Cyberinfrastructure Resources at the State and National Level
Important Terms:

**Top500** - The TOP500 project ranks and details the 500 most powerful known computer systems in the world twice per year.

**HPL** - a measure of a system's floating point computing power measured by how fast a computer solves a dense N by N system of linear equations $Ax = b$.

**BLAS** - Basic Linear Algebra Subprograms (BLAS) is a de facto application programming interface standard for publishing libraries to perform basic linear algebra operations such as vector and matrix multiplication.

**FLOP/s** - Floating point operations (calculations) per second.

**Rpeak** – Theoretical performance of a system in an ideal world. This is calculated as:

\[ \text{Rpeak} = \text{# of Cores} \times \text{Core Clock} \times \text{FPIR (Number of ops per cycle)} = \text{FLOP/s} \]

My New Workstation: 6 cores * 2.8GHz * 4 floats/clock = 67.2 GFLOP/s

**Rmax** – Actual sustained performance of a system running HPL reported in FLOP/s

Typically 70-90% of the Rpeak number.
## Top500 List – Nov ‘09

<table>
<thead>
<tr>
<th>Rank</th>
<th>Rmax Peak (Tflops)</th>
<th>Name</th>
<th>Computer Processor cores</th>
<th>Vendor</th>
<th>Site Country, Year</th>
<th>Operating System</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1759.00 2331.00</td>
<td>Jaguar</td>
<td>Cray XT5 224162 (Opteron)</td>
<td>Cray</td>
<td>Oak Ridge National Laboratory United States, 2008</td>
<td>Linux (CLE)</td>
</tr>
<tr>
<td>2</td>
<td>1042.00 1375.78</td>
<td>Roadrunner</td>
<td>BladeCenter QS22/LS21 122400 (Cell/Opteron)</td>
<td>IBM</td>
<td>Los Alamos National Laboratory United States, 2008</td>
<td>Linux</td>
</tr>
<tr>
<td>3</td>
<td>831.70 1028.85</td>
<td>Kraken</td>
<td>Cray XT5 98928 (Opteron)</td>
<td>Cray</td>
<td>National Institute for Computational Sciences United States, 2008</td>
<td>Linux (CLE)</td>
</tr>
<tr>
<td>4</td>
<td>825.50 1002.70</td>
<td>JUGENE</td>
<td>Blue Gene/P Solution 294912 (Power)</td>
<td>IBM</td>
<td>Jülich Research Centre Germany, 2009</td>
<td>Linux (SLES 11)</td>
</tr>
<tr>
<td>5</td>
<td>563.10 1206.19</td>
<td>Tianhe-I</td>
<td>NUDT TH-1 71680 (Xeon), InfiniBand</td>
<td>NUDT</td>
<td>National SuperComputer Center China, 2009</td>
<td>Linux</td>
</tr>
<tr>
<td>6</td>
<td>544.30 673.26</td>
<td>Pleiades</td>
<td>SGI Altix ICE 8200EX 56320 (Xeon), InfiniBand</td>
<td>SGI</td>
<td>NASA Ames Research Center United States, 2008</td>
<td>Linux (SLES 10 + SGI ProPack 5)</td>
</tr>
<tr>
<td>7</td>
<td>478.20 596.38</td>
<td>Blue Gene/L</td>
<td>eServer Blue Gene Solution 212992 (Power)</td>
<td>IBM</td>
<td>Lawrence Livermore National Laboratory United States, 2007</td>
<td>Linux (CNK/SLES 9)</td>
</tr>
<tr>
<td>8</td>
<td>458.61 557.06</td>
<td>Intrepid</td>
<td>Blue Gene/P Solution 163840 (Power)</td>
<td>IBM</td>
<td>Argonne National Laboratory United States, 2007</td>
<td>Linux (CNK/SLES 9)</td>
</tr>
<tr>
<td>9</td>
<td>433.20 579.38</td>
<td>Ranger</td>
<td>Sun Constellation System 62976 (Opteron), InfiniBand</td>
<td>Sun</td>
<td>Texas Advanced Computing Center at The University of Texas at Austin United States, 2008</td>
<td>Linux</td>
</tr>
<tr>
<td>10</td>
<td>423.90 487.74</td>
<td>Red Sky</td>
<td>Sun Constellation System 41616 (Xeon), InfiniBand</td>
<td>Sun</td>
<td>Sandia National Laboratories United States, 2009</td>
<td>Linux (CentOS)</td>
</tr>
</tbody>
</table>
National Resources
Department of Defense
Supercomputing Resource Centers (DSRC's)
DSRC Sites

- ERDC DSRC
- ARL DSRC
- AFRL DSRC
- ARSC DSRC
- NAVY DSRC
- AHPCRC
- University of Arkansas
Department of Energy
Innovative and Novel Computational Impact on Theory and Experiment (INCITE)
What is INCITE?

Each year the Innovative and Novel Computational Impact on Theory and Experiment (INCITE) program awards to researchers millions of supercomputer processor hours and 100 trillion bytes of data storage space at the Department of Energy's (DOE's) leadership computing facilities for unclassified supercomputing, which include some of the most powerful computers in the world.

