High Performance Parallel Computing *Bootcamp*

August 7-10 and 13-16, 2007

Sponsored by Virginia Tech and University of Virginia

At Research Computing Lab, Brown Library, University of Virginia

I feel the need, the need for speed - Tom Cruise in "Top Gun"

Instructors: Andrew Grimshaw, UVa and Nicholas Polys, VT

Purpose: The purpose of this course is to introduce the attendee to the basics of high-performance parallel computing and the national cyber-infrastructure. The course is targeted at graduate students, staff, and faculty with computational science and engineering problems that demand high performance. When successfully completed the attendee will know how to: 1) optimize sequential applications, 2) exploit high throughput computing opportunities, 3) use queuing systems such as PBS, 4) use existing high-end resources at UVA, Virginia Tech, and San Diego SuperComputing Center (SDSC), 5) write basic MPI and OpenMP applications, and 6) understand the opportunities and challenges of data visualization tools and display technologies.

Who Should Attend: Faculty, graduate students, and research staff with computational science and engineering problems that need high performance and those who want their programs to run faster, complete sooner, or tackle problems previously thought too computationally difficult.

Topics to be covered include:

- Performance measurement & optimization
- Parallel computer architectures and Flynn's taxonomy
  - Interconnection networks
  - Vector processors and Multiprocessors
  - Multicomputers and clusters
  - Tightly coupled MPP's
- Limits to parallelization.
- Embarrassingly (pleasingly parallel) applications – a.k.a. high-throughput computing, and the tools available.
- Data parallel applications, MPI (Message Passing Interface), and OpenMP
  - Simple stencil problems (e.g., explicit methods)
  - More complex irregular structures
- Graphics and visualization
  - Design effective visualizations
  - Manipulate heterogeneous data with common visual analytic tools
  - Produce visualizations for collaboration or publication

Pre-Requisites: It is expected that the participant know one or more of C, C++, or Fortran, as well as Unix basics such as editing, compiling, the file system, and simple scripts. A brief "Introduction to Unix" will be offered for those who might need it or want a refresher the week or so before this seminar begins.

Format: Morning lectures and afternoon hands-on computer exercises with multiple support staff present to assist participants. Free morning & afternoon snacks & boxed lunch will be provided.

High Performance Parallel Computing *Bootcamp*

August 7-10 and 13-16, 2007

Sponsored by Virginia Tech and University of Virginia

At Research Computing Lab, Brown Library, University of Virginia

(Continued)

Day-by-Day Seminar Outline

Day	Topic	Details
TBA, if needed	**Unix Basics taught at local campus**	This optional session will introduce Unix basics such as editing, makefiles, shell scripting, ssh, and the file system to attendees who are unfamiliar with Unix.
Tuesday, August 7	**Background**	Computer architecture basics - especially the cache. Sequential program optimization, performance profiles, etc. HW: Optimize a sequential program.
Wednesday, August 8	**Parallelism basics**	Parallel computer architectures, Flynn's taxonomy, message passing and shared memory machines. Styles of parallel programming from high-throughput to vector, problem decomposition. High-throughput examples from bioinformatics to movies. HW: High-throughput computing on UVA resources and teragrid resources. They can bring their own code or we will provide one.
Thursday, August 9	**Distributed Memory (DM) 1**	Basic architecture, scalability discussion, programming model, performance cost modeling & estimation. MPI basics (init, send, receive), and setting up an MPI job in the queue. HW: A simple MPI program such as rings.
Friday, August 10	**DM 2**	More MPI: scatter/gather, barrier, data layout, HALO. HW: HALO performance surface generation.
Monday, August 13	**DM 3**	Simple methods with MPI: matrix multiply, SOR, Gaussian elimination, sorting, etc. HW: Gaussian elimination
Tuesday, August 14	**Shared memory**	Shared memory lecture with a focus on limitations and programming model, e.g., threads. HW. Gaussian elimination using threads and/or OpenMP.
Wednesday, August 15	**Graphics & visualization**	Design effective visualizations, manipulate heterogeneous data with common visual analytic tools, and produce visualizations for collaboration or publication, Nicholas Polys, Virginia Tech
Thursday, August 16	**Field Trip to Va Tech Visualization facilities**	Experience first-hand the latest large-format and immersive display technologies.

The bootcamp is free to attendees. Financial assistance available for hotel accommodations if needed. SIGN UP by visiting:

http://www.itc.virginia.edu/research/vt-uva-hpc/bootcamp.html

Or contact:

At Va. Tech: Terry Herdman, Associate VP for Research Computing
Email: herd88@vt.edu or phone: 540-231-7667

At Univ. of Va: Tim Tolson, Manager, ITC Research Computing Support
Email: ttolson@virginia.edu or phone 434-243-6592