Adventures in Supercomputing with R

Lecture 2: Hardware & Software Overview

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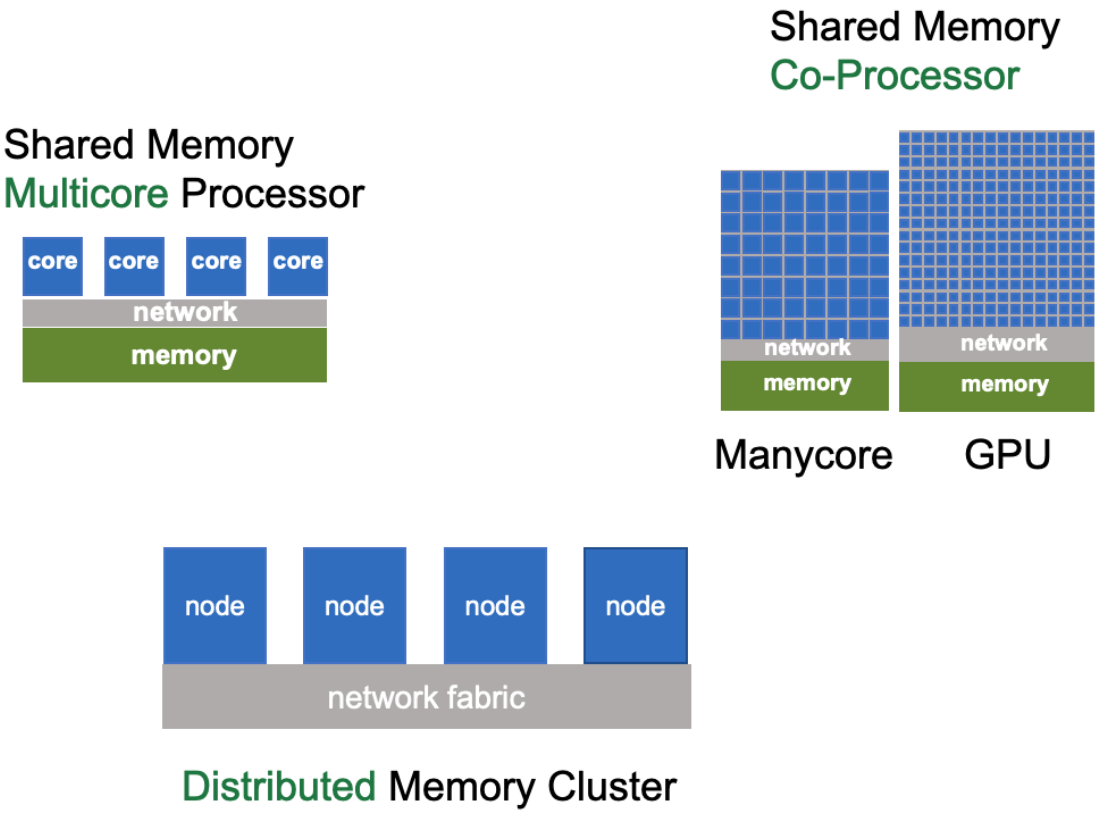
Summary of Last Lecure

- Two parallel computing communities
  - Parallel numerical math (generating data) - supercomputing
  - Parallel databases (storing and serving data) - data centers
- Statistical computing left batch environment to be interactive
  - Developed S and then R
  - High-level, extensible, and interactive
  - Use numerical libraries
- Supercomputing takes R back to batch
  - High-level, extensible, but batch
  - Use scalable numerical libraries
- Workflow, accounts, tools
  - RStudio, git, GitHub, ssh, unix

