Bootable Cluster CD
Cascadia 2011

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Questions (and answers)

- Intel Corporation
- Supercomputing Conference
- Earlham College
- Shodor Foundation
- Contra Costa College

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AUFS Another Union FileSystem

BCCD Bootable Cluster CD (not just for CDs anymore!)

CUDA Compute Unified Device Architecture

CSE Computational science education

DHCP Dynamic Host Configuration Protocol

GPGPU General Purpose computation on Graphics Processor Units

HPC High performance computing

MPI Message Passing Interface

STEM Science, Technology, Engineering, and Mathematics

What is the BCCD?

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Questions (and answers)

- A software tool for domain educators for teaching CSE
- A stable platform for the writing of curricula for CSE
- One part of a larger CSE community
  - Shodor Foundation
  - National Computational Sciences Institute (NCSI)
  - CSE Reference Desk (CSERD)
- "Teaching Parallelism Made Easy"

BCCD early history

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Questions (and answers)

- BCCDv1 – BCCDv2
  - Begun in 2003 by Paul Gray and students
  - Based on the LNX-BBC distribution
  - Custom build and packaging mechanism
  - Assumed to be live CD, fixed cluster difficult to configure

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Questions (and answers)

BCCD today

- BCCDv3
  - Work started in 2006 - Motivated by "liberation"
  - Debian-based
  - Standard Debian methods for build and configuration
  - Fixed clusters an assumed state for the BCCDv3
  - Backwards-compatible with BCCDv2
- Five current active developers
- Current work includes:
  - Automated test suite
  - Live upgrades
  - Accessibility

What is the problem?

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Questions (and answers)

- STEM education is becoming more important than ever [3]
- Computers are a large part of any science curriculum
- Early introduction of parallel & computational methods is critical
- Schools do not have the resources or expertise

What is the problem? (cont'd)

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Questions (and answers)

- Computer labs
  - (+) Visual
  - (-) Can't take it home
  - (-) Not all parallel paradigms available
  - (-) Not stable (reboots)
  - (-) Not predictable or uniform (what software is installed?)

What is the problem? (cont'd)

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Questions (and answers)

- Compute cluster (if one is available)
  - (+) Generally most parallel paradigms available
  - (+) Relatively stable & uniform
  - (-) Job scheduler interferes with immediate, visual results
  - (-) Primarily (often completely) for research, not education
  - (-) Can't take it home

How is BCCD an answer?

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Questions (and answers)

- Live CD (or USB or VM) - runs in a computer lab environment
- No need to be a sysadmin
  - Networking is automatic and non–disruptive
  - Clustering tools pre–configured (MPI, OpenMP, Torque, etc.)
- Visualization easy because every system has a GUI
- Can be taken home or back to class

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Questions (and answers)

General usage of the BCCD

- Change out software packages with `Modules`
- Copy data to all BCCD nodes with `bccd-sync-dir`
- Liberation

  Make BCCD permanent using "liberation"

  Post-liberation, `bccd-reset-network` will setup a diskless cluster

Parallel methods BCCD can use

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Questions (and answers)

- Embarrassingly parallel - just use `bccd-syncdir` and `ssh`
- Shared memory (pthreads, OpenMP)
- Message passing (OpenMPI)
- GPGPU (CUDA, OpenCL in the future)
- Hybrid methods
  - Combinations of shared memory & message passing
  - Or combinations of message passing & GPGPU
  - Etc.

Visualizations with the BCCD

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Questions (and answers)

- GalaxSee
  - N-body simulation of galaxy formation
  - Uses MPI for communication
- Parameter Space
  - Monte Carlo simulation of dart throwing
  - Uses MPI for communication
- Life
  - Cellular automata simulation
  - Can use serial, OpenMP, or MPI

Nitty-gritty details of BCCD

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Questions (and answers)

- Live CD and diskless nodes use AUFS

  Read/write branch stored in RAM

- Live CD uses cloop back–end (from KNOPPIX)
- DHCP lock–down is accomplished by using custom options
- Node auto–detection uses custom "pkbcast"

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Questions (and answers)

- Solution for people who don't want to build their own cluster [2]
- BCCD designed to run on LittleFe
- Designed to be portable
- Hardware
  - 6x dual-core Intel Atom boards
  - NVIDIA/CUDA support
  - Ethernet switch
  - AC/DC power supply
  - Custom aluminum case

