CS 550:
Advanced Operating Systems

Introduction to
Distributed Systems

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CS 550
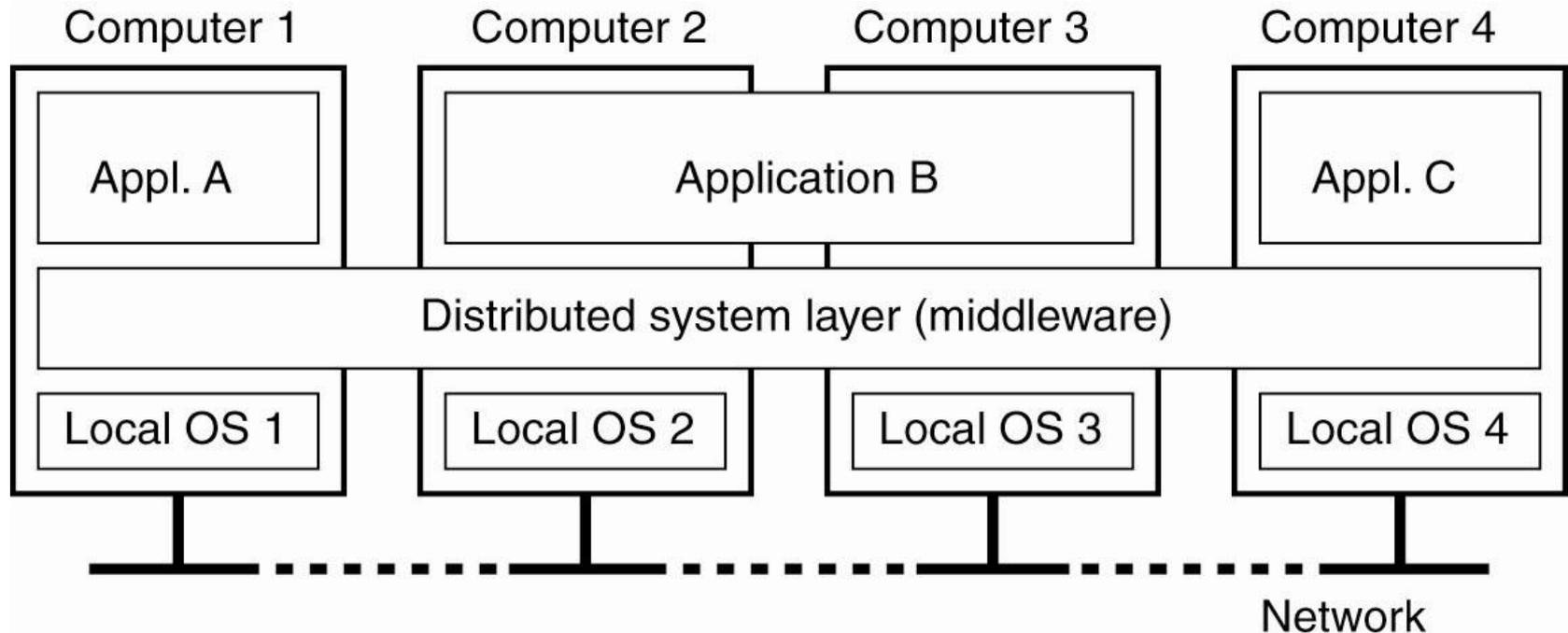Advanced Operating Systems
January 13th, 2011

Distributed Systems

- What is a distributed system?

