Budget Beowulfs: A Showcase of Inexpensive Clusters for Teaching PDC

Joel Adams, Calvin College (Organizer)

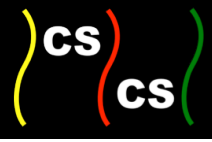
Jacob Caswell, St. Olaf College

Suzanne Matthews, West Point

Charles Peck, Earlham College

Elizabeth Shoop, Macalester College

David Toth, Centre College



Session Overview

1. Lightning talks by presenters (~25 min.)
2. "Panel format" all-group Q&A (~25 min.)
3. "Poster format" show-and-tell (~25 min.)

Materials for this session are available at:

http://csinparallel.org/

Participants in this Session

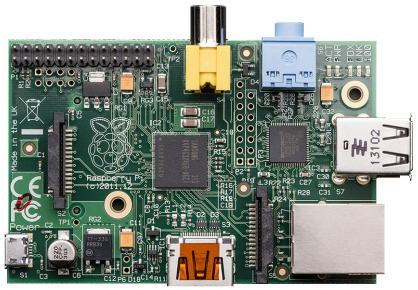
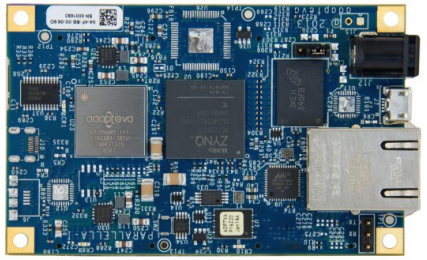
Participant	Cluster(s)	Base System	# Nodes	Price
Suzanne Matthews West Point	*StudentPi* *StudentParallella*	Raspberry Pi Parallella	4 4	$240 $650
Jacob Caswell St. Olaf College	*Pi'sToGo*	Raspberry Pi 2	5	$300
David Toth Centre College	*HSC-1* *HSC-2*	CubieBoard2 ODROID-U3	2 2	$198 $211
Libby Shoop Macalester College	*Rosie*	Nvidia Jetson TK-1	6	$1350
Charlie Peck Earlham College	*LittleFe*	Intel Celeron	6	$2500 (free)*
YOU!				

Student Pi and Student Parallella Clusters

Suzanne J. Matthews

West Point

System On A Board

	Raspberry Pi	Parallella
CPU	1 700Mhz CPU	1 GHz dual-core CPU, 16-core co-processor
RAM	512 MB	1 GB
Disk	4 GB+ Flash Card	8GB+ µSD card
Cost	$39.95/board ~$60 = power supply + SD card + cables	~$160.00/board Includes power supply + heat-sink SD card + cables: ~ +$10
Image		

Student Cluster Overview

Cluster Name	Student Pi	Student Parallella
Nodes	4	4
Interconnect	100 Mbps Ethernet	Gigabit Ethernet
Total Cores	4	72
Total RAM	2 GB	4 GB
Cost	~ $240 ($60 p/core)	~$680 ($10 p/core)
Image		

Uses (Curriculum)

- New parallel computing course (Spring ’15) – CS485
- New computer organization course (Fall ‘15) – CS380
- Use for:
  - Parallella:
    - Single board: Pthreads, OpenMP, MPI, Co-processor
    - Cluster: CS485 “Build a Cluster” Lab
    - TBD: CS485 projects(?)
  - Raspberry Pi:
    - Single board (Raspberry Pi 2): CS380
    - Cluster (Raspberry Pi 2) : CS380
    - Variant Cluster: Independent Study (20 nodes, wireless);

Summary

- Setup tutorials, case STL files, and pre-configured master node images at: http://www.suzannejmatthews.com/private/cluster.html

- The future: Raspberry Pi 2 clusters!
  - Each board now has 4 cores
  - How does it compare to Parallella cluster?
  - Can share updated master images if anyone is interested…

Pi‘sToGo

Jacob Caswell

St. Olaf College

Design

- Passively Cooled
- Commodity Parts
- Travel Ready
- “Layers of Familiarity”
  1. Like a Laptop
  2. Actually a Cluster
  3. Inner workings of the Cluster

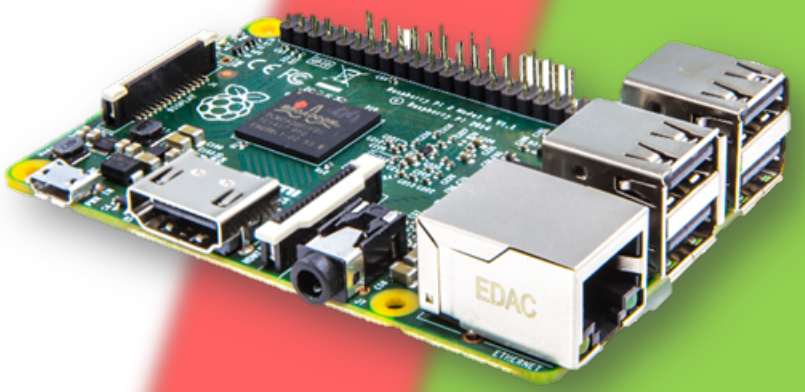
Cluster Overview

- < $500 *
- 5 Nodes
- 5-20 Cores
- 10/100Mbps
- 2.5-5 GB of RAM
- Self-Contained

