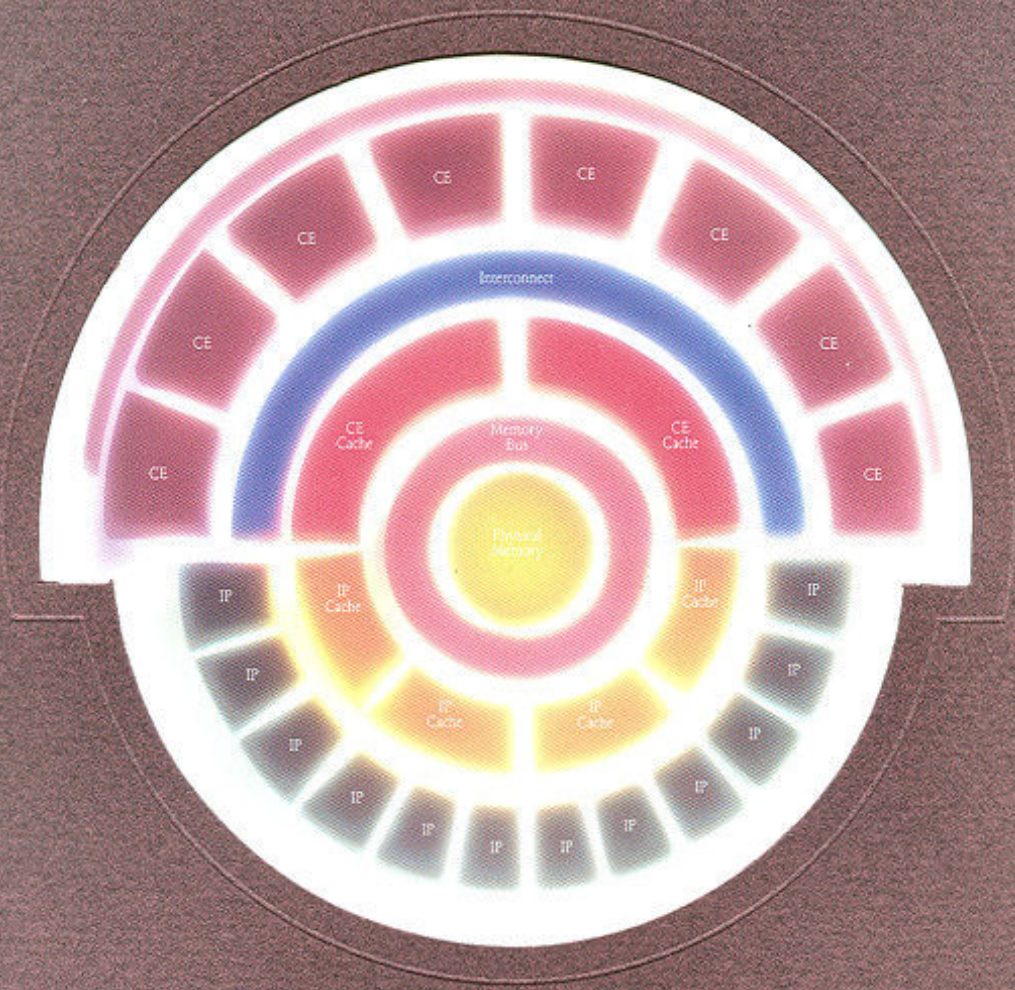
Delivering on the Promise of Parallel Processing.

