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CDAC

ANNUAL REPORT
2008-2009

CENTRE FOR DEVELOPMENT OF ADVANCED COMPUTING

Governing Council

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Overview

From its mission of building indigenous supercomputers in 1988, C-DAC has progressively grown and enhanced its competencies in other areas of ICTE such as Multilingual Computing, Software Technologies, Electronics, RF, VLSI-ASIC and Hardware design of specialized industrial products. C-DAC has built an effective eco-system and institutional framework for innovation, market-oriented technology and product development, delivery, deployment and transfer of technologies in several niche areas of national importance. Through in-house research and in synergistic collaborations with Academia, Research Labs and Industry in India and abroad C-DAC has converted many promising ideas into practical tools, technologies, products and services to meet the needs of industry and end-users in Scientific and Engineering, manufacturing and service, government, health and other strategic sectors. With its focus on applied research and development, C-DAC continues to concentrate on innovation and development of solutions that either impact large public or make a big difference in cost or performance or contribute to better quality of life by offering new functionalities.

During 2008-09, C-DAC consolidated the activities conceived during 2007-08 under six broad thematic areas of technology namely High Performance Computing and Grid Computing, Multilingual and Heritage Computing, Software Technologies and FOSS, Professional Electronics VLSI and Embedded Systems, Cyber Security and Cyber Forensics, Health Informatics. A few representative activities in each of these areas are below:

HIGH PERFORMANCE COMPUTING (HPC) and GRID COMPUTING

The emphasis is on designing HPC systems using off-the-shelf components such as CPUs and storage along with in-house designed hardware such as high speed networks and accelerators, system software such as light-weight communication protocols, program development environment, and facility management tools; and a range of application software to solve specialized numerical analysis and complex mathematical problems which necessitate a massively parallel computing environment. Integration of several HPC systems with a high-bandwidth backbone network to create a national grid infrastructure is also being pursued.

Hardware

- PARAM -YUVA Parallel Computing Cluster along with various subsystems (system area network, accelerators, memory and storage, support software, mechanical housing, cooling, ergonomics, etc.)
- Design and deployment of multi-node clusters for scientific and academic research
- GARUDA Service Oriented Grid Architecture and Network connecting 45 institutions in 17 cities country-wide, enabling powerful shared computing resources

Software

- System software for parallel computing, scheduling and resource management

- Open Grid Standards, Web Services Resources Framework

- Application software in the domains of computational fluid dynamics, weather modeling, atmospheric sciences, structural mechanics, seismic data processing, bioinformatics, and evolutionary computing

- GARUDA applications demonstrated for e-learning, disaster management, molecular docking, and computer-aided engineering

Multilingual and Heritage Computing

Activities in this area continued towards enhancing the features of already developed tools and technologies and development of new tools for increased use of IT in Indian languages. These include

- Comprehensive Indian language support for all computer applications

- English-to-Indian Language Machine Aided Translation Systems using different approaches

- Text-to-Speech Synthesis tools and technologies for PC and Embedded System applications

- Optical Character and Handwriting Recognition (off-line and on-line versions)

- Technical support to Govt. of India for standardizing Internationalised Domain Tables

- Indian language software tools to empower the physically challenged

- Analytical tools for study of manuscripts portraying India's rich heritage

SOFTWARE TECHNOLOGIES AND FOSS

Development and deployment of software tools, technologies and solutions continued in the areas of Software engineering, e-Governance, Web services, Geomatics, Multimedia computing, Operating Systems, and Digital library. NRC-FOSS activities aim at establishing and processing viable alternatives to MS-WINDOWS. These include

- GIS based application for land resource mapping

- A range of tools for E-governance applications

- E-learning tools for Education, Quality Assurance, and Collaborative classrooms

- Business software development projects in various user domains and applications

- Consolidation of Open Source Software into a single Indian-language enabled CD called BOSS, enabling use by SMEs and Govt. departments

- BOSS Linux Advanced Server for office environment

- Development of low-cost ERP modules using Boss-Linux platform

- Rural empowerment through India Development Gateway (InDG) - hosting information on key livelihood sectors in six Indian languages

- E-governance Service Delivery Gateway at national and state levels.
- Digital library of India Megacentre, with 14 million pages of rare and copyright free books (35,000+) from Eastern and North-Eastern India, with functions for indexing, searching, and metadata creation.

PROFESSIONAL ELECTRONICS, VLSI AND EMBEDDED SYSTEMS

This area includes design of hard-core circuits, hardware, signal processing algorithms, firmware etc. for electronics products and systems. The R&D work focuses on development and validation of various re-usable Intellectual Property modules applying them in various electronics systems. The broad areas of Power Electronics, Advanced Wireless Communications, VLSI, Embedded Systems, Acoustics and Ultrasonics, Control and Automation Systems are covered. Some major activities include :

- Software Defined Radio
- TETRA Professional Mobile Radio - technology and product development, deployment for Police, Disaster Management, etc.
- Static Power Converters for power quality improvement, Traction, Transportation
- Area Traffic Control Systems for urban cities, Vehicle Tracking Systems
- Smart Sensors and Sensor Networks, RFID Technologies
- ASIC Intellectual Property Cores for embedding into System-on-Chip
- Product designs for Complex-Compact-Cost effective high volume products such as Digital Programmable Hearing Aid, Medical Endoscopy Camera
- Ultrasonics technologies and products for Non-Destructive Testing, Mine Detection, etc.
- Professional electronic systems for Automotive, Nuclear medicine
- Agri-electronic products and systems for tea, sericulture, etc.

CYBER SECURITY AND CYBER FORENSICS

To assist in the enforcement of IT Act and to build up expertise in tackling the menace of cyber crimes, C-DAC became a major partner of E-Security Division of DIT for research and product development. Major activities are

- CyberCheck, indigenously developed software suite for digital evidence acquisition and analysis by law enforcement authorities, acceptable in a court of law
- Tools for analyzing network log files, analyzing and reconstructing digital data from sessions of captured network data
- PDA Imager and Analyzer for analyzing WinCE and Palm OS based PDAs and Smart Phones
- SIM Card Imager and Analyzer for analyzing GSM based SIM cards of mobile phones,
- Call Data Record Analyzer for analyzing Call Data Records of cell phone service providers
- High-speed hand-held devices for disk imaging, write protecting of storage media while acquiring digital evidence
- Steganography Suite to detect image files with hidden text messages
- Face Recognition Software tools

- Cryptanalysis tools using parallel computing technology
- Resource Centre for Malware analysis
- Network Intrusion Detection technology using Honeynet
- Enterprise Forensics and network security assurance products

HEALTH INFORMATICS

C-DAC has a range of telemedicine products, for Open Source, Windows-based, Web enabled and point-to-point, Enterprise specific requirements. Many solutions have been installed in various parts of India including the north east. These products were further enhanced in functionality and features. Some research projects under way are

- A national framework for distributed Electronic Medical Record (EMR) storage
- Design and Engineering of a fully equipped Mobile Telemedicine Van for Tele-oncology
- Health Management Information Systems for both rural and urban community
- Information and Data management Systems for hospitals
- Detection of Cervical Cancer by digital cytopathology
- Achieving compatibility of Electronic Health and Medical Records with HL7 and DICOM Standards
- Decision support systems for public health authorities and general public in case of disease outbreaks.

EDUCATION AND TRAINING

Besides technology development, C-DAC is engaged in Human Resources Development in the area of Electronics and Information Technology, with a range of educational programmes. The activities are aimed at enhancing the technical skills of young people at graduate level. Employment-oriented capsule programmes and diplomas in specialized software areas such as Embedded Systems, Geomatics, Cyber security, Enterprise Resource Management, Language Technology and Localisation, .NET, JAVA, JSP, IBM Mainframe, etc. offer value-addition to students and employed professionals to enhance their career prospects. These programmes are conducted either directly by C-DAC Centres, or through Authorised Training Centers. Besides the above, various C-DAC Centres also offer M.Tech programmes in VLSI and Embedded Systems. The M.Tech, MCA and MBA Programmes are all recognised by AICTE, and affiliated with reputed Universities such as CUSAT, Indraprastha University, etc.

INFRASTRUCTURE

During the previous year, the parent Ministry approved construction of new buildings at Pune, Thiruvanthapuram, Chennai, New Delhi and Hyderabad to address the infrastructure needs of the respective centres. Building construction work is progressing well at various centres.

Technical Activities

HIGH PERFORMANCE COMPUTING AND GRID COMPUTING

High Performance Computing (HPC)

PARAM Yuva: C-DAC's latest HPC System:

Centre for Development of Advanced Computing (C-DAC), a premier R&D Institute of the Department of Information Technology, Ministry of Communications and Information Technology, Government of India is engaged in the design, development and deployment of High Performance Computing (HPC) Systems and Solutions. Over the past two decades, C-DAC has delivered a series of PARAM supercomputers and has built national capabilities to make use of supercomputing technologies for human enrichment. PARAM Yuva is the latest addition to the series. This system with sustained performance of 37.80 TFs and peak performance of 54.01 TFs has ranked 68th in the coveted list of Top 500 supercomputers of the world.

Housed at C-DAC premises in Pune University Campus, PARAM Yuva is a quad core, quad socket node based compute cluster with multiple interconnects, hardware accelerators, high performance storage and supporting softwares for parallel computing. Arranged in 19" racks occupying 5000 sq.ft space, the ecosystem is designed for power efficiency and optimal cooling. In the PARAM series of supercomputers, Yuva is a next step towards creating a general purpose research-oriented computational environment architected to solve bigger problems and provide an opportunity for scientific breakthroughs.

Along with off- the-shelf building blocks, PARAM Yuva uses several indigenously designed components. These include:

- PARAMNet System Area Network
- Reconfigurable Computing System (RCS) technology based performance accelerator cards
- A suite of System Software, and
- A wide range of Application Software

Supercomputers are an important tool for scientists and engineers of all disciplines to carry out state-of the-art research in their respective domains. Some important application areas in which they will utilize the power of PARAM Yuva for solving grand challenge problems are:

- Bioinformatics
- Computational Chemistry
- Computational Fluid Dynamics
- Computational Atmospheric Science
- Disaster Management
- Seismic Data Processing

Research activities carried on PARAM Yuva in above areas will have several benefits to the common man such as:

- Advance prediction of natural calamities like Tsunami, Earthquake, Cyclone, and Flood, to enable governments to take precautionary measures
- Highly precise weather and monsoon forecasts for the benefit of the agrarian community
- Customized and affordable medicines for better healthcare
- Smart vehicles that ensure passenger safety in case of accidents
- Stronger composite structures and materials to ensure durability and safety

PARAM Yuva is an intermediate milestone of C-DAC's HPC roadmap towards Petaflop Computing.

PARAM Yuva

Hardware Technology Development

The year 2008-09, witnessed significant achievements in the design and development of products which are the outcome of intense R&D efforts for last three years requiring expertise in areas of System Architecture, Hardware Design, VLSI Design, Software/ Firmware Design, Design Validation and Testing, Industrial Design and Packaging, System Integration, Testing and Benchmarking. The details of these products and related significant achievements are as under:

a) System Area Network: PARAMNet-3 @10Gbps

PARAMNet-3 is a high performance cluster interconnect network developed indigenously by C-DAC over the last three years. With the development of PARAMNet-3, C-DAC has joined an elite group of system developers worldwide (mostly in Europe and US), capable of supplying a critical high performance component for building Supercomputers. Main application of PARAMNet-3 is PARAM Yuva. Other application areas identified for deployment of PARAMNet-3 are storage and database applications.

PARAMNet-3 has tightly integrated hardware and software components. The hardware components consist of Network Interface Cards (NIC) based on fourth generation communication coprocessor "GEMINI" and modular 48 Port Packet Routing Switch "ANVAY". The software component "KSHIPRA" is a light weight protocol stack designed to exploit capabilities of hardware and to provide industry standard interfaces to the applications. PARAMNet-3 is already deployed on:

- A 16 Node Synergy Linux Cluster (3 TF) at Hardware Labs, Pune Centre.

- PARAM Shirsh (4 TF) System at NEHU, Shillong.

It is deployed on 48 Nodes of C-DAC's PARAM Yuva 54 TF Cluster System commissioned in November 2008 at newly created National PARAM Supercomputing Facility (NPSF) on the ground floor of the Main Building at pune.

Paramnet - 3

PARAM Yuva with PARAMNet-3

b) Reconfigurable Computing System (RCS) :

Reconfigurable Computing (RC) is an innovative way of speeding-up HPC applications by dynamically configuring hardware to suite algorithms or applications deployed for the first time on PARAM Yuva.   A great advantage that RC brings compared to other technologies for application acceleration is tremendous savings in terms of power and space at the same time increasing application performance by many folds.

HPC community is keenly observing RC technology to bridge the supercomputing needs. These new supercomputers for parallel and distributed processing use both, reconfigurable hardware resources as well as conventional microprocessors. C-DAC is one of the pioneering organizations that bring RC technology to the country. The RC activity includes the design and development of the latest RC hardware, system software, and hardware libraries that enable application acceleration on the cluster.

RCS-III:

In order to enhance the computing power and I/O bandwidth of the present RCS, HTDG has developed RCS-III. The development includes- design of RCS-III hardware, hardware library functions and system software. Preliminary performance benchmarks are encouraging, showing up to 150x speedup compared to purely software solution. The value of speedup depends upon the application and platform (node) selected.

Present status:

- Assembly, integration and testing of 16 RCS-III cards has been completed.

- Design of software environment- device driver, library, administration scripts and usage documentation completed.

- Completed the following:

    (i)   Development of sequence search hardware library

    (ii)   Application testing and Benchmarks on Super-micro 2.8 GHz Intel Xeon and HP DL580G 2.93 GHz nodes

    (iii)   Successful deployment of 16 RCS cards in a 16-node cluster comprising of quad-core-quad-cpu HP DL580G5 system as a Compute Node.

    (iv)   Additional performance analysis/ runs is in progress.

RCS-IV:

In order to provide acceleration for small size servers, a small form factor RCS is desired. To cater to this need, design of RCS-IV is undertaken.

c)   Industrial Design, Packaging and Engineering of PARAM Yuva System:

The 54TF PARAM Yuva is the next step in the evolution of the PARAM series of supercomputers. It incorporates several innovations and incremental improvements over the previous generations resulting in a free, open (mechanical) architecture and easier installation and maintenance.

The entire PARAM Yuva was conceptualized, built and deployed within a period of 6 months. The activities spanned the entire gamut including de-commissioning and dismantling of existing infrastructure, updating of site to suite the PARAM Yuva concept and the actual building and commissioning of the machine. The entire computing facility occupies approximately 3600 sq-ft with the machine room occupying approximately 1400 sq-ft. of floor space.

The PARAM Yuva is housed in specially designed 19" cabinets in six rows of eight cabinets each. The cabinets incorporate custom rear extensions that make both network and power cabling easier without the need for threading the cables through the cabinet frame.

While the power supply is from the bottom of the cabinets, all four types of network cabling (PARAMnet, Infiniband, Gigabit Ethernet and Fast Ethernet) are done above the cabinets in specially designed horizontal and longitudinal trays. This design prevents cables from intersecting each other and makes cable maintenance easier. The updated site has 2 x 400 kVA UPS, 2 x 625 kVA DG set and a 150 T (5 x 30 T) precision cooling for the facility. A cold aisle containment concept is used for cooling the system, with the hot exhaust mixing with the ambient air before returning to the PAC. The machine has been successfully run and tested to 77% capacity during LINPAC runs, which appears to be the limit for the current cooling design.

The facility also has an updated NoC and a machine control room for round-the-clock monitoring of the system.

PARAM Yuva Cluster

d)   PARAMNet-3: 16 Port Switch:

The 16-port PARAMnet-3 switch was specially developed for the education and research segment as well as for the export market; several switches have been deployed as part of C-DAC's HPC solutions across India and abroad. This innovative packaging uses the same and proven PCBs and power supplies as the larger 48-port switch deployed in the PARAM Yuva, resulting in faster product development times and minimal electronics development.

e)   16 Nodes Linux Cluster called Synergy:

HTDG has installed, commissioned and tested a 16 Node Linux Cluster with PARAMNet-3 as the Primary Interconnection Network. It's peak computing power is around 3 TFs. The cluster is being used as a Test Bed for Hardware and Software / firmware developments carried out by HTDG members.

The Synergy Cluster has ranked at No.9 among India's Top Supercomputers' List published by SERC, IISC, Bangalore during HiPC 2008 Conference held in December 2008 at Bangalore.

National PARAM Supercomputing Facility (NPSF)

NPSF activities during the year were focused primarily towards commissioning of the new PARAM system (PARAM Yuva) in C-DAC's Main Building, Pune University Campus. This included the following activities:

- Site preparation activities including site layout, power sizing, cooling setup, and placement of system stacks.
- System integration of components and sub-components including computing, networking, storage, and other resources into a unified supercomputing system.
- Proper configuration of the system to ease its usage as a cluster. The cluster was partitioned into three types of nodes – login/ compile nodes (10 nos.), compute nodes (262 nos.) and storage nodes (16 nos.). Login/ compile nodes are used for access and storage of the cluster and for editing-compiling-debugging of jobs/programs. Compute nodes are used for executing long running/ production jobs and are accessible only through the commands provided by the job submission/ batch-scheduling interface. Storage nodes were populated with maximum possible disks (8 disks per node) and a single storage space of 12TB was created using the Lustre open source parallel file system across the nodes. A benchmarking exercise using IOR benchmark on the storage space indicated a performance of about 2.8 GB/s sustained aggregate write

bandwidth to a single file.

- Benchmarking the system for registering its performance in the list of Top 500 Supercomputers of the world. The system was ranked 68th in the Top 500 list in November 2008.
- Testing the system and tuning performance of various scientific and engineering applications on it. These include performance tuning and scaling of Bioinformatics code "MEME" and weather code "WRF" on more than 4096 cores of the system.
- Developing a web application for secure remote access of the system. The developed application gave system's command line access - terminal emulation over the secure web (secure HTTP - https) protocol.
- Developing/customizing and installing required tools for monitoring and management of smooth operations of PARAM Yuva facility. These include tools for cluster management and monitoring, environmental parameters monitoring, and UPS load monitoring. The team also developed an auto notification mechanism, which sends alarms/ alerts in the form of SMS to mobile handsets of designated responsible members in case of emergencies.
- Configuring Ganglia open source software to monitor utilization of CPU, memory, network, and storage. resource utilization of PARAM Yuva cluster while executing Weather code "WRF" and Bio-informatics code "MEME" on 256 nodes of the cluster.

National PARAM Supercomputing Facility (NPSF)

High Performance Computing Solutions Activities:

Creation of Centre of Excellence at North East Institute of Science and Technology, (NEIST) Jorhat

C-DAC has installed Linux based state-of- the art High Performance Computing (HPC) PARAM Facility at North East Institute of Science and Technology, Jorhat. The system will be backboned by C-DAC's indigenously manufactured High Speed Low latency PARAMNet 3 Interconnect. This facility will help the NEIST scientific community for conducting research in Seismic Data Processing and other scientific applications involving large data sets. Two C-DAC engineers from the application team are working with NEIST scientists for developing the application. This facility shall serve as a research platform and assist in Early Warning System for Dissemination of Scientific Data to publicize hazard related information on a real time basis.

Centre of Excellence in HPC, Hanoi University of Technology, Vietnam.

A state of the art HPC Solution consisting of Compute Nodes, High Performance Storage, High Speed Interconnects which includes C-DAC's high speed low latency interconnect PARAMNet 3 as Primary, Infiniband as Secondary interconnect and Gigabit network for storage, management, Visualization nodes etc, shall be deployed at Hanoi University of Technology, Vietnam. A set of mutually agreed high end scientific applications in the field of Bioinformatics, Computational fluid dynamics, Finite Element analysis etc, will also be deployed and demonstrated.

PARAM based Centralized High Performance Computing Facility at North-Eastern Hill University, Shillong.

A PARAM based centralized HPC facility has set up at North East Hill University (NEHU). This includes 4 TF HPC with PARAMNet 3 as the primary interconnect, Infiniband as secondary along with 36 TB of storage and related system software. The value addition for NEHU includes one application Scientist and one System Administrator onsite for a period of one year. C-DAC's indigenously developed HPC Portal 'CHReME' and state of the art Data Centre have also been installed. The facility was inaugurated by Prof. M. G. K. Menon, Chancellor, NEHU.

Indian Institute of Tropical Meteorology, Pune

C-DAC has completed the installation of HPC facility having a peak performance of approximately 2.5 Tera Flops, 48 Terabytes of High Performance Storage space and high speed Infiniband as the primary interconnect. This infrastructure will be housed in Data centre designed and implemented by C-DAC. An Application Engineer from C-DAC will be deputed onsite for application support, parallelization and porting of the mutually agreed applications, which shall enable quality research in the area of tropical meteorology using various codes like Hirham, Précis, MOM4, and COSMOS. C-DAC has also supplied and Installed PBS Pro scheduling software for 256 cores with three years of support and updates.

Jawaharlal Nehru University, New Delhi

C-DAC has set up a state of the art High Performance Computing facility for Parallel Computing at JNU, New Delhi. The installation of facility is completed and a systems support engineer has been deployed at site for a period of one year. Research in the areas of Bioinformatics and Life sciences are being carried out using this facility.

National Institute of Oceanography, Goa

A Memorandum of Understanding was signed between C-DAC and NIO; after considering the IT opportunities in various departments of NIO. The current projects undertaken are fully functional Data Centre, HPC facility in Seismic and IT Groups, LAN audits etc. Joint collaboration projects in the fields of scientific projects which include the areas of Ocean Modelling, Seismic data exploration, Visualization, Computer Aided Taxonomy information system etc, have been initiated.

Physical Research Laboratory, Ahmedabad (Consultancy)

C-DAC has signed a Memorandum of Understanding with PRL, Ahmedabad for establishing a HPC Infrastructure having a peak performance of 3 Teraflops with approximately 10 TB of storage. C-DAC is providing consultancy services to PRL for the procurement and deployment of HPC System and deployment of an Application engineer for a period of one year. The scope of the project includes providing consultancy, setting up of a state of the art HPC facility, and onsite application engineer support and data centre. The facility shall be used for education and research purpose in the areas of Space and Atmospheric Sciences, Astronomy and Astrophysics, Theoretical Physics, Planetary and Geosciences.

NCMRWF, Noida

National Centre for Medium Range Weather Forecasting, Noida has a 28 Nodes HPC Cluster which will be installed and commissioned by C-DAC in 2009 using C-DAC's earlier version of interconnect PARAMNet 3. This system is being used in production environment to predict Weather on a daily basis. C-DAC has been managing the HPC support and maintenance of the facility. High Performance storage is being upgraded to 80 TB in May 2008.

Bharathidasan University, Tiruchirappalli

C-DAC has completed installation of 6-Node and 4-Node HPC Cluster for the Bioinformatics and Physics Departments respectively, this will act as a test bed for the up coming 36 Node Cluster for the Physics department and 50 Node cluster for Computer department.

A HPC system having 36 Nodes with a capacity of 3.17 Teraflops peak performance with 10TB storage will be deployed at Physics department, Bharathidasan University, Tiruchirappalli. Technical Evaluation is in process

National Chemical Laboratory (NCL)

C-DAC has completed installation of 8-Node for the Chemical Catalyst Department at NCL. C-DAC has proposed an upgradation of the existing 8-node HPC Cluster with 10TB SAS storage and 8 compute nodes by realizing the existing requirement.

University of Hyderabad

A network attached storage of 10 TB, a combination of SATA and SAS was provided to University of Hyderabad. This is to be attached to the existing cluster at University of Hyderabad.

NBRI, Lucknow

An MOU has been signed between C-DAC and NBRI, Lucknow for setting up a state-of-art HPC facility with facility management service for 3-years. The project of mutual interest is being undertaken for the next 3-years.

Scientific and Engineering Applications

(a) Computational Atmospheric Sciences (CAS)

For the regional coupled ocean-atmosphere project (DST sponsored) in collaboration with IITM, Pune, two ocean models ROMS and HYCOM spinups and model simulations were completed. Atmosphere-Ocean model coupling strategy for WRF-ROMS model has been developed. The multiyear-coupled runs for prediction skill analysis have been carried out. The coupler passes the Sea Surface Temperature from ROMS to WRF and Net Radiation flux, Wind stress and Shortwave radiation from WRF to ROMS
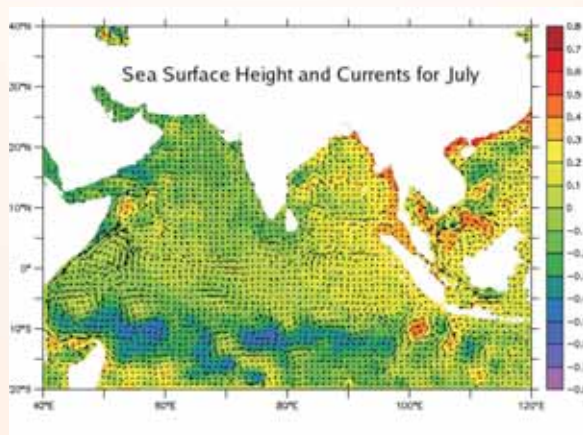

Simulation of Sea Surface Height and Currents

C-DAC is participating in a multi-institutional Indo-US S&T Forum project "Knowledge R&D Networked Centre for Nanoparticle Aerosol Science and Technology (NAST)". This virtual Centre is created with several faculty from IIT Bombay, three partner institu-

tions in the USA: Washington University in St. Louis; University of Iowa; the University of Maryland, and C-DAC, Pune. The science plan and initial development work for STEM model implementation using PARAM Supercomputer is underway.

The latest version of STEM model along with the required pre/ post processing tools has been obtained from University of Iowa and installed at C-DAC. The model and code is being studied to understand its emission data requirements so that the latest emission inventory from IITB can be formatted as input for the actual simulations. Similarly, the existing preprocessor for WRF data is being studied for any requirement of optimization/ up gradation to latest WRF version. Iowa scientists along with IITB scientists visited C-DAC Pune to discuss and design the WRF-STEM model experiments As part of its activities under Urban Air Quality modelling, C-DAC has evaluated the state-of-the-science Community Multiscale Air Quality (CMAQ) Model developed for the US Environment Protection Agency for application over Indian cities.

