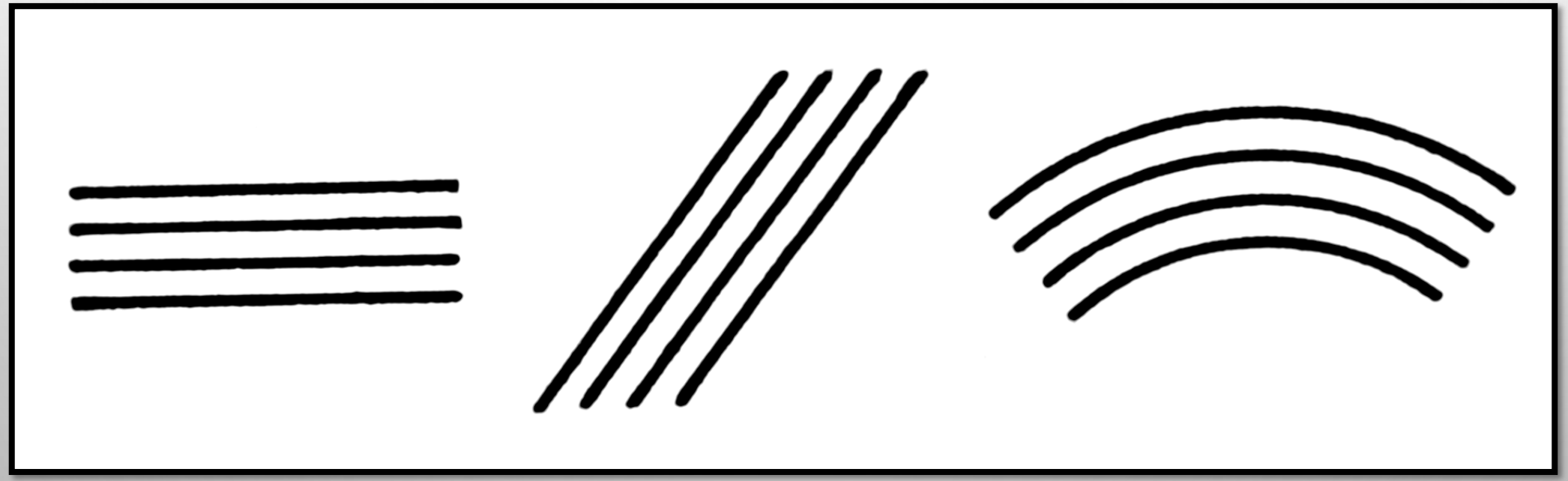
Lecture-1

COMPUTING

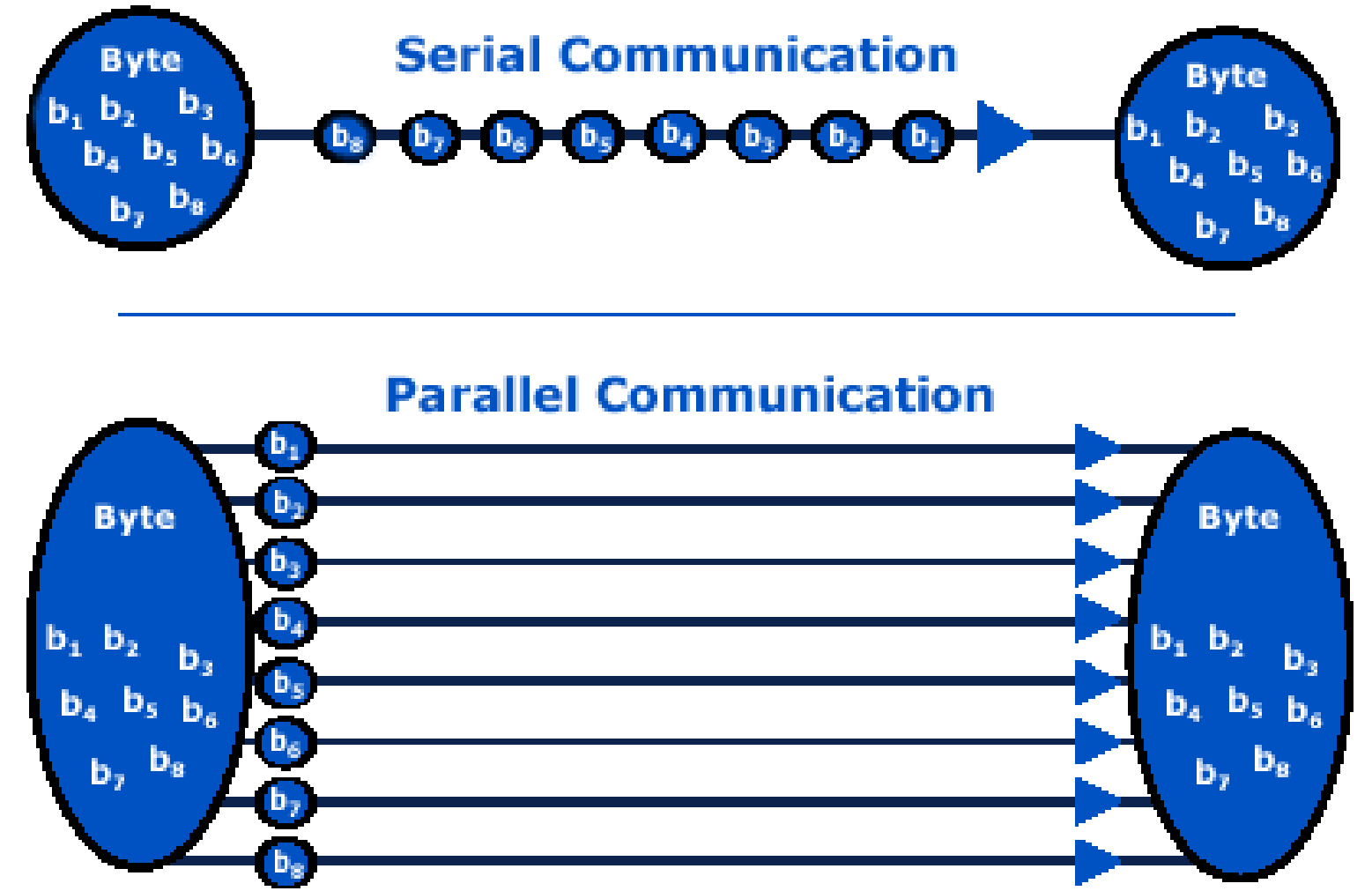
- Computing is the **process to complete a given goal-oriented task** by **using computer technology**.
- Computing may include the **design and development** of **software and hardware systems** for a **broad range of purposes,** often consist of ***structuring***, ***processing*** and ***managing*** any kind of **information**.

