OVERVIEW OF THE AURAGEN SYSTEM

Introduction
Before today, most business applications were considered too expensive to develop, run and maintain with full fault tolerance. Even when the prohibitive cost of fault tolerance was not a concern, fault tolerant systems did not always perform efficiently in high volume transaction environments.

Now, AURAGEN™ makes fault tolerance a viable choice for all businesses. Recent advances in hardware and software technology have enabled AURAGEN to make a dramatic cost and performance breakthrough in fault tolerant transaction processing.

AURAGEN provides not only affordable fault tolerance with high system performance, but also full function and ease of use.

The AURAGEN 4000 fault tolerant computer uses a 32-bit distributed architecture. AURAGEN fault tolerance is achieved by combining backup hardware with an enhanced UNIX™-based operating system. The AUROS™ operating system provides fast I/O execution speed, file integrity privacy and recovery capabilities. These features make the AURAGEN System ideally suited for handling large transaction processing applications. The System 4000 supports modular growth so it can be configured to meet the changing needs of your business.

AURAGEN offers a comprehensive set of communications capabilities including SNA and X.25. System 4000 is superior to other fault tolerant systems because more of its backup hardware is available to do productive work during normal processing.

The AURAGEN System is designed to minimize the hidden costs of computing. Installation of the System 4000 is simple, fast, and inexpensive; no special computer room is needed. The AURAGEN System 4000 does not require a trained systems operator. Programmer productivity tools speed the development and maintenance of efficient programs. The use of menus and HELP facilities reduces the time and cost associated with end-user training by making the System 4000 easy to learn. On-line diagnostics, correction and dial-up support from AURAGEN service centers simplify system maintenance. The AURAGEN System 4000 fault tolerant computer is a cost-effective alternative to conventional computer systems.
The AURAGEN System Architecture

The AURAGEN System is made up of multiple Motorola 68000's that are grouped in tightly coupled multiprocessor units called Processor Clusters or Clusters. The entry AURAGEN System has two Processor Clusters. Each Processor Cluster consists of an Executive Processor Module, a Work Processor Module and an 1 Mbyte Memory Module. A Processor Cluster can be expanded to contain up to four Disk/Tape Processor Modules, a maximum of four Communications Processor Modules and up to 8 Mbytes of Memory Communications Processors are connected to external devices via Interface Modules.

An AURAGEN System can be expanded from 2 to 32 Clusters. If one Cluster should fail another is immediately available to take over and continue its work. Processors within a Cluster communicate over a 20 Mbyte/ sec Cluster Bus. Clusters are connected via two 16 Mbyte/sec System Buses. If one System Bus fails, Clusters can still communicate over the second System Bus. Disk and tape drives are dual ported to Disk/Tape Processors in different Clusters. If one Disk/Tape Processor fails, the second Disk/Tape Processor can be used to access data. Terminals and line printers are connected to Communications Processors in different Clusters via dual high speed 4 Mbyte/sec Communications Buses. Communications within the AURAGEN System continues even if a Communications Processor or Communications Bus should fail. AURAGEN's backup hardware provides additional computing power during normal operations.

Executive Processor. The AUROS operating system provides automatic fault tolerant computing and runs primarily in the Executive Processor. This processor further supports fault tolerant operations by handling all interprocess and intercluster communication. The Executive Processor is made up of an MC68000 with on-board RAM, and 16 Kbytes of ROM. It also has Cluster Bus and System Bus interface logic, direct memory access control logic, an on-board diagnostic processor, and a message buffer.

Work Processor. User programs execute in the Work Processor. In addition, the Work Processor supports demand pagable virtual memory. This module consists of two MC68010 CPUs, which work simultaneously on separate programs. It also has Cluster Bus interface logic, memory management logic, and an on-board diagnostic processor.
**Memory Module.** A Memory Module contains 1 Mbyte of error checking and correcting RAM, and an on-board diagnostic processor. Each Cluster can contain up to 8 Mbytes of memory with 375 nsec full cycle time.