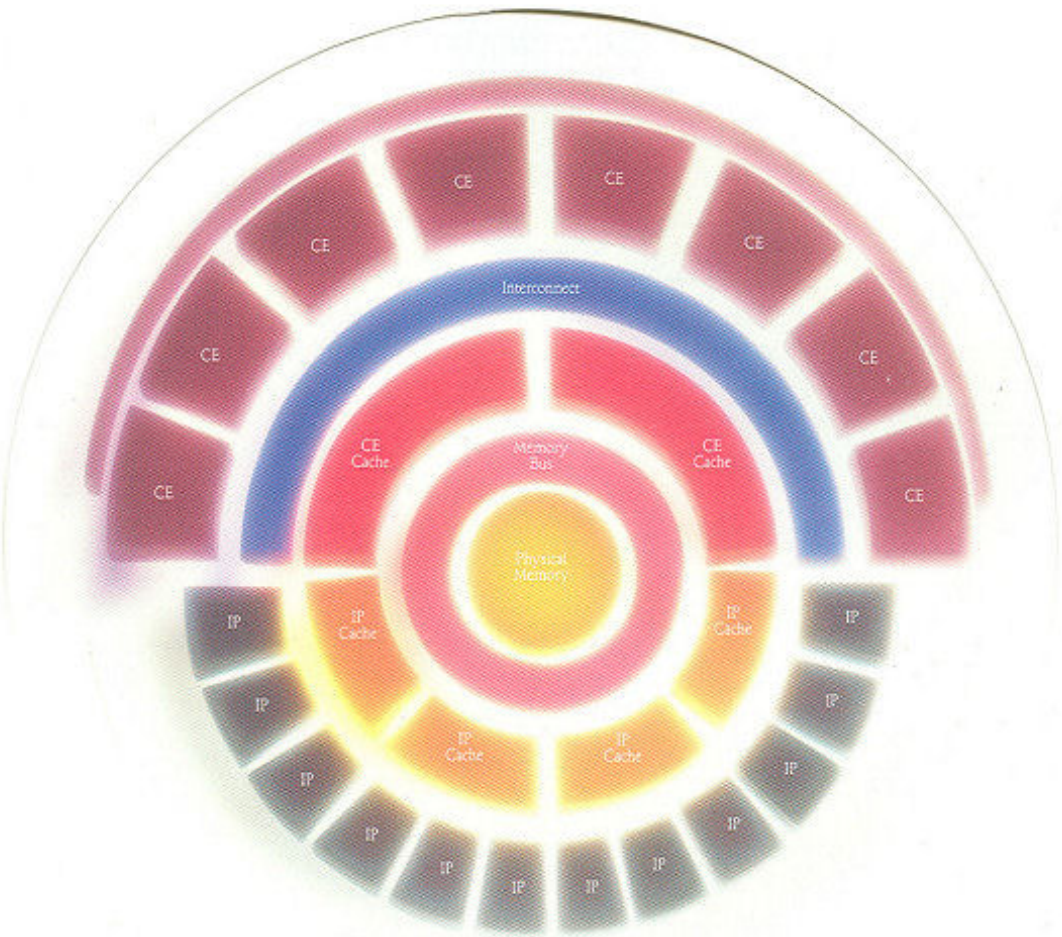


ALLIANT

Computer Systems Corporation

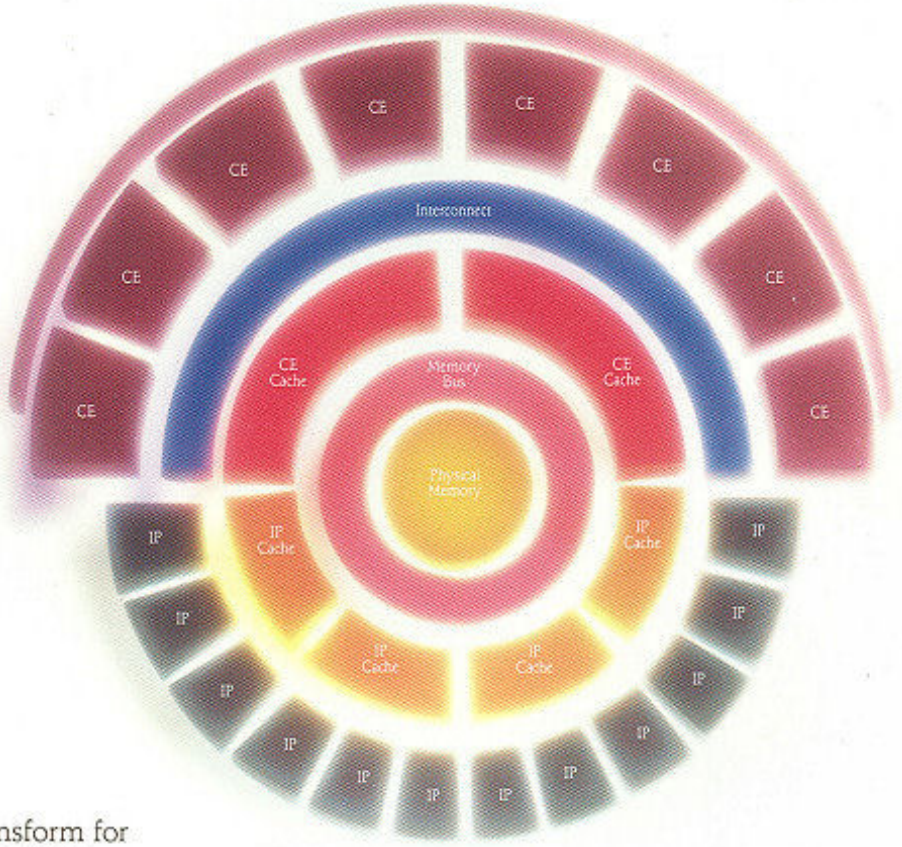
The Alliant™ FX/Series™ architecture combines up to eight high performance processors, each with an integral vector processing facility, in a parallel design that delivers 94 million floating point operations per second (MFLOPS) and 37 MIPS peak performance to engineering and scientific applications.

Alliant computers run individual programs coded in widely used languages, including Fortran and C, in parallel, providing exceedingly fast time-to-solution for computationally intense applications. By combining parallel processing with multi-processing, FX/Series systems provide near-supercomputer performance yet maintain multi-user throughput and responsiveness unavailable in uni-processor scalar or vector computers.



The FX/Series Architecture

- Parallel execution of individual user jobs results in fast time-to-solution.
- Up to eight computational elements (CEs), each with a five-stage pipelined instruction processor and an integral vector processing facility, provide near-supercomputer performance.
- Multiprocessing on detached CEs provides high throughput support for production and development on the same system.
- A 2 GB virtual address space is available to each program.
- 376-MB-per-second cache supports the full bandwidth of all CEs operating in parallel.
- 188-MB-per-second memory bus provides high sustained bandwidth to a large physical memory.

