컴퓨터시스템의
최신 변화와 이슈들

2012. 7.27

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What has changed ??

- Multi-core CPU
  - No faster CPUs
  - Moor's law still holds

- New Memory Technology
  - Flash Memory
  - Phase Change Memory

Multi-core CPU

- 4-core is norm,
  - 8,12 core readily available
  - 100 core available by the end of this year
  - 1000s of cores in near future

- Are applications scalable ?

- Are Oses scalable ?

Applications

- Parallel programming is hard
  - We still don't know how to do it right
  - High performance computing
  - Scientific computation

- Finding bugs is harder
  - How to find race conditions ?
  - How to find concurrency ?

OS scalability

- Linux was found pretty scalable up to ~20 cores.
- For more cores, even small critical sections can collapse the OS performance
  - Cache invalidation storm
  - Queueing effect

- Need lock-free mechanism

Virtualization

- When several virtual machines run on a physical machine, there's interference
  - Each core has private L1, L2 cache
  - LLC is shared
  - Memory controller is shared

- How can we identify/isolate VM performance ?

New Memory Technology(1)

- Flash memory
  - Read/write
  - No overwrite/block erase
  - Limited erase cycle

- Phase Change Memory
  - Can overwrite
  - Write is slower than read

New Memory Technology(2)

- Phase Change Memory
  - Can overwrite
  - Read is fast ~1us
  - Write is slow
    - 0 -> 1 ~10us
    - 1 -> 0 ~20us
  - Limited overwrite cycle (100,000-1,000,000)

PCM as fast storage

- Can we do more reads and writes less ?
- Wear-leveling

- Flash Translation Layer is too complex

PCM as Main Memory

- How to identify memory read/write pattern so that we can place less mutable data in PCM ?

- Wear-leveling

- Bigger cache for performance/endurance

Challenges

- Given a program written in some language, can we find out
  - How much memory it will use ?
  - For each variable, # of read/write
  - Cache access (hit/miss)

  - Concurrency ?
  - Race condition ?