PARALLEL

- Parallel (in mathematics) means two lines that never intersect — think of an equal sign.



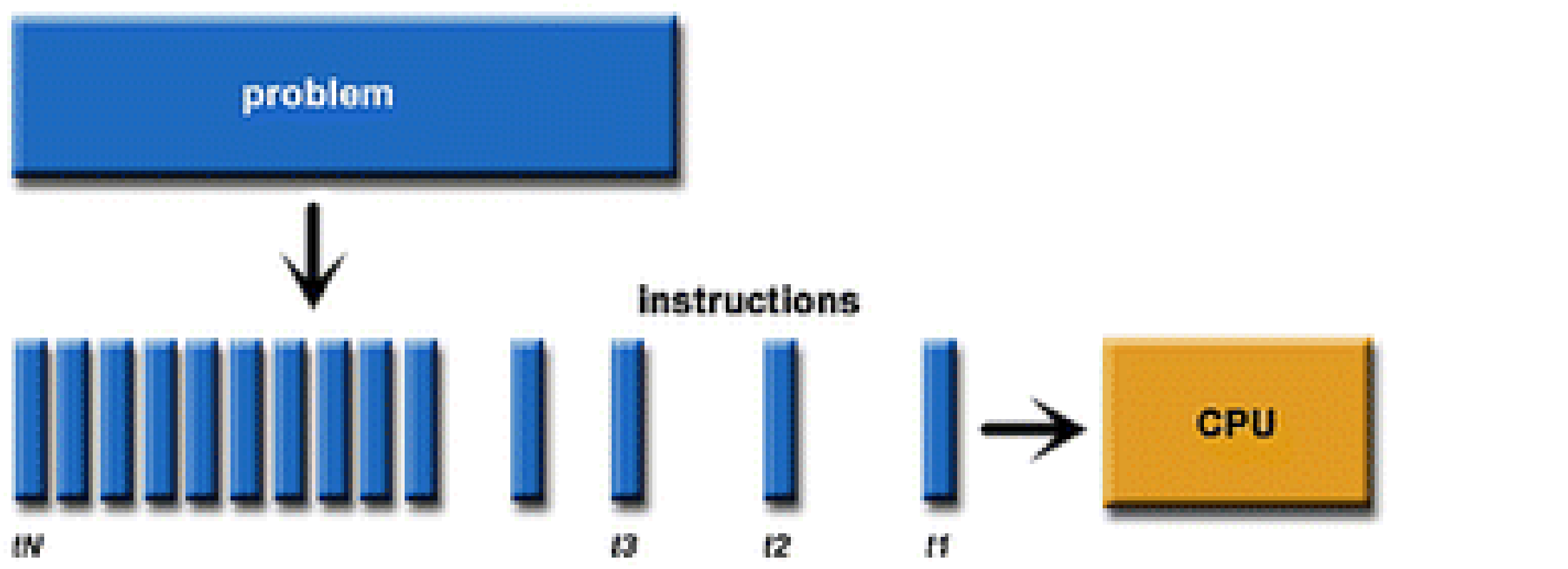
SERIAL VS. PARALLEL



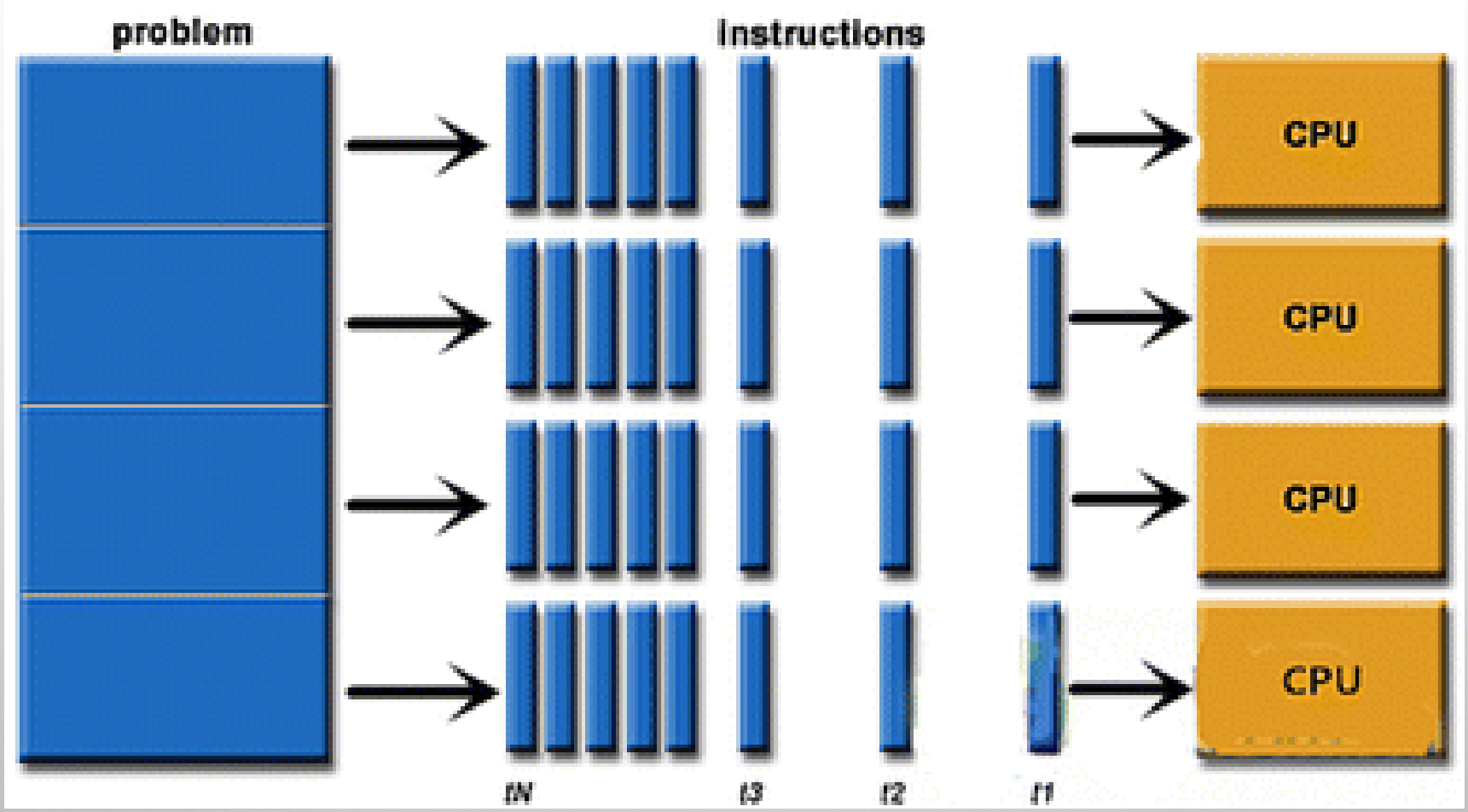
PARALLEL COMPUTING SYSTEMS

- **Parallel computing systems** are the **simultaneous execution** of the ***single task*** (split up and adapted) on multiple processors in order to obtain results faster.
- The idea is based on the fact that the process of solving a problem usually can be divided into **smaller tasks (divide and conquer),** which may be carried out simultaneously with some coordination.

