CDCC
The Supercomputing People

ACTS

Business Computing Solutions

GIST

Real Time Systems

Multimedia

Hardware Design

Healthcare

Telecom

Artificial Intelligence

HPCC

Geomatics

ANNUAL REPORT
2000 - 2001

CENTRE FOR DEVELOPMENT OF ADVANCED COMPUTING

ANNUAL REPORT

2000-2001

CDCC

CENTRE FOR
DEVELOPMENT
OF ADVANCED
COMPUTING

A Scientific Society of
Ministry of Information Technology
Government of India

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* as on 31-Mar-2001

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OVERVIEW

Set up over a decade ago, as India's national initiative for design, development and delivery of high performance computing (supercomputer systems) and solutions based on parallel processing technology, the Centre for Development of Advanced Computing (C-DAC) has over the years diversified its activities, transferring the expertise it acquired and technologies it developed in high-performance computing to develop and deploy advanced Information Technology (IT) based solutions in various sectors of the economy. Through this approach, it has maintained a balance between developing strategic technologies needed in the country in the high performance computing area for achieving self-reliance, and using the skills so developed to commercialize its technologies and products to address the various requirements.

C-DAC has been operating in a mission mode in order to develop the technologies in the specific time targeted manner. It has accordingly delivered out in its earlier Missions, the PARAM series of Supercomputers. C-DAC's current mission is for the development of the Next Generation High Performance Computing & Communications (HPCC) technologies and applications, taking advantage of the developments carried out in its previous missions in this area. As part of this, C-DAC has set up a National PARAM Supercomputing Facility (NPSF) to allow access to researchers to solve their compute

PARAM Systems and Application Softwares
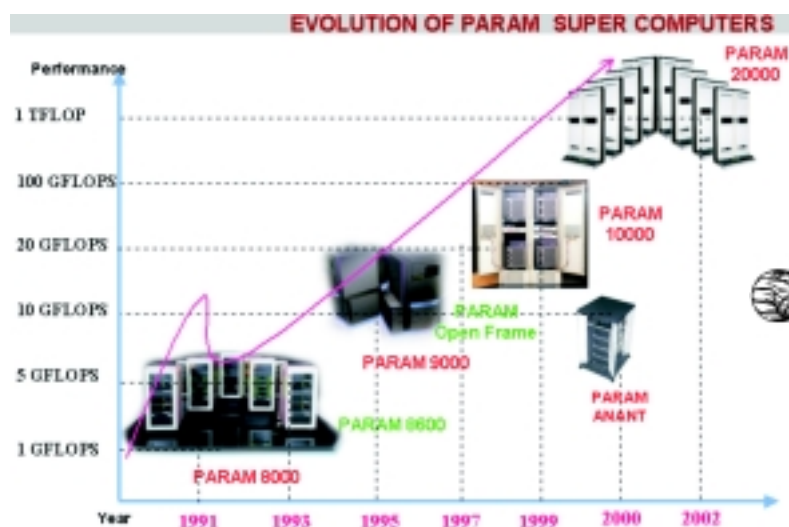
- Atmospheric Sciences
- Seismic Data Processing
- Computational Fluid Dynamics
- Structural Mechanics
- Financial Modelling
- Molecular Modeling
- Finite Element Modeling
- Bioinformatics
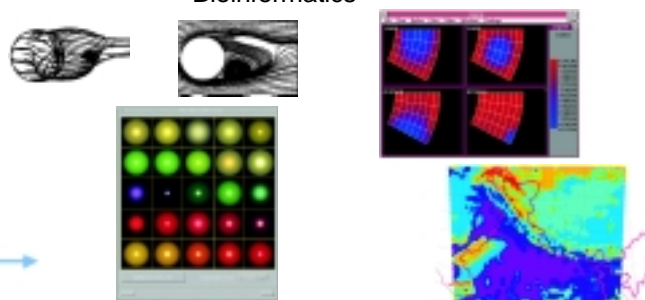
intensive problems in various areas of Science & Engineering, and is now building a large teraflop system for solving very high-end scientific problems of national interest.

Till date, with an investment of about Rs.125 crores and close to 2000 man years of efforts on development, apart from supplying 52 different types of PARAM supercomputers to various users including 8 overseas, C-DAC's efforts have brought India in the select league of nations having capability in this strategically and economically important area.

C-DAC's other activity, the language technology mission, was initiated to create a framework for support to the various living languages with diverse scripts on standard computers. C-DAC has innovated its trail blazing **G**raphics and **I**ntelligence based **S**cript **T**echnology (**GIST**) to achieve this goal. This technology is now extended to include multimedia and multilingual computing solutions, covering a wide range of applications such as publishing and printing, word processing, office automation

GIST Hardware

- Gist Card
- Gist Terminals

GIST Software

- LEAP range of products
- (LEAP Office, *i*LEAP)
- ISM range
- Gist Software Development Kit
- iPlugin

suites with language interfaces for popular third party softwares on various operating platforms, electronic mail, natural language processing and artificial intelligence based machine aided translation & language learning, video & television and multimedia content in Indian languages. These have been successfully commercialized. Some popular products in this category are displayed here.

Artificial Intelligence

- Mantra
- LILA

Video Works

- Teleprompter
- Move CG
- MANAS
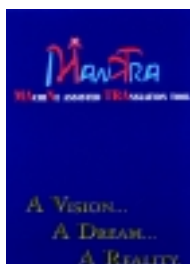
Multimedia

- Shaili
- Quick MM Album
- Pratibimb
- Dnyaneshwari

C-DAC also undertakes sponsored projects from the Government for developments in specific areas. The total R&D outlay on such projects including C-DAC's inputs was Rs13.74 crores in 2000-2001 and is expected to be Rs 24.47 crores in 2001-02.

Under the mandate given to C-DAC to generate manpower to address the growing demand for trained manpower in the extremely fast moving sector of Information Technology, C-DAC established its Advanced Computing Training School (ACTS). This school, currently offers a variety of course options in Software technologies, Enterprise System Management (ESM), Geomatics, VLSI designs, Digital Multimedia and so on. These are offered through a dozen different courses currently at its own four centers and about 100 authorized centers around the country.

Building on its foundation in almost all major areas of Information Technology, C-DAC offers advanced computing products, solutions and services for several sectors including Education, Research, Power, Telecom, Health Care, Finance, Networking and Internet applications. Specific areas of focus currently are e-Governance, e-Commerce, Digital Libraries and advanced solutions based on Data Warehousing, Genetic Algorithms, Network Security, GIS, Artificial Intelligence and Real Time Systems.

Data Warehousing for Decision Support in Government

Citizen Databases :

- **Voter List**
- **Food and Distribution**
- **Industry & Professionals**
- **Household data**
- **Health Data**
- **Economic Status**
- **Demographic**

The development and training activities have enabled C-DAC to generate revenue to sustain its operations and help plough back the surplus for further development and infrastructure creation. In the year 2000-2001 C-DAC achieved a turnover of Rs.74 crores and expects this figure to go up to Rs.100 crores in the year 2001-2002 on these activities.

ACTIVITIES

C-DAC's activities extend to the following broad areas in Information Technology:

- **RESEARCH & DEVELOPMENT**
- **SPONSORED / CONTRACT PROJECTS**
- **EDUCATION & TRAINING**
- **BUSINESS OPERATIONS**

RESEARCH & DEVELOPMENT

Our R & D efforts are focused in the areas of:

— **High Performance Computing and Communication (HPCC) Technology and Applications**

— **Multilingual and Multimedia Computing Technology**

— **Other advanced areas in Information Technology**

High Performance Computing and Communication (HPCC) Technology and Applications

C-DAC's initiatives in the area of advanced technologies for the next generation of HPCC have been manifold, and are driven by the Mission objectives. Under the third HPCC Mission of C-DAC that is currently underway, a budget of Rs 49.5 crores, including Rs 39.5 crore of budgetary support, from the Ministry of Information Technology was approved, with an internally generated revenue of Rs 10 crore by C-DAC to cover the various activities. The developments carried out during the year are briefly mentioned in the following sections.

The **H**ardware **T**echnology **D**evelopment **G**roup (**HTDG**) is engaged in the development of advanced technologies for the next generation **S**ystem **A**rea **N**etworks (**SAN**), **R**econfigurable **C**omputing **S**ystems (**RCS**) and engineering of a scalable parallel supercomputing system based on commodity processor elements.

System Area Network (SAN)

The development of Phase-I of SAN having 1Gbit/Sec speed including SAN Switch (8 Port) and Network Interface Card (NIC) with C-DAC's Communication Co-Processor (CCP-II) with latencies less than 18 microseconds has been completed. This constitutes C-DAC's PARAMNet sub-system used in HPCC clusters. A test bed for round the clock testing of SAN is being set-up to ensure and verify the scalability and stability of the network.

The design and development of Phase-II of SAN having 1 Gbit/Sec speed using the newly designed and developed CCP-III and **V**irtual **I**nterface **A**rchitecture (**VIA**), is in progress. In this, the device driver development study of **V**irtual **I**nterface **P**eripheral **L**ibrary (**VIPL**) over Linux and Windows NT has been completed, and the speed of SAN would be taken up to 5 Gbit/Sec.

Reconfigurable Computing System (RCS)

The fabrication of the RCS prototype board has been completed and is under test. Development & porting of two important application solvers namely Fast Fourier Transform (FFT) and Matrix Multiplication, is in progress.

Terascale Supercomputing System

C-DAC is working towards engineering and building a high performance computing cluster with a peak computing power of a Teraflop, by the year 2002 as a deliverable of its Third Mission. Towards this end, the first set of vendor presentations for selecting storage and compute nodes and file servers has been completed and the technical evaluation is in progress. The developed hardware and software tools would be integrated with these third party products.

The **S**ystem **S**oftware **D**evelopment **G**roup (**SSDG**) addresses performance and usability challenges through HPCC Software - a high performance flexible software environment, being developed by C-DAC, which adheres to established and emerging standards in parallel and distributed computing. This development programme has been maintaining a quality system, which fulfils the requirements of the ISO 9001:1994.

The HPCC software suite of products includes high performance compilers, parallel debuggers, data visualisers and performance profilers.

HPCC - BASE Software

For parallel applications to scale on large clusters, the HPCC base software provides low overhead communication, optimized Message Passing Interface (MPI) and a parallel file system.
HPCC software's KSHIPRA communication substrate provides lightweight communication primitives on the PARAMNet conforming to the Active Messages II specifications of the University of California, Berkeley.

Over and above this low-level communication substrate, HPCC software provides MPI application programming interface for parallel computing. A significant improvement in performance using KSHIPRA for real applications like the T80 and T126 weather forecasting codes based parallel climate model has been achieved.

Parallel applications to scale also require an efficient parallel file system. C-DAC is presently working on C-PFS, an efficient parallel file system exporting MPI-IO interface. This development is being executed in collaboration with the Indian Institute of Science (IISc), Bangalore.

