Lecture 11

Midterm review
Announcements

• Midterm: Monday 10/30, 7:00 to 8:20 PM
• Room: SSB 106
• Open book, but no notes
• No lecture on 11/14
  – But note time changes
  – Makeup on 11/17 9:30AM to 10:50 AM
  – Section will be held on Thurs 11/16 in our class room at usual meeting time
Terms and concepts

- Know the definition and significance of ….
- Parallel speedup and efficiency, super-linear speedup, scaled speedup,
- Scalability, cost, cost-efficient, isoefficiency
- Amdahl's law, serial bottlenecks
- Granularity, surface-to-volume effect
- Loop carried dependence
Terms and concepts

• CRCW, CREW PRAM
• SPMD, MIMD, SIMD
• Multiprocessors and multicomputers; shared memory, message passing
• Interconnection networks: hypercube, ring, mesh, k-ary d-cube, broadcast and reduction algorithms; diameter and bisection bandwidth
• Message startup, half power point $n^{1/2}$, peak bandwidth
• Processor geometry and blocked data decompositions
Implementation techniques

• Message passing with MPI
  – asynchronous, blocking and non-blocking communication
  – MPI sending modes (buffered, standard, etc)
  – collective communication: reduction, broadcast
  – communicators
  – Eager vs. rendezvous communication

• Performance modeling and performance measurement techniques
Algorithms

- Know the purpose of the following algorithms, and the significant implementation issues affecting performance.
- Be familiar with performance models for each and be prepared to analyze performance and scalability.

**Sorting**
- Enumeration sort, odd-even sort, odd-even transposition sort, bitonic sort, bucket sort, sample sort

**Stencil methods**
- **ODE solver:** 1D case
- Multidimensional cases: 2D and 3D
- “Curse of dimensionality:” surface to volume ratios
- Convergence and how to check it
- Ghost cells, partitioning, performance models
- Dealing with Loop carried dependences

**Matrix multiplication**
- Canon’s algorithm, SUMMA

**LU Decomposition (Gaussian elimination)**
- Cyclic decompositions
Practice problems

• You have 2 machines
  – UMA.net—a Uniform Memory Access (UMA) multiprocessor with 64 processors and 32 GB of shared memory
  – Distributed.net loose connection of 145,000 processors with 9 Terabytes of RAM tied together over the internet with 5Mbit/s network connections with an average latency of 20ms between processors

• Match to the two workloads
  – Analyzes Japanese Haiku poetry. The algorithm almost 100% serial—one can only find parallelism between instructions issued a few cycles apart from each other. Each poem takes 30 seconds on a single processor to compute. Enormous amount of haiku to process, and each poem can be processed separately from the other.
  – LU decomposition on 70,000 x 70,000 matrices
Networks

- Diameter, bisection bandwidth
- Map a 1D ring onto a hypercube, mesh, k-ary d-cube
- How many parallel/unique paths between any two nodes in a hypercube?
- Sort on a 2D network
- Sort on a hypercube