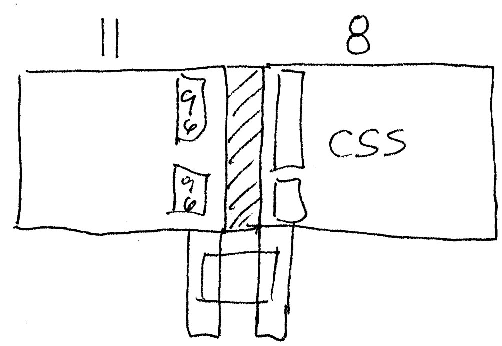
Arix Corporation

System90 Hardware Description

19 September 1988



1. Arix System90 Hardware Description

1.1 General

This document is intended as a technical overview of the Arix System90. It identifies the major hardware components of the system and describes their function. Additional documents detail the function and operation of the major system components.

1.2 System90 Overview

The Arix System90 is a high performance general purpose computer system. The system is intended to enhance Arix's position as a vendor of high performance on-line multiprocessor UNIX systems.

The system logic is composed of a computational subsystem and an I/O subsystem. The computational subsystem is newly designed specifically for the System90 while the I/O subsystem is largely retained from the A1000 family.

The system is packaged in a series of 22" wide modular cabinets. The primary cabinet contains the computational subsystem. Additional cabinets contain either I/O subsystems or peripherals.

1.3 Related Documents

The following related documents detail the hardware operation of various major system components.

S90 System Busses - Functional Description
S90 Service Processor Module - Functional Description
S90 68020 Processor Module - Functional Description
S90 Memory Module - Functional Description
S90 I/O Module - Functional Description
S90 A1000 I/O Adaptor - Functional Description

2. Computational Subsystem

The System90 Computational Subsystem (CSS) consists of a cluster of tightly coupled processors and memory modules on a high speed system bus. Also in the CSS are I/O modules which adapt the main system bus to I/O buses.

The major components of the CSS are the Processor Modules, Memory Modules, I/O Modules, Service Processor Module, CSS Arbiter, and CSS backplane.

2.1 CSS Bus

The CSS bus is the backbone of the System90. It is a 64 bit wide, high speed synchronous data transfer bus. It is designed to accommodate up to 16 modules; either Processor Modules, Memory Modules, or I/O Modules.

The CSS bus is implemented as an N-port time division multiplexed transmission switch. The bus supports read and write operations between all attached modules. Read operations transfer 64 bits and write operations transfer up to 32 bits. The bus supports concurrent operations to and from the modules on the bus. This allows overlapping cycles on individual modules and provides enough bus bandwidth to minimize contention for this system resource. This allows the support of multiple high performance processors with near linear incremental performance as each processor is added. The bus is used only for issuing a command for an operation to occur and for returning a response to that command.

The CSS bus is a synchronous bus that is designed to clock at 20 MHz creating a fundamental time division of 50 nS. This allows 20 million bus operations per second.

A write operation uses a single bus cycle allowing write throughput of 80 Mbytes per second. The bus supports single and burst transfer deferred read responses. Thirty-two byte burst read operations use a single bus cycle to initiate a read operation and four cycles to return the read response. This allows a 128 Mbyte per second read transfer rate.

The CSS bus supports end-to-end transmission checking on each bus operation. Transmission checks are performed by the each destination module to detect errors on address, data, and control fields.

2.2 CSS Bus Arbiter

The CSS Bus Arbiter is a module that provides the control for the CSS bus. It is responsible for the arbitration of the CSS bus as well as system clock generation. The CBA collects requests for use of the bus from all elements and grants use on each bus clock tick.

The CSS Bus Arbiter is implemented as a separate printed circuit card that attaches to the CSS motherboard.

2.3 CSS Backplane

The system backplane is the system bus motherboard that distributes bus signals between modules of the CSS and A1000 I/O controllers. It also provides DC power distribution to the cards.

There are two types of system backplanes. The first accommodates 16 CSS modules; either Processor Modules, Memory Modules, or I/O Modules and a Service Processor Module. The second is a hybrid accommodating 8 CSS modules; either Processor Modules, Memory Modules, or I/O Modules and a Service Processor Module ; and also accommodating 11 A1000 I/O controllers.