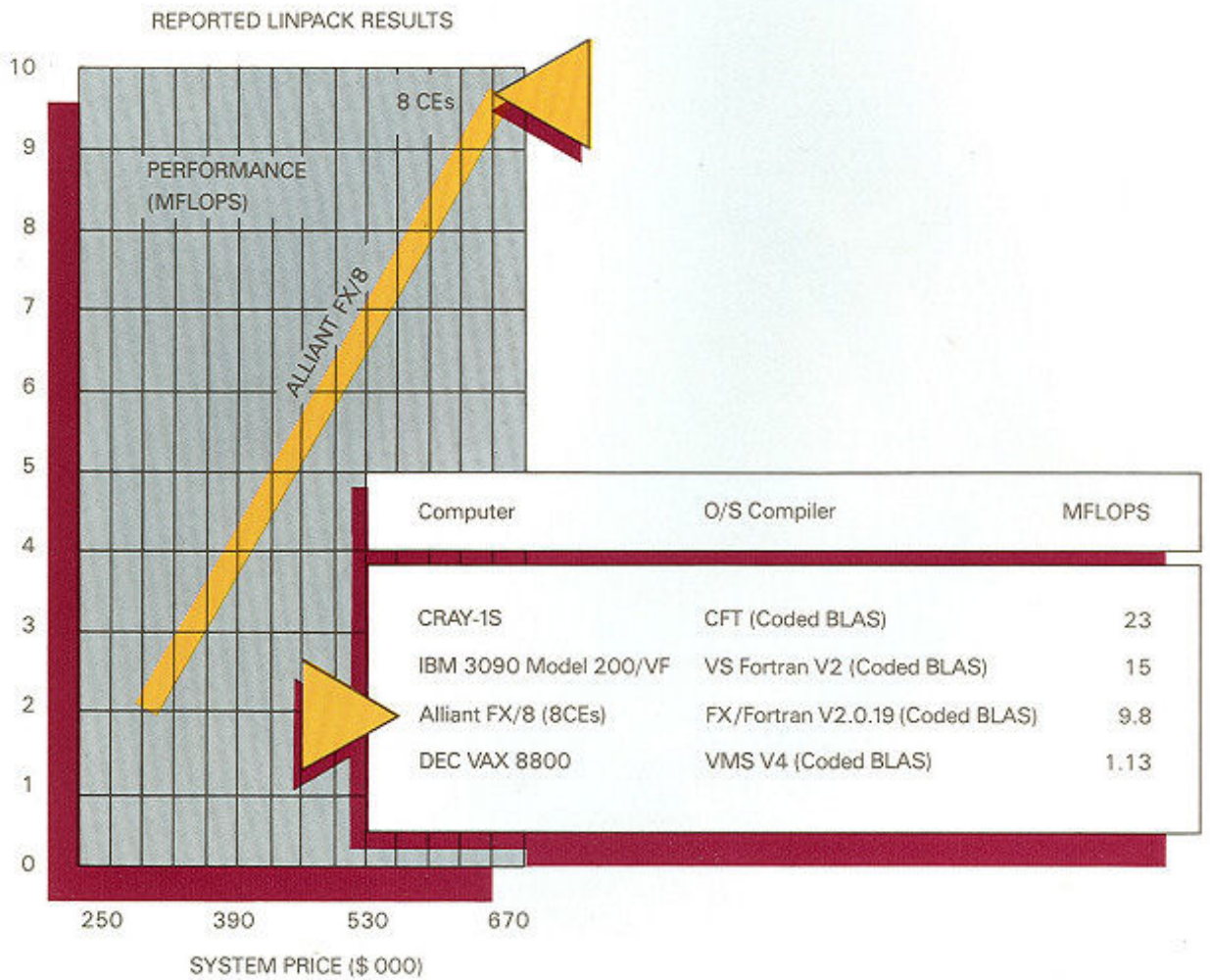


- Existing programs transform for parallel and vector execution with little or no reprogramming.
- Low overhead parallel processing results from an independent concurrency control bus and dedicated control hardware on each CE.
- Large physical memory is shared by all processors through a high-speed coherent cache system.
- A pool of up to 12 interactive processors (IPs) multi-process the operating system and interactive user jobs to assure system responsiveness.
- Up to 12 independent I/O channels support high bandwidth I/O and a wide range of peripheral options.

High Performance in a Family of Compatible Systems

FX/Series computers provide high performance through a parallel architecture that supports up to 20 processors in a single system. Two processor types: computational elements (CEs) and interactive processors (IPs) are combined in a family of systems that deliver near-supercomputer performance and high multi-user responsiveness and throughput.

The Alliant architecture supports a new form of parallel processing, Alliant concurrency, that delivers very-high performance to existing applications. Alliant concurrency groups CEs together into a "computational complex" that executes individual user programs in parallel, reducing time-to-solution for computationally-intense applications.



Computer	O/S Compiler	MFLOPS
CRAY-1S	CFT (Coded BLAS)	23
IBM 3090 Model 200/VF	VS Fortran V2 (Coded BLAS)	15
Alliant FX/8 (8CEs)	FX/Fortran V2.0.19 (Coded BLAS)	9.8
DEC VAX 8800	VMS V4 (Coded BLAS)	1.13

In parallel with CE jobs, a pool of IPs execute multiple interactive user programs and the operating system, including I/O. IPs off-load the CEs while maintaining system responsiveness.

The addition of processors improves system performance and reduces the time-to-solution of existing applications, without requiring replacement of previously purchased hardware or changes to existing software.

The expandable FX/8™ combines from one to eight CEs, up to 12 IPs, and a large physical memory in its compact, air-cooled cabinet.

The compatible FX/1™ uses a single CE and one or two IPs to deliver performance well above that of today's superminicomputers in a desk-high system. Both are ideal as a multi-user departmental computer, computational server to networks of distributed workstations, or the ultimate personal supercomputer.

Advanced architecture combined with extensive use of VLSI technology, with up to 256 Alliant-designed gate arrays in a single system, means low power consumption and cool, reliable operation.

Applications coded in ordinary languages run in parallel on Alliant Computers providing fast time-to-solution and high multi-user throughput.

Parallel and Vector Processing From Existing Languages

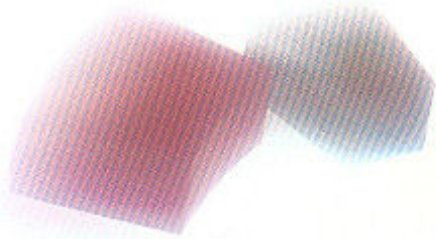
Alliant delivers the benefits of parallel and vector processing with widely-used programming languages. Applications written for conventional mini, mainframe, and supercomputers port easily and take advantage of Alliant's architecture with little or no modification.