**Disk/Tape Processor(s).** The Disk/Tape Processor executes all disk and tape commands. This specialized processor contains a high-speed 2901 bit slice processor which provides efficient and flexible access to stored data. It also has an on-board diagnostic processor. A Cluster can have a maximum of four disk/tape processors. Each Disk/Tape Processor can control up to four disk drives at transfer rates of up to 3 Mbytes/sec, and up to four tape drives. Data on the disk drives can be selectively or fully mirrored.

**Communications Processor(s).** The Communications Processor provides modular and flexible fault tolerant communications capabilities. A Communications Processor can control up to 64 lines; each Cluster can contain up to four Communications Processor Modules for a total of 256 lines per Cluster. A fully configured 32-Cluster fault tolerant system can support up to 4,096 lines. The Communications Processor consists of an MC68000 processor with on-board RAM, 16 Kbytes of ROM, Cluster Bus and Communications Bus interface logic, and an on-board diagnostic processor. Other AURAGEN Cluster Processors are offloaded by having a separate Communications Processor dedicated to handling front end processing for terminals, communications lines and local networks.

**Interface Modules.** Communications Processors are connected to Interface Modules by high-speed dual Communications Buses. There are three types of Interface Modules:

- Terminal/Line Module, supporting up to 8 lines
- System Services Module, supporting 2 parallel printer interfaces, a calendar clock, and a remote diagnostics interface
- Local Area Network (LAN) Module, supporting 1 network interface

**Modular Growth Capability**

AURAGEN's distributed architecture provides modular growth. Modules can be added to a Cluster, or Clusters can be added to the system, all while normal operations continue.

Unique processing requirements can be addressed by specific Cluster configurations:

**For additional processing power:**
Clusters can be configured with:
- An Executive Processor
- A Work Processor
- Memory Module(s)

**For additional database power:**
Clusters can be configured with:
- An Executive Processor
- A Work Processor
- Memory Module(s)
- Disk/Tape Processor(s)

**For additional communications:**
Clusters can be configured with:
- An Executive Processor
- A Work Processor
- Memory Module(s)
- Communications Processor(s)

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**AURAGEN System 4000 Architecture.**
AUROS Interprocess and Intercluster Communication.

**AUROS Operating System**

AUROS is the AURAGEN operating system. It was derived from and is compatible with UNIX System III, a multi-user, multi-process operating system. AUROS has been enhanced to provide distributed multi-processing capabilities and fault tolerance. AUROS will support up to 32 Clusters running as many as 256 concurrent tasks per Cluster. File management and system management services have been separated from the AUROS kernel. Separate file servers and screen servers allow different AURAGEN Clusters to be specialized to handle different processes (e.g., I/O) and backend processes (e.g., database functions). The performance of multiple Clusters in an AURAGEN System can be optimized for handling large transaction applications by using these separate AUROS servers to support distributed front-end and back-end processing. The flexibility of the AURAGEN architecture enables the system to be easily configured with or without this Cluster specialization.

Other AURAGEN enhancements to AUROS include:

- Adding new system calls to gain higher performance in commercial transaction environments
- Providing full fault tolerance by integrating AURAGEN's highly efficient Message System with the kernel. Programs that run under UNIX System III will run in fault tolerant mode on the AURAGEN System without modification.
- Enhancing the file system to preserve the integrity of user files in the event of a crash
- Implementing demand page virtual memory which allows all user programs running on a single Cluster to address up to 32 Mbytes of virtual memory
- Providing the AUROS Visual Interface™ (AVI™), which allows users to perform various file manipulation and programming operations with function keys and cursor movement keys
- Offering AUROSHELL™ a user-friendly command mode that supports both standard UNIX and AUROS commands

**Fault Tolerance**

AURAGEN's multiple Cluster architecture and the AUROS operating system support full fault tolerance. Every primary process (executing program) running under AUROS in one of AURAGEN's Clusters has a backup copy in a different Cluster. The backup is capable of continuing processing if the primary fails. AURAGEN fault tolerance is transparent to both end-users and programmers. No special knowledge is needed to write and run AURAGEN fault tolerant programs.