2.4 68020 Processor Module

The Processor Module (PM) is the main computational element within the CSS. It is based on a 25 MHz Motorola 68020 32 bit microprocessor and 12.5 through 25 MHz 68881 floating point unit (FPU).

The PM includes a proprietary memory management unit (MMU) which is well suited for demand paged virtual memory implementation in a multiple processor environment. The MMU is optimized for rapid context switching in a multi-processor environment by sharing system memory resident page maps and caching entries in a 1024 entry TLB. The MMU support access permission enforcement and paging statistics on each page.

The PM also includes a 64KB on-board virtual cache memory. It is organized as a single direct mapped set organized as 4096 sixteen byte lines. This cache provides no-wait-state performance. A 98% read hit ratio is anticipated.

2.5 Memory Module

The Memory Module (MM) is the main system storage element of the CSS. It provides from 8 to 32 MB of storage by populating one, two, or four banks.

The MM supports single or burst mode 64 bit reads. Burst sizes are 16 and 32 bytes. It also supports 8, 16, 24, and 32 bit writes.

The board provides high throughput by allowing two way interleaving between banks. Also page interleaving across multiple memory modules, to further enhance throughput, is supported.

The MM is designed with 1 Mbit dynamic RAM but will also accommodate 4 Mbit devices as they become readily available. It uses VLSI error detection and correction using a modified 7 bit hamming code which corrects all single bits errors and detects all double bit and many multiple bit errors.

2.6 Service Processor Module

The Service Processor Module (SPM) provides the central console interface, interrupt dispatcher, CSS bus error registers, system environmental monitoring, time of day clock, nonvolatile storage, and the floppy disk interface.

The central console interface includes console port, remote diagnostics port, hard copy console port, and remote UPS interface. This interface is the primary interface for manufacturing and field diagnostics.

The SPM provides a system wide interrupt dispatcher that collects system interrupts distributes them to all Processor Modules within the CSS. The SPM supports the notion of "directed" and "non-directed" interrupts. Directed interrupts are point-to-point interrupts where the sender specifies the intended receiver. Non-directed interrupts and "fairly" distributed across all processors.

The SPM contains logic which monitors each CSS bus operation checking for invalid transmissions and bus protocol violations. Error status relevant error information is saved for reporting. This aids in isolation and correction failed system components.

Environmental interfaces continually sample DC voltages and internal system temperatures. This allows diagnostic and runtime software to respond to abnormal or dangerous operating conditions.

The Service Processor interfaces to the Real World Interface board, which contains the system console port, the remote diagnostic port, the UPS interface port, the system DC power interfaces, the system AC power interfaces, the system environmental status monitors, and the front panel interface.

2.7 I/O Module

The I/O Module (IOM) is an adaptor between the CSS bus and an I/O bus. It provides DMA routing from the I/O Link to the CSS bus.

The IOM is a fast bidirectional data transfer FIFO connecting the CSS bus and the I/O Link. Each IOM is capable of up to 25 Mbytes per second transfer rates.

The IOM also contains fault status logic to detect I/O Link and CSS bus errors and capture useful fault information.

2.8 CSS Configurations

The CSS can be configured with mixes of the above boards to best meet particular requirements of a given system application. Below is a matrix showing minimum, optimal maximum, and physical maximum numbers of modules allowed in a configuration.

Minimum is the number of a given board that is required to run a minimal system configuration. Optimal is what is considered to be a reasonable maximum configuration for commercial applications.

16 Slot Compute Subsystem.		
	Min	Optimal
Processor Module	1	8
Memory Module	1	4
Service Processor Module	1	1
I/O Module	1	2
8 Slot Compute + 11 Slot I/O		
Processor Module	1	4
Memory Module	1	2
Service Processor Module	1	1
I/O Module	1	1
I/O Adaptor	1	1
EDT or SCSI Controller	1	2
GC-16 IOCP	0	6
Multibus/Ethernet	0	1

Several restrictions and guidelines apply to system configurations.

3. I/O Subsystem

An I/O Subsystem (IOSS) of the System90 consists of an I/O Link, an I/O adaptor, a I/O backplane, and a variety of I/O processors.