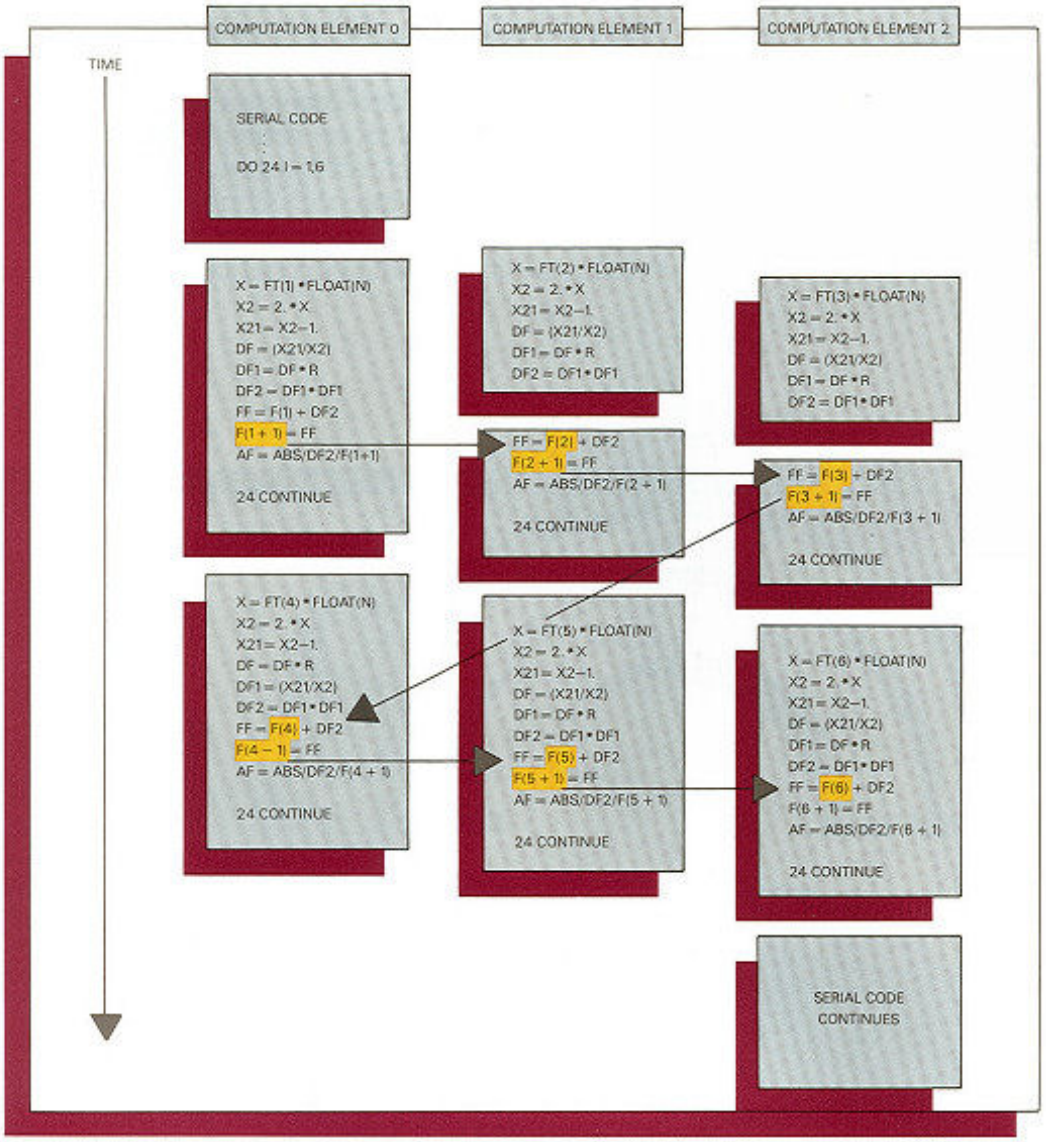
Alliant's FX/Fortran™ compiler automatically identifies opportunities for fine-grained parallel processing (Alliant concurrency) and vector execution in existing applications and generates globally optimized code that executes efficiently on multiple processors.

VAX Compatible—FX/Fortran fully implements the ANSI Fortran-77 standard and includes most of the extensions found in other popular compilers, including VAX/VMS™ Fortran-77. Fortran programs written for VAX computers port quickly to Alliant computers, taking full advantage of the FX/Series architecture, while remaining industry compatible.

Automatic Transformation for Alliant Concurrency—FX/Fortran analyzes source programs for iterative loops that can run in parallel. It then generates code that executes each iteration of the loop on a separate processor. This innovative approach:

- *Does not require changes to source code.* Loops and loop dependencies are easily identified by the compiler.
- *Introduces no compile-time dependencies on the number of CEs in the computational complex.* Concurrency is controlled at execution. The same code can run on from one to eight CEs, automatically taking advantage of all installed processors.
- *Delivers high performance.* A single application can benefit from both vector and parallel processing. For example, nested loops can execute with the inner loop vectorized and the outer loop in concurrent mode.
- *Results in high parallel processing efficiency.* Task assignment and dependency synchronization are handled in dedicated hardware.
- *Adapts to a wide range of applications.* Many loops that must run in slower scalar mode on conventional vector computers can run in scalar concurrent mode on the FX/8.





Loops with intra-loop data dependencies that automatically optimize for parallel execution, would run in scalar mode on traditional scalar or vector-only architectures.

Automatic Vectorization—FX/Fortran is a fully vectorizing language that makes direct use of the integrated vector processing facility on each CE. Vector processing, first introduced on the Cray-1™, provides high performance to technical applications.

FX/Fortran provides for automatic vectorization across all data types and generates code that makes direct use of advanced hardware features such as vector indices (scatter/gather), vector edits (mask, merge, and compress) and compound operations (triadic instructions).