PARALLEL COMPUTING SYSTEMS CONT…
SERIAL VARIATION



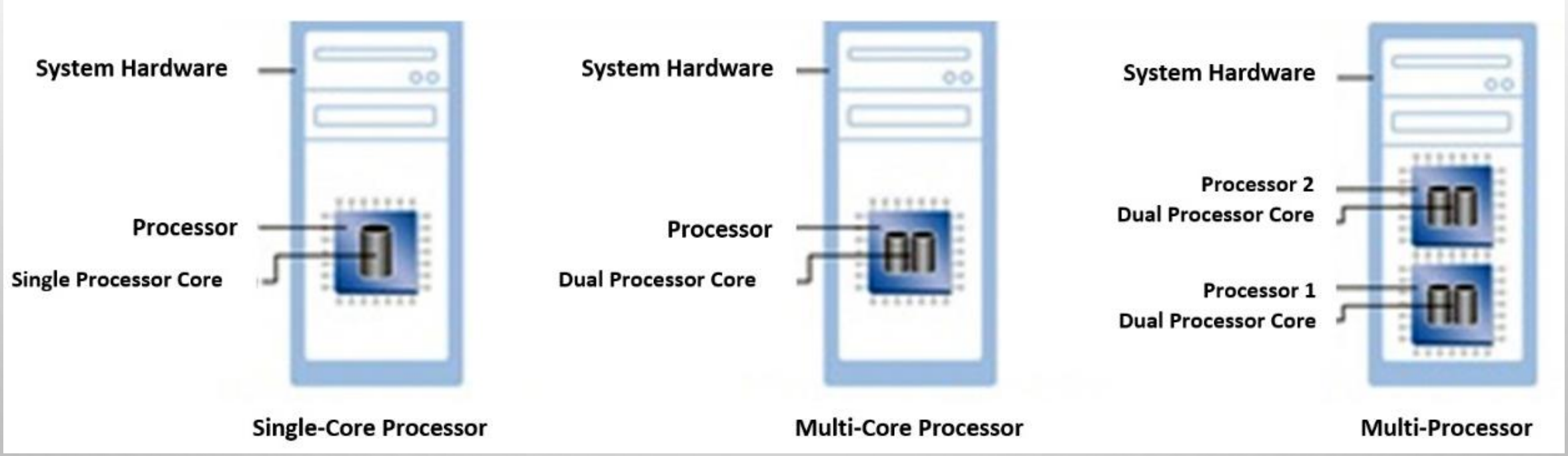
PARALLEL COMPUTING SYSTEMS CONT…



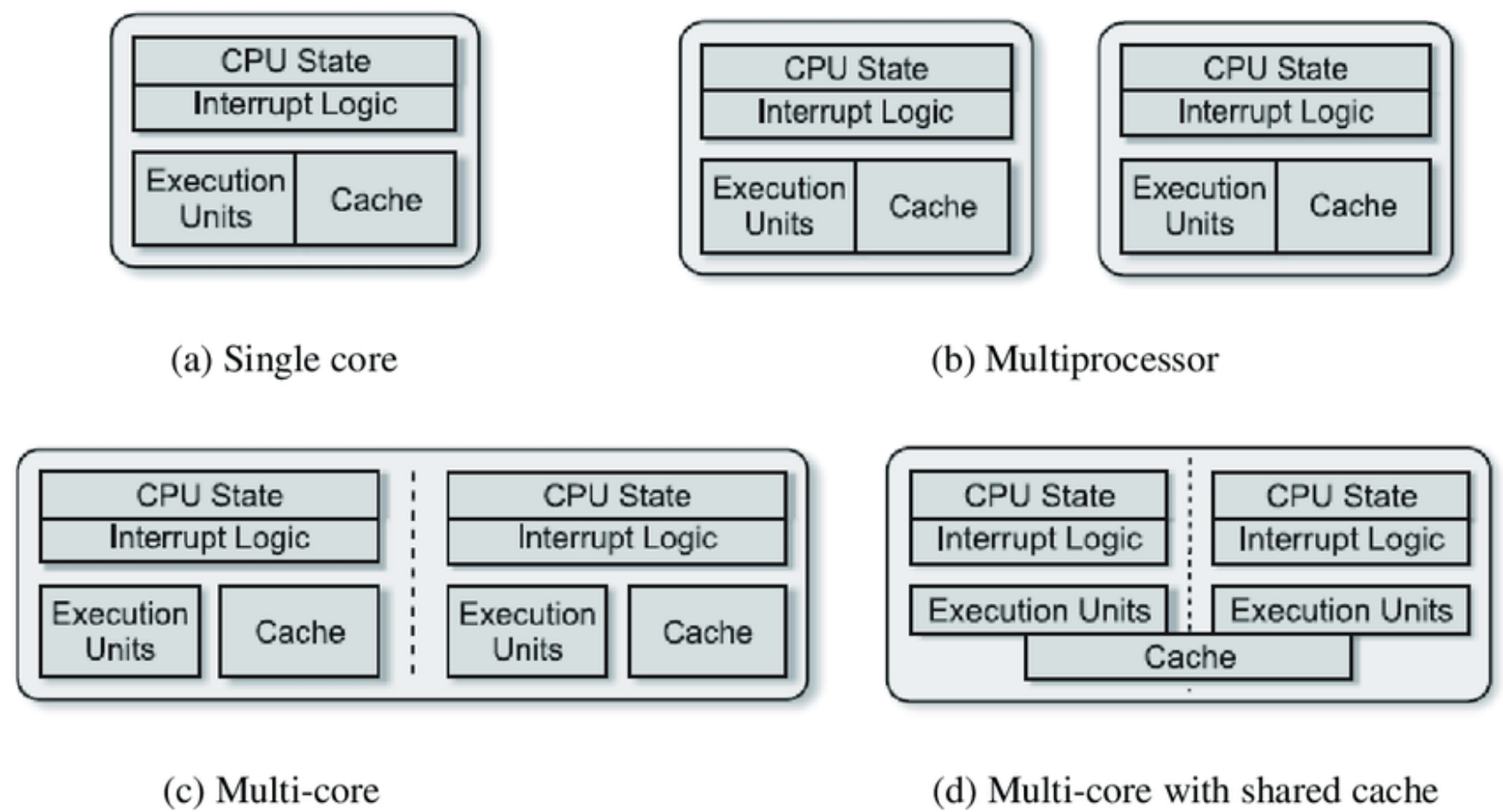
PARALLEL COMPUTING CONT…

- The terms **parallel computing architecture** sometimes used for a computer with **more than one processor** (few to thousands), available for processing.