The I/O Link is a generic bus interface between the CSS bus and specific system I/O busses. The I/O Link protocols are similar to those of the CSS bus.

The I/O adaptor is a card that adapts the I/O Link to the particular characteristics of the I/O bus. The I/O backplane carries bus signals between the I/O processors and the I/O bus adaptor. The I/O processors are intelligent device and peripheral controllers.

3.1 I/O Link

The I/O Link (IOL) is 32 bit time division multiplexed bus that provides an interconnect between I/O modules and I/O adaptors. It is intended to be generic and allow connectivity to different varieties of I/O adaptors.

The IOL is a synchronous bus which is designed to clock every 100 nS. By multiplexing addresses and data on the bus, a peak transfer rate of 25 MB per second is achieved.

3.2 A1000 I/O Adaptor

The A1000 I/O Adaptor (IOA) provides an adaptation between the generic I/O Link and the A1000 I/O buses (the ICB and the DTB). This is the only IOA that will initially be supported in the System90.

3.3 A1000 I/O Backplane

The A1000 I/O Backplane carries ICB and DTB signals between the A1000 I/O Adaptor and the A1000 I/O controllers. It also provides DC power distribution to those controllers.

The backplane accommodates 20 cards which allows a single I/O adaptor and up to 19 I/O controllers.

3.4 Industry Standard Bus Interface

It is intended that an industry standard bus interface (ie - VME32) be supported within the System90. This is possible by developing an additional I/O Adaptor that adapts the I/O Link with the specific industry standard bus.

Additional industry standard bus interfaces are not currently planned in the initial System90, however accommodations have been made to allow this in the future.

3.5 I/O Control Processors

The System90 I/O subsystem is based on controllers and peripherals from the A1000 family. These I/O controllers include disk, tape, serial communication, parallel communications controllers. Also included is a Multibus adaptor adapting A1000 busses to the IEEE-796 bus. The I/O control processors (IOCP) are intelligent devices allowing a high degree of distributed I/O processing.

3.5.1 Enhanced Disk Tape IOCP

The Enhanced Disk Tape IOCP (EDT) is a high performance Disk and Tape controller. It provides a 2.4 MB/S ESMD interface and supports tape interface to either QIC or Pertec devices.

The EDT itself is a 68000 based controller with 256 KB of local memory. It has a SMD disk data channel and a parallel tape interface that can be adapted to either cartridge tape drives or nine track drives. The EDT communicates with the system through the A1000 ICB and A1000 DTB.

The EDT interfaces to one of two interface cards. The Dual Port interface (DP/IF) allows connection to 4 ESMD devices and a single QIC interface. This allows support of high performance disks and streaming cartridge tape devices. The 9 Track interface (9T/IF) connects to 4 ESMD devices and a single Pertec interface. This allows support of high performance disks while supporting half inch (9 track) tape devices.

3.5.2 Enhanced General Communications IOCP

The Enhanced General Communications IOCP (EGC) is a medium performance serial and parallel communications controller. It provides interface to 8 serial channels, 2 of which can be synchronous, and a single parallel port.

The EGC is based on a 10 MHz 68000 processor and provides either 512 KB or 1 MB of local RAM. The EGC attaches to the I/O system through the A1000 ICB only.

The EGC interfaces to the General Communications interface card (GC/IF). This card allows interfacing to 8 RS-232 ports (two of which have full complement of signals to support synchronous operation) and a Centronics compatible parallel printer port.

3.5.3 Multibus Adaptor

The Multibus Adaptor Card (MAC) provides an interface from the A1000 I/O system to IEEE-796 bus (Multibus). The MAC is a "dumb" interface device providing only a shared buffer memory area between the central processors and the Multibus card.

The MAC interfaces to the A1000 I/O system through the ICB only.

3.5.4 Sixteen Channel General Communications IOCP

The Sixteen Channel General Communications IOCP (GC16) is a high performance communications controller supporting serial interfaces. It supports up to 16 serial channels.

Two interface cards are available for the GC16/IOCP. One interface card provides an interface to 14 asynchronous RS-232 ports on RJ-12 connectors and 2 synchronous RS-232 ports on DB-15 connectors. The second interface provides 4 RS-422 ports.