C-DAC in collaboration with IIT Mumbai and PRL, Ahmedabad is participating in the project "An atmospheric simulation platform for analysis of regional-scale aerosol-climate interactions: Application to ISRO-GBP observational campaigns" under the ISRO-Geosphere Biosphere Program. Model status: The ECHAM5 model was selected for use in this project on the basis of its detailed aerosol module, well represented sulfate chemistry, the option for using user prescribed aerosol optical parameterization, the latest version of ECHAM5 model with aerosols (ECHAM5-HAM 5.3.2) at C-DAC. Sample data was obtained with the help of an MPI researcher and model was set up for T63 resolution. A sample run of one month duration has been carried out at this resolution for January 2009.
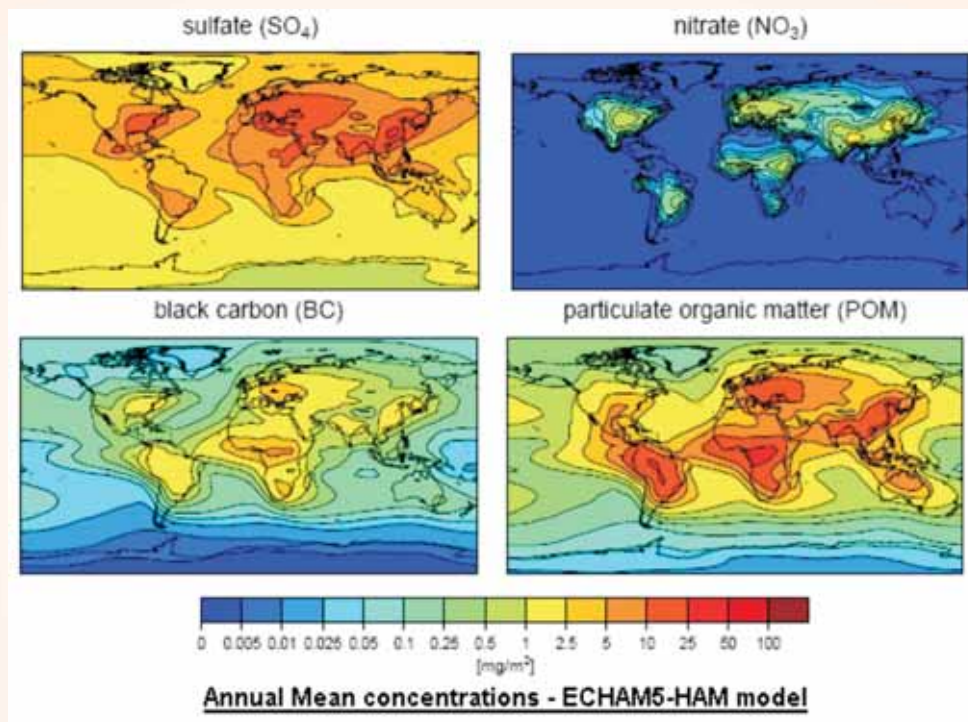

Annual Mean Concentrations-ECHAM5-HAM Model

For the project entitled "Assimilation of OceanSat-2 derived winds in mesoscale models using advanced assimilation techniques" sponsored by Space Application Centre, ISRO, multi-cyclone events were simulated using WRF and RAMS model.

Under the EU-Indiagrid project, C-DAC has completed implementation of RegCM-ROMS and WRF_AERMOD system on Garuda and EGEE grid resources.

Kerala State Planning Board has awarded 'real time weather information' service for Allapuzha district project. C-DAC has simulated multi-season multi-category short range weather forecast using high resolution weather forecast model.
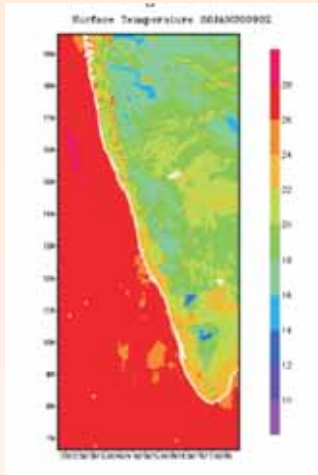
Simulation of Surface Temperature

C-DAC has initiated development of meteorology and air quality modelling database development. This data portal will facilitate access to regional and global atmospheric model output, ocean model output and air quality model output with metadata creation, visualization and download facility.

C-DAC has submitted research publications based on Agni simulation by WRF model, Maharashtra rainfall climatology, real time validation of weather forecasts obtained from mesoscale model WRF for the year of 2007 to test its applicability for aviation planning and operation, PM10 modelling using WRF-Chem model for Pune City, QPF method for Koyana rainfall prediction.

**(b) Computational Fluid Dynamics (CFD)**

C-DAC has worked in major applications areas of CFD and heat transfer with special emphasis on the effective use of HPC systems in solving complex research problems. Some of the key activities carried out during the current year are described here.

i) Computation of flow over a Wind Turbine blade

A computational intensive project with a company was completed with the dual objectives - reduced computational time and superior aerodynamic analysis. The work involved computation of three dimensional (3-D) flow over a single blade of a wind turbine with three million cells.


A three blade wind turbine blade
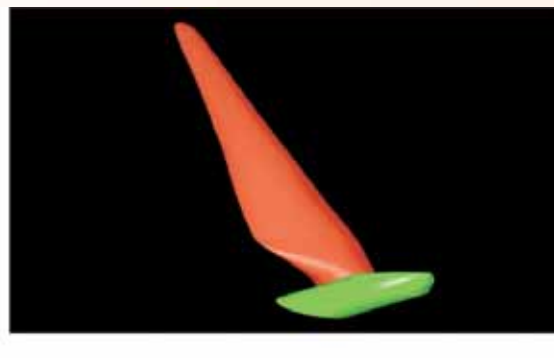
Model of a 40m wind turbine

Aerodynamic performance: Skin friction coefficient

ii) Flow predictions in a passage of transonic compressor rotor

As a part of the collaborative project with IIT-Bombay, additional simulations on parallel platform were carried out deploying the computational resources from PARAM Padma. This involved fine-tuning and enhancement of the earlier solution and reanalyzing the new data for enhanced understanding of complete flow field in a transonic axial compressor rotor. The figures below depict the tip leakage flow behavior for two different operating conditions.
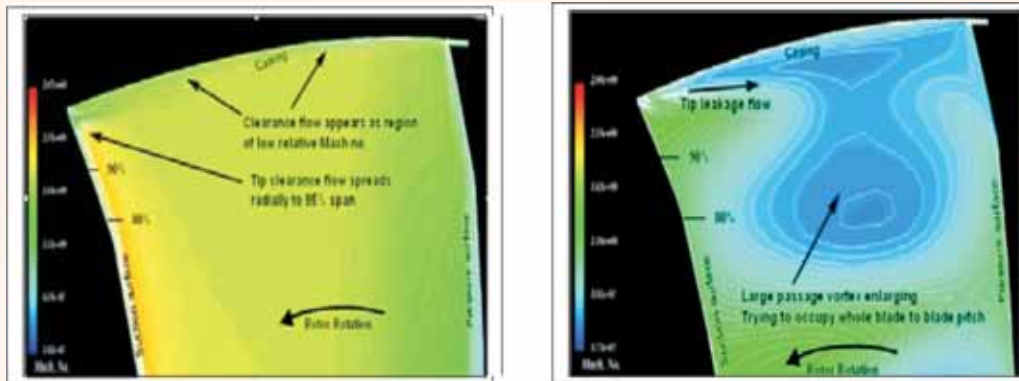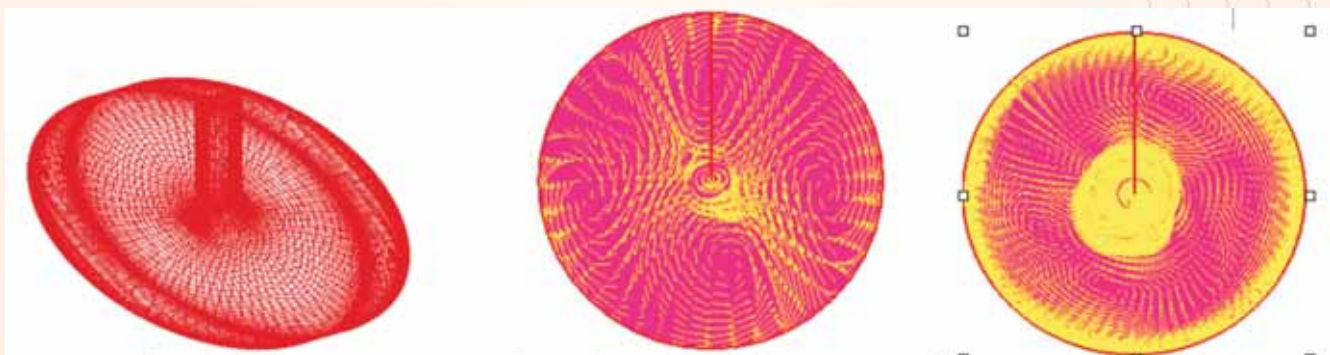

Peak efficiency condition   *Stall condition*

Radial Development of Flow Due to Tip Clearance at 20% chord

iii) Conjugate heat transfer of compressor disc cavity of an aero engine

High performance computing was jointly undertaken with a faculty member from College of Military Engineering, Pune, for calculating flow profile in a compressor disc cavity.

Computational grid   *Laminar flow simulation*   *Turbulent flow simulation*

iv) 3-D heat transfer and fluid flow model for cooling of a single egg under forced convection

Shell eggs are cooled under forced convection in commercial egg coolers. Accurate estimation of egg temperature under various storage conditions would assist egg processing industries to evaluate the adequacy of the egg chilling unit operation to assure food safety. In order to determine the Centre temperature of a shell egg under transient forced air convection cooling condition, numerical simulations were carried out using a finite volume based CFD model. Conduction heat transfer was solved inside the egg and convective heat transfer was solved in the fluid domain.

The fluid flow was solved first under steady state condition and the steady flow field was used to compute transient temperature of the egg to reduce computation time. The CFD model was validated by comparing the results with experimental observations. The root mean square error of the egg Centre temperature predicted by the CFD model varied from 0.2 - 0.9 $^{\circ}$C at constant inlet air temperature. The validated CFD model was used to study the effects of air velocity on egg Centre temperature under forced convection cooling.

v) Benchmarking, implementation and deployment of CFD application on PARAM Yuva

C-DAC, Pune and Zeus Numerix Pvt Ltd (ZNPL), Mumbai are currently involved in testing and benchmarking of a grid generation and parallel CFD solver code implementation on Param Yuva.

vi) CFD software tool distribution

The PHOENICS CFD software was made available and supplied to BARC, Mumbai for meeting their Tsunami related studies / applications. The software was installed and commissioned. Further, individual group training was provided by C-DAC personnel to the members of BARC for efficient usage of the tool.

(c) Computational Structural Mechanics (CSM)

The INTCOMP package was launched during the 21st foundation day of C-DAC (April 2008). INTCOMP is a Finite Element based application for stress analysis of plate/shell structures of fiber-reinforced composite materials. The GID pre and postprocessor have been integrated with INTCOMP. The process of adding vibration and buckling analysis modules in INTCOMP v1.0. is in progress.

In Earthquake Engineering domain, C-DAC is working in collaboration with SGSITS-Indore on Computer Aided Seismic Analysis and Design of Concrete Structures. The coding of dynamic analysis of Slab and Beam is under progress. The 10 month project "Non-Linear Earthquake Analysis of R/C Framed Buildings" has also been completed. The study of IDARC software, for nonlinear earthquake engineering analysis, has also been carried out

In collaboration with SGSITS-Indore, C-DAC has undertaken the development of EQ-Check v1.0, which will help to tackle problems, related to checking and design of earthquake resistant structures, potentially saving money, structures and lives. The EQ-Check is the software for computer aided seismic checking and design of concrete structures and it was launched during the March 2009

Under the Earthquake Engineering - Public Domain software activity, porting and benchmarking of OpenSees software on PADMA and Xeon Cluster has been carried out. C-DAC acquired GID software and it is in use for data generation and visualization of simulation results.

C-DAC has started a project with IIT-Guwahati, on Optimum Design and Active Vibration Control of Smart FRP Structures on Parallel Platform. This project is of two years duration and is sponsored by DST.

Under EU-India Grid Project, C-DAC has, ported OpenSees and SMART codes on the grid, and report is submitted.

Under ILTP-RICCR-ICAD-C-DAC Joint Project Proposal on Development and parallelization of numerical methods for the non-linear analysis of complex structures is submitted. This is in continuation with the long term association with ICAD-Moscow.

Structural Damage due to Earthquake

EQ-Check GUI
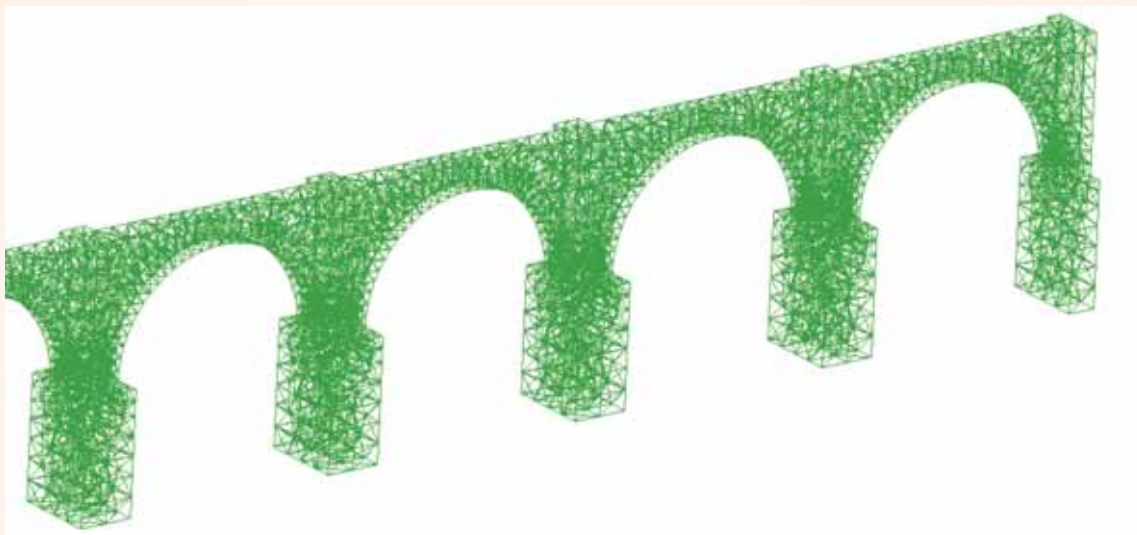
Bridge modeling using GID and Simulation using OpenSees

(d) Seismic Data Processing (SDP)

Seismic Data Processing (SDP) is important for imaging underground geological structures and is being used all over the world to detect the presence of petroleum deposits and to probe the deeper portions of the earth. Large data volumes and complex mathematical algorithms make seismic data processing an extremely compute and I/O intensive activity which require high performance computers with a large memory.
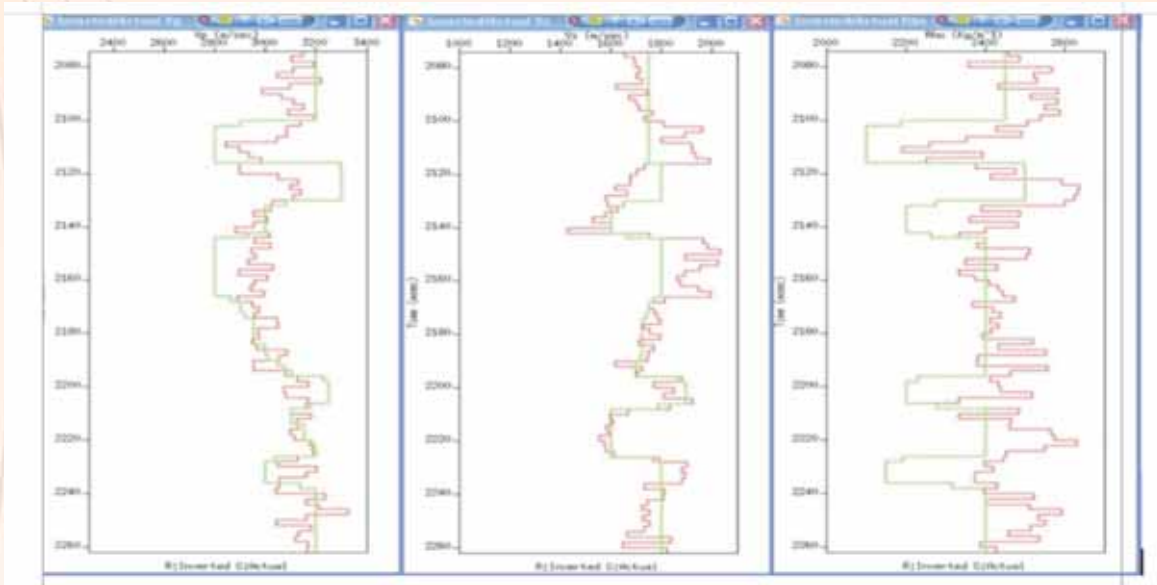
i)   Porting of INWAV II code on Xeon Machine

      The primary objective INWAV II is to develop and parallelize 2D model-based seismic waveform inversion algorithm based on RCGA and Generalized Linear Inversion techniques for estimating the material properties of the earth in time domain. Porting of INWAV II code on xeon machine has been done and considerable time gain is obtained. Enhancement in performance

comparison with SGI machine is observed.

ii)   Bench marking of SEISTOM

Seismic Travel time Tomography is a high-resolution geophysical tool, which can be used to reconstruct a velocity model of the Earth's subsurface using propagation times of wave fields. Bench marking of SEISTOM code on xeon machine has been done and corresponding speed up graph is shown in the figure below A paper titled "Multiple realisation of real-coded genetic algorithm: A tool for 2D travel time tomographic inversion" is submitted to SEG on the result of seismic travel time tomography (SEISTOM) project.

Result of INWAV II
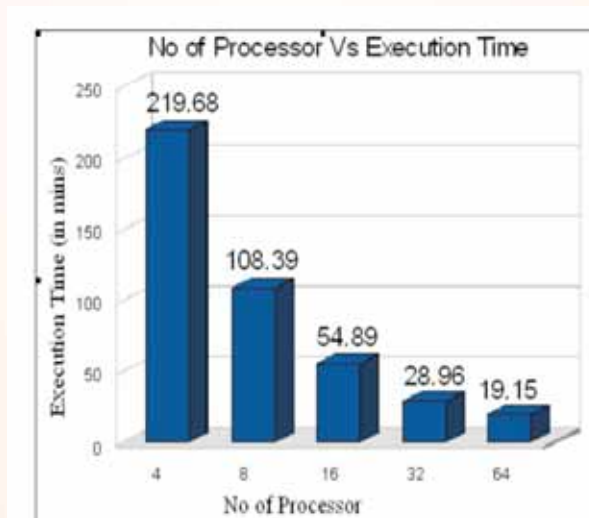
Speed up Graph of SEISTOM on Xeon Machine.

iii)   Object Oriented Programming (OOP's) designing concept in INWAV III

The prime objective of converting INWAV II from C to C++ is to gain advantages of OOP, which are modular programming, re usability of code by using polymorphism and inheritance, easy maintainability of project, robust and secure as data is encapsulated in class which is no more global.

iv)   GUI for in house application

GUI for in house application is in process, graphical user interface for easy access to tools and applications, which is built in house.

v)   Deployment of New Machine

In 2008, a new Xeon machine was inducted, which is 8-node dual socket quad core with 2.33 GHz, with 8GB RAM, storage capacity ~ 2 TB. The system is used for large scale simulations in dedicated mode.
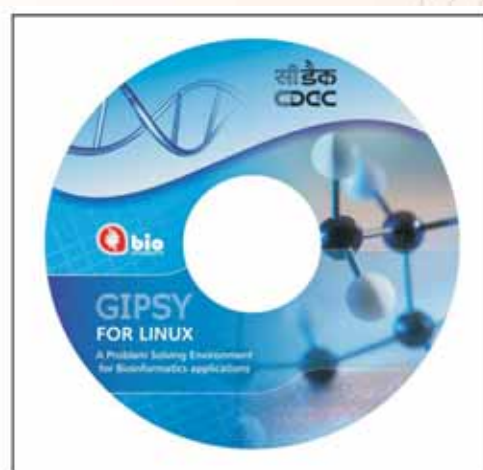
(e) Bioinformatics (Bio)

i)   **BRAF**

Bioinformatics Resources and Applications Facility (BRAF -II) is DIT funded project initiated in the month of April 2006. 1TF (BIOGENE) machine has been commissioned at C-DAC Pune in April 2008. All the approved software by the sub-committee of three members has been procured and is placed. The web computing portal GIPSY deployed on BIOGENE has various sequence analysis and molecular modeling codes and is available for use by academia and industries. The new codes like OPENEYE and MEME are the additions to the GIPSY. GIPSY is now available as product CD.

Under the BRAF project, Bioinformatics team has been interacting with various industries like SYNTEL, INC.(Pune), Capitol Technologies CTIS (US), JUBILANT BIOSYS LTD.(Bangalore), Nicholas Piramal Research Centre (Mumbai) for collaborative Industry projects. RCS card for SW is the result of inter-group interactions between the hardware and bioinformatics teams of C-DAC. C-DAC has tied up with OCCIMUM Biosolution (Hyderabad) for RCS card marketing and executing business projects in the area of bioinformatics.

The 1TF (Biogene) Machine   *Gipsy*
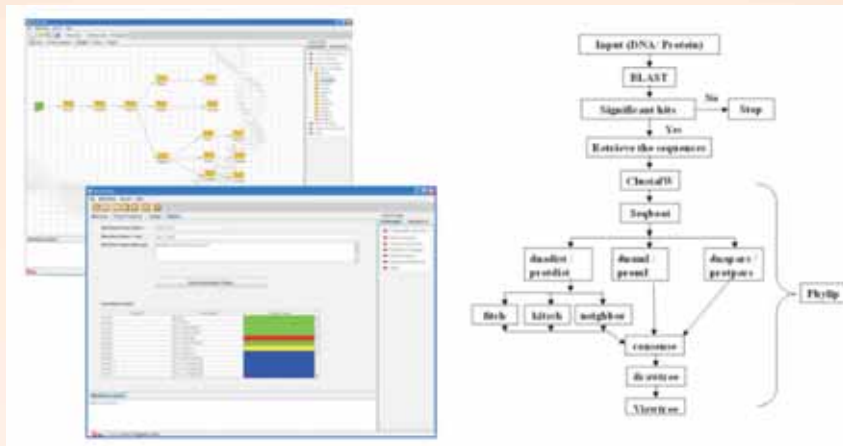
ii)   Workflow

The project titled "Development of high-throughput computational workflows for genome analysis" is also funded by DIT and has been initiated in December 2007. The prototype for high throughput computational workflow project has been completed. The client GUI has been developed using java swing. The server is based on Apache Axis and My SQL database resides at server end.

Workflow prototype

iii) PARAM Yuva

Benchmarking of MEME on PARAM yuva has been done. It is showing linear scale up as shown in the graph.
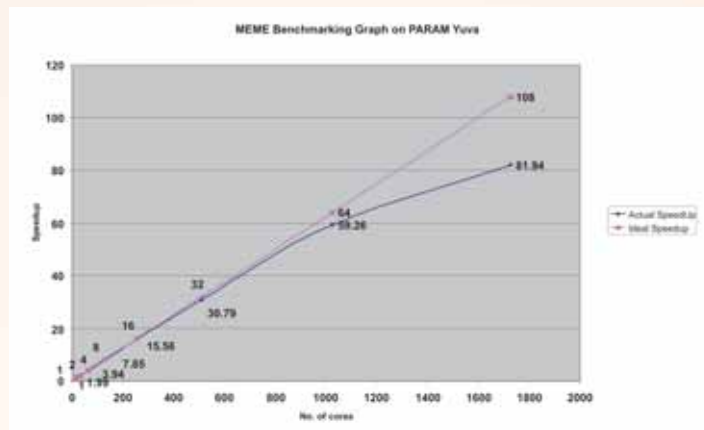
MEME Benchmarking Graph on PARAM Yuva

iv) Research, Collaborative and Industry projects

Protein folding problem is scientifically and computationally challenging. Bioinformatics team at C-DAC is constantly engaged in doing long folding simulations using different and advanced methodologies. Currently, very long folding simulations have been planned using advance techniques like replica exchange molecular dynamics (REMD) and coarse grain molecular dynamics (CGMD). The part of the work has been published in international journal highlighting our results on the journal's cover page.

Phylogenetic profiles are description of pattern of distribution of a given gene in the set of organisms with completely sequenced genomes. Proteins with similar Phylogenetic profiles are often components of the same pathway. Research in this area has been carried out on mycobacterium tuberculosis. Phylogenetic FootPrinting has also been done, which does comparison of non-coding regions of orthologous genes amongst closely related organisms. If found conserved are often known to reveal novel binding sites of transcription factors

The collaborative work along with IISER, Pune on peptide nucleic acid is the good example of comparing experiments and computational finding. The long molecular dynamics simulations on PNA would help in the structural understanding of PNA. The PNA work has been published in the international journal. Similarly, the work of metal complexes, a collaboration with

chemistry department, Pune University, is getting published in the reputed journals. Similarly, the collaborative work on GPCR proteins using CGMD is of great interest and professor at IIT Chennai is keen to work with bioinformatics team to do docking studies of GPCR proteins.

Bioinformatics team has gained a contract research project from Nicholas Piramal Research Centre, Mumbai. The project was on the simulations of protein of their interest. The project has been completed and results are handed over to them.


Cover page of the journal carries the image of the work done on protein folding (Stride Analysis plot)

(f)   Evolutionary Computing (EC)

Protein structure prediction using genetic algorithms (PSP-GA) has been implemented with a new emerging force field ECEPP (including the solvation energy). Hybrid Taguchi genetic algorithm (HTGA) based on orthogonal arrays for protein structure prediction has been completed. Grid-enabling of protein structure prediction application based on Genetic Algo rithms was carried out. The divide-and-construct method (DCM) for protein structure prediction works on the principle of splitting the protein sequence into small overlapping parts. This strategy not only helped in grid-enabling the application by spawning each part on different computational resources on GARUDA Grid, but also led to a distributed methodology for PSP that can be applied for larger molecules. The PSE for this application is in development stage.

