Teaching HPC with a small Raspberry Pi Cluster

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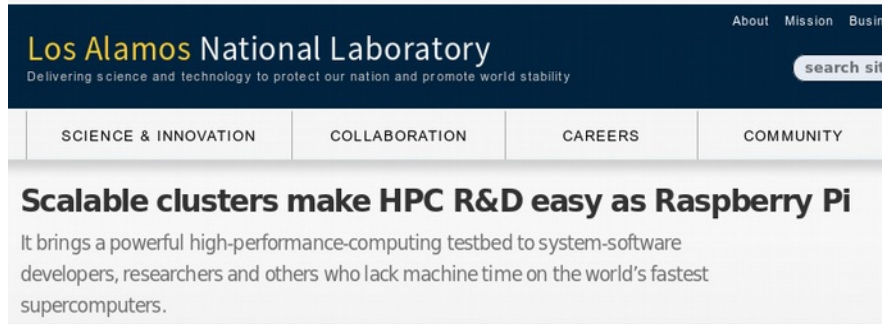
Research Software Engineer
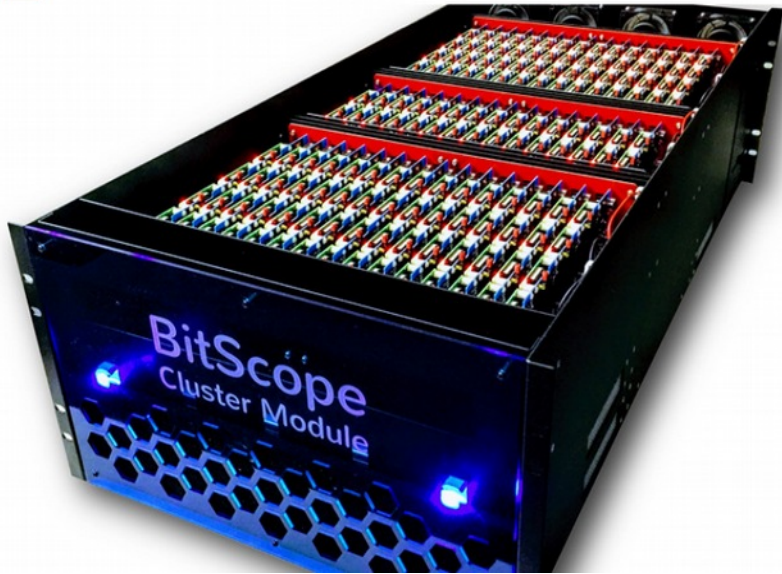Super Computing Wales Project
Aberystwyth University

Overview

- Inspirations

- Why teach HPC with Raspberry Pi?

- My Raspberry Pi cluster

- Experiences from teaching

- Future Work

Inspiration #1: Los Alamos National Laboratory

Los Alamos National Laboratory
Delivering science and technology to protect our nation and promote world stability

SCIENCE & INNOVATION   COLLABORATION   CAREERS   COMMUNITY

Scalable clusters make HPC R&D easy as Raspberry Pi

It brings a powerful high-performance-computing testbed to system-software developers, researchers and others who lack machine time on the world's fastest supercomputers.
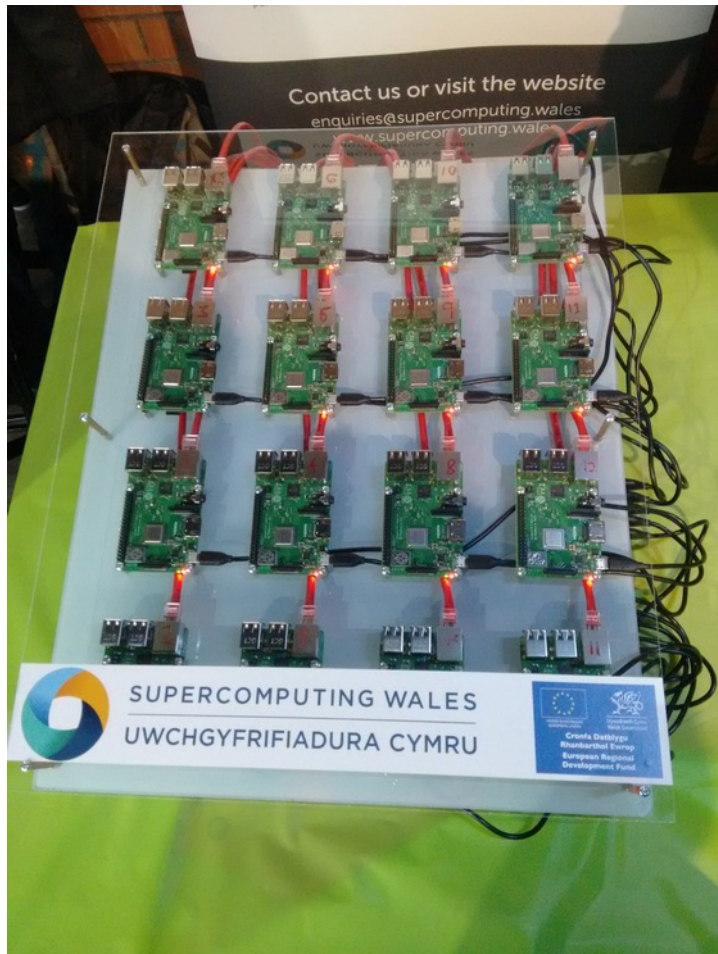
November 13, 2017