HPCC - Program Development

HPCC software provides an integrated Fortran program development environment, which includes the Fortran 90 compiler, debugger, source browser, profiler, project manager and FORTRAN 77 to Fortran 90 converter (CAF). CAF90 is a highly optimising Fortran 90 and Fortran 77 compiler developed jointly by C-DAC and Apogee Inc., USA. C-DAC is presently working on a parallelizing compiler project in collaboration with the Institute for Systems Programming (ISP), Moscow and with consultancy support from IISc., Bangalore.

For correctness and performance debugging of parallel applications, the HPCC software provides DIViA integrated debugging environment. DIViA (Debugger with Integrated Visualizer and Analyzer) works under MPI environment and debugs C or Fortran language parallel programs.

HPCC - System Management

A large cluster requires tools to manage the system effectively. The system management tool - PARMON - allows the cluster user or administrator to monitor activities and resource utilization of various components of the cluster. It monitors the machine both at the node level and at the system level exhibiting a single system image. The PARMON monitors system activities like

process activities, system log activities, kernel activities, controls devices, and generates and analyses events. It also provides physical and logical views of the components of the system. The Parallel Unix Commands - PARCOM - is another tool for executing UNIX commands in a cluster environment where there is a frequent need to execute a given UNIX command on several processors in the cluster at the same time.
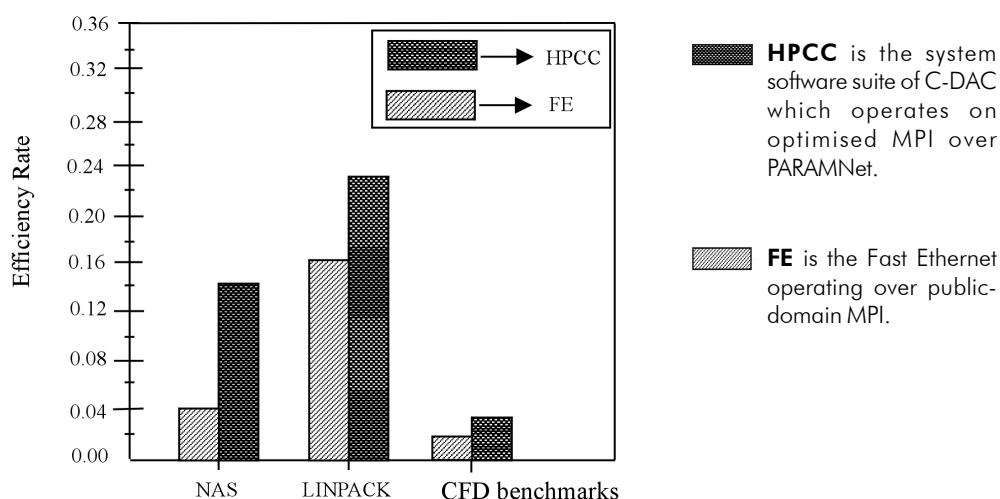
HPCC - Software Engineering

HPCC software also provides programmers with tools for producing and maintaining a quality code. The HPCC software is now available for both Solaris and Linux clusters. It supports Fortran 77/90 and C languages. The communication protocols are available on ParamNet.

System and Application Benchmark on PARAM 10000

Macro and Micro benchmarks have been used to evaluate the performance of PARAM 10000. Some of them investigate the use of real application programs while other employ short kernel codes to evaluate the sustained performance.

The first one includes evaluating the computing performance on PARAM 10000 for LAPACK, NAS, LINPACK, and third party Computational Fluid Dynamics (CFD) applications. C-DAC has in addition developed P-COMS (PARAM- Communication Overhead Measurement Suites) software to address several issues in communication on PARAM 10000. These suites have been used to measure the overheads on 16, 32, 48 and 64 processors of PARAM 10000. Several other test suite have been ported to investigate the use of real application programs to evaluate the sustained performance on PARAM 10000. The efficiency rate for important application and system benchmarks on 8 nodes (32 processors) of PARAM 10000 has been plotted in the figure below.

HPCC is the system software suite of C-DAC which operates on optimised MPI over PARAMNet.

FE is the Fast Ethernet operating over public-domain MPI.

The newly released LINPACK benchmark *hplbench* was ported on 16 processors of PARAM 10000 using Fast Ethernet (100Base T) using public domain MPI and it achieved a sustained performance of 3.5 Glop/s on the peak performance of 9.6 Gflop/s. The Optimization of this code using HPCC software for large configuration is in progress and it is expected to achieve nearly 4.5 Gflop/s on the same configuration.

C-DAC has also carried out the development of job accounting and job management software. These software have been used to manage both batch and interactive jobs to provide better services from the PARAM 10000, and also help in tracking

real usage levels across system nodes to enhance their effective utilization. Along with this, a dedicated booking software that helps a user to book dedicated time on the PARAM 10000 has been developed. Using this software, it is possible to book system nodes at different time intervals.

Scientific and Engineering Applications on PARAM

Over the years, C-DAC's applications development program has grown rapidly and now covers a wide range of applications including specific mission critical ones. These cover both science & engineering and business computing fields.

Some of the major applications are listed below:

Atmospheric Science

One of the major applications requiring high performance computing resources is numerical weather prediction. This discipline requires large computing power and accurate modeling for timely forecasts. PARAM 10000 has been utilized for the design and development of weather and climate modeling and forecast.

C-DAC's atmospheric science applications team, has closely interacted with the National Centre for Medium Range Weather Forecasting (NCMRWF), New Delhi; Indian Institute of Tropical Meteorology (IITM), Pune; European Centre for Medium Range Weather Forecasting (ECMWF), UK; Institute of Numerical Mathematics (INM), Moscow; Institute of Computer Aided Design (ICAD), Moscow; Iowa State University, USA; Snow and Avalanche Study Establishment (SASE), Chandigarh for various application programs.

A 8 processor configuration of PARAM10000 was earlier installed at the NCMRWF, New Delhi for the purpose of weather forecasting and research. The forecasts generated through this system have been validated using the T-80 model for an end-to-end forecasting cycle covering pre-processing, forecasting and post-processing. The results of the total cycle take 4 hrs 5 mins for forecast. Similarly, the forecasting part of the cycle using the T-126 model, a higher resolution model, was run on a 16 processor system of PARAM 10000 to take 30 minutes.
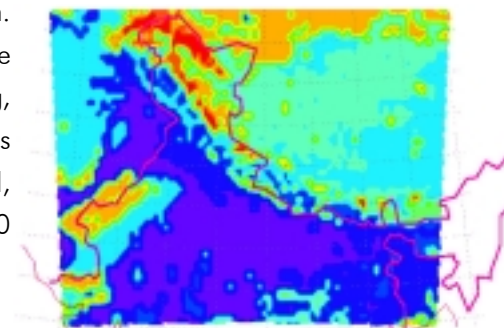
MM5 : LAND USE

C-DAC, Indian Institute of Tropical Meteorology (IITM) and IIT, Delhi are developing a parallel climate model based on NCMRWF's T80 model. Under this, climate simulation of 2 yrs has been carried out using 16 nodes of PARAM 10000 for a long term monsoon simulation. The second phase of this project has been proposed to the Department of Science and Technology (DST).
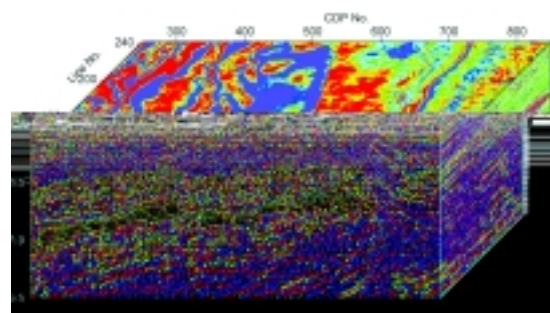
C-DAC is also carrying out a collaborative project with the Institute of Numerical Mathematics (INM) to develop a Parallel Coupled Atmosphere-Ocean Model under the Indo-Russian Integrated Long Term Programme (ILTP) of the Department of Science and Technology and the Russian Academy of Sciences. The parallel ocean model has been ported on the PARAM 10000 and work on a parallel coupler between Atmospheric and Ocean Model has been initiated.

C-DAC has developed a pre-processor for the regional forecasting Mesoscale (MM5) model on PARAM 10000 for the Indian region. Also, the parallel MM5 model has been implemented on PARAM 10000. These will help the Snow and Avalanche Study Establishment (SASE) in their research and accurate forecast for the Indian regions of interest.

In order to explore scalable parallelisation strategies, C-DAC has proposed a collaborative project with Iowa State University under DST-NSF funding for the study of automatic parallelisation agent for medium range weather forecasting models.

Seismic Data Processing

Seismic Data Processing (SDP) is concerned with obtaining information about underground geological structures and their physical properties. This information is essential for the exploration of oil and natural gas resources, as well as for reservoir characterization. The input seismic data is acquired by carrying out seismic experiments in the field. Several terabytes of data are collected to get a three-dimensional image of the earth. Present day processing technology is based on very complex mathematical algorithms. Computational requirements for SDP processing are extremely large, in terms of processor speed, memory and I/O. Fortunately, the algorithms are inherently parallel and therefore are highly suitable for parallel architecture machines, like PARAM 10000.


C-DAC is concentrating on the development of highly compute and I/O intensive algorithms. Several migration and modeling algorithms have been developed and tested on real data sets. A number of new algorithms have been added to the set of existing algorithms. The techniques have been developed under two projects supported by the Department of Science and Technology. The developed algorithms will

3D Depth Migrated System

eventually be added to the WAVES: an indigenously developed parallel seismic migration and modeling package on PARAM 10000, to make it more comprehensive. The algorithms have been successfully implemented on 144-processor configuration of PARAM 10000.

Structural Mechanics

FEMCOMP is a software for enabling composite materials analysis. It has been developed as a result of a joint collaboration between C-DAC and IIT-Mumbai. The installation of the FEMCOMP package developed by C-DAC has been successfully completed at the 10 premier academic institutes. The benchmarking of FEMCOMP on PARAM 10000 with different
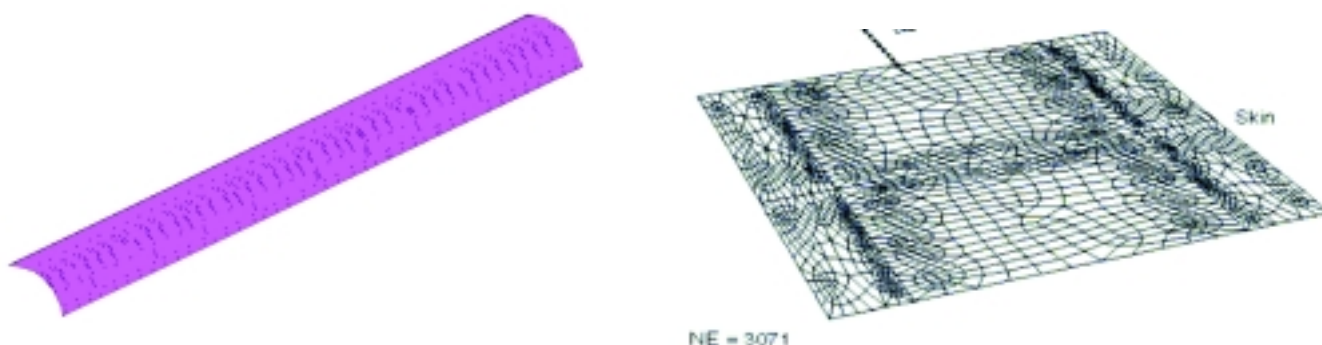

FEMCOMP Benchmarking

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interconnection networks and for various new models was carried out as a feedback from some of the premier institutes.

