Some of the applications that make use of this grid infrastructure include:

- Open Source Drug Discovery (OSDD)
- Collaborative Class Room
- Computer Aided Engineering
- Oncology Research
- Disaster Management using Synthetic Aperture Radar
- Biodiversity Conservation

Cloud Computing

C-DAC's research focus in cloud computing includes design and development of Open Source cloud middleware, virtualization and management tools, end-to-end security solution for the cloud, etc. to name a few. A plethora of applications developed in C-DAC are being migrated to cloud computing technology. These include hospital information systems, disaster recovery, telemedicine, HPC services, language technology applications (like machine translation), e-governance applications, etc. Considering the related but complimentary driving forces of grid and cloud computing disciplines, C-DAC is also exploring the integration of grid and cloud computing.

Open Source software based on open standard and open data formats	Create and deploy private, public or hybrid cloud	Ease of management and maintenance
Security and the Quality of Sevice (QoS)	Interoperable interfaces and functionalities	Control on resources and distribution of services
Maximum abstraction of resources	Avoidance of vendor lock-in	Compatible with most of the platforms to provide maximum freedom to users and developers

Meghdoot - Cloud Stack

C-DAC has developed a complete open source based software stack named 'Meghdoot' for setting up a private cloud to offer basic cloud services such as infrastructure, platform and software services. On demand dynamic provisioning, metering and monitoring, graphical installation of middleware stack, customized elasticity and the web service based management of cloud are among the value additions by C-DAC.

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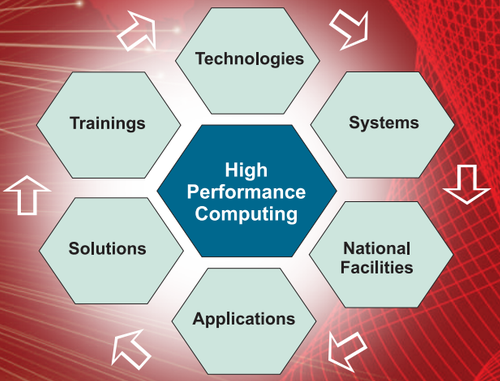
High Performance Computing



Supercomputing Systems
National Supercomputing Facilities
Supercomputing Applications
Supercomputing Solutions
Grid Computing
Cloud Computing

प्रगत संगणन विकास केंद्र
CENTRE FOR DEVELOPMENT OF ADVANCED COMPUTING

High Performance Computing (HPC) plays an important role in both scientific advancement and economic competitiveness of a nation – making production of scientific and industrial solutions faster, less expensive, and of higher quality. HPC is a key component in many applications such as designing vehicles and airplanes; designing high-rise buildings and bridges; discovery of drugs; discovery and extraction of new energy sources like oil and natural gas; weather forecasting; and many more.

Supercomputing Systems

C-DAC embarked on its first HPC mission in 1988. Since then, it has delivered a series of supercomputing systems called PARAM series of supercomputers. These include:

C-DAC's PARAM YUVA-II is ranked number 44 in the Green 500 list of World's Supercomputers announced in November, 2013. It is the number 1 system in India as per this list.

- PARAM 8000, India's first Gigascale supercomputer in 1990
- PARAM 10000, a 100 Gigaflop supercomputer in 1998
- PARAM Padma, India's first Terascale supercomputer in 2002. This was also India's first supercomputer to enter the Top500 list of supercomputers of the world (ranked 171 in June 2003)
- PARAM Yuva, a 54 Teraflop supercomputer in 2008 (ranked 68 in November 2008)
- PARAM Yuva II, a 529 Teraflop supercomputer in 2013 (ranked 69 in June 2013)
- PARAM Biochrome, an HPC cluster for Bioinformatics applications having compute capacity of 5 Teraflops
- PARAM Bio Blaze, a supercomputing facility with peak compute power of 10.65 Teraflops, launched on February 18, 2014 to address the challenges in Bioinformatics

PARAM Yuva II, the latest in the series, is an eight-core, dual-socket node based hybrid computing cluster with multiple interconnects, compute co-processor, hardware accelerator, high performance storage and supporting software for parallel computing. It incorporates C-DAC's in-house technologies including PARAMNet-3 – a High Speed System Area Network, FPGA based hardware accelerators called Reconfigurable Computing System (RCS), a range of system and application software components as well as industrial design and engineering of the whole system. PARAM Yuva II has sustained performance of 386.71 TF for LINPACK Benchmark with a peak performance of 529.4TF. It has high bandwidth storage of 200 Terabytes.

