TEXAS TECH UNIVERSITY
Department *of* Computer Science

CS5375 Computer Systems Organization and Architecture

Lecture 24

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Announcements

- Last HW#5 due on 12/6, Tuesday
  - Hard deadline, will post the solution after the deadline
  - Plan to post a recorded HW#5 review and discussion too

- Final exam on Tuesday, December 13th, 8 a.m. to 10:00 a.m.
  - Must take the exam during the class time and in person in the classroom
  - Test subjects we discussed regarding Chapters 3, 4, 5, and 6, i.e., all lectures from Lecture 10
    - Only subjects we discussed in class, you should review lecture slides, HW, related textbook discussion
  - All multi-choice questions, open-book, open-note, but cannot use any other resources
  - Will still enforce randomized seating and encourage to take via Blackboard – to be graded automatically, and please take your laptop with you
    - Will also provide paper copies and will collect your preference for us to prepare in advance

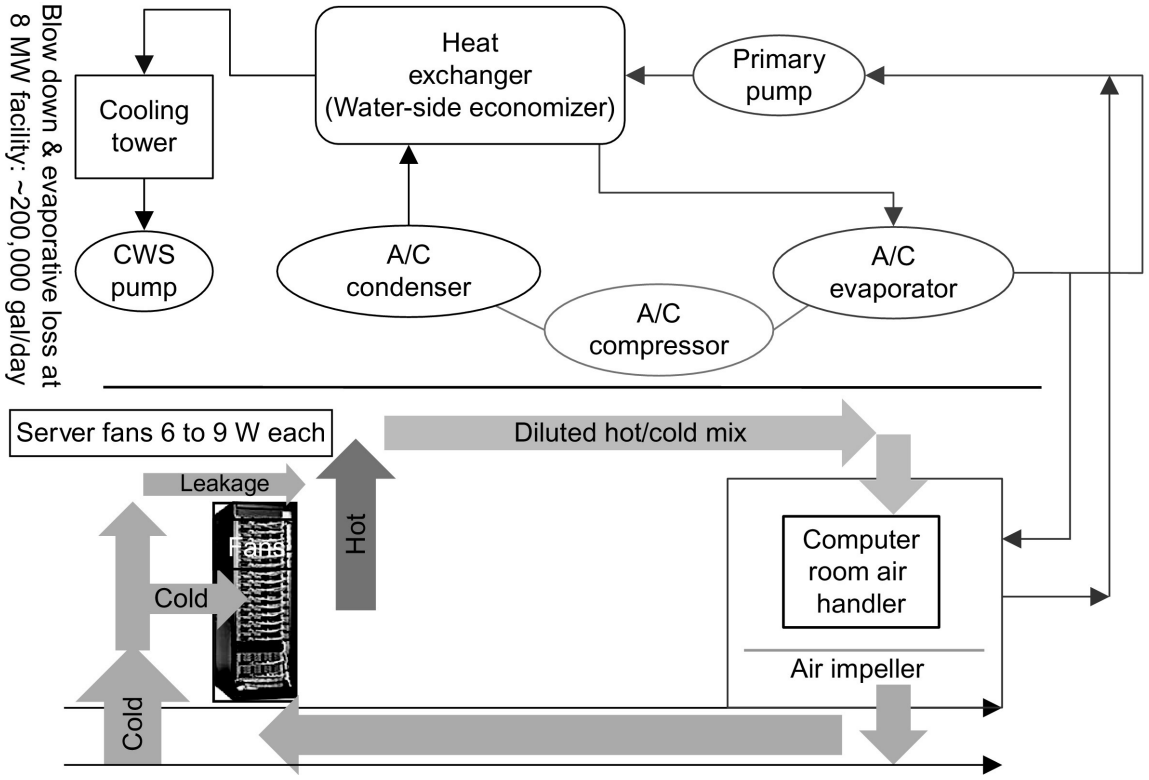
Outline

- Infrastructure of Warehouse-Scale Computer (cont.)
- HW3 and HW4 Review

Infrastructure of Warehouse-Scale Computer (cont.)

- Cooling
  - Air conditioning used to cool server room
  - Cooling system also uses water
    - E.g., 70,000 to 200,000 gallons per day for an 8 MW facility

- Typical power usage by component:
  - Processors: 42%
  - DRAM: 12%
  - Disks: 14%
  - Networking: 5%
  - Cooling: 15%
  - Power overhead: 8%
  - Miscellaneous: 4%



Cost of a WSC

- Capital expenditures (CAPEX)
  - Cost to build a WSC
- Operational expenditures (OPEX)
  - Cost to operate a WSC

Cloud Computing: The Return of Utility Computing

- A large-scale computing system that
  - Focus on hosting data and applications for users by utilizing service-oriented architecture, virtualization and storage techniques

- Driven by
  - Industry, economies of scale, pay as you go model – attractive for small/medium-scale businesses
  - Virtualization, dynamically-scalable resources
  - Delivered on demand

Cloud Computing: The Return of Utility Computing (cont.)

In 2017 Google had 15 sites. In the Americas: Berkeley County, South Carolina; Council Bluffs, Iowa; Douglas County, Georgia; Jackson County, Alabama; Lenoir, North Carolina; Mayes County, Oklahoma; Montgomery County, Tennessee; Quilicura, Chile; and The Dalles, Oregon. In Asia: Changhua County, Taiwan; Singapore. In Europe: Dublin, Ireland; Eemshaven, Netherlands; Hamina, Finland; St. Ghislain, Belgium. https://www.google.com/about/datacenters/inside/locations/.

Outline

- Infrastructure of Warehouse-Scale Computer (cont.)
- HW3 and HW4 Review

Congratulations to you all!!

Readings

- Chapter 6, 6.2-6.5

- Message Passing Interface (MPI) tutorial, by Blaise Barney, Lawrence Livermore National Laboratory: https://hpc-tutorials.llnl.gov/mpi/

- “MapReduce: Simplified Data Processing on Large Clusters”, by Jeffrey Dean and Sanjay Ghemawat, Google, Inc., OSDI'04: Sixth Symposium on Operating System Design and Implementation, San Francisco, CA (2004), pp. 137-150