- The recent **multicore processors** (chips with more than one processor core) are some commercial examples which **bring parallel computing to the desktop.**

PARALLEL COMPUTING CONT…
MULTI-CORE & MULTI-PROCESSOR



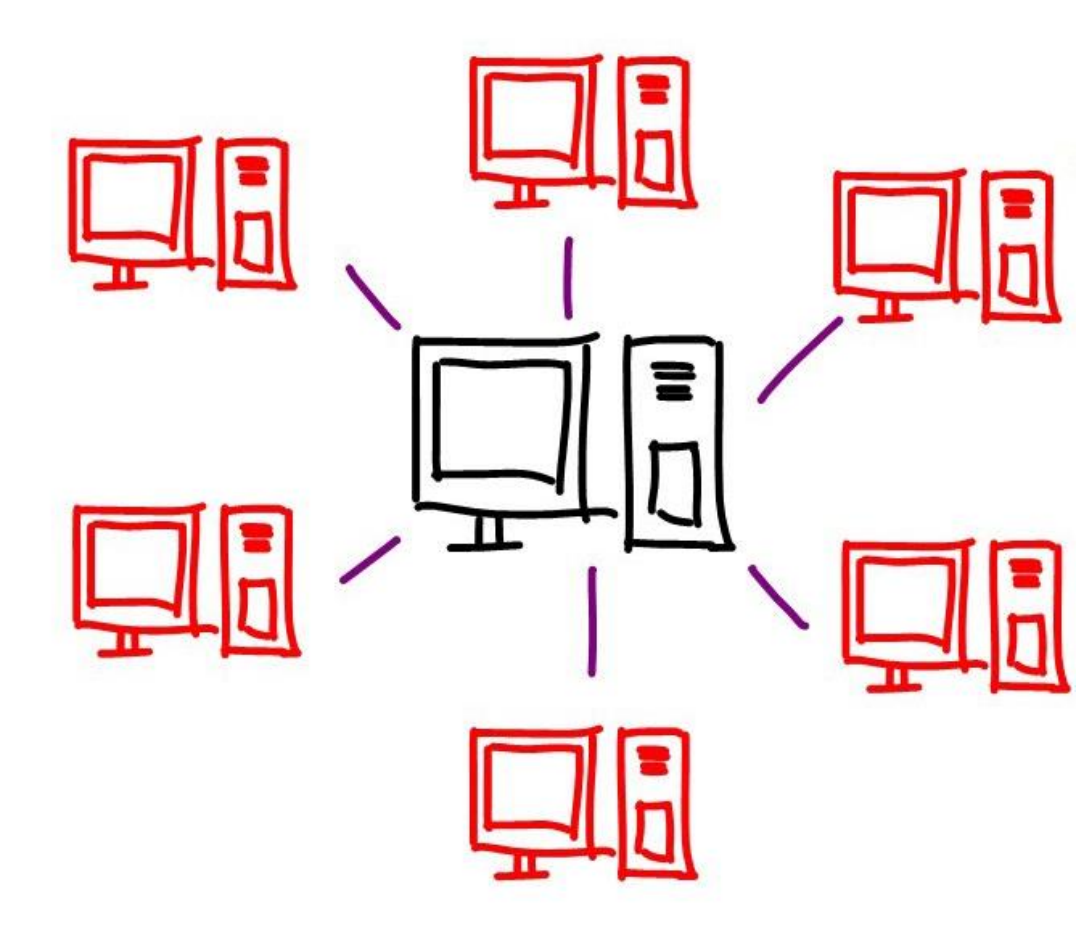
PARALLEL COMPUTING CONT… MULTI-CORE & MULTI-PROCESSOR



