Parallel Computing

Hardware

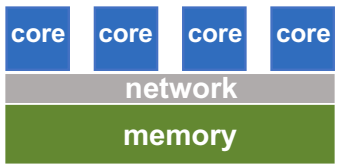
Introduction

1. Processor Hardware
    a. Three Flavors
    b. Combining Flavors

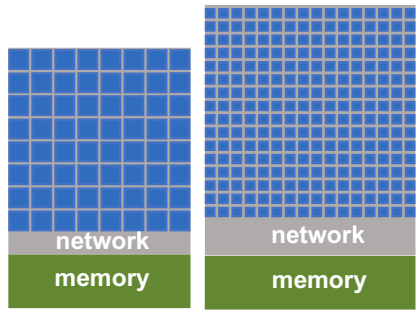
2. Cluster Architectures
    a. Early Clusters
    b. Hadoop Clusters
    c. Modern HPC Clusters

Three Flavors of Parallel Hardware

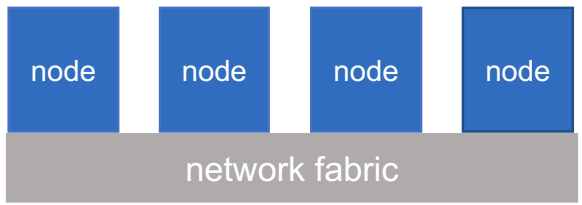
Shared Memory
Multicore Processor



Shared Memory
Co-Processor

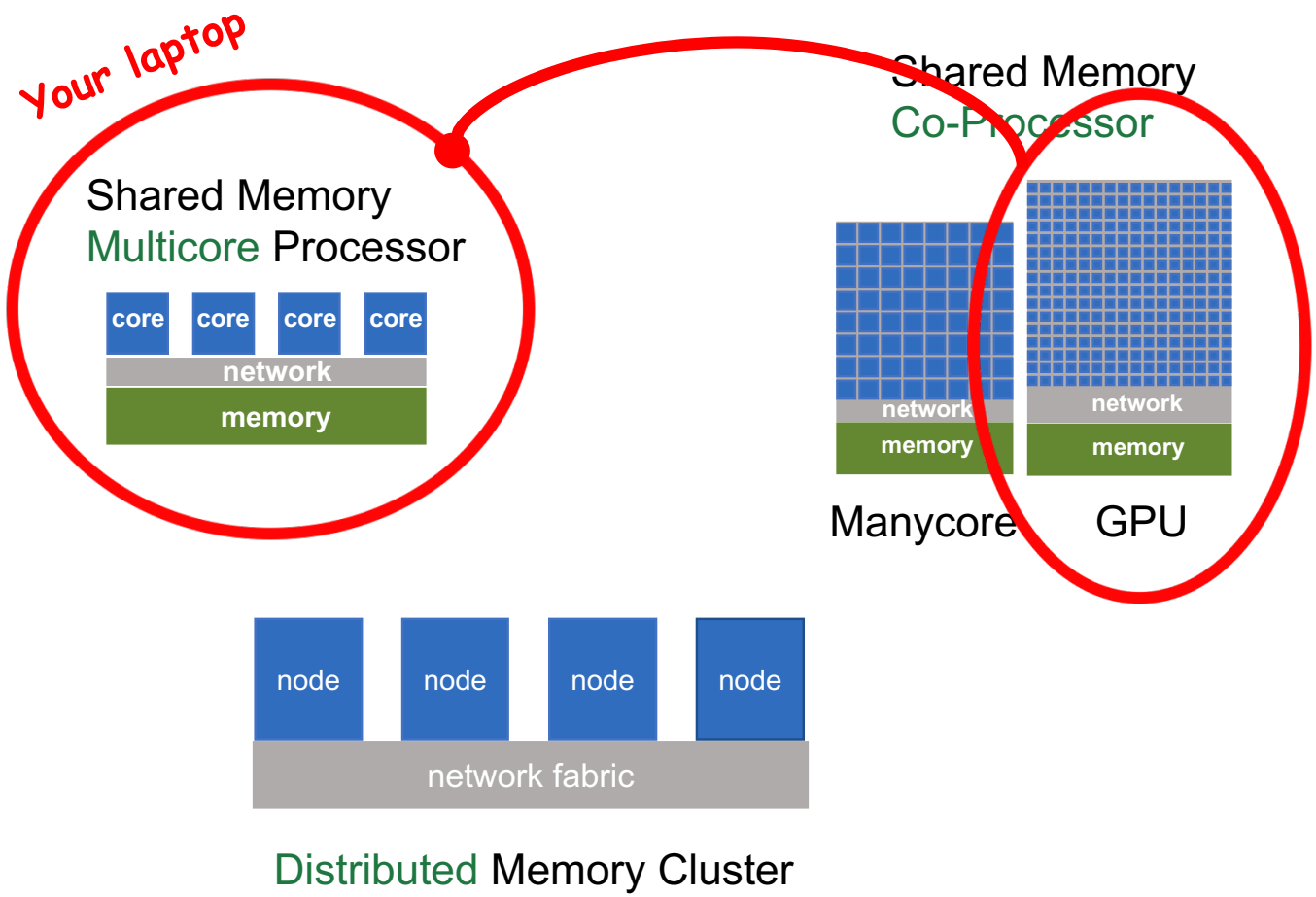