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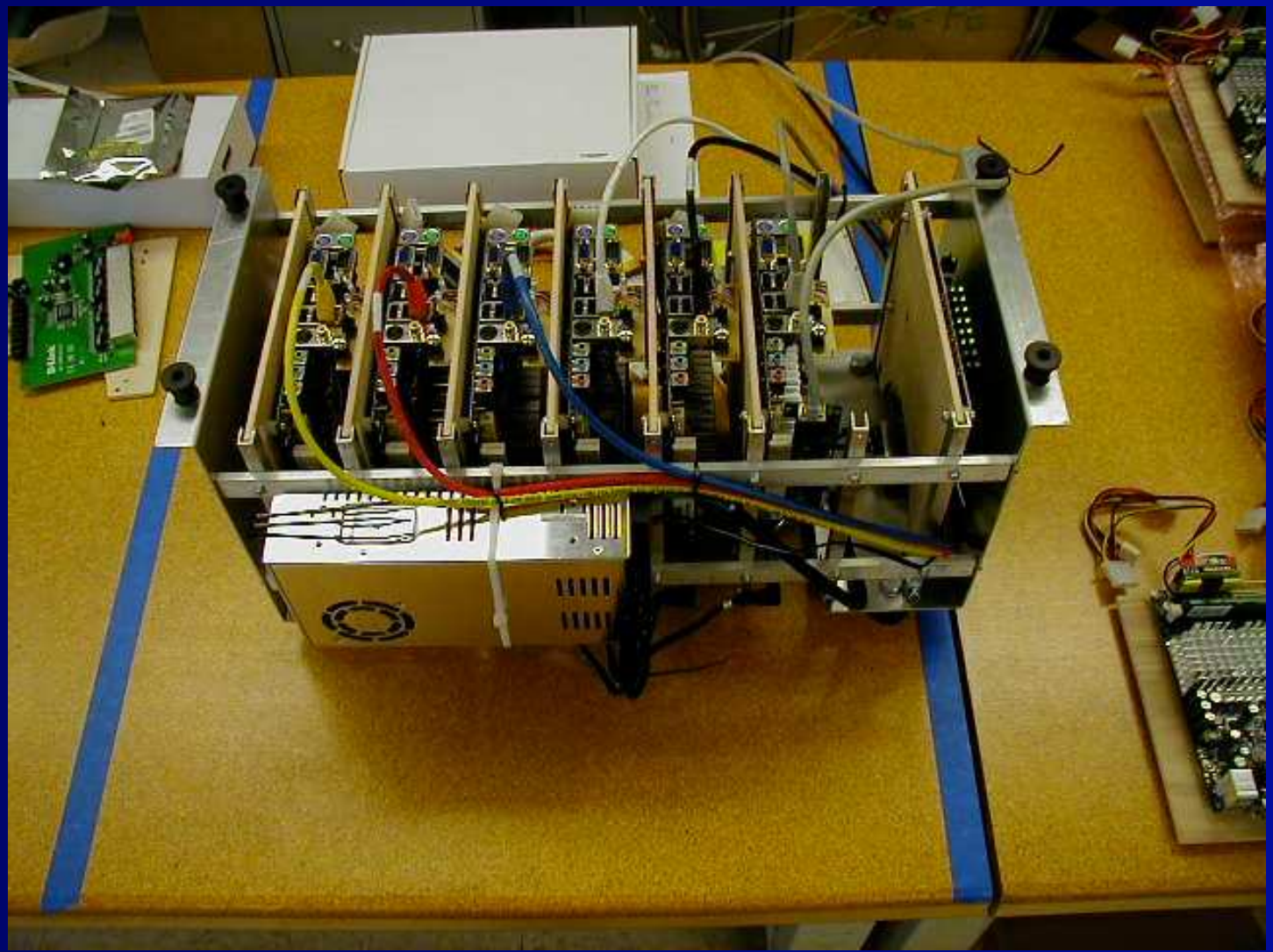

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Questions (and answers)

- BCCD
  - Main website: `http://bccd.net`
  - Email: `bccd-developers` *at* `bccd.net`
- LittleFe
  - Main website: `http://littlefe.net`
  - Email: `littlefe` *at* `cs.earlham.edu`
  - Build–out event: `http://littlefe.net/buildout`
- *Teaching high performance computing to undergraduate faculty and undergraduate students* [1]
  - Teragrid 2010 Best Paper in Education
  - Available to ACM members

