CSinParallel Four Corners Workshop

Introduction to CSinParallel

Dick Brown, St. Olaf College

Tuesday morning, 7/29/2013
Navajo Tech, Crownpoint NM

MACALESTER COLLEGE

ST·OLAF COLLEGE

Workshop site

On CSinParallel.org:
http://serc.carleton.edu/csinparallel/workshops/four_corners/

See also workshop handouts

MACALESTER COLLEGE

ST·OLAF COLLEGE

Take-home messages

- The **traditional CS curriculum is "striking out"** against the fastballs and curve balls of current computing technologies

- Our students need **preparation in parallel and distributed computing (PDC)** for their careers

- The **CSinParallel strategy** for effective, quicker curricular change

- **Strategic resources** for teaching PDC

- The BIG challenge: **Forming an effective community to support this curricular transition**

MACALESTER COLLEGE

ST·OLAF COLLEGE

Striking out against new PDC technologies

http://armchairgm.wikia.com/File:1206127655_Strikeout.gif

MACALESTER COLLEGE

ST·OLAF COLLEGE

Striking out against new PDC technologies
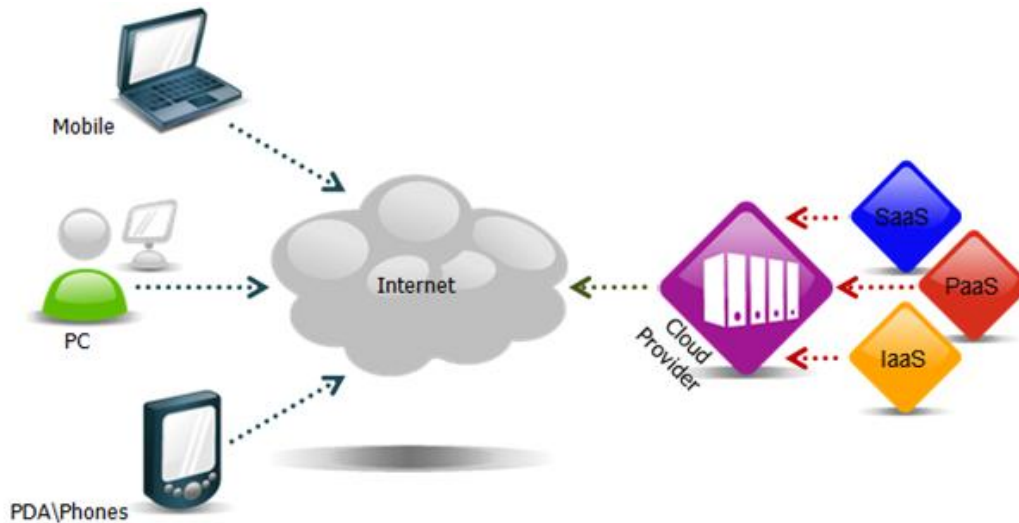
Strike 1: **Multicore processors**

- The norm for about **10 years**

- *Why?* "Hitting the wall" in:

  a. (Electrical) **power**

  b. **ILP** (can't hide much more parallelism within core)

  c. Deepening **memory hierarchy**
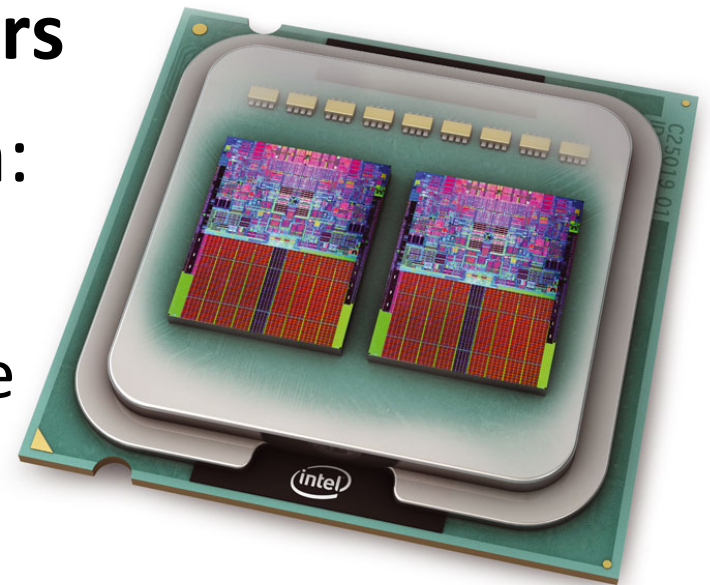
http://media.soundonsound.com/sos/jan08/images/PCMusician_01_l.jpg

