Lecture 14
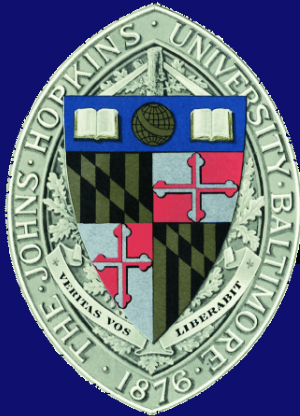# Top 500

EN 600.320/420/620

Instructor: Randal Burns
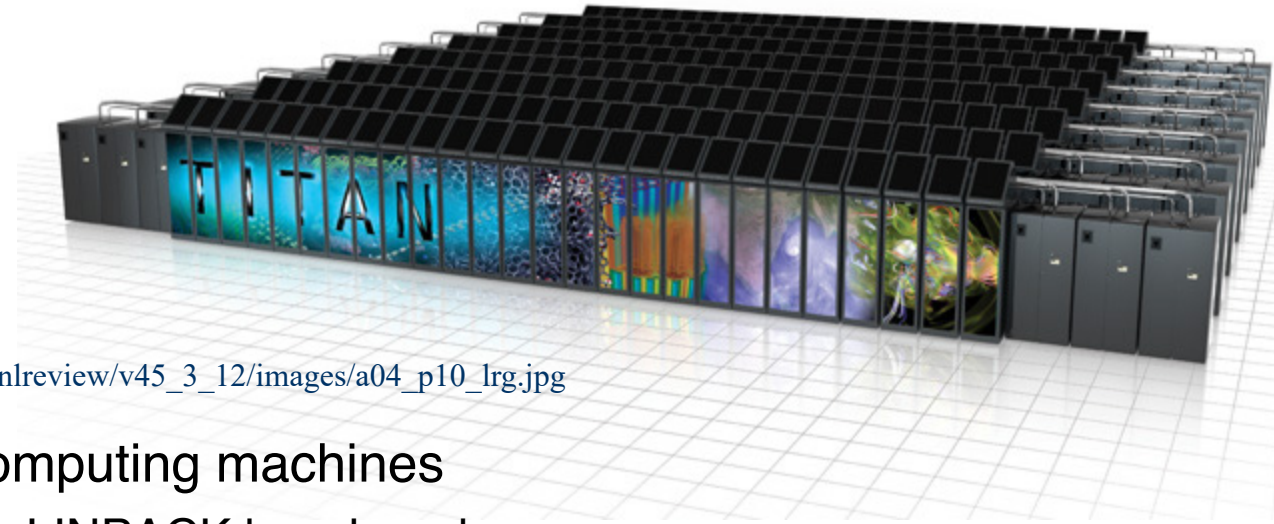
21 October 2020

Department of Computer Science, *Johns Hopkins University*

TOP500

http://ornl.gov/info/ornlreview/v45_3_12/images/a04_p10_lrg.jpg

- Fastest 500 computing machines
  - According to LINPACK benchmark
- Controversial
  - Other metrics represent other problems
  - Green500: best computing power per watt
  - Does not measure I/O to storage
  - Does measure networking between nodes (needed to succeed)

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TOP500: Interpreting their Slides

https://www.top500.org/media/filer_public/54/77/5477d858-1f1e-410b-994b-b7122cfd1d57/top500_2020_06_v2_web.pdf

- Slide 10
  - An Exaflop! has been reaced (at reduced precision)
  - New architectures have emerged
    - Both in Green500 and Top500
- Slide 11
  - 4 new entrants: 2 in Europe, 1 from Industry
- Slide 12
  - HPCG is an alternative benchmark than HPL (LinPack)
  - Complex gradients involve sparse patterns of a suite of modern applications

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Green 500 (slide 13-14)

https://www.top500.org/media/filer_public/54/77/5477d858-1f1e-410b-994b-b7122cfd1d57/top500_2020_06_v2_web.pdf

- Two new architectures

- nVidia A100: low-power data-center tensor GPU
  - Supports multiple word sizes
  - Up to 7 GPUs collaborate on single task
  - Selene system – most powerful industrial system ever
    - AI designed – train big neural nets