The *Ab initio* optical properties of bare and passivated Zinc Selenide (Zn_nSe_n, n = 1 to 13) clusters were calculated within the framework of time dependent density functional theory (TD-DFT). The stable geometries, binding energy, bond lengths and charge density at the highest occupied molecular orbital (HOMO) and lowest unoccupied molecular orbital (LUMO) have also been calculated. Though the largest simulated cluster is about 0.5 Angstrom smaller than the experimentally reported smallest quantum dot (QD), the trend in the optical gap calculated are inclined towards the experimental values. In Fig. (a) and (b) the yellow ball represent Se, the pink ball Zn, while the blue ball is the partially charged fictitious H* atom. Fig. (c) shows that the HOMO is mostly composed of Se *p* orbitals, while Fig. (d) depicts that the LUMO is the admixture of *s* and *p* orbital of Se and s orbital of Zn.
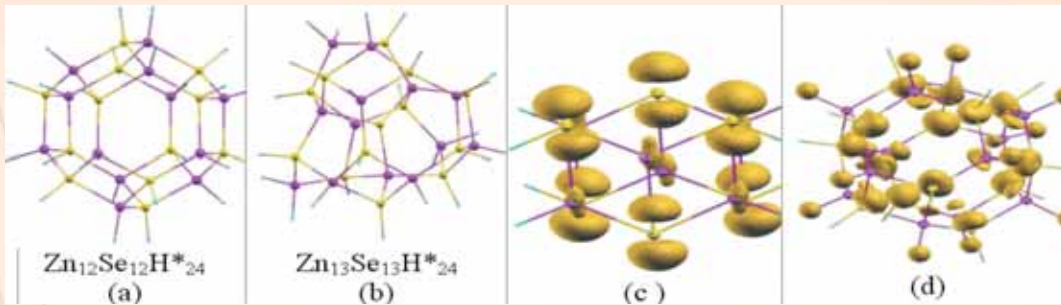
Optimized geometries of passivated Zn_nSe_n for n = 12 (a) and n = 13 (b) clusters, (c)-Charge density plot of highest occupied molecular orbital (HOMO) of $Zn_6Se_6H^*_{12}$, (d)-Lowest unoccupied molecular orbital (LUMO) of $Zn_{12}Se_{12}H^*_{24}$.

A prototype CBIR system for Indian manuscripts has been developed for Digital Library Project. It supports search for manuscript images that contain pictures, text, gold platted figures, and crooked borders. It also enables computing of metadata in terms of page size and the number of text lines in a page.
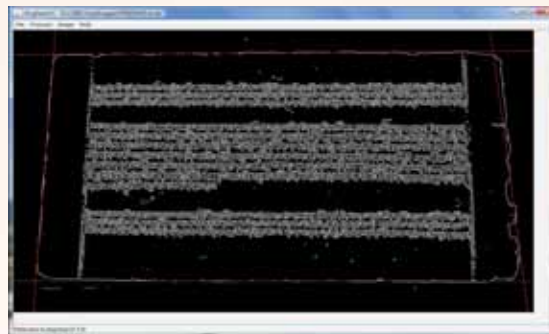
Detecting manuscripts with damaged borders and searching for gold-plated manuscript images
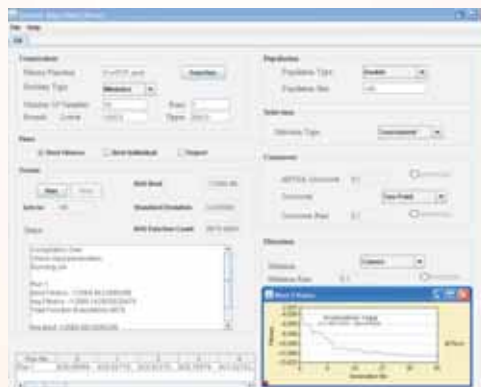
Grid Computing

GARUDA Grid

From April 2008 the Foundation Phase of GARUDA is in progress. This aims to include more users' applications, providing Service Oriented architecture, improving network stability and upgrading grid resources. The key objectives of the Foundation Phase are:
- To advance the scientific and technological excellence in the area of Grid Technologies
- To demonstrate selected pilot applications of national and strategic importance
- To strengthen and improve the GARUDA grid infrastructure

GARUDA Grid connectivity

The success of the PoC phase prompted DIT to approve the Foundation Phase GARUDA in May 2008 for duration of one year. The Grid is up with 100 megabits per second, running with over 1500 processors connected, and 60 TB of storage. Over this infrastructure more than four applications in the areas of Disaster Management, Bio Informatics, Computer Aided Engineering and E-learning have been demonstrated.

The major accomplishments in GARUDA Foundation Phase include:
- Migration to Service Oriented Architecture
- Deploying a suitable Grid Meta scheduler
- Upgrade Grid Resources
- Establishing a Certificate Authority for national grid operation
- Operation Pilot of selected applications
- Interoperability Study between Garuda and EGEE infrastructure

GARUDA: Service Oriented Grid

The Service Oriented Architecture (SOA) is a component based model for building an application architecture within which all functions are defined as independent number of discrete services with well defined invokable interfaces that can be called in a sequence to form a larger application. Grid middleware is now moving towards Web Standards based on Open Grid Standards Architecture (OGSI) and Web Services Resources Framework (WSRF). The Foundation Phase GARUDA migrated to Service Oriented Architecture based on Globus Toolkit Version 4.x. This has been deployed on selected resources.
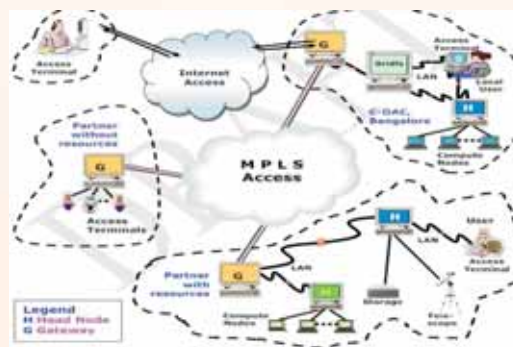
GARUDA SOA

Gridway open source scheduler for grid has been customized and deployed in selected resources of GARUDA and configured in a peer-to-peer mode to support high availability of compute resources. Advanced reservation has been introduced to ensure QoS in the SOA grid. Security features have been enhanced using MyProxy, VOMS and IGCA. Significant progress has been made in the Data Management area by using an experimental prototype of SRM

GARUDA Resources

In this collaborative grid project, various resources such as HPC systems and satellite based communication systems have been committed by different centres of C-DAC and GARUDA partners as detailed below.

During the Foundation Phase the GARUDA compute and storage resources have been augmented by 4TF each at C-DAC Bangalore, C-DAC Chennai and C-DAC Hyderabad, aggregating to more than 1500 CPUs of computational power and 60TB storage. Each 4TF cluster is composed of 40 nodes of quad core dual CPU, Xeon, machines with Infiniband interconnect.

The operation and administrative functions of GARUDA grid have been strengthened. The GARUDA Grid Operations and Administration (GGOA) team has been setup which handles all administrative issues across Garuda locations on daily basis.

Institution	No of CPUs , OS
C-DAC, Bangalore	320 CPU Xeon, Linux cluster
	32 CPU POWER4, AIX cluster
	16 CPU Xeon, Linux Cluster
C-DAC, Pune	16 CPU Xeon, Linux Cluster
C-DAC, Chennai	320 CPU Xeon, Linux cluster
	16 CPU Xeon, Linux Cluster
C-DAC, Hyderabad	320 CPU Xeon, Linux cluster
	16 CPU Xeon, Linux Cluster
IISc, Bangalore	64 CPU POWER5, Linux Cluster
RRI, Bangalore	32 CPU Opteron, Linux Cluster
IMSc, Chennai	24 CPU Opteron Cluster (Cray XD1)
MIT, Chennai	60 CPU P4, Linux Cluster
IIT-D, Delhi	32 CPU Opteron, Linux cluster
JNU, Delhi	48 CPU AMD Opteron, Linux
	16 CPU Intel Itanium, Linux
IGIB, Delhi	64 CPU Xeon, Linux
IIT-G, Gowhati	128 CPU Opteron, Linux
UoH, Hyderabad	32 way SMP, POWER4, AIX
IIT-K, Kharagpur	16 CPU Xeon, Linux Cluster
	16 CPU PowerPC2, AIX Cluster
SAC, Ahm	GSAT Terminals - 2

Certification Authority for National Grid Operation

The Indian Grid Certification Authority (IGCA) accredited by the APGridPMA has been setup in C-DAC Bangalore. The IGCA will help scientists, users and collaborative community in India and neighboring countries, to obtain an internationally recognized digital certificate to interoperate with state-of-the-art grids worldwide.

The IGCA was inaugurated on 14 Jan 09, by Dr. R Chidambaram. PSA to Govt. of India and presided by Secretary. DIT. IGCA is fully operational now and issuing user and host certificates

Inauguration of IGCA by Dr. R Chidambaram , PSA to GoI

On 5th November 2008, the IGCA was granted accreditation by the Asia Pacific Grid Policy Management as IGTF compliant CA. This is the First CA in India for the purpose of Grid research. It issues Digital Certificates to support the secure environment in Grid.

Applications demonstrated in GARUDA

Applications of national importance requiring aggregation of geographically distributed resources have been developed and deployed on GARUDA Grid. Following applications were chosen for operational deployment on GAURDA Foundation Phase:

- Disaster Management – Flood Assessment
- OpenEye – Molecular Docking
- E-Learning
- Computer Aided Engineering

Additional applications in Atomic physics and Protein Structure Prediction have also been successfully executed on GARUDA during this period.

Disaster Management – Flood Assessment

This project is a joint effort between C-DAC and SAC, ISRO. It is about assessment of river flood using Synthetic Aperture Radar (SAR), Grid Computing and Geo synchronous SATellite (GSAT) technology. The airborne SAR captures raw data of the flooding river. This is voluminous and requires significant computing power for processing. The following tasks have been completed in this application:

- The interface between SATGrid and GARUDA has been completed.
- Tremendous speedup in execution time of the DMSAR processing code was achieved through grid enabling.
- Remote geospatial visualization has been carried out between geographically distant locations (C-DAC-Bangalore, C-DAC - Hyderabad and SAC – Ahmedabad).
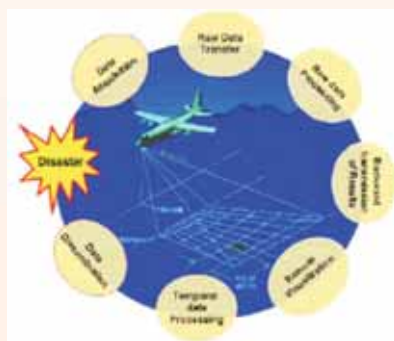
Disaster Management Application workflow

OpenEye – Molecular Docking

Molecular Docking is to place a ligand (small molecule) into the binding site of a receptor in the manner appropriate for optimal interactions with a receptor. It is useful in Pharmacy and Drug Design. This project was done in close interactions with JNU and Jubilant Biosys Ltd. The FILTER, OMEGA and FRED modules of Openeye Docking have been pipelined on multiple GARUDA grid computat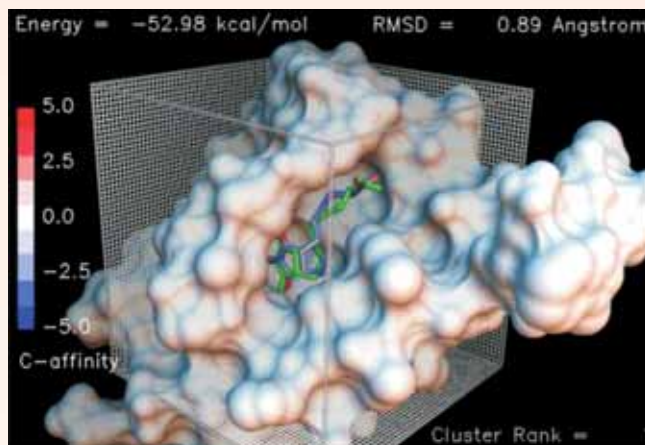ional resources and significant speed up has been obtained. The GenomeGRID portal deployed on the GARUDA grid which access the high performance computing power clusters across four geographically distributed locations has been completed.

Molecular Docking Example

E-Learning

E-learning has matured from the Computer Based Training to Learning Management Systems to Collaborative learning through virtual classrooms. This project aimed to implement advanced collaborative grid-based software for learning which can leverage the network infrastructure and middleware. Following are accomplished in this application:

- Access grid has been deployed across C-DAC centres at Bangalore, Hyderabad and Pune on the GARUDA network to enable e-learning.
- Multicast has been enabled at selected locations for access grid deployment.
- Expert faculty and resources at one location can be shared with other remote locations. Recording and replay of sessions has been demonstrated.

E-learning in progress

Grid Operating System

C-DAC is aiming at developing an open source Grid Operating System, where the services of grid are brought down to kernel focusing on Desktop grid. To overcome the limitations of the existing Grid middleware, it advocates a Grid Operating System and proposes an architecture to migrate grid computing into a Grid operating system which will help remove most of the technical barriers to the adoption of grid computing and make it relevant to the day-to-day user. This proposed transition to a Grid OS will drive more pervasive grid computing research and application development and deployment in future. The ultimate objective is to bring grid computing to the desktop, and the desktop to the Grid. The Feasibility Study, Literature Survey, Analysis and High Level Design of the Desktop Grid Operating System is completed and implementation of the modules is ongoing.

MULTILINGUAL AND HERITAGE COMPUTING

MANTRA-Rajbhasha

MANTRA-Rajbhasha project has been sponsored by Department of Official Language (DOL), Ministry of Home Affairs, GoI. MAN-TRA-Rajbhasha is English to Hindi translation system for the domains comprising of Administration, Finance, Small Scale Industries, Agriculture, Information Technology and HealthCare. On the occasion of Hindi Diwas, i.e. September 14, 2008 Mantra-Rajbhasha Translation system (*for Education and Banking domains*) was launched at Vigyan Bhavan, New Delhi by Shri Shivraj Patil, Hon'ble Home Minister and presented to Her Excellency Smt. Pratibha Devisingh Patil, President of India.

MANTRA-Rajbhasha

MANTRA – Rajya Sabha

The project MANTRA-Rajya Sabha is sponsored by Rajya Sabha Secretariat, Government of India. MANTRA-Rajya Sabha is English to Hindi translation system in an Intranet environment. Development is in progress for Bulletin Part II and Synopsis domains.
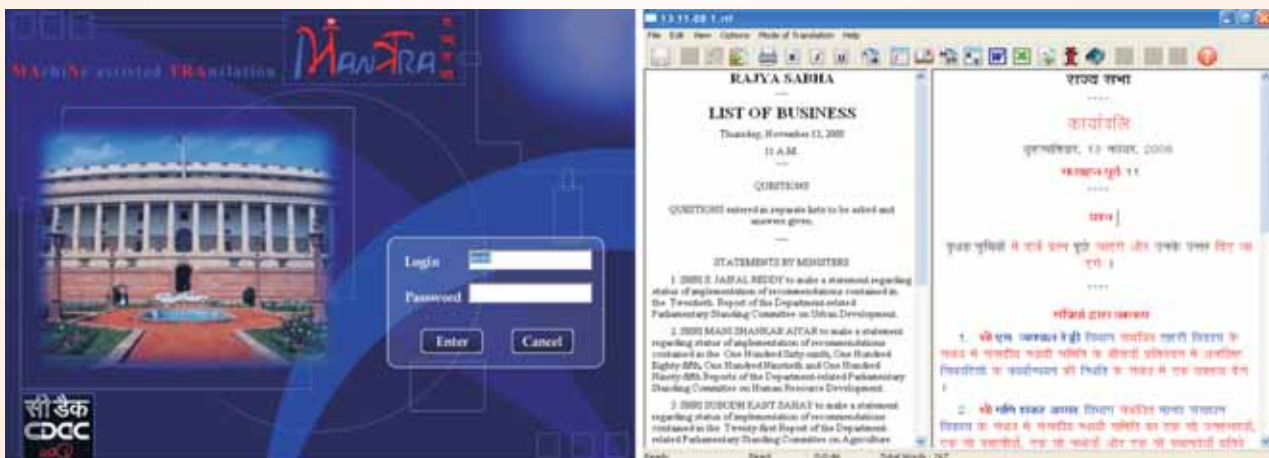
MANTRA-Rajya Sabha

English to Indian Languages Machine Translation (EILMT) System

C-DAC is also working on the development of English to Indian Languages Machine Translation (EILMT) System. This project is being implemented by a Consortium of 10 institutes. C-DAC, Pune is the Consortium Leader. The project is sponsored by Department of Information Technology (DIT), GoI. The domains are Tourism and Health care. Under this project a system is developed to translate from English to six Indian languages such as Hindi, Urdu, Bangla, Marathi, Oriya and Tamil. The work component of C-DAC mainly consists of developing Machine Translation component using Tree Adjoining Grammar (TAG), compilation of corpus related activities and coordination of the project. Currently the work related to evaluation of EILMT system for Alpha version is in progress.
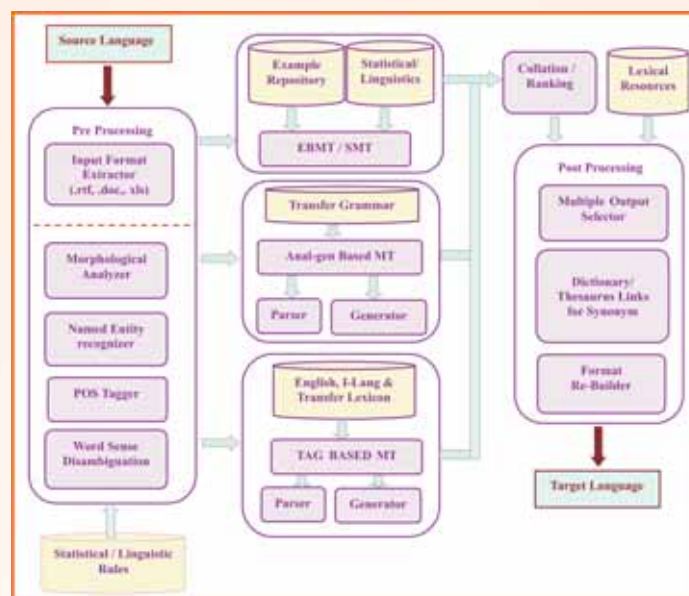

EILMT System Architecture

Indian Language to Indian Language Machine Translation (ILMT) system

C-DAC is participating in the development of Indian Language to Indian Language Machine Translation (ILMT) as a consortium member. This project is being implemented by a Consortium of 12 institutes. The project is sponsored by Department of Information Technology (DIT), GoI. The work components of C-DAC consist of development of evaluation modules for evaluation of translation between different Indian language pairs and linguistic related tasks. Currently the work related to evaluation of ILMT system for Alpha version is in progress.

Vachantar-Rajbhasha

VACHANTAR-Rajbhasha is an integrated system that transcribes and translates English speech to Hindi text in the domains of Administrative, Finance, Agriculture, Small-Scale Industry, Information Technology, Health care, Education and Banking. The system combines a Speech Recognition Engine and MANTRA-Rajbhasha. On the occasion of Hindi Diwas, September 14, 2008 Vachantar-Rajbhasha was launched by Shri Shivraj Patil, Hon'ble Home Minister and presented to Her Excellency Smt. Pratibha Devisingh Patil, President of India at New Delhi.

LILA Hindi Prabodh (revised courseware) on the Internet

LILA (Learn Indian Languages through Artificial Intelligence) a multimedia language tutoring system for teaching Hindi at Prabodh level (revised courseware) for the Government, PSU, Corporate and Banking officials and is made available through the World Wide

Web (Internet). The project was sponsored by the Rajbhasha Vibhag, DOL, GoI.The tutoring package for Prabodh (revised courseware) teaches Hindi through the media of Bodo, Kannada,Malayalam, Tamil and Telugu. The packages can be accessed online at the website http://lilappp.cdac.in.

These packages were launched by Shri Shivraj Patil, Hon'ble Home Minister on the occasion of Hindi Diwas (September 14, 2008) and were presented to Her Excellency Smt. Pratibha Devisingh Patil, President of India at New Delhi.

LILA PPP

e-Mahashabdkosh

C-DAC has initiated and commenced the work for the e-Mahashabdkosh (*a bilingual bidirectional Hindi /English Dictionary with pronunciation*). Terms, Phrases and vocabularies used in the Administration of Government correspondence are included under Phase-I of the project. The dictionary can be used as a reference material for translators and also as a general reference by the anxious people. It is intended to enhance and include more such domains later.

The project was sponsored by the Rajbhasha Vibhag, DoL GoI. The packages can be accessed online at the website http://e-mahashabdkosh.cdac.in . These packages were launched by Shri Shivraj Patil, Hon'ble Home Minister on the occasion of Hindi Diwas (September 14, 2008) and were presented to Her Excellency Smt. Pratibha Devisingh Patil, President of India at New Delhi.

e-Mahashabdkosh

Information Extraction and Retrieval (IE/IR)

C-DAC undertakes the development of Cross-Lingual Information Access (CLIA) System as a consortium member. This project is being implemented by a Consortium of 11 institutes and is sponsored by Department of Information Technology (DIT), GoI.. The work components of C-DAC, Pune consists of development of Font Recognizer, Meta search engine, parallel and distributed search, soft keyboard and other corpus related activities. Soft keyboard version with modifications has been integrated into CLIA

system. Integration and testing of new developed and modified plug in of the System is in progress. This has also crawled Marathi URLs for CLIA database. Environment for testing CLIA System in Parallel and Distributed mode using Hadoop Architecture has been setup in C-DAC, Pune.

Development of "Web Based Patent Management System"

Patent applications published in the ICT area in the IPO journal are on an average in the range of 200-300 half yearly. "Web Based Patent Management System" will assist the process of patent analysis. One of the prime objectives of the project is to analyze the patent applications, check for the credibility of patentability criteria and oppose or prompt interested party of those opposable applications which may affect Indian ICT IP adversely. For this, experts from relevant fields in ICT will be contracted for analyzing the patent applications depending upon their area of expertise such as communications, embedded systems, processor, digital electronics, etc.

Since it will be web based, all the stake holders can participate as well as get benefited from such system. Apart from this some free services will be provided to the user, like IPR Query, Patent Search and Patentability Analysis.

Web Based Patent Management System

Indian language Data Centre for proliferation and promotion of free language CDs

It is a web based Indian Language Data Centre (ILDC) by which user friendly software tools and fonts are being made available free for public through language CDs and web downloads for the benefit of masses.


ILDC Website

Internationalized Domain Names (IDN)

To ensure that India and Indian languages have their rightful place in the fast-evolving scenario, C-DAC GIST undertook research and study of various IDN related RFCs and their applicability vis-à-vis Indian Languages. The pilot study was under the aegis of the DIT.

The main aim was dual:

1. Primarily to ensure that a user can create and access URL's in his own language and

2. Closely associated with the above, to ensure that the average user who is little aware of spoofing or phishing or pharming does not suffer financial loss or identity loss. Thus an average user doesn't care about a seemingly trivial URL string unless he comes across it inadvertently and gets robbed. For him,

3. By clicking on the wrong URL, (s)he could be phished or pharmed. for e.g.
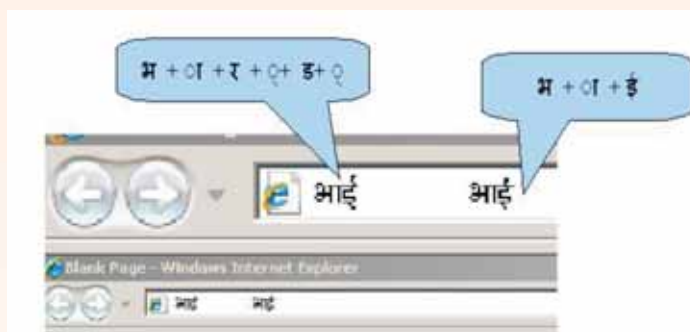
To prevent such spoofing and phishing attacks in IL scenario, a careful study of some scripts is done by C-DAC GIST, especially in the area of homographs: characters and their combinations which look alike but are different in reality, as in the example given above.

Onscreen keyboard for entering domain names in Indian languages.

Testing, Evaluation and Benchmarking of various consortia projects

GIST has been entrusted the crucial part of Testing, Evaluation and Benchmarking of following consortia projects.

Machine Assisted Translation projects (IL-ILMT, EILMT, AnglaMT), Cross lingual Information Access (CLIA), Optical character recognition (OCR), Online handwritten recognition (OHWR), and Speech consortium.

After detailed research and consultation with subject experts of C-DAC, and GIST along with STQC, Delhi evolved the Testing, Benchmarking and evaluation strategies for various consortia projects viz .EILMT, ILILMT, AnglaMT, CLIA, OCR and OHWR. The same was also discussed with consortia leaders before finalization.

Test data set and tools required for undertaking the testing, evaluation and benchmarking has been developed. Some of the international accepted norms of testing such as BLEU, Metor are getting suitably modified to support Indian languages. The Alpha level testing has been carried out by C-DAC GIST and one level of feedback is being submitted to consortia and DIT.

MAC – Implementation of Keyboard and Fonts for Macintosh platform

C-DAC has developed fonts for the MACintosh platform to display Indian language data. Currently the fonts for all the scripts supported by MACintosh have been developed and rest of the scripts font i.e. not supported by MACintosh is under development.

OL-CHIKI Converter Application

This Application will convert Santhali po edit files written in Devanagari into OL- CHIKI (Santhali) files.

OL-CHIKI Typing Tool

This tool enable the user to type OL-CHIKI in any editor.

Synonym builder

GIST Synonym Builder

Synonym Builder Project sub modules:
- Building of dictionary
- Importing previous data.
- Sorting of dictionary as per sorting sequence provided.
- Encryption of Dictionary

Dictionary Building Module involves removal of duplicates, preserving grammar information and generating, gathering synonyms for every word. Importing involves support for older data, cleaning of dictionaries so that our tool can read it. Sorting Sequence is provided as text file and entire dictionary can be sorted as per provided sequence. Option for Saving dictionary without sort is also available.

Data preservation – Annotator Tool

GIST Annotator Tool

1.　　　Vedic and Roman keyboard and fonts have been integrated in the tool
2.　　　Data entered are saved in xml files; created per slip
3.　　　Searching has been done on Vocable and Abbreviation
4.　　　Noise removal algorithm is implemented
5.　　　Data entered for slips can also be edited later
2.　　　Zoom in and Zoom out feature is also supported

Vedic Keyboard

Upgraded to have extensive coverage of known existing vedic characters.

Vedic Keyboard

Limbu Script:

● 　　Research on Limbu script.
● 　　Design Keyboard for Limbu Script for typing.