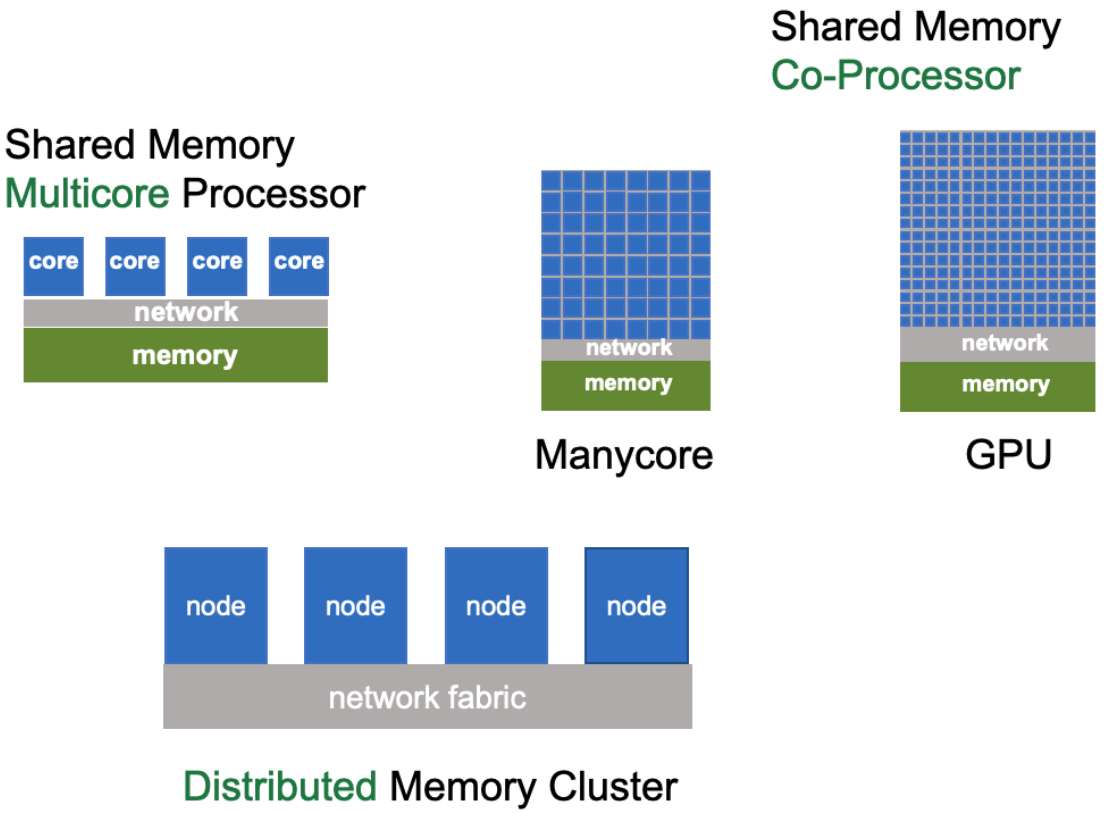
Parallel Hardware

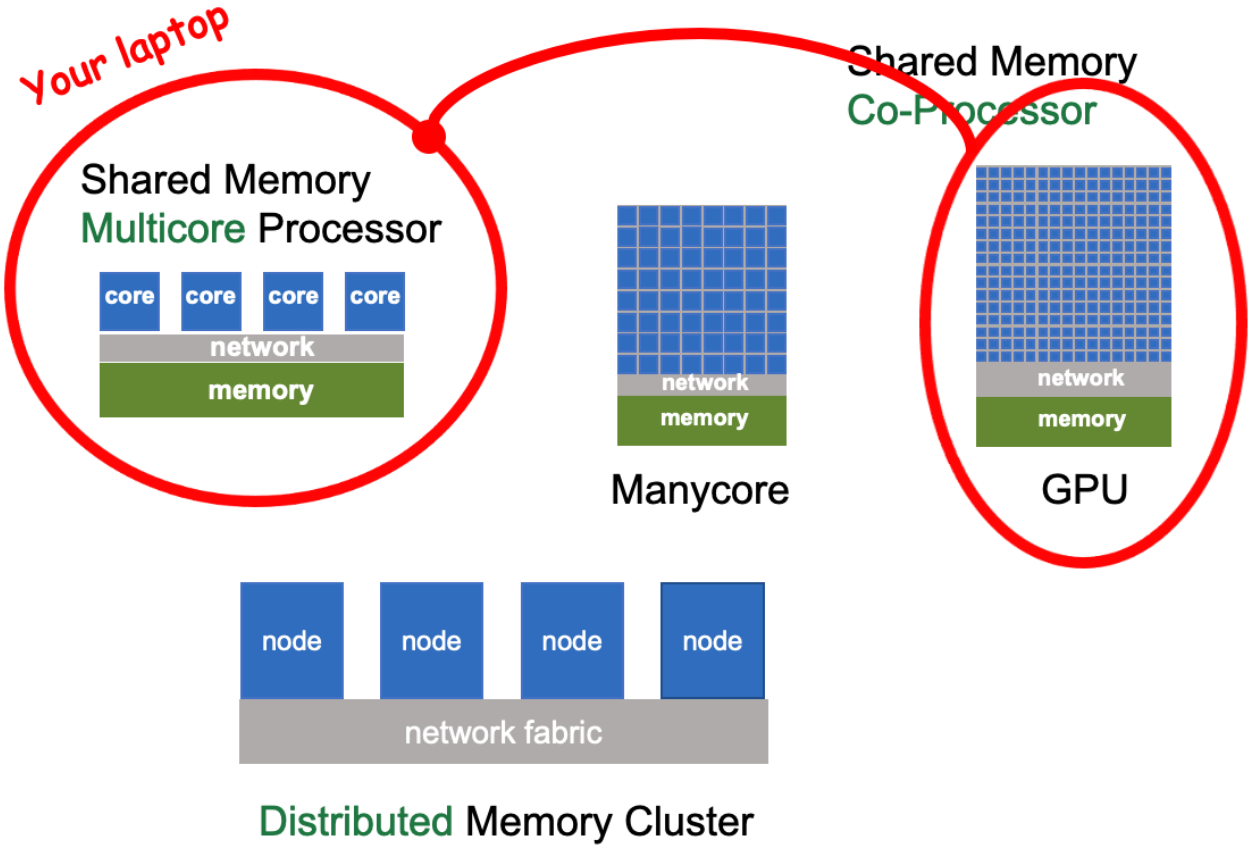
A high level look at what matters ...

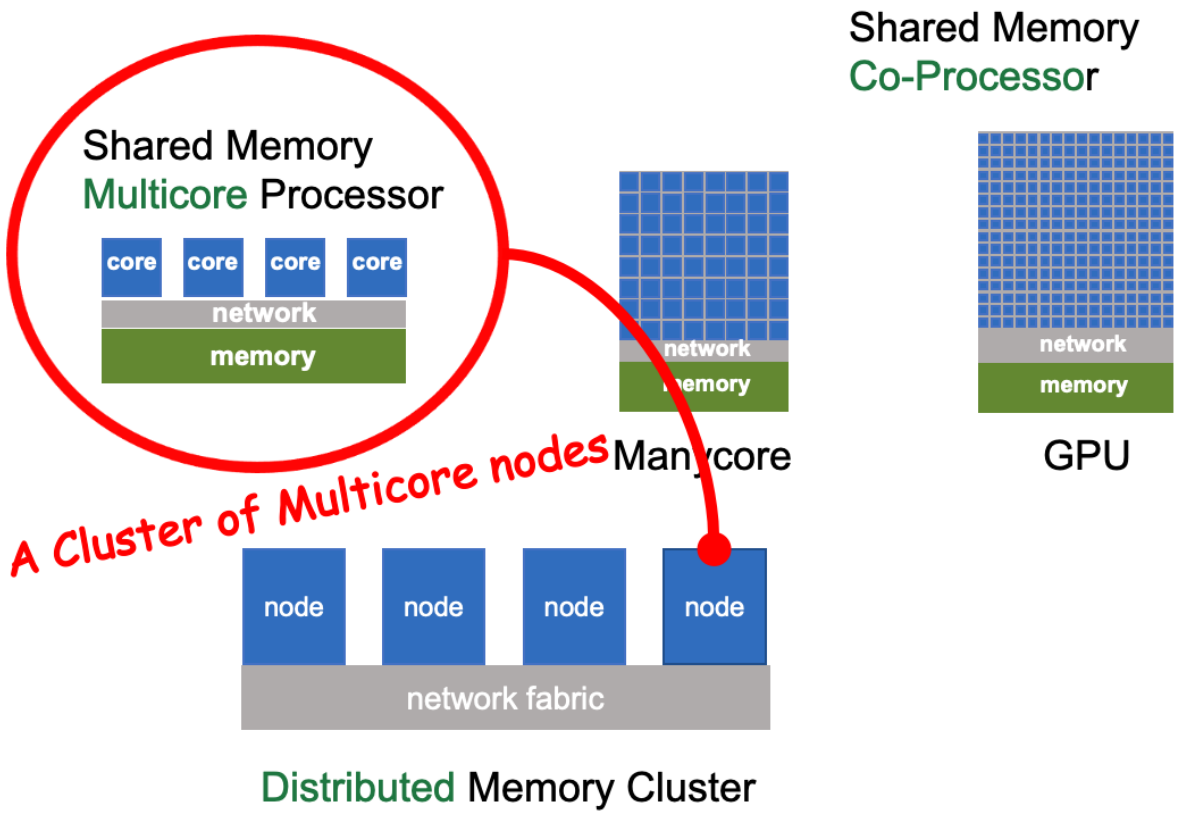
Three Basic Concepts in Hardware



Three Basic Concepts in Hardware




Your laptop
Shared Memory
Multicore Processor
core
core
core
core
network
memory
Shared Memory
Co-Processor
network
memory
GPU
network
memory
Manycore
node
node
node
node
network fabric
Distributed Memory Cluster