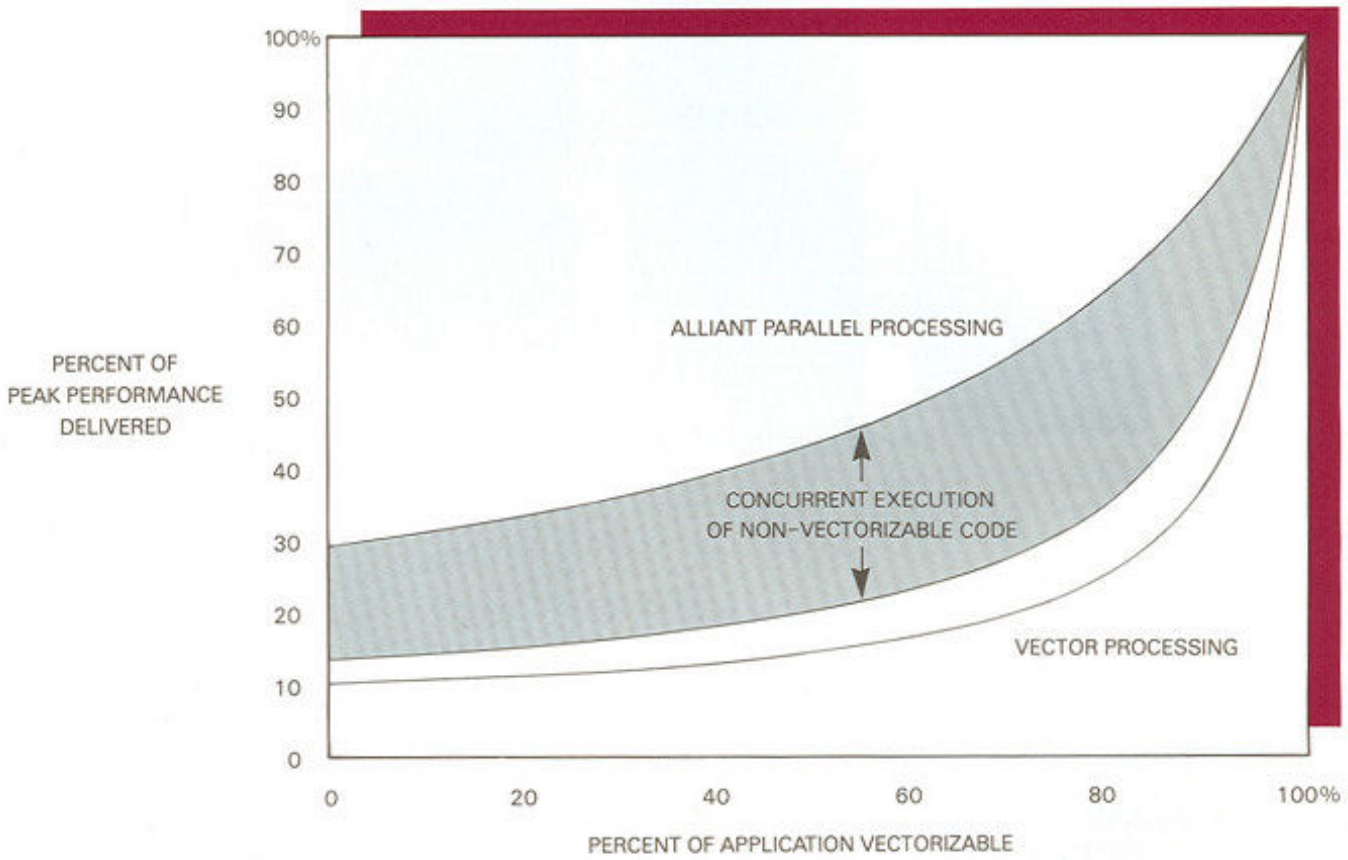
Multiple Language Applicability—Complementing FX/Fortran are industry-standard C and Pascal compilers. The Alliant C compiler is an enhanced version of the portable C compiler. It provides programmers access to concurrency and vector processing through explicit mechanisms. A concurrent call feature allows subroutines to be called to execute in parallel from within C programs. In addition, an extensive library of vector and concurrent operations is callable from C programs.

Concurrency Architecture—Unique to Alliant is an instruction set architecture and dedicated hardware to control Alliant concurrency with very low overhead. A single instruction, automatically inserted by the Fortran compiler, switches a user program from serial to concurrent execution in less than two microseconds.

Efficient control permits FX/Fortran to exploit the numerous opportunities for fine-grained parallelism that exist throughout engineering and scientific programs.

ANSI Standard Array Extensions–FX/Fortran extends the Fortran language to permit assignment and other operations on full arrays, as well as the use of arrays in intrinsic functions. These extensions simplify source code and follow updates proposed for the next ANSI standard.

Alliant Systems Deliver More of Their Peak Performance–Alliant concurrency allows FX/Fortran to optimize more of an application than would be possible with a vector architecture alone. Loops that execute in vector mode on supercomputers are compiled to run as concurrent vectors on the FX/Series. More importantly, Alliant concurrency enables FX/Fortran to process in parallel many code constructs that typically do not optimize for vector execution on vector computers. Loops containing subroutine calls, intra-loop data dependencies, conditional code, recursions, and loop exits optimize for parallel execution with Alliant concurrency.



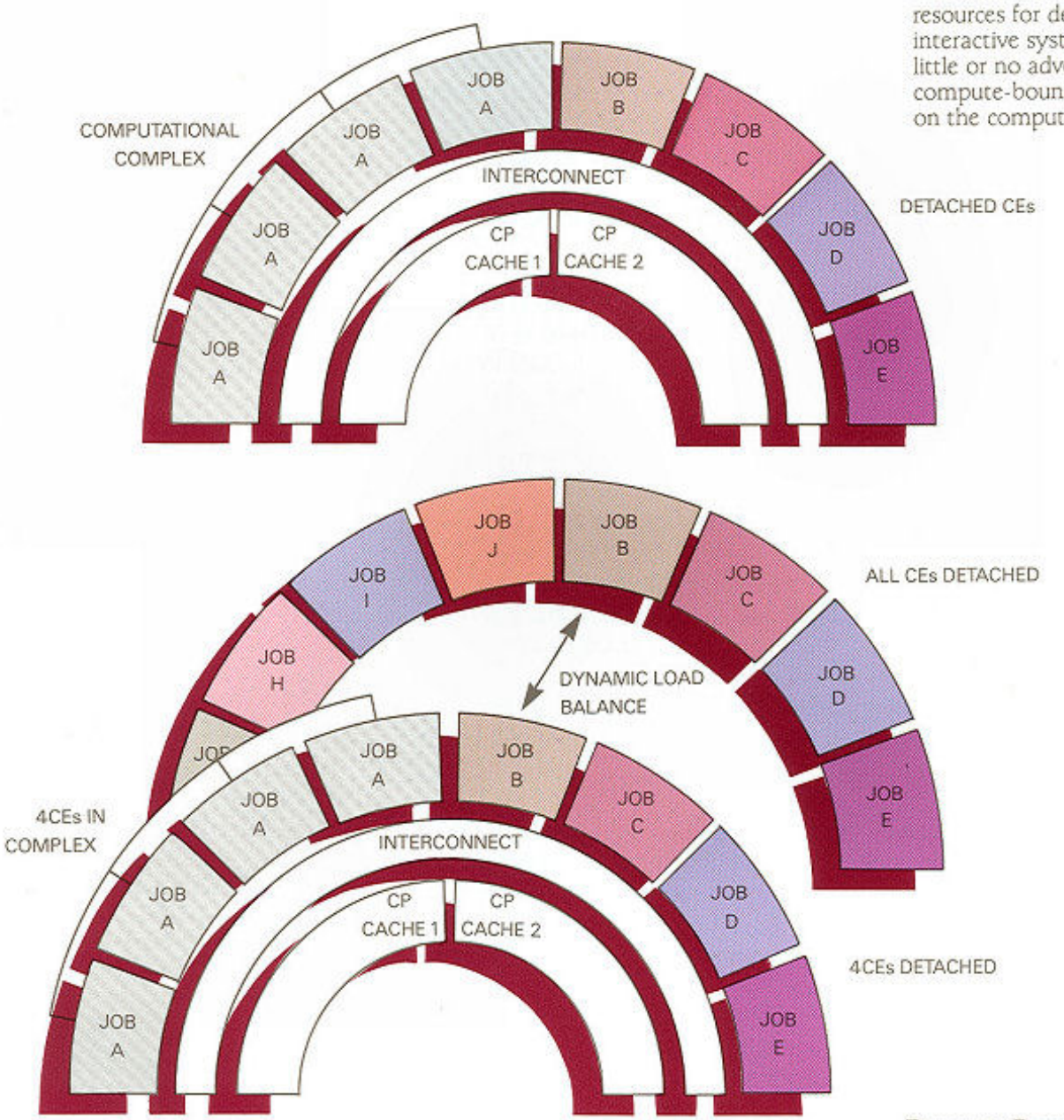
With Alliant concurrency, FX/Fortran can optimize more of an application, delivering more of the computer's peak performance than would be possible with vector-only processors. Compared with vector computers, the FX/8 provides greater absolute performance and faster time-to-solution.