MACALESTER COLLEGE

ST · OLAF COLLEGE

Striking out against new PDC technologies

Strike 2: **Cloud computing revolution**

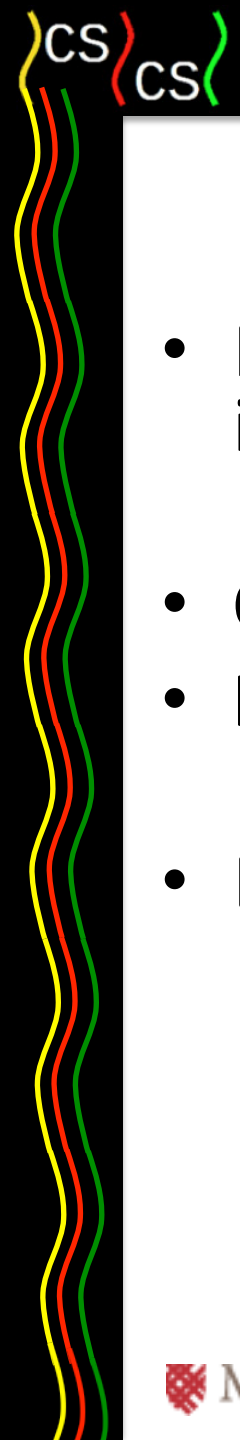
- Distributed computing empowers exciting new web services

http://cloudcomputingadvices.com/wp-content/uploads/2012/08/cloud_computing-Features.jpg

MACALESTER COLLEGE

ST·OLAF COLLEGE

Striking out against new PDC technologies

Strike 3: **Heterogeneous computation**

(It's not just for HPC anymore)

- Commodity chips with multiple core types
  - Intel vector cores; AMD GPU + CPU cores
- Multicore and heterogeneous multicore as distributed/cluster computing nodes

MACALESTER COLLEGE

ST·OLAF COLLEGE

Educating students for their careers

- Parallelism and concurrency traditionally taught in Architecture and Operating Systems
  - **Still necessary, but no longer sufficient**
- **Commodity computing**, not just HPC research
- **Hardware *and* software** evolving rapidly
  - Including languages, libraries, frameworks
- Emerging **curriculum recommendations**
  - ACM/IEEE CS2013, for undergraduate CS majors
  - TCPP recommendations for PDC

MACALESTER COLLEGE

ST·OLAF COLLEGE

Educating students for their careers

- Parallelism and concurrency traditionally taught in Architecture and Operating Systems
  - **Still necessary, but no longer sufficient**
- **Commodity computing**, not just HPC research
- **Hardware** *and* **software** evolving rapidly
  - Including languages, libraries, frameworks
- Emerging **curriculum recommendations**
  - ACM/IEEE CS2013, for undergraduate CS majors
  - TCPP recommendations for PDC

… Rapid curricular change??

The CSinParallel strategy

1. Brief, flexible PDC teaching modules

- Almost any course, at almost any level

- 1- to 3-day course units, for feasible incremental modifications to a syllabus

- Broad variety of topics, technologies, languages, etc.

- Adaptable/editable for local modification

- Emphasis on hands-on exercises with current technologies

- Learning objectives, teaching tips, etc.