Shared Memory
Multicore Processor
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A Cluster of Multicore nodes
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node
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network fabric
Distributed Memory Cluster
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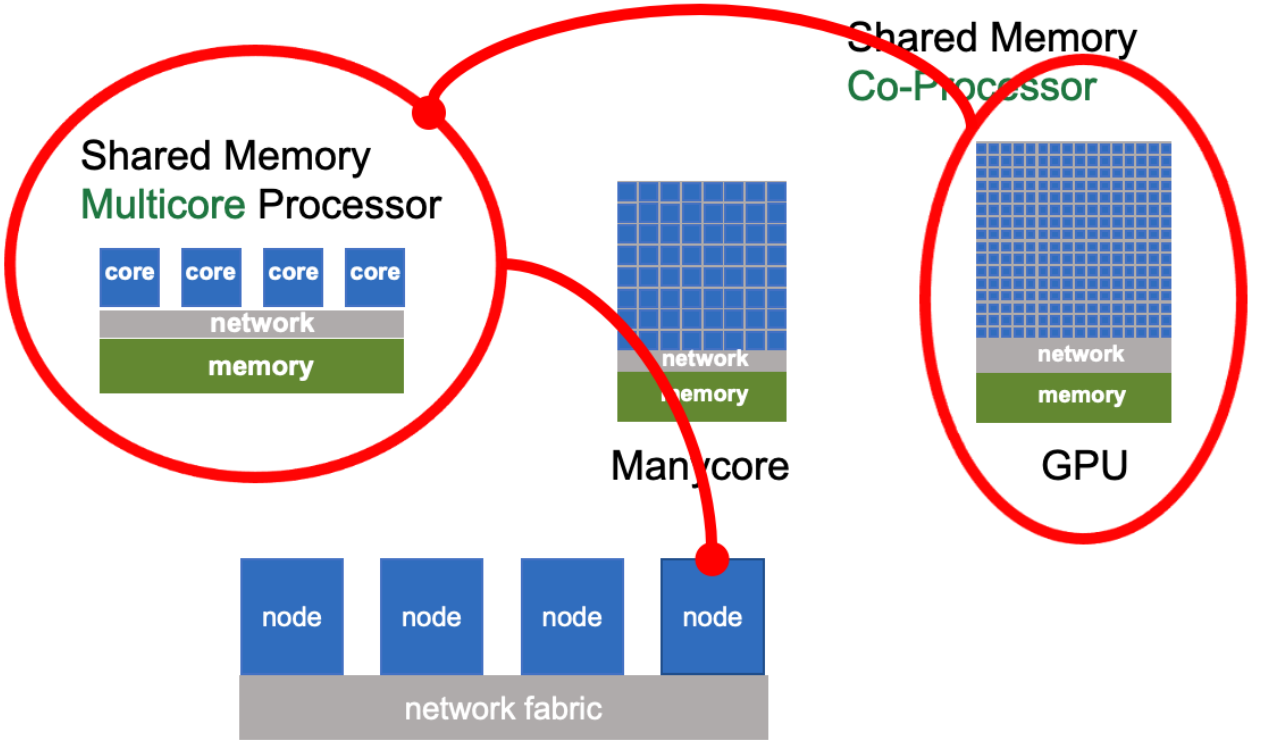
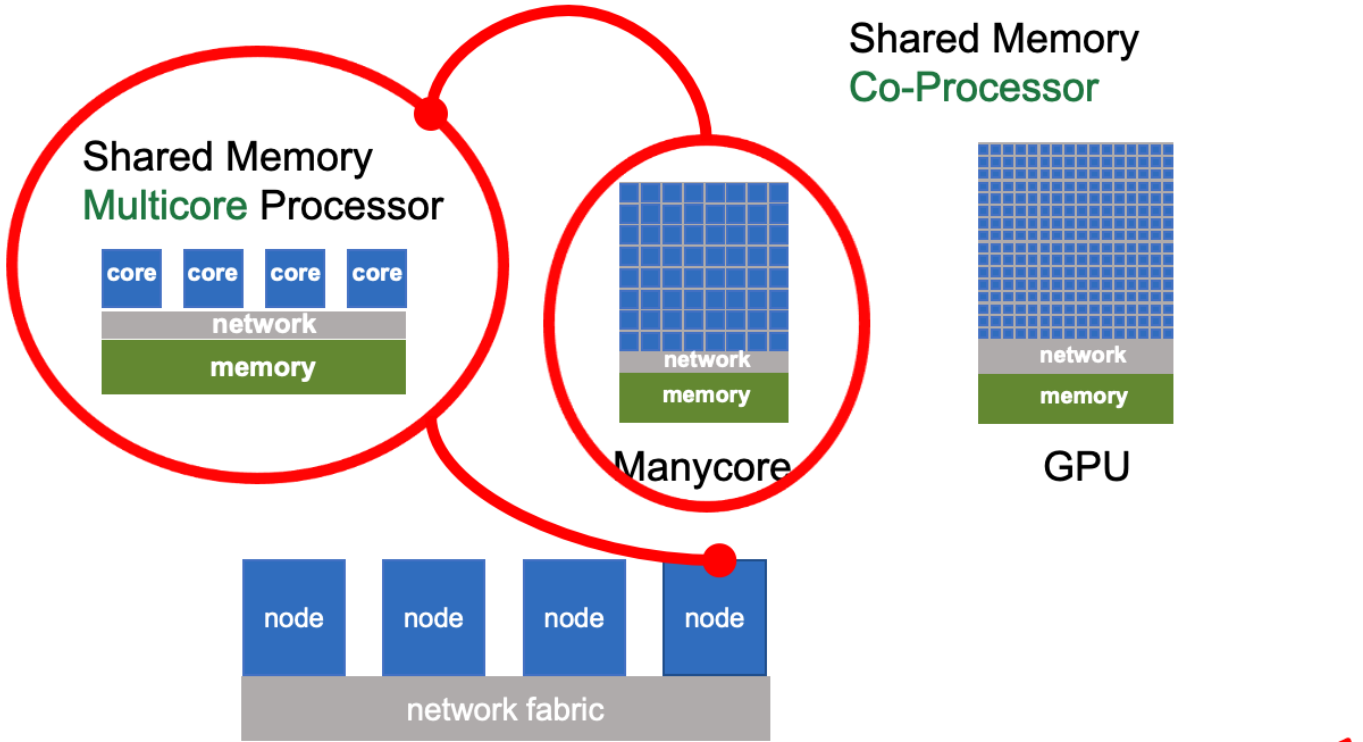
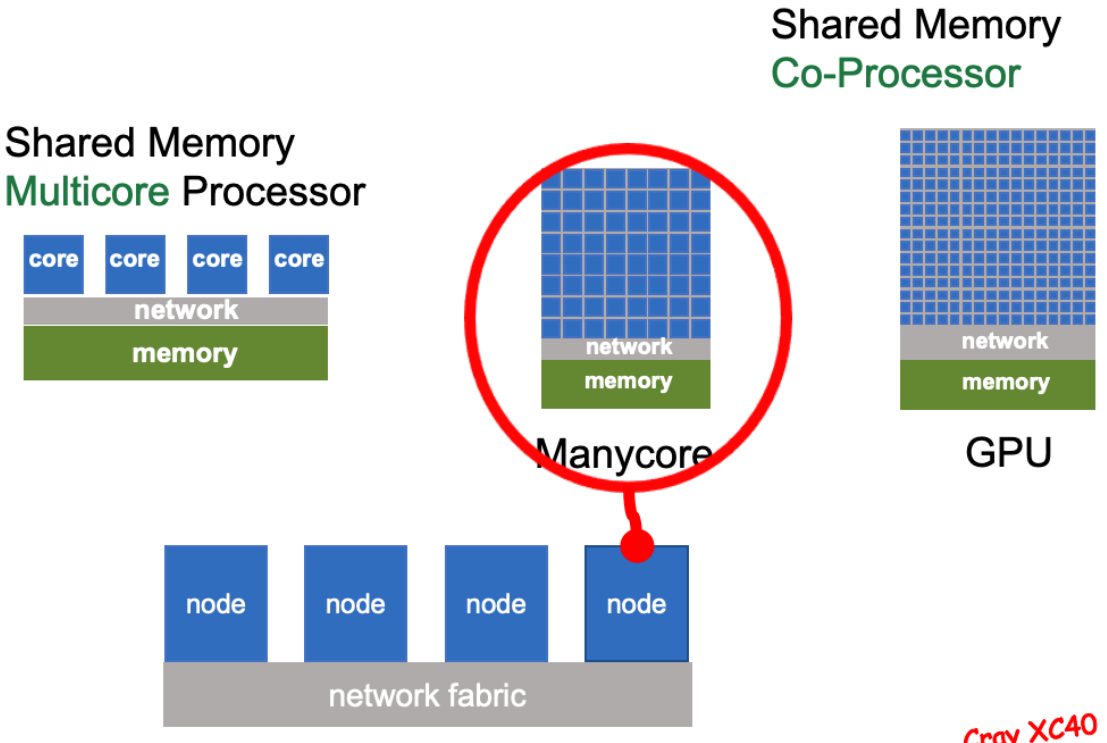