Manycore GPU

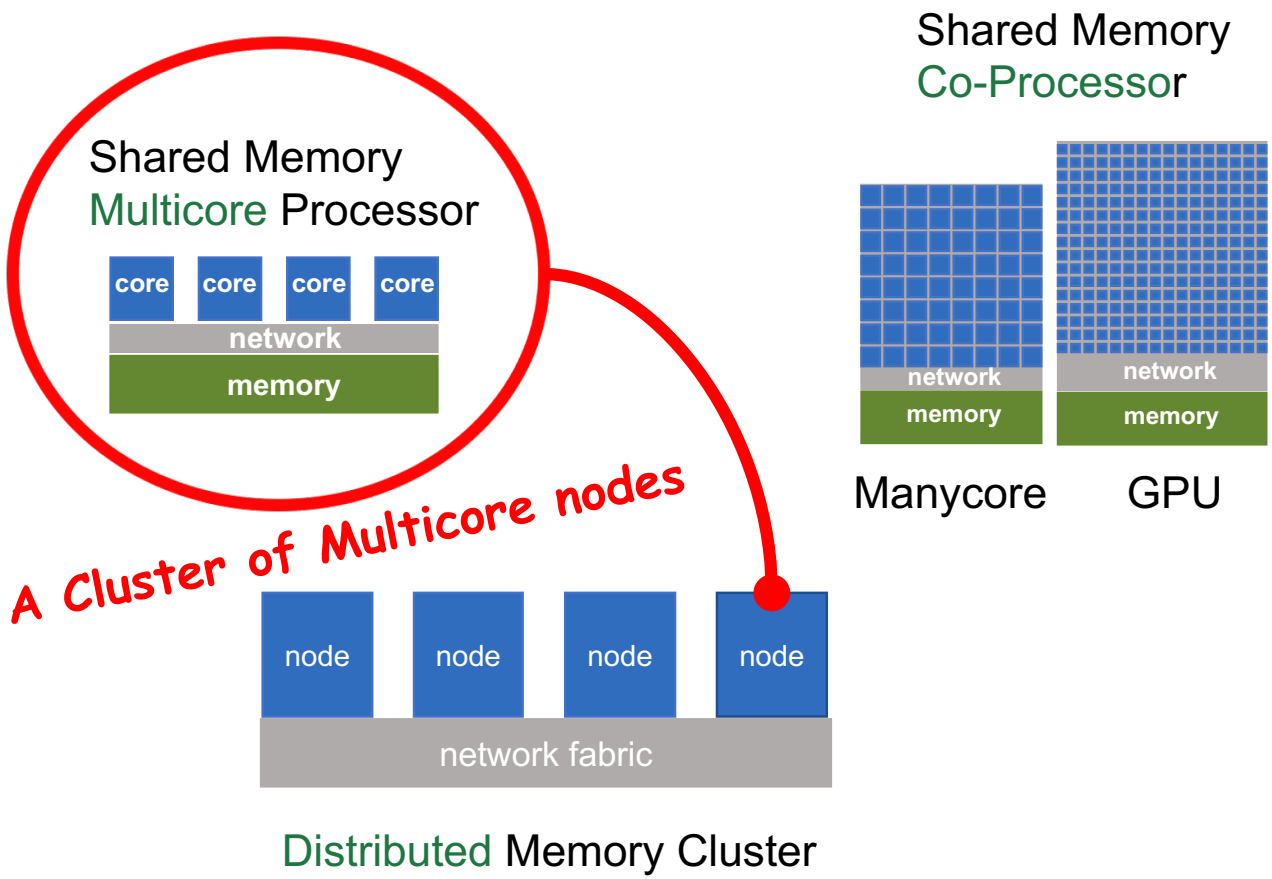


Distributed Memory Cluster

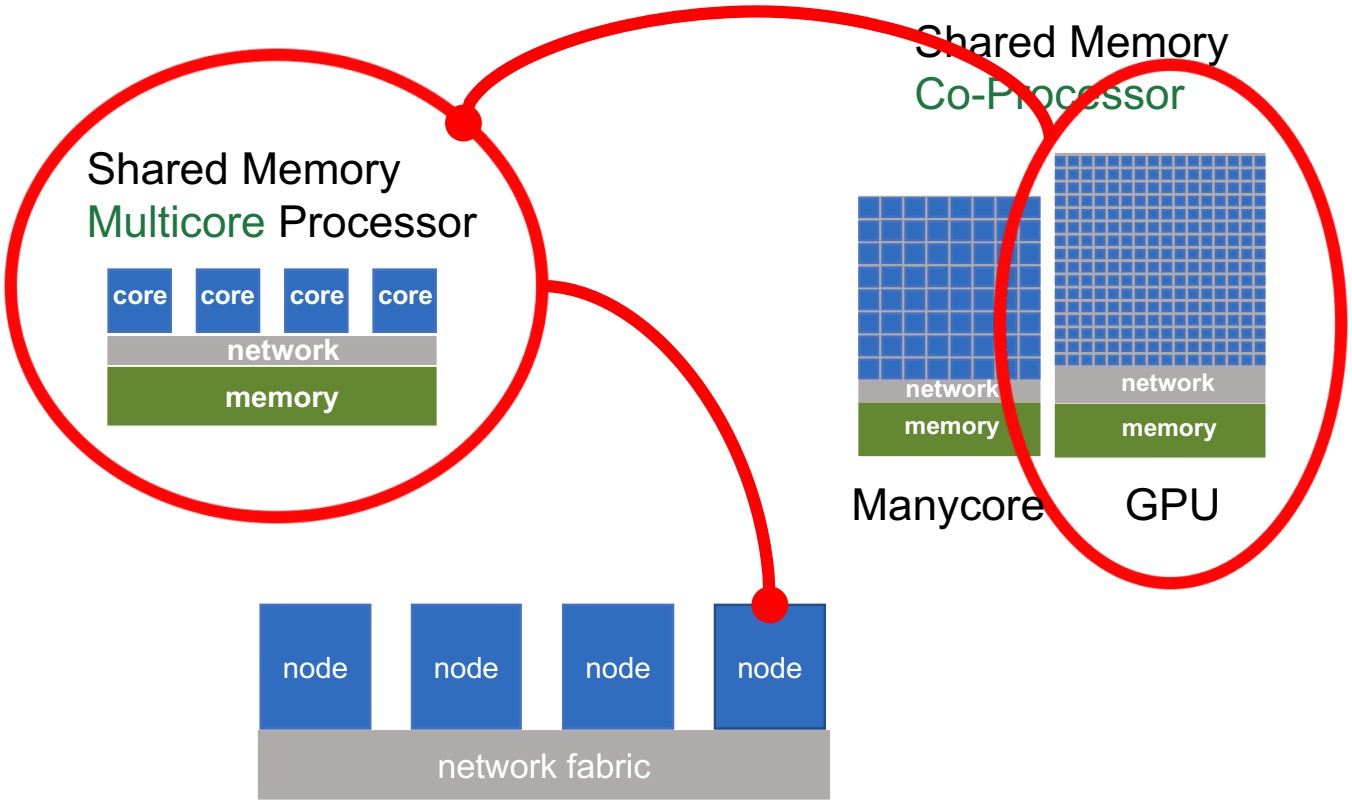
Three Flavors of Parallel Hardware



Three Flavors of Parallel Hardware

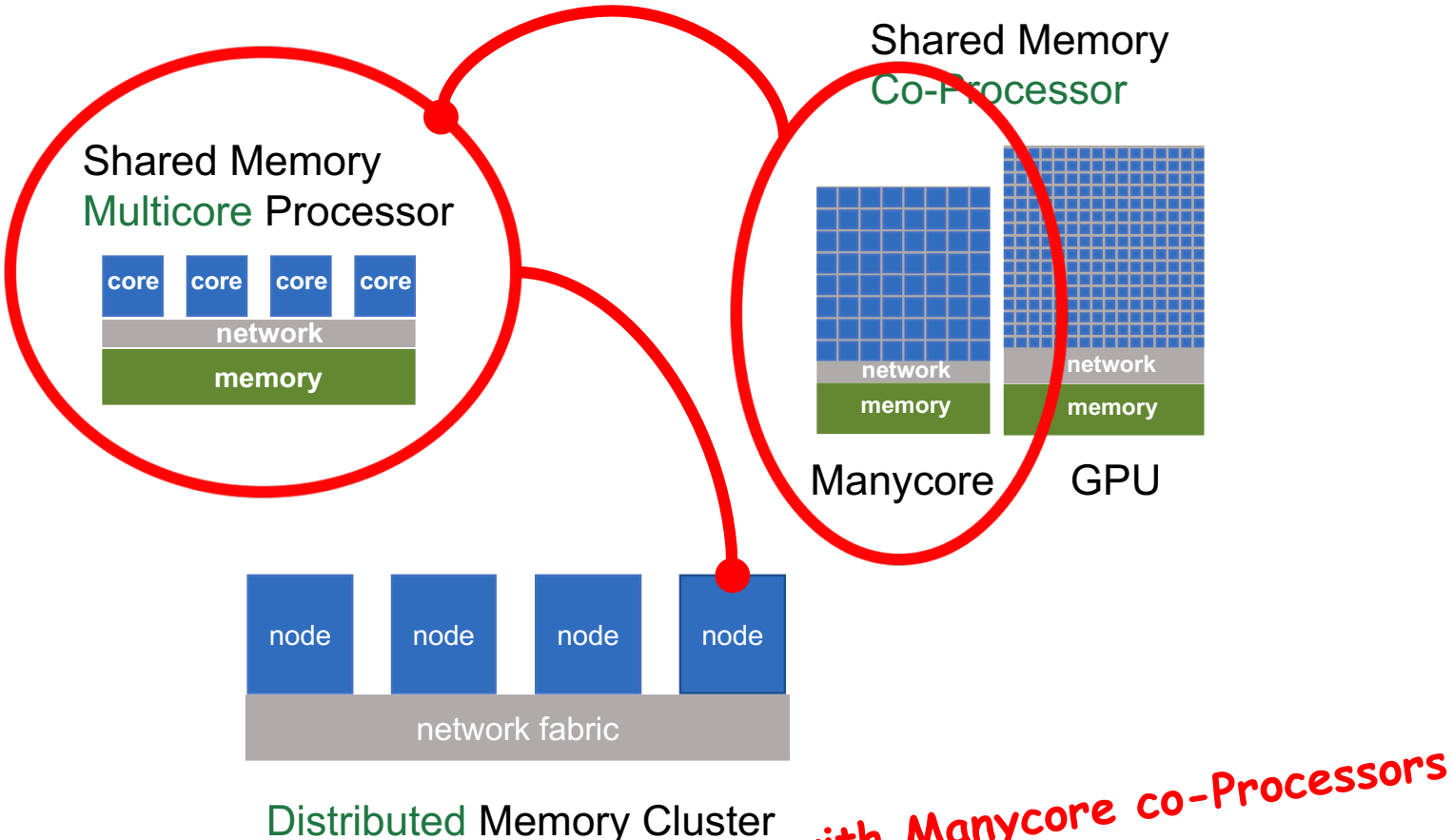


