
PARAM
PARALLEL
SUPERCOMPUTERS
The power of massive parallel processing... World-class supercomputers within reach.
CDEC

The PARAM

Supercomputing Solutions for the 90s

PARAM is a product of India's national initiative in high-performance computing. Developed and backed by the Centre for Development of Advanced Computing (C-DAC), an organisation that has vision, commitment and the resources to provide total parallel supercomputing solutions for the 1990s and beyond.

PARAM is a superior, massively parallel supercomputer that uniquely harnesses the parallel processing power of the transputers and the compute power of the i860s along with the high-capacity and high-bandwidth of parallel disk arrays. Endowed with an advanced and comprehensive software environment and a rich layer of libraries and solvers, PARAM really facilitates parallel applications development. PARAM supercomputers are backed by one of the world's largest and leading teams that is committed to advancement of parallel processing.

Highlights

- Scalable, Balanced, Future-Proof Architecture
- Awesome Power - over 5 Gigaflops / 7500 MIPS Peak
- Integrated Vector Processing Capability
- Large Main Memory - 1.5 Giga Bytes
- High–Capacity, High–Bandwidth Parallel File System
- Comprehensive, Easy-to-Use, Software Environment
- Extensive Host Connectivity

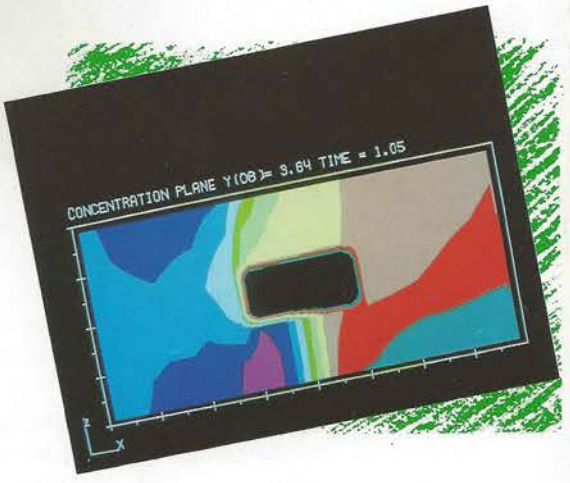
Scalable Supercomputing

PARAM series of supercomputers provide scalable performance exceeding 5 GFLOPS (peak) and over 7500 MIPS (peak). Whatever be the throughput requirement for an application, there is an optimised PARAM configuration to meet it. With PARAM supercomputing platforms, you can solve existing problems faster or you can grapple with large problems which have been just too big for the existing systems.

PARAM is a truly scalable supercomputer in terms of compute power, memory and I/O. You can buy a configuration according to your available resources today. Systems can be upgraded in the field.

PARAM harnesses massively parallel processing technology and spans a broad product range, with systems ranging in size from just one or four processors to machines with over hundreds of processors. Processors can be pure scalar or combined with vector processors. Processors communicate with one another by exchanging messages – which means many processors can be effectively employed in solving a given problem. PARAM is fully reconfigurable. This means that processors can be configured to a topology that is well matched to the communications requirements of the problem being solved. The result is a flexible, highly scalable, massively parallel supercomputer that can realise substantially better performance than with fixed architectures.

Machines



PARAM's computing power and excellent integrated visualisation makes it an ideal tool for clean room design. Picture depicts the isolevels of concentration inside a clean room with machinery.

Impressive Sustained Performance

PARAM series supercomputers are built with state-of-the-art powerful scalar as well as vector nodes. The peak compute power of the 30 MHz T805 scalar node is 4.30 MFlops and 40 MHz i860 is 80 MFlops (with 50 MHz i860 100 MFlops). Scalability of PARAM series systems built with hundreds of such nodes has been demonstrated, yielding sustained performance of several hundreds of megaflops in a range of applications.