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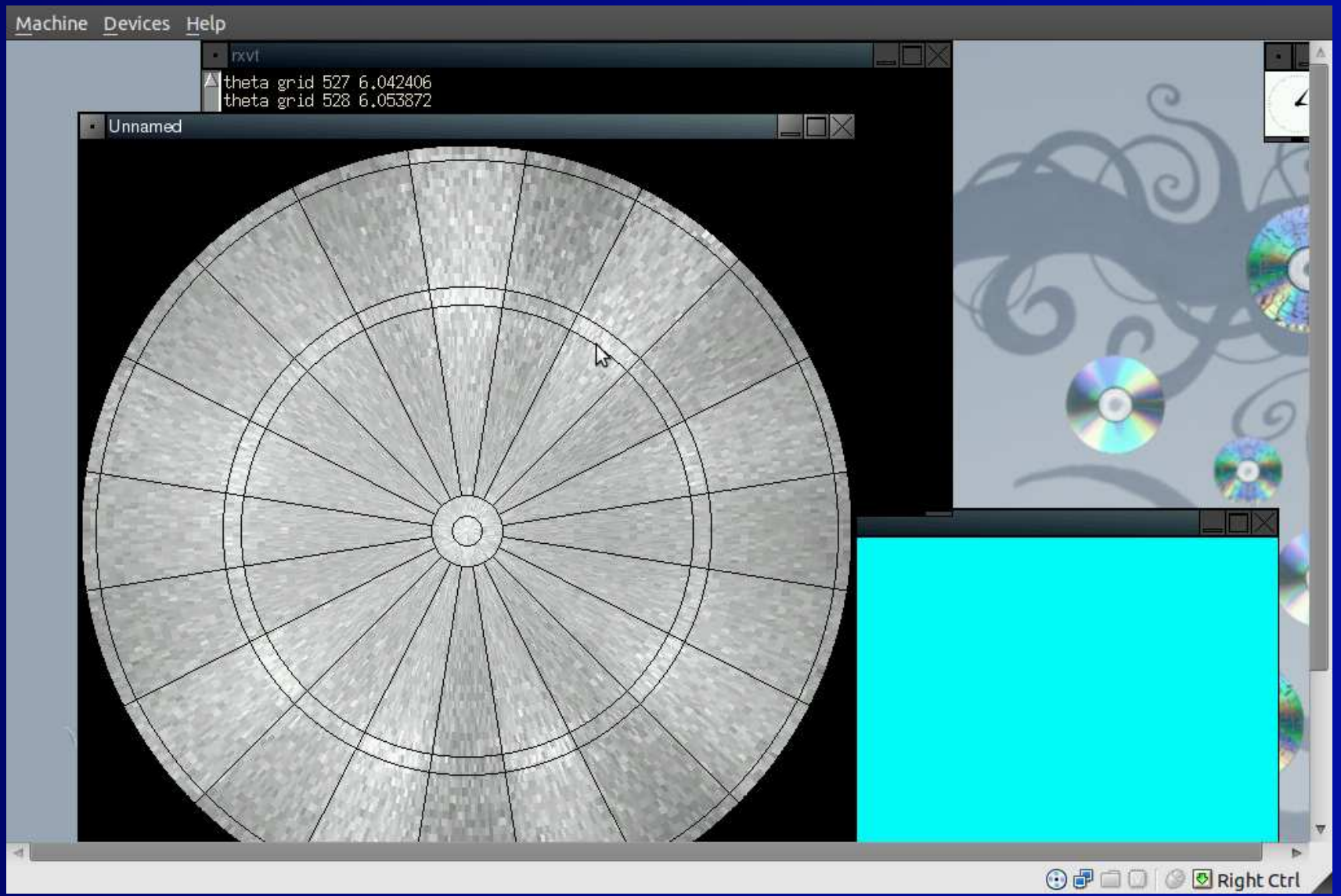

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[1] Andrew Fitz Gibbon, David A. Joiner, Henry Neeman, Charles Peck, and Skylar Thompson. Teaching high performance computing to undergraduate faculty and undergraduate students. In *Proceedings of the 2010 TeraGrid Conference*, TG '10, pages 7:1–7:7, New York, NY, USA, 2010. ACM.

[2] Tom Murphy, Charlie Peck, and Paul Gray. Little-fe: A portable, educational pc cluster. *HPC Wire*, 14(42), October 2005.

[3] Jeannette M. Wing. Computational thinking. *Commun. ACM*, 49:33–35, March 2006.

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