Multiprocessing for High Multi-User Throughput

The Alliant architecture allows multiple jobs to execute simultaneously on separate "detached" CEs. This multiprocessing provides high throughput and efficient utilization of the CEs.

Serial programs, including compilations, can execute in parallel with each other, and with programs executing on the computational complex. On an FX/8, up to eight independent CE jobs can execute simultaneously in "multiprocessing" mode.

Access to multiprocessing on the CEs is straightforward. Jobs are marked, at the time of execution or linking, as being serial or parallel. The operating system then schedules serial jobs for any one of the detached processors and parallel jobs for the computational complex.



Detached Mode—Detached mode sets aside a fixed pool of resources for developers and interactive systems users with little or no adverse impact on compute-bound tasks executing on the computational complex.

Dynamic Complex Mode—The computational complex can be time- and load-multiplexed between two modes: all CEs in the complex attached and all detached. This assures maximum throughput for a varying mix of production and development jobs.

Task-level Parallel Processing–Independent processes, running on the computational complex, detached CEs, or IPs, can be coordinated through operating system mechanisms that support shared memory, general forms of synchronization, and atomic locks.

Task level parallel processing allows program developers to exploit the high level parallelism found in certain applications. This process is logically the same as that used on traditional multi-processor systems such as the Cray X-MP™ and Cray 2™, making Alliant computers an ideal development system for programs targeted for these systems.

A Resource Class Dedicated to Interactive Computing–All Alliant systems include an expandable pool of IPs that independently execute actual UNIX processes. IPs are complete computers–not simply I/O processors. They maintain high interactive and network response and enable the CEs to "concentrate" on computation.

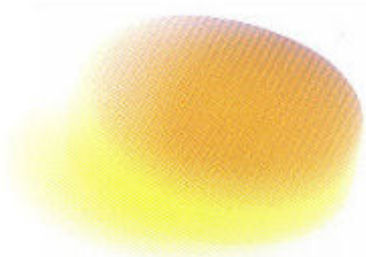
IPs share a common memory with the CEs. They execute interactive user jobs, such as editors, operating system tasks created by jobs running on the CEs, like I/O, and system activity, such as paging.

Berkeley Unix

Concentrix™, the Alliant operating system, is a full native port of the Berkeley Unix operating system. Unlike uni-processor systems, Concentrix manages multiple queues of ready-to-run tasks for the computational complex, detached CEs and interactive processors, transparently to the programmer and system operator. Computational jobs are scheduled for the CEs; interactive and operating system activity for any available IP. Multiple user jobs and operating system activity run on the system simultaneously.

Concentrix is designed for large applications executing in a multi-user, multi-processor, parallel environment. It supports 256 megabytes of physical address space, a two gigabyte virtual address space per process and local area networking via Ethernet™ TCP/IP.