To enhance FEMCOMP capabilities and to carry out further work in composites analysis, C-DAC has further collaborated with IIT-Mumbai and submitted a proposal for further developments to the Aeronautics Research and Development Board, Govt of India.

Computational Fluid Dynamics

C-DAC has been interacting with the Vikram Sarabhai Space Centre (VSSC), Thiruvananthapuram, to carry out numerical simulation of flow around a re-entry class of vehicles in hypersonic regime. As part of C-DAC's collaboration with the Institute of Computer Aided Design (ICAD), Moscow, the grid generation has been accomplished with effective geometric modelling for a three-dimensional object configuration provided by VSSC. The preliminary results were obtained by solving 3D Euler equations with non-equilibrium and chemical reactions. Finer mesh was incorporated for wing-fuselage and stagnation point region. Improvements in algorithm to solve Navier-Stokes' equation using multimode PARAM 10000 are in progress. Another CFD application to simulate complex in-cylinder flow in an IC engine of an automobile is being worked upon.
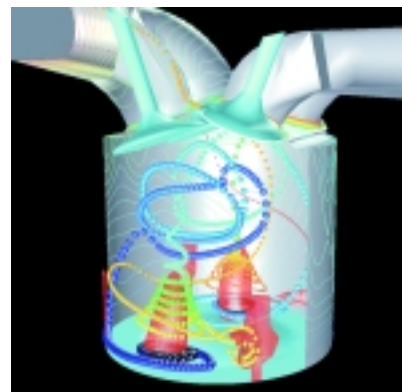
CFD can simulate complex in-cylinder flow for an IC engine

Fracture Mechanics Application

C-DAC's interaction with IISc, Bangalore in 3-D Fracture Mechanics algorithm development and parallelization has resulted in the submission of a project proposal to the Department of Science and Technology. The preliminary work on modeling of fractured geometries has begun.

Development on the project INTEGRA has begun in which the solid modellar and visualization tool are proposed to be developed in Object Oriented Design. This platform independent software will be designed to act as a preprocessor and postprocessor of several application packages.

Based on the joint work with the Institute of Computer Aided Design (ICAD), Moscow, in nonlinear stability analysis, a research paper was submitted to HPC Asia 2001 Conference, Gold Coast, Australia. A paper has also been submitted to Supercomputing 2001 Conference, Denver, USA, based on the joint development work with IIT-Mumbai.

Bioinformatics

The Bioinformatics activities are mainly centered around the implementation and optimization of molecular modeling and sequence analysis software on PARAM 10000 and also carrying out research in the domain area.

- **Molecular Modeling**

    Molecular Dynamics (MD) methods are used to obtain high resolution data. Motions on a molecular scale, which are not often accessible to experiment, are sampled by MD. Molecular modeling programs like AMBER and CHARMM have the capability to carry out MD simulations. These programs can normally be run on single processor workstations, but would take a long time for carrying out a simulation. If one wants to simulate large biomolecules in realistic conditions like water and ions, one has to use more powerful parallel supercomputers.

    a. **AMBER:** AMBER (**A**ssisted **M**odel **B**uilding with **E**nergy **R**efinement) is the most widely used package for molecular

modelling.This package has been optimised and ported on the PARAM 10000 in the PVM and MPI environment. The package has also been used extensively to carry out large realistic simulations. This code has been extensively tested on PARAM 10000 using various networks like Fast-Ethernet, Myrinet & PARAMNet and also using libraries like AM-MPI.

b. **CHARMM:** CHARMM (**C**hemistry at **HAR**vard **M**olecular **M**echanics) is also a general-purpose program for macromolecular dynamics and mechanics. The parallel version of CHARMM has been ported and optimized on PARAM 10000, both using MPI and SOCKETS. This code has also been tested on PARAM 10000 using various networks like Fast-Ethernet, Myrinet & PARAMNet and also using libraries like AM-MPI.

c. **GROMACS:** GROMACS (**GRO**ningen **MA**chine for **C**hemical **S**imulations) is another modeling and simulation tool, which is extensively used, to carry out minimization, molecular dynamics, simulated annealing, free energy perturbation, umbrella sampling and AFM pulling. This code has been ported and optimized on PARAM 10000 using MPI and tested on the Fast-Ethernet. Further testing using Myrinet and PARAMNet is in progress.
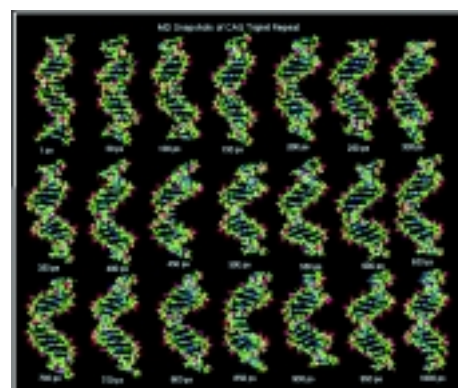
- **Genome Sequence Database Search and Analysis**

One of the most successful techniques for analyzing genetic data is through sequence similarity analysis using sequence similarity algorithms. Calculation of similarity between newly obtained sequence and archives of various types of information is perhaps the most valuable tool for obtaining biological knowledge. Sequence similarity algorithms are a well-developed aspect of computational molecular biology research and employ dynamic programming and heuristic search techniques. These algorithms identify similar regions between sequences.

FASTA: FASTA is one of the many heuristic algorithms proposed to speed up the database search process. FASTA is a two-step algorithm. The FASTA code has been implemented in parallel on the PARAM 10000 and benchmarked.

Benchmark of FASTA on PARAM 10000

Query sequence: DNA sequence of length= 1,48,849

Database: Human sequence database
Total number of sequences = 1,36,626
Total number of residues = 1,360,544,633

No. of CPUs	Time taken
2	1282 mins
8	223 mins
16	112 mins
32	57 mins

BLAST: This heuristic search algorithm is based on mathematical results that allow the statistical significance of matching segments to be estimated under an appropriate random sequence model. The BLAST code has been implemented using threads on the PARAM 10000.

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- **Smith-Waterman:** The Smith-Waterman algorithm is one of the dynamic programming methods that yields a local alignment between two sequences. The Smith-Waterman pairwise alignment has been implemented on the PARAM 10000.

- **Research:** Structural and dynamical properties of DNA may depend on the sequence of the nucleotides that make up the DNA. Examples include a few triplet repeat DNA involved in certain neurodegenerative disorders. Such large time scale simulations of macromolecules in realistic conditions require very high computing power and were carried out on the PARAM 10000.

MD Snapshots of CAG Triplet Repeat

- **Applications of evolution based Algorithms:** This research involves the development of evolution-based optimization methodologies towards applications in Bioinformatics such as multiple sequence alignment and Protein structure prediction, on PARAM 10000. Work in this area has been initiated.

Multiple sequence alignment

Multiple alignments of many DNA or protein sequences are among the most important and challenging problems in Bioinformatics. A new approach for efficient multiple sequence alignment based on parallel genetic algorithm has been developed on PARAM 10000. This approach has consistently performed better than the sequential genetic algorithm. Also, this algorithm yields alignments that are qualitatively better than an alternative method, Clustal W. An extensive investigation of the algorithm's parameters further confirms the superior performance.

Adaptive Parallel Genetic Algorithm

Common parallel genetic algorithm paradigms use the same evolution behavior on each population. The objective of this research is to propose a method to overcome the problem of choice, using a variety of operators, parameters, and mechanisms. The method is called Adaptive parallel genetic algorithm, which uses different evolution behavior on each population to overcome the problem of choice of operator selection. Work in this area is progressing.

Structure Prediction Using Ant Colony System

Structure optimization, which is minimizing the energy of a molecule, is a challenging task. Classical algorithms based on calculus fail to locate the global minimum. Ant Colony optimization which borrows the ideas of how ants find a minimal path to their food has been used in this work. It has been observed that this technique outperforms some of the popular techniques like genetic algorithms and simulated annealing. This algorithm was applied to the case of polypeptides of sizes up to 10 amino acids. It was found that the results are better than those obtained using both sequential and parallel genetic algorithms.
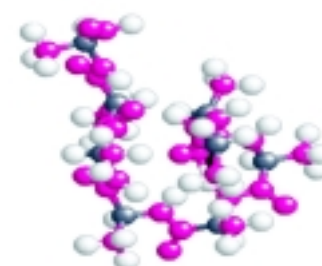
Optimized structure of
Octa-alanine

Ab initio Molecular Dynamics

Cadmium selenide semiconductor clusters, nanocrystals and quantum dots have recently been studied quite extensively because of their interesting variation in the band gap with the size and consequent variations in low-energy optical and electrical properties. The Vienna *Ab initio* Simulation Package (VASP) employs the Vanderbilt ultra-soft pseudo-potentials with Generalized

Gradient Approximation over Local Density Approximation. Conjugate Gradient method has been used to obtain the geometry optimization of CdSe clusters by relaxing both electronic and ionic degrees of freedom.

Lowest energy
structure of $(CdSe)_{12}$

The HOMO-LUMO gaps show significant variations with size and a local maximum is obtained for clusters with a planar or cage-like structure. The second order difference of energy as well as the fragmentation energies indicate that clusters with 3, 4, 6, 8 and 12 CdSe pairs are magic and very stable. The cage like structures observed in CdSe are similar to those of MgO and BN clusters. Also these features have similarity to those in fullerenes. Beyond the size x = 6, six member $(CdSe)_3$ rings dominate the structure. It is interesting to note that in experiments of Kasuya's group such x = 3 and 6 clusters are also found to be magic. Research in these areas are progressing at C-DAC using PARAM 10000 for analysis.

Quantum Chemistry

C-DAC has supported the development and porting of codes for quantum chemistry applications on PARAM 10000 in collaboration with the University of Pune. This culminated into INDMOL an *ab initio* molecular orbital package.

The systems studied recently by employing INDMOL include:

- Hydrogen bonded H-p complexes of C_2H_2 and C_2H_4:

- Polarization corrected molecular electrostatic potential (PMESP).

- MESP of a large molecule, Sucrose octaoleate with 453 atoms.
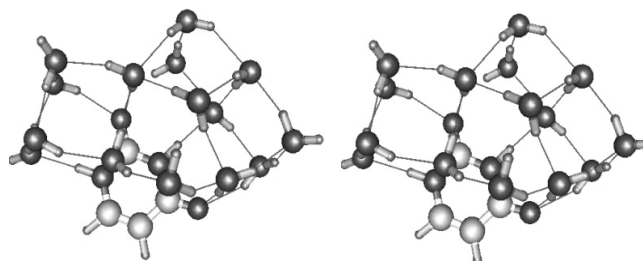
Hydrogen bonded H-p complexes of C2H2 and C2H4

GAMESS is the public-domain *ab initio* package, the latest version of which has been ported on PARAM 10000. It can compute wavefunctions ranging from RHF, ROHF, UHF, GVB, and MCSCF, with CI energy corrections available for some of these.

