Final Lecture: Futures

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Plan for today

- Some directions things are headed
- New desires
  - ubiquitous computing
  - Internet-scale computing
- New technologies
  - Flash-based disk drives
  - Flash replacement: Phase change memory (PCM)
  - Multi-threaded multi-core processors
  - Better tools for handling complexity

Ubiquitous computing

- IDEA: Computers all over the place
  - but, they're just part of the environment, not really in your face
- Lots of ongoing projects now
  - Aura (CMU), Oxygen (MIT), Endeavor (UCB), etc…
- Lots of interesting challenges
  - low power and power management
  - wireless networking
  - real-time and on-time services
  - computation and data migration
  - addressing information overload
  - security and privacy!

Internet-wide computing

- Very wide-area computing and information sharing
  - Video conferencing and other forms of communication
  - Grid computing
  - Peer-to-peer distributed lookup and storage systems
  - PDA and other forms of remote information access
- Lots of projects
- Lots of interesting challenges
  - resource discovery and selection
  - person location
  - data and/or computation survival and migration
  - cost/benefit models
  - security, privacy, and fighting denial of service attacks

New technologies

- Changing technology requires changes in system mgmt.
- Moore's Law
  - faster CPUs, more memory, more storage, more bandwidth
- Shared memory parallel computing becomes mainstream
  - Renewed interest in efficient synchronization, parallel scheduling, distributed shared memory
- Better wireless technologies, smaller devices
  - Ubiquitous computing vision becoming realistic
- Changes in storage technology
  - Cheap, fast non-volatile storage simplifies many file system problems

Better Tools

- Project AURA (CMU Ubicomp) catchphrase:
  - The most precious resource in a computer system is no longer its processor, memory, disk or network. Rather, it is a resource not subject to Moore's law: **User Attention**.
- Complexity of systems continues to grow, human ability to handle complexity does not
  - Need better languages to specify and check concurrent programs (HPCS languages: X10, FORTRESS, Chapel)
  - Automatic extraction of rules from code, and verification that rules are followed (Engler et al.: metacompilation)
  - Automatic diagnosis and recovery from errors (autonomous computing)
  - Reduction to less complex system (virtual machines)

What's next …

- Today:
  - Pick up A1 from box outside my office after 1pm
- Tomorrow:
  - Pick up A2 from box outside my office (after 10am)
- Thursday:
  - Test 2, 10:10 am – noon
  - Expect similar format to Test 1
- Final (unofficial) marks by next Friday
- After that: Have a great break!