Advanced Computer Systems Architecture

Chip-Multiprocessors: Applications and Architectures

CSE 526M
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Plan for Today

- Announcements
  - Office hours end at 3:45 today
- Questions
- Today’s discussion
Data Flow

- The idea
  - Achieve concurrent program execution with a processor organization that allows an instruction to execute as soon as its operands are available
  - In contrast to the implied serial execution of traditional computers
- Most data flow proponents used new programming languages devoid of serial baggage
- A formal modeling technique, based on Petri nets, inspired these ideas and can be used to derive formal properties of such systems

Sample Data Flow Program

- Nodes are operators or links (large dots = init vals)
- Arcs transmit values, represented by tokens
- A node is enabled only when all its inputs contain tokens
- A node may fire when it is enabled; tokens are removed from inputs, and one is placed on the output arc
- Note: no control flow
Elementary Processor

- Data flow program stored in instruction cells
- Arb network routes instruction cells to operation units
- Dist network routes results to memory

Memory Format

- An instruction cell is enabled when each of its three registers are full
Basic Data Flow Program

- Structure is essentially the same
- Packet formats have same character
- Number of instruction cells is a limitation
Basic Processor with Memory Hierarchy

- Auxiliary memory allows larger programs
- Cell block must now perform a sort of caching and demand fetching

Cell Block Structure

- There are more memory locations than instruction cells
- Assoc table records that status of each cell
- Stack maintains displacement order
Tomasulo’s Algorithm

Brief Perspective

• FPLib
Intellectual Digestion

- What difficulties do you see with using data flow ideas in a system?
- Most data flow examples focus on concurrent computations. Can data flow ideas help tolerate slow memory or fast I/O? If so, how?
- Does the presence of multiple threads increase or decrease the utility of a data flow organization? Why?

Difficulties

- Data flow-friendly languages never achieved critical mass (serial, control flow baggage must be tolerated)
- Serial execution lends itself to step-through debugging; how do you debug a highly concurrent parallel computation?
Data Flow vs. Slow Mem and Fast I/O

- Slow memory
  - Execution can proceed past memory ops whenever independent instructions exist (indirect benefit)
- Fast I/O
  - Perhaps, but no one has done anything yet

Threads and Data Flow

- I think there is merit in considering thread dispatch mechanisms inspired by data flow ideas, but no one has looked at it yet
Assignment

- Thursday (4/22):
  - **Commentary**: Architecture and Applications of the HEP Multiprocessor Computer System
  - 15 minute perspective: TOE
- Tuesday (4/20):
  - **Commentary**: Reflections in a Pool of Processors/An Experience Report on C.mmp/Hydra
  - 15 minute perspective: Bloom Filter