Multilingual and Multimedia Computing Technology

C-DAC's Language Technology Mission complements its high-performance computing and communications initiative to create a framework for the co-existence of various living languages with diverse scripts, on standard computers. C-DAC has continuously evolved and updated its **G**raphics and **I**ntelligence based **S**cript **T**echnology (**GIST**) to proliferate the benefits of Information Technology to the vast and diversified multilingual population of India. Accordingly, C-DAC's language technology is now extended to include multilingual and multimedia computing solutions covering a wide range of applications such as Publishing & Printing, Word-processing, Accounting, Spreadsheets, Electronic Mail application, Web development tools, Multimedia content, Video works and Television, Newsroom Automation, Language learning, Natural language Processing based Machine Aided Translation.

With a lead role provided in the establishment of standards in the field of language computing technology, C-DAC has extended its services to development of software tools and technologies for various platforms, application development and deployment, development of hardware tools, consultancy, training and development of channel partners for its various multilingual and multimedia products. The GIST has also been successful in popularizing the use of Internet tools to focus on providing Indian language based content and applications on the Internet.

GIST has to its credit several innovative products, which have been designed and developed over the past decade. More than 5 million GIST technology users on various platforms such as DOS, UNIX, Windows bear testimony to the GIST success story.

During the period of this report, some of the projects and products launched were:

iPlugin

iPlugin is a web application development tool, which provides an option to develop a profusion of unique applications for the Internet in Indian languages. Some of its features include an interactive chat in Indian languages, on-the-fly Scheduler & Calendar, data entry form on the web. It also supports Indian languages with specially designed and attractive web fonts

ISM 2000

ISM 2000, a multilingual office automation solution for Indian language word processing and data processing, on-line communication, publishing – including web publishing and many other applications, was launched as a considerable update from its previous version.

It incorporates new features like a configurable keyboard which allows the user flexibility in using the keyboard; the facility of a floating keyboard for users not familiar with the keyboard overlay or where the keyboard does not feature the overlay printed for the script in use; an Official Language dictionary application that refers to administrative terminology, a date and time facility to view the date and time in Indian languages in different formats; a figures to words facility to convert numbers in Indian languages and so on.

LEAP Office 2000

LEAP Office 2000, a complete Indian language software for office applications was launched. This is the most advanced package in the LEAP range of products. LEAP Office 2000 has a number of features to make the use of Indian languages on computers extremely easy. It provides a number of tools to increase the efficiency of the user. These include multilingual Spellchecker, keyboard shortcuts, search and replace, online keyboard and official language dictionaries.

New technologies like the Internet have been well adopted by LEAP Office 2000. It incorporates the facility to send an Indian language e-Mail without going to a separate editor. Creating web pages using LEAP Office 2000 is as simple as creating any other document.

Remington keyboard support for GIST Terminal

The Gist Terminals are VT100 / VT200 compatible Multilingual terminals and hitherto supported only the Inscript keyboard layout. However, the demand for a Remington type typewriter layout has led to the Devnagari implementation of the same.

GIST is providing the tools and technologies for enabling the Tally project accounting system in all Indian languages.

The **Lipi Data Systems** Dot Matrix Printer has been enabled with Devanagri and Tamil Fonts on specific demand. With this the printer now accepts ISCII input and prints directly.

The **GIST PACE** activities continued to gather momentum in imparting quality IT education to the masses with Indian languages in the background through a large number of GIST PACE Bureaux Indiawide. Beginning April 2000, the operations of

Programme for **A**dvancing **C**omputer **E**ducation (**PACE**) were streamlined to offer more efficient services in terms of better coordination of supply of quality course material, issue of certificates and more informed MIS reports.

Advertising and sales promotion efforts were also reinforced and a State Agency meet was held in February 2001 with a view to securing first hand feedback and evolving and introducing appropriate policies state wise.

With completion of its developments several copyrights were filed for its Convertors, Spellcheckers, Web search engine, Generic Font convertor to ISCII, Phonetic keyboard and Unicode Font Engine.

Natural Language Processing

Using Artificial Intelligence, C-DAC has developed a series of intelligent self tutoring systems for Indian languages under the umbrella of **L**earning **I**ndian **L**anguages through **A**rtificial Intelligence (**LILA**), incorporating state-of-the-art technology on diverse platforms of DOS, UNIX, and Windows to WEB. As part of this work, development of LILA Praveen and Pragya is under progress.

As part of the **C**omputer – **A**ssisted **T**ranslation **S**ystem (**CATS**) project, C-DAC has developed **MANTRA** - Rajbhasha which is based on the architecture of the MANTRA - a core system developed by C-DAC for machine assisted translation, with the
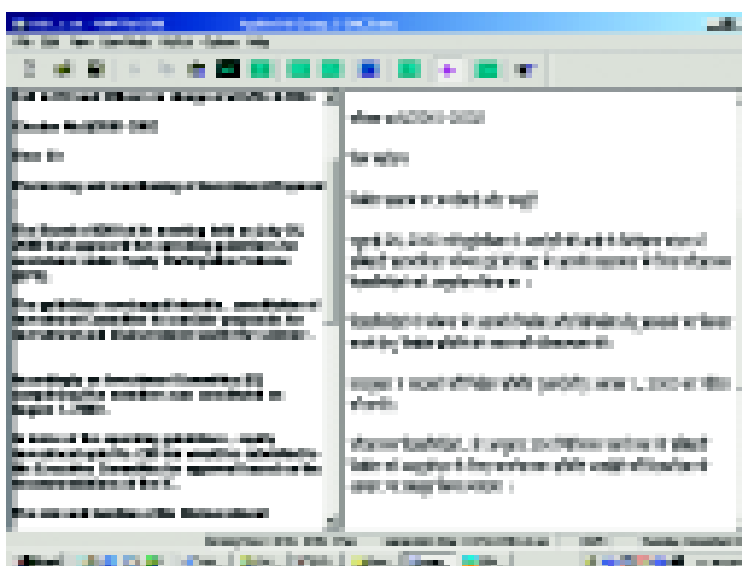
objective of translating English text into Hindi in a specified domain of Personnel Administration, specifically Gazette Notifications, Office Orders, Office Memoranda and Circulars pertaining to appointments, transfers and promotions. The Beta version of MANTRA-Rajbhasha was submitted to the Ministries of Home Affairs, Railways, Finance, and Information Technology and the President's Secretariat for evaluation.

MANTRA uses Lexicalized Tree Adjoining Grammar (LTAG) formalism to represent English as well as Hindi grammar. It is now being expanded to translate English texts into other Indian languages such as Gujarati, Bengali and Telugu, and also to translate Hindi text into English in the specified domains of Personnel Administration, Banking, Transportation and Agriculture.

MULTIMEDIA

The National Multimedia Resource Centre (NMRC) of C-DAC has been engaged in activities ranging from product development to multimedia content and training. It has developed a range of products with the objective of proliferating the benefits of this technology to the masses. The activities of the Centre during the year were as follows:

Documenting the Life & Works of Ramanujan

A project proposal titled 'Multimedia CD Title on Ramanujan: The Genius Mathematician' was prepared in close consultation with The Institute of Mathematical Sciences (IMSc), Chennai and submitted to the Department of Science & Technology, Government of India. It has been proposed that the biographical sketch of Ramanujan and his invaluable contributions to the world of Mathematics will be digitized and presented in the form of multimedia based on experts' analysis of his popular research works and contributions to the world of science. The multimedia presentation will be stored on CD ROM for distribution purpose. The Department of Science & Technology has in principle approved the project, and preliminary work on designing the first multimedia title has begun.

Multimedia Application Development for National Museum

An interactive application, that presents various portions of a video film about the Harappan Civilization was developed for the National Museum, New Delhi. The application was hosted on a multimedia Kiosk also designed by C-DAC during the inaugural function of the Harappan gallery. The gallery was inaugurated by the Hon'ble Union Home Minister, Govt. of India on 19th Sept. 2000. A detailed project proposal has now been prepared and submitted to the Department of Culture, Government of India that includes the development of the complete multimedia application about the Harappan Gallery and the supply of multimedia kiosks.

Multimedia Kiosk for Centre for e-Governance

A multimedia presentation, with an interactive interface which provides information about the e-Governance initiative of the Ministry of Information Technology was developed and is currently running at the Centre for e-Governance set up at the Ministry of Information Technology, New Delhi, which is being managed by C-DAC. The presentation also covers the benefits and success stories of e-Governance applications developed and commissioned in various States in India. Hosted on a touch screen kiosk, the information is updated regularly.

Multimedia Rendering of Dnyaneshwari and Bhagvad Gita (Volume I)

An implementation plan for the complete Dnyaneshwari project was prepared and work was initiated in July 2000. New metaphors were rendered in multimedia and were indexed and integrated as a separate multimedia executable. Multiple bookmarks and annotations have been made available as new features in this volume. The first 12 chapters have been integrated in the authoring framework, which includes a commentary by Sant Dnyaneshwar, Shlokas from the Bhagvad Gita, translations in Marathi, meanings of difficult words and corresponding audio links. The first volume based on this was released at the Rural Connectivity International Conference held in February 2001, by the Hon'ble Union Minister of Information Technology. Digitization and editing of the musical recitation for all 18 Chapters of Dnyaneshwari and Bhagvad Gita have also been completed.

Upgraded version of Shaili

Shaili is a rich collection of computer-generated designs, inspired from traditional Indian art forms. The CD consists of a variety of decorative Borders, Motifs, Tiles, Arches and Corners. Reusable Ornamental Components and Borders are exclusively

tuned for web page designing and readymade decorative frames. The Shaili CD consists of over 800 unique designs rendered and tuned to 6 different application file formats. A Windows based browser has been designed for previewing the collection of designs from the Shaili CD.

An upgraded version of Shaili was launched, during the period under review. A new volume of Shaili is being conceived and work has been initiated for the development of new designs, decorative animation clips and ornamental fonts.

QuickMM Album Author

The Quick MM Album Author is a multimedia album authoring Template developed by the Centre, for the production of cost effective multimedia albums of family and corporate events, documentation of cultural events, conferences, seminars, product catalogs, linear presentations, portfolios for fine artists and fashion designers and so on.

New features like user definable stage size; theme cursor library and content search have been incorporated in the Quick MM Album Author and is being provided with a User Manual.