A Cluster of Multicore nodes with GPU co-Processors



A Cluster of Multicore nodes with Manycore co-Processors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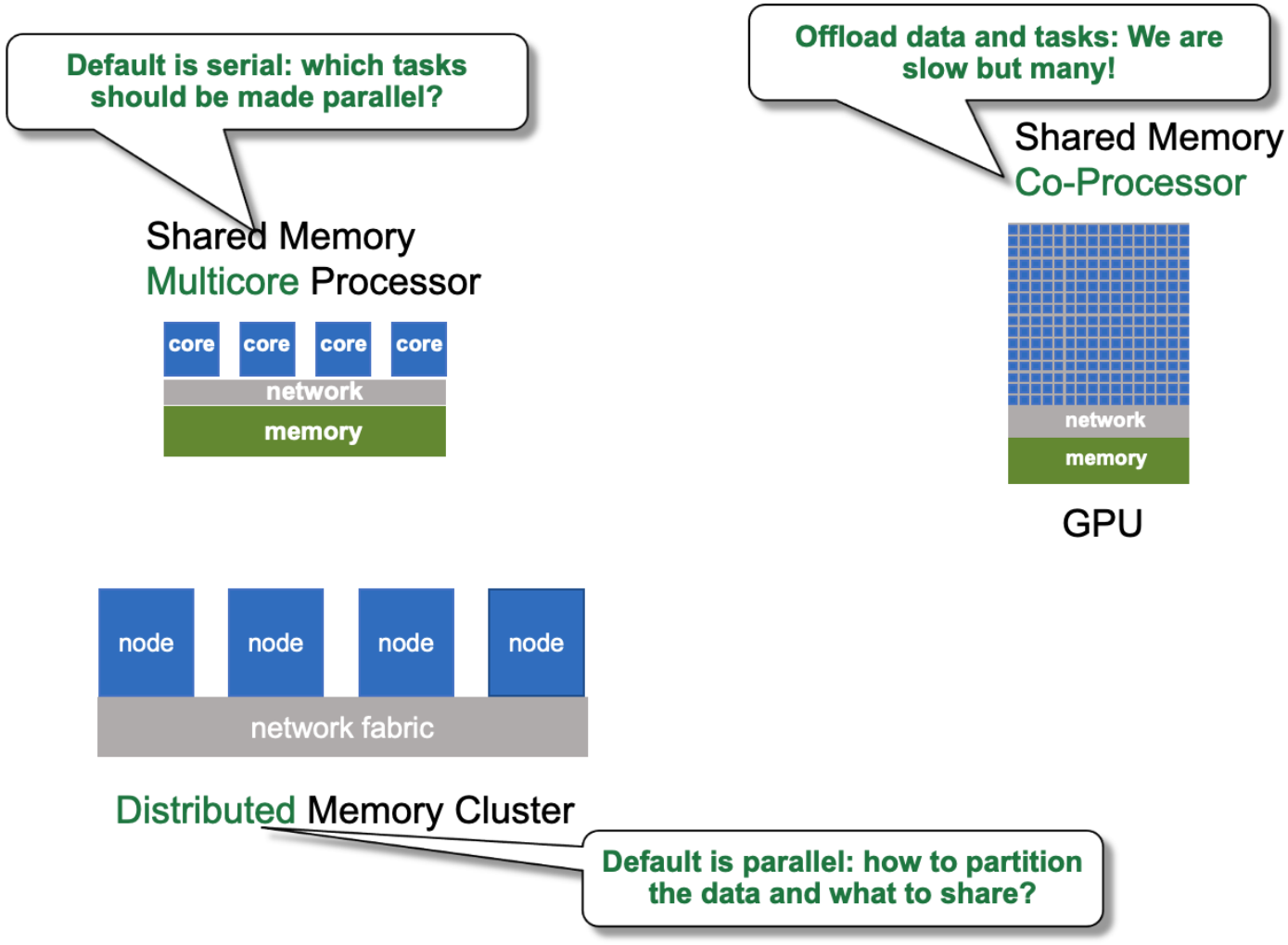
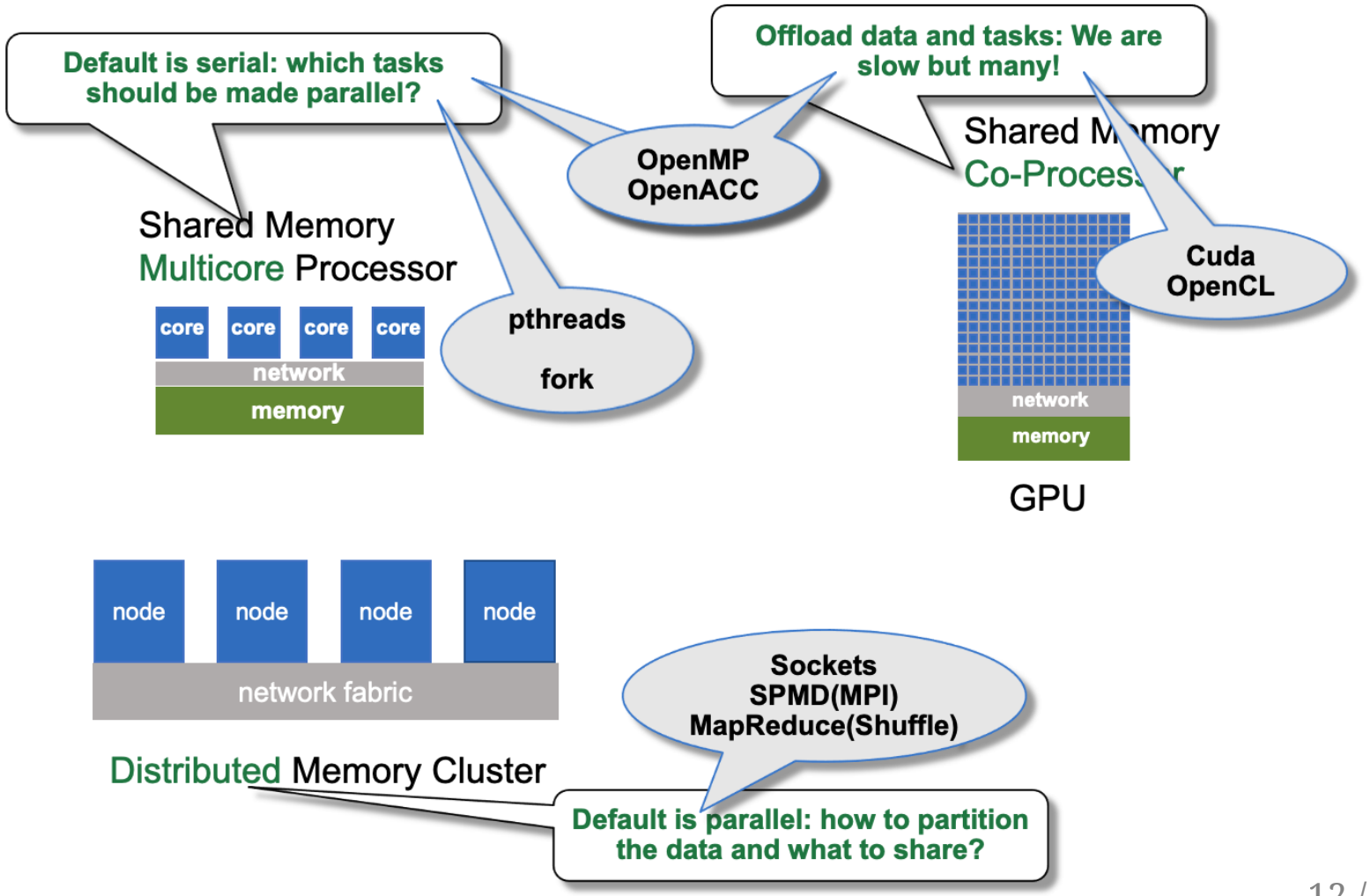
Distributed Memory Cluster
A Cluster of Manycore Nodes
Cray XC40
2nd generation Manycore
Intel Xeon Phi "KNL"
Fugaku ARM