*$170 Screen, keyboard, and $50 case included

System On A Board: Raspberry Pi 2

- "6X Faster"
- 1 GB RAM
- $35 Per Board
- Quad Core @ 1GHz

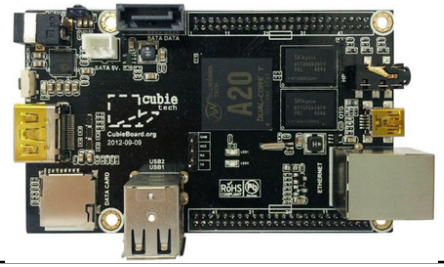
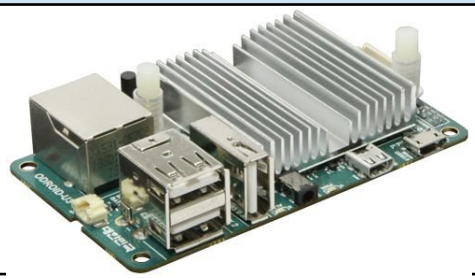
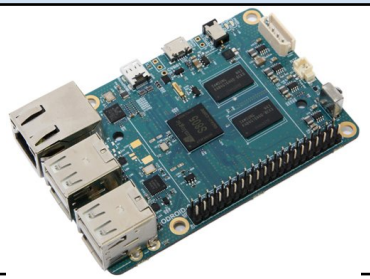


Half Shoebox Clusters (HSC-1 and HSC-2)

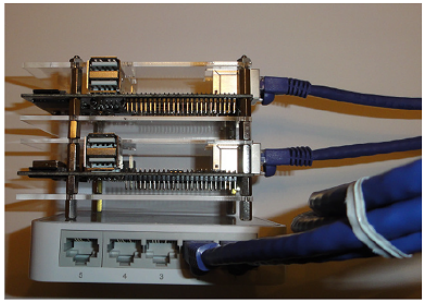
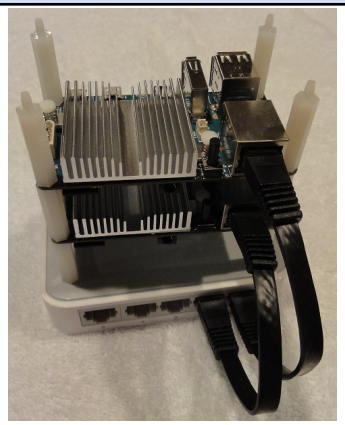
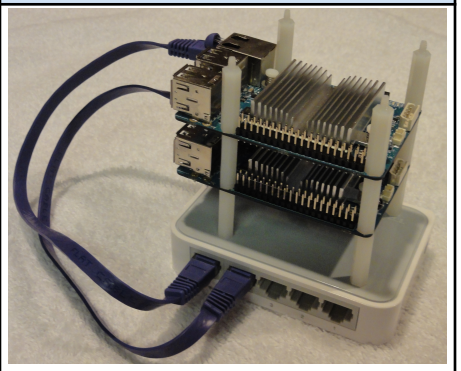
Dave Toth

Centre College

System On A Board

	Cubieboard2	Odroid U3	Odroid C1
CPU	1 GHz dual-core	1.7 GHz quad-core	1.5 GHz quad-core
RAM	1 GB	2 GB	1 GB
Disk	4 GB Nand flash – supports µSD card	None – supports µSD card or eMMC card	None – supports µSD card or eMMC card
Cost	$64.50/board $72.45 includes power supply (there's no heat sink)	$74.95/board $80.90 includes power supply (heat sink included w/ board)	$36.95/board $46.85 includes power supply & heat sink
Image			

Cluster Overview

Board	Cubieboard2	Odroid U3	Odroid C1
Nodes	2	2	2
Interconnect	100 Mbps Ethernet	100 Mbps Ethernet	1000 Mbps Ethernet
Total Cores	4	8	8
Total RAM	2 GB	4 GB	2 GB
Cost	~ $200		~ $150
Image			

Uses (Curriculum)

- Postponed first use (UMW→Centre)
- New parallel computing course (Fall '15)
  - CSC 350 Parallel Computing
- Use for
  - Learning OpenMP, MPI, hybrid
  - Course project
    - Solve embarrassingly parallel problem (TSP)
    - Compare performance (sequential, OpenMP, MPI)
    - Compare energy consumption & time to solve vs. x86/x64

Summary

- Two quad-core nodes w/1 GB RAM each & Gigabit Ethernet for ~$150

- Pre-configured images for all 3 clusters at http://davetoth.com/portablecluster/index.html

- Want to help me write basic free textbook to keep student costs down?

LittleFe

Charlie Peck

Earlham College

What is LittleFe?

- 6 node/24 core/24GB RAM/320GB disc computational cluster
- Portable, less than 50lbs packed in a rugged case
- Inexpensive (about $2,000USD)
- Low friction, uses the Bootable Cluster CD distribution and a single system image
- Supports shared memory, distributed memory, GPGPU and hybrid based parallel models
- Open hardware design and software stack; frame kits and complete units also available

Hardware Manifest - LittleFe v4d (circa spring 2015)

- 6 - ASRock mainboard with Intel Celeron 4 core CPU (DX-11 graphics), 4GB RAM
- 1 - 320GB 7200RPM 32MB cache 2.5" form-factor SATA disk drive
- 1 - 8-port GB Ethernet switch
- 1 - PCI-E WiFi adapter
- 1 - PB-360P-12 switching transformer with power correction
- 1 - Custom frame
- 1 - Pelican 1610 Case

Use Cases for LittleFe/BCCD

- About 100+ units in the field, almost all in the USA (Canada, China, Australia)
- Curriculum modules baked-in to the BCCD (GalaxSee, Pandemic, ParamSpace and many more)
- Outreach and broadening engagement appliance
- On-ramp to XSEDE and other national resources
- 10th anniversary in 2014, now a project of Earlham College and the Shodor Education Foundation

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