Multi-user Reconfigurable Systems

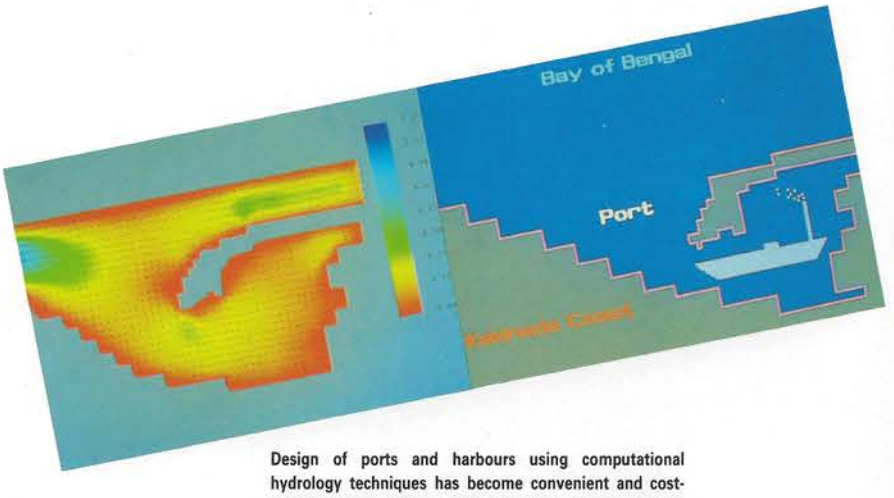
Networked Supercomputing Support

High-Performance Graphics and Visualisation

Wide Range of Applications

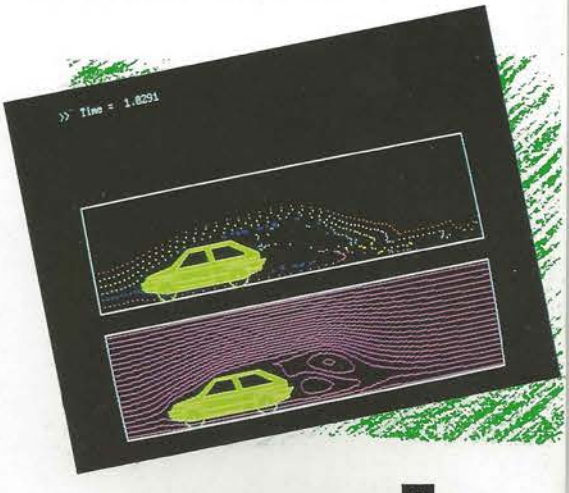
Robust Air-Cooled Systems

Range of Competitive Price / Performance Models



Design of ports and harbours using computational hydrology techniques has become convenient and cost-effective with the number-crunching power of the PARAM.

PARAM is being used for automobile designs through computational fluid dynamics analysis tools. The particle trace and streamline of flow past a typical model are being studied here for optimised fuel consumption.



Easy Installation and Minimal Operating Costs

With PARAM, supercomputing no longer means exotic machines; machines that need special life support systems — from cooling plants to special rooms. Because they are air-cooled and consume only about 1KW power per cabinet, PARAM supercomputers can be installed in a standard airconditioned environment. Cabling is limited to just plugging in a few host terminals or a network cable making installation relatively simple. Installation and operating costs are obviously very minimal.

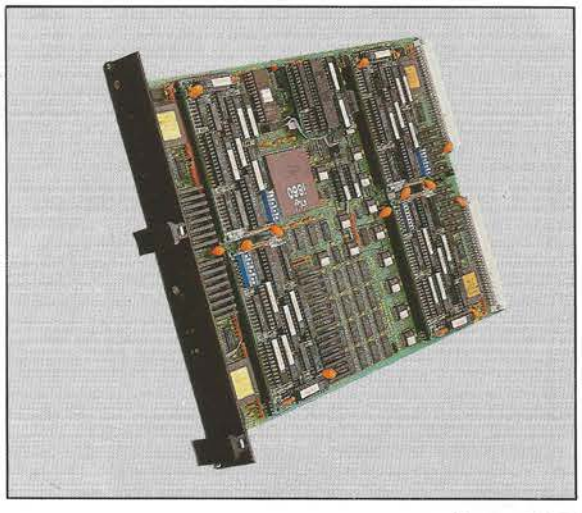
The PARAM

High-Performance Architecture

PARAM is based on a high-performance and truly balanced architecture that features powerful processors, high communications bandwidth between processors and high throughput I/O to deliver true supercomputing performance.

Powerful Replicated Scalar and Vector Processing

PARAM is based on the distributed memory model of parallel computing where powerful replicated scalar and/or vector processing nodes, and the processes executed on them communicate and synchronise with each other by exchanging messages. Processing nodes provide scalar processing through a 32 bit transputer with on chip 64 bit floating point unit. Vector processing is through an Intel i860 processor. PARAM is equipped with several such processors to provide supercomputing performance through massive parallelism.



