

# ANUPAM SUPER-COMPUTER

Supercomputers are extensively used for solving very large computational problems in scientific research, engineering, industry, defence and business for variety of applications like molecular dynamics, modeling & simulation, Computational Fluid dynamics, Finite element analysis, Monte-Carlo simulation, Simulation of collision of galaxies, crash studies of vehicles in automobile, aerospace, nuclear-weapon, seismic studies, oil exploration, geology etc.

Since 1991, BARC is involved in developing series of parallel computing architectures to meet high performance computing needs of in-house researchers.

It was also recognized that a processor-independent design only can keep pace with the changing technology. BARC designers adopted a flexible design approach to parallel processing architecture and concentrated more on development of system software, tools and parallel-ization of application software.

In 2002 BARC developed 64-node ANUPAM parallel machine, which attained 43 Gflops sustained performance. The new ANUPAM system uses Pentium IV microprocessors operating at 1.7 GHz interconnected through 100 Mbps fast Ethernet network and has 256Mb memory per node. This system is about 30-40 times faster than any parallel supercomputer developed by other institutions in the country. The latest ANUPAM PIV computer consisting of 64 nodes has attained 43 Gflops of sustained performance using fast Ethernet, for Industry standard benchmarks. This has been now enhanced to 72 Gflops by incorporating ultra high speed 2D/3D PCI based Scalable Coherent Interface (SCI) connectivity a very low latency (about 8 microsecond), ultra high bandwidth (up to 667 Mbytes) network.

In June 2003, BARC achieved very significant milestone in the field of supercomputers by developing a 128-processor ANUPAM supercomputer. The computing speed of this supercomputer is observed to be higher than 340 Giga Floating Point Operations Per Second (GFLOPS) on High Performance Linpack benchmark program. This computer is about six times faster than the 64-node supercomputer developed earlier, in July 2002. The present supercomputer is more than 10,000 times faster than the first 4-node super computer developed at BARC in December 1991.

BARC has achieved a very significant milestone by commissioning an ANUPAM-ARUNA parallel supercomputer with 128 processors, giving a computational speed of 360 Gigaflops on the high performance Linpack benchmark. Within a period of next one year BARC expects to reach a computational speed of about 1.5 Teraflop using 512 processors.

The ANUPAM Systems have not only made available super-computing power at a fraction of

supercomputer cost to the DAE scientists, but these systems are also being used in several outside labs including Department of Space (VSSC), Defense (ADA), many IIT'S and several universities. Since December 1999 ANUPAM-ALPHA system has been



operational at NCMRWF, New Delhi and it has replaced old Cray-XMP at NCMRWF, New Delhi running operational weather codes much faster and costing less than one tenth that of Cray supercomputer. There was only one CRAY X-MP supercomputer in India, which was used at the National Center for Medium Range Weather Forecasting (NCMRWF), New Delhi. So far BARC has commissioned 37 ANUPAM systems based on i860, Alpha and Pentium at BARC and other leading institutes in the country including ADA, Bangalore, VSSC, Trivendram, NCMRWF (weather), New Delhi, IIT's and many universities.

Also number of additional parallel software tools such as Automatic installer, Parallel I/O file system, Integrated virtual console environment, Grid enable software, Parallel batch scheduler etc have been developed to enrich parallel environment to help users in using ANUPAM system much more effectively. These efforts and investment in HPC have resulted in the generation of valuable expertise and capability in using these systems, awareness, large trained manpower and skills which very few countries have.

So far BARC has developed 16 different models of the ANUPAM series of parallel supercomputers using a variety of processors as compute nodes and various technologies for interconnection networks. ANUPAM supercomputers have highly user-friendly software environments and provides very high reliability of operation required for continuous operations of such supercomputers on 24\*7 hours basis, for solving very large problems. These systems being based on commercially available off-the-shelf components are highly cost effective and easy to manufacture.

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