SPONSORED / CONTRACT PROJECTS

C-DAC has undertaken projects concerning different aspects of Information technology, which have been sponsored by various Ministries and Departments of the Government of India, such as the Ministry of Information Technology, Department of Official Language (DOL), Department of Science and Technology (DST), Department of Scientific and Industrial Research (DSIR), Department of Culture (DOC) and Department of Biotechnology (DBT). Some of the important projects currently in progress are briefly described below:

Real-time, Fault-tolerant Systems

The Ministry of Information Technology, has sponsored the development of Real-time, Fault-tolerant systems with a view to develop indigenous capability in designing and developing distributed software fault-tolerant systems targeting industrial applications. Under the project, the Common Object Request Broker Architecture (CORBA) based real-time fault-tolerant
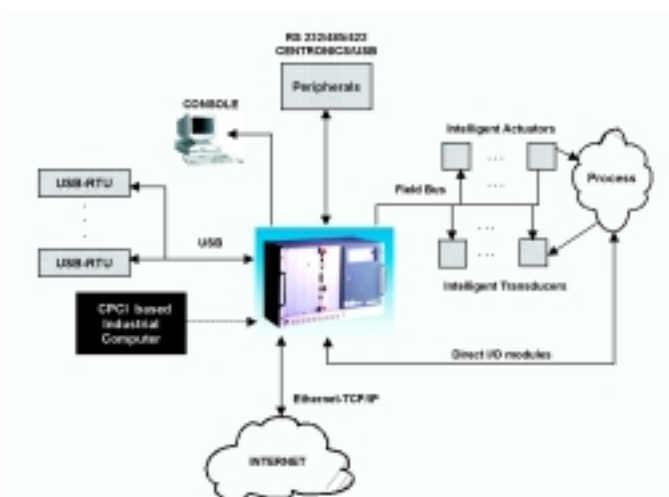
Typical Configuration of CompactPCI based Industrial Computer systems for
Process Control Application

systems infrastructure has been developed. The architecture developed would facilitate application development across heterogeneous hardware, language and operating systems. An initial version of this system CORBA Based Real-Time Fault Tolerant System For Industrial Applications (CORFIA) was announced at the CORBA Based Real-Time Fault Tolerant System For Industrial Applications workshop.

The Ministry of Information Technology, Govt. of India, also initiated another project for developing Compact PCI bus based industrial computers to meet the growing needs of Indian industry. Compact PCI is emerging as an Industry standard architecture for embedded real-time controllers for Instrumentation, Telecom and Military applications.

The processor and various input modules of the phase-I of the project have been designed adhering to Compact PCI specifications and the development is in progress.

The **M**ultilingual **A**dvanced **N**ewsroom **A**utomation **S**ystem (**MANAS**), project sponsored by the Ministry of Information Technology and Doordarshan, is a total solution for News automation and consists of various modules such as NewsEditor, NewsCG, NewsAV, NewsController, and NewsAdmin is proposed to be installed at identified Doordarshan Kendras. The development of various modules has been completed and testing is in progress.

The MPEG-2 DVD Authoring system is ready on a DVD with 32 different language subtitles & 8 audio tracks. A DVD for "Bharat Ek Khoj" was successfully created as a part of the project, sponsored by the Ministry of Information Technology.

Perso-Arabic Resource Center

C-DAC has been identified as a Resource Center for the development of tools / technologies for Perso-Arabic scripts like Urdu, Kashmiri & Sindhi, and has completed the development of NASKH & Nastaliq fonts for Urdu, a simple text editor for Urdu, UTRANS – Translitration from Hindi to Urdu, a single line edit control for Urdu, generation of dictionaries for Hindi-Urdu with domain specific requirements. The project is one of the thirteen centres selected for works in various Indian languages, by the Ministry of Information Technology.

PARAM for Premier Academic Institutions

Sponsored by the Ministry of Information Technology, and endorsed by the Ministry of Human Resources Department, a four-node PARAM 10000 was installed at each of the eight premier institutes which include the IITs – Mumbai, Delhi, Kanpur, Guwahati and Chennai; IISc Bangalore; University of Roorkee and Motilal Nehru Regional Engineering College (MNREC), Allahabad.
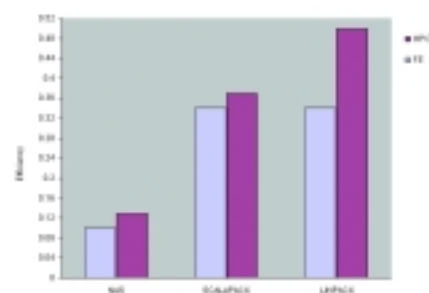
Efficiency rate for various benchmark suites on 8 processor PARAM 10000 for HPCC and FE

Core technologies of Network Security

This project sponsored by the Ministry of Information Technology, deals with the development of some of the core technologies needed for network security. As some of the high end products for encryption of messages are under export control from outside, the project covers development of cryptographic keys (C-crypto) and Virtual Private Network (C-VPN). The C-crypto keys based on standard and popular algorithms are being optimised to provide higher performance upto key lengths of 2KB. Design of C-VPN has also been carried out. Documentation and its implementation is to start.

Data Warehousing for the Government of Andhra Pradesh

C-DAC, in collaboration with **A**ndhra **P**radesh **T**echnology **S**ervices (**APTS**) of Andhra Pradesh Government, developed a

multipurpose, multilingual and multimedia information warehouse to aid state officials in their decision making process. The objective of this project was to organize **M**ulti**P**urpose **H**ousehold **S**urvey (**MPHS**) and the land records data of the state of Andhra Pradesh into a meaningful information warehouse, thereby assisting decision makers to assess the impact of their decisions on intended sections of the population. This project adopts technologies like parallel database server, data warehousing, multilingual interface, and information access through the web, kiosk and mobile terminals.
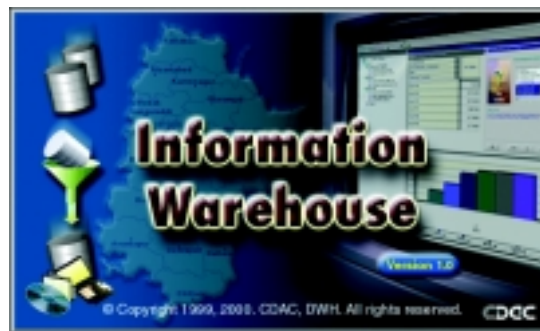
During the year, the system was loaded with more than 850 mandals of data pertaining to person, house and occupation, and several meaningful analysis were carried out on the loaded data. Suggestions made by end users were incorporated to make the system user-friendly. The system with the full application is installed at the Govt of Andhra Pradesh Secretariat in Hyderabad. The project was jointly funded by the Ministry of Information Technology and Govt. of Andhra Pradesh.

Financial Modeling

Sponsored by the Ministry of Information Technology, BourseAnalyzer, a fundamental analysis based capital enhancement tool is being developed. The main objective of the system is to build an Internet-based scalable platform to analyze and compare market movements of shares of leading Information Technology related companies with those of companies constituting the market index. The analysis will essentially be based on historical fundamental data of these companies and it will deploy data mining techniques for unearthing patterns and trends hidden in this massive data. This fundamental analysis can help investors to form investment policies, especially long term policies, for maximizing returns and minimizing risk.

The system is Web-based and serves as a repository of financial data. Balance sheet data of the companies will be scrubbed, processed and transformed into ready-to-use format for non-IT users. The system will also house the following libraries: Library of Financial Ratios, Library of Financial Indicators and Library of Trading Strategies. Investors, Stock exchanges, Credit Rating Agencies, Researchers and Regulatory Bodies are the potential users of the system.

A market research was carried out, which involved meeting and interviewing capital market participants of different categories including from the Stock Exchanges, Research and Consultancy Institutes for the Banking industry, Research and Consultancy Institutes for the Insurance industry, Research and Development Institutes and Credit Rating Agencies to ascertain their interest and needs.

Telemedicine

Sponsored by the Ministry of Information Technology, under this project a Telemedicine System has been developed and is ready for implementation. The deliverable of the project has been productised and was launched as **MERCURY** on 26th March 2001 by the Secretary of the Ministry of Information Technology on C-DAC's 14th Foundation Day.

As part of this project, C-DAC has also developed a protocol for communication in Telemedicine systems. The protocol addresses the stream format, the message exchange and the system parameters for communications in Telemedicine systems.

The Telemedicine system was demonstrated to the Hon'ble Union Minister for Health and Family Welfare, at the Post Graduate Institute of Medical Education and Research (PGIMER), Chandigarh. The system has been proposed to be installed for field experimentation at All India Institute of Medical Sciences (AIIMS), New Delhi, Sanjay Gandhi Post Graduate Institute (SGPGI), Lucknow and PGIMER, Chandigarh.

High Performance Molecular Modeling Project

The Department of Biotechnology, Govt of India, recently sanctioned a project titled "Creation of a High Performance Molecular Modelling Infrastructure for Biotechnologists, in the National PARAM Supercomputing Facility (NPSF) at C-DAC". The prime objective of this project is to establish the NPSF as a centre of excellence to carry out high performance molecular modelling of large biomolecules. The project work has been initiated.

Digital Library

The Digital Library project aims at the development of technology, tools and content products for the preservation and dissemination of India's rich heritage through the use of modern digital technology. The deliverables towards this project cover providing the technology, contents and infrastructure for a Digital Library of Indian Heritage.

Under the project, templates, which would host the contents of the Digital Library project have been designed. Manuscripts from Thanjavur Saraswati Mahal Library were digitised and a website giving information on their collections has been designed. Some of the rare documents of Kepler's work belonging to Indian Institute of Astrophysics, Bangalore were digitized and stored in compact disks to ensure protection and permanency of the documents. Work on authoring of Indian epics such as Bhagwad Gita, Vishnusahasranama and RigVeda was carried out to provide content for the Digital Library providing various features like indexing, search and analysis for various interested users. The work on Dnyaneshwari which is a commentary on Gita was also carried out in the project to provide the content. The design of the Digital Library architecture covering computing and storage infrastructure and the analysis software was also finalised.

Sanskrit Authoring System

The Ministry of Information Technology had sponsored the development of a Sanskrit Authoring System to enable knowledge based authoring, editing, indexing, search and analysis on Indian epics. Language tools developed by C-DAC were used for this purpose. The project was also aimed to reach the teaching of these epics to the masses. With the completion of this project C-Vyasa, a product which is a rich collection of well-known works like RgVeda, YajurVeda, various Sutras, Mahabharatha, Gita, Ramayana, Ashtadhyayi Alankara, Amarkosha, Brahma Sutra has been brought out which enables the author to retrieve the desired information using various user-friendly methods. C-Vyasa was launched an the 14th Foundation Day of C-DAC.

LILA – Learn **I**ndian **L**anguages through **A**rtificial Intelligence

C-DAC is developing a series of intelligent self-tutoring systems for Indian languages under the umbrella of LILA incorporating contemporary state-of-the-art technology on diverse platforms ranging from DOS, UNIX and Windows to Web to meet various user's requirements.