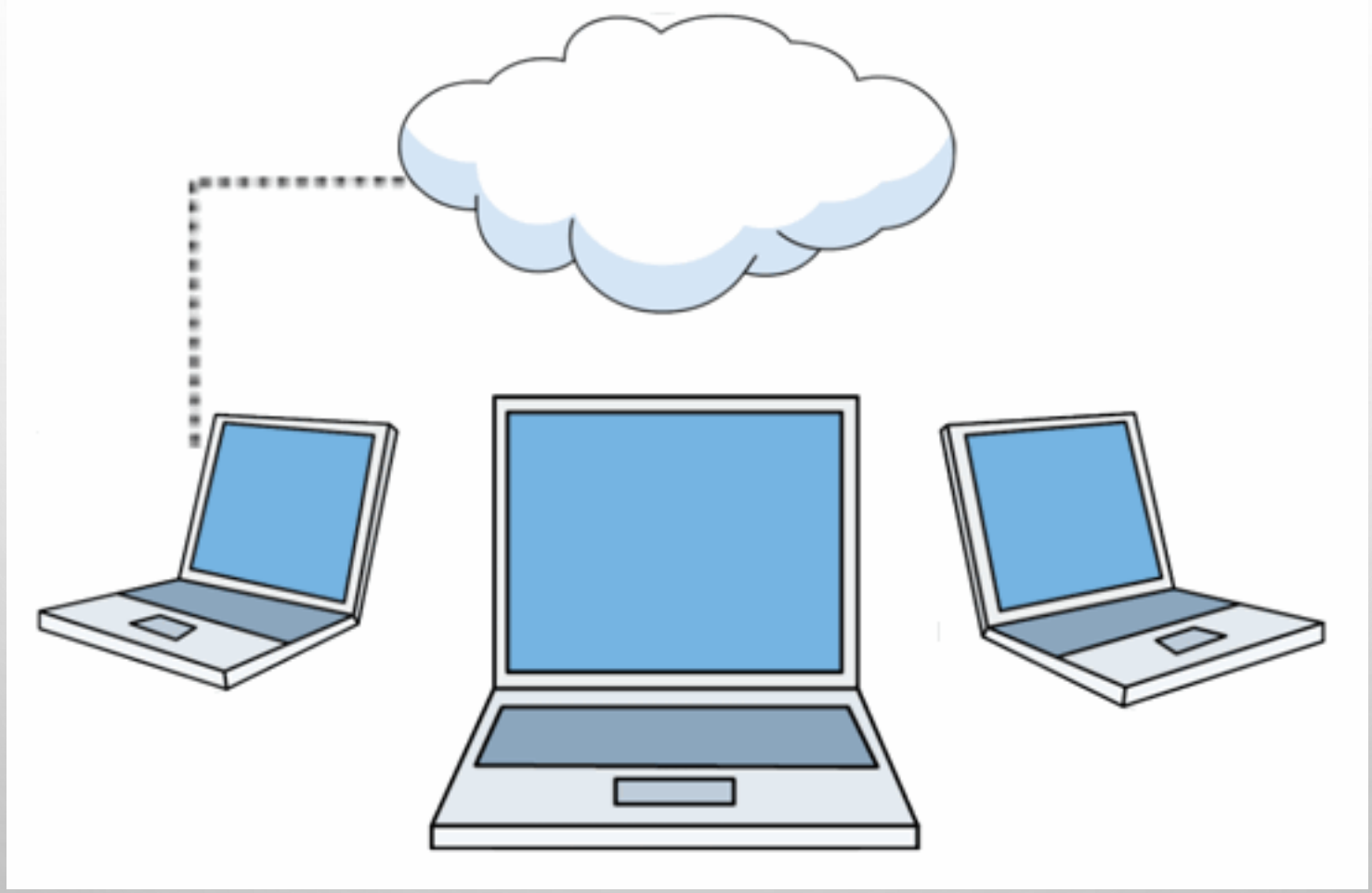
DISTRIBUTED SYSTEMS

- We define a **distributed system** as one in which ***hardware or software components*** located at **networked computers communicate and coordinate their actions only by passing messages**.
- This simple definition covers the entire range of systems in which networked computers can usefully be deployed.

