EECS 570

Midterm Review

Parallel Computer Architecture

Intel Paragon XP/S

Winter 2024

Prof. Ronald Dreslinski

http://www.eecs.umich.edu/courses/eecs570/

Slides developed in part by Profs. Austin, Adve, Falsafi, Martin, Narayanasamy, Nowatzyk, Peh, and Wenisch of CMU, EPFL, MIT, UPenn, U-M, UIUC

Lecture 1: Intro

- ILP Wall
- Power Wall
- Dennard Scaling / Post-Dennard Scaling
- Motivating Multiprocessors

Lecture 2: Models and MPI

- Complexity analysis
  - Work & Depth
  - Critical Path
- Scheduling
  - Greedy scheduler
- Ahmdahl's Law
- Message Passing
  - Asynchronus vs Synchronus
  - Deadlock

Lecture 3: Shared Memory + DLP

- Global address space
- Virtual addressing
- Synchronization
  - Locks
  - Barriers
- Bus based interconnect
- Point-to-point interconnects

- Vector Processing

Lecture 4: GPU

- SIMT Execution Model
- GPU -> GPGPU
- Thread Warps for latency hiding
- ISA is scalar − no semantics of vectors
- Scoreboarding for ready warps

Lecture 5&6: Synchronization

- Aquire/Wait/Obtain
- Locks
  - Need atomic operations for Read-Modify-Write
    - Test&set
    - Fetch&op
    - Swap
    - Compare&swap
  - Test and Set Spin
  - Test and Test and Set Spin
  - Ticket Locks
  - Array Based Queue Locks
  - MCS Lock
- Barriers
  - Sense reversing barrier
  - Tree-Based

Lecture 7: Transactional Memory

- Insert, lookup, delete -> transfer
- Fine grained locking − difficult to program
- Coarse grained locking − too slow
- Create TM (Read set, Write set)
- Version management (Eager or Lazy)
- Conflict Detetction (Eager or Lazy)

- Where does TM not work at replacing locks

Lecture 8: Snooping

- Single Reader Multiple Writer – or – Data value invariant
- Caches snoop all requests on single bus
- Make decisions about cacheline state
- Valid – Invalid
- M – O – E –S –I
- Update vs. Invalidate protocols

Lecture 9: SMP Designs

- Coherence Control Implementation
- Writebacks, non-atomicity, serialization/order
- Hierarchical caches
- Split Busses
- Deadlock, livelock & starvation
- TLB Coherence

Lecture 10: Directory Protocols

- Snooping has bus bandwidth and snooping bandwidth problems
- Make a NoC, and add directory protocol
- Centralized vs Distributed
- Share list options
  - Bit vector, pointers, linked-lists, coarse vectors
- 4-hop vs 3-hop transactions
- Use of Ack's
- Race conditions
- Bounding messages