"A collection of independent computers that appears to its users as a single coherent system"
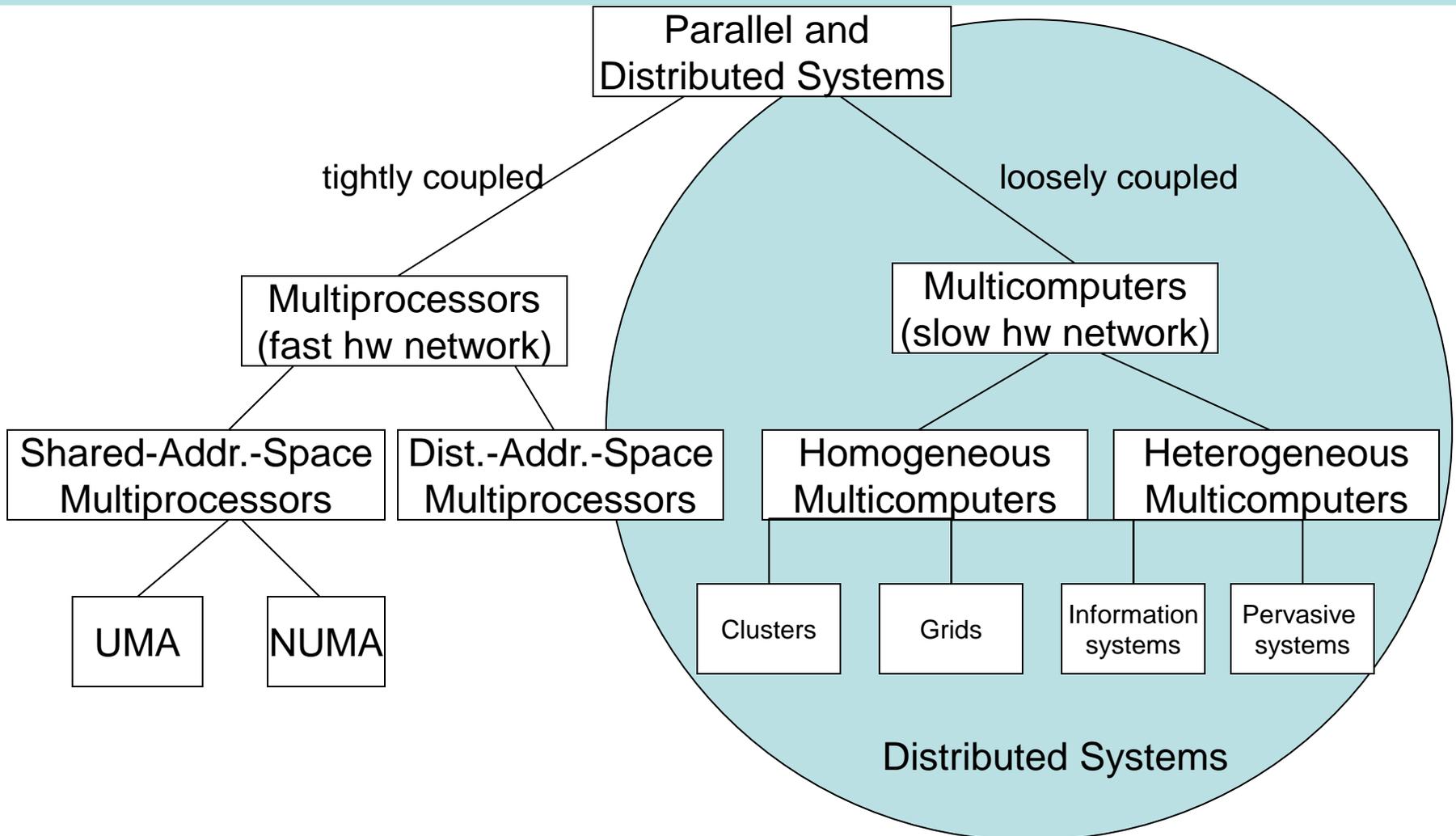
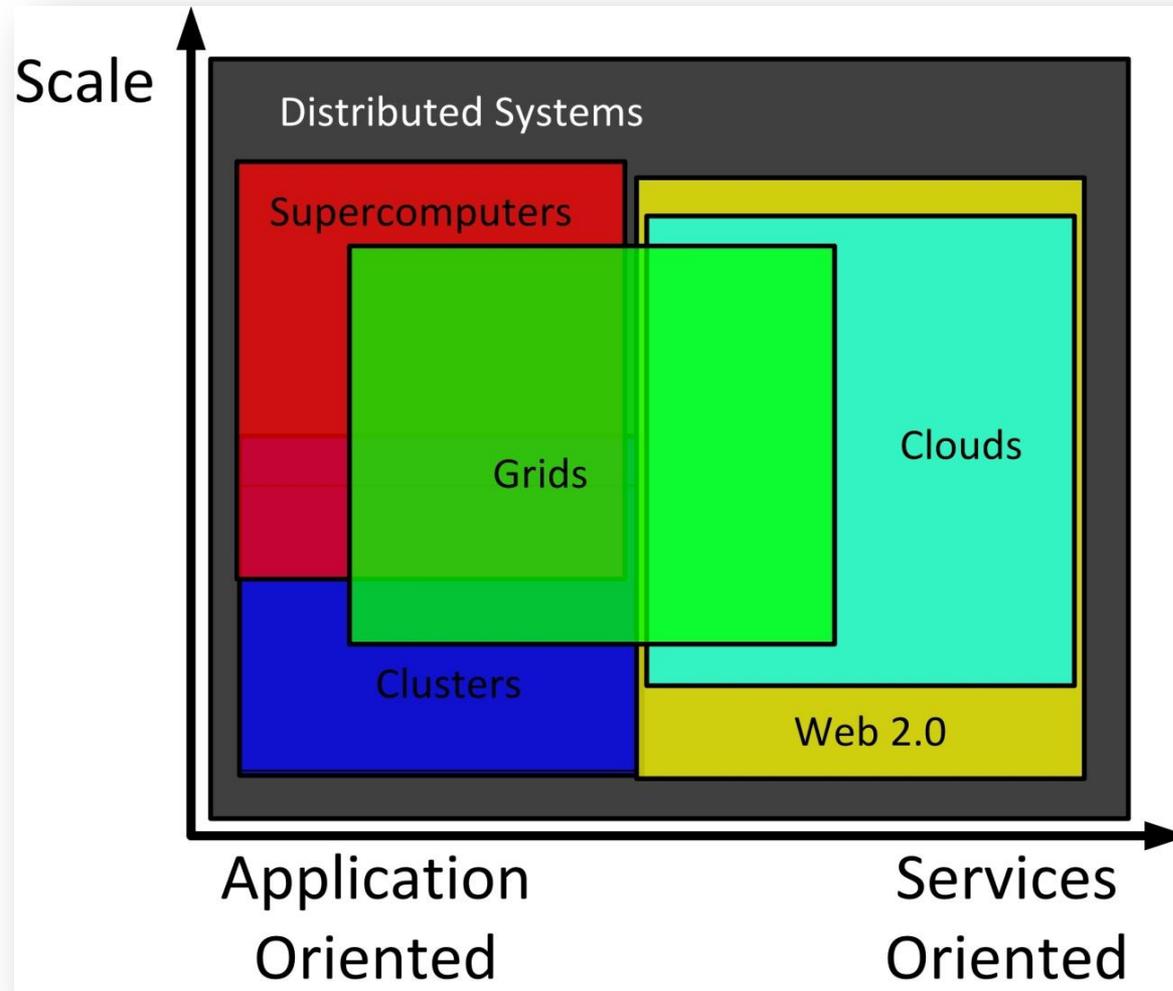**-A. Tanenbaum**