DISTRIBUTED SYSTEMS CONT…



DISTRIBUTED SYSTEMS CONT…



WHY USE PARALLEL COMPUTING?

- The real world is massively complex
- In the natural world, many complex, interrelated events are happening at the same time, yet within a temporal sequence.
- Compared to serial computing, parallel computing is much better suited for modeling, simulating and complex, real world phenomena.
- For example, imagine modeling these serially:

WHY USE PARALLEL COMPUTING? CONT…

Galaxy Formation

Planetary Movments

Climate Change

Rush Hour Traffic

Plate Tectonics

Weather

WHY USE PARALLEL COMPUTING? CONT…

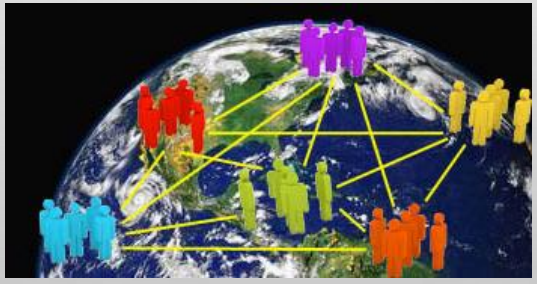
- **Save time and/or money**
- In theory, throwing more resources at a task will shorten its time to completion, with potential cost savings.
- Parallel computers can be built from cheap, commodity components.

WHY USE PARALLEL COMPUTING? CONT…

- **Solve larger / more complex problems**
- Many problems are so large and/or complex that it is impractical or impossible to solve them using a serial program, especially given limited computer memory.
- Example: web search engines/databases processing millions of transactions every second

WHY USE PARALLEL COMPUTING? CONT…

- **Provide concurrency**
- A single compute resource can only do one thing at a time.
- Multiple compute resources can do many things simultaneously.
- Example: collaborative networks provide a global venue where people from around the world can meet and conduct work "virtually".