Three Flavors of Parallel Hardware

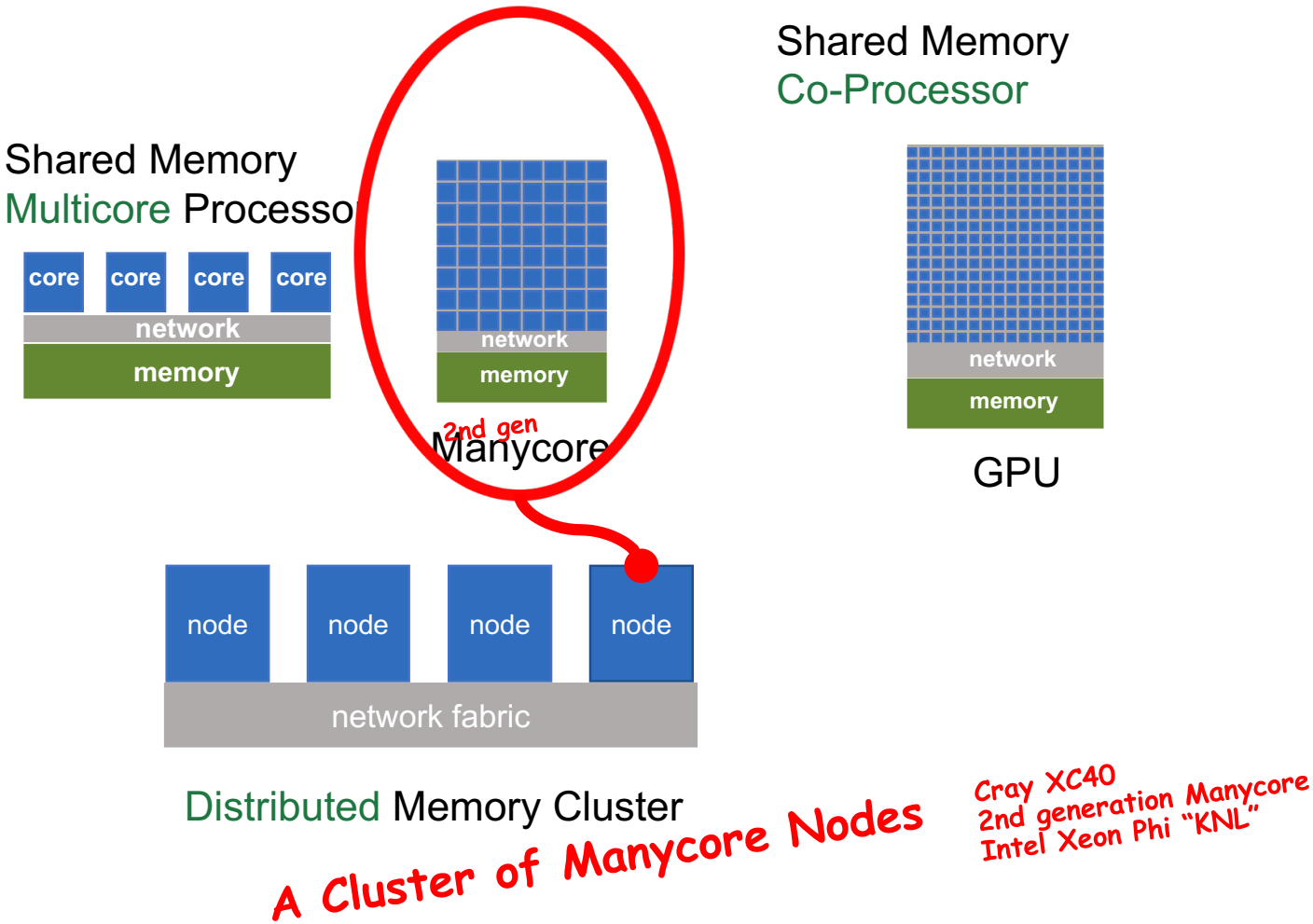


A Cluster of Multicore nodes with GPU co-Processors

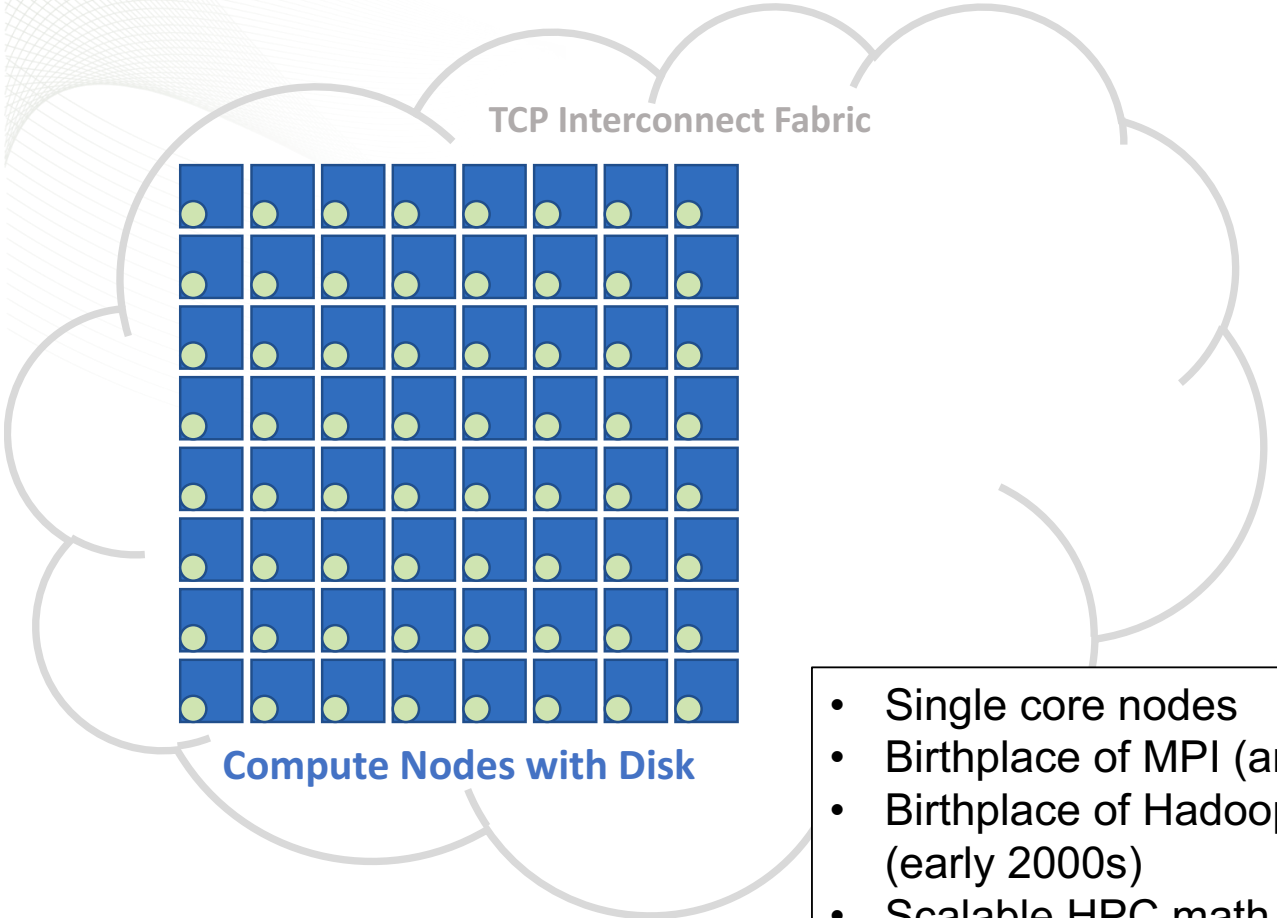
Three Flavors of Parallel Hardware



Three Flavors of Parallel Hardware



Commodity Cluster Computer Before 2003



- Single core nodes
- Birthplace of MPI (around 1990)
- Birthplace of Hadoop/HDFS/MapReduce (early 2000s)
- Scalable HPC math libraries are built
  - ScaLAPACK, PETSc, Trillinos, …