Distributed Systems

A distributed system organized as middleware. The middleware layer extends over multiple machines, and offers each application the same interface.
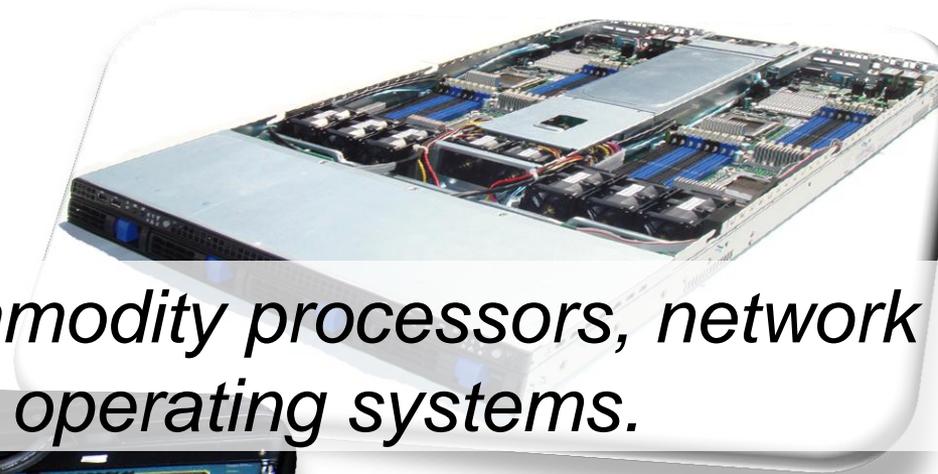
Distributed Systems

