CS527: Parallel Computer Architecture

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Slot-G1: Wed, Thur, Fri [5:00 — 6:00 PM]

Room: MS-Teams

Book: Parallel Computer Architecture: A Hardware/Software Approach

David Culler, J. P. Singh and A. Gupta

Evaluation: 3-4 short online exams

seminar/term-paper/research paper based test

TAs:

PhD students, department of CSE

Palash Das

Sheel Sindhu Manohar

Arijit Nath

Aswathy

Yash Soni

Shashank Maurya

Topics

- Why are we building multicore systems?
  - —Application requirement
    - Hardware design constraints
- Different parallel systems
- shared memory used for communication
- data consistency / coherence
- Coherence protocols
    - 3-4 types
  - —protocol implementation details
    - protocol correctness issues
- Consistency
- Synchronisation

Why Parallel Computing?

Lecture-1

Applications need Parallelism

Why we need ever increasing Parallelism?

- Dramatic advancement in the field of science, internet, entertainment have increased computational power at the foundation/heart
- e.g. decoding the human genome, accurate medical imaging, fast and accurate web search, more realistic computer games

Open problems

- Climate modeling: includes interactions of ocean, atmosphere, land, ice-caps, etc.
- Protein folding: misfolded proteins leads to diseases: Huntington, Parksinson, Alzheimer, etc. Our ability to study configurations of complex molecules is severely limited by compute power
- Drug discovery' analysis of genome and drug effectiveness for personalised treatment of diseases depending on individuals
- Energy research: we will be able to program more detailed models of wind turbines, solar cells, batteries. Construct more efficient clean energy sources
- Data Analysis: we generate tremendous amounts of data, doubling every two years. Unless analysed, this data is useless
  - e.g. sequence of nucleotides in DNA is of little use unless we analyse it for its effect on diseases
  - Vast quantities of data are generated by particle colliders — Large Hadron Collider at CERN, medical imaging, astronomical research, web search engines

More appln: Science and Engg

- Examples:
  - Weather prediction
  - Evolution o1 galaxies
  - Oil reservoir simulation
  - Automobile crash tests
  - Drug development
  - VLSI CAD
  - Nuclear bomb simulation

- Typically model physical systems or phenomena
- Problems are 2D or 3D
- Usually require “number crunching”
- involve “true” parallelism

More appln: Commercial

- Examples
  - On-line transaction processing (OLTP)
  - Decision support systems (DSS)
  - “Application servers" or "middleware (WebSphere)

- Involves data movement, not much numbercrunching
  - OTLP has many small queries
  - DSS has fewer but larger queries

- Involves throughput parallelism
  - Inter-query parallelism for OLTP
  - Intra-query parallelism for DSS

More appln: multi-media

- Examples:
  - Speech recognition
  - Audio/video
  - Data compression/decompression
  - 3D graphics
  - Gaming!

- Involves everything (crunching, data movement, true parallelism, and throughput parallelism)

Hardware design Constraint
are driving towards
Parallelism