The GC16/IOCP is a 68020 based controller. It attached to the I/O system through the ICB only.

3.5.5 SCSI IOCP

The SCSI IOCP is a high performance peripheral controller supporting the Small Computer Systems Interface and the QIC-02 interface. The SCSI IOCP is a 68000 based controller with 256 KB of local memory. It supports two SCSI channels, each of which can accommodate up to 7 peripheral devices. Each channel can be configured for Single Ended or Differential operation. Each channel runs in Asynchronous mode at up to 6 MB (Burst) and in Synchronous mode at up to 5 MB (Burst). Actual rates will depend on the attached peripheral. The SCSI IOCP communicates with the system through the A1000 ICB and A1000 DTB.

The SCSI interface will be the one of choice for supporting tape drives, optical drives, and large arrays of 5-1/4 inch and 3-1/2 inch disks.

4. Peripherals

Various on-line and archival storage devices are supported by the System90. High capacity, high performance ESMD disk drives provide on-line main system storage. Quarter inch cartridge tape drives provide low performance and low to medium capacity archival storage. Half inch tape drives provide low to high performance and capacity archival storage. Optical disks provide very high capacity archival capability.

In general, the same peripherals offers in the A1000 system will be applicable to the System90. Peripherals devices that will be obsoleted in the A1000 within the next year will not be supported on the System90.

4.1 Magnetic Disk Storage

Hard magnetic disk storage is provided for on-line main system storage and a low cost, low performance floppy disk drive is provided for IPL and software update purposes.

4.1.1 Hard Disk Storage

The System90 supports 8 inch ESMD interface magnetic disk devices and 5-1/4 inch SCSI interface devices.

The 8 inch ESMD drives are mounted in an 8 inch Disk module. Each module contains up to two drives of 824 MB or 337 MB unformatted capacity, and the necessary power and cooling for these two drives. The module is supplied with AC power from the System90 AC power network. Up to 4 of these modules may be mounted in a System90 Peripheral Cabinet, and a single module may be mounted in each of the System90 logic cabinets.

Support for 5-1/4 inch SCSI drives comes in two forms. The first is support within each of the System90 logic cabinets for up to 4 5-1/4 inch SCSI disks of 380 MB unformatted capacity. Each logic cabinet contains all the power, cooling and cabling for these 4 disk drives. The drives are mounted in modules for enhanced ruggedness and ease of removal and installation. Each module contains one disk drive and associated cabling and shock mounting. The module is removed or installed in the system by simply sliding in or out from the front and attaching/releasing with two screws. The section of the System90 which supports 4 of these modules is called the removable media module and is designed to accommodate devices which need operator access for the removal and installation of media such as 1/4 inch tape, as well as these 5-1/4 inch hard disk drives. In the logic cabinet which contains the compute subsystem, one of these 4 module slots is occupied by the floppy disk and quarter inch cartridge tape drives, leaving 3 for the disk drives.

The second form of 5-1/4 inch SCSI drive support is a module which contains up to 6 of the 5-1/4 inch SCSI disks of 380 MB unformatted capacity. This module provides all the power, cooling and cabling for the drives, and may contain an optional differential SCSI adaptor to provide long electrical cable runs in a large system installation. Up to 4 of these modules may be installed in a System90 peripheral cabinet, and up to 1 of these modules may be installed in a System90 logic cabinet instead of the ESMD module. The module supports up to 2 SCSI busses, and the module can be configured such that all 6 SCSI disks reside on one bus, or such that up to 3 SCSI disks can reside on each of the 2 busses. AC power for the module is supplied by the System90 AC power network. This module will not be available in the initial release of System90.

4.1.2 Floppy Disk Storage

A low performance 5-1/4 inch floppy disk drive is provided for diagnostic use and software updates. It is accessible only by the SPM and is not available as a standard I/O device. The drive is located in the cabinet containing the CSS.

4.2 Tape Storage

Magnetic tape storage is provided for archival purposes. An inexpensive, low performance cartridge drive and higher performance half inch drives are provided.

