ECE 574 – Cluster Computing
Lecture 21

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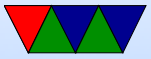
19 November 2015

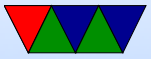
Announcements

- Don't forget Project updates



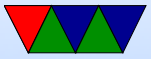
Supercomputing Recap

- OpenACC
- PMPI? MPI profiling
- NVIDIA releasing open-source CUDA compiler in March 2016
- Top500 BoF
- Lustre BoF



Cluster Computing Power

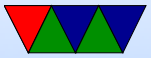
Can spend a whole class (i.e. ECE571) discussing where power goes in a modern computing system.



Go over Paper/Assignment

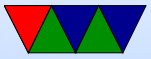
Design and Analysis of a 32-bit Embedded High-Performance Cluster Optimized for Energy and Performance

- Presented this at last supercomputing. Actually has been cited a few times.
- Some of the measurements are slightly out of date, should be re-run with OpenBLAS
- Co-authors are former ECE students

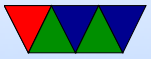


Changes since that paper has been written

Raspberry Pi-2, 1.4GFLOPs/ roughly 2.5W, so 400MFLOPS/W, is much better than other machines. *but* that is measured at wall outlet, with ATLAS, so some power conversion inefficiencies and other reasons not a fair comparison.

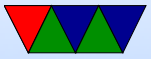


Pi-cluster Power



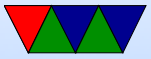
Green500

- Green 500 list
- Push for more accurate power reporting in the Top500 list
- Top, Riken, 7GFLOPS/W. #10 is 3GFLOPS/W. Tail end are regular x86 machines with NVIDIA cards and 10GBPs ethernet.



SuperComputer Power

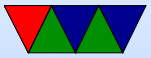
- Cooling
- DVFS
- Power-capping



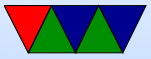
Power-Capping

Power Capping: a Prelude to Power Shifting by Lefurgy Wang, and Ware

- Traditionally you have to design for the "worst-case" thermal and power behavior
- Often this will leave some resources underutilized "over-provisioned"
- Power-capping – let you design cheaper power/thermal setup, and if the CPU detects it is getting too hot/too

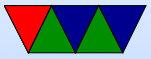


much power automatically slows things down



Measuring Power and Energy

- Sense resistor or Hall Effect sensor gives you the current
- Sense resistor is small resistor. Measure voltage drop. Current V=IR Ohm's Law, so V/R=I
- Voltage drops are often small (why?) so you made need to amplify with instrumentation amplifier
- Then you need to measure with A/D converter
- $P = IV$ and you know the voltage



- How to get Energy from Power?