In this series, development of LILA-Hindi Prabodh, LILA-Hindi Praveen,

and LILA-Hindi Pragya have been sponsored by the Department of Official Language (DOL), Ministry of Home Affairs and are aimed at teaching Hindi to the government and corporate employees with a view to enable them to use Hindi in official correspondence. These courses are based on the prescribed syllabus of the DOL. LILA-Hindi Prabodh (DOS, LINUX, Windows versions) was already launched and submitted to the DOL, and is now being marketed. LILA Praveen , the next stage of Hindi learning, is in an advanced stage of development. With the success of this development, Web-LILA another package, which is based on the web technology comprising of multimedia language tutoring systems supporting speech, images, and video was taken up. Five languages - Hindi, Gujarati, Bangla, Telugu, and Tamil have been covered at the first level. Web-LILA Hindi was launched on the 14th Foundation Day of C-DAC on 14th March, 2001. Indbazar.com, a family portal has sponsored this project and it is aimed at addressing the needs of the NRIs and foreigners who are interested in learning Hindi through English as a medium of instruction. These courses are based on well-defined and graded lessons along with the hyperlinking to the grammatical notes, classified pictorial vocabulary, exercises, practices, and self-evaluation test.

MAHABHARATHA Database Project

The Central Secretariat Library, Department of Culture, has sponsored the Mahabharatha Database project for making the great epic available to researchers and common readers. The project proposes to create a database of Mahabharatha slokas in ISCII format, such that these can be transliterated into any Indian language script using C-DAC's GIST technology and stored in a CD-ROM for use by research scholars.

BUSINESS OPERATIONS

The Business Division is the commercial arm of C-DAC to extend and propagate its technologies to the academic, scientific and various other business sectors commercially. The division provides marketing, customer support, consultancy and training services covering products and technologies in the areas of High Performance Computing & Communication (HPCC), Language Computing technology, Geomatics, Artificial Intelligence, Electronic Governance, Real Time Solutions, Network Security and so on. C-DAC's business activities provide IT solutions in many areas of Government and sectors such as Power, Telecom, Health, Financial, Education and Agriculture.
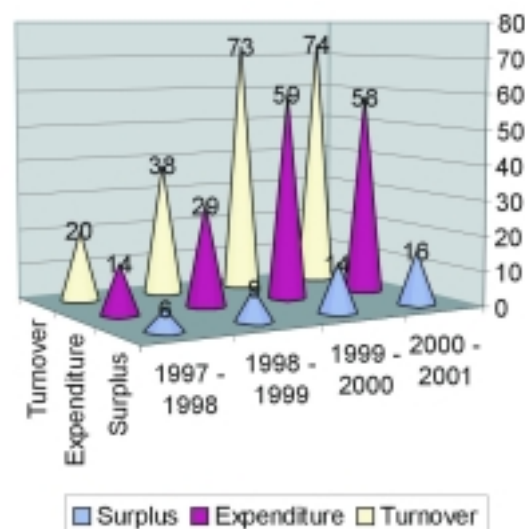
These activities have enabled C-DAC to generate revenue for the sustainance of their operations and help plough back the part surplus amount generated for its research & development activities and infrastructure development. During the year, C-DAC achieved a turnover of Rs.74 crore with a surplus of Rs.16 crore.

C-DAC signed two major contracts with the Institute of Computer Aided Design (ICAD), Moscow, for setting up of a 12.8 Gigaflop PARAM 10000 system at Russian Indian Centre for Advanced Computing Research, Moscow. Another agreement was signed for the up-gradation of this system. Commissioning of the system at ICAD was completed in June 2000 and was inaugurated by Hon'ble Union Minister of Science & Technology, Human Resource Development and Ocean Development.

Negotiations were initiated with the Laboratirio National de Computacao Cientifica (LNCC), Brazil, for establishing a Supercomputing system developed by C-DAC in their premises and help in developing scientific applications of mutual interest. In collaboration with the Andhra Pradesh Technical Services (APTS), Government of Andhra Pradesh a PARAM based Datawarehouse project has been commissioned along with RAID storage of 500 GB with Oracle database and OLAP tools to provide a decision support system to the state officials.

Using the expertise built up by C-DAC in advanced hardware technologies, C-DAC took up on a contract the first phase of development of Fast Ethernet MAC CORE for a **U**niversal **M**icro **S**ystem (**UMS**) for an overseas company. Based on the success of this, the second phase of this contract was initialised in January 2000.

The system software expertise of C-DAC enabled it to successfully deliver a PC based CORAL and Fortran 90 program development environment including compilers, debuggers, profilers, assemblers and linkers under a contract with a customer.

A feasibility study and architectural design of a virtual private network application implementation was carried out on the multifunctional Universal Microprocessor chip of a customer overseas.

The Government of Maharashtra, contracted a project for networking seven engineering colleges with the DTE which was successfully completed. A project for the Election Commission of the Government of Maharashtra that involved generating an up to date integrated electoral roll for the assembly constituencies was successfully completed.

In order to ensure high quality of product integration and total customer support, C-DAC has strategic alliances with the following multinational organisations:

- *Sun Microsystems Inc. - for their Solaris based Sun Sparc and Ultra Sparc systems.*

- *Compaq India Ltd. - for PCs and servers*

- *PCI, Canada - for Geomatics - GIS and Imaging products and services*

- *CHAM, UK - for PHOENICS products and services*

- *Apogee, USA - for joint development and promoting the CAF90 compiler*

An order for the computerization of operations of Municipal Corporations in Karnataka State, funded by the Karnataka Urban Infrastructure Development and Finance Corporation (**KUIDFC**) was received. This is being implemented across 6 cities in Karnataka. The software modules developed include:

- Property Tax Billing and Collection

- Water Supply Billing and Collection

- Issue of Trade Licenses

- Issue of Birth and Death Certificate

- Payroll of employees

- Municipal Accounting

- Customer Complaints

During the period of this report, **GIST** secured contracts from prestigious clients such as CCI (Cotton Corporation of India)and IOCL (Indian Oil Corporation Ltd) for multilingual computing software, from ETV, Hyderabad, for MOVE CG video system, and the first export order for a LIPS creation station from Video Visuals Ltd, Mauritius and LIPS Creation Station and LIPS Arabic Decoder System from B4U channel.

SANSK-NET (A Network of Sanskrit Institutions)

Several Sanskrit Universities and Vidyapeethas in the country specializing in different fields of Sanskrit and Indology, have a rich collection of published and unpublished, as also rare manuscripts of great indological values. In recent years there has been a growing recognition of the use of Sanskrit in developing computer languages. There is also growing awareness that the rich literature in Sanskrit contains valuable material relevant to the contemporary fields of physical and social sciences.

Due to the inadequate linkage between the information systems of the traditional world and modern scientific world, the rich potential of knowledge that exists in the traditional world has not been fully explored by the modern world. The basic objective of this project is to work out an innovative scheme to bridge the gap that exists between the traditional scholarship and the modern scientific expertise of this kind. Sansk-Net is essentially aimed at networking the Sanskrit institutions that have diverse information and databases. As the first phase of work, in this project, four different institutes have been identified viz. AMSC (Ahobila Mutt Sanskrit College, Madhrantakam, Tamil Nadu), PPSM (Poorna Prjna Samshodhana Mandiram, Bangalore), CIF (Cochin International Foundation, Valiyandu, Kerala), ASRM (Academy of Sanskrit Research, Melkote, Karnataka) with RSVP (Rashtriya Sanskrit Vidyapeetha, Tirupati) and C-DAC, Bangalore, as nodal centres.

C-DAC is responsible for developing application on the Vedanta (Gita, Brahma Sutrs, Upanishad) for all the three systems of Advaita, Dvatia, VishishtAdvaita, and is devising a scheme for data entry/integration in addition to content creation.

Geomatics

Geomatics is the key to building an information infrastructure by suitably integrating spatial information and making it available over the Internet for planning and decision-making by various government departments. C-DAC has been offering GIS based products and solutions to various organisations. As part of this, C-DAC is working to customise OrthoEngine for updating existing maps using IRS Satellite 1-C/D data. OrthoEngine from PCI Geomatics has already demonstrated extraction of digital evaluation model from stereo pair of IRS 1-C/D and ortho-rectification of the same.

C-DAC is collaborating with the Maharashtra Industrial Development Corporation (MIDC) under a contract with them for implementation of GIS enabled Land Management System (GLMS). The system will use the Geomatica Web Server for dissemination of information related to industrial plots on the web. C-DAC is developing a computer-aided information system for processing and analysis of important information elements overlaid on topographic maps. It will enable scientific integration of large volume of data for situation analysis and decision-making. DVD translator and symbol library have been developed for the same.

The present concept of Disaster Management needs an interactive, intelligent, spatial information system that utilizes various aspects of advanced computational techniques including intelligent reasoning, GIS, and flexible GUI to support real time communication and coordination. The National Centre for Disaster Management (NCDM) of the Indian Institute of Public Administration (IIPA) has engaged C-DAC in consultancy for exploitation of expertise in GIS, GPS and Web based technologies for linkage of Ministry of Agriculture with States/UTs, NCDM and the concerned Central Ministries/ Departments.

C-DAC has installed more than 250 copies of GIS software tools in over six-dozen institutions.

Real Time Solutions

The Real-time solution for the power sector is developed as a product, called **COPS** (C-DAC's Open Process Solutions), a totally indigenous developed solution. It has been deployed successfully in Power Grid Corporation of India Ltd (PGCIL) (Northern, Eastern regions) & Punjab State Electricity Board (PSEB) load despatch centre, Energy Management System (EMS) for Steel Authority of India (SAIL).

Online status of Plant Grid

During the year, the PGCIL (North Region) Phase III project, development & deployment of intelligent terminals for Haryana Vidyut Prasaran Nigam Ltd (HVPNL), PGCIL, Jammu, Central Power Research Institute (CPRI), Bangalore - Phase II were completed. A repeat order from CPRI for Phase III Lab automation was received and partial installation & commissioning of Lab automation module was completed. New orders were also received from HVPNL & PGCIL, Jammu.

USB based Remote Terminal Unit

The Remote Terminal Units are basically remote Data Acquisition Systems which collect real-time data from various processes and send the data to the master station for further processing. CDAC's earlier COPS-90 RTU was based on Transputers and the I/O Modules were interconnected using proprietary backplane bus. Since the transputer chips are now obsolete, C-DAC took up development of a Pentium based RTU with Universal Serial Bus (USB) backplane. USB based RTUs would have state-of-the-art features such as plug-and-play, hot swap ability and web connectivity.

The software for islanding & Load Shedding System for SAIL, Rourkela is completed and ready for installation & commissioning. Major modules of COPS have been ported on to LINUX platform to minimise the costs. It has been planned to complete the remaining modules of COPS on LINUX shortly.