The program seeks computationally intensive, large-scale research projects that can make high-impact scientific and engineering advances through the use of a substantial allocation of computer time and data storage. The INCITE program specifically encourages proposals from research organizations including universities, national laboratories, and industry.
Intrepid
163,840 Compute Cores
#8 on Top500 – Nov ’09
Jaguar
224,162 Compute Cores
#1 on Top500 – Nov '09
NASA
Advanced Supercomputing Division (NAS)
Pleiades
56,320 Compute Cores
#6 on Top500 – Nov ’09
Who is Eligible?

**DoD**
DoD resources are available to PI's and researchers who have DoD grants and are working on DoD research projects. These resources address the expanding DoD requirements for HPC capability.

**DoE**
The INCITE program is open to all researchers and research organizations—academic, governmental, and industrial—needing large allocations of computer time, supporting resources, and data storage to pursue transformational advances in science and engineering.

**NASA**
NASA resources are available to PI's and researchers who have NASA grants and are working on NASA research projects.
OSG
Open Science Grid
What is OSG?

- OSG brings together computing and storage resources from campuses and research communities into a common, shared grid infrastructure over research networks via a common set of middleware.

- OSG offers participating research communities low-threshold access to more resources than they could afford individually, via a combination of dedicated, scheduled and opportunistic alternatives.

- OSG is a consortium of software, service and resource providers and researchers, from universities, national laboratories and computing centers across the U.S. The project is funded by the NSF and DOE.
TeraGrid
What is TeraGrid?

• TeraGrid is the world's largest, most comprehensive distributed cyberinfrastructure for open scientific research.

• Integrates high-performance computers, data resources and tools, and high-end experimental facilities around the country.

• More than a petaflop of computing capability.

• More than 30 petabytes of online and archival data storage.

• More than 100 discipline-specific databases.
Kraken
98,928 Compute Cores
#3 on Top500 – Nov ‘09
Ranger
62,976 Compute Cores
#9 on Top500 – Nov '09
and in 2011...
...IBM Blue Waters!

With more than 300,000 compute cores, Blue Waters will achieve peak performance of approximately 10 petaflops (10 quadrillion calculations every second) and will deliver sustained performance of at least 1 petaflop on a range of real-world science and engineering applications.

Blue Waters will have:
- a peak memory bandwidth of nearly 5 petabytes/second
- more than 1 petabyte of memory
- more than 18 petabytes of disk storage
- more than 500 petabytes of archival storage.
Advanced Support for TeraGrid Applications (ASTA)

Advanced Support for TeraGrid Applications (ASTA) provides collaboration between Advanced User Support (AUS) staff and users of TeraGrid resources. As a part of the ASTA program, guided by the allocation process, one or multiple AUS staff will join the principle investigator's (PI's) team to collaborate for up to a year, working with users' applications.

Collaborative work can include any of the following:

- Porting applications to new resources
- Providing help for portal and gateway development
- Implementing algorithmic enhancements
- Implementing parallel math libraries
- Improving the scalability of codes to higher processor counts
- Optimizing codes to efficiently utilize specific resources
- Assisting with visualization, workflow, and data analysis/transfer
To qualify for an allocation, the principal investigator (PI) must be a researcher or educator at a U.S. academic or non-profit research institution.

A qualified advisor may apply for an allocation for his or her class, but a high school, undergraduate or graduate student may not be a PI.

A postdoctoral researcher can also be a PI. (After receiving an allocation, PIs can request that students be given accounts to use the allocation.)

Contact help@teragrid.org or your local TeraGrid Campus Champion for details.
# TeraGrid Allocations

<table>
<thead>
<tr>
<th>Open Submissions</th>
<th>Close Submissions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dec 15</td>
<td>Jan 15</td>
</tr>
<tr>
<td>Mar 15</td>
<td>Apr 15</td>
</tr>
<tr>
<td>Jun 15</td>
<td>Jul 15</td>
</tr>
<tr>
<td>Sep 15</td>
<td>Oct 15</td>
</tr>
</tbody>
</table>
Arkansas High Performance Computing Center at the University of Arkansas
Star of Arkansas
1256 2.66GHz Compute Cores
12 NVIDIA GPU's
#339 on Top500 – June '08
AHPCC Personnel

Amy Apon, Director

David Chaffin, Associate Director for Operations and User Support

Jeff Pummill, Manager of Cyberinfrastructure Enablement

Wesley Emeneker, Graduate Assistant

Kelley Emeneker, Communications Specialist
AHPCC – Who is Eligible?

-Anyone at an Arkansas institution or part of the CI TRAIN project can use AHPCC resources

-Each ARE-ON institution appoints a local point of contact
  -Is first line of support
  -Is the primary Campus CI Champion for that campus
  -Assists users in getting accounts and in basic use of the system
URL's to Noted CI Resources

- DoD Supercomputing Resource Centers
- DoE INCITE
  http://www.er.doe.gov/ascr/incite/
- NASA Advanced Supercomputing Division (NAS)
  http://www.nas.nasa.gov
- Open Science Grid
  http://www.opensciencegrid.org/
- TeraGrid
  https://www.teragrid.org/
- Arkansas High Performance Computing Center
  http://hpc.uark.edu