4.2.1 Cartridge Tape

Quarter inch cartridge tape is provided for low priced, low performance backup. Streaming tape drives using the QIC-02 interface support up to 150 MB of storage are used. Internally the drives utilize the QIC-36 device level interface. Data is written to tape in the QIC-150 or QIC-120 format depending upon the cartridge type used and the density is automatically selected by the drive. Tapes written in QIC-150, QIC-120, and QIC-24 formats can be read by the tape drive.

The cartridge tape drive and the floppy disk drive will be located together in a single 5-1/4 inch Module and will be located in the rightmost slot of the Removable Media Module in the Compute Subsystem cabinet.

4.2.2 Half Inch Tape

Half inch 9 track tape is provided for standard media interchange and high performance archiving. Two half inch drives are supported. The first is a medium performance front loading device suited to standard media interchange and moderately demanding back-up performance. The second is a high performance front loading device for demanding back-up performance.

The low performance device is the Cipher 891 and is available with the initian System90 release.

The high performance device is SCSI based, and supports recording densities of 800 BPI (NRZI), 1600 BPI (PE), 3200 BPI (DDPE), and 6250 BPI (GCR). This device is NOT available in the initial System90 release.

4.3 Optical Disk Storage

Optical disk storage is provided for very high capacity archival and on-line storage. Each optical disk device stores 1 Gigabyte on each side of a removable cartridge. The optical disk is SCSI based and will be supported by the SCSI IOCP on a SCSI channel configured in differential mode. This peripheral is not available in the initial release of th eSystem90. Up to 4 optical drives can be installed in a System90 peripheral cabinet.

5. System Package

Consistent with the concept of system scalability and configurability, the system packaging is modular and easily configured. All major subsystems and peripherals are installed as modules. Although internal subsystems and peripherals are configured modularly, the entire system package remains a single integrated system.

This modular approach is intended to provide greatest system configurability, ease of manufacture, and ease of service.

The system is packaged in a series of 22" wide modular cabinets. The primary cabinet contains the computational subsystem. Additional cabinets may contain either I/O subsystems or peripherals. The system can expand to a maximum of 7 cabinets. Each modular cabinet can be configured in one of 4 basic modes; a 16 slot compute subsystem, a 20 slot A1000 I/O subsystem, or combined 8 slot compute with 11 slot A1000 I/O Subsystems and 4 slot peripheral cabinet.

5.1 Cabinet

The cabinet is based on standard 19 inch NEMA rack width. It serves as the external shell for the internal modules.

The system can be configured from one to seven cabinets, with a maximum of one cabinet containing compute subsystem logic, and a maximum of 4 cabinets containing I/O subsystem logic. Each logic based cabinet contains the power and cooling for any of the three types of card cages and for four 5-1/4 inch peripherals. A multi-cabinet system is physically a single unit, when installed in the customer site, with all cabling contained within the system. The cabinets will be shipped as individual units and assembled at the end use site by trained installation engineers.

The dimensions of a single cabinet are: 47" H x 22" W x 37.75" D. When multiple cabinets are assembled there is a spacer of approximately 2" between each of them.

The following are the major system sub-assemblies within the system cabinet.

5.2 CCM 8-CSS/11-A1000

The 8-CSS/11-A1000 Card Cage Module (CCM) is a unit which mounts in the main or Compute cabinet. It contains the backplane, Arbiter, cooling, mechanical support and attachment for up to 8 CSS type cards and up to 11 A1000 type cards.

5.3 CCM 20-A1000

The 20-A1000 Card Cage Module (CCM) is a unit that mounts in the I/O subsystem cabinet. It contains the backplane, cooling, mechanical support and attachment for up to

20 A1000 type cards.

5.4 CCM 16-CSS

The 16-CSS card cage module (CCM) is a unit that mounts in the main or compute cabinet. It contains the backplane, Arbiter, cooling, mechanical support and attachment for up to 16 CSS type cards.

5.5 Power Supply Module

The Power Supply Module (PSM) contains system power supplies and control components. The Power Supply Module mounts in the top portion of a logic cabinet and supplies all dc power for circuit cards mounted within that cabinet, and for all peripherals mounted in that cabinets Removable Media Module (RMM).