Distributed Systems:
Clusters, Grids, Clouds, and Supercomputers

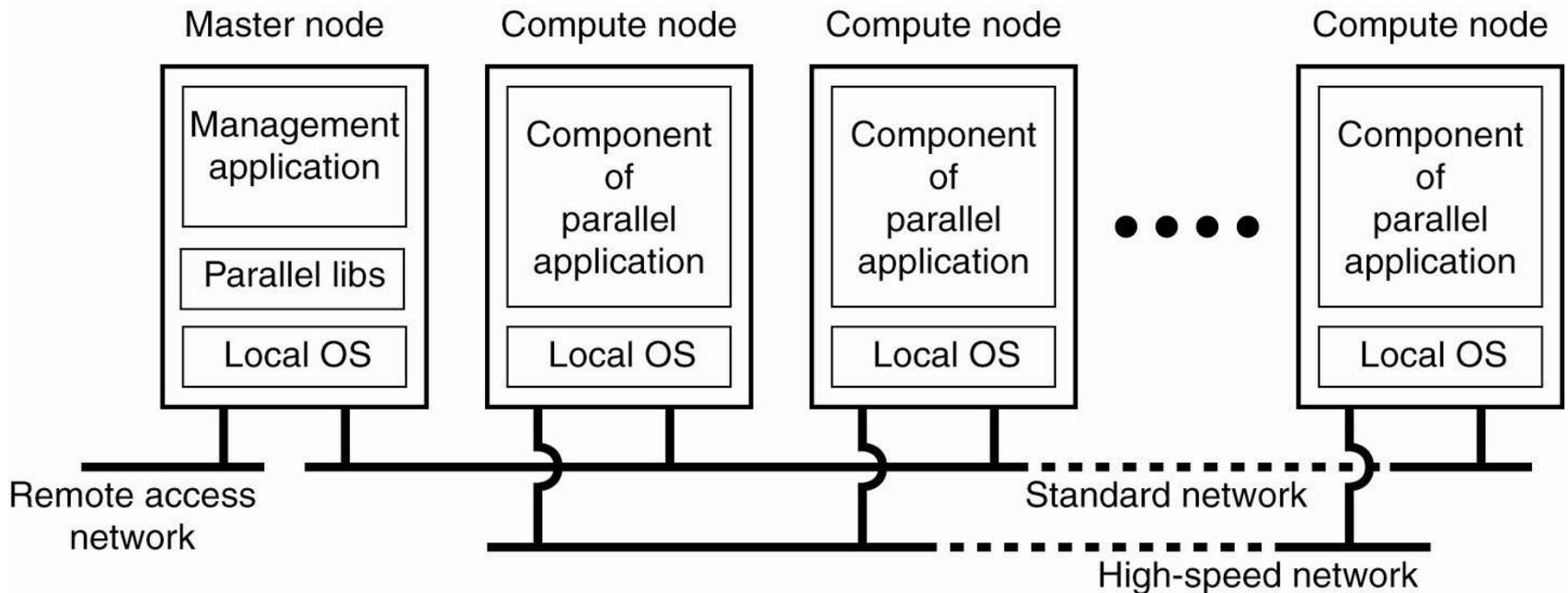**[GCE08]** "Cloud Computing and Grid Computing 360-Degree Compared"