Supercomputing Solution in a Box

PARAM Shavak – Supercomputing in a Box

PARAM Shavak is a Supercomputing solution in a box, designed for research organizations and academic institutions that wish to adopt HPC culture. It is equipped with C-DAC's indigenously developed technologies and solutions for HPC applications in academic and scientific domains.

Its salient features include:

- A table top model with 2 Teraflop and above computing power
- Pre-loaded with parallel programming development environment
- Support for C-DAC's Reconfigurable Computing System technology to speed up applications through hardware

National Supercomputing Facilities

C-DAC has commissioned and operates three national supercomputing facilities for HPC users community.

1. National PARAM Supercomputing Facility at C-DAC, Pune
2. C-DAC's Terascale Supercomputing Facility at C-DAC, Bengaluru
3. Bioinformatics Resources and Applications Facility (BRAF) at C-DAC, Pune

NPSF @ Pune

CTSF @ Bengaluru

BRAF @ Pune

These facilities are used by scientists and researchers across the nation and abroad for carrying out their research effectively. While the first two facilities cater to the requirements of users from various application domains, the third facility is specifically for users working in Computational Biology domain.

Supercomputing Applications

The supercomputing systems and facilities of C-DAC are used to solve computationally challenging problems in a number of areas of practical significance. These include:

Computational Atmospheric Science

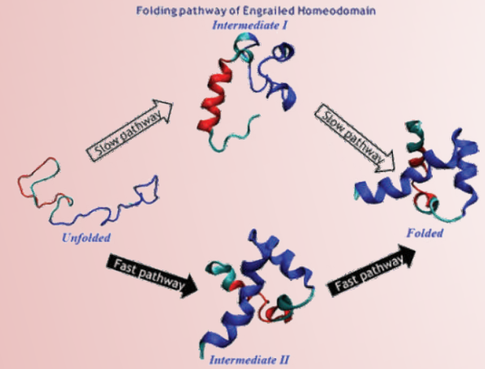
- Mesoscale modelling
- Climate system model
- Medium range weather forecasting
- Air quality modelling and management

Computational Biology

- Genome sequence assembly
- Microarray data analysis
- Structure-based drug discovery
- Protein folding
- Molecular Dynamics simulation

Computational Fluid Dynamics

- Viscous, compressible, unsteady flows
- Laminar natural convection flows
- Fluid flow and heat transfer for heat exchangers
- Simulation of fire in high rise buildings



Folding pathway of Engrailed Home domain

Computational Structural Mechanics

- Stress analysis of fibre-reinforced composite structures
- Fracture mechanics
- Nonlinear stability analysis
- Seismic vulnerability analysis
- Hazard assessment of civil structures

Supercomputing Solutions

Drawing from a large pool of resources and skill sets developed over the years as part of its HPC program, C-DAC extends its expertise as well to address HPC requirements of customers, right from incubation to implementation. C-DAC offers end-to-end solution building services and comprehensive training to its HPC clients. C-DAC's esteemed HPC clientele includes leading R&D organizations and educational institutions both in India and abroad.

Grid Computing

Garuda is India's national grid infrastructure of HPC systems, connecting 70 academic and research institutions across 17 cities of the country with India's Nation Knowledge Network (NKN). The Indian Grid Certification Authority (IGCA) accredited by the APGrid-PMA (Asia Pacific Grid Policy Management Authority) has been set up in C-DAC. The IGCA helps scientists, researchers and collaborative communities in India and neighboring countries to obtain its internationally recognized digital certificate to interoperate with state-of-the-art grids worldwide.

GARUDA
India's National Grid Computing Initiative