- 750 node cluster

- Test system for software development

- Avoid tying up the real cluster

Inspiration #2: Wee Archie/Archlet

- EPCC's Raspberry Pi Cluster
- Archie: 18x Raspberry Pi 2's (4 cores each)
- Archlet: smaller 4 or 5 node clusters.
- Used for outreach demos.
- Setup instructions: https://github.com/EPCCed/wee_archlet

Image from
https://raw.githubusercontent.com/EPCCed/wee_archlet/master/images/IMG_20170210_132818620.jpg

Inspiration #3: Swansea's Raspberry Pi Cluster

- 16x Raspberry Pi 3s

- CFD demo using a Kinect sensor

- Demoed at the Swansea Festival of Science last year

- More about this in Ed Bennett's talk on 12pm tomorrow

Why Teach with a Raspberry Pi cluster?

- Avoid loading real clusters doing actual research
  - Less fear from learners that they might break something
- Resource limits more apparent
- More control over the environment
- Hardware less abstract
- No need to have accounts on a real HPC

My Cluster

- "Tweety Pi"
  - 10x Raspberry Pi model B version 1s
  - 1x Raspberry Pi 3 as head/login node
  - Raspbian Stretch
  - Slurm job manager
- Head node acts as WiFi access point
  - Internet via phone or laptop
- Used a British Science Week 2019
  - Simple Pi with Monte Carlo methods demo

Teaching Materials

- Based on Introduction to HPC with Super Computing Wales carpentry style lesson:
  - What is an HPC?
  - Logging in
  - Filesystems and transferring data
  - Submitting/monitoring jobs with Slurm
  - Profiling
  - Parallelising code, Amdahl's law
  - MPI
  - HPC Best Practice

Experiences from Teaching

- Ran two courses, part of STFC summer school
- 15 people each time
  - 1st time using HPC for many
  - Most had some Unix experience
- Subset of Super Computing Wales introduction to HPC carpentry lesson
- Slurm issues during first workshop
- Worries about WiFi

Technical Problems

- Compute nodes run root filesystem over NFS from the head node
- Created accounts on the head node
- Copied /etc/passwd to the NFS share
- Original files were different, extra Slurm related system user on the nodes
- Broke Slurm :(
- Fixed for second group

Feedback

- Very Positive
- A lot seemed to enjoy playing around with SSH/SCP
    - First time using a remote shell for some
    - Others more adventurous than they might have been on a real HPC
- Main complaint was lack of time (only 1.5 hours)
    - Only got as far as covering basic job submission
    - Quick theoretical run through of MPI and Amdahl's law
    - Probably have 3-4 hours of material
- Queuing became very apparent
    - 10 nodes, 15 users
    - "watch squeue" running on screen during practical parts

Future Work

- More complete setup instructions (link on next slide)

- Script based install

- CentOS/Open HPC stack instead of Raspbian

- Use for full intro to SCW course

  - Hybrid of Raspberry Pi and real cluster

- Public engagement demo which focuses on our research

  - Analysing satellite imagery

  - Simulate the monsters from MonsterLab (https://monster-lab.org/)

More Information

- My setup instructions - https://github.com/colinsauze/pi_cluster
- Teaching material - https://github.com/SCW-Aberystwyth/Introduction-to-HPC-with-RaspberryPi
- Email me: cos@aber.ac.uk