- MNCore – deep learning training accelerator
  - Optimized for matrix operators
  - Supposed to be a 'neural processor' don't know what that means

- These two new architectures follow on two new ones last time
  - ZettaScaler: hierarchical with stacked ram
  - A64FX: 512 wide vector

- There is a revolution in accelerator architecture

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Replacement (slide 15-17)

https://www.top500.org/media/filer_public/54/77/5477d858-1f1e-410b-994b-b7122cfd1d57/top500_2020_06_v2_web.pdf

- Lowest replacement rate ever
    - Sum lower than trend
    - 500th lower than trend
- Technology improvement pacing
    - #1 machine on Moore's law
    - With discretization effects

Countries (slide 19-23)

https://www.top500.org/media/filer_public/54/77/5477d858-1f1e-410b-994b-b7122cfd1d57/top500_2020_06_v2_web.pdf

Rise of Chinese manufacturing

- Diversity narrowed to US only by 2009
  - These are the system vendors/integrators
  - Representing a global (mostly Asia) supply chain
- China committed to vertical intergration
  - From chip to HPC, the whole system
  - First all Chinese supercomputer 2016
- But it's more complex:
  - In 2015, US Government rejected an export license for Intel to send CPUs and coprocessors boards.
  - Triggered a commitment to self-sufficiency
  - Remain export controls in effect today

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Research v. Industry (slides 23,27,29)

https://www.top500.org/media/filer_public/54/77/5477d858-1f1e-410b-994b-b7122cfd1d57/top500_2020_06_v2_web.pdf

- Diverse set of vendors
  - Prefer performance share to system share
  - In both categories
  - Different vendors in each sector
- Chip share is more confusing
  - Multiple offerings per vendor
    - Intel CPUs and Xeon Phi
    - NVidia GPU accelerators and A200 tensor
    - ARM is Fujitsi
- Split between
  - Research: HPC for science
  - Industry: training deep networks for AI
    - e.g. driverless cars were a stated goal of NVidia.

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Couple Comments

- Evolution of types of systems shows Moore's law consequences
  - Death of single CPU
    - Multicore ->
    - SMP ->
    - NUMA ->
    - Distributed memory ->
    - Accelerators
  - Rise of commodity hardware