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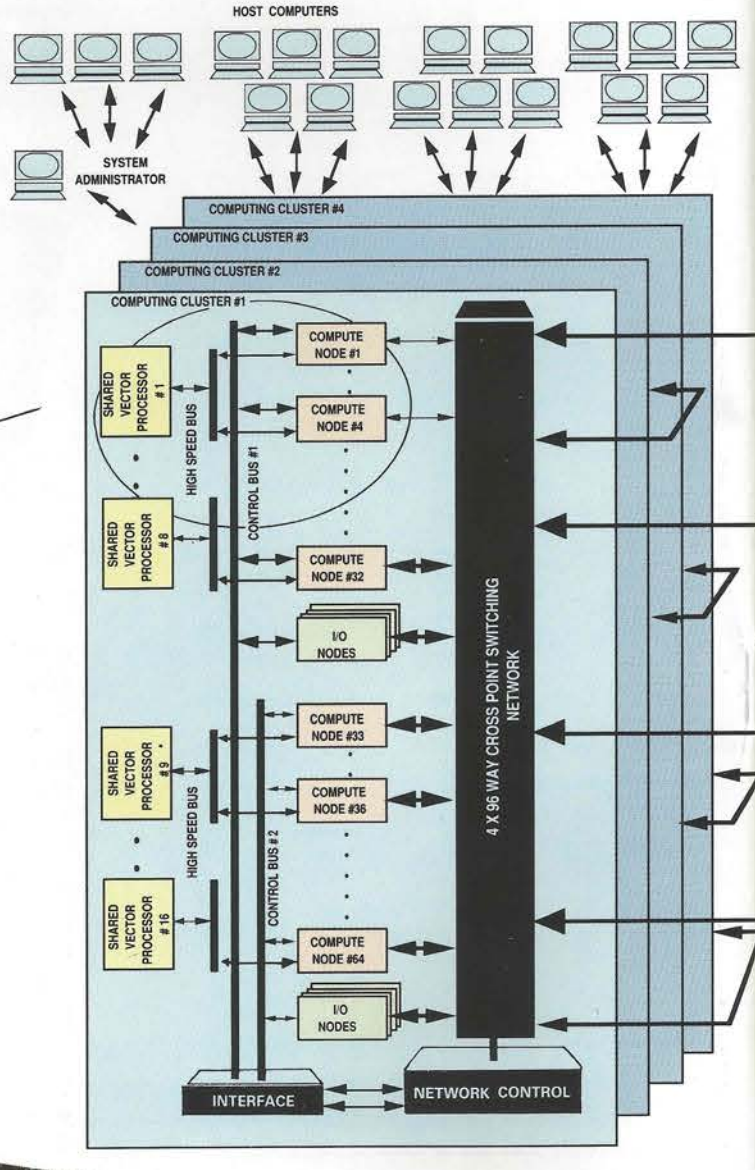


Balanced Communications

PARAM has eliminated communicaton buses and uses point-to-point communication channels between processors and ensures that communications bandwidth increases in proportion to processing capacity. As more processors are added, more point-to-point communication links are automatically added.