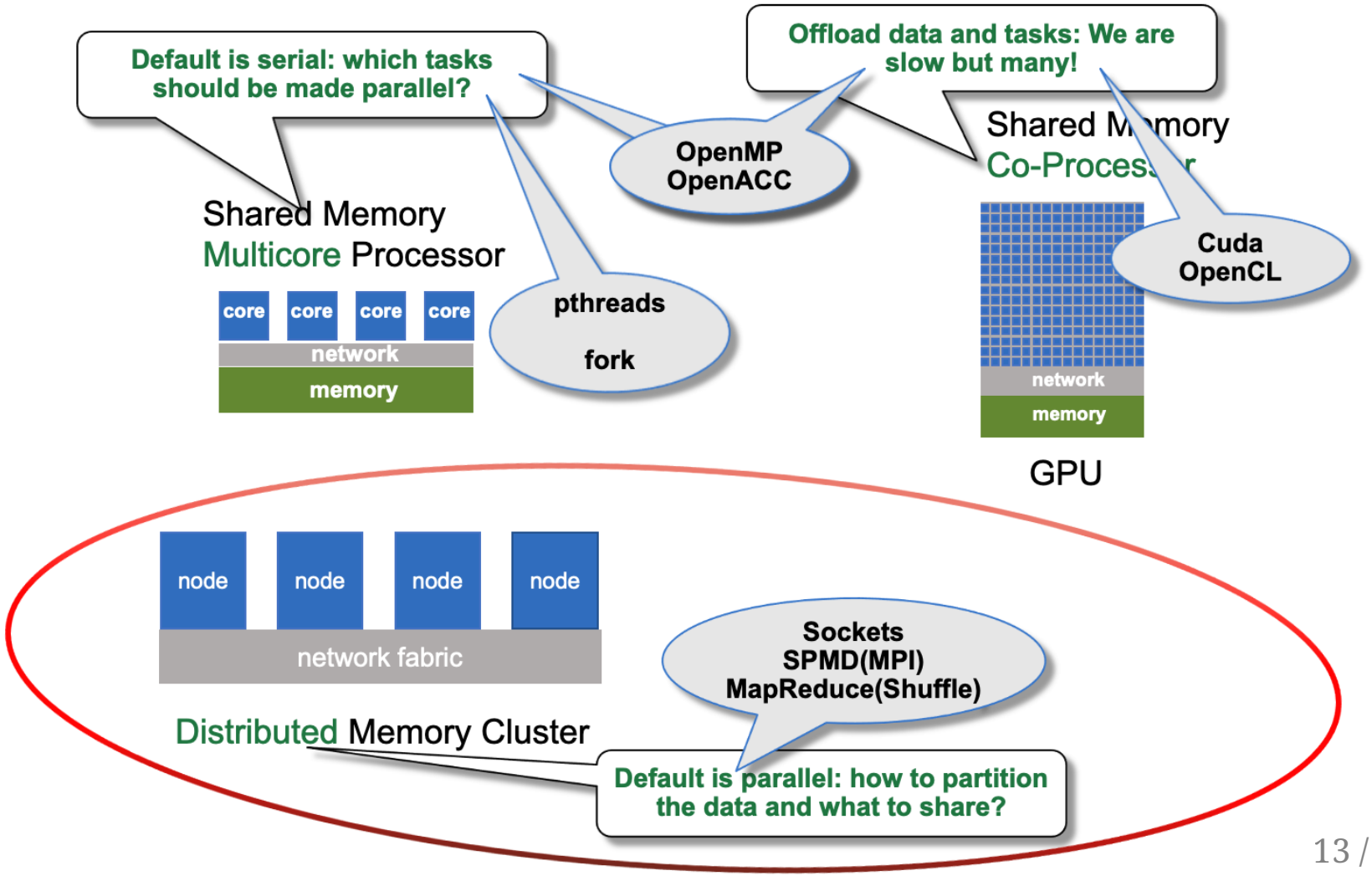
Native Programming Mindset



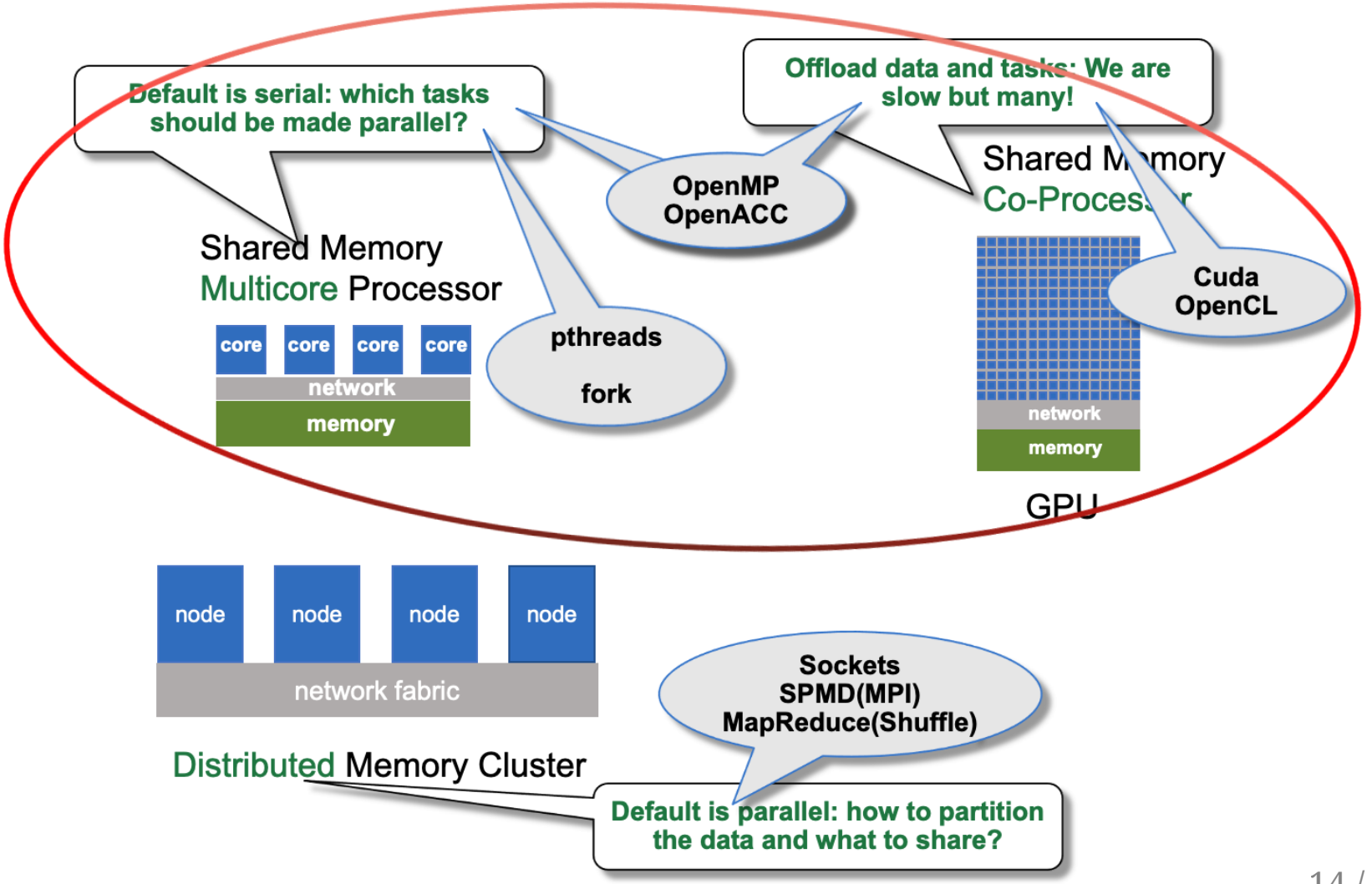
