Figure 1: The University of New Mexico High Performance Computing Centers

Proposal for Developing Algorithms and Applications for High Performance SMP Clusters

With the cost of commercial off-the-shelf (COTS) high performance interconnects falling and the respective performance of microprocessors increasing, workstation clusters have become an attractive computing platform offering potentially a superior cost effective performance. In recent years, we have seen the maturing of Symmetric Multiprocessors (SMPs) technology, and the heavy reliance upon SMPs as the work-intensive servers for client/server applications. There are already several examples of clusters of SMPs, such as clusters of DEC AlphaServer, SGI Origin, Sun Ultra HPC machines, and the IBM SP system with SMP "High" nodes; moreover, the Department of Energy's Accelerated Strategic Computing Initiative (ASCI) program relies on the success of computational clusters such as Option White, a 512-node IBM SP-2 with 16-way SMP nodes. With the acceptance of message passing standards such as MPI, and threading packages such as OpenMP and POSIX threads, it has become easier to design portable parallel algorithms making use of these primitives.

The Albuquerque High Performance Computing Center (AHPCC) at The University of New Mexico is a both a technical and a geographic organizational center for coordinating cluster computing activities for the diverse collection of high performance applications in the State of New Mexico. AHPCC sits at the crossroads of Highway 66 (connecting it to Sandia National Laboratories in Albuquerque) and the I-25 technology corridor, with Los Alamos National Laboratories an hour north, and heading south, the NSF-sponsored Sevilleta Long-
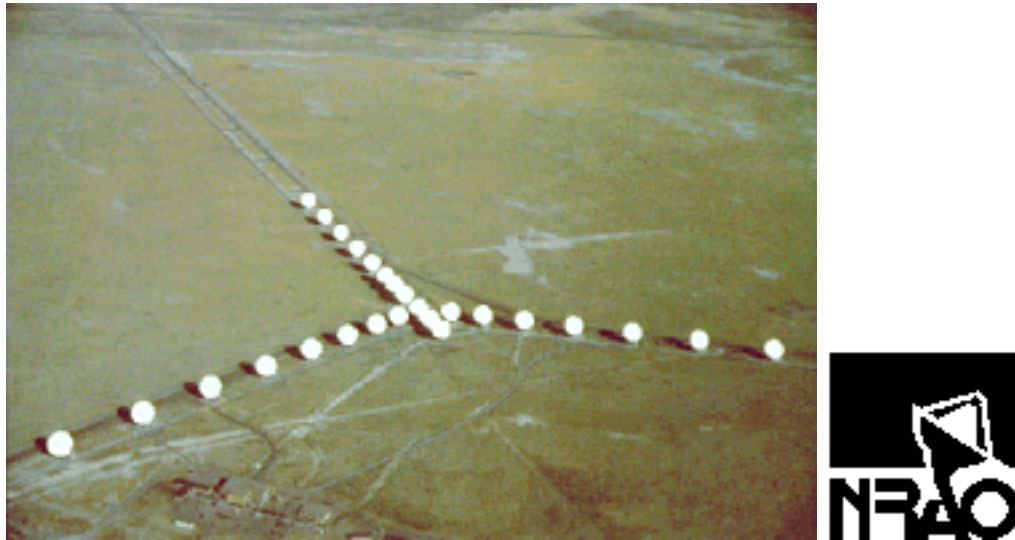
Figure 2: The Very Large Array (VLA) at the NRAO Facility, Socorro County, NM

Term Ecological Research (LTER) program at the Sevilleta National Wildlife Refuge in Socorro County, NM, and the NSF National Radio Astronomy Observatory (NRAO) which operates the Very Large Array (VLA) (27 25m radio antennas on the Plains of San Augustin) and Very Long Base Array (VLBA) (0 25m radio antennas spread across the United States).

AHPCC contains a wealth of high performance cluster computing expertise and resources. The principal investigator of this initiative will be HPCERC-affiliated Electrical & Computer Engineering professor David A. Bader, who recently joined UNM after completing an NSF CISE Postdoctoral Research Associateship in experimental computer science at the University of Maryland. David's strong research in high performance, parallel algorithms, and recent work in methodologies and models for high performance applications on clusters of symmetric multiprocessors, makes him an excellent member of the Alliance to organize this task. Besides access to the computational clusters at Los Alamos and Sandia, HPCERC/AHPCC houses a 128-node IBM SP-2 and manages the large SP-2 (with several SMP High Nodes) at Maui. In addition, David A. Bader is the PI the AHPCC SMP Cluster Computing Project for designing efficient, portable algorithms on an Alta Technology "AltaCluster", consisting of 8 dual-Pentium II (333 MHz) nodes, with a Myrinet interconnection network, running *ExtremeLinux* and upgradable to the Gigabit Ethernet.

Figure 3: National Laboratories

Figure 4: NSF Sevilleta Long-Term Ecological Research (LTER) program

We propose to organize and execute the following tasks.

1. **Train** undergraduate and graduate students in algorithmic and programming methodologies for cluster computing;

2. **Educate** students and faculty colleagues on designing high performance computing applications;

3. **Research** new methodologies for designing efficient and portable algorithms for SMP clusters;

4. **Design** high performance applications in collaboration with the the National Laboratories and Projects (for instance, NRAO, LTER, Los Alamos, and Sandia); and

5. **Coordinate** cluster computing activities in the State of New Mexico.

To this end, our project will need support for one graduate research assistant; travel support to organize activities in New Mexico and to attend professional conferences and workshops, and to report results to the Alliance; and support for arranging cluster computing workshops in the State.

Item	Cost
Graduate Research Assistant (1 Year)	$ 30,000
Travel	$ 2,500
Arrange Workshops	$ 5,000
TOTAL	$ 37,500

Table 1: Budget

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