Limbu Keyboard

Sinhala Script:

Implement Keyboard for Sinhala Script for typing.

Sinhala Keyboard

UNICODE enabled iPlugin

iPlugin

iPlugin UNICODE is a web application development tool, which gives an option to develop web applications for the Internet in Indian languages without any change in the look and feel of the web-page. It contains floating keyboard, using which a novice user can type by clicking on its buttons using the mouse.

iPlugin UNICODE now also supports IE7, IE8, Vista, Firefox, Chrome, Phonetic Assitant (Transliteration), Semi Transparent Floating Keyboard, Ajax support, Unicode support for additional Languages like Assamese, Bengali, Bodo, Dogri, Gujarati, Hindi, Kannada, Konkani, Malayalam, Marathi, Maithali, Manipuri, Nepali, Oriya, Punjabi / Gurumukhi, Santhali, Sanskrit, Tamil, Telugu

iPlugin UNICODE Support

This also has iPlugin Toolbar using which user can easily change the script key, keyboard type, perform in-page search etc.

Gist Transliteration on Mobile

In today's mobile era, in India, number of the messages in Hindi transliterated in English or Hinglish language easily outnumber the messages either of languages put together. Often it is difficult if not impossible to understand the text, especially words like TOH or MANN. To address this and bring an easy solution for mobile users, GistMobile has been created. Using state of the art technology and the best heuristic algorithms, Gist Mobile has the lowest Key Stroked per Character (KSPC) and with minimal key presses, you can get the word typed in English and, with a single key press, get it transliterated in Hindi.

This is a very useful tool for people who can operate mobile but find it difficult to type messages in either Hindi or English due to either the lack of language knowledge or due to complex settings and operational functionalities in mobile. It is currently Unicode based and developed in Java and supports Hindi only.

Features
- Easy to operate
- Direct transliteration to IL, currently Hindi is supported.
- Unicode based transliteration so supported by all handsets having Unicode support.
- Minimal key presses required than normal.
- Suggestions available on each * key press.
- User specific suggestions that is suggestion accepted by user will pop up as transliteration output for that English word.

Gist-Trans

Gist-Trans is a phonetic transliteration mechanism that transliterates English data to Indian Language content (Hindi). You can type a word of your choice in English and get the transliterated output in selected language like Hindi or Gujarati. It supports some attractive features like chat lingo, number to text transliteration, abbreviations like M. Tech, IIT and transliteration of complex English words like Somnambulist or Encyclopedia. It also supports transliteration of lengthy Indian names or phrases like "Rashtrabhasha" or "Bharatvarsha". It also generates handful of relevant suggestions for the entered query to choose one of your choice.

It is a very easy to use web based tool that takes nothing to download at client side. Presently It is available in Hindi, Gujarati and Marathi at present and works with IE(6+), Mozilla and Opera(9+).

Gist-Trans is available for public use. It can be accessed at http://transliteration.cdac.in

It is a tool that facilitates to write in English and get the equivalent output words in Hindi.

Features
- Supports Hindi Gujarati and Marathi (alpha).
- Easy to use web application
- Works with IE and Mozilla, Opera.
- Easy to alter the contents.
- Supports limited chat lingo
- Supports number to word transliteration
- Supports abbreviations.
- Can be used for Transliterating names.
- Mail the contents in image format to self or someone else.
- Take a printout of the contents.
- User specific suggestions i.e. suggestions accepted by the user will pop up as the first transliteration output for that English word.

Localization for Reports Tools

Reports/ Banks Statements for internal as well as customer interactions can be generated on the fly in Indian Languages using these tools. Formatting of the reports is maintained. Both DOS based and windows based tools are available.

Salient Features:

- Automatically generates format information e.g. - options to translate / retain English
- Tool generates translated report depending on format information
- Allows updation format information
- Allows adjustment of the width of the columns
- Allows an option to specify columns for translation
- Handles plain text report
- Report should have a structure

Passbook Printing Utility:

This tool can be used for printing the passbook in Indian Languages on passbook printer.

Dictionary tool:

This tool is used for building the dictionary, which is used by the Report Generation tools for converting the dynamic data of the reports. Words and phrases are kept in this dictionary through this tool.

Salient Features:

- Data can be added / deleted / modified
- Priorities of meanings can be altered
- Translated meaning or acronym of word
- Search for words - can return all meanings or highest priority
- Personal dictionary to add words/ phrases which will supercede the rules of translation
- Dictionary data in encrypted form

Bulk Converter

This is a bulk file converter which converts different files from English to Hindi Unicode. It supports Word, HTML and text files. All the formatting information of data is retained after conversion while keeping the look and feel of the file as same. It uses the Indian language dictionaries which can be built by using Dictionary Tools. It also uses nTrans for name transliteration.

Salient Features

- Bulk conversion of data – Large number of files can be converted in single execution.
- Converts following types of files
- Word Files (*.doc,*.rtf), Excel Files
- HTML Files (*.html,*.htm)
- Text Files (*.txt)
- Retains all formatting information after conversion.

Embedded – Pocket Dictionary (Taking and picture)

Pocket Dictionary

Compact Digital Pocket Dictionary for Indian Languages -

1.   Complete in-house design of H/W and S/W
2.   EN to IL , IL to EN , IL to IL, EN-EN
3.   Meaning of words
4.   Usage of words
5.   Antonyms
6.   Synonym
7.   Pictures
8.   Sound (limited)
9.   Device Features

Compact Size

1.   OLED 64K COLOR Screen
2.   Latest ARM processor Technology
3.   SD Card support upto 2 GB Memory
4.   10-bit Audio out
5.   USB support for dictionary upgrade
6.   20 keys keyboard for easy IL entry
7.   Battery backup
8.   Works as a normal storage device

Bhashavali

A machine aided translation system for translating the simple sentences of English language into Punjabi language- a tool for expanding the English/ Punjabi corpus has been developed. A corpus of 150 words has been developed for initial trials. Later this corpus will be enhanced. Demo version for simple sentences has been developed.

IT Terminology

The corpus for IT terminology has been developed for 9000 words. Both translation and transliterations are possible using this.

MaTra2

Matra is a Fully-Automatic Indicative English to Hindi Machine Translation System. It is targeted to work with text in open domains like World Wide Web documents and news stories. Given the complexity of machine translation problem and the variability found in open domain text, MaTra2 aims to provide only an indicative translation. As of now MaTra2 performs better for the 'News' and 'Medical' domains. System is working well for simple sentences. The work to enhance the capability to cover other types of sentences such as compound, complex, interrogative, exclamatory, etc. is in progress

Statistical Machine Translation

Statistical models of machine translation are being explored as part of the English to Indian language consortium of the DIT. A baseline system has been operational for a few months now. Use of morphological analysis, and word order alignment have shown significant performance improvement. The system has been tested for Hindi, Marathi and Bengali. Further work is in progress.

Setu with clustering

Setu enables access of English documents in Hindi and is essentially a combination of two technologies: Cross Lingual Information Retrieval (CLIR), for locating English documents on the web via Indian language queries, and Machine Translation (MT), to translate the relevant documents and search results to the language of the query. Setu takes the query from the user in Hindi (Devanagari). The query is mapped into an equivalent English query and is used to search documents using existing search engines. The search result page along with concordance is displayed in Hindi after translation. The document selected by the user is retrieved and displayed in Hindi after an indicative translation (or transliteration, when translation is unsuccessful). The project is currently working towards enriching Setu with Clustering feature. Clustering will group the search results returned by the search engine according to the similarities among them. The clusters will represent the various possible concepts present in the results set. Clustering will also help the user to navigate faster through the results set to reach the desired search result. Clustering is of particular importance for systems like Setu due to the higher degree of conceptual ambiguity that arises due to translation.

Anumaan

It is an open source adaptive Predictive Text Entry System which facilitates text entry by anticipating words and sentences based on prior experience, usually given in the form of a training corpus. This helps to enhance the text input speed for those who do not have high keyboard speed and reduces errors due to data entry. The system has been released internally for feedback. Work in progress to develop the evaluation component.

SuTra

Sutra is an intelligent suggestive translation tool for localisation. This project aims at creating an integrated set of tools to support activities such as automatic updation of glossary, locating reusable components given a string to be translated, provide for effective use of such strings in creating translation, etc. which will aid the translators in translating any software application. Version 1.0 had been released for feedback. The system has been updated accoring to the user feedbacks. There were requests to release the APIs of the system, work for which is in progress. Translation review feature and complete glossary suite have been implemented. Work on automatic glossary updation has begun.

Speech to speech translation among Asian Languages (A-STAR)

A-STAR is a consortium initiative of different South Asian countries with the objective of speech to speech translation among Asian languages. C-DAC is a member of this important international consortium. The first trial demo of speech to speech translation was

conducted in March 2009 and based on the experience a comprehensive demo involving Japanese, Chinese, Korean, Thai, Vietnamese, Indonesian, and Hindi is planned in August 2009. This demonstration will coincide with the TCAST-2009 Workshop – an ACL-IJCNLP-2009 co-located event in Singapore on 2nd August 2009. The work undertaken under this includes development of a Statistical Machine Translation model for Hindi and HMM based Hindi Speech Synthesis system. A speech recording facility was established to obtain the required speech corpus recordings for the work. All the major building blocks of the system are converted as web services and integrated.

Cross Lingual Information Access (CLIA) among Indian Languages

CLIA is a consortium mode project, including academic and research Institutions with industry partners. Project is aimed at enhancing Indian Language search over web, focused on tourism domain. CLIA provides results in six Indian languages and English documents. To achieve this goal tools like Language analyzers, Stemmers, Name Entity recognizer, Transliteration engine, Translation engine (statistical machine), Font-transponders (Non-Unicode to Unicode) and many other modules have been developed. Intensive effort has performed in developing linguistic resources, like Named Entity corpus, Word Sense Disambiguation corpora, Concept based Synset dictionary and Multi word expressions. The system is based upon open source search engine framework Nutch. To facilitate user, a graphical interface (GUI) has been developed based on web page Internationalization. Beta release of the system is due in August 2009.

Indian Language to Indian Language Machine translation

This consortium based project is aimed at facilitating translation among Indian languages. Various tools were adapted and developed to deal with Punjabi including Parsing, Vibhakti Analysis, Word sense disambiguation, Transfer grammar and Named Entity recognition. Linguistic resources such as lexicon, tagged POS and chunk tagged corpus and Parallel corpus for snippet translation were developed. Test data sets of 1000 sentences for both languages (Hindi / Punjabi) including reference output for each module involved were also prepared.

English to Indian Language Machine translation

This project is based on Anglabharti approach where the system is being adapted to some of the Indian target languages by exploiting the commonality among various Indian languages. The work is being accomplished by a consortium of institutions wherein Punjabi and Urdu are taken care by C-DAC Noida. Corpus Analysis, target language dependent changes in the modules, lexical resource building is being handled for Health and Tourism domains.

Embedded Text to Speech [ETTS]

This customized version of the popular PC based Text-To-Speech conversion system based on ESNOLA (Epoch Synchronous Non-Overlapping Add) approach, is optimized for ARM 9 based embedded applications. The system database has been customized to have a smaller memory foot print and the data retrieval has been made faster by converting the Partneme database to a single, in-memory binary file. The Speech Synthesizer performance has been enhanced by adapting the signal conditioning algorithm for vowel generation from floating point to a fixed point implementation.

Major features:

- Unlimited domain TTS
- Eliminating searching for partnemes
- Direct address manipulation
- Any Indian language Database can be plugged in for realizing a TTS in that particular language.
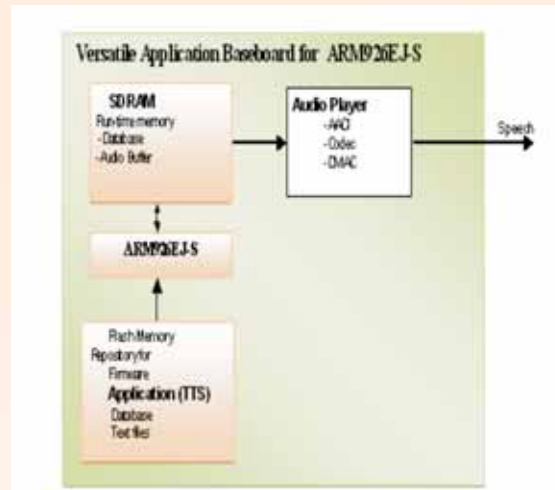
Versatile Application Baseboard for ARM9 based Embedded Applications

Natural Language Processing (NLP) - Bangla

Machine translation systems translating English to Indian languages are a necessity in our country in order to facilitate effective communication with the common man and for breaking the linguistic barrier that exist in our society. Besides this, most of the information on the Internet is available only in English and so the benefits of the ICT revolution cannot reach the common masses unless these are provided in their own language.

Objectives:

To develop an English to Indian languages machine translation system based on AnglaBharti technology where,

● A user will be able to input a document in English.
● The user will be able to get the translated document in an Indian language as per choice of the user.
● The MT system will be developed in the Tourism and Health domains with 80-85% minimum accuracy.

The language pairs involved will be English – Urdu, English – Punjabi, English–Bengali and English – Malayalam. C-DAC, Kolkata is undertaking English-Bengali language pair and has developed the Web Version of the Translation System.

AnglaBharati Technology

AnglaBharti represents a machine aided translation methodology specifically designed for translating English to Indian languages. English is a SVO language while Indian languages are SOV and are relatively of free word order. Instead of designing translators for English to each Indian language AnglaBharti uses a pseudo Interlingua approach. It analyzes English only once and creates an intermediate structure with most of the disambiguation performed. The intermediate structure is then converted to each Indian language through a process of text generation.

AnglaBharati Machine Translation

Speech Processing (Bangla and Nepali)

BANGLA VANNI (Text to Speech Synthesis system for Bangla) and NEPALI BOLI (Text to Speech Synthesis system for Nepali) (ESNOLA based Indigenous technology) : are developed by C-DAC.

System features:
(a)   Run in both platform Windows and Linux.
(b)   Unicode supported with unlimited vocabulary of Nepali.
(c)   Can be ported to any hand-held devices.

TTS Synthesis System for Nepali

Demonstrable Prosody Model For Bangla

For the development of Prosody of Model for Bangla, C-DAC and the University of Tokyo is perusing a 3-years long collaborative R&D Project under the Sponsorship of the Indo-Japan S&T Collaboration program of DST, Govt. of India. The Fujisaki Intonation Model will be adopted for Bangla under this collaborative project. The developed Prosody Model will be integrated with two different Flat TTS systems for Bangla; namely: (a) light-weight ESNOLA-based TTS System developed by the C-DAC for hand-held devices, and also (b) a heavyweight HTS-based TTS system

A demonstrable Prosody Model of Bangla is already developed.

Instrumental Setup for Objective Verification of Place and Manner of Articulation

Electropalatography (EPG) system from Articulate Instruments Ltd was installed in C-DAC, Kolkata for objective verification of place of articulation of Bangla Phonemes.

Electropalatography (EPG) namely WinEPG system records the timing and location of tongue contact with the hard palate during continuous speech along with the acoustical signal. Instrument can be used for objective verification of place of articulation of other Indian language phonemes also.

Custom-made Palates   *WinEPG System*

Other R&D activities in the area of Speech Technology Development in Indian language:

Manner Based Lexically Driven (MBLD) model for Indian language speech recognition (starting with Bangla).

OHR (Handwriting recognition)

Developed a demonstrable version of Bangla on-line handwritten character recognition system. High recognition rate is achieved for writer dependent system. Currently work is going on for writer adaptive mode of OHR system for Bangla.

Development of an off line Bangla character recognition system is also going on for off line form processing application.

Unicode Compliant Bengali Typewriter simulator software:

The product has been developed keeping in mind the user group, who has acquired a huge typing skill and speed over a long period of years by burning their fingers on mechanical Bengali Typewriter and wants to switch over to Personal Computer. In mechanical Bengali typewriter, the typing is done the way characters are printed but that is not the case with available Bengali keyboard drivers (the ligatures are typed after the character). Not all Bengali script's consonants and vowels and ligatures are present as a separate individual key in the typewriter layout. Hence, a combination of certain sequence of keys makes a required consonant or vowel. The product has been successfully delivered to West Bengal Legislative Assembly Secretariat (Assembly House).

Specialty of the software:

- Dual keyboard drivers both for Bengali and English languages (Switching of language by pressing F2 key).
- Layout of Bengali Keyboard conforms to mechanical typewriter (Ramington / Godrej Typewriters).
- Typing can be done from keyboard as well as with the help of mouse.
- Keyboard typing speed of 25 to 30 words per minute has been achieved as per the feedback from typists of West Bengal Legislative Assembly Secretariat.
- The product is rigorously tested and verified for almost all kinds of clusters that exist in Bengali language.
- Can be extended to other Indian languages easily.

Heritage Computing

Development of Analytical Tools for Large Scientific Knowledge Bases in Grid Computing Environment.
This is a DIT sponsored project to develop tools and technology for study, collation, analysis and critical editions of manuscripts and accented texts and deploy in Grid Environment. Editor with transliteration facility developed including Vedic accents and Unicode support. Processing of palm-leaf manuscript images (about 2000) involving separation into folio/sides, sequencing and linking/ aligning with text being done. Samaveda Samhita, Stobha-pada, Chandah-pada, and Rahasya-gana are included in the application. Integration of the content and processing data under progress.

Pandulipi Samshodak Version 2.0

Pandulipi Samshodhak Ver. 2.0 a Package for manuscript processing is developed with Unicode support and image-processing tool for processing manuscript. The software helps in preserving, processing, and analysis of manuscript in different scripts.

Pandulipi Samshodak V2.0

Authoring System

.NET application with Unicode support and transliteration was developed to browse, search and retrieve Veda, Vedanga and Upanga texts. This application also includes multilingual Unicode Editor with Grantha script support for article writing using the linked texts.

Heritage Information System for MMR-HCS

Heritage Conservation Society of Mumbai Metropolitan Region Development Authority (MMRDA) has awarded the project for development of Heritage Information System to Human-Centred Design and Computing Group of C-DAC, Pune. The purpose of this project is to build a digital archive of information on approx. 4500 heritage sites distributed in and around Mumbai region. The information contents include detailed records prepared by the conservation architects and photographic documentation of each heritage site. It is expected to provide accessibility to this information through interactive maps of Mumbai region.

SOFTWARE TECHNOLOGIES (Including F/OSS)

Agriculture and Sericulture

Image Processing Applications for Sericulture

This project takes a holistic look at all the operational areas of Tasar sericulture and proposes pragmatic solutions for determination of sericultural quality control at various operations as described below.

An important aspect of silkworm seed production is to detect and discard the most dangerous and trans-ovarial disease called Pebrine (which is a protozoa) and ensure supply of such disease free eggs to the silkworm rearers. For that reason, the abdomens of the egg-laying moths are cut and their tissues are examined under microscope to detect the presence of Pebrine spores in those tissues. If the tissues are found free of infection, then only the corresponding eggs are distributed amongst the villagers pursuing silkworm rearing. The eggs corresponding to the diseased moths are destroyed. At present in silkworm seed production Centres, large number of moths are homogenized individually and in groups and examined every day by several moth testers. This is a time and labour intensive process and many a time human error creeps in leading to outbreak of Pebrine disease. With increase in production, this activity in most seed production Centres (called grainages) may assume unmanageable proportion. Besides, Pebrine spores are not visible through normal microscope in all its different stages. This project proposes to collect information on characteristics of pebrine spore at its different stages of the life cycle; automation of the detection of Pebrine spore in all its stages by capturing digital images from the microscope slide and classifying Pebrine spores using digital image processing software thereby improving productivity and accuracy of this process.

Commercial cocoons are valued based on the quantity of silk available in it. The present method of sorting cocoons individually based on the estimated silk content heavily depends on human experience (by visual appearance or feel by mild finger pressing etc.) There being no instrumental technique, no objective basis for silk content estimation in a tasar cocoon exists as of date. With such subjective and non-transparent conventional methods of silk content estimation, in most of the cases, the buyer and seller remain unhappy over any transaction. This project proposes to explore electronic sensor based solution for quantification of the silk content in tasar cocoons.
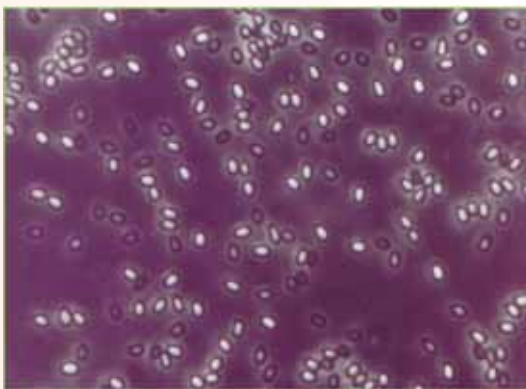
Pebrine Spore – Image taken using high end Microscope

Image capturing setup – Interfacing with microscope and camera

Tasar yarns are of two types, the reeled yarns that are made of single filament from 8-10 whole cocoons, extracted and twisted through a peddle / motor operated machine; the spun yarn that is extracted out of a single cut/pierced/inferior quality of cocoon, where a bunch of filament from a single cocoon is extracted and spun through a different but peddle / motor operated machine. The problem here is online monitoring and control of the thickness of the yarn produced, thickness of the yarn being the most important factor that affect the fabric quality after weaving. This single problem in Indian Tropical Tasar silk yarn hinders it's use in power loom

and other improved looms. It may be noted that the imported yarns (Temperate Tasar) do not have such problem, thus Indian yarns always brings less market value than imported yarns. Under this project, investigation will be done to identify / develop suitable sensor coupled with intelligent software that can be fitted in the existing machines to monitor the thickness variation online and raise alarms when the thickness of the yarn produced deviate beyond desired limits.

The colour of Tasar yarns produced is determined by a number of production factors, any slight variation in any one of these factors lead to variation in colour of the yarn produced. Thus it is difficult to produce yarns of uniform colour at the producers' level, but once produced, those yarns can be sorted based on its colour. The other important characteristic of tasar silk yarn is its lustrous nature, it reflects light, thus difficult to ascertain the exact colour manually. This project proposes to develop suitable software and hardware to sort the yarns based on its colour mechanically.

The developed software and hardware under the project will be validated at the user level and refined. Then the software and hardware will be deployed in the sericulture industry for improvement in quality and quantity of silk production in our country.

### Pilot-scale deployment of ENV Systems in India and Kenya

The developed ENV (Electronic Nose and Vision) system has been deployed in pilot scale at 4 Tea industries in India and one Tea Industry in Kenya. The Indian Industries are a) Kanan Devan Hill Plantations, Munar, b) Parry Agro, Valparai, c) UPASI Tea Research Foundation, Valparai and d) Malankara Plantation, Kerala. In Kenya, the ENV system has been deployed at the James Finlay, Kenya.

Land Degradation Mapping, Bihar State

Under the Natural Resources Census (NRC) programme of National Remote Sensing Centre (NRSC), Hyderabad, a Nation wide mapping of land degradation is underway. Within this NRC programme C-DAC is carrying out the mapping of land degradation of Bihar State. The project aims at generating information on degraded lands at 1:50,000 scale using multi-temporal (for Khraif, Rabi and Zaid) satellite data of IRS P6 LISS-III, to create uniform digital data base for Bihar state. A Land Degradation Information System (LDIS) will be prepared for easy query and retrieval of land degradation details. This would be useful for providing spatial database on degradation for planning reclamation programs at district level and facilitates to monitor the same at five years time interval. LDIS will serve as primary database for environmental studies and to identify areas of rapid change.

U-Agri

The application of WSN technology in the field of agriculture, demonstrates tremendous potential in the aggregation of macro and micro weather information, from spatial locations in the field in temporal contexts. It further enhances decision support by facilitating automated systems, capable of weather data aggregation, data analysis and decision making.
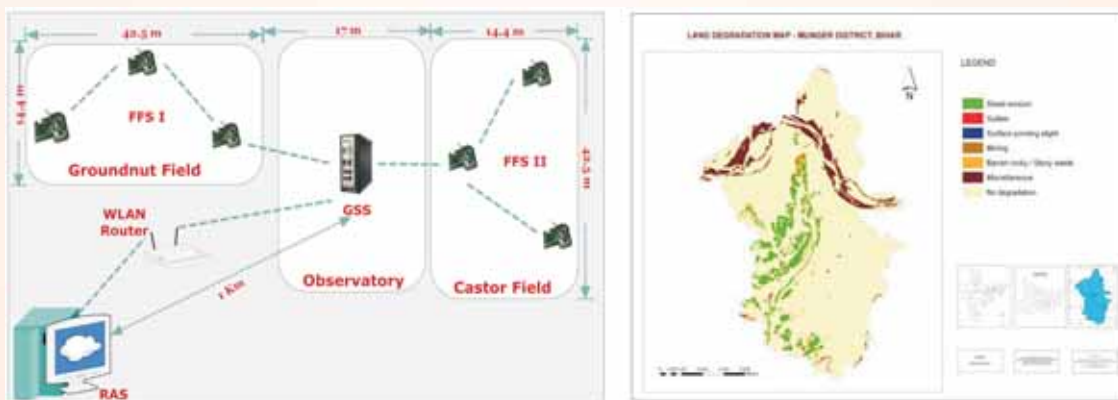
U-Agri Applications

U-Agri : Field Deployment

U-Agri focuses on Pest Management, by modelling selected pest growth cycles. These growth cycles are correlated with weather information available from the WSN. Decision Support Systems correlating conducive weather conditions and the growth of these pests are developed to forewarn possible pest infestations. MoU has been executed between C-DAC and Central Research Institute for Dry land Agriculture (CRIDA) to collaboratively work in this area. Groundnut and castor crops have been identified for the research and pests namely leaf miner, late leaf spot and Red hairy caterpillar are being modelled.

The WSN has been deployed in the fields with sensors namely Temperature, Relative Humidity, Leaf Wetness, Rainfall, Solar Radiation, and Wind Speed and Direction. These sensors sense in intervals of one hour. The sensed data is stored on Internet accessible database for analysis.

E-learning

**Content for Secondary Schools, West Bengal**

Computer Aided Learning (CAL) Material for Secondary School Student of West Bengal has been developed. Uniqueness of this methodology lies in empowering school teachers in such a fashion so that they can make their own lecture material with minimum knowledge of multimedia applications. It has developed 11 CAL Material in different subjects. Collaborating agency of this project is State Council of Educational Research and Training (SCERT), Govt. of West Bengal.

Sanskrit Swa-Adhyaya CD-project.