The AURAGEN System 4000 maintains backup processes more efficiently than any other fault tolerant system. The AURAGEN backup scheme works in the following manner: AUROS runs in the Executive Processor of each Cluster. The Message System, which is a part of AUROS, automatically creates a backup copy of every executing program. This backup program does not execute — it simply receives and saves messages sent by the Message System. These messages contain the same information that was sent to the executing primary process. If the primary fails, the backup can re-create and continue the work of the primary by processing its stored messages. The Message System assures that backups read the available messages in exactly the same order as the primary. The Message System also ensures that when a backup process begins executing, it does not resend any messages already sent by the primary. AUROS backup hardware can do productive work during normal operation because the Message System uses only a minimal amount of system resources to manage messages for backup processes.
**Programmer Productivity**

AURAGEN has made available a wide range of tools designed to increase programmer productivity. They permit sophisticated fault tolerant, interactive applications to be easily generated.

**Screen Manager**

The AURAGEN Screen Manager allows users with no programming skills to quickly create complex displays. Users merely "draw" the desired screen format interactively and specify input and output fields by name and attribute. The Screen Manager automatically generates a screen template that high level language application programs can call with simple screen READ and WRITE statements.

**Menu System**

The AURAGEN Menu System provides a user interface that both experienced and non-technical users will find easy to learn and use. The Menu System also provides tools to simplify the design and implementation of fully menu-driven applications.

**Database Management System**

AURAGEN's database manager, AURELATE™, is a powerful yet easy to use relational database system. AURELATE organizes data in a logical way and stores information independent of data access strategies. New applications can be supported, and new information can be added without reorganizing the database or changing existing programs. SOL is AURELATE's high level, English-like query language. SOL maintains full compatibility with the query language used by IBM's relational database manager, SQL/DS. Inexperienced programmers will quickly learn how to do sophisticated database manipulations with simple AURELATE statements.

**Transaction Processing Management System**

The AURAGEN Transaction Processing Management System (TPMS) speeds the development and maintenance of efficient, high volume transaction processing applications. Small programs written to deal with single transactions in single user environments are integrated by TPMS into complex, high performance, multi-user applications.

**Productivity Tools**

AUROS supports the full complement of UNIX utilities including:
- The Programmers Workbench, which was designed to improve programming productivity and the quality of programmers' work
- File and string manipulation programs, that sort and check files, as well as check string content and correct file errors for database manipulation
- Text editors and document formatting packages

In addition, AURAGEN provides:
- Complete spooling capabilities
- Spread sheet manipulation
- Word processing

**Languages**

The AURAGEN System provides a full range of languages (with compilers, source debuggers, and runtime libraries) which automatically generate fault tolerant programs. These include:
- C, the language of the AUROS operating system
- ANSI 74 High Level COBOL, including interpreter
- ANSI 77 Standard FORTRAN
- Pascal, conforming to proposed ISO Standard with extensions similar to those in the UCSD Pascal system
- BASIC PLUS, a powerful BASIC interpreter

AURAGEN Transaction Processing Management System.
AURELATE Views control users' access to data stored in the database

Data Integrity
AUREGEN recognizes the importance of maintaining the integrity of data stored in the system. In the unlikely event of a system crash, the enhanced AUROS file system ensures that no files are lost. If a power failure occurs, the System 4000 battery backup keeps all system electronics and one disk running for three minutes — long enough to write all data stored in memory to the disk so that no data will be lost. Further data integrity is provided by mirrored files. Files can be selectively written on two disks. If one disk fails, the mirrored file can still be read from the other disk. Each disk drive in the AUREGEN System is connected to two clusters. If one cluster fails, a disk can still be accessed through its second connection. AURELATE, AUREGEN's relational database management system, provides several features designed to support data integrity. Transaction failback ensures consistent data even if a user fails to complete a transaction or if an unreliable transaction program crashes. This is accomplished by updating the database only when a transaction completes. Rollback allows the reconstruction of an entire database from a journal file. This facility guarantees that no data will be lost even if a catastrophic system crash would occur. AURELATE also provides concurrency control. Data remains consistent even when multiple users simultaneously update the same database.