MACALESTER COLLEGE

ST·OLAF COLLEGE

The CSinParallel strategy

2. Pedagogical effectiveness

- **Small interventions, big impact**
  - Opportunities for <u>broad exposure</u> to PDC
- Effective **hands-on learning** with PDC tools
- **Spiral approach**
  - Recurring topics in multiple contexts leads to better retention and <u>deeper understanding</u>
- Early and often
  - Delivered message: **PDC is natural, pervasive in CS**

MACALESTER COLLEGE

ST · OLAF COLLEGE

The CSinParallel strategy

3. Community of folks seeking to teach PDC

- **Community support**
  - Communicating with others trying same things (modules, institution types, courses, techs,…)
  - Resources for recording others' past experiences (e.g., Piazza, teaching tips)

Creating community/human networking is the primary goal for this workshop event

MACALESTER COLLEGE

ST·OLAF COLLEGE

Some strategic resources

- **Platform resources**
  - Example: _WebMapReduce (WMR)_, for beginning or advanced students to learn about scalable computations that fuel cloud-powered services
  - Example: Intel _Manycore Testing Lab (MTL)_, free educational access to 40-core computers
- **Students helping** profs, other students
  - Scalable collaborative resource
  - Student capacity for **exploring new technologies**

MACALESTER COLLEGE

ST·OLAF COLLEGE

Some strategic resources

- **Basic CSinParallel modules**
  - Examples: WMR for CS1; Multicore Programming (intro); Concurrent Data Structures (C++ or Java); Parallel Sorting

- **"Exemplar" modules**
  - Present a significant domain application (e.g., drug design, epidemiology, traffic flow) together with a sequential implementation
  - Choice of parallel/distributed implementations
  - Pedagogical possibilities **+** student motivation

- **"Taste" modules**
  - Brief introductory experience of a new technology, or parallel language, larger educational work, etc., pointing to the original source for further explorations

MACALESTER COLLEGE

ST·OLAF COLLEGE

Some strategic resources

- Relating local courses and CSinParallel materials to **emerging curriculum recommendations** (CS2013, TCPP)

- **Parallel Programming Patterns**
  - Recurring design strategies for parallel programs, distilled from practices of experienced pros
  - Guides to problem solving and parallel thinking for undergraduate learners of PDC

MACALESTER COLLEGE

ST·OLAF COLLEGE

This workshop

- **Planned, but not a fixed program, since your interests should drive this workshop**

Overview of schedule:

Tues. morning	Intro to CSinParallel (✔); overview of PDC; modules and resources
Tues. afternoon	1. *What participants want 2. Breakout sessions by interests
Wed. morning	The new CS curriculum reports
Wed. lunch	How shall we proceed?

MACALESTER COLLEGE

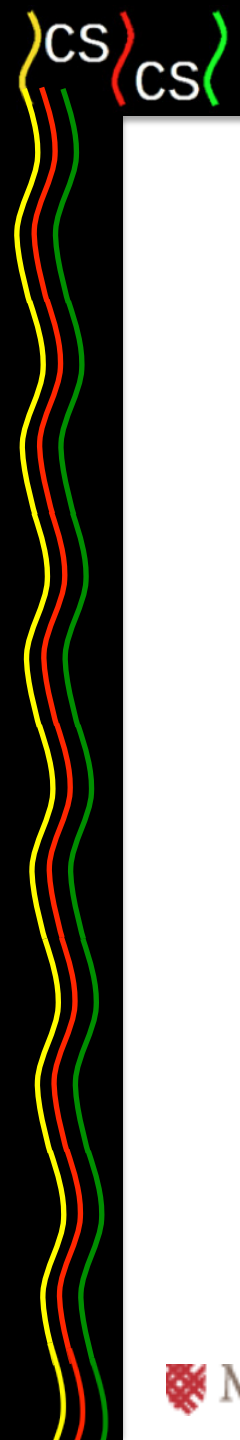ST · OLAF COLLEGE

The BIG challenge

How can we form a supportive community that **benefits professors more than it "costs"**

What are the "costs"?

- **Learning new systems** (e.g., piazza)
- **Competition for time** during the term
- Weight of **inertia against change**

MACALESTER COLLEGE

ST· OLAF COLLEGE

Recap

- Hardware and software parallel and distributed computing (PDC) technologies are **evolving rapidly, with no end in sight**
  - Multicore; cloud/distributed; *heterogenous*
- **Students need to know about PDC** as they enter the workforce.
- *CSinParallel offers modules, resources, and strategies for teaching PDC, in a context of* ***supportive community***
- Biggest unsolved problem:
  Creating a support community worth the effort

MACALESTER COLLEGE

ST·OLAF COLLEGE

Questions?

MACALESTER COLLEGE

ST · OLAF COLLEGE