This is an ongoing project to harness the power of multimedia computer systems for systematic self-learning in Sanskrit with links to analysis. Rashtriya Sanskrit Sansthan, New Delhi, sponsors this project. Phase IV of the project covering Vakya Vistara and Sambhashanam is in progress.

Quality Assurance Framework for e-Learning Environment

Quality Assurance Framework for e-Learning is a three year project funded by e-Learning Division, DIT, Government of India. Objective of the project is to develop quality metrics that can be used for quantifying the various quality parameters of an e-learning tool and the content, and develop a prototype tool that can be used by end users for deriving the quality metrics so that the effectiveness of a tool can be measured and also different tools can be compared.
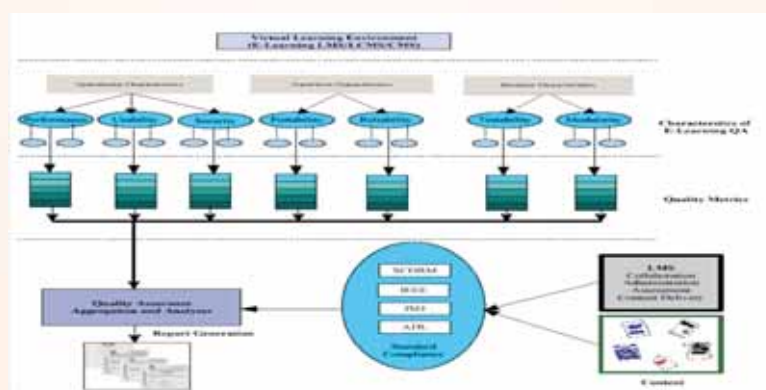
QA Evaluation Architecure

C-DAC has developed a prototype tool for quality analysis of e-Learning environment. The prototype tool provides a framework for evaluating e-Learning tools and content based on five quality parameters viz., Usability, Accessibility, Content Reusability and

Portability and Quality, Security and Performance. The prototype tool provide a flexible framework so that questionnaire scale point, weight-ages for quality parameters can be assigned based on mutual consent of certification agency, stakeholders and product vendors. A weight-age based grading approach is followed in order to evaluate and perceive total quality index of the e-Learning tools and content.

The quality analysis framework project adopted web service architecture to facilitate deployment of quality parameter evaluation modules on different nodes to circumvent inherent limitations while evaluating the parameters. The architecture which depicts the process flow and the modules developed for evaluating the quality indicators is given below:

Prototype Tool Architecture

Snapshot of Executive Summary Report Format

Grid Learning

"Collaborative Class Room" grid based e-Learning experimentation is a funded project by Department of Information Technology, Government of India under foundation phase of Garuda Grid Computing initiative. The objective of the project is to establish collaborative environment for educational purpose jointly by IIT Kharagpur and C-DAC in collaboration with Garuda Grid Partner Institutes. The project focus is to deploy access-grid collaboration environment that comes with various tools and solutions for e-learning especially video conferencing and audio conferencing coupled with third party software solution for content aggregation and hosting on grid nodes. This project has research component which involves exploring network infrastructure based experiments such as QoS, High-quality-video transmission and Multicasting and come up with specific interfaces for e-Learning grid services.

During the foundation phase of Garuda Grid project, C-DAC has experimented with high quality video transmission between multiple C-DAC centres using AccessGrid solution. Proposal on collaborative class room has been prepared to be carried out during main phase of Garuda Grid project initiative.

Veda

Veda is an on line testing and question banking system. Questions are organized into topics and topics have user-specific rights which control the access and manipulation of questions. Veda supports a variety of questions containing text as well as multimedia.

Through rich user interface, a teacher can create and edit questions, quizzes and exams and administer the exam to a group of students. Veda takes care of abrupt system crashes due to external factors (like network connection failure) by detailed and high frequency logging to restore the exam status of the student with minimum loss. The testing framework supports negative marking scheme, scrambling, etc. Testing framework generates a wide range of analysis reports providing extensive information about performance of students, exams, quizzes, questions etc. This information diagnosis of certain problems like ambiguous or wrong options, identifying strength and weakness of student etc. This in turn will make the system more effective for enhancing the learner experience. This system is being used in C-DAC Mumbai's diploma programme assessments.

Subjective Evaluation Framework (SEF)

SEF is an open-source, web-based system to prepare, conduct and evaluate examinations consisting of descriptive or subjective type questions. It is useful tool for educational organizations conducting exams that consist of descriptive type questions or a mix of descriptive and objective questions. Many time and resource consuming tasks involved in managing and conducting exams can be made easy and online using SEF. The system supports rich question paper templates with optional and m out of n type questions, as well as multiple parts. The evaluation component provides support in computing marks for such complex paper patterns also. Discussions are on to deploy this system at select colleges in Mumbai.

Maths Tutor

It is an intelligent tutoring system that teaches students to solve simultaneous equations. It is part of the focus on constructive learning environments in the Educational technology group at C-DAC Mumbai. The system can track student responses through an interactive dialogue and give him directions in solving the problem, and detect errors made, if any.

Vartalaap-II Virtual Classroom System

A Vartalaap-II virtual classroom system has been developed which extends the initial Vartalaap virtual classroom system with features of application sharing and voice communication. The Vartalaap Virtual Classroom System is a client-server style computer-based solution that runs over a computer network and enables conduct of live interactive tutorial sessions by a Teacher with a group of students who may be at different physical locations. It creates an environment modelled closely on a real-world classroom. Teachers and students communicate in real-time via instant messaging, and can use tools like the virtual whiteboard and presentation window for explaining a subject matter. The system has been developed using open source and freely available software. A paper describing the Vartalaap-II system design and usage scenarios has been published in IEEE NCOSS 2009 conference.

User Personalized Elearning System

A framework for a user personalized elearning system has been designed that proposes a solution to the personalized context-aware content delivery aspect of e-learning. The system employs semantic web and text mining techniques for content organization and personalized content retrieval. A prototype implementing a context-aware LCMS is completed. Two papers have been published in international conferences based on the project – in IADIS Elearning 2008, and in 11th International Conference on Informatics and Semiotics 2009.

Open Source Software

National Resource Centre for F/OSS – Phase-II

This is a coordinated project sponsored by MCIT involving various C-DAC Centres, IIT Chennai, IIT Mumbai, AU-KBC Research Centre Chennai. This project has been principally cleared by DIT and is awaiting administrative clearance. The project is scheduled to start in May 2009 and will last till May 2012.

National Resource Centre for F/OSS: PhaseI/Part-II

It is a DIT sponsored project. The duration of the Project was April 2005 to September 2008. Under the project, the following milestones were achieved-

- BOSS GNU/ Linux ver 3.0- coupled with Gnome and KDE desktop environment was released on September 2008 at New Delhi. Currently BOSS Linux is available in almost all the Indian Languages
- PIS: An Application for the office automation of C-DAC named as Personnel Information System (PIS) has been developed to showcase the benefits of SOA such as re-usability and loose-coupling.
- A study had been made on the "Software as a Service (SaaS)" and WebOS - a technology to deploy SaaS. A study report has been prepared.
- A study on various popular RTLinux distributions which are available in the market was made. It was found that most of them are proprietary or use proprietary real time cores. The project team is currently analysing the possibilities of incorporating the same on to BOSS Linux. This will give BOSS Linux a soft Real-time performance.

Establishment of BOSS Linux Support Centres and Business Development

It is a DIT sponsored project. The duration of the project was April 2007 to March 2010. Under the project, the following milestones were achieved-

- Support group setup at C-DAC Centres (Chennai, Bangalore (EC), Hyderabad, Thiruvananthapuram, Mumbai, Noida, Mohali and Delhi (DIT).
- BOSS GNU/Linux system repository setup at DIT – will help users in DIT to update their Linux from this server which is synchronised to the main repository at NRCFOSS. This would in future support central govt departments in Delhi.
- Data Centre with Storage Networking based on EMC Storage Area Network with capacity of 2 Tera Bytes and scalable upwards.
- The Centre has also setup the data centre with UTM based security solution with Sonic Wall Unified threat Monitoring solution which includes a Firewall with deep packet inspection engine, real-time gateway anti-virus, anti-spyware, anti-spam and intrusion prevention, and CISCO Core and edge switches.
- MOUs signed with CHiPS Chattisgarh, ELCOT Tamil Nadu, Government of Bihar, Government of Tripura, and National Informatics Centre (NIC) for deployment of BOSS Linux across the country,
- Government of Punjab has issued order for deployment of BOSS Linux in 46000 desktops spread across 4965 schools in Punjab under Sarva Shiksha Abhiyan programme. Installation and training/ workshops at pilot districts (Mohali and Fatehgarh Sahib) have commenced. The Punjabi User Manuals proposed to be supplied (minimum 5) to all the schools in the districts of Punjab is ready. For the coverage of the initial phase we will publish at least 10,000 copies.
- Implementation on in Kerala in 101 villages across Palakkad and Thrissur districts (application DC Suite)
- CHiPS Chattisgarh – trained over 175 staff, installed BOSS Linux in over 200 systems. BOSS Linux deployed for their prestigious project CHOiCE in Six districts.
- Talks initiated with Indian Navy for BOSS Linux deployment. Process on to sign MOU with Indian Navy. Conducted training programs in Mumbai, Kochi, Vishakapatnam and Noida for Navy officials. Conducted 2nd user level training programs across Kochi, Vishakapatnam and Mumbai. Conducted administrator level training programme in Chennai. Around 300+ officials have been trained till date. BOSS Linux currently installed in 500+ systems.
- National Help desk facility setup in Chennai (helpline number:1800 4250 455).
- Demonstration / implementation of BOSS Linux done in around 58 Engineering colleges / Polytechnics in Punjab / Haryana / Himachal Pradesh. Concept of BOSS Linux labs is being developed. Promotion of BOSS Linux O.S. at Northern regions of India namely Chandigarh, Punjab, Haryana, Himachal Pradesh and Jammu and Kashmir. Around 2000 successful implementations are completed within 90 institutes/ academic colleges/ Universities among different states.
- BOSS Linux desktop ver 3.0 released during September 2008 in DIT. Delhi. BOSS Linux 3.0 upgraded to ver 3.1. BOSS Linux ver 3.1 features a user friendly graphical environment, with Gnome and KDE as the desktop environment, with the Kernel version 2.6.22-3, localisation support for Gnome desktop upto 18 Indian languages, an enhanced BOSS presentation tool,

migration tool, Online dictionary, Gnome-orca and E-Speak for accessibility, Onscreen keyboard with language support, internet tools, Multimedia support and support for variety of Printers, USB devices, cameras, Scanners. Also includes Open Office 3.0 with support for 16 Indian languages, Support for MID, Projector, flash player plug-in for web browser, and additional security features.

BOSS Linux Server (Advanced Level Server)

BOSS GNU/ Linux has upgraded from Entry level server to advanced server. It supports Intel and AMD x86/x86-64 architecture. BOSS Linux advanced Level server has unique features such as Web server, proxy server, Database server, Mail server, Network server, File and Print server, SMS server, LDAP server. BOSS GNU/ Linux advanced server is comprised with administration tool such as Webmin which is a web based interface, Gadmin, PHP Myadmin, PHP LDAP admin, PG admin. It also contains wireshark GUI tool for network protocol analyzer, nmap utility for network exploration or security auditing. The Snort utility in BOSS GNU/Linux server is utilized for network intrusion prevention and detection system utilizing a rule-driven language, which combines the benefits of signature, protocol and anomaly based inspection methods.

Release of BOSS Linux Server by Dr Debesh Das, Minister in Charge, Department of Information Technology, Government of West Bengal at IndiaSoft 2009

BOSS Linux Server (Advanced level Server) with the above features was released during IndiaSoft 2009 by Dr. Debesh Das, Minister-In-Charge, Department of Information Technology, Government of West Bengal at Kolkata on February 2009.

Digital Library

Mega Centre: Digital Library of India Project:

C-DAC, Kolkata is the Regional Mega Scanning Centre, established in 2005 by DIT, MCandIT, Govt. of India, for digitization of rare and copyright free books of Eastern and North-eastern part of the country. The aim is to create a portal of Heritage Books and Manuscripts for the Digital Library of India, which will foster creativity and free access to all human knowledge.

As a first step in realizing this mission, it is proposed to create the Digital Library with a free-to-read, searchable collection of one million books, predominantly in Indian languages, available to everyone over the Internet. This portal will also become an aggregator of all the knowledge and digital contents created by other digital library initiatives in India. The result will be a unique resource accessible to anyone in the world 24x7.

One of the objectives of the Digital Library of India Project is to provide support for full text indexing and searching based on OCR technologies. The availability of online search allows users to locate relevant information quickly and reliably thus enhancing student's success in their research endeavors. This 24x7 resource would also provide an excellent test bed for language processing research in areas such as machine translation, optical character recognition, summarization, speech and hand writing recognition, intelligent indexing, and information retrieval in Indian languages.

On successful completion of 1st Phase of Digital Library Project Work (i.e. Digitization of over 14 Million pages from 35 thousand Copyright Free Books), the 2nd Phase work is in progress and in this phase another 14 Million pages from Rare and Copyright Free Books are to be digitized in the next two years and digitization of above 2 Million pages from around 5 thousand Rare and Copyright Free Books has already been done. The project is running with 100% sponsorship of DIT and the 20 Nos. Book Scanners (Zeutschel make) and the necessary Software provided by the Carnegie Mellon University, Pittsburgh, USA during the 1st phase will be used in the current phase also.

Other Verticals

Handloom and Carpet industry

A unique solution for creating innovative design for Handloom and Carpet Industry of West Bengal and North Eastern Region has been developed. By adopting this methodology and solution, weavers/ artisans of West Bengal and Sikkim are creating lots of innovative/ traditional design by using computer without purchasing any latest available costly CAD Software.

Bharateeya Embroidery (Phulkari-traditional embroidery of Punjab)

Software to create motifs or to design a new pattern of shirt using the library had been developed. The demo version developed earlier has been upgraded to version 1.0 after conducting beta version testing.

General Application Software

Executive Information System (EIS): Based on Data Warehousing Technology and Business Intelligence (BI)

A prominent characteristic of the executive's role is the making of decisions constantly. In order to take effective decisions, executives need to have access to high quality of information from various dimensions. Executive Information System empowered by Data Warehousing Technology can provide high-level valuable information from various perspectives by integrating and aggregating real transactional data from various online processes (may be from heterogeneous Databases and data sources). It offers strong reporting features like rollup, drill-down, slice, dice and pivot to present suitable form of data from macro to micro. Data can be viewed by executive in different perspective and direction/dimension by just a mouse click, without prior knowledge of the underlying system or technical know-how. In EIS, the same data can be presented in different graphical format (e.g., Bar graph, Pie Chart, etc) for better visibility to help top-level executives to Analyze the areas like Performance monitoring, Trend analysis, Fault repairing, identification of future plan, Business modeling etc.
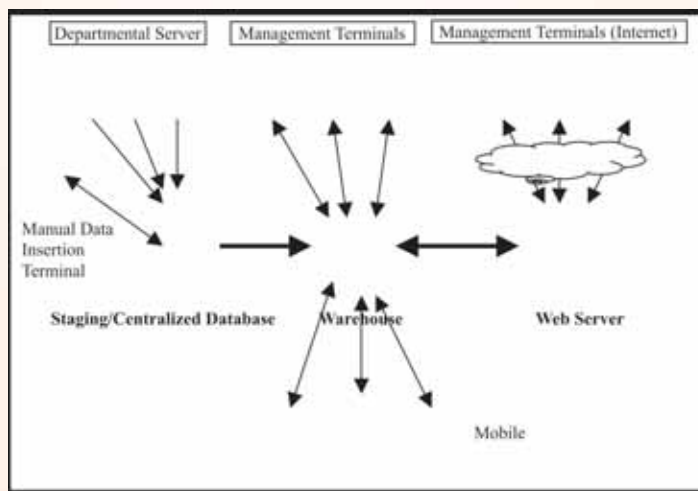
EIS Model

An implementation of the Executive Information System (EIS) at Kolkata Port Trust is integrating and serving various functional departments (physically distributed in different places and heterogeneous databases e.g. ingress, dbase, SQL server, Oracle, etc.) of Kolkata Port Trust.

Saarathy: A Mobile Navigation Solution

An indigenous multilingual mobile software has been developed for navigation utilities. This GIS-GPS enabled software has the following capabilities:

- The system does not require service from mobile service providers as it uses the data saved in the mobile unit.
- Reads shape (.shp), .kml and intrinsic formats.
- Displays satellite data.
- Multilingual menu and labelling
- Creates path and save GPS paths (create vector).
- Replay tracks: It can replay 'saved tracks' and can also play tracks from other sources; for instance a .kml file from Google Earth
- Follow path: Give warning when a planned route is not followed. This utility can be used to give warning when people approach hazardous/restricted area; for example, warn when near a crevasse in glaciated area.
- Rescue: If an emergency button is pressed, parent/employer can see the position of the person in a map. Highly useful for BPO employees.

The system is currently operative in Windows Mobile having an inbuilt GPS


Saarathy

Ground Water Prospecting for part of Assam under Rajiv Gandhi National Drinking Water Mission

The Department of Drinking Water Supply, through the Rajiv Gandhi National Drinking Water Mission (RGNDWM) supplement the efforts of the State Governments to accelerate the pace of coverage of drinking water supply to Non-Covered (NC), Partially Covered (PC) and quality affected rural habitations with mission approach by providing Central assistance under the Accelerated Rural Water Supply Programme (ARWSP). Taking this as a serious issue, the Govt. of India has included the supply of drinking water to these habitations in a time-bound-period in the 'common minimum programme' of the central Government. The nodal agency for this project is National Remote Sensing Centre (NRSC), ISRO, Hyderabad. The objective of this project is to provide scientific data on drinking water sources (ground water sources) within 1.6 kms radius in the plains and within 100 meters elevation difference in the hills of NC and PC habitations using satellite data.

Under this project C-DAC has been awarded the task of preparing Groundwater Prospects Maps for part of Assam State. The project has been carried out on a 1:50,000 scale. The themes that were generated are surface water bodies viz., streams, canal, and tanks, groundwater irrigated area, artificial recharge structures (check dam, recharge well, nalah bund, desilting of tank, etc), structures, geomorphology, lineaments and lithology. The map shows, prospective zones for ground water occurrence and tentative locations

for constructing recharge structures. The information provided in the ground water prospects maps form a suitable database for narrowing down the target zones and systematic selection of sites for drilling, after conducting follow-up ground surveys, to establish drinking water sources to all the NC and PC habitations, besides providing information for selection of sites for construction of recharge structures to improve the sustainability of drinking water sources, wherever required.
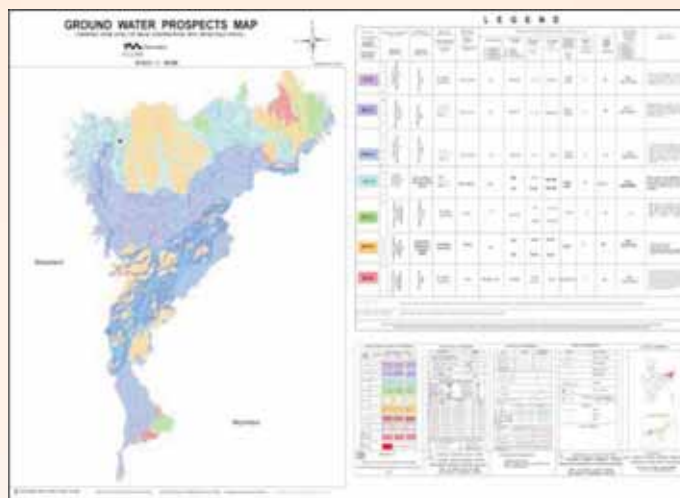
Ground Water Prospects Map

Vidwan (An Expert System Shell)

Vidwan is a web based expert system shell which allows creation of rule based expert systems, by encoding expert's knowledge as a set of rules. Designing a current expert system mainly requires knowledge acquisition and knowledge engineering while Vidwan handles all the other aspects like inferring and user-interaction also. The system supports a full fledged interactive rule editor and a set of utilities for rule base verification. The web based beta version of Vidwan is now available for use and is accessible at http://www.cdacmumbai.in/ Vidwan. A help link accessible through the homepage of Vidwan is helpful for better understanding of the system and provides user guidelines.

Graph Mining Tool

The Graph mining tool will be useful for finding associations and clusters in any application domain where data is represented as a graph, such as WWW, social networks,complex relational database and research citations. The Framework has been designed and a first cut proof-of-concept (PoC) for finding and visualizing substructures using graph database has been implemented using DBLP dataset. Also developed the "Lattice generation and visualization" module for DSAR project (Decision Support for Automatic Refactoring of Java programs). A paper outlining the Graph Mining Framework has been published in IEEE ASONAM 2009 conference.

Multi-modal Interface for HCI

The aim of this project is to improve the human computer interaction. A proposed approach for a new Multi-modal interface for HCI was formulated which uses – speech input, pen/finger gestures, and text input. A preliminary prototype application for Multi-modal interface to a Computer Desktop window has been developed. This application is able to recognize the human hand-finger gestures captured via web cam (limited) and speech input (limited vocabulary) for interacting with the desktop. User can do simple operations like open, delete, selection etc with help of the gesture and speech input. User can bring the cursor to a desired icon on the screen using finger gesture and can say to "open" to open the file / program associated with it. Speech recognition system will identify the command and corresponding response can be observed. Open source software have been used in developing the prototype. A paper on the proposed approach has been published in IEEE- ICADIWT-08 international conference.

Government Applications

In order to enhance the efficiency and effectiveness of government functionaries the following systems have been developed by C-DAC

Works and Accounting Management Information System (WAMIS)

WAMIS have been initiated for Rural Development Department, Government of Orissa. WAMIS is an integrated and workflow enabled system with Budget, Works Monitoring, Billing and Accounting System based on the CPWA code. WAMIS has been developed adopting PMGSY model thereby enhancing the transparency in the work executed by RD Department.

Online Management, Monitoring and Accounting System for Pradhan Mantri Gram Sadak Yojana

The OMMAS for PMGSY has been designed and being used effectively to monitor the entire programme and has successfully brought in greater efficiency, accountability and transparency.

e-Payment is successfully implemented by 5 states on pilot basis. Decision Support System equipped with graphical reports is developed for state level officers and MoRD/ NRRDA officials to support business and organizational decision-making as well as view current information of assets and to increase organizational control. Localization of reports, which are available for citizens, is implemented.

MIS for ICDS -Phase II

State ICDS (Integrated Child Development Services) Scheme covers more than 29000 Anganwadi units, under 163 ICDS blocks spreading all over Kerala. The MIS software is installed at three levels- block, District and the State. MIS reports from Anganwadi units are collected at block level and sent to the state level office through the district level offices. All the blocks are connected to their respective district offices, and each district is connected to the state headquarters through a Dial-up network.

MIS for Integrated Child Development Services

India Development Gateway (InDG)

The nation-wide initiative, India Development Gateway (InDG), facilitates rural empowerment through provision of credible information products and services catering the real and strategic needs of the rural community in their local language.

The financial year 2008-09 was eventful for India Development Gateway (InDG), as it got nationwide visibility through launch of the

portal and various outreach events. The multilingual portal (www.indg.in) developed as the part of this project was launched by the President of India, Smt. Pratibha Devisingh Patil on July 4, 2008 at Vigyan Bhavan, New Delhi.

Launch of India Development Gateway Portal by Her Excellency, Smt Pratibha Devisingh Patil
The Hon'ble President of India on July 4, 2008 at Vigyan Bhawan, New Delhi

The multilingual portal (www.indg.in) currently hosts information related to key livelihood sectors - Agriculture, Health, Primary Education, Rural Energy and E-Governance- in six languages - Hindi, Tamil, Telugu, Bengali, Marathi and English covering information on 2100+ topics. As part of outreach activities, 11 multi-stakeholder consultation workshops, 6 capacity building trainings and 32 community level ICT awareness programmes were completed in 7 states during this period. One of the key strategies of InDG has been building partnerships. InDG has established partnerships with over 200 stakeholders from Government, civil society, academia and private sector for content generation, validation, translation and outreach activities.

New portal features such as, ask an expert, SMS based market information to farmers, interface for public utility forms, news archiving, opinion polls etc were added to the portal. Two issues of the multilingual newsletter - "Gateway to India's development" and three capacity building training manuals for kiosk operators have also been published during this period.

National e-Governance Service Delivery Gateway (NSDG)

C-DAC is shouldering responsibilities of Gateway Service Provider for National eGovernance Service Delivery Gateway. C-DAC Mumbai completed the development of NSDG in October 2007 and solution was released for Go-Live after deployment and system testing at NIC Hyderabad on August 14, 2008. C-DAC has participated in enhancing the eGovernance Standards viz., Interoperability Interface Protocol (IIP) and InterGateway Interconnect Specification (IGIS) with DIT officials. The current implementation has been upgraded to the new eGovernance standards and is ready for deployment at NICSI Delhi. The launch of upgraded implementation of NSDG along with National Services Directory (NSD), the infrastructure for Gateway constellation is envisaged around last week of May 2009.

State e-Governance Service Delivery Gateway (SSDG)

The project is nominated to C-DAC by DIT after the implementation of NSDG. SSDG is the instance of NSDG which will be present in every state as a gateway. C-DAC's gateway product will serve as SSDG that is to be implemented at every state. C-DAC role is to provide and maintain the product. The implementation agencies that are empanelled by DIT will deploy this product at state level. C-DAC provides training and maintenance support for the product to the implementation agencies and states. The project has already commenced.

eForm Engine (FULCRUM)

DIT approved C-DAC e-Form Engine on March 30, 2009. C-DAC Mumbai has started working on Phase I which targets building of e-Form POC by end of April 2009 and completion of Phase II by end of June 01, 2010. The broad objectives of project are as follows:-

1. Customization of e-Form Product to current requirements
2. Creation of 50 e-Forms as part of POC demonstration
3. Integration of e-Forms with Portal, NSDG and Demo SP
4. Bring out Architecture Design for Integration with Other MMPs using e-District as a Reference Mode
5. e-Form Engine migration to Open Standard mandated by DIT
6. XML Signature Implementation
7. Front-end Workflow Management Engine for e-Form
8. Creation of common interface for interfacing with portal, SSDG and application layer as envisaged under this project and other MMPs like e-District

Decision Support for Automatic Refactoring (DSAR)

DIT has approved DSAR project as research initiative under NeGP. C-DAC Mumbai has engaged resources and is currently in the Planning and the Requirement Specifications phase. The broad objectives of this project are:-
1. To provide automated guidelines for re-engineering an object oriented application. The guidelines include class name, method name or attribute name, refactoring technique to be applied and how to apply the specified refactoring.
2. Based on the user response for the automated suggestions, aim is to perform the desired refactorings automatically.
3. Develop a tool that suggests and implements refactoring for Java..