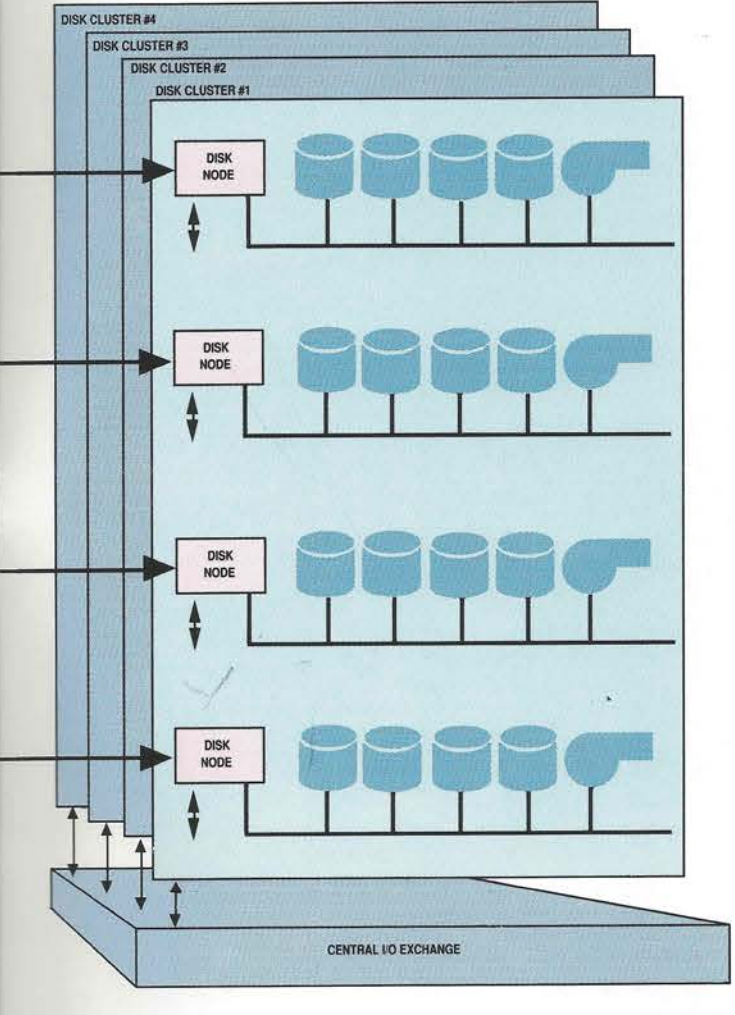
Architecture

Reconfigurable Topology

Direct communication between any two nodes is established through a cross-point switch which users set through software. This connection topology is totally reconfigurable to suit diverse application requirements. PARAM's switching network has been specially designed to provide inter-processor communication without any degradation in performance.

Modular, Scalable and Configurable Hardware

PARAM hardware is based on a modular configurable architecture organised into compute clusters and disk clusters. The compute cluster comprises processing nodes and a switching network. Each computing cluster can be equipped with upto 16 processing node boards, their type based on the PARAM model. Systems can be upgraded in the field. Large systems are realised by combining several compute and disk clusters.



High Capacity, High Bandwidth Mass Storage

With so many processors working in parallel they could soon starve for data if I/O cannot match the processor requirements. PARAM exploits parallelism in I/O too to address this problem. The result is the Parallel File Server where a number of Disk Controllers handle I/O requests. More Disk Controllers and disks can be added to meet the demands for more data storage. As more Disk Controllers are added, the number of data transfer channels also automatically increase creating a higher bandwith between the disks and the processors.

The parallel file server is organised into disk clusters. Files themselves are scattered over multiple disks. Concurrency is implemented at various levels to realise high throughput. This architecture ensures high I/O throughput that matches the processing requirements.

Extensive Host Connectivity

PARAM is a backend supercomputing resource accessible from a wide range of industry standard hosts. Directly connectible are PCs, Sun Workstations, VME platforms, UNISYS U6000, or VAX machines. Remote or campus hosts can be connected through fibre-optic links. Program development is done on the host and downloaded on PARAM for execution. Thus PARAM lets you harness its power through your own standard hosts with familiar operating environment such as DOS, UNIX, XENIX and VMS.

The PARAM Architecture

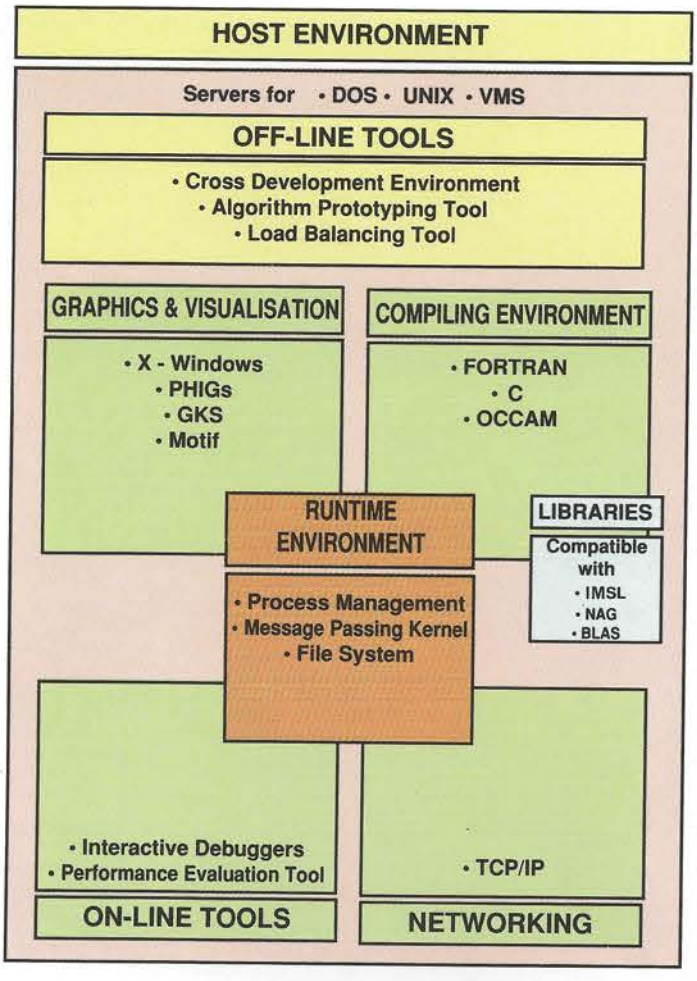
PARAS - The Golden Pro
Environment on PA