C-DAC has a major activity in the area of e-Governance, and has consequently executed a number of projects in this area for various States. Important projects progressed during this year are for:

- Stamp and Registration Department, Government of Maharashtra
- Stamp and Registration Department, Government of Uttar Pradesh
- Public Works Department, Government of Maharashtra
- Department of Archives, Government of Maharashtra

- Legislative Assembly/Council Secretariat, Maharashtra

- Maharashtra Induatrial Development Corporation

- Maharashtra State Seed Corporation

- Octroi, Nashik Municipal Corporation

- Minicipal Corporations, Karnataka

- Andhra Pradesh Technical Services, Government of Andhra Pradesh

- State Election Commission, Maharashtra

In addition to the above, consultancy projects were carried out for the Governments of Gujarat and Madhya Pradesh. It covered the preparation of a framework for Statewide policy and procedure for selection of services and vendors, standardisation of front end/back end for application interfaces along with network topology and components, and processes for compiling tender documents, evaluation and supervising installation. Presentations/demonstration on a number of projects have been made to the various departments in Madhya Pradesh, Rajasthan, Punjab, Haryana, West Bengal, Himachal Pradesh, Goa, Karnataka and Kerala.

The Ministry of Information Technology has set up a **Centre for e-Governance** in the Electronics Niketan, New Delhi, to showcase the e-Governance projects successfully implemented by various States and current practices in the area of e-Governance. C-DAC is managing the operations of this Centre apart from show-casing its diverse e-Governance applications along with others. The Centre has received wide appreciation from the various important visitors for its high quality work.

Hospital Information System

C-DAC completed the contract for development and commissioning of the Hospital Information System (HIS) for Guru Tej Bahadur Hospital, Government of NCT, Delhi, covering networking, computers and application softwares. Further, support to the running of HIS on-line at the Sanjay Gandhi Post Graduate Institute of Medical Sciences (SGPGI), Lucknow was provided, with the development of the system on a turnkey basis having been completed earlier.

C-DAC provided support of both hardware and software for the telecom billing system earlier developed and installed for Pune Telecom.

Intranet Based Automation System for DNA Fingerprinting and Diagnostics

A project contract titled " Intranet Based Automation System for DNA Fingerprinting and Diagnostics" was received from the Centre for DNA Fingerprinting and Diagnostics (CDFD), Department of Science and Technology, Government of India by C-DAC, Hyderabad on a turnkey basis. The purpose of the project was to automate CDFD's casework in DNA Fingerprinting process. The hardware installation, networking and software development were successfully completed during this financial year and the acceptance test, training and handing over of the system is being carried out.

Natural Language Processing and Artificial Intelligence

C-DAC has been carrying out developments in this area for providing solutions to a range of applications. Some of the applications on which work has been carried out for specific customers are intelligent information retrieval and analysis, machine aided translation, language learning tools, simulation and so on.

EDUCATION AND TRAINING

C-DAC's **A**dvanced **C**omputing **T**raining **S**chool (**ACTS**), set up in 1993 is dedicated to creating high quality manpower for C-DAC in particular and the IT industry in general by way of designing and delivering various courses in the area of IT. Over the years, ACTS has emerged as a highly sought after institute not only by professionals in the field but also students seeking high quality training from an established and credible institution. Its various courses have been well received and have been very popular among the student community and those seeking quality IT training on contemporary subjects.

ACTS currently offers its courses through its Head office in Pune, its centres in Bangalore, Delhi and Hyderabad and through 96 different Authorised Training Centres (ATCs) spread over India.

Course Counselling Kiosk

A multimedia Course Counselling Kiosk has been developed to help in counselling students who approach our centre for various training needs. A collection of Frequently Asked Questions relating to multimedia courses was used for developing the script. These queries were addressed by multimedia experts from the multimedia centre and recorded on video. The video recording is integrated into the multimedia application. The multimedia application provides information on the entire syllabus of the course, admission procedure and facilities of the Centre.The course counseling application is interfaced with a touch sensitive monitor.

The course options currently offered by ACTS are:

- **Preparatory Course for Diploma in Advanced Computing (PreDAC)**: This course is designed to prepare students seeking admission to C-DAC's advanced course DAC.

- **Diploma in Advanced Computing (DAC**): A post-graduate full time course which aims at developing skills of graduates for the software industry and equipping them with higher value skills in tools and methodologies of software development.

- **Diploma in Information Technology (DIT) and Advanced Diploma in Information Technology (ADIT)**: These courses cater to the needs of students, teachers, executives, government employees, businessmen, professionals, housewives & senior citizens and those who would like to use computers intelligently in their profession, and undertake software development for small and medium size business houses.

- **The Diploma in VLSI Design (DVLSI):** This course trains engineers and electronic science students in various advanced topics of VLSI Design, and is imparted by an expert faculty from C-DAC and those drawn from the field.

- **Cocurricular Diploma in Advanced Computing (CcDAC)**: This is a 3-year part time course consisting of 6 semester terms, which can be taken up by students simultaneously while pursuing a degree or by working professionals, while practicing their profession. The course covers all topics relevant to the needs of the industry for software development.

- **Diploma in Advanced Computer Arts (DACA)**: This full time course is designed to impart knowledge and skills to those seeking to use digital multimedia in their profession such as artists, film production, architects, medical, web design, and is offered by multimedia specialists of C-DAC.

- **Certificate courses in Low Cost Multimedia Creations and Applied Computer Arts (LCMC)**: This is part time course meant for those enterpreneurs who wish to adopt multimedia in their profession such as photographers, video shooting professionals, fine artists, facilitators, event managers, secretariat staff, advertising & publishing professionals.

- **Diploma in Business Computing (DBC)**: This was offered as a specially designed course for two batches of the Army and a new course for the Army in the area of Data Communication and Networking (DCN) was designed and developed at C-DAC.

Sr.No.	Course Name	No. of Centres	No. of Students
01	Diploma in Advanced Computing (DAC)	47	6039
02	Diploma in Information Technology (DIT)	62	21451
03	Advanced Diploma in Information Technology (ADIT)	62	842
04	Diploma in Advanced Computer Arts (DACA)	11	513
05	Co-curricular Diploma in Advanced Computing (CcDAC)	55	1268
06	Preparatory Course for Diploma in Advanced Computing (Pre DAC)	82	279
07	Certificate in Applied Computer Arts	04	66
08	Certificate in Low Cost Multimedia Creations (LCMC)	04	57
09	Diploma in VLSI Design	07	323

Courses and Number of Students registered during the year

As many, as 30,838 students enrolled in more than 95 centres were trained during the year.

HUMAN RESOURCES DEVELOPMENT

Human Resources Department in C-DAC has been restructured with a focus on two distinct areas viz. developmental and classical personnel management functions. All HR processes have been documented with the objective of putting these online and to make these employee friendly. HRIS (Human Resources Information System) with various modules is presently under implementation to make HR processes and systems more meaningful and responsive. To ensure effective induction of new members in the organisation leading to their fast adaptation to C-DAC culture and become productive with out much lead-time, the induction process in C-DAC has been institutionalised.

A mentoring process has also been institutionalised in C-DAC and across all its centers to ensure that the new inductees settle down, progress within the C-DAC culture and derive full benefits through a defined career path. To ensure proper skills development of C-DACians and in the process, contribute to their own as also the organisational effectiveness, a well-defined process of training and development has been laid down. C-DAC's training policy has been formulated and the Annual Training Calendar has been created which forms the basis for all training in C-DAC for its members.
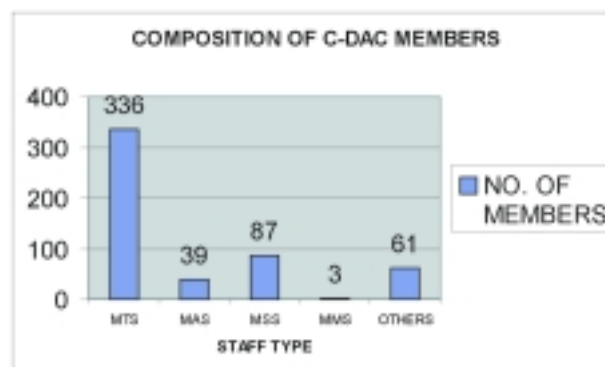
To ensure that employee grievances are attended to promptly and their expectations are met, a system of spot surveys has

been formalized. This also includes periodical meetings between the HR and the groups to assess employee responses and expectations and take follow up HR actions. C-DAC is a very young institution with an average age of 27 across it 550 members, three fourth of whom are technical.

INFRASTRUCTURE and FACILITIES

Head quartered in Pune, C-DAC's operations are spread over its centers in Delhi, Bangalore, Hyderabad, Chennai, Kolkata and Thiruvananthapuram.

C-DAC's new premises in Bangalore, called the C-DAC Knowledge Park, spread over an area of 54,000 square feet were acquired after signing an agreement for the purchase of two buildings and surrounding area from the NGEF, Bangalore in May 2000. The final sale deed with NGEF was signed in July 2000, and its renovation and interiors were undertaken to suit the specific needs of software and hardware activities.

National PARAM Supercomputing Facility (NPSF)

C-DAC's National PARAM Supercomputing Facility (NPSF) within the Pune University Campus in the Science & Technology Park provides supercomputing facilities to industries, research and academic institutes in India that need such a facility to process their diverse compute intensive applications. The PARAM 10000 installed at NPSF makes this facility the largest supercomputing facility in India and one of the largest in Asia. A remote connectivity is available at NPSF for these users who wish to work on it remotely by establishing adequate connectivity bandwidth as per their requirement. A 4-node configuration of PARAM 10000 is also set up at C-DAC's Knowledge Park at Bangalore.

A 64 KBPs point-to-point dedicated leased line data circuit was established this year between C-DAC, Pune and Bangalore to access the facility remotely. This has greatly helped in faster development and testing of the various systems software and applications being developed by various C-DAC groups. Several external users including those from Indian Institute of Astrophysics, Bangalore, University of Chennai, Indian Institute of Meteorology, Indian Institute of Armament Technology, Pune, National Chemical Laboratory, Pune and some of the Departments of Pune University have availed of the facility.

Information Centre

C-DAC has a well-equipped technical library in the form of an information and documentation centre, with more than 7000 books and conference proceedings. The library subscribes to 130 periodicals and to online versions of some journals. There are 2000 bound volumes of periodicals. A reference service is provided to users through the in-house collection, as well as through the Internet search. Techlib is a newsgroup on the C-DAC intranet on which various types of library information is posted. The Library also provides an e-Clippings service on e-mail to select C-DACians from Pune, Delhi, Bangalore, Hyderabad and to the senior officials of the Ministry of Information Technology.

'E Index to EIP' is a CD which has a software developed to give access to the Ministry of Information Technology's monthly journal 'Electronics: Information and Planning'. More than 1500 articles of 27 volumes of EIP could be accessed electronically using this CD. The CD was released during ELITEX- 2001 in February 2001 at Delhi by the Hon'ble Union Minister of Information Technology.

Hindi Cell

With a view to proliferate the use of information technology amongst the larger population in Hindi, C-DAC's commitment is

manifest through the pioneering contributions it has made in developing tools and technologies to enable the use of Hindi on computers. A number of software packages were introduced during the year in addition to the training workshops and seminars that were organized to popularize the use of Hindi.

Vigilance, Greviance and Liason

In accordance with the directives of the government, C-DAC has earmarked its senior members to function as a Vigilance officer, a Greviance officer and a Liason officer for reserved category of members.