Setting up of Rural Tele Centres in Lao PDR

This project was implemented as part of bilateral cooperation between Lao PDR and India in the area of communications and information technology. The work consisted of establishment of the system in 10 rural centres spread over the country. It included setting up of physical and networking infrastructure, system installation, re-engineering of e-Governance applications to suit the needs of the Lao language and imparting necessary training to operators at Lao PDR. It was completed on turnkey basis within a short span of 4 months.

Personnel Information System for Dakshin Haryana Vidyut Bitran Nigam (DHVBN) Limited

DHVBN has awarded a turnkey project to C-DAC for setting up computerized Personnel Management System and Pay Bill Register System for all their offices in Haryana. It automates the activities in the Establishment and Accounting Sections of more than 36 offices of DHVBN and UHVBN. The project has the potential for usage in other State Electricity Boards as well.

Import Valuation Assistance for Customs

C-DAC Mumbai had developed a valuation assistance system — Mulyaankan — for Indian customs a few years back. Based on the success of the system, a request to build a similar system was received from Kenya Revenue Authority. Based on detailed discussions and reviews, requirements was finalised, and the proposal to develop a fresh system for them was approved. The work also involves the Valuation department of Indian customs. The work is in progress

PROFESSIONAL ELECTRONICS (Including VLSI and Embedded Systems)

Load Forecasting Tool

Economically efficient generation scheduling requires accurate forecasting of load. Short Term Load Forecasting (STLF) plays an important role in load management and planning of electric power system operations. It is fundamental to provide economic generation, system security, load management and planning.

C-DAC's load forecasting tool provides three models to predict the load statistics. Among them one is Adaptive Response Rated Single Exponential Smoothing (ARRSES), second is Holt's Linear Method and last one is Auto Regressive Integrated Moving Average (ARIMA). Before using any model, the historical data is prepared for the corresponding day by taking seasonality and holidays into consideration.
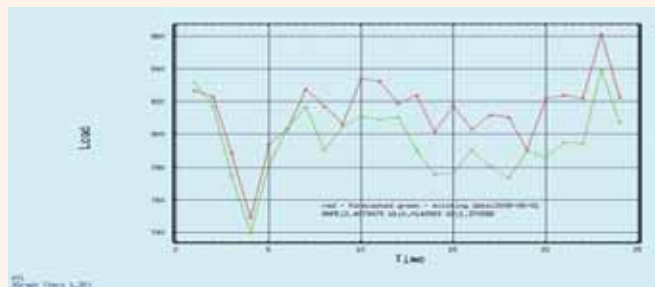
Load Forecasting Tool

C-DAC SCADA System Diagnostic Tool

C-DAC has developed a SCADA system diagnostic tool for testing a system's health in distributed networks. This tool assists in monitoring process status of configured SCADA processes and network status of the system and system performance parameters such as CPU usage, memory usage, swap usage and Load average. IPC status of the system can also be observed if any IPC key is required. These tools are made available in both JAVA and C platforms.

C-DAC SCADA System Diagnostic Tool

Agent-Web Services: Multi-Agent Autonomic Approach for Web Services

This tool intends to develop high-end enterprise IT systems. An Agent-Web service has features of both agent technology and Web services technology, and is managed by an autonomic system based on multi-agent support.

IT systems developed by this technology are optimal, highly available, extremely reliable and highly adaptable. In fact, this can generate a reconfigurable, self-manageable and coordinated approach to perform business process management both across and within an enterprise.

Mobile Agent Framework

Design and Development of Wireless Sensor Motes

C-DAC has designed and developed a wireless sensor based on IEEE 802.15.4 and Zigbee standards using Texas Instruments CC2430 SOC. The first version of the node is tested, which has separate communication and battery modules.

Zigbee has been ported into our sensor node and few applications have been tested. We ported Tiny OS on sensor node and sample applications have been tested.

Testing the DATA frame of IEEE 802.15.4 MAC IP on hardware has been done. The encryption schemes related to MAC security has been designed and tested.

Wireless Sensor

SIP Telephone

This new product, SIP (Session Initiation Protocol) Telephone, designed by C-DAC is a standalone unit with provisions of Ethernet interfacing. SIP has utilized the expertise of C-DAC in the area of IP Telephone design acquired from its earlier H.323 IP Phone development project.

This system has been developed around the state-of-the-art-technology components for VoIP applications. The IP phone processor used in the design consists of a MIPS processor and a digital signal processor for performing the high-speed computations demanded by the current and evolving IP telephone standards. The dual-channel 16-bit audio codec handles the handset, headset, and speaker drivers. The Ethernet subsystem has two Ethernet media access controllers and physical-layer interfaces.

This forms a highly cost effective VoIP solution, as the chipset used will reduce the component count and power consumption of this product. This product is ideal for Internet and corporate intranet applications.

Intelligent SCADA in Retrofit Automation

The Intelligent SCADA system developed by C-DAC is an excellent tool in automating a chain of power stations or any other process plants.

The SCADA system comprises FPGA based Intelligent Analog Input, Analog Output, Digital Input, Digital Output modules and an Intelligent Process Controller built on a dual-core DSP processor with Intelligent Decision System and platform independent SCADA software. The compact 3U size Intelligent Process Controller (IPC) is ideal for Retrofit Automation. The Remote Terminal Units (RTU) can be mounted inside the existing panels and are much beneficial while compared to the old versions (with 6U size modules) that require a separate system cabinet.

IPC performs Intelligent Process Control functions such as detection of module type, channel number and Input/output type. The other functions include intelligent processing of defective and noisy signals and execution of complex data acquisition algorithms. The FPGA based Input-Output modules with their embedded algorithms execute all data acquisition and control functions, relieving the Process Controller module to carry out high level decision making functions.

Salient features of the system include embedded control system architecture, optimal state estimation filtering prediction, data fusion, and intelligent fault detection and operator guidance. This product eliminates the normal requirement of large quantity of cables in retrofit automation under stringent space constraints.

A model system implemented at Kerala Water Authority Water Treatment Plant No. - III at Aluva is working successfully and is used regularly by the plant operating staff.

Area Traffic Control System Implementation in Jaipur

Area Traffic Control System (ATCS) is a fully adaptive road traffic control system that uses data from vehicle detectors and optimizes traffic signal settings for a particular geographical area having multiple traffic corridors, lanes and junctions. ACTS developed by C-DAC helps to reduce vehicle delays and stops and also enables traffic police to detect violations and enforce rules by monitoring the system from a remote control station.

The ATCS was implemented in two phases at MI Road, Jaipur. Following are the major building blocks of ATCS:

- Traffic Signal Controller
- Street Furniture
- Vehicle Detectors
- Application Software
- Central Control Station
- Communication Network
- Street Furniture

Surveillance cameras are deployed along the entire MI road as part of the ATCS project. In the first phase twenty-three cameras are installed which will cover nine junctions with eight controllers where one of the controller manages two junctions. Four junctions with four controllers are added up during the second phase with the installation of seventeen additional cameras. The facilities of the control room for video surveillance include four monitors and two LCD panels of forty-six inch (46") LCD. Inductive loop detectors (ILD) are used at every ATCS intersections to monitor the traffic density for real-time control.

The control system operates in a closed loop real-time environment. Bandwidth sharing is done for the real-time video and ATCS data packets on the same communication network. The video data is used by traffic police to detect violations and enforce rules.

Phase I and Phase II ATCS implementation on MI Road

Camera images received at the Control Room

DARPAN – Real Time Network Visualization and SLA Monitoring Tool

The Realtime IT operations management and Service Level Agreement (SLA) monitoring system developed by C-DAC Thiruvananthapuram is a visualization and monitoring tool for E-Governance networks. This agent-less web-based tool facilitates the monitoring of SLA parameters of systems, services and applications on IP based heterogeneous networks.
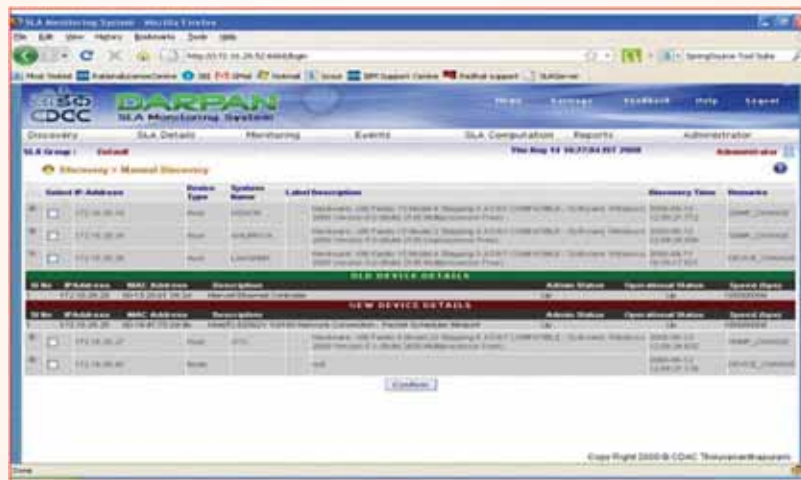
DARPAN

Power Supply Card for Mirage Aircraft

Indigenously developed by C-DAC, Thiruvananthapuram for Indian Air force, this power supply module is capable of generating all the different DC Voltages required for the control modules in the A/S (Aircraft-to-Store) interface box of Mirage Aircraft, and is a one-to-one replacement of the existing imported unit.

This Power Supply Module was tested for compliance to MIL standards for airborne electronic equipment for operation, primarily in piloted aircraft, and also for performance, power quality, reliability, environmental, EMC, and vibration. The product design is done

with utmost care to maintain the form factor regarding size, shape and weight of I/O interface of the existing imported unit, to facilitate the one-to-one replacement.
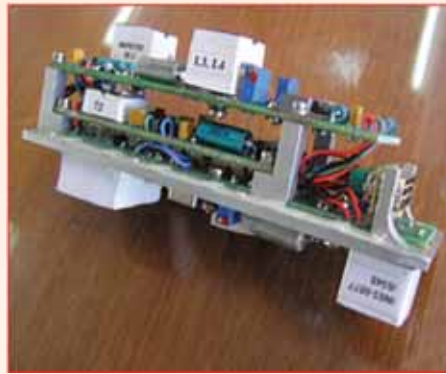
Power Supply Card for Mirage Aircraft

Matrix Converter

This is a technology development project under NaMPET programme. jointly executed by C-DAC and IISc, Bangalore. The objective of the project is to develop the converter topology and control technique of a MATRIX converter.

The matrix converter offers an "all silicon" solution for AC-AC conversion, removing the need for reactive energy storage components used in conventional rectifier-inverter based systems. It does not have any DC-link circuit and does not need any large energy storage elements. A 3-phase to 3-phase matrix converter consists of nine bi-directional switches that are used to connect the input phases directly to the output phases of the converter. The switching of these bi-directional switches is then modulated to produce the desired output voltage and frequency. Matrix converters offer many advantages over traditional topologies such as the ability to regenerate energy back to the utility, sinusoidal input and output currents and controllable input current displacement factor. The size of the converter can also be reduced since there are no large reactive components for energy storage.

Matrix Converter
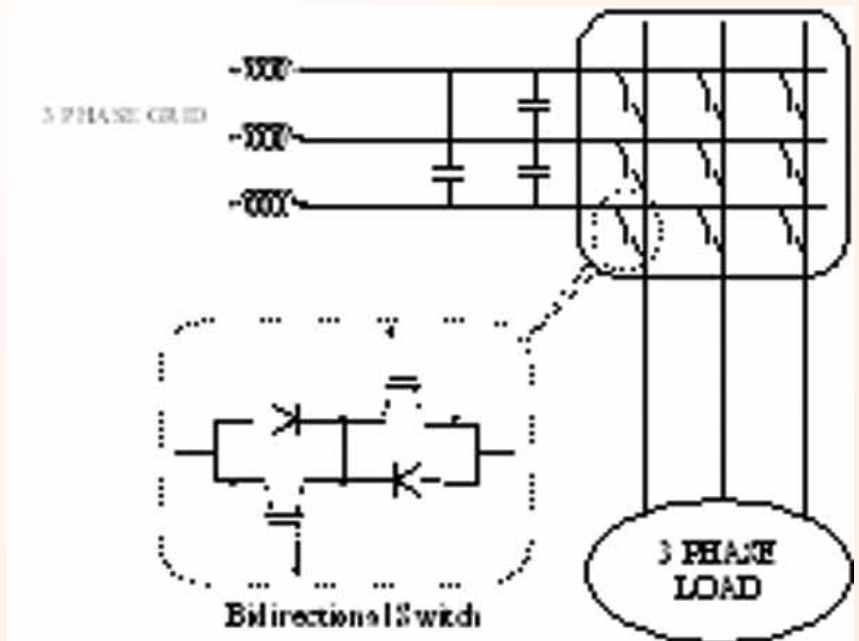
One 50KVA prototype is developed and tested successfully.

Hall Effect Current Sensor

This is a product development project under NaMPET programme, jointly developed by M/s Electrohms Bangalore and C-DAC. Hall Effect Current Sensors (HECS) of current rating 25A and 100A used for measurement of DC and AC current in industrial applications. Magnetic flux crea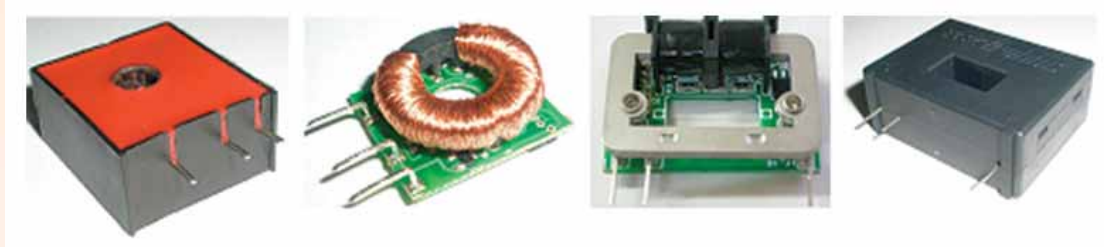ted by the primary AT is balanced by a compensating equivalent secondary AT using closed loop technology with advantage of high accuracy, good linearity, and no insertion losses, over open loop type.

25A HECS   *100A HECS*

Power Assisted Bicycle

Motor assisted pedal cycle designed by C-DAC is a two wheeled vehicle that helps to augment the primary motive force achieved by human rider. It is conceived as a conventional human powered bicycle with an auxiliary add-on system with motor assistance. User is not required to operate any special controls for engaging the auxiliary motor assist while the vehicle is in motion. The rider of the vehicle pedals the cycle similar to that of conventional human powered bicycle. The force exerted by the rider is sensed by the system and the motor augments the rider's effort. The threshold at which the assist system can cut in can be pre-set to match the user characteristics and preferences.

Signal Processing Engine with Embedded Digitizers

The Signal Processing Engine with Embedded Digitizers is a high performance standalone Digital Signal Processing (DSP) board with Ethernet/USB/PCI-E interface and A-to-D converters. This board is capable of continuous acquiring of multiple channels of data signals processing and transferring the same to a PC. The board acquires data at a rate of 20 M samples/Sec. DSP chips process the acquired data and USB 2.0, Ethernet and PCI-Express options facilitate the transfer of data to the next stage.

Signal Processing Engine with Embedded Digitizers

Range Vessel Tracking System

VETRA is a high accuracy DGPS (Differential GPS) based system that will precisely calculate the co-ordinates of the two ends of ships (Stern and Bow). This data is required for ranging of ships. In addition, the system includes Radio Telemetry equipments to feed real-time data to the range set up on shore, Radio Repeaters to take care of submarine ranging, and Time Division Multiplexing modules to support four Rovers (Module Units) from one Base Station.

32bit RISC processor based Development System Board

A dual FPGA (Xilinx Virtex-4 & Spartan3) board has been developed with 32-bit RISC processor and in-built peripherals integrated, IT can be used as a development system for complex hardware implementation in various domains and also as a training platform for Embedded Systems. ER922 based board provides a complete development platform, which enables designers to implement embedded ER922 processor based applications with extreme flexibility using IP cores and customized modules. It provides RS232, Ethernet and USB ports for interfacing to a PC. ER922MPB also has 56 Bytes NVRAM+RTC for nonvolatile storage of data as well as for time keeping functions. The board also has a Touch Screen LCD display and integrates a 4MB flash memory for storing the application firmware. ER922MPB is capable of controlling the interface boards to which it is to be connected as well as acquiring and storing data.

32bit RISC processor based Development System Board

UHF RFID Reader LR100

LR100 is a cost effective UHF RFID Reader with EPC Class 1 Gen 2 Compliance, operating at 866MHz, enabling user to deploy solutions for demanding applications such as supply chain management, logistics, library management, manufacturing,etc. The unit has a read range upto five meters. LR 100 provides added simplicity of a mono-static antenna topology, which provides a smaller footprint and easier integration. It also incorporates an RTC and NVRAM for time stamped applications with data storage. LR 100 supports USB and 10/100Mbps Ethernet connectivity.

UHF RFID Reader LR100

Development - Fabrication of ASIC, Productionisation of Digital Programmable Hearing Aid and its Deployment

This project aims to convert the FPGA based DPHA design into an ASIC in a suitable Very Deep Sub Micron process technology to enable considerable reduction in the device cost, besides yielding performance advantages, speed and power consumption, etc., essential for the success of the product. As part of the project 1,20,000 ASIC will be fabricated and 20,000 digital Hearing Aids (15,000 BW and 5000 BTE), will be manufactured and deployed.

Digital Programmable Hearing Aid

C-DAC Open Power Solutions (COPS)

COPS is the SCADA engine indigenously developed by C-DAC for the network integration of various systems.

The complete software is distributed across a group of servers networked over LAN. The heart of the system is Peripheral Resource Server (PRS) and hosts most of the modules that are distributed on the basis of their functionality. ELCOM-90, which is layered over TCP/IP, is used for all communications. As all the modules are layered over ELCOM-90, the modules can run on any machines on the network. The data packets received through modems or uplink of another PRS are coming over as a set of serial links to PRS process which are further processed and stored in the database for future purposes. The ELCOM-90 server at PRS provides the contact point for all other modules for accessing dynamic, static and alarm data over the network. The database server runs on PRS and has functionality to export data to FoxPro, ORACLE, MySQL etc., and is a client to ELCOM-90 server for giving database support. The operator controls Man Machine Interface (MMI) is on the network contacting PRS for dynamic data, static data, etc., for continuous display data and pictures.

The Peripheral Server (PS) module handles all print requests and controls all peripheral devices. The Web Server (WS) module uploads the online data and creates the required web pages. The Remote Terminal Server (RTS) runs on a separate machine, which acts like a gateway to other dumb terminals and intelligent terminals connected to the system for remote monitoring.

SCADA Solution for Rajasthan Rajya Vidyut Prasaran Nigam Limited

In this SCADA solution developed by C-DAC, the real time measurand (analogue) data is captured from the ULDC system and made available on the web. The web server uploads online data to three DISCOMS in every two minutes using UDP link. Time synchronization between the three DISCOMS is achieved by using GPS connected with Web Server.

SCADA Solution for Madhya Gujarat Vij Company Limited

This solution by C-DAC enables to run a communication module on the Intermediate Server (IS) to read online data provided by SLDC Gotri and to upload the online data to HMI and PS for monitoring and report generation with an update time of 30 seconds. The Short Term Load Forecasting tool of this SCADA solution enables the accurate forecasting of electric power system operation load management and planning.

SCADA Solution for Steel Authority of India Limited

This system offers to transfer online data between SLCC (SAIL Kolkata) and Plant Systems (Bokaro, Durgapur, Rourkela, Bhilai and Delhi). At plant side, UPLs communicate with ECIL systems and the data is uplinked to SAIL Kolkata. The acquired data is validated at PRS and transferred to Man Machine Interface and Peripheral Server for monitoring and report generation. This project is under maintenance.

Haryana Vidhyut Prasaran Nigam Limited Web Scheme

In this project the real time data is captured from the ULDC server and made available on the web with an update time of 30 seconds. The last 14 days data at 15 minute instantaneous resolution is made available on the web. This project is under maintenance.

Energy Trading Software for Northern Region Load Despatch Center

The Short Term Open Access (STOA) software has been developed for Northern Region Load Dispatch Center (NRLDC) as a subset of Energy Trading software. This n-tier application built on J2EE technology is using Oracle Application Server and Oracle Database Server. The functions include online filing, processing of applications for approval, prorata calculations based on avail-ability with scheduling and payment schedule generation.

Maintenance of RTUs supplied to Punjab State Electricity Board (PSEB)

This project offers the maintenance of Remote Terminal Units (RTUs) supplied to Punjab State Electricity Board. RTUs are used for data acquisition from field devices. All the RTUs are supplied with IEC compliant communication ports.

Local Display of RTU Solution Given to Siliguri

This distributed intelligent SCADA solution given to Siliguri is made available for display of captured data (from RTU over IEC compliant communication port), punching of data in log sheet and report generation.

Smart Parking (SPARK)

The main focus of Smart Parking (SPARK) system is to provide real time information related to the availability of vehicle parking lots to the users and enable them to reserve parking lot from remote locations through web and mobile-based clientele devices. SPARK is capable of guiding the users to locate vacant parking spaces so as to park their cars quickly and safely. The system architecture and subsystem level component of SPARK as a part of UCRC project is developed based on the requirement analysis of existing car parking management. This system consists of Wireless Sensor Networks (WSN), Gateway, Parking Management, Automated Guidance, Entrance Display and Client Reservation as subsystems.

The implementation of a full-fledged prototype model, as a proof of concept to realize and understand the real time scenarios in parking management systems is sufficed.

Adaptive Framework for Wireless Sensor Networks Application (AFWA)

Adaptive Framework for Wireless Sensor Networks Application (AFWA) is a software tool developed by C-DAC, which facilitates rapid development of Wireless Sensor Network Application. This tool can be utilized by both the System Component Developer and Application Developer. Salient features of this tool from the perspective of system component developer include easy integration of custom system components viz,. Network Communication, Time Synchronization, Security and Localization, Simulators and over-the-air programming functionalities. While from the WSN Application Developers perspective it facilitates the flexibility of opting system components specific to the WSN Application, allowing the application developer to build and simulate the application and programme the compiled application image over-the-air.

RFID Technology

Radio Frequency Identification (RFID) tracking application (Anupathak), developed by C-DAC Mohali, can be used to control and manage movement of documents. Anupathak centrally manages the document and its location along with all the access history associated with the document movement .It employs RFID tag attached to a product and deploys RFID readers. Anupathak has applications in industries like insurance, medical and legal and also in government sector where the loss of important files can cause numerous problems.

RFID readers generally available in the market do not store the data and are restricted to tag detection role. C-DAC is in the process of developing a customized RFID reader with memory and serial interface, which can be interfaced with PC for database handling and various report generations. These readers would be useful for RFID based attendance systems also.

Anupathak

Black Box for Automobiles

This device developed by C-DAC is used to record various parameters like speed, load, brake oil, temperature and alcohol of the vehicle during its usage. Its development has been completed and demonstrated. The technology transfer of know how is in progress according to the earlier agreement. In order to ensure the smooth transfer interaction with the unit has been intensified along with revisiting various milestones. Improvement in technology for downloading data through GSM/ GPRS would also be undertaken.

National RFID Programme

C-DAC is participating in the National RFID Programme, jointly with Indian Institute of Technology, Kanpur and SAMEER, Mumbai and C-DAC, Noida. It focuses on research and development in the areas of RFID and sensor networks with special emphasis on Indian scenario. C-DAC provides integration expertise for generating end-to-end solutions, IIT, Kanpur provides academic lead for the development, and SAMEER provides expertise in RF, Antennae and Field Measurement Technologies.

Major ongoing activities in C-DAC under this project are: -

- Speed Post Bag Tracking with RFID Enabled Bar-Code Tags: This is a Proof of Concept demonstration project for usage of RFID tags in tracking of Speed Post Bags. In the first phase, the bag tracking between 25 selected Post Offices in Delhi, Mumbai and Chennai will be RFID enabled. After this, three other metros namely, Bangalore, Hyderabad and Kolkata will be linked to this network. On successful completion of the Proof of Concept phase, Department of Posts will take over the system for their regular operations. The system is presently under testing and is expected to be operationalised by the third quarter of 2009.

- Bio-Medical Waste Management System: The project aims to implement RFID technology in Bio-medical waste management of Delhi Government Hospitals. Guru Gobind Singh hospital has agreed for pilot implementation. Procurement is in progress and the system will be operational by the end of 2009. Once successfully implemented, GNCTD is planning to implement the system in all of their 32 hospitals in Delhi.

- Access Control and People Management System: An RFID based People Management system for registering employee attendance and tracking of their movement across various locations of the campus, has been developed. The system is installed in the academic and administrative sections of C-DAC, Noida and has been operational for the past 5 months. The system is now ready for technology transfer and can be used for various applications like attendance recording, access control, and management of events like games. The system was demonstrated in IETE Technical Convention and Exhibition held in Sept. 2008.

FPGA based Systems

The objective of this project is to augment the hardware modules of FPGA based systems developed earlier towards customized solutions and making them deployable as system components in consultation with prospective users.

Noise Cleaning of Ultrasonographic Images

The aim of this project is to implement noise-cleaning algorithm on a piece of hardware to offload computational load from software to hardware

The input to the Software package is the raw USG image in .bmp format. A C Program has been written for stripping off the .bmp header and the data is written to the PCI bus. The FPGA on the PCI card reads this data and stores them onto the on-board RAM in consecutive memory locations with adjustments in the data values as per Median filtering algorithm. An algorithm called replication sort has been deployed and the result is achieved in two clock cycles. The result obtained in hardware platform is exactly compliant with the software output.

"Bangla" TTS: FPGA Implementation

This project is meant for FPGA implementation of text-to-speech conversion. The work is divided into 2 modules. While the Text-Analyzer module is implemented through Software on the PC platform, the Synthesizer module is implemented through Hardware on an FPGA board. Input Bangla Text file is converted to a phoneme string at the PC. This phoneme string is given to the FPGA Board through UART serial port. A delta-sigma DAC is implemented on the FPGA to play the sound. This DAC output is fed to a Speaker through two external components, a resistor and a capacitor. The design is implemented on a Xilinx Virtex (XCV200) FPGA Board.