Native Programming Models and Tools



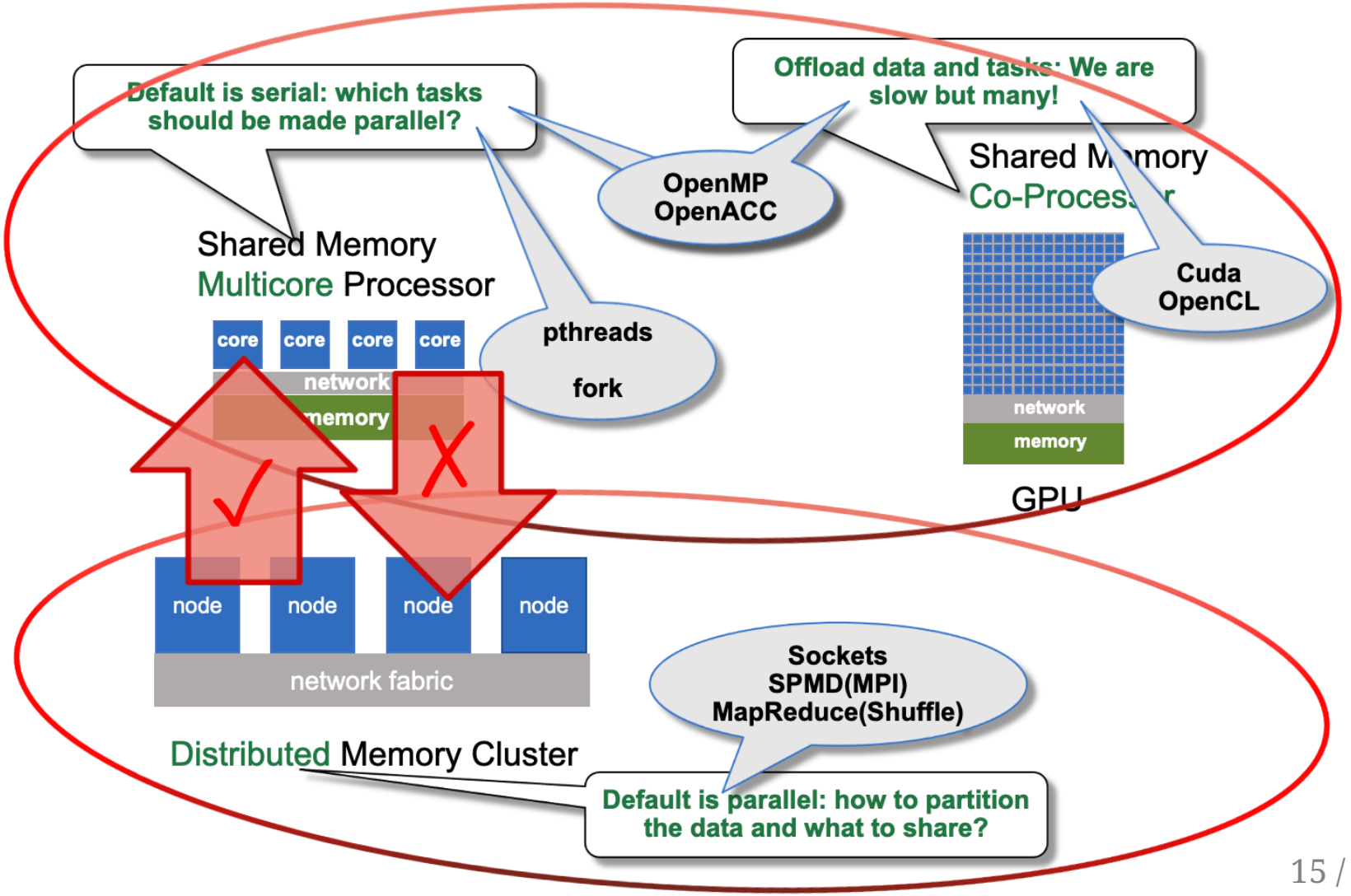
35+ Years of Parallel Computing Research