PARAS literally gives a golden touch to PARAM and enables the users to efficiently harness the power of parallel processing offered by PARAM. PARAS is an advanced software environment that simplifies the task of developing and executing parallel programs.

A comprehensive software environment, PARAS, features ANSI standard C and FORTRAN compilers with parallel extensions. A whole suite of parallel processing tools, utilities, and libraries make the job of developing parallel programs easy.

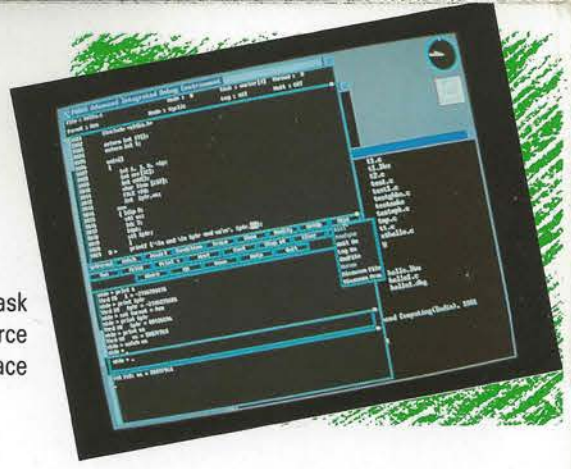
ANSI Standard FORTRAN and C compilers are fully supported by the PARAS compilers. So also is OCCAM and a host of third party compilers. A rich runtime environment providing communication, multi-threading and semaphores makes program development easy. Mixed language programming and in-line assembly support along with comprehensive runtime libraries adds flexibility and power to PARAS.

Program Development Utilities available in PARAS help cut down parallel programme development time and aid in the generation of efficient programmes. The cross-programme development utilities provide powerful parallel programming learning aids on standard environments. Standard menu-driven user-friendly graphical interfaces facilitate the use of these utilities.



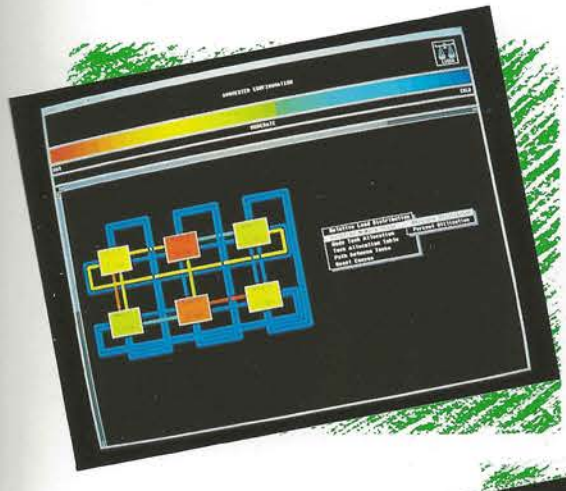
PARAS Overview

gramming RAM

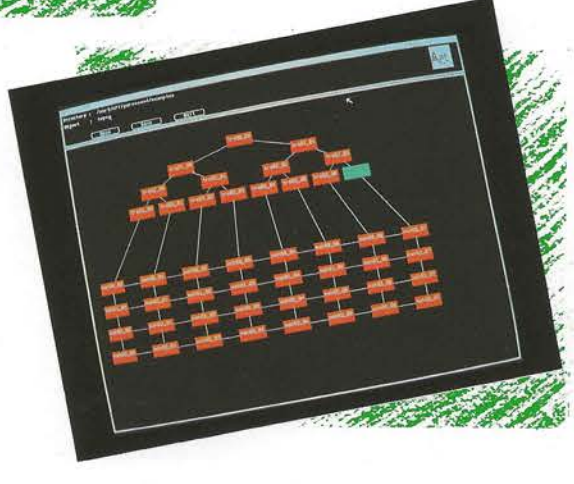


AIDE (Advanced Integrated Debug Environment) simplifies the challenging task of debugging parallel programmes at the source level. Facilities for Cyclic, Post Mortem, and Trace debugging are provided.