Virtual Instrumentation

This project undertakes the core research and feasibility studies in developing and deploying Smart Virtual Instrumentation Systems including Acoustic Doppler Velocimetry and Automated Wave Generation features for modernization of Indoor Hydraulic Laboratory. The work is continued in co-operation with River Research Institute, Govt. of West Bengal and the detailed conceptual model for a specific experimental-setup has been created for "Studying Cross-shore Sediment Transport by Wave action and Bed-return Current" in a Wave Flume.

Agri-Electronics

Salient activities during the year in Agri-Electronics area were as follows.

- Image Processing Applications for Sericulture
- Measurement of Blackness and Fibre Content of Black Tea
- Pilot-scale deployment of Electronic Nose & Vision (ENV) Systems in North Eastern states
- Taste Characterization of Black Tea by Electronic Tongue
- Quality measurement of Basmati Rice and Mango using ENV System

Given below are the glimpses of the applications developed in few of the above fields.
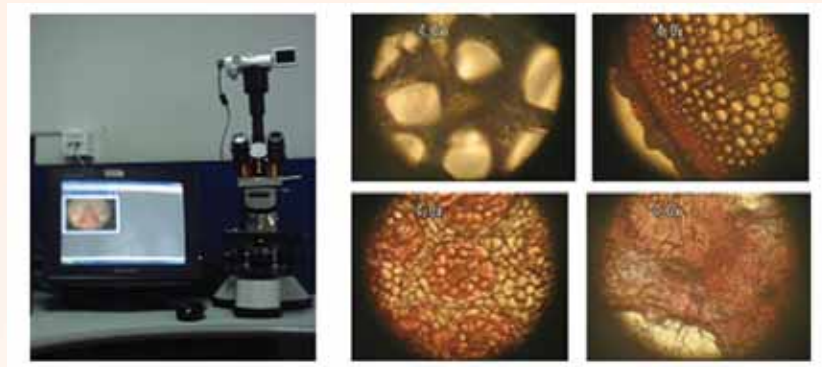
Pebrin Spore identification using micro-image processing for Tasar Sericulture
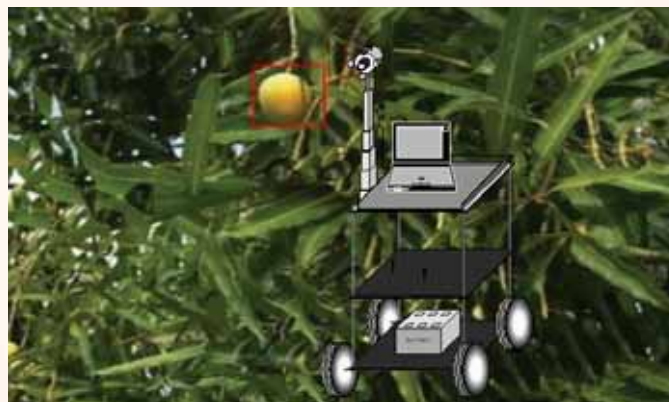
On-line detection of mango ripening status and quality by ENV system

CYBER SECURITY AND CYBER FORENSICS

Cyber Security

Cryptanalysis: Algorithms and High Performance Computing Techniques

Factorisation of numbers up to 536 bits including RSA 512 bit number has been completed. It is planned to port quadratic sieve on NVIDIA Graphical Processor Unit (GPU). GPU is multi - core with individual cache attached to each core.

Complete DES brute force (56 bit key search) on hardware has been completed on new DINI Virtex-5 based card. The worst-case time for the complete key search is 13 days and the average time is 6.5 days for DES. DES brute force software implementation on NVIDIA GPU has been ported and the testing is under progress. AES pipelined version has been optimized. It is the fastest FPGA AES implementation compared to all the published similar kinds of results.

Pipelined decryption engines for IDEA, 3-DES, Blowfish, CAST, GHOST, Rijndael, Serpent, Twofish, Mars, RC6, RC5, RC4 encryption schemes as part of the supplement phase of the project have been developed.

Intelligent Intrusion Detection System (In2DS)

Physical Intrusion Detection Systems are expected to foster as a strategic application, which provide future benefits to various public and private organizations. Though emerging technologies have metamorphosed the nature of surveillance and monitoring applications, the sensory data collected using these gadgets still remains unreliable and poorly synchronized. Based on the analysis from existing and traditional surveillance systems as well as keeping in view the need for a well refined data analysis system for surveillance applications, development of an Intelligent Intrusion Detection System (In2DS) based on wireless sensor network (WSN) technology as part of the Ubiquitous Computing Resource Centre (UCRC) project is under progress. This system is expected to provide wider sensing coverage, night and harsh weather surveillance, improved warning and alarm functionalities, and reduced manual intervention. The system is capable of event based real-time video surveillance, thereby reducing the amount of unwanted data accumulation. Video and sensor information related to any detected events are collected and displayed to the end-user through web. The current project activity includes development of a proof of concept of the In2DS system thereby realizing a full-fledged model.

Information Security Education and Awareness (ISEA): Information Security Awareness

The nation-wide initiative, Information Security Education and Awareness (ISEA), with an objective to identify, design, implement and coordinate a comprehensive national awareness campaign on Information Security for Children, Students, Teachers, Parents, etc. to generate information security awareness among Indian citizens to enable them to participate safely in Information Society.

The financial year 2008-09 was eventful for ISEA program, as it started the activities like conducting Awareness workshop for all Participating Institutes of ISEA program. The Participating Institutes from NITs, IIITs, Engineering Colleges, C-DAC, DoEACC Centres across the country attended the same on June 09, 2008 to understand ISEA Awareness Program and workshops conduction for various target users to initiate the same at their places.

Around 16 workshops were conducted across India by Participating Institutes at Allahabad, Bhopal, Chennai, Gwalior, Hyderabad, Surat, Suratkal, Visakhapatnam, Ranchi and Shimla.

As part of the programme, a website *www.infosecawareness.in* is hosted to support the activities of Participating Institutes and target users for various security risks, guidelines, tips along with download section for security awareness guide books. There are separate sections for different target users, which are being updated continuously.

Information Security Awareness Website

End System Security

End System security is one of the focus areas at C-DAC. EnSAFE and RealSAFE products are the outcome of research efforts. Initiation of EnSAFE technology transfer is one of the important events of the year. EnSAFE is an end system based security solution for TCP based applications. Technology Transfer of EnSAFE is initiated with an identified industry as per the technology transfer fee fixed by Department of Information Technology (DIT), Government of India.

ToT of EnSAFE

Malware Prevention System

This project has been initiated during 2008-09. It focuses on developing an end system based Malware Prevention System by considering the behaviour of applications. A model of application is generated based on the usage of operating systems resources in terms of system calls and its arguments. This is verified against the security policies. At the time of execution, model is enforced and if there is no deviation from the model, application is allowed for execution. During the financial year 2008-09, Proof of concept of the Malware Prevention System with model generation, model enforcement is developed for MSWord and Evince PDF reader in Windows and Linux Operating Systems respectively. Currently efforts are being made to generalize the solution for Windows and Linux Operating Systems.

U-Visvaas

U-Visvaas is a flexible and comprehensive framework for addressing dynamic security, trust and privacy demands and the binding between users, devices, services and active spaces of Ubiquitous Computing environment, addressing the needs of enterprise as well as peer-to-peer applications. This framework addresses the critical requirements like Multi Mechanism Support, Transparency

and unobtrusiveness, Multilevel Security, Context-Awareness, Flexibility and Customizability, Interoperability, Extended boundaries, Scalability, Dynamic Access Control Mechanisms and Trust Formation Using Automated Reasoning. Security framework for enterprise applications is based on Context Role Based Access Control (CRBAC) model and for Peer-to-Peer applications it is based on Trust Negotiation model. Prototype for CRBAC model has been completed.

Honeynet

Both preventive as well as defensive measures for Internet-based attacks have acquired significance. Since the current trend among the attackers is of launching large scale targeted attacks on specific functional domains, C-DAC is developing a Distributed Honeynet System, which would eventually lead to an early warning system for large scale targeted and coordinated attacks.

Honeynet is a highly controlled environment to capture the activities of hackers / attackers either on the network or the client system. During the year, state - of - the - art developments in Honeynet Technology were studied. Open source software tools currently being deployed for attack data capture and analysis in Generation III Honeynet architecture were deployed. The Honeynet architecture Gen III was further enhanced to incorporate Host level Intrusion Detection System and Application level Intrusion Detection System through their output data fusion into a unified data analysis framework. The issues related to data fusion were resolved and relational database system was generated. This work on data fusion has been published in IEEE explore. This work greatly eases analysis of collected data through the Honeynet. During this period, data on a financial and strategic web sites were collected in the lab and processed for attack analysis and modelling. This data and its interpretations were also shared with CERT. To counter the large scale automated and integrated attacks (self propagating type), it is proposed to develop a network of distributed Honeynets (a sensor for capturing attack specific data). The attack data collected from distributed nodes would be sent to central location for analysis as a first step towards developing preventive and defensive measures for new attacks and defensive measures for new attacks.

Kernel Immune System

The aim is to design and implement a working model of anomaly based adaptive IPS which must satisfy three design goals of a competent network based IPS: distributed, self-organizing and lightweight. The current status is:

- Finalized the Kernel Immune System design and architecture.
- Studied Process Tracing utilities at kernel Level and user level.
- Experimented and Implemented Neural Network and SOM.
- Tested stide data on weka (neural network).
- Collected normal data for specific processes by strace /stap.
- Explored Different ways to infect the system.
- Collected the abnormal data (system calls) after it infected the system and tested it.
- Explored flow of packets coming from outside network and going to the TCP/ IP stack to understand the flow of packets.
- Experimented traceing of the packets corresponding to particular process with the help of jprobe.

Bharatiya- Automated Fingerprint Identification System (B-AFIS)

The objectives of B-AFIS are :

i) To develop an indigenous "Level 3–based" secure BioSDK: "C–BioEngine".

ii) A biometric application built on top of "C–BioEngine" to enable the end user to perform Enrollment, Verification, Identification, and other relevant operations.

Establishing the identity of a person is becoming critical in our vastly interconnected society. The need for reliable user authentication techniques has increased in the wake of increased concerns about security and rapid advancements in networking, communication and mobility. Biometrics, described as the science of recognizing an individual based on her physiological or behavioural traits, is beginning to gain acceptance as a legitimate method for determining an individual's identity.

"Bharatiya-AFIS" prototype-based systems/solutions can be deployed fairly quickly in various commercial, civilian and forensic applications as a means of establishing identity These systems will rely on the evidence of fingerprints to either validate or determine an identity. This prototype-based product is likely to cater to:

i)   Governmental establishments, such as Passport division, DG–Shipping, Ministry of External Affair (M.E.A.), etc.
ii)   Country's security agencies, such as Police Departments, User Agencies, RAW (the Research and Analysis Wing (RAW) — India's premier external intelligence agency),etc.
iii) Contribute to Research and Development in Multimodal Biometric System, etc.

CCA-DR

The ongoing CCA-DR project was carried out as a continuing operational activity during 2008-2009 also.

QoS Test - bed

The QoS Test-Bed Project (IQNET-Indian QoS Network Test-Bed Project) was carried along with IISc, IIT-Madras, IIT-Bombay, IIT-Delhi, IIT-Kharaghpur and ERNET where the team developed a network monitoring tool called "KYN-Know Your Network" that is made available in the open-source. The team along with all the above institutions carried out WAN based QoS network experiments related to VoIP, Video conferencing, E-learning and Network Measurements. (Product developed – KYN)

Hardware Intrusion Prevention System

The design and development of hardware based Intrusion Prevention System was carried out. The team also initiated novel techniques of analysis such as State based Detection and flow based network analysis as part of this project. (Product is being developed: Guard your Network – GYN)

Self-Managed System

The system is under development and is called EDGE which is an Enterprise wide Self-Managed Network Solution". Its design is based on network traffic analysis. (Product is being developed: EDGE)

Cyber Security

STARS

CNIE, Bangalore carried out the design and development of a Secure Two factor based Authentication for Remote Systems. (STARS). The aim is to develop a strong two factor authentication system for web based users. The research objective was to propose a protocol which should provide important security features such as confidentiality, integrity and authentication against several types of security threats. As part of this, a secure authentication protocol is designed and published in International Conference on Security. Further to it, a Proof of concept implementation is completed which will soon be made online for validation and feedback.

DyNeF (Dynamic Network Firewall)

DyNeF is a firewall for grid environment, which supports the dynamic nature of the grid and protects it from network intrusions. Our architecture provides host-based access privileges for hosts within the virtual communities, and utilizes these privileges for configuring the network firewall dynamically. The Proof of concept implementation in the widely used grid middleware "Globus Toolkit" is completed and tested.

RUDRAA

Towards carrying out attack analysis and formulation of Intrusion Detection and Prevention signatures, CNIE, C-DAC, EC carried out this project which resulted in setting up an attack analysis environment, identification and formulation of IDS and IPS signatures.

Steganography Resource Centre

Keeping in view the needs of the nation, C-DAC started the R&D activities in stegoanalysis under the umbrella of Steganography Resource Centre. StegoCheck V3.1 is the outcome of this activity. The software is capable of analyzing different multimedia formats like .BMP, .JPG, .GIF, .WAV, .TXT etc. and can detect, extract and reconstruct a hidden message within these digital multimedia formats. The product has been benchmarked with the internationally available products like StegoSuite V5.1 from M/s Wetstone Technologies and Stegalyser SS, AS and RTS from M/s. backbone Security and it is found that the product StegoCheck V3.1 is comparable with them. The integration of StegoCheck V3.1 with Cybercheck is envisaged in near future.

A user meet was organized during 3rd week of April, 2009. Representatives from various government agencies were at the user meet and expressed their views on the need of continuous R&D activity in this strategic area. The knowledge corpus, infrastructure as well as a group of trained manpower, created by this R&D activity may further be utilized to cater to the need of the nation in an integrated way.

Face Recognition System

As an outcome of the R&D activity in the area of Face Recognition, an Indigenous Face Recognition System (FRS V3.0) has been developed, which can recognize a person from his/ her digital, or scanned stored image, or on-line image grabbed by a camera. FRS V3.0 is being benchmarked with a number of International commercially available products and their literature. The performance analysis in terms of False Recognition Rate (FRR) and False Acceptance Rate (FAR) are comparable with the international products. However through several joint explorations with user agencies it is observed that more R&D inputs are required to make the face recognition system matured to the level of user satisfaction.

Facial Feature Extraction and Human Behaviour Analysis for a Dialogue System

C-DAC will now extend their R&D activities in the area of Facial Expression Analysis. Automatic facial expression analysis can be utilized in Human Computer Interaction (HCI), Ubiquitous Computing, behavioural science and medicine. This activity has been initiated by a joint collaborative project between NICT, Japan and C-DAC sponsored by JST-DST forum. The literature survey and

initial development is in progress. As an activity of the project, the 1st Indo-Japan conference on "Science and Technology of Facial Expression Analysis" was held on 12th March, 2009 at C-DAC, Kolkata. Researchers and experts were present from NICT, Japan, IIT, Kharagpur, ISI, Kolkata, Jadavpur University, and C-DAC to share their views and experience in the areas of facial expression, emotion analysis and their various applications including Ubiquitous Computing.

Cyber Forensics

To assist in the enforcement of the IT Act and also to build up expertise in tackling the ever growing menace of cyber crimes, the Department of Information Technology, Ministry of Communications and Information Technology has setup a full-fledged Resource Centre for Cyber Forensics (RCCF) at C-DAC, Thiruvananthapuram. The objectives of the resource centre is to develop cyber forensics tools and to provide technical support and necessary training to Law Enforcement Agencies in the country. Within a short span of three and half years, RCCF has established itself as the premier centre in India carrying out Research and Development of products and systems for cyber forensics. RCCF has now built up expertise in all areas of cyber forensics like Disk, Network and Device Forensics. A dedicated team in RCCF is helping Law Enforcement Agencies in the analysis of many important cases and over 200 cases have been analyzed so far.

CyberCheck Suite software developed by RCCF is the first indigenously developed software in the country for digital evidence acquisition and analysis. It matches, and in many cases outperforms established international software products from developed countries and has been certified by leading Law Enforcement Agencies in India. Over 200 copies of the software have been licensed to leading Law Enforcement Agencies all over the country. Other tools developed at RCCF include CyberInvestigator, for analyzing network log files, Network Session Analyser (NeSA), for forensically analyzing and reconstructing digital data from sessions of captured network data, PDA Imager and Analyzer for analyzing WinCE and Palm OS based PDAs and Smart Phones, SIM Card Imager and Analyzer for analyzing GSM based SIM cards of mobile phones, Call Data Record Analyzer for analyzing Call Data Records of different cell phone service providers. Hardware tools like TrueImager, a high-speed hand-held hardware device for disk imaging and TrueLock, a hardware device for write protecting different storage media while acquiring digital evidence, have also been successfully developed.

CyberCheck Suite

RCCF has also been extremely active in providing training and technical support. In the last three years, it conducted over twenty training programmes. These include basic awareness creation programmes as well as specialized advanced programmes in the investigation and analysis of cyber crimes using cyber forensics methodologies and tools. Apart from Law Enforcement Officers from Police departments of various states, CBI officers and scientists from Forensic Science Labs have been provided training. Several programmes for Judicial Officers, all over the country, have also been conducted.

With a view to enhance the forensic capabilities to cover corporate networks and enterprises, C-DAC has recently started work on the development of Enterprise Forensics System. This system will be capable of on-line monitoring of enterprise networks and also carry out stealth previewing and live imaging of remote systems using secure communication protocols. Advanced forensic software tools to meet the emerging requirements like Malware analysis, Software Forensics, Windows Vista Forensics, Live Incident Response, Anti Forensics Detection, Large Storage analysis and advanced Forensics Hardware tools are also being developed as part of this project. A Virtual Training Environment is also being setup for carrying out advanced cyber forensics training.

HEALTH INFORMATICS

Telemedicine Solutions

Telemedicine Facilities in Tamil Nadu

A telemedicine facility was set up by C-DAC in Tamil Nadu. The facility includes Govt. Royapettah Hospital, Chennai as Telemedicine Referral Centre (TRC) and Remote Telemedicine Centers (RTCs) at Government Head Quarter Hospitals at Tiruvallur, Kancheepuram, Tiruvannamalai, Krishnagiri, Ooty, and Rameshwaram. The facility was inaugurated and dedicated to the people of the state on April 8, 2008 by Dr. K. Karunanidhi, Hon. Chief Minister, Tamilnadu. Thiru T. R. Baalu, Hon. Union Minister of Shipping, Road Transport and Highways and Thiru A. Raja, Hon. Union Minister of Communication and Information Technology, were present during the inaugural function.

Telemedicine Facilities in Tamil Nadu Inaugurated

More than 600 patients have received remote healthcare services using this facility. Project review committee extended the project scope with inclusion of Government General Hospital, Chennai as another specialist node in the telemedicine network.

Mercury™, C-DAC's Integrated Telemedicine Solution deployed under the project, has been developed by C-DAC under a DIT funded project.

Telemedicine Facilities in Himachal Pradesh

This facility connects twenty one sites, including community health centres in remote areas with IGMC, Shimla, PGIMER, Chandigarh, and C-DAC, Mohali. All sites are connected using ISDN lines and use "Sanjeevani" software, which has been developed by C-DAC. The facility offers tele-consultation on pathology, cardiology and radiology. The sites will be handed over to the state government shortly.

Telemedicine Facilities in Punjab

This facility connects eighteen district hospitals and medical colleges with PGIMER, Chandigarh and C-DAC, Mohali. The connectivity is through VPN (Virtual Private Network) over broadband lines. Telemedicine software has been deployed for tele-pathology, tele-cardiology, and tele-radiology. Continuing Medical Education sessions are being conducted regularly. The sites will be handed over to Punjab Health System Corporation shortly.

e-Sanjeevani Tele ophthalmology image capturing

Low Cost Mobile Telemedicine Facility

The Mobile Telemedicine facility extends healthcare services to the doorsteps of remote population. This is helpful particularly to pregnant women and elders with restricted mobility. The mobile van is equipped with a Digital X- Ray unit, Ultrasound scanner, ECG machine, Hematology analyzer, Digital Trinocular microscope and other diagnostic systems.

The van is staffed with a doctor and an adequate support team. In addition to the basic diagnosis and treatment procedures, the Van also facilitates live consultations with specialist doctors at the hospital using a Video Conferencing system. All diagnostic and treatment details, including medical images, records, and outputs from the medical apparatus, are communicated in real time to the hospital for reference and analysis by a specialist doctor.

A snapshot of Low Cost Mobile Telemedicine Facility

Healthcare Management Information Systems

Computerization of PGIMER, Chandigarh

This project aims to setup a complete ERP solution in the health sector in a turnkey mode. The system consists of all aspects of Hospital Management including Registration, IPD, OPD, Blood Bank, Diet Kitchen, Bio-Medical Waste Management, Back Office Functions, etc. C-DAC is responsible for the full system implementation including setting up of infrastructure, networking, training,

hand-holding and facility management. It is expected to be operationalized by the end of 2009. C-DAC's HIS Software (Sushrut) is being deployed in this project.

Computerization of SMS Hospital, Jaipur

This project is being executed jointly by M/s. RajComp and C-DAC. M/s. RajComp, a State Government Enterprise, is responsible for setting up hardware and networking infrastructure, whereas C-DAC is responsible for software and hand-holding support. The first phase of the system is now operational. C-DAC's HIS Software (Sushrut) is being deployed in this project.

Computerization of Hospitals in GNCT, Delhi

Under this project, C-DAC's HIS software (Sushrut) will be deployed in all the 32 hospitals in GNCT, Delhi. The implementation will be done in phases, and the first phase is under implementation in Guru Gobind Singh hospital. Once this is successfully completed, the implementation in remaining hospitals will be taken up in parallel.

Healthcare Management System

A web based healthcare system has been developed, which can access digitized Electronic Medical Record (EMR) of patients anywhere on the Internet. The module covers subscriber, consultant, uploader, agent, administrator, nurse, reviewer and other hospital aspects. Efforts are underway to make it independent of connecting media.

e-Svaasthya – An HIS for Indian Hospitals

This is an Open Source HIS that is being developed for Indian hospitals. C-DAC was approached by the Dervan hospital in Maharashtra to provide them with an Open Source HIS. This system is being developed by extending the popular open source HIS, Care2X. The idea is to develop the complete HIS and to make its subsystems independently available for use. Work has started on this project – the prototype version of the Pharmacy subsystem is almost ready and work has started on the Blood Bank subsystem.

Healthcare Decision Support Systems

AyuSoft

AyuSoft is a Decision Support System (DSS) for Ayurveda. IIT Bombay Alumni Association and Tie Foundations selected it for "Innovations 2009: Ideas in practice" award.

AyuSoft was also showcased in 3rd world Ayurveda congress, held at Jaipur in November 2008. Many Ayurveda experts, who visited the congress, appreciated the product. This year, through AyuSoft propagation activities, new reputed physicians and research institutes have been added to the client list. AyuSoft is now being used by several hospitals, academic and research institutes, and physicians. Two national projects are using AyuSoft for research.

AyuSoft selected for Innovations 2009

Cure@Home

Cure@Home was launched by Dr. M. G. K. Menon at Indian Science Congress, Shillong, on January 05, 2009. It is a DSS with a knowledgebase of integrative (Allopathy, Ayurveda, Homeopathy, Yoga) medicine to address the healthcare needs of a common man. It is a health educational tool, which can be deployed on personal computers (Desktops, Laptops) or on Kiosks (having Touch Screen). It can be used at home, clinics, hospitals, healthcare centres, public places and schools. Cure@Home educates a common man for primitive health and disease prevention. It offers the following applications:

- **My Care:** Helps to analyze constitution and health status and stores electronic health records for primary care.
- **Diet and Lifestyle:** Helps in understanding properties of dietary items and effects of various lifestyle modifications. Extensive therapeutic application of cereals, pulses, milk products, meat, and recipes as well as effects of Yoga and exercise are described in simple and user friendly manner.
- **Home Remedies:** It provides information on holistic solutions for primary care and prevention of diseases.
- **Encyclopaedia:** Contains a multimedia gallery of images, audio clips, video clips and articles, which aim at increasing health awareness.

Cure@Home Software launch at Indian Science Congress

A snapshot of Cure@Home

Cure@Home caters to the healthcare needs of a common man in the following ways:

- Provides awareness about diseases (like AIDS, Malaria) and causative factors (like addictions, unhygienic lifestyle), which are prevalent in North East India.
- Educates on national health issues like maternal and infant mortality, communicable and non-communicable diseases.
- Educates on utilization of local medicinal plants and practices for health status improvement.
- Provides information on improving status of health training centres.
- Provides information on capacity building of health workers.
- Educates on overall promotive, preventive, and curative healthcare management

It has been deployed in ten villages of Arunachal Pradesh. The users of Cure@Home include common man, doctors, and wellness centres.

Pulse Analyzer

It has been developed in collaboration with Bhabha Atomic Research Centre (BARC) and IIT, Mumbai. It aims at design and development of instrumentation assisted Decision Support System by simulating Ayurvedic Pulse Examination using a non-invasive technology.

The project team has examined more than 600 healthy volunteers and patients of various diseases. Software was developed for analysis and interpretation of Pulse signal. Based on the results of mathematical models and analytical studies, applications for two patents have been filed.

A snapshot of Pulse Analyzer

Tools for Healthcare Standards

Class Libraries for DICOM and HL7

C-DAC designed and developed software components that can be used to build class libraries/SDK/API/Toolkit, which in turn can be used to incorporate Digital Imaging and Communications in Medicine (DICOM) v3.0-2004 and Health Level 7 (HL7) v2.5 support in end user applications in the area of Medical Informatics.

The Beta version of the SDK was released on September 5, 2008 followed by Beta-2 in January 2009. The first release versions of SDKs were released on 22nd Foundation Day of C-DAC on March 29, 2009.

Other Healthcare Initiatives

Distributed, Scalable, and Reliable Healthcare Information Store

C-DAC bagged a new DIT sponsored project for developing technologies for a distributed, scalable, and reliable healthcare information store system.

The objective of the project is to architect and develop technology/ mechanisms/ framework that can be used to build a distributed, scalable, and reliable healthcare information store system that can have a single EHR (Electronic Health Record) for every indi-

vidual of a nation in the area of Medical Informatics.