Architecture Share Over Time 1993-2011
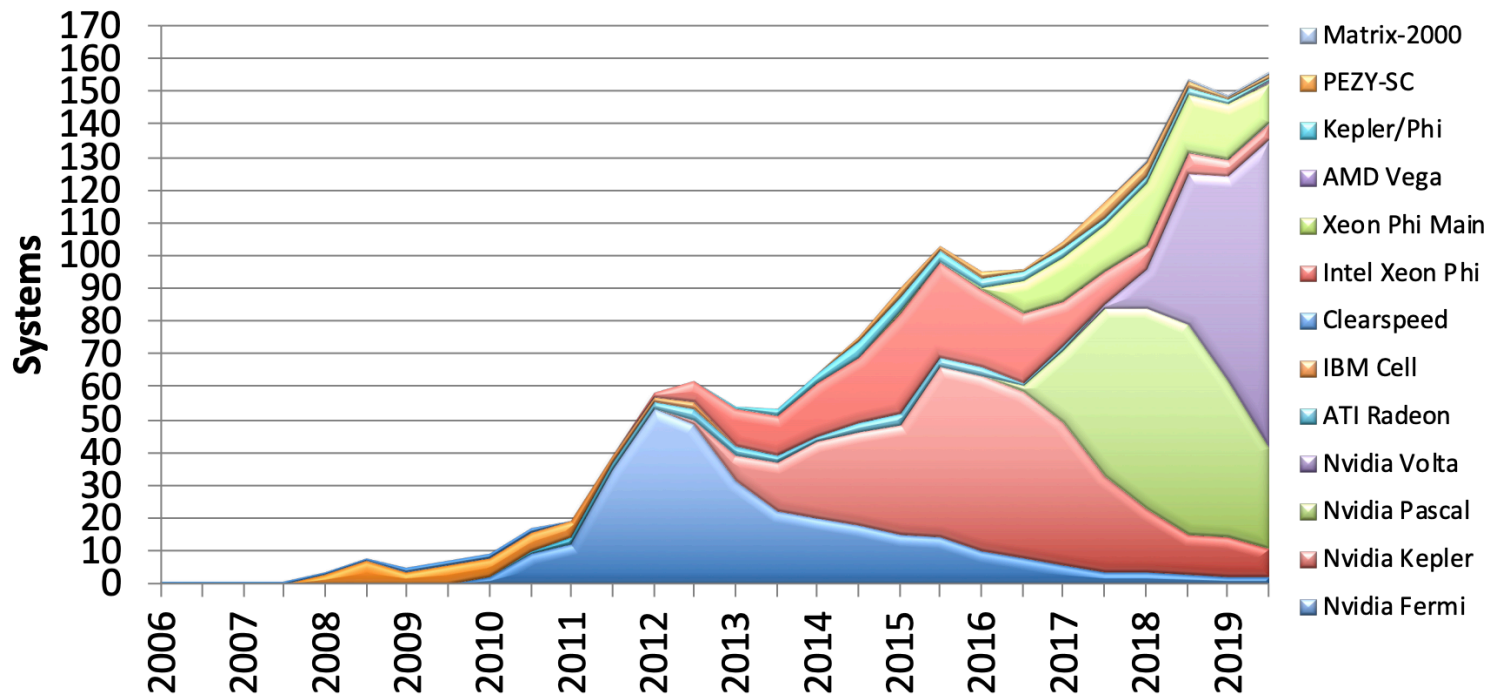
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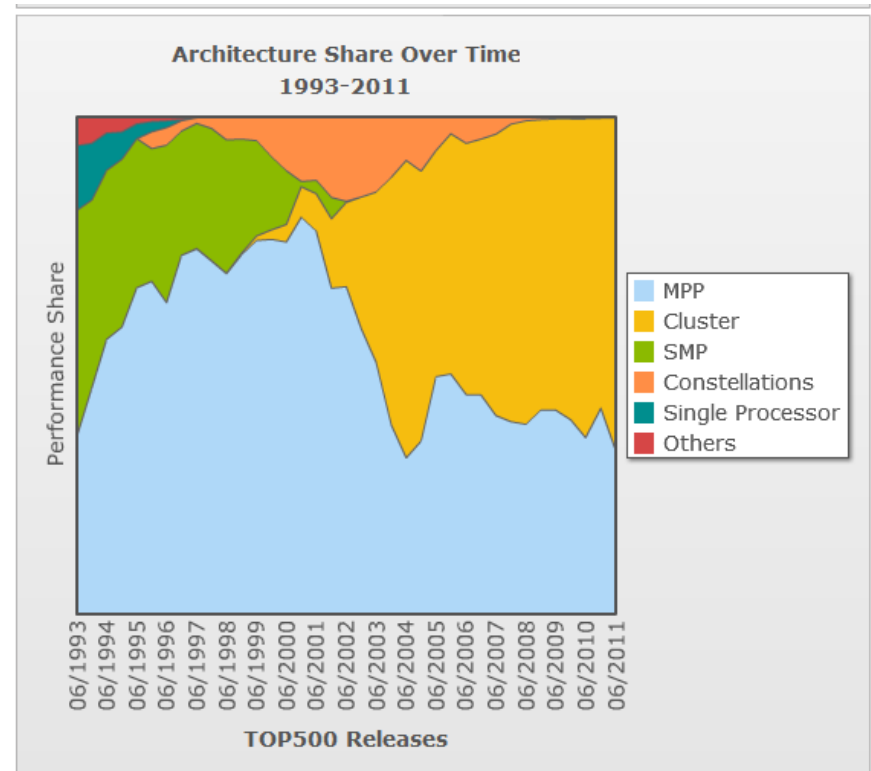
Couple Comments

From previous years presentations

- Accelerators
    - Solve problems with Dennard scaling
    - In response to same factors as CPU multicore (2004)

The Rise of Accelerators

- Accelerators emerged as a way to defer Dennard scaling limitations
  - 1/3 of systems, but > 50% of flops
- Almost all Nvidia GPUs

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