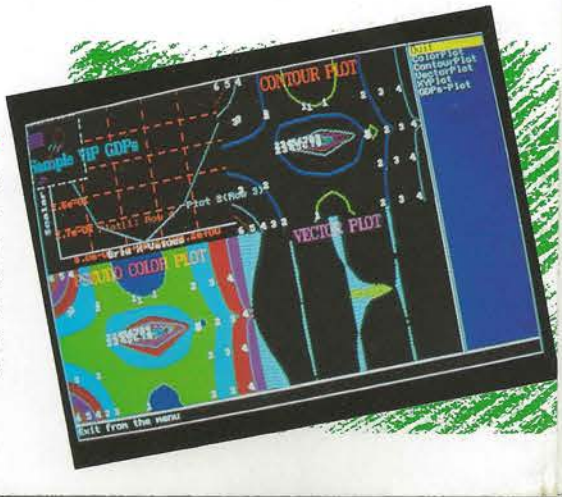
PET (Performance Evaluation Tool) monitors the execution of an application, measures CPU utilisation, identifies performance bottlenecks, and helps the user to fine-tune application programmes.



LiBRA (Load Balanced Resource Allocator) is a powerful tool that provides the user with near-optimal solutions for processor interconnect topology, task placement and message routing. It can be used initially at a stage when the user is prototyping an algorithm, or later, when he is fine-tuning an existing code.



APT (Algorithm Prototyping Tool) provides the environment for algorithm prototyping which allows the user to simulate the execution of an application, debugging, and experimentation with topology and partitioning without detailed coding. The output in terms of execution time, processor and link utilisation and thread activity greatly helps in quick development of an algorithm prototype for a parallel programme.



Powerful Graphics and Visualization tools harness the power of host as well as back-end graphics. Availability of X-Window system, OSF's motif toolkit and similar standard graphic user interfaces allows most applications that can run on PARAM to have the same look and human-interface as the popular workstation environments, making PARAM even more easier to use.

CODE - the integrated C-DAC OCCAM Development Environment provides an excellent vehicle for initiation into, and learning the art of parallel programming in OCCAM on stand alone PCs.

High-Bandwidth Parallel File Systems

Programmes running on PARAM can avail of either Host File System facilities or the Parallel File System facilities through a set of standard file operation functions and a set of advanced file operation functions that treat files as multi-dimensional arrays. The standard functions maintain compatibility with corresponding UNIX standard I/O library functions.

The **Host File System** is resident on host. A library of functions callable from both C and FORTRAN provides the user a transparent mechanism to access the file system in a host-independent way.

The **Parallel File System** implemented on the PARAM disk clusters provides the large data storage and high I/O bandwidth requirements for typical supercomputing applicatons. Blocks allocated to a file are distributed over several disks so that multiple disks can respond to a file request in maximum concurrency.

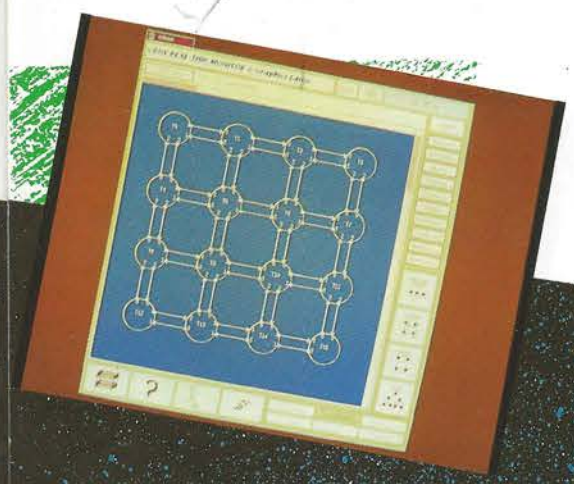
PARUL - The Parallel User Library

Libraries of parallel programs of fundamental scientific and mathematical problems can be unquestionably useful for developing large application programs. PARUL enables an user to call a function from the parallel library from within a sequential program written either in C or FORTRAN language executing on the host processor.