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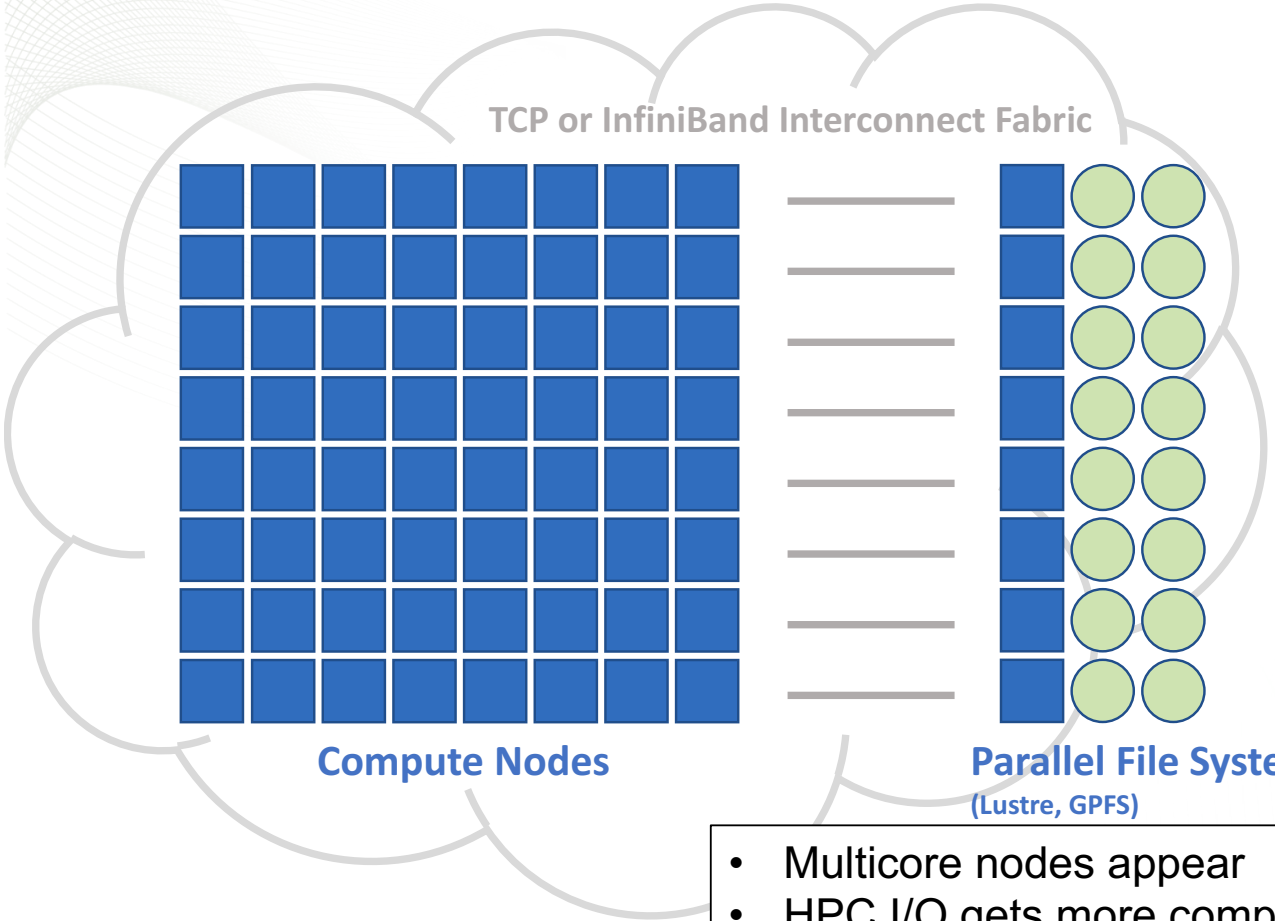
HPC Introduces Diskless Compute Nodes ~2003



- Multicore nodes appear
- HPC I/O gets more complicated
- HPC develops Lustre, GPFS, ADIOS
- But Hadoop/HDFS continues diskfull