Cluster Computing

Computer clusters using commodity processors, network interconnects, and operating systems.
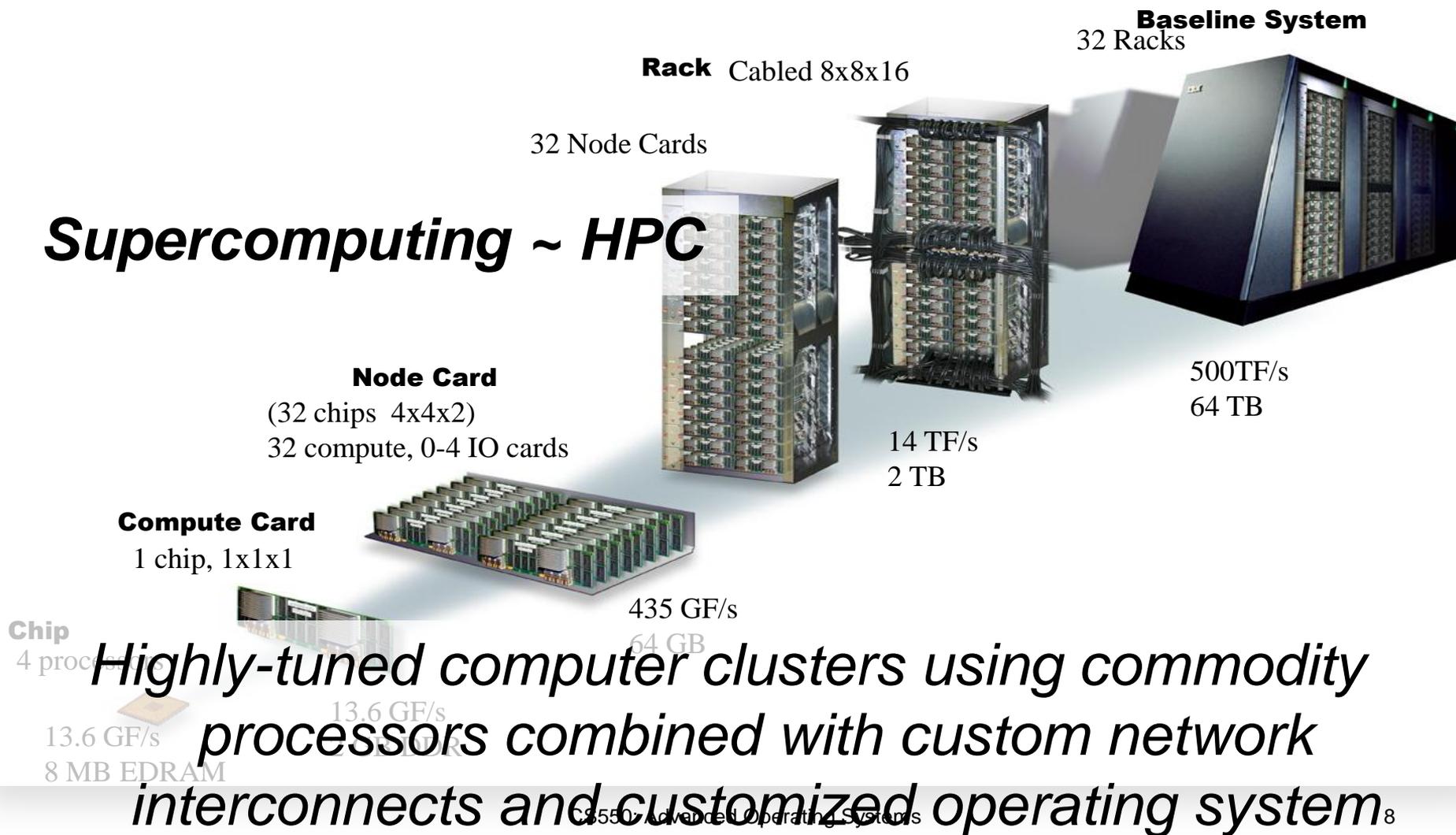
Cluster Computing Systems