AI Programming Environment

PARAM can also be used as a powerful platform for Knowledge Based Computer System (KBCS) Applications. AI Languages and Programming environments such as CT scheme, CS Prolog, Strand 88, and a parallel neural network simulator P-NEST are supported.

CRUX is a toolset that allows the development of Parallel C and Parallel FORTRAN programmes on a network of UNIX machines. The parallel programmes thus developed, can be easily ported on PARAM or any other transputer based parallel machines.



Third Party Software

PARAM hosts a rich layer of system software from third parties which includes C, FORTRAN, Pascal, Basic, ADA, C++, and Modula-2 compilers for transputers as well as C and FORTRAN compilers and vectorizers for i860.

Networked Supercomputing

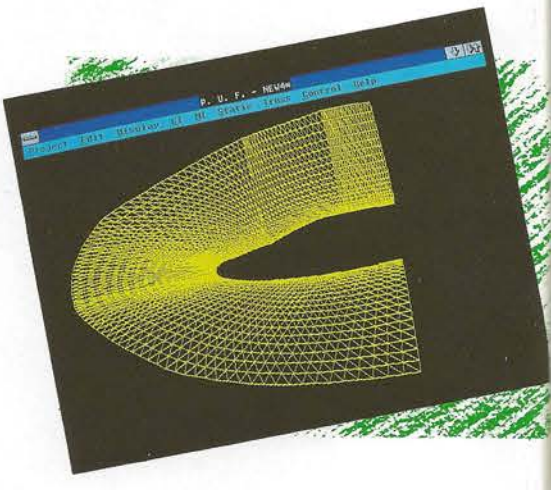
PARAM brings the benefits of networked supercomputing to more users than ever before. PARAM can be connected through an interface to a network of user machines, and can co-exist as a resource in a networking environment. Present protocol supported is TCP/IP, but C-DAC is committed to support present and emerging standards like NFS, ISO's, OSI, FDDI, HIPPI, etc.

	8000 / 40	8000 / 50	8000 / 60	8000 / 80	8600 / 40	8600 / 50	8600 / 60	8600 / 80
No. of nodes	16	32	64	256	16	32	64	256
No. of vector processors	-	-	-	-	4	8	16	64
Memory ... MBytes	64	128	256	1024	96	192	384	1536
Disk capacity ... GBytes	5	5	5	20	5	5	5	20
No of users	8	8	8	18	8	8	8	18
MIPS peak	480	960	1920	7680	640	1280	2560	10240
MFLOPS peak	67	135	275	1100	387	775	1555	6220
Communication bandwidth MBytes / sec	27	55	111	445	291	583	1167	4669
Dimensions (each cabinet)								
Height	1330 mm							
Width	600 mm							
Depth	650 mm							
Weight	Computer cluster cabinet ... 165 Kgs Disk cluster cabinet ... 140 kgs							
No of cabinets								
Compute	1	1	1	4	1	1	1	4
Disk	1	1	1	4	1	1	1	4
Other	-	-	-	1	-	-	-	1
Operating Temperature	0 to 35 degrees C							
Voltage	220 /110 V							
Power consumption — KW	1.85	2.0	2.3	9.3	2.0	2.3	2.9	11.7
Software Environment	PARAS				PARAS with Vector Processing Support			

The PARAM Models - Technical Data

Applicatio

The PARAM series is addressed to general purpose supercomputing covering science and engineering, database and OLTP, and AI applications. Because they admit heterogeneous compute nodes, wide range application specific nodes, I/O interfaces, and peripherals, systems can be configured and tuned for specific end-user requirements and applications. A rich availability of parallel libraries and solvers make the job of parallelizing and porting applications quick and easy. PARAM systems are backed by one of the largest applications development programmes and C-DAC has committed its largest resources to applications development and end-user hand-holding.

