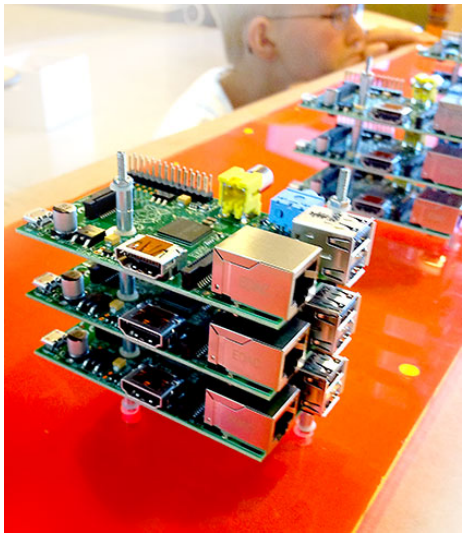
Build Your Own Raspberry Pi Cluster



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Abstract

Right now, there are few courses on parallel programming even at the undergraduate level, but the basic concepts aren't difficult. We want to get those concepts out to students in an accessible way by helping people build and use small supercomputers. We'll show you how to put together a Linux cluster using 4 Raspberry Pis, including hardware assembly, networking, and user account management. The cluster will be a working model of a supercomputer and able to run the same parallel applications (at a smaller scale), which we'll do in the workshop. Our experience with Raspberry Pis is also tied to visualization, and there will be displays available for each Pi, to demonstrate developing distributed video games and other graphical applications. At the end, you'll keep the cluster, to take back to your students and let them start creating the next parallel algorithm.

Note

This workshop requires a materials fee of approximately $250 for the Raspberry Pis, network switch, etc., that the attendees will take with them. These items will be packaged in a small box that will fit into a suitcase for travel.

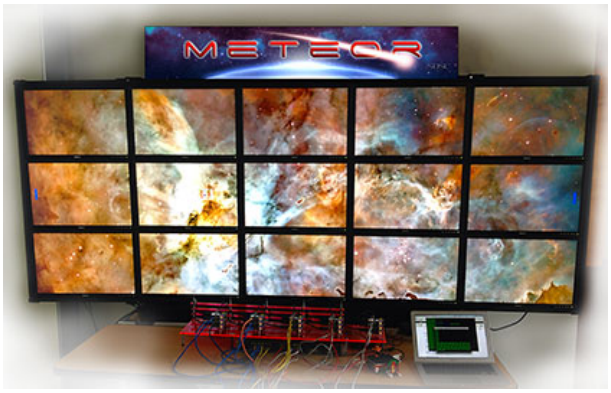
Background

For the last few years, Rick Wagner has been working with undergraduates at the University of California, San Diego introducing them to parallel and distributed computing using Raspberry Pis[1]. This experience is easily adaptable to the high school setting, so long as the students have some help getting over the technical hurdles, like network configuration and setting up an environment to run libraries such as the Message Passing Interface[2]. From there, students can learn to build networked applications like chat clients, model a 3-tier client-logic-storage web

[1] http://cacm.acm.org/careers/169669-sdsc-uses-raspberry-pi-cluster-to-teach-parallel-computing/fulltext

[2] https://en.wikipedia.org/wiki/Message_Passing_Interface

architecture, or run fluid dynamics simulations. The purpose of the workshop is to show the teachers how to set up the cluster, and then spend some time running parallel applications.



A big part of the work at UCSD has used a tiled display wall (multiple LCD panels arranged in a grid) to draw students in. Each display is connected to a single Raspberry Pi, and the display can show what each Pi is doing. This helps the students build a conceptual model around what each part of the cluster—Pi, network, power, display—is doing. It also lets students develop video games and other graphics programs that are fun and challenging. We will bring enough LCD panels to the workshop so that as many attendees as possible can attach four to their cluster to test some of the example applications we'll share.

Topics

- The importance of parallel programming and high performance computing (e.g., the National Strategic Computing Initiative[3])
- Introduction to parallel programming in research: models and tools
- What is a Linux cluster?
- An overview of the Raspberry Pi, the project, the hardware, and the community
- Basic network configuration
- Using SSH
- Running parallel applications using MPI
- How to architect a simple distributed graphics application

Relevance

On their own, Raspberry Pis are a great resource for many types of classes. They can be used for programming, robotics, or electronics. The Pis low cost and small size also make them more accessible for many students. Beyond this, creating a cluster of Raspberry Pis opens up a new area, one where students begin to think about how to take advantage of multiple threads of execution on separate processors, or to break up the workload onto several computers. This is what professionals at the technology giants (Google, Microsoft, Amazon, etc.) are doing all the time, along with scientists modeling earthquakes or stars.

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[3] https://www.whitehouse.gov/the-press-office/2015/07/29/executive-order-creating-national-strategic-computing-initiative

Handouts

The course materials (presentations, software, etc.) will be hosted online, and a copy of will be placed on the Raspberry Pis' storage for reference. A minimal set of handouts will be used to help the attendees get started.

As described earlier, the clusters (minus the LCD panels) are something the attendees will take with them. This will include:

- power supplies;
- network switch;
- network cables;
- 4 Raspberry Pis;
- 4 SD cards.

A box will be provided to hold the materials. There are a several examples online of what these look like when assembled.[4]

[4] http://makezine.com/projects/build-a-compact-4-node-raspberry-pi-cluster/