Next Generation Computing
Supercomputing Challenge Kickoff
Oct 11-12, NM Tech, Socorro, NM

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LA-UR-14-27945
Topics

• Cloud Supercomputing
  – Mobile

• GPU Computing
  – IOS, Android
  – Hobbyist devices – Jetson TK1, Parallella

• MIC – Intel accelerator
Why these topics?

• To help you develop skills that will be in high demand
• Previous years we focused on parallel computing – it has been expanded to include a wider array of new technologies
• Lay out skill path needed
• How do you start?
Cloud Supercomputing

Weather simulation is a prototypical example. Data is gathered from many distributed sources and fed into cloud servers. Then a simulation is run on a supercomputer. Lastly the weather is distributed via mobile and web.

Another example is waze.com, a traffic app that gathers data from mobile devices and recalculates best routes based on traffic and accident data that is input from other people. What are the possible components?

• Distributed data collection
• Large network
• "Cloud" database on large server farm
• Supercomputer
• Data dissemination and local compute
Cloud Supercomputing Exercise

Pick a favorite application.

• What components of cloud supercomputing are used in this application?

• Could some of the other elements be used to enhance the application?

• Where is the computing done and why?
Mobile Computing

- Use an Internet-connected smartphone to provide and gather data anywhere
- Phones will often include networking, gyroscopes, GPS, two cameras, microphone, accelerometer, compass, light sensor, pressure sensor
Apple/iOS

- Free software development kit (SDK) and emulator on a Mac
- $100/yr Developer Account (necessary for deploying on a device)
- Only one programming language, Objective C (but being replaced by Swift)
- Uses Storyboarding to build app
Mac Xcode Storyboard
Android

• Free SDK and emulator for Mac, PC, or Linux: http://developer.android.com/sdk/index.html
• Free deployment on devices (sideloading)
• Plethora of programming languages
  – Java via official SDKs: http://developer.android.com/training/basics/firstapp/
  – Python: http://kivy.org/
  – BASIC (http://laughton.com/basic/)
Android Storyboarding

Add an activity to Mobile

- Add No Activity
- Blank Activity
- Blank Activity with Fragment
- Fullscreen Activity
- Google Maps Activity
- Google Play Services Activity
- Login Activity
- Master/Detail Flow
- Navigation Drawer Activity
- Settings Activity

Finish
Cross-platform -- PhoneGap

**Mobile communications in education**

Canadian school district strengthens communications between parents, schools, and teachers with cross-platform mobile app built with Adobe PhoneGap Parents of the 70,000 elementary and high school...

**Software Developer Wunderkind Opt for PhoneGap, All the Cool Kids are Doing It!**

Should we be worried that a nine-year-old can explain how to interface with the 31-pin sync port, or that he's got an opinion on Objective-C? Nah. Especially when the software development...

**Big data on small screens**

International initiative broadens access to survey data, using Adobe PhoneGap to rapidly deliver data visualization and mapping app across mobile devices Since its inception in 1984, the MEASURE...
Cross-platform -- Titanium

• Produces native looking apps on each device
  – http://www.smashingmagazine.com/2014/03/10/4-ways-build-mobile-application-part4-appcelerator-titanium/

• Many others are being announced
Non-programming Mobile Apps

- SC Kickoff Conference App was created using Yapp (yapp.us)
- Many others exist or are being announced
Parallel Computing

- Shallow-water simulation demo from ~2008 kickoff originated McCurdy High School project (Joseph Koby, Sarah Armstrong, Juan-Antonio Vigil, Vanessa Trujillo)
  - Morphed into adaptive mesh refinement co-design application CLAMR at http://www.github.com/losalamos, contributions by Dennis Trujillo, McCurdy
  - CLAMR runs on CPUs, GPUs, MICs
CLAMR Demo
Parallel Computing
Global Sums

• Dealt with different sum results depending on number of processors
• Finite precision arithmetic not associative
• Enhanced Precision Sums
  – Used Sapient, a Supercomputing Challenge project, by Jon Robey and published in Parallel Computing journal
Parallel Computing

Hashing

- Sorting exercise – pair off and everyone compare last names. Sort alphabetically and if < move left; > move right. Repeat with next person until room is sorted. Compare time it takes versus setting out letters alphabetically across room and everyone go to their letter

Perfect Hashing

- Developed in part by Rachel Robey and published in SIAM Journal of Scientific Computing
- Done instead of a Supercomputing Challenge Project

Compact Hashing

- Developed in part by Peter Ahrens, Los Alamos and Sara Hartse, Desert Academy
- Near publication in SIAM Journal of Scientific Computing
GPU Computing: Why GPUs

GPU allocates more chip space to arithmetic operations (green) than the CPU.

Floating point operations and bandwidth are increasing faster on GPUs than CPUs.

“Processors” in blue are thread engines execute 32 threads each and there are many of these thread engines. (Tosaka, Wikimedia)
GPU Computing

- Massively parallel processing (speeding up computations), closer to your display (better/faster graphics)
- Best with NVIDIA graphics cards and the CUDA programming language
- Samples are included!
- Designed for use with C, C++, or FORTRAN
GPU Computing (cont.)

• Accessible from almost any programming language with some effort, but “bindings” (software interfaces) are available
  – Python
    • [http://mathema.tician.de/software/pycuda/](http://mathema.tician.de/software/pycuda/)

• Sample application execution
  – N-body simulation: [https://www.youtube.com/watch?v=WVd6DT2IQ1o](https://www.youtube.com/watch?v=WVd6DT2IQ1o)
  – Fluid motion: [https://www.youtube.com/watch?v=wwy7bcmDjGQ](https://www.youtube.com/watch?v=wwy7bcmDjGQ)
  – Mandelbrot: [https://www.youtube.com/watch?v=RaCPfXYQiRE](https://www.youtube.com/watch?v=RaCPfXYQiRE)
Other GPU languages

- OpenACC – being merged into OpenMP
- OpenCL – actually any device from multi-core to GPU to handheld
Jetson TK1

- An Nvidia Kepler GPU with 192 “cores” and a 4 core ARM CPU for less than $200.
- Modified Ubuntu OS and runs CUDA Applications
Jetson TK1 Demo

- Lets see some apps running on the Jetson TK1
Another hobbyist system is the parallellella board with 16-64 processors. It is a credit card size system (http://www.parallellella.org/board). Prices run from $120 to $250.
MIC (Intel Accelerator Board)

- Massively parallel processing (speeding up computations) in a format we are used to (compatibility with existing libraries and applications)
- Entry development can be done with multicore using MPI and/or OpenMP
- Knights Corner – on a expansion card on PCI bus
- Knights Landing – main chip will have 60+ cores
- New LANL/Sandia Supercomputer, Trinity, will use Knights Landing architecture