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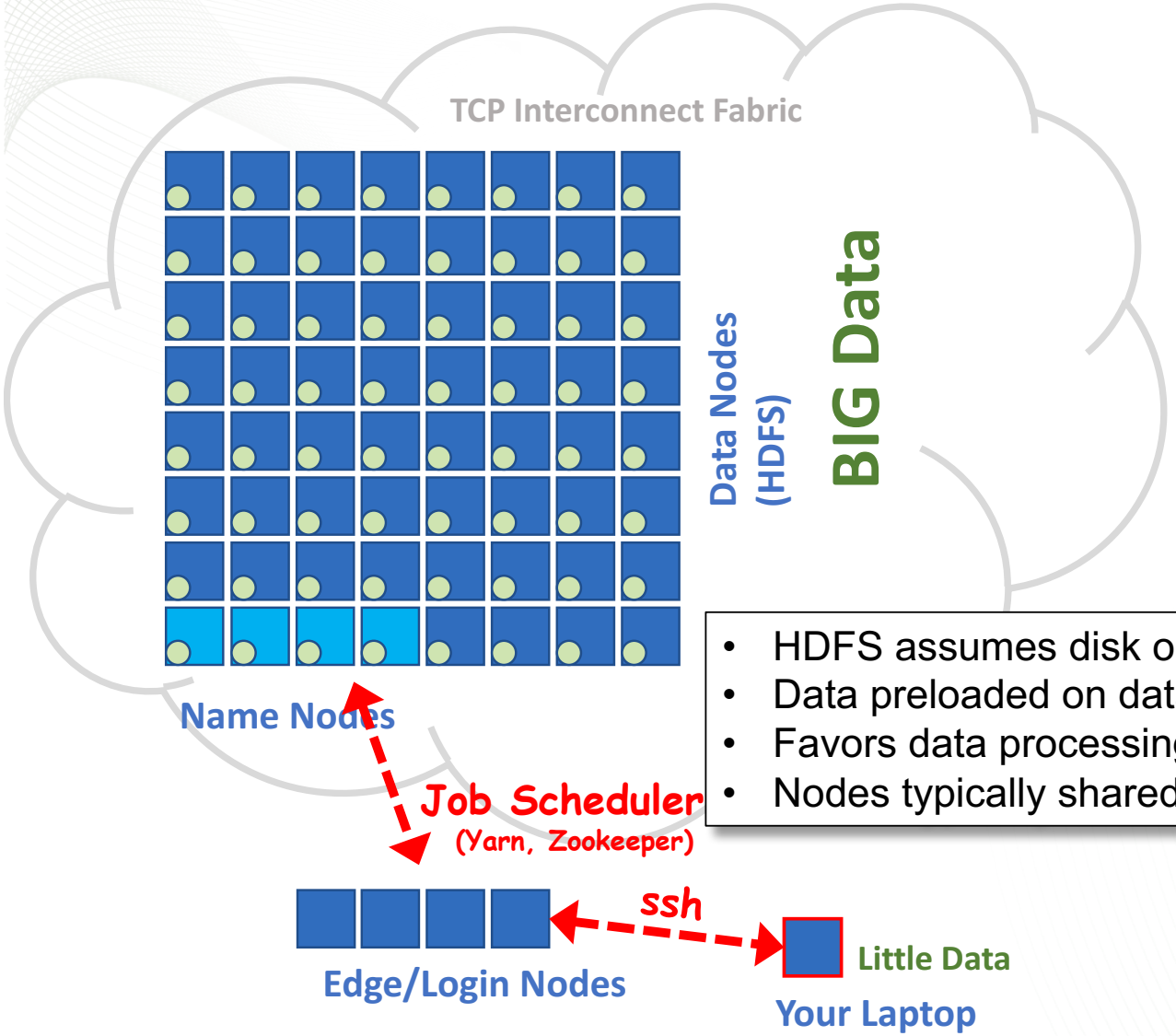
Modern Hadoop Clusters Continue Diskfull



- HDFS assumes disk on nodes
- Data preloaded on data nodes
- Favors data processing over data analysis
- Nodes typically shared between users

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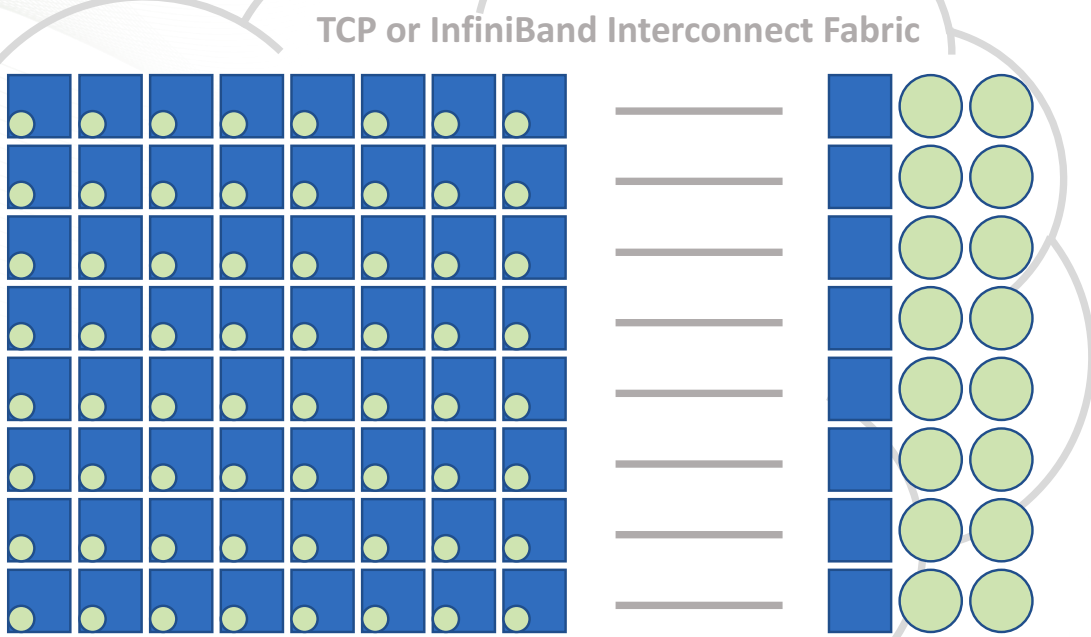
Disk Comes Back in HPC as SSD ~ 2010



- Spark: in-memory MapReduce
- Spark/Hadoop on Lustre ~2015
- HPC/MPI faster for data analysis

