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CSE 291: Operating Systems in Datacenters

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Agenda for Today

- Announcements
- Introduction to multicore and heterogeneity
- Multikernel discussion

Announcements

- Enrollment
  - The class is close to full
  - If you hope to join, continue doing the course work
  - Give me your email after class
- Office hours
  - Wednesday 1-2 pm or by appointment in CSE 3130
- Piazza
  - Linked from course website
  - Intended for students to assist each other

Announcements, continued

- Warm-up assignment
  - Posted on the course website
  - Individual assignment
  - Due Monday 10/16 at 11:59 pm (after the add deadline)
    - Don’t leave it until the last minute

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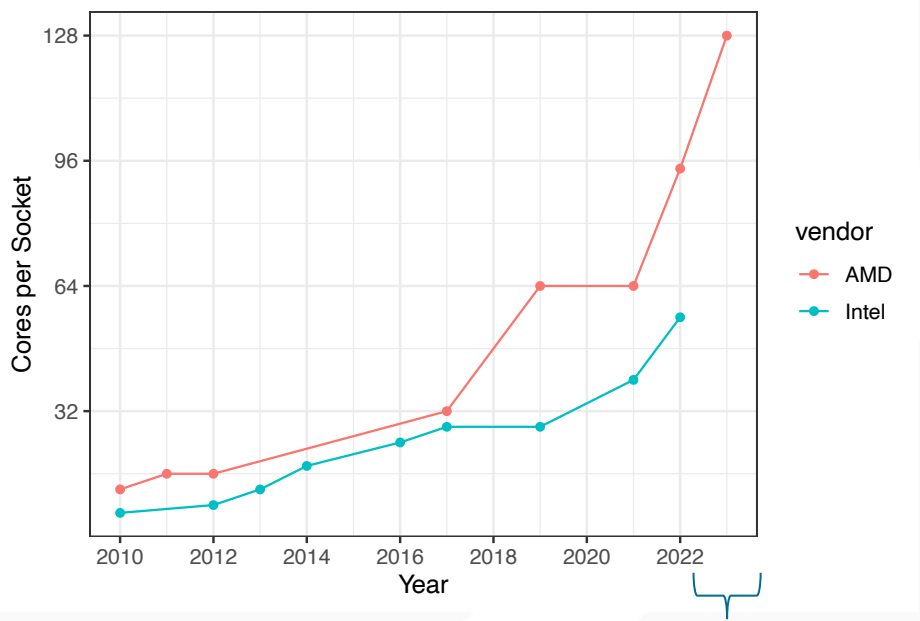
Introduction to Multicore and Heterogeneity

The Rise of Multicore

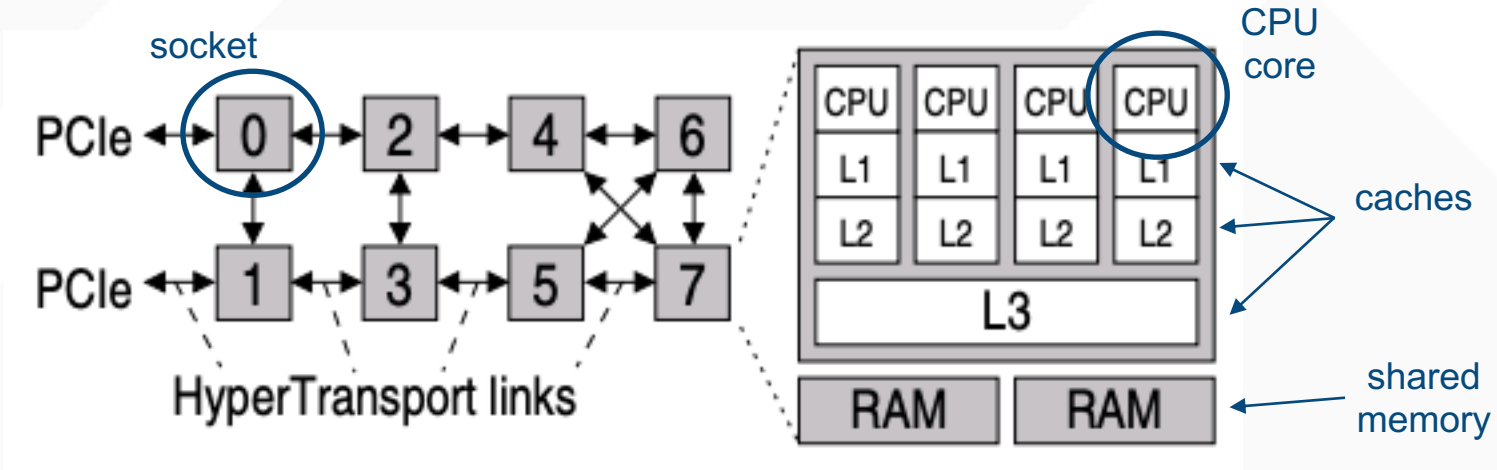
- First multicore CPUs?
  - IBM's Power4 in 2001 had 2 cores
- Driven by the end of Moore's Law



Data from: https://www.servethehome.com/amd-and-intel-2p-server-core-count-growth-2010-2022/

Multicore Architectures

- Cores grouped into sockets
  - Also referred to as “multi-core processors” or “NUMA nodes”
  - Interconnect in between them
- Cache coherence
  - Keeping data in separate caches consistent



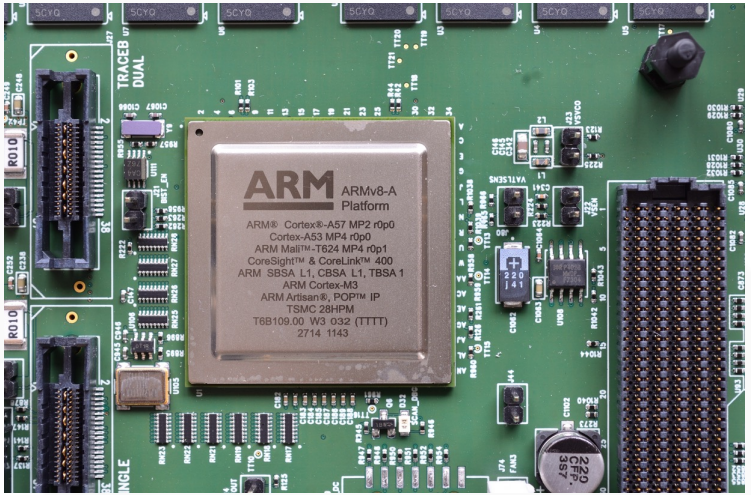
Challenges of Multicore

- How do you design **applications** that scale well across many cores?
- How do you build an **OS** that scales well? ← today
  - How do you design the application-OS **interface** to enable scalability? ← "The Scalable Commutativity Rule" [SOSP '13]
  - How do you build a scalable **network stack**? ← Thursday
  - How do you make **CPU scheduling** scalable? ← later this quarter
  - How do you scale **memory management**? ← later this quarter

Heterogeneity

- Heterogeneous processors
  - Different power consumption ← common in mobile and tablets
    - E.g., ARM's big.LITTLE announced in 2011
  - Different ISAs
- Other types of heterogeneity:
  - GPUs
  - SmartNICs
  - FPGAs
  - Accelerators

common in datacenters



Challenges of Heterogeneity

- May not be cache coherent
- Different memory layouts
- Different models of computation (e.g., GPU vs. CPU)

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Multikernel Discussion