The project is proposed under Sweden-India Technology Collaboration Program and will be jointly executed by Centre for Development of Advanced Computing (C-DAC) and Swedish Institute of Computer Science (SICS) with each taking part in developing composite technologies and know-how.

Healthcare Knowledge Engineering System

A new R&D activity on "Knowledge Engineering" has been initiated and a demonstrable comprehensive knowledge engineering product - "Health Care Knowledge System Using Concept Maps" has been developed by C-DAC. Such initiative on Web-enabled concept map-based Healthcare Knowledge system is the first of its kind in India. This system aims to aid understanding of complex topics of healthcare very quickly and precisely without any ambiguity. Health concepts have been graphically and semantically represented along with their interrelationships. Its visual presentation has greater impact on human cognition. Negotiation is going on with the Health Department of West Bengal, North East State Governments, etc. for its deployment. Study activity on "Knowledge Visualization of Digital Library" has also been initiated.

A snapshot of Healthcare Knowledge Engineering System

Instrumentation and Control Electronics for Blood Collection Monitoring System

This system has features such as Blood Flow Rate display, Automatic clamping on Low and High flow rate detection, and Alarm indicators. Data pertaining to 1000 collections can be saved in memory and can be transferred to a computer via RS232, USB, or Ethernet interface. The product complies with the Safety standard IEC60601-1 and the technology has been handed over to Terumo Penpol Ltd., Thiruvananthapuram.

Blood Collection Monitoring System

Technical Events in Health Informatics

Symposium on Medical Informatics Standards in Indian Context

C-DAC hosted and organized a one-day workshop titled "Symposium on Medical Informatics Standards in Indian Context" on September 5, 2008 at Pune. The objective of the workshop was to promote the use and adoption of Medical Informatics Standards by bringing together academic, service, and industry sectors of healthcare domain. Eminent personalities from industry and medical domain discussed need, efforts, issues, roadmap, and more on the medical informatics standards in medical applications/devices.

Opening ceremony of Symposium on Medical Informatics Standards in Indian Context

Meet on Cancer Biomedical Informatics Grid: Cooperation For Cancer Research

C-DAC, Pune in collaboration with cancer – Biomedical Informatics Grid (caBIG), USA organized a one-and-half-day technical event titled "Meet on Cancer Biomedical Informatics Grid: Cooperation for Cancer Research" on February 11-12, 2009. The objective of the meet was to promote exchange of information, knowledge, and know-how towards forging a concerted effort by bringing together academic, service, and industry sectors of healthcare domain. This meeting prepared the ground for Medical Researchers, Practitioners, and Technologists for evolving ideas, tools, trainings and to create large consortia of determined individuals, groups, and organizations for finding an answer for Cancer using available and future technologies.

Meet on caBIG: Cooperation for Cancer Research

UBIQUITOUS COMPUTING

National Level Ubiquitous Computing Research Resource Centre

C-DAC is executing a R&D project titled "Establishment of National Level Ubiquitous Computing Research Resource Centre" at its three centres – Hyderabad, Chennai and Bangalore with the support from DIT. Efforts are focused mainly towards establishing state-of-the-art laboratory and Knowledge Centre for Ubiquitous Computing. R&D focus at these three centres is in the multidisciplinary areas of Ubiquitous Computing like design of indigenous sensor node, adaptive framework for the development of Wireless Sensor Network (WSN) Applications, credible applications using WSN in the areas of Agriculture, Intrusion Detection and Vehicle Parking, U-Learning applications and GrUb Computing, Framework addressing security, privacy and trust, middleware for context-aware Computing, Health Applications, etc.

Following development activities are being carried out at the Ubiquitous Computing Research Centres of C-DAC:

Intelligent Room

Development of Ubiquitous Computing technologies for Aware Home (Intelligent Room). Hardware Architecture for Zigbee based Home Network and artefacts such as Interactive Mirror, Smart Kitchen cabinet, Smart Bed have been finalized. High level design has been completed. A smart open source software library management system based on RFID has also been developed and is being deployed in our library.
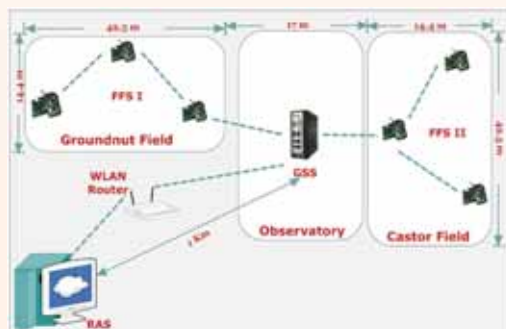
Healthcare

Development of a Ubiquitous Network to monitor and acquire data from the various medical sensors associated with the patient in a kiosk. High level design of the portal has been completed.

Development of Context Aware Framework for Healthcare

Design and implementation of Context Builder and context to service modules have been completed. Context Framework has been integrated with Wireless Medical Sensors like ECG Monitor, Pulse Oximeter and BP Monitor. Health parameters like ECG, blood pressure, etc. are acquired from wireless medical sensors and sent to the context layer where the context is derived for triggering appropriate healthcare service events.

u-Agri

Application of WSN technology in the field of agriculture, demonstrates tremendous potential in the aggregation of macro and micro weather information, from spatial locations in the field in temporal contexts. It further enhances decision support by facilitating automated systems, capable of weather data aggregation, data analysis and decision making.

U-Agri : Field Deployment

U-Agri focuses on Pest Management by modelling selected pest growth cycles. These growth cycles are correlated with weather information available from the WSN. Decision Support Systems correlating conducive weather conditions and the growth of these pests are developed to forewarn possible pest infestations. MoU has been executed between C-DAC and Central Research Institute for Dry land Agriculture (CRIDA) to collaboratively work in this area. Groundnut and castor crops have been identified for the research and pests namely leaf miner, late leaf spot and red hairy caterpillar are being modelled.

WSN has been deployed in the fields with sensors namely Temperature, Relative Humidity, Leaf Wetness, Rainfall, Solar Radiation, and Wind Speed and Direction. These sensors sense in intervals of one hour. The sensed data is stored on the Internet accessible database for analysis.

Intelligent Intrusion Detection System (In2DS)

Physical Intrusion Detection Systems are expected to foster as a strategic application which provide future benefits to various public and private organizations. Though emerging technologies have metamorphosed the nature of surveillance and monitoring applications, the sensory data collected using these gadgets still remains unreliable and poorly synchronized. Based on the analysis from existing and traditional surveillance systems as well as keeping in view the need for a well refined data analysis system for surveillance applications, development of an Intelligent Intrusion Detection System (In2DS) based on wireless sensor network (WSN) technology as part of the UCRC project is under progress. This system is expected to provide wider sensing coverage, night and harsh weather surveillance, improved warning and alarm functionalities, and reduced manual intervention. The system is capable of event based realtime video surveillance, thereby reducing the amount of unwanted data accumulation. Video and sensor information related to any detected events are collected and displayed to the end-user through web. The current project activity includes development of a proof of concept of the In2DS system, thereby realizing a full fledged model.

Smart Parking (SPARK)

Based on the requirement analysis for existing car parking management, a system architecture and its subsystem level components of Smart Parking (SPARK) as part of UCRC project is being developed. This system consists of Wireless Sensor Networks (WSN), Gateway, Parking Management, Automated Guidance, Entrance Display and Client Reservation subsystems. At a glance, the system will be able to display real time information related to the availability of parking lots to the users and would also enable users to reserve parking lot from remote locations through web and mobile based clientele devices. The system will also be capable of guiding users to efficiently locate vacant parking spaces so as to park their cars quickly and safely. Finally, an implementation of a full fledged prototype model, as a proof of concept to realize and understand the real time scenarios in parking management systems is sufficed.

Adaptive Framework for Wireless Sensor Networks Application (AFWA)

C-DAC is working on "Adaptive Framework for Wireless Sensor Networks Application" (AFWA) - a software tool which facilitates rapid development of Wireless Sensor Network applications. This tool can be utilized by both System Component Developers and Application Developers. Salient features of this tool from the perspective of system component developer include easy integration of custom system components viz Network Communication, Time Synchronization, Security and Localization, simulators and over-the-air programming functionalities. on the oher hand, from the WSN application developers perspective it facilitates the flexibility of opting system components specific to the WSN Application, allowing the application developer to build and simulate the application and program the compiled application image over-the-air.

Wireless Sensor Boards

Development of wireless sensor based on IEEE 802.15.4 and Zigbee Standards using Texas Instruments CC2430 SOC has been completed. The first version of the node is tested which has separate communication and battery modules. The second version of

the node where these two modules are integrated is sent for manufacturing. It is expected that this node will be tested by the end of June 2009. A separate very low power sensor node is planned and is under design process.

Zigbee has been ported into our sensor node and few applications have been tested. We ported Tiny OS on sensor node and sample applications have been tested. Porting of Zigbee on Tiny OS is under process and expected to be completed by the end of June 2009.

DATA frame of IEEE 802.15.4 MAC IP on hardware is being tested. Encryption schemes related to MAC security has been designed and tested. Integration of security modules with remaining MAC primitives will be carried out after the testing process.

EDUCATION AND TRAINING

C-DAC is dedicated to create high quality manpower for C-DAC in particular and the IT industry in general through the design and delivery of various courses. The courses are offered through a network of Authorized Training Centres (ATCs) in India, as well as C-DAC's own centres at 10 locations.

C-DAC continued its role as human resource developer in the IT area and offered courses of various shades including high - end programmes of M.Tech, MCA and MBA. From this year a new programme on medical informatics and telemedicine has been introduced and conducted for foreign students under ITEC programme. This was attended by 18 participants from around 10 countries.

Various faculty development programmes were initiated and the faculty took part in many sponsored programmes like Network Security, DB2, Software Engineering, Wireless Communications, Research Methodology, Linux Asia, etc.

Two students of M. Tech. Programme won gold medal for their first position in University.

A student of School of Management, MBA (SEM) Batch 2006-08, Mr. Nikhil Kumar Gupta, was awarded the Gold Medal by GGSIP University, Delhi for his outstanding performance in the programme.

Advanced Computing Training School (ACTS)

ACTS emerged as one of the top finishing school in IT training through its unique curriculum and in accommodating requirements of IT industry by launching new courses. Through its state - of - the - art training methodology, it is fulfilling its objective of creating highly skilled IT resources. It is recognized by major corporate in India to be a preferred high-end provider of skilled manpower in the areas of ICT. On one hand ACTS is assisting several third world Nations to leap frog into IT and on the other bridging the digital divide of urban and rural students.

Over the last fifteen years, activities of ACTS have extended nationally and internationally. It has spread into the International arena with Collaborative Training Operations at Accra (Ghana), Quatre-Barnes (Mauritius). It provided ICT training facility at Dushanbe (Tajikistan), Tashkent (Uzbekistan), and Yangon (Myanmar).

The diverse IT training programmes offered by ACTS are popular and most sought after. The six months Diploma courses that were offered at ACTS during the year are

1.   Diploma in Advanced Computing (DAC)
2.   Diploma in Wireless and Mobile Computing (WiMC)
3.   Diploma in VLSI Design (DVLSI)
4.   Diploma in Embedded Systems Design (DESD)
5.   Diploma in Advanced Computer Arts (DACA)
6.   Diploma in Geoinformatics (DGi)
7.   Diploma in System Software Design (DSSD)
8.   Post Graduate Diploma in Information Systems and Cyber Security (DISCS).

Geomatics, being a rapidly growing industry with applications as varied as utility enhancement and e-governance to conservation, resource and disaster management, is having huge demand for skilled manpower. ACTS with the help of Geomatics group of C-DAC, designed a new course, Post Graduate Diploma in Geoinformatics, which was launched in August 2008.
Diploma in System Software Design (DSSD) course, designed by C-DAC Hyderabad was started at ACTS from March 2009.

With the help of C-DAC's High Perfomance Computing and Communication group, ACTS designed a new course viz. Post Graduate Diploma in Information System and Cyber Security (DISCS). This course will enable students to understand the concepts of information system, network and cyber security and learn the techniques of detecting the attacks and securing a network from internal and external attacks. This field, which offers interesting and fulfilling careers that can contribute to the world in a real way, has employment opportunities worldwide. Admission and related activities for this new course has been completed in March 2009 and the course will be started in the month of April 2009. Similar high - end courses, with the help of other C-DAC groups and IT industry are in pipeline and are expected to be launched soon.

ACTS expanded its training infrastructure at the newly hired premises at Pune. This facility can cater to train 500 students per batch, compared to the previous total of 225 students per batch. Due to the initiatives taken by ACTS the intake of students rose by 50% for August 2008 batch compared to Feb 2008 batch. Courses were started in the new premises in August 2008.

An umbrella MoU between Motilal Nehru National Institute of Technology (MNNIT), Allahabad and C-DAC, Pune was signed, to collaborate in R&D for different areas of mutual interests like e-Learning, Semantic web, high - end IT training, etc. MNNIT has been made the Satellite centre of C-DAC. Accordingly, MNNIT will conduct ACTS training programmes at Allahabad.

TechSangam

In order to acquaint various engineering colleges in India about the developments in IT sector, thereby bridging the gap between industry and academia, C-DAC came up with a national initiative – "TechSangam: C-DAC - Academia Collaboration Initiative", a fusion of C-DAC experts and academia. Around 250 colleges have given their consent to be part of this initiative. C-DAC shall provide these institutions with various IT training programmes, Faculty orientation/ training programmes, periodic seminars on latest technology trends in the IT field, consultancy services for setting up/ upgrading the IT infrastructure, etc.

Various IT courses of short duration have been designed for the TechSangam programme, to be run in the educational institutions that are part of TechSangam. A Principals' Meet was conducted on November 27, 2008 at Pune, as part of the TechSangam programme. This meet was a platform for the Principals and Directors of various engineering colleges across India to interact with each other and discuss about the training needs of the formal education sector in the current industry scenario. Similar meets are planned at various locations across India, to create awareness about TechSangam.

Diverse high end courses have also been designed under TechSangam, exclusively for the Faculty members of the TechSangam educational institutions. Under the Faculty Development Programme, a short-term course on Natural Language Processing was conducted at Pune, from 13th to 17th December 2008.

C-DAC signed an MOU with Solapur University to conduct ACTS training programs under joint certification with the university.

National Online Test System for Graduate Engineers in Information Technology

The aim of this important initiative is to create a national test system for benchmarking of graduate engineers in IT for self-assessment, supervised learning and placement in the industry. The system is expected to start operations by the close of 2008 with linkages of C-DAC and DOEACC centres. Once fully operational, it would be primarily hosted in C-DAC, Noida with possible multiple hosting all over the Garuda network so that the large population could use it. The backbone of the system is a large question bank in the area of IT originating from participating academic institutions across the country. This ensures that changing academic scenario dictated by multiple users, operating in this sphere is properly captured by the question bank. The system is expected to mature into self-financing mode of operations within three years of its gestation.

Information Technology Consultancy Clinic

This is a major initiative of C-DAC supported by DSIR for helping the small and medium scale industries to start their enterprises in the area of IT. Under this project, SMEs are encouraged to incubate their ideas in the Consultancy Clinic provided in the Noida Centre of C-DAC, where the vibrant academic facilities and the PG student community are available for prototyping their systems. Twenty three companies have already registered under this project and many of them have been able to come out with viable systems and products.

e-Learning System for e-Security

e-Learning is an emerging field with potential to complement the conventional learning and teaching methods in a very significant fashion. Considering the importance of this area, C-DAC has set up an e-learning resource centre for e-security applications. Hosted in its Noida Centre, this system has been attracting users within and outside the country. A workshop was conducted to demonstrate and popularize this technology and a lot of interest was generated in the exploitation of the technology for providing e-security education using this medium of communication. The system is now fully functional and is regularly being used by many enthusiastic users.

Non-Formal Education

ERP Division of C-DAC, Noida conducted a total of 11 programmes for corporate clients like Genpact, NHPC and BAE, and regular full-time and part-time programmes.

More than 1000 students were trained in various Post-Graduate Diploma programmes like ASDD (Advanced Software Design and Development), EVD (Embedded Systems and VLSI Design), SDA (Systems and Database Administration), ISAD (Information Security and Application Development), LT (Language Technology), WTA (Wireless Technologies and Application), SEM (Software Enterprise Management), GIS (Geographic Information System and Remote Sensing) and DOAECC 'B' level programmes.

Information Security Education

As part of ISEA education, the following activities were carried during the reporting year :

(a)   Conducted two 1-week workshops on various aspects of Information Security Awareness

(b)   Conducted two 5 month training programs (CNSS: Certification Course in Networking and Systems Security, source : www.cdachyd.in/cnss)

(c)   Introduced network security modules in various Diploma Programs focusing on security for developers

(d)   As part of Development of Courseware in IT Security, C-DAC Hyderabad has taken up a project on Courseware Development for Government Officers in IT Security and the following modules are planned, courseware design for four modules has been completed

- Module 1: Master Trainers Training
- Module 2: Unix and Scripting Languages
- Module 3: Information Security Management
- Module 4: Understanding TCP/IP
- Module 5: Threats, Vulnerabilities and Countermeasures
- Module 6: Introduction to Cryptography and Security Protocols
- Module 7: Perimeter Security
- Module 8: Incident Handling and Enterprise Forensics
- Module 9: Business Continuity and Disaster Recovery Management
- Module 10: Security Standards and models

PREPARE FUTURE [PRoposal for ExPAnsion of tRraining facility for DESD, DSSD and DAC and FacUlTy Updation ProgRammE]

The Project titled "PREPARE FUTURE"is an initiative of HRD Division, DIT, Government of India under a scheme for Manpower Development for Software Export Industry. The primary objective of this programme is to update/ enhance the skills of engineering faculties in advanced domains of Information Technology keeping pace with the IT industry. The engineering faculties may be exposed to the needs of IT industry so that they can in-turn nurture, educate and mould their students while they are still in the college.

Inauguration of PREPARE FUTURE programme on 12th May 2008

The courses are designed for faculties to keep abreast with rapidly growing trends in Embedded Software, System Software and Application Software. As of now, a total of 280 faculty members from 17 states in India have been trained under this programme during a span of one year. Classroom and Labs for additional intake of 60% were established. The labs were provided with state-of-art systems and tools. Content Storage Framework on e-Learning platform e-Sikshak was designed for individual courses (ES, SS and AS). Initial contents including power point presentations, lab assignments, etc. were prepared for ES, SS and AS and the same was uploaded on e-Sikshak platform for faculty use.

RESOURCES, FACILITATION SERVICES AND TECHNICAL EVENTS

HUMAN RESOURCE DEVELOPMENT (HRD)

C-DAC has its presence in 10 Centres across India with approximately 2500 employees working at various centres on regular, contract and project basis. During the year, C-DAC continued to strive hard to establish and maintain its image of being an employee centric organization. The focus of the HRD team was to respond to the demands of the institution in attracting and retaining the finest talent for attaining it goals. HRD team also worked towards maintaining an employee friendly, transparent, conducive and professional work environment.

With the fast changing economic and market conditions, there was increasing pressure on C-DAC to perform. This required C-DAC to have talent that could evolve, champion, steer and support the strategic initiatives. To attract and retain the best talent, one of the key processes focused by the HRD team was that of 'employer branding'. Employer branding has been receiving attention in the recent times, as a form of managing corporate identity by creating a favourable image of the organisation as a 'desirable employer', both internally as well as externally. The intangible aspect of employer branding enabled C-DAC to create competitive advantage.

Under the initiatives of HRD team, software has been deployed at C-DAC automating the routine processes with respect to employees to start with, and gradually expanding the scope to cover all critical areas and aspects. This will help employees to work at their best potential, fully aligning to institutional goals and targets.

C-DAC carried out induction training for all new appointees during the year so that it enabled them to integrate seamlessly into the organisation. They are briefed on C-DAC's value systems and the importance of inculcating these values.

Following are the other activities undertaken by C-DAC during the year across all the centres for manpower resource enrichment:

- Recruitment across various technical and non-technical posts by way of Direct Recruitment / Transfer absorption / Deputation / Campus Interviews was carried out across all centres.
- Regular Performance Appraisals, Probation Clearance, Contract Review (Contract Extension, Termination, and Increment etc.)
- Various external and in-house trainings, including induction, symposia, technical and management trainings.
- Around 30 employees were nominated for attending seminars / conferences abroad.
- Employee Engagement Survey to assess the level of involvement of its members in the activities of C-DAC. The results of this survey revealed that a significant section of its members intended to continue working with C-DAC.
- Corporate HRD team has set up workgroups to prepare a blueprint for a new Performance Management System.

RTI, LEGAL AND IPR ACTIVITIES

1. The work of IPR Project sanctioned by IPR Division DIT, New Delhi is in progress as per schedule. The PRSG Meeting held in December 2008 has reviewed the work and expressed its satisfaction over the progress.

2. Apart from drafting/ vetting several contracts/ MOUs group also organized IPR awareness programmes for few groups of C- DAC. Such awareness/ sensitization seminars result into filing of patent/ copyright/ trademark applications.

3. Corporate Head – Legal was invited to deliver lectures on IPR, Cyber law, etc. at ILS Law College, Modern College, TIFR. He also organized two lectures on technology law in association with Technology Law Forum of NASSCOM.

4. One day workshop on 'Patent Search' was conducted at C-DAC, Pune.

5. Knowledge Management Cell in consultation with group facilitated 12 filing of patent, copyright, trademark applications.

6. C-DAC, Pune has received 13 Copyright Registrations during the year.

7. 91 applications were received under RTI Act, 2005 by all centres of C-DAC and all the applications were disposed off as per Provisions of RTI Act, 2005.

WORKSHOPS / SEMINARS / CONFERENCES / TRAINING PROGRAMMES ORGANIZED

A two-day symposium on "Genes to Drugs : In-Silico Approaches" was organized at Pune during April 29-30, 2008

A National Seminar on Automation Systems Technology, under the Automation System Technology Centre was organized at Thiruvananthapuram during May 2-3, 2008

A Workshop on Information Hiding and Cyber Forensics was organized at Thiruvananthapuram on June 4, 2008 at Lal Bahadur Shastri Institute of Technology for Women, Thiruvananthapuram.

A workshop on Moodle for Teachers was organized at Mumbai during June 21-22, 2008

A programme on CAN (Controller Area Network) in Automation was organized at Thiruvananthapuram on July 7, 2008

A one-day workshop titled "Symposium on Medical Informatics Standards in Indian Context" was organized at Pune on September 5, 2008 at Pune.

A one-day National workshop "Ubicomp India 2008" on Ubiquitous Computing was organized at Hyderabad on September 5, 2008

A one-day Tutorial on Analog VLSI Filters and Mixed Signal Design was organized at Hyderabad on September 12, 2008

A five-day technology workshop on Performance Enhancement on Emerging Parallel Processing Platforms (PEEP) was organized by C-DAC, Pune at Pune in September 2008

A seminar 'Hindi Bhasha computing ke kshetra mein C-DAC ka yogdan – Dwitiya Sangosti' was organized at Pune on September 26, 2008 as part of Hindi fortnight celebrations.

UbiComp India 2008

A Rule Based Expert Systems Workshop, was organized at Mumbai at Kharghar, Mumbai, during Oct. 17-18, 2008

A pre-conference workshop of the Telemedicon 2008, was organized at Mohali on November 14, 2008. www.telemedicon2008.com National Level Conference of the Telemedicine Society of India "Telemedicon08" was organized at Mohali along with PGIMER Chandigarh at PGIMER during November 15-16, 2008.

A programme on Electro Magnetic Interference (EMI) and Electro Magnetic Compatibility (EMC) was organized at Thiruvananthapuram on December 5, 2008 in association with VSSC Engineers

A 'Short-term course on Natural Language Processing, Focus: Phonetics and Linguistics for Speech Technology' was organized at Pune during December 13-17, 2008

A BOSS GNU-Linux workshop was organized at Hyderabad at Dr. Marri Channa Reddy Institute of Human Resource Development on December 18, 2008

A Machine Learning Workshop was organized at Mumbai (Kharghar) during Dec. 19-20, 2008

An International Conference 2008 (ICON2008) on Natural Language processing (NLP) was organized at Pune in collaboration with IIIT-Hyderabad during December 20-22, 2008 at ICC Towers, Pune

A half-day workshop on "Recent Advances in Parallel and Distributed Computing" was organized at Hyderabad on January 7, 2009

A 1-day HR Summit on "Skill Mapping: Integrating Academia with Industry" was organized by C-DAC, Noida on January 8, 2009

An "Industrial Liasioning Workshop on IT-Technopreneurship" was organized at Noida on January 9, 2009

Introductory training on BOSS Linux was organized at Chennai for BSNL employees at Hyderabad during February 2009

FOSS Training Programme under ASEAN Cooperation was organized at Chennai during February 2-13, 2009

One-and-half-day event "Meet on Cancer Biomedical Informatics Grid: Cooperation for Cancer Research" was organized at Pune in collaboration with cancer – Biomedical Informatics Grid (caBIG), USA during February 11-12, 2009.

A one day workshop on "Telemedicine and Tele-education" was organized at Mohali on February 17, 2009 for the faculty of Gian Sagar Medical College and Hospital Banur, Punjab

A two-day seminar titled "Annual Seminar of C-DAC Noida Technologies (ASCNT-09)" was organized at Noida during March 4-5, 2009, as a part of National Science Day celebrations

A two-day management development programme on "Telemedicine" was organized at International Institute of Health Management Research New Delhi on March 12-13, 2009

A five-day programme on NeSec (Network Security 2009) was organized at Bangalore (EC) for BEL, Bangalore

Indo-US Workshop on International Trends in Digital Preservation was organized at Pune in collaboration with University of Maryland, College Park, USA during March 24-25, 2009

Indo-US Workshop on International Trends in Digital Preservation

Parallel Programming Workshops conducted during the year:

- Indian Institute of Tropical Metrology (4 days Sept-08)
- National Institute of Oceanography (5 days, Oct-08)
- University of Hyderabad (4 days, Oct-08)
- NCMRWF, Noida (4 days, January-09)
- North East Hill University (4 days, January-09)
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Inauguration of India Development Gateway and Partners' Exhibition by
Thiru A. Raja, Hon'ble Union Minister for Communications and Information Technology
in the presence of Shri Jyotiraditya M. Scindia, Hon'ble Union Minister of State for
Communications and Information Technology
at Vigyan Bhavan, New Delhi on July 4, 2008