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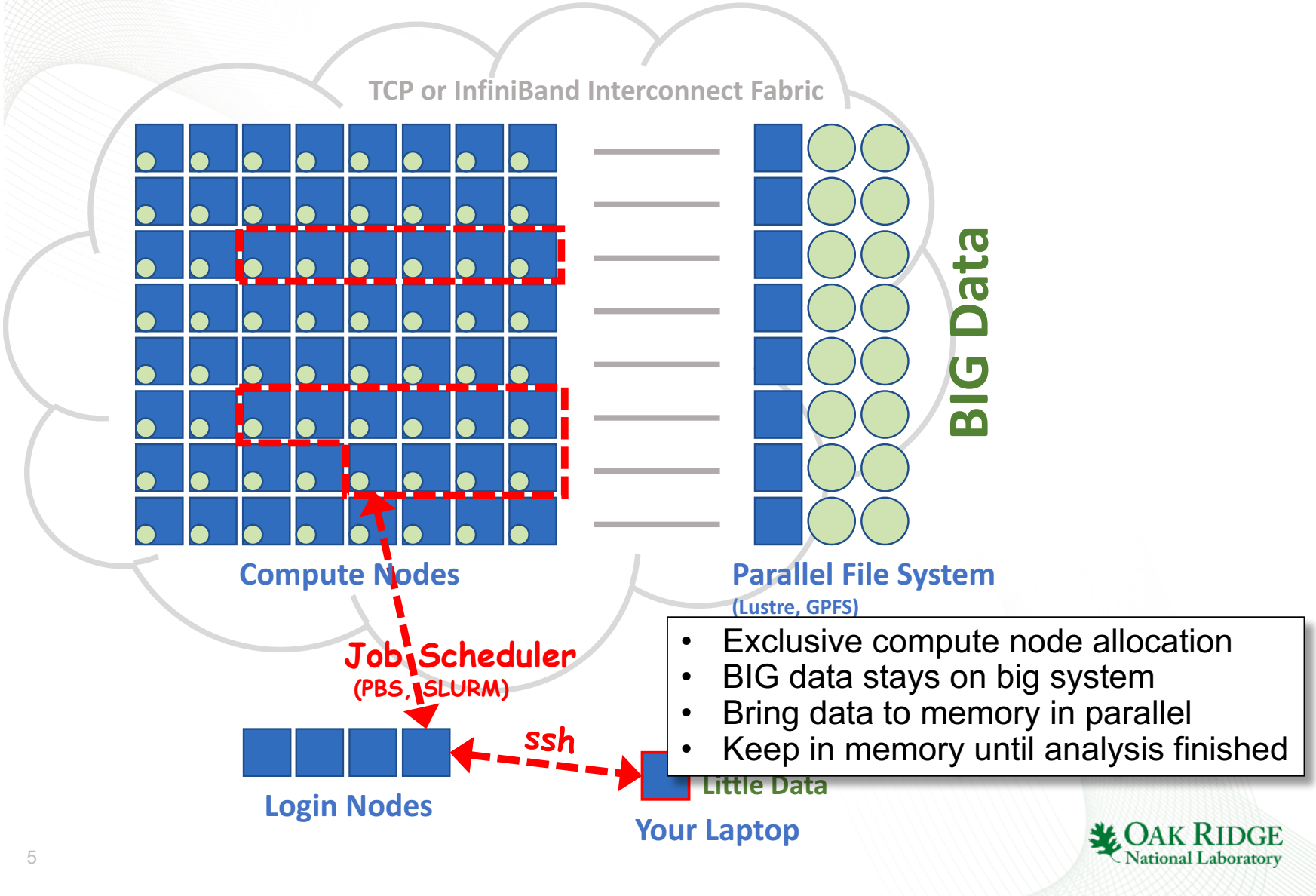
Working with Modern HPC Clusters



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Indian supercomputers in the TOP500 [edit]

As of June 2018, India has 5 systems on the TOP500 list ranking.[7]

Rank	Site	Name	Rmax (TFlop/s)	Rpeak (TFlop/s)
39	Indian Institute of Tropical Meteorology	Pratyush (Cray XC40)	3,763.9	4,006.2
66	National Centre for Medium Range Weather Forecasting	Mihir (Cray XC40)	2,570.4	2,808.7
206	Software Company	InC1 - Lenovo C1040	1,123.2	1,413.1
327	Indian Institute of Science	SERC - Cray XC40	901.5	1,244.2
496	Indian Institute of Tropical Meteorology	iDataPlex DX360M4	719.2	790.7

India Gearing Up for Big Supercomputing Expansion

Michael Feldman | July 24, 2017 22:14 CEST

A number of news outlets in India are reporting the government is close to deploying six new supercomputers, two of which will deliver a peak performance of two petaflops.

According to a report in the Hindustan Times, the six new systems are part of the initial phase of a three-phase project that eventually result in the deployment of 50 supercomputers across the country. The Indian government has allocated Rs 4,500 crore (close to 700 million USD) for the project, which was approved in March 2016. The effort is being managed by the Centre for Development of Advanced Computing (C-DAC), an R&D institution under India's Ministry of Electronics and Information Technology.