Privacy and Security
Privacy and security on the AUREGEN System are achieved through:
- AUROS and AURELATE logon passwords
- AURELATE views, providing windows through which individual users are restricted to access only selected portions of a database
- File encryption
- Specification of user restricted menu privileges
- Definition of read, write and execute file permissions for individual users and groups of users

Service and Support
AUREGEN extends its philosophy of ease of use to its service and maintenance program by combining customer diagnostic and maintenance procedures with AUREGEN maintenance and support services. Thirty percent of the System 4000 circuitry is dedicated to on-line error detection and correction. All of AUREGEN's automatic diagnostic procedures can be performed while normal processing is occurring. AUREGEN diagnostics include:

- **SYSTEM INITIALIZATION TESTS**—run from ROM by the Executive Disk/Tape and Communications Processors. Contained in 4 Kbytes of ROM on each board, these tests exercise the CPU, ROM, RAM, board logic, buses, Work Processors, and main memory.

- **SYSTEM TESTS**—thorough tests of all Clusters that are run prior to starting user processes

- **ON-LINE DIAGNOSTICS**—constant monitoring and exercising of all system electronics

- **COMMUNICATIONS DIAGNOSTICS**—allow operators to test communication lines by sending test messages, or running the line in loopback mode

- **ON-BOARD DIAGNOSTIC PROCESSORS**—automatically diagnose and record on-board hard and soft errors for subsequent readout by AUREGEN field service technicians, also localize any hardware fault in a suspect Cluster

- **ERROR LOGGING**—each Cluster reports both hard and soft errors to a "system doctor" which logs all errors. The system doctor, under local, remote, or system control can order diagnostics to be run in suspect Clusters and can report errors to the user.

- **REMOTE DIAGNOSTICS**—AUREGEN's centralized service center can dial in and run extensive tests while the system continues to run. The System 4000 automatically dials out to the AUREGEN service center whenever the system detects a fault. New versions of system software can be remotely installed.

AUREGEN's modular design allows either a user or a service representative to replace faulty hardware components while normal processing continues.
Communications/Networking
The AURAGEN System supports a full array of communications devices, protocols, and networking facilities and extends fault tolerance to AURAGEN peripherals. The following protocols are supported:
- Asynchronous: RS232 and RS422
- Bisync: ASCII, IBM's EBCDIC, transparent EBCDIC
- RJE: 2780/3780 and HASP/IES
- HDLC and SDL
AURAGEN also supports networking facilities including:
- AURAGEN's private network, a TCP/IP based network
- SNA
- X.25, Telnet certified
- IEEE 802 standard local area networks, including Ethernet™
- Remote File System

PERIPHERALS

Disk
The AURAGEN System provides a full range of Winchester disk drives. Formatted disk capacities are available at 76, 152, 302, and 448 Mbytes.

Tape
A tape drive to back up disks and for archiving is available at:
- transfer rates from 40 Kbytes/sec in start/stop mode to 160 Kbytes/sec in streaming mode
- optional start/stop emulation up to 380 Kbytes/sec

TERMINALS
AURAGEN provides an ergonomically designed intelligent display terminal. It contains:
- An MC68008 CPU
- 32 to 128 Kbytes of RAM
- 512 bytes of non-volatile RAM (2048 bytes optional)
- A real time clock
This terminal is downline loadable. Programs can execute locally and data can be stored within the terminal. This enhances system performance by increasing processing speed at the terminal and offloading the host. AURAGEN also supports industry standard terminal devices.