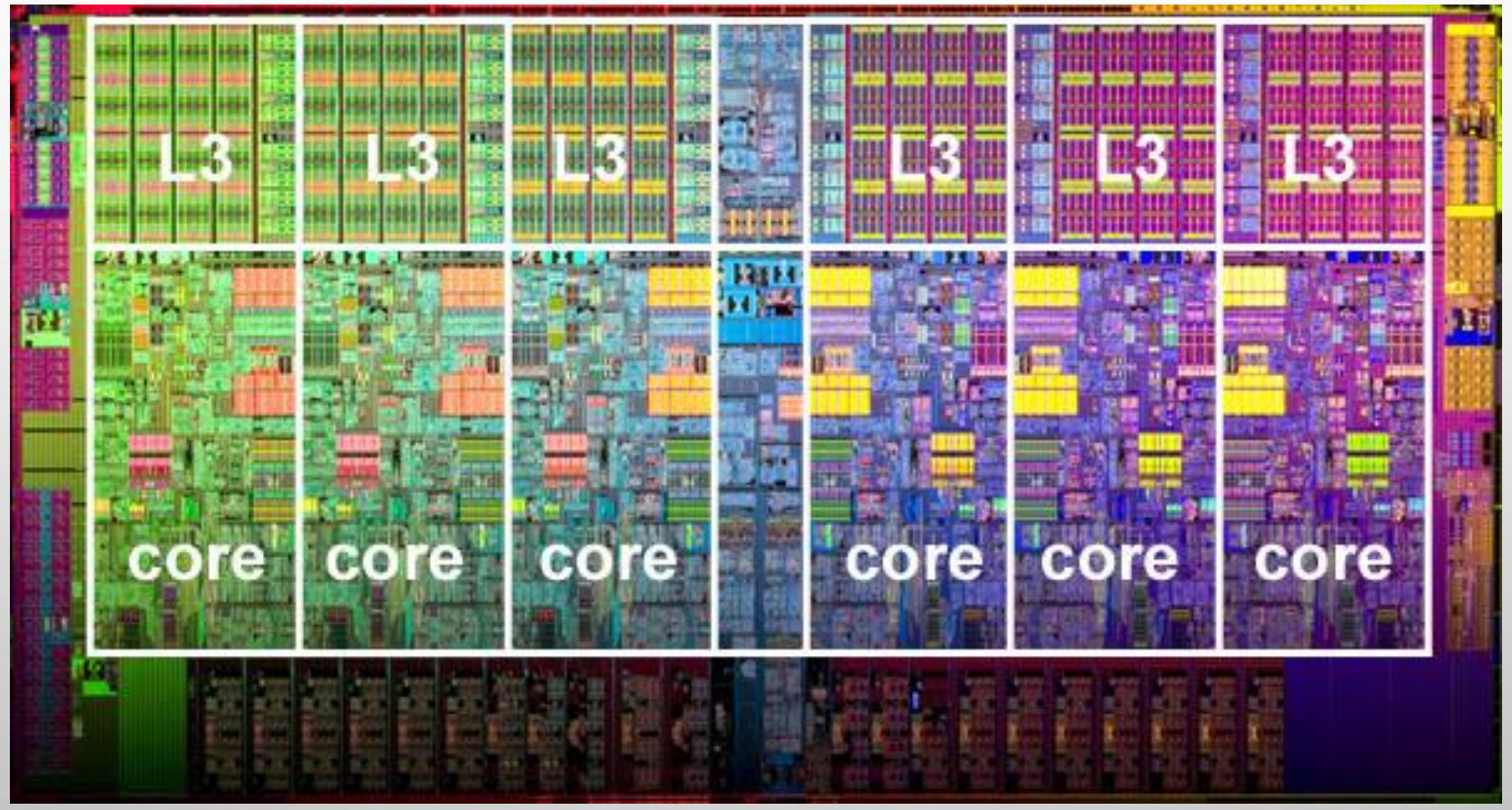
WHY USE PARALLEL COMPUTING? CONT…

- **Take advantage of non-local resources**
- Using compute resources on a wide area network, or even the internet when local compute resources are scarce or insufficient.

WHY USE PARALLEL COMPUTING? CONT…

- **Make better use of underlying parallel hardware**
- Modern computers, even laptops, are parallel in architecture with multiple processors/cores.
- Parallel software is specifically intended for parallel hardware with multiple cores, threads, etc.
- In most cases, serial programs run on modern computers "waste" potential computing power.

WHY USE PARALLEL COMPUTING? CONT…



WHY USE DISTRIBUTED COMPUTING?

- One reason is **historical**: computing resources that used to operate independently now need to work together.
- For example, consider an office that acquired personal workstations for individual use.

WHY USE DISTRIBUTED COMPUTING? CONT…

- After a while, there were many workstations in the office building, and the users recognized that it would be desirable to share data and resources among the individual computers.
- They accomplished this by connecting the workstations over a network.

WHY USE DISTRIBUTED COMPUTING? CONT…

- A second reason is **functional**: if there is special-function hardware or software available over the network, then that functionality does not have to be duplicated on every computer system (or node) that needs to access the special-purpose resource.

WHY USE DISTRIBUTED COMPUTING? CONT…

- A third reason is **economical**: it may be more cost-effective to have many small computers working together than one large computer of equivalent power.
- In addition, having many units connected to a network is the more flexible configuration; if more resources are needed, another unit can be added in place, rather than bringing the whole system down and replacing it with an upgraded one.

WHY USE DISTRIBUTED COMPUTING? CONT…

- Furthermore, a distributed system can be **more reliable** and **available** than a centralized system.
- This is a result of the ability to replicate both data and functionality.
- For example, when a given file is copied on two different machines, then even if one machine is unavailable, the file can still be accessed on the other machine.

WHY USE DISTRIBUTED COMPUTING? CONT…

- Likewise, if several printers are attached to a network, then even if an administrator takes one printer offline for maintenance, users can still print their files using an alternate printer.

WHY USE DISTRIBUTED COMPUTING? CONT…

- Distributed computing inherently brings with it not only potential advantages, but also new problems.
- Examples are ***keeping multiple copies of data consistent***, and ***keeping the clocks on different machines*** in the ***system synchronized***.
- A system that provides distributed computing support must address these new issues.

PARALLEL COMPUTING VS. DISTRIBUTED COMPUTING

Sr.	Parallel computing	Distributed computing
1.	Many operations are performed simultaneously	System components are located at different locations
2.	Single computer is required	Uses multiple computers
3.	Multiple processors perform multiple operations	Multiple computers perform multiple operations

PARALLEL COMPUTING VS DISTRIBUTED COMPUTING

Sr.	Parallel computing	Distributed computing
4.	It may have shared or distributed memory	It have only distributed memory
5.	Processors communicate with each other through bus	Computer communicate with each other through message passing.
6.	Improves the system performance	Improves system scalability, fault tolerance and resource sharing capabilities