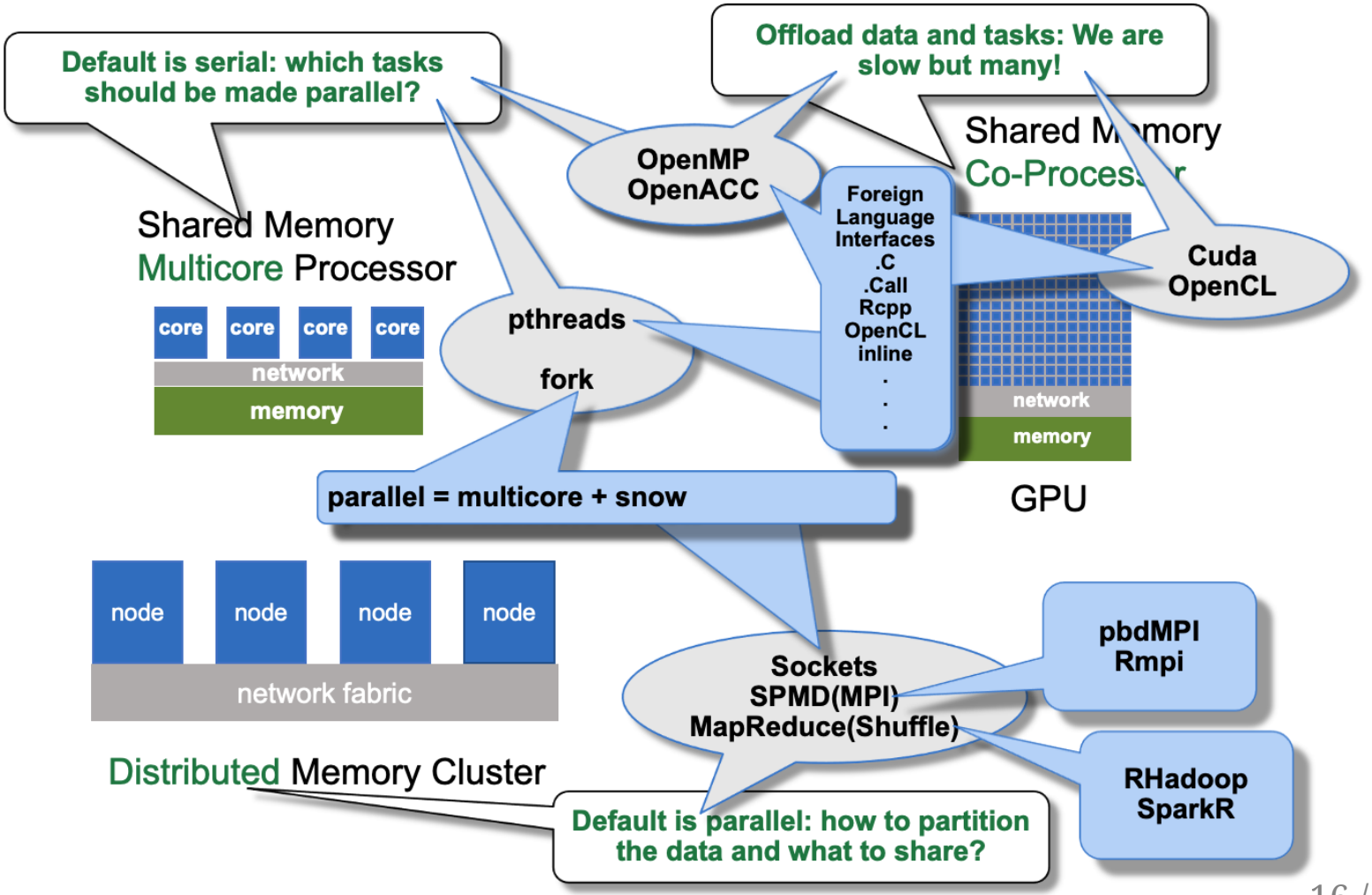
Last 15+ years of Advances



Distributed Programming Works in Shared Memory



R Interfaces to Low-Level Native Tools



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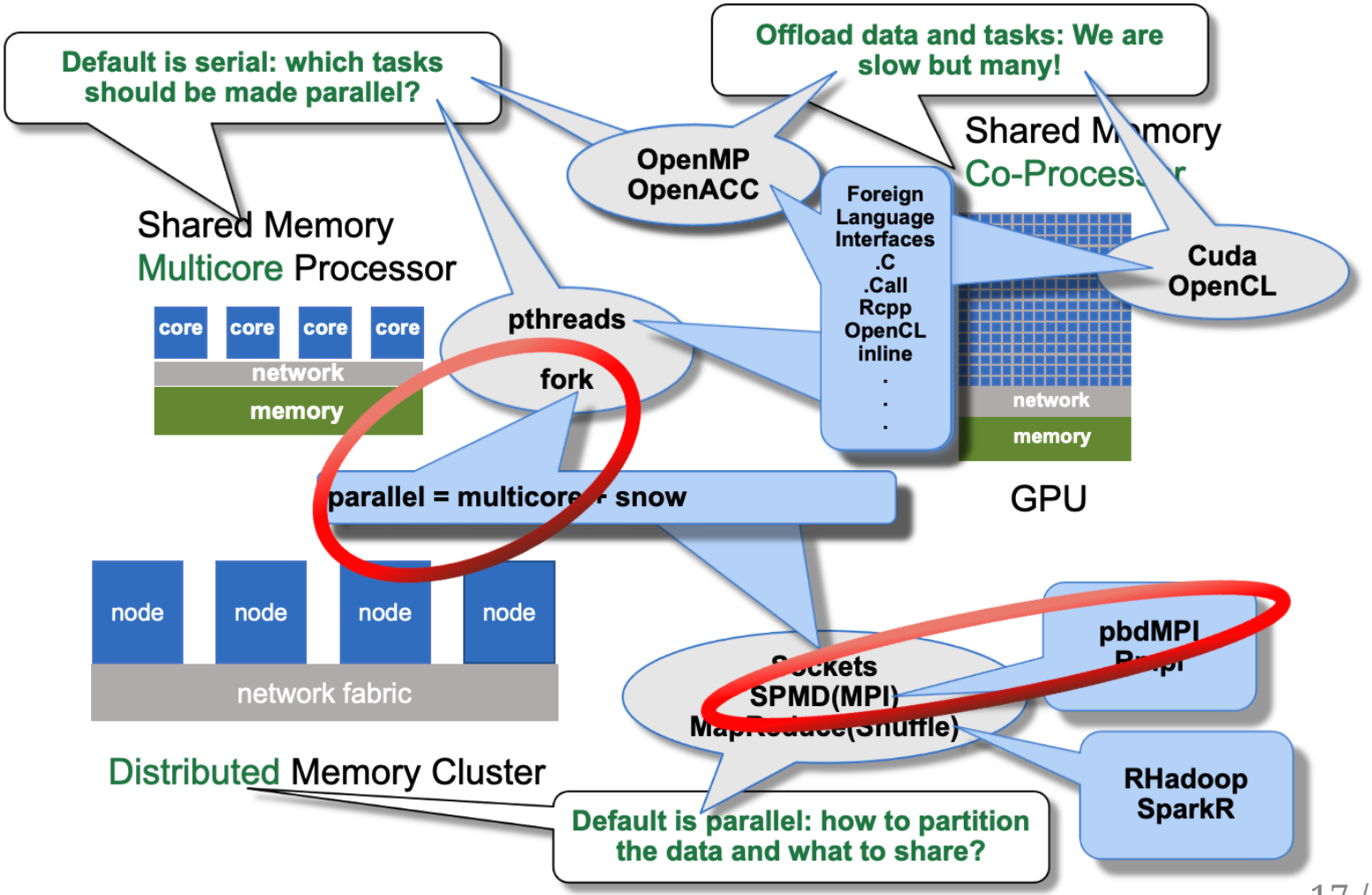
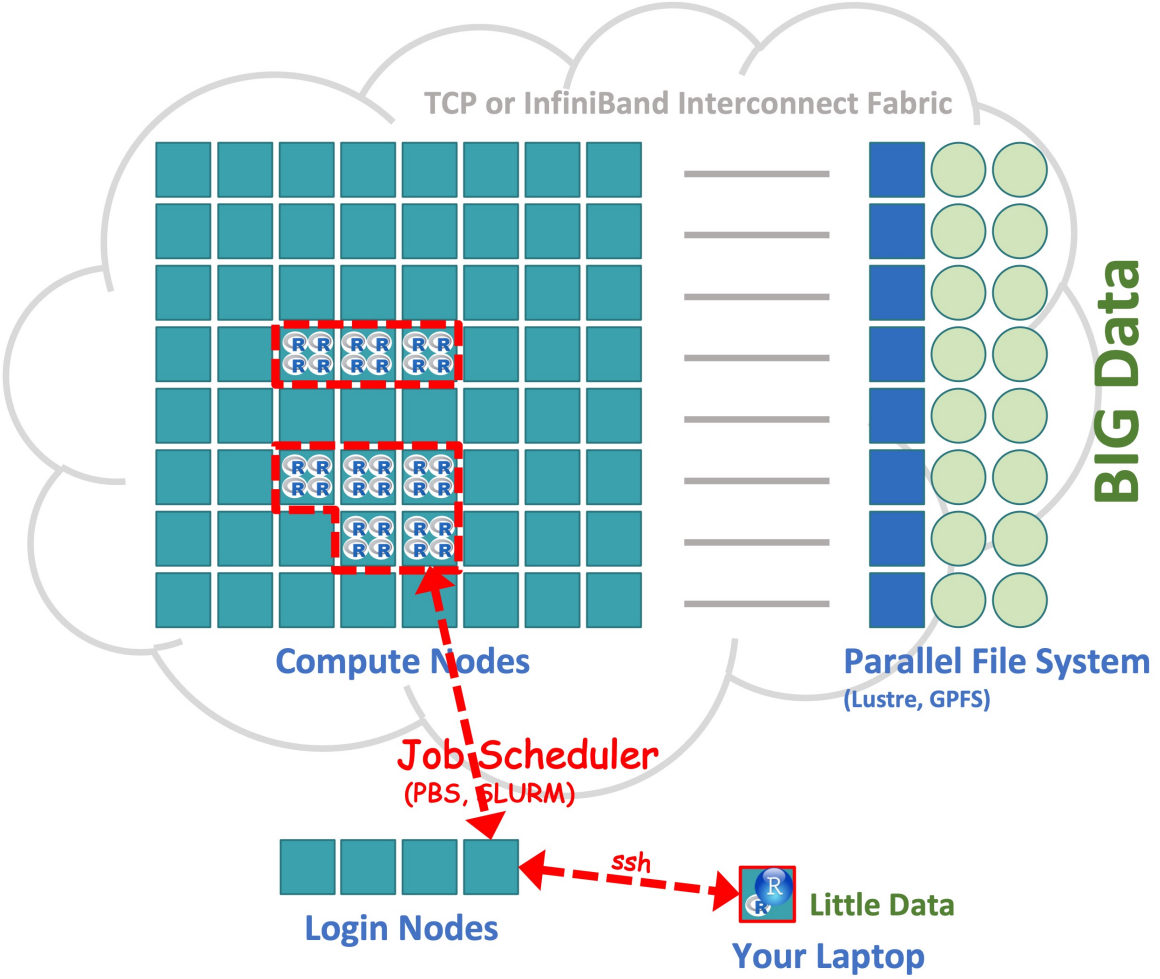
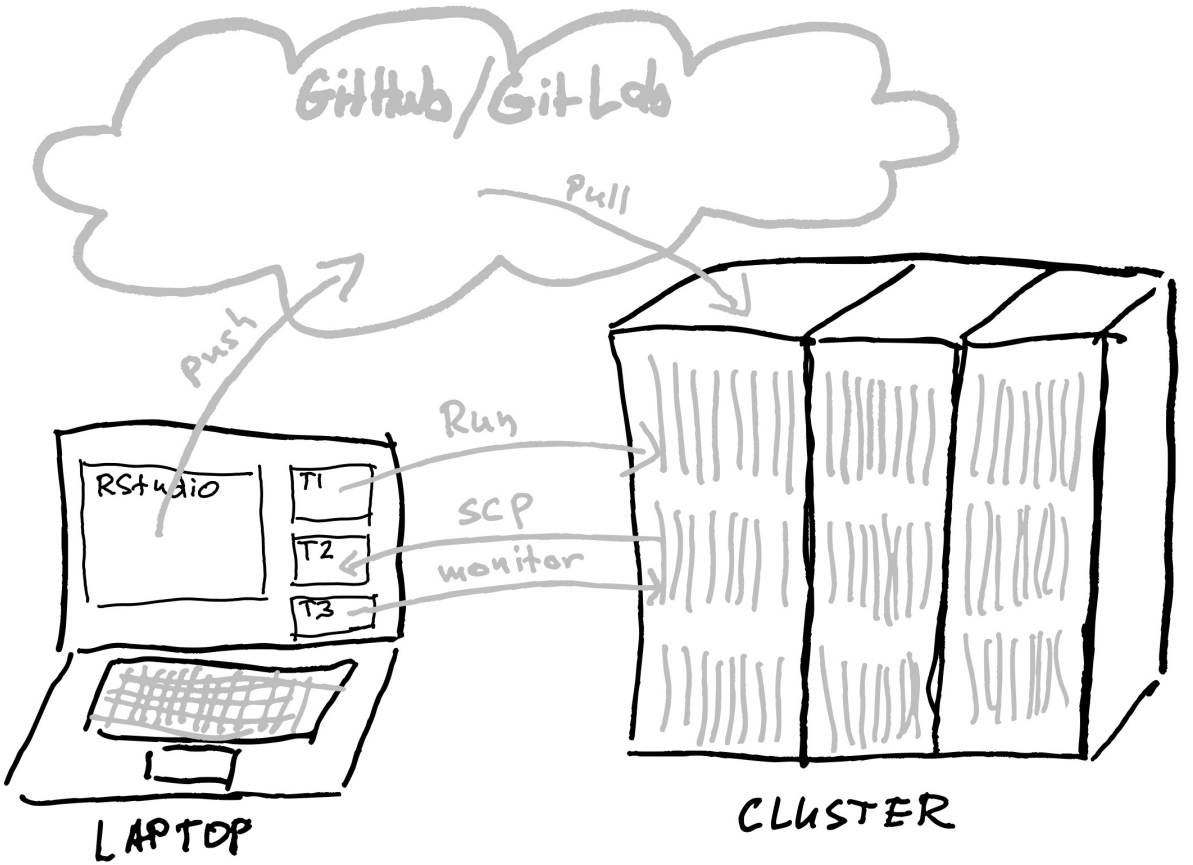


Running Distributed on a Cluster



Typical Workflow from Laptop to Cluster



Unix Concepts and Starting your Workflow

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Some useful Unix concepts

- Linux is one of many descendants of original Unix. Mac OS X is another.
- Like all file systems, Unix files are organized as a tree.
- When in a terminal, you are talking to a *shell* program (*bash* is most common)
- Commands are looked up in directories listed in your PATH variable
- Spaces delimit commands and options
- > and >> redirect standard output to a file
- *command1* | *command2* pipes standard output1 to standard input2
- **$** means substitute variable value
- There are many resources on the web to learn Linux basics.

Some useful Linux commands

- **pwd** Show curent directory
- **ls** List files in current directory
  - **ls** -*a* Include files that start with **.**
  - **ls** -*l* Long listing with *permissions*, *owners*, and *last change time*
- **cd** *dir_name* Change directory to dir_name
  - **cd** without dir_name or ~ as dir_name changes to home directory
- **mkdir** *dir_name* Creates directory dir_name
- **rmdir** *dir_name* Deletes directory (must be empty)
- **rm** *file_name* Deletes file_name
- **cat** *file_name* Displays content of entire file_name
- **less** *file_name* Displays content of file_name with paging
- **man** *command* Displays the manual page for *command* with paging
- **which** *command* Returns location of command
- **exit** Quit shell and logout

Demo follows

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