Supercomputing

Baseline System

32 Racks

Rack Cabled 8x8x16

32 Node Cards

Supercomputing ~ HPC

500TF/s
64 TB

Node Card
(32 chips 4x4x2)
32 compute, 0-4 IO cards

14 TF/s
2 TB

Compute Card
1 chip, 1x1x1

435 GF/s
64 GB

Chip
4 processors

13.6 GF/s

13.6 GF/s
8 MB EDRAM

Highly-tuned computer clusters using commodity processors combined with custom network interconnects and customized operating system
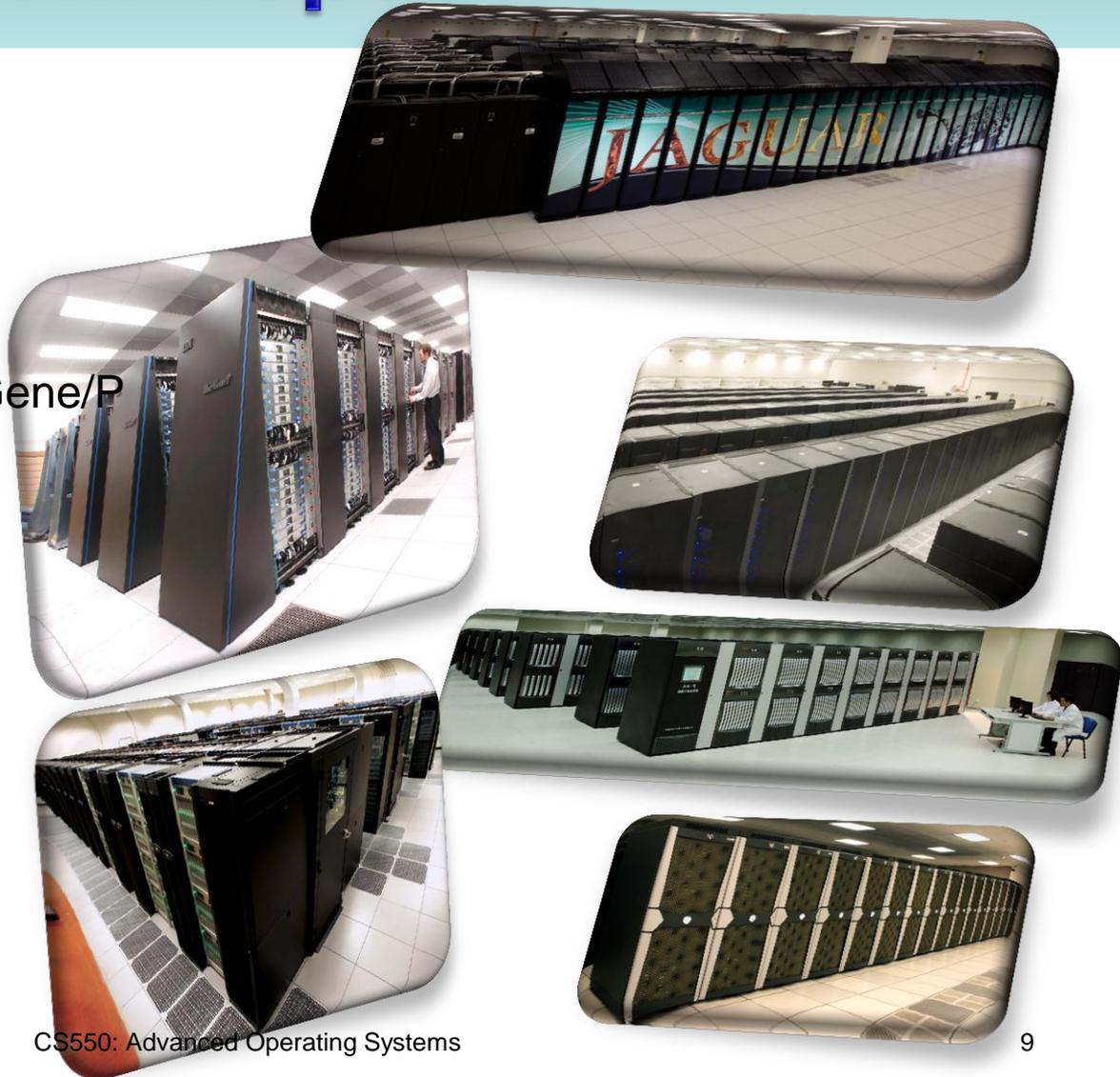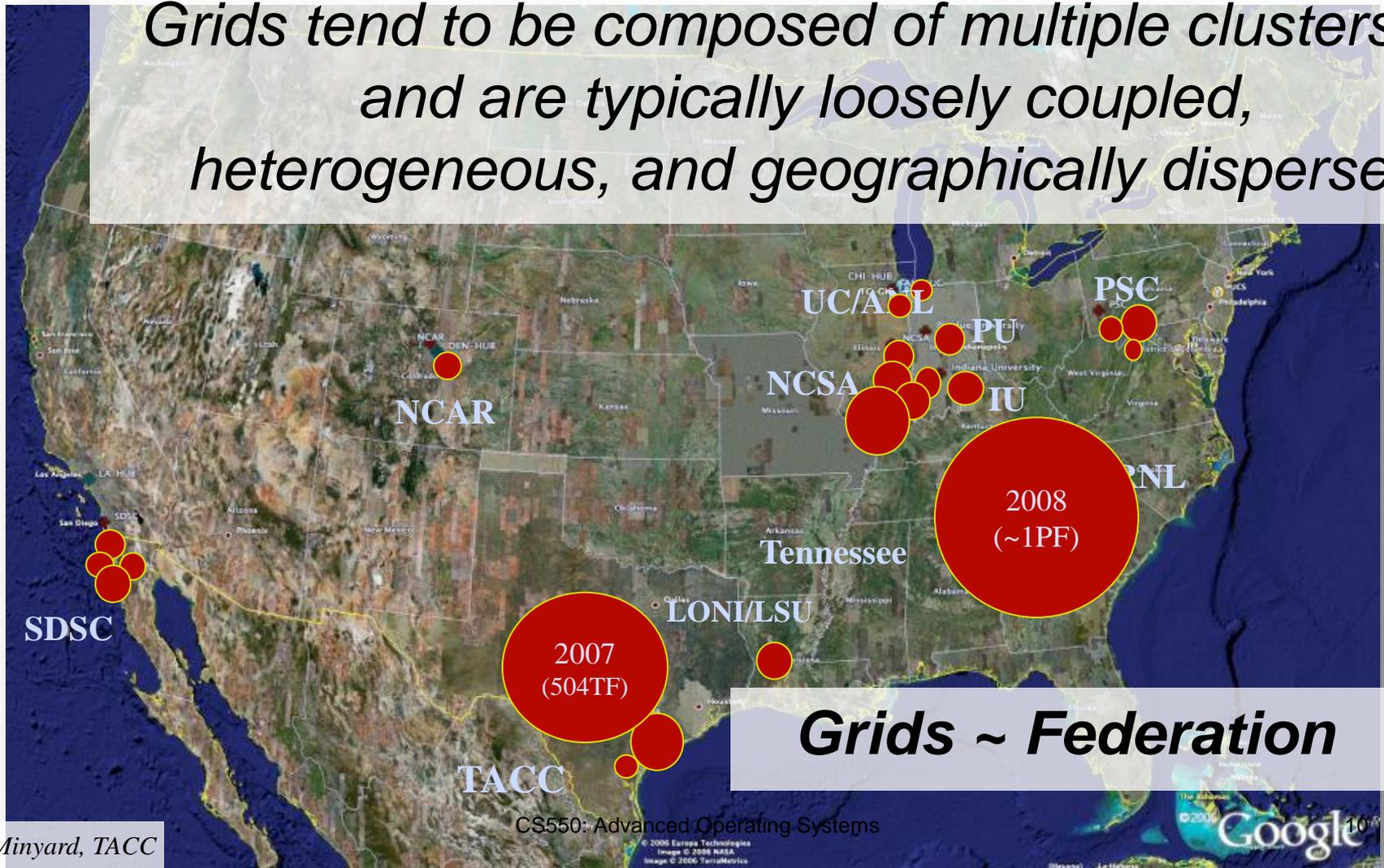
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Top 10 Supercomputers from Top500

- Cray XT4 & XT5
  - Jaguar #1
  - Kraken #3
- IBM BladeCenter Hybrid
  - Roadrunner #2
- IBM BlueGene/L & BlueGene/P
  - Jugene #4
  - Intrepid #8
  - BG/L #7
- NUDT (GPU based)
  - Tianhe-1 #5
- SGI Altix ICE
  - Plaiedas #6
- Sun Constellation
  - Ranger #9
  - Red Sky #10

Grid Computing

Grids tend to be composed of multiple clusters, and are typically loosely coupled, heterogeneous, and geographically dispersed

PSC

UC/ANL

PU

NCSA

IU

NCAR

PNL

2008
(~1PF)

Tennessee

SDSC

LONI/LSU

2007
(504TF)

Grids ~ Federation

TACC

Tommy Minyard, TACC

Major Grids

- ## TeraGrid (TG)
  - 200K-cores across 11 institutions and 22 systems over the US

- ## Open Science Grid (OSG)
  - 43K-cores across 80 institutions over the US

- ## Enabling Grids for E-sciencE (EGEE)

- ## LHC Computing Grid from CERN

- ## Middleware
  - Globus Toolkit
  - Unicore

Questions

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