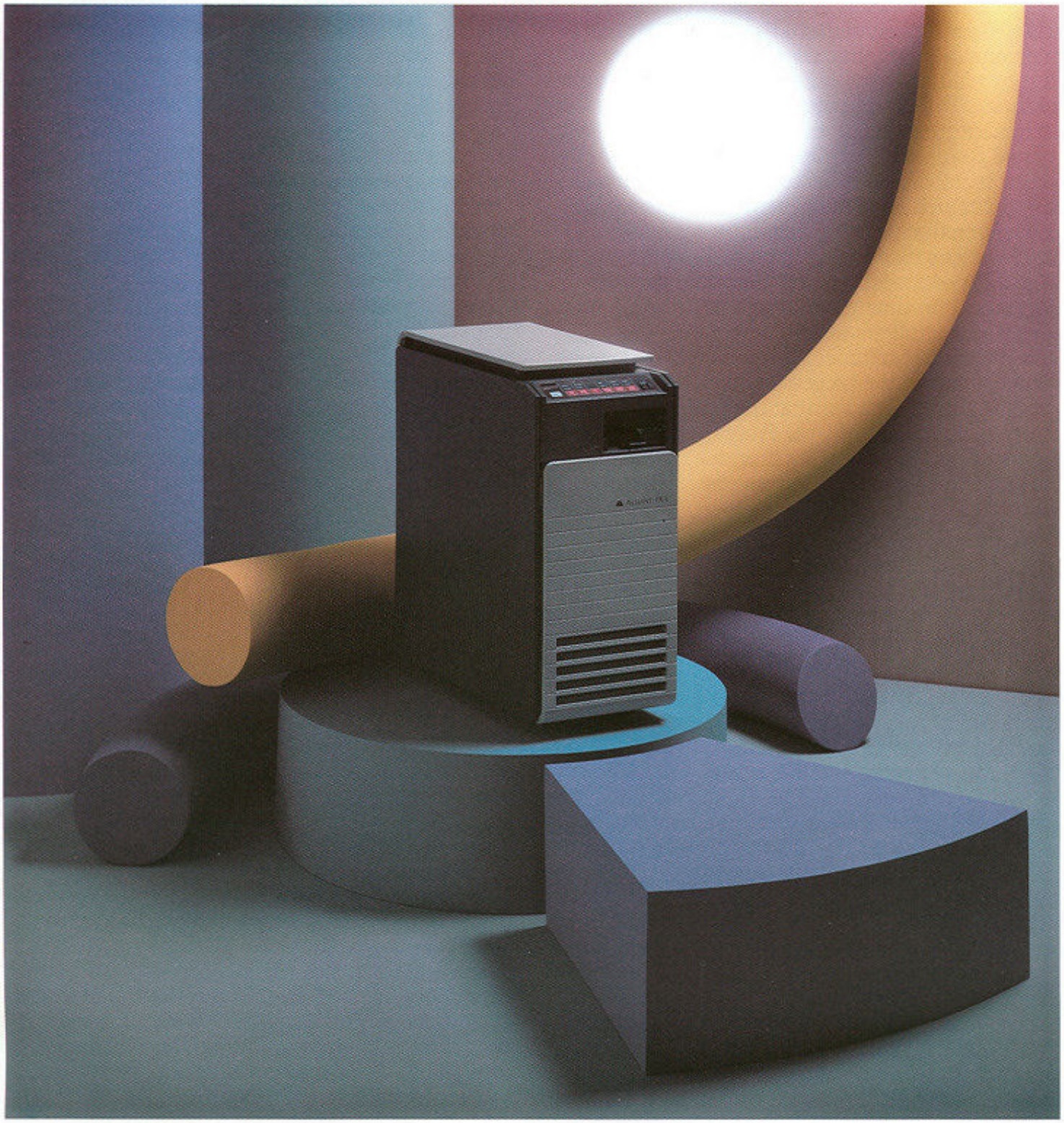
Concentrix is further extended for engineering and scientific applications. It is enhanced for improved performance with:



- *Multiple processor support.* User jobs and system processes migrate between system resources (IPs, detached CEs, and the computational complex) to take maximum advantage of available computing cycles.
- *Demand-paged virtual memory.* Up to two gigabytes per process.
- *Mapped file support.* The high speed virtual memory system is used to bypass the traditional UNIX buffered I/O for both random and sequential file access unless overridden by the user.
- *Copy-on-write process creation.* Concentrix supports shared code and data between processes with a copy-on-write feature that speeds process creation.
- *Shared library support.* Pointers, rather than actual library routines, are linked, resulting in smaller executable images and easier updates.
- *Fast file system.* Concentrix includes techniques for clustered file placement, resulting in improved disk transfer performance.
- *High bandwidth paging/swapping I/O support.* Concentrix provides an additional large-block read/write capability that results in very fast paging and swapping. Scatter-read and gather-write I/O can be accomplished in blocks of up to 1 MB with a single transfer.
- *Device auto-configuration.* The operating system interrogates all I/O channels for Alliant supported devices, and automatically performs the logical to physical mapping of device name to device.

Peripheral Support and Expansion—Alliant peripherals include disk and tape systems, terminals and printers, and local area networking products. Controllers for these peripherals connect to the system through up to 12 independent I/O chassis (two in the FX/1), each supported by a separate IP. This insures high available I/O bandwidth through multiple independent channels, and flexibility in configuring and upgrading systems.

Workstation Network Support—Concentrix allows Alliant systems to be tightly integrated into networks of engineering workstations providing both compute and file services. Support is provided to interconnect to the Apollo Domain™ environment and to Sun Microsystems workstations through TCP/IP with full support for the Network File System™ (NFS).



The FX/1 is based on the same hardware and systems software used in the Alliant FX/8. Software is fully transportable among all Alliant systems at the source and object code level.

Advanced Programming Tools Provide Access to Maximum Performance

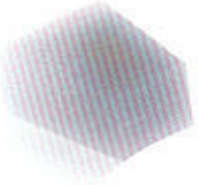
Alliant systems include the programming and system management tools required to take maximum advantage of the FX/Series architecture. In addition to syntax checking and run-time feedback, FX/Fortran provides optional feedback on the optimization process at the loop, subroutine, or global level. Optimization feedback indicates the degree of vector and parallel optimization attained and provides the user with insight into optional compiler directives and program modifications that further improve performance.

Developers Focus on Compute-Bound Routines—Run-time profiling and call-trace analysis are easily invoked. They quickly highlight the specific routines and loops where time is spent in running the program with actual data. Profiling details time spent at the routine or source-code statement level. Program developers can focus optimization efforts on the code having the greatest potential for improved performance.

Source Language and Assembly Debuggers—To support program development, Alliant provides source language and assembly debuggers. Both operate in the parallel execution environment of FX/Series computers.

The source debugger, dbx, provides an environment that enables program developers to easily explore, display and modify variables within a running program. As the programmer steps through the program, dbx displays the source code, making it easier to monitor execution and isolate bugs.

System Profiling—A system monitor graphically details the percent utilization of all system resources. This powerful tool enables system administrators to quickly "tune" a multi-user system to provide balanced support for large and small production jobs and development activity or to favor one class of jobs in response to user requirements.