PRINTERS
AURAGEN provides a full range of printers:
- Letter quality printers at 45 cps
- Dot matrix printers at up to 200 cps
- Line printers at 600, 1200, and 1800 lpm
**SPECIFICATIONS**

**EXECUTIVE PROCESSOR**
- Processor: MC68000
- Clock Rate: 8 MHz
- Local Memory: 128 kilobytes RAM with parity
- Message Buffer Size: 8 kilobytes
- Diagnostics: On-board diagnostic processor

**WORK PROCESSOR**
- Processor: Two MC68000s
- Clock Rate: 8 MHz
- Memory Management: Demand paged virtual memory
- Diagnostics: On-board diagnostic processor

**MEMORY**
- Size: Up to 8 Megabytes per Cluster
- Addressing Modes: Longword (32 bit), Word (16 bit)
- Cycle Time: 375 nsec
- Error Handling: Single bit error correction & double bit detection
- Diagnostics: On-board diagnostic processor

**DISK/TAPE PROCESSOR**
- Local Memory: 8 kilobytes RAM
- Processor: 2500 bit/sec
- Transfer Rate: 3 Megabytes/sec
- Diagnostics: On-board diagnostic processor

**COMMUNICATIONS PROCESSOR**
- Processor: MC68000
- Local Memory: 128 kilobytes RAM
- Clock Rate: 8 MHz
- Diagnostics: On-board diagnostic processor

**BUSES**
- Transfer Rate: Two 40 Megabytes/sec, 32 Megabytes/sec aggregate
- System Bus: 20 Megabytes/sec
- Cluster Bus: 4 Megabytes/sec

**DISK**
- Technology: Winchester fixed
- Ulimitation: 84 / 168 / 336 / 474
- Disk (Mbytes): 70 / 152 / 302 / 466
- Formatted Disk (Mbytes): 12 / 10 / 10 / 10
- Transfer Rate: 20 / 27 / 27 / 18
- Average Seek Time (ms/sec): 20 / 39 / 39 / 27
- Average Access Time (ms/sec): Interface: SMIG SMIG SMIG SMIG

**TAPE**
- TAPE VEL (Kbps) DENSITY (Kbps/sec) TRANSFER RATE (Kbps/sec)
  - Streaming Mode: 20 / 3200 / 160
  - Start/Stop Mode: 25 / 3200 / 80
  - End/Start (Cache Emulation)
  - Emulated tapec: 25-240 Kbps/sec
  - Emulated transfer rates: 40-500 Kbps/sec

**PRINTER**
- Letter Quality: 46 cpm
- Interface: RS232/Centronics parallel
- Dot Matrix: 200 cps draft mode
- 90 cps correspondence mode
- Interface: RS232
- Line Printer: 600/1200 and 1600 lpm
- Interface: Dataprinter

**TERMINALS**
- Processor: MC6809
- Local & Non-Local: 32 kilobytes of 128 kilobytes RAM
- Memory: 32 kilobytes non-volatile RAM
- Real-time clock

**CONFIGURABILITY**
- Each system consists of 2 or more Processor Clusters.
- Every Processor Cluster must have at least:
  - AN EXECUTIVE PROCESSOR
  - A WORK PROCESSOR
  - 1 Mode I/M ONLY

**POWER REQUIREMENTS**
- 115 VAC 230 VAC
- Line Voltage: 115 VAC ± 10% 230 VAC ± 10%
- Line Frequency: 60 Hz ± 1% 50 Hz ± 1%
- Backup: Battery backup provided
- Current (Max): 30A 15A

**PHYSICAL CHARACTERISTICS**
- Processor Cabinet & Peripherals Cabinet
  - Width: 22.8 in.
  - Height: 12.3 in.
  - Depth: 156 cm
  - Weight (CPU): 12.7 lbs.
  - Weight (Peripheral): 198 lbs.
  - Max. Height (Peripheral): 255.6 W
  - Max. Horizontal (Peripheral): 175.0 W

Direct Sales and Service in U.S.A. are available from:

Auragen Systems Corp.
Two Executive Drive, Fort Lee, N.J. 07024 (201) 461-3400

**EASE OF USE**
**AUROS / UNIX**
**COMMUNICATIONS**
**MODULAR GROWTH**
**HIGH PERFORMANCE**
**PRODUCTIVITY TOOLS**

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