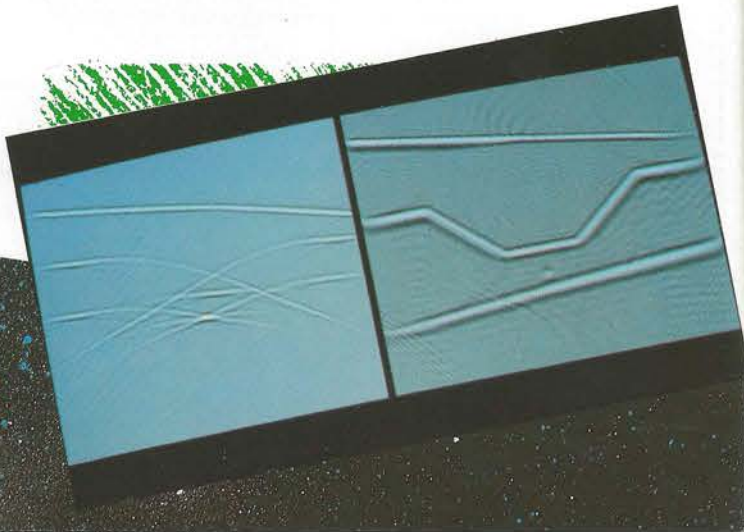


PUF, an interactive, user friendly preprocessor utility for a variety of diversified applications, has been effectively used here for representing the outfield of an aircraft canopy. It was discretised into six zones and then, each zone was meshed using some of PUF's powerful mesh generation capabilities.

- Remote Sensing • Image Processing
- Signal Processing • Computational Fluid Dynamics
- Launch Vehicle Dynamics • Finite Element Modelling • Materials Science
- Power System Analysis • Seismic Data Processing • Computational Mathematics
- Oil Reservoir Modelling • Astronomy & Astrophysics • Process Control
- Computational Physics • Computational Chemistry
- Robotics • Scheduling and Optimization

The process of porting industry-standard software by independent software vendors and development of new application-specific software by leading groups is making the applications layer on PARAM richer and richer every day. Massive compute power, large main memory and high-bandwidth and high capacity secondary storage make PARAM series the ideal solution for today's challenging problems in scientific research, engineering design, business and strategic applications.

Seismic processing aims at the correct geological cross section determination for the exploitation of the petroleum reservoir. Post stack migration, a compute and memory intensive process, transforms the output from routine processing to the true description of the subsurface geological boundaries.



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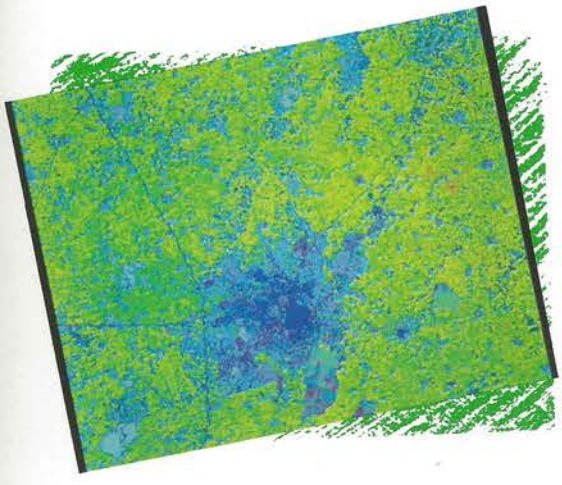
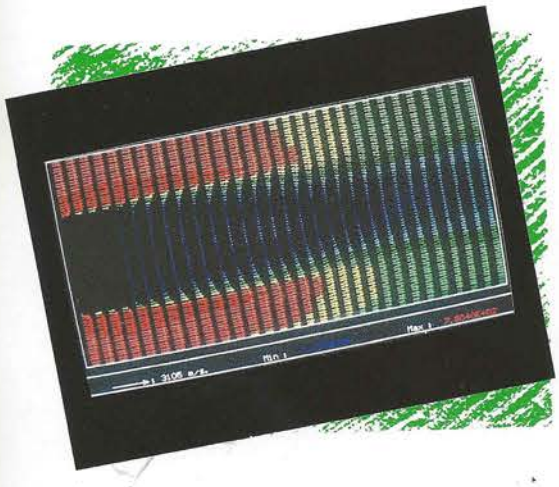
The Indian Space Research Organisation is using PARAM to classify remotely sensed images. PARAM has exhibited significant speed-ups for this application and ISRO will be able to classify atleast hundred images per 8 hour shift for its IRS 1-C mission.





The base flow at the nozzle exit is simulated using K-E turbulance model. The analysis of the recirculatory region interacting with external flow decisively affects propulsion systems of the aerospace applications.

C-DAC's long term vision is to participate in the advancement of the frontiers of general purpose parallel supercomputing technology and applications in the '90s; to successfully commercialize the technologies in the global context; and to establish a successful, self-sustainable, and stable model for mission-oriented R&D.

C-DAC represents today one of the world's largest and leading group in parallel computing.