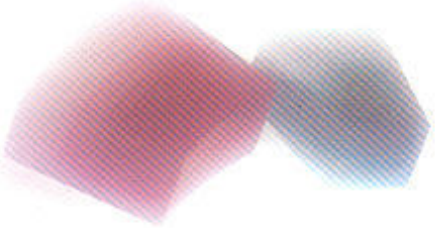
High Speed Global Memory System

Physical memory on Alliant systems is comprised of four-way interleaved modules. Each module supplies the full memory bus bandwidth of 188 MB-per-second on sequential read access (150 MB-per-second on sequential write access). As a result, Alliant systems can operate at peak computational performance with only a small memory complement.

Coherent Cache System—The FX/8 uses two expandable cache systems (a single cache is used on the FX/1) each with an 85-nanosecond cycle time. Both feature a write-back architecture that minimizes memory bus traffic by "writing back" to main memory only when necessary.

Alliant caches maintain coherency to ensure that all processors, CEs and IPs, see a common and accurate view of global memory at all times. Coherency is controlled in hardware, making it possible for an individual job to run efficiently on multiple processors and to migrate between CEs and IPs depending on the class of resource it requires.

376 MB-Per-Second Interconnect—On the FX/8 a crossbar interconnect links the computational processor cache to the CEs. This four by eight address and data switch is implemented in 24 2600-gate gate arrays mounted on the system backplane. It dynamically connects the CEs to the cache at a 376-MB-per-second sustained bandwidth. Each of the CEs can execute at its full 47-MB-per-second bandwidth without memory bus contention. High bandwidth and coherency combine to allow many parallel loops to execute entirely from cache memory.

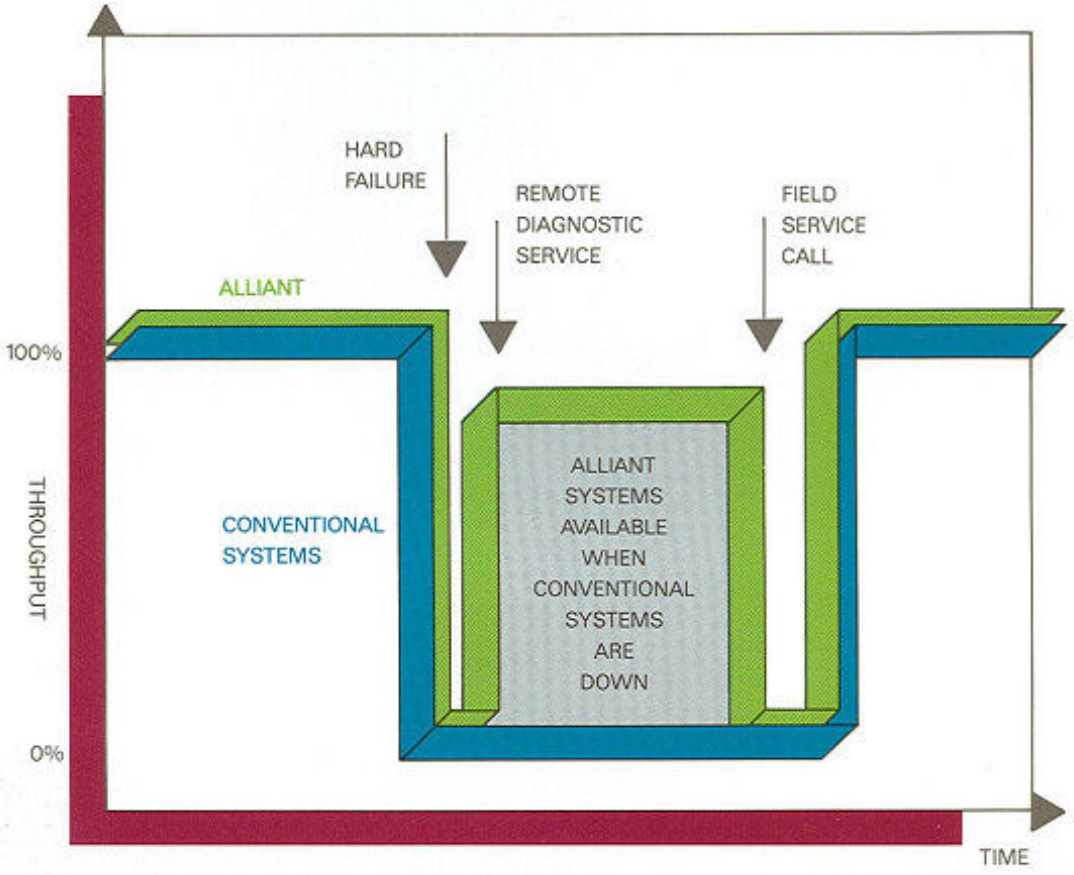


High Availability

Alliant computers have established an availability record in the field of more than 99 per cent. This high availability results from a parallel design that enables faulty modules to be logically disconnected through remote access, making it possible to restart the system quickly after a hard failure.

To support rapid fault isolation, each FX/Series hardware module contains a dedicated diagnostic processor. Each contains registers for fault capture and includes non-volatile memory for storage of diagnostic routines and module/system configuration data. Up to 23 diagnostic processors communicate over an independent system diagnostic bus making it possible to quickly isolate faults with only a small fraction of the hardware operational.

Remote Diagnostics—All Alliant systems support diagnostic sessions, under access control of a front panel switch, that can be invoked locally or remotely under both Diagnostix™ (the Alliant diagnostic operating system) and Concentrix. These sessions minimize system downtime and maintenance costs by giving Alliant personnel direct access for preventive maintenance checks, error log analysis and problem isolation.



Alliant computers can continue to perform useful work when conventional systems would experience hard failures.

The Difference Begins with the Name

Alliant, an early French form of the word alliance, is an expression of our determination to engage our customers in a productive and mutually beneficial relationship.

With this philosophy as a base, Alliant people are committed to delivering the finest quality products and services possible. We intend to be distinguished not only as a technology leader in scientific computing, but also as a responsive and professional business partner.

In this manner, we strive to earn the loyalty of our customers.

Ronald H. Gruner
President, Alliant Computer Systems

The information contained herein is summary in nature and subject to change without notice. More detailed information is available from Alliant.

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Diagnostix	FX/1

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