WORKSHOPS, SEMINARS and EXHIBITIONS

C-DAC organized a number of national seminars and workshops and participated in exhibitions during the year.

- A workshop on Advanced techniques in Geographic Information System was organized at C-DAC, Pune during August 2000 and February 2001.

- A workshop on High Performance Computing Applications in Bioinformatics was held during August 3 – 4, 2000, at C-DAC, Pune.

- The 'National Conference on Multimedia Technology for Culture' was organized during December 1-2, 2000 with the objective of creating awareness about multimedia and the activities of National Multimedia Resource Centre. The conference was inaugurated by Shri Vinay Kohli, Secretary, Ministry of Information Technology, Government of India.

- A Solaris System Administration Workshop was conducted in August 2000 in C-DAC, Pune for training information technology professionals on effective system administration technology and practices.

- C-DAC hosted a Commonwealth of Learning Sponsored Workshop on Design and Development of Instructional New Media Material" held at C-DAC's Advanced Computing Training School (ACTS) in April, 2001. Twenty participants from various educational and research institutions such as Yashwantrao Chavan Maharashtra Open University (YCMOU), Nashik, Vasantdada Sugar Institute, Pune, Tamil Nadu Agricultural University, Coimbatore, MS Swaminathan Research Foundation, Chennai, Bioinformatics Centre, University of Pune, and C-DAC's Advanced Computing Training School, Pune, participated.

- A six week training on GIS for the officers of the Indian Army was conducted during January - February 2001.

- A five day workshop on VLSI Design was held at Hyderabad during January 2001.

- C-DAC participated in IT COMDEX, held in New Delhi in December 2000 displaying the diverse multilingual range of products.

- C-DAC's participation in the BangaloreIT.com in November 2000 showcased its expertise in e-Governance and allied areas of IT.

- C-DAC participated in ELITEX 2000, organized by the Ministry of Information Technology during February 2001, displaying its expertise in e-Governance and multilingual technologies, including its range of video works products.

- C-DAC participated in the 18th UNICODE conference at Hong Kong during April 2001.

- C-DAC along with the Ministry of Information Technology participated in INDEXPO 2001 in February 2001 held in Dubai. Amongst the products exhibited were language and video products and training courses

- C-DAC participated in the HiPC 2000 event held in Bangalore in January 2001. On display was the PARAM Anant (4-Node Cluster) and visitors to the stall were given a demonstration of the HPCC Software on Linux developed by C-DAC.

- C-DAC participated in the IT-BT Conference and Exhibition organised by Pune Vyaspeeth during December 2000.

C-DAC's members participated in a number of **national and international conferences** including presenting technical papers in some of them. Some of these are listed:

- HPC (High Performance Computing) Asia 2000 at Beijing, China

- SAN Security DC 2000 conference, Washington DC

- SEG (Society of Exploration Geophysicists) 2000 International Exposition, Calgary, Canada

- 17th UNICODE Conference, California, USA

- IBC 2000 Conference, Amsterdam

- Summit 2000, Kathmandu, Nepal

- TeleHealth 2000 Conference, Los Angeles, USA

- SuperComputing 2000, Dallas, Texas, USA

- Conference on High Performance Computing in Meteorology, England

- 21st Asian Conference on Remote Sensing, Taipei, Taiwan

- INEXPO 2001, Dubai, UAE

AWARDS

- ISM 2000 was awarded the 'Best Computer Package in Hindi'. The award was received by Shri. R.K.Arora, Executive Director, C-DAC from Shri. Pramod Mahajan, Hon'ble Minister of Information Technology.

- The Rashtriya Swayamsevak Sangh Jankalyan Samiti (Maharashtra State) announced the Shri Guruji awards and recognised C-DAC for its pioneering contributions in research.

- For the fourth consecutive year, The PC Quest Users Choice Award was conferred on iLEAP for the year 2000.

- Smart Computing Magazine adjudged ILEAP 'The Best Hindi Software' in that category.

- C-DAC was adjudged the winner for the Best Reseller Award by PCI Geomatics, Canada for the year 2000.

- The Business Division of C-DAC was a recipient of the Sunshine Award from Sun Microsystem, Asia South, in recognition of its excellence in performance.

FOUNDATION DAY

The Fourteenth Foundation Day of C-DAC was celebrated on March 26, 2001 on the auspicious occasion of Gudi Padwa, the Maharashtrian New Year day. Shri Vinay Kohli, Secretary, Ministry of Information Technology presided over the function. The Chief Guest, Prof A Paulraj, of Information Systems Laboratory, Stanford University, USA delivered the Foundation Day address and Prof V S Ramamurthy Secretary, Department of Science and Technology delivered the keynote address. They lauded the efforts of C-DAC in its various areas of activity and contribution in Information Technology. Shri.R.K Arora, Executive Director, C-DAC presented the achievements of C-DAC during the year. Messages received from Shri Pramod Mahajan, Hon'ble Union Minister of Parliamentary Affairs and Information Technology and Chairman, Governing Council of C-DAC, Prof. Kasturirangan, Secretary, Department of Space and Chairman, ISRO and Dr. Arun Netravalli, CTO, Lucent Technologies and President, Bell Labs, were read out on the occasion. The Foundation Day witnessed the launch of new products, namely Mercury, Web LILA and C-Vyasa.

On the occasion, C-DAC also organised a cultural evening, 'Darkness To Dawn' a group dance presentation by renowed classical dance exponent Sucheta Chapekar and the Kalavardhini Troupe.

C-DACians who had completed a decade of service in C-DAC were recognized for their dedication to the organization. Other sixteen members were awarded certificates in recognition of their meritorious service to C-DAC.

'Darkness to Dawn' the cultural program on the eve of the fourteenth Foundation Day

WEB PRESENCE

C-DAC's Website can be accessed at www.cdacindia.com. The web site is highly interactive and is updated regularly. At C-DAC, as we have envisioned to lead in all our endeavors, the vision has also been carried forward in the new look of our website with the sole mission of providing a satisfying user experience. Towards the fulfillment of this objective, efforts have been made to make the site aesthetically appealing and highly interactive with leaner file sizes to ensure faster downloads. The site being Streaming-Media and Webcast-enabled, audio-visual presentations of key events can now be viewed online. There is also a customized search engine on the website, developed in-house by the Web team.


This site presently hosts more than 200MB of content and records an average hit-rate of more than 150,000 hits per day, with over 35,000 downloads recorded in the last calendar year. There has been a 40% increase in the hit-rate lately.

Enterprise Wide Connectivity

C-DAC currently has four major Centres located at Pune (Corporate Headquarters), Delhi, Bangalore and Hyderabad and new centres at Chennai, Kolkata and Thiruvanathapuram. Each centre is individually networked, and interconnected with a high-bandwidth, robust Wide Area Network (WAN), to maximally and efficiently harness individual resources, infrastructure and manpower.

The C-DAC enterprise network infrastructure compares favorably with that of many similar organizations and is one of the most modern, providing very high levels of availability backed by tested processes. The design is geared to support rapid expansion in C-DAC's operations and the ever-widening range of activities that require quick acclivity in project deliverables. The C-DAC Local Area Network is based on structured CAT-5 cabling and manageable Fast Ethernet switches which deliver 100 Mbps to each desktop. The network is being migrated to a Gigaspeed backbone with manageable Layer-3 Switches. Leased line connections at Bangalore, Delhi and Hyderabad are already in place and the work of interconnecting other centres is at an advanced stage of completion. Video conferencing links have been established over ISDN between the Pune and Bangalore centres to facilitate easy interaction between technical and administrative staff.
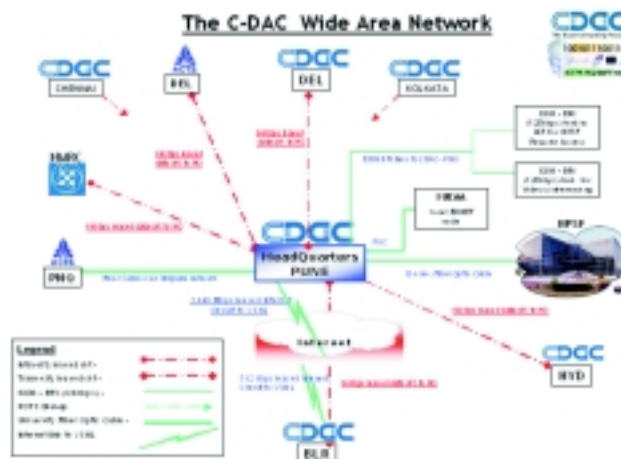
The main Network Operations and Command Center (NOCC) at Pune which serves as the nerve center for inter-connectivity between leased line circuits and the Internet is available round-the-clock to provide stable Web-hosting platforms and to monitor system health. To ensure adequacy of bandwidth and to prevent bottlenecks in data transmission, a 2 Mbps Internet link has been established with VSNL.

Additionally, a standby link has also been established with ERNET for reliable e-Mail access. In the highly inter-connected world of today, since security is of prime concern, C-DAC has ensured it through industry standard security solutions as well as through its own tested and effective security policy. Special care has also been taken to cater to contingencies regarding equipment and site availability, disaster recovery procedures have been formulated, the roles and responsibilities to implement them defined and the resources to tackle outages kept ready.

The C-DAC Network Infrastructure is thus fully geared up to meet the requirement of any project with demanding infrastructure requirements.

ACKNOWLEDGEMENTS

C-DAC would like to acknowledge and thank Shri Pramod Mahajan, Hon'ble Minister of Parliamentary Affairs and Information Technology and Chairman of the C-DAC Governing Council; Shri Vinay Kohli, Secretary, Ministry of Information Technology and Vice Chairman of the C-DAC Governing Council and Chairman of the Steering Committee for their continuous support, guidance and encouragement. C-DAC would also like to thank Dr. A.K. Chakravarti, Advisor, Dr. Om Vikas, Sr. Director, Shri W.R. Deshpande, Sr. Director, Shri J.S. Maini, Joint Secretary & Financial Advisor, and Smt. P.M. Singh, Jt. Secretary and other officials in the Ministry of Information Technology, Government of India, for their cooperation and support. C-DAC would also like to place on record its appreciation to the officials of Department of Official Language, Department of Science & Technology, Department of Scientific and Industrial Research, Department of Biotechnology and University of Pune for their understanding and support. C-DAC would also like to take this opportunity to express its appreciation to all its valued clients and associates.

Inauguration of C-DAC's Fourteenth Foundation Day: (l - r) Dr. S.C. Purohit, Director-Protem C-DAC, Acad. Belotserkovskii, Director ICAD, Moscow, Prof. V.S. Ramamurthy, Secretary DST, Govt. Of India, Prof. A. Paulraj, Information Systems Laboratory, Stanford University, U.S.A., Shri Vinay Kohli, Secretary MIT, Govt. Of India and Shri R.K. Arora, Executive Director C-DAC.

Prof. V.S. Ramamurthy releases C-VYASA at the 14th Foundation Day. Also seen (l-r) Prof. A. Paulraj,Shri Vinay Kohli and Shri R.K. Arora.