The PSM comes in two types, one for mounting in the Compute Subsystem (CSS) cabinet, and one for mounting in all other logic cabinets. The CSS type PSM has an additional small power supply which supplies power to a portion of the Service Processor and Real World Interface even when the system is powered off at the front panel. This is to accommodate system level features such as remote power up and down.

5.6 AC Module

The AC Module (ACM) provides filtering, switching and distribution for the AC in a cabinet. It is located in the lower rear of each cabinet, below the cable trough. The main system circuit breaker is located in the ACM and is accessible at the rear of the system just above the line cord. The circuit breaker is rated at 30 amps.

5.7 Peripherals

Peripherals can be mounted in both the logic cabinets and the peripheral cabinets.

5.7.1 Removable Media Module

Logic cabinets can accommodate up to four 5-1/4 inch peripherals in the Removable Media Module (RMM). This module is a mandatory unit in each logic cabinet, and provides power and cooling for all four peripherals. It is located in front of the PSM at the top of the system and is accessible behind the top, front door. The main logic cabinet (the CSS cabinet) comes with one of the RMM slots occupied by a 1/2 high floppy disk and a 1/2 high 1/4 inch streaming tape drive of 150 MB capacity. All slots in the RMM are cabled and configured for SCSI peripherals, with a full high 380 MB hard disk available with the initial release of the System90.

5.7.2 Peripheral Expansion Cabinet

Peripheral cabinets can accommodate up to 4 peripheral modules. The peripheral cabinet is divided into 4 sections, each of which accepts a single peripheral module. Each of the sections sections are 7 inches high and accommodate an Arix standard peripheral module. All peripherals installed occupy one or more of the 7" sections. A front loading 9 track tape drive is approximately 10" high and requires a filler panel and will utilize 2 full 7" sections.

All peripheral modules require AC power from the ACM as all contain their own DC power supplies. They are also self cooled so that no extra cooling fans are required in the cabinet.

The disk modules contain a power supply, fans, and all power and signal cabling for installation and connection to the I/O subsystem. The tape drive has an integral cable retractor for ease of service, it may be extended while powered and operating. The tape drive is an AC powered device and comes with all power and signal cabling for installation and connection to the I/O subsystem.

All cabling from controllers to peripherals is contained in a cable trough at the rear of the system. All cabling is internal to the system and no external cables are required for peripherals installed in a system cabinet. This greatly improves the system's appearance and accessibility from the rear for service.

Modules available in the initial release are the dual 8 inch SMD disk drive module and the Cipher 9 track tape drive.

5.8 Configurations

A minimally configured system may be completely contained in a single cabinet. A maximum system consists of up to 7 cabinets including up to 5 cabinets with backplanes of various types.

The following diagram illustrates the possible combinations.

Cabinet 7	Cabinet 6	Cabinet 5	Cabinet 1	Cabinet 2	Cabinet 3	Cabinet 4
PERIPH EXP ONLY	CCM-20 OR PERIPH EXP	CCM-20 OR PERIPH EXP	CCM-8/11 OR CCM-16	CCM-20 OR PERIPH EXP	CCM-20 OR PERIPH EXP	PERIPH EXP ONLY EXP

Notice that the first cabinet is in the center and that the system builds outward from the center. There is no restriction on whether the system builds to the right or left initially. The CCM-20 backplanes must be immediately adjacent to the CSS backplane; no peripheral expansion units may be placed between any cabinets containing backplanes.

Cabling for peripherals is routed from a controller to a peripheral either in the same cabinet as the controller or to an expansion cabinet outboard of the one in which the controller resides. For example, it is not allowed to run a cable from Cabinet 2 to Cabinet 5, 6 or 7 in the above configuration.

6. System Control

System control consists of an operator's panel and a system console terminal.

6.1 Front Panel

The front panel is the operator access to power the system up and down. It also is used to manually reset the system. A light is present that indicates the system is up and running. A full system status is read from the system console.

6.1.1 Front Panel Control Keyswitch

The front panel consists of a keyswitch and two indicator lights. The keyswitch performs power on, power off, and system manual reset. This protects the system from unauthorized or inadvertent access as a key is required. The keyswitch positions are read and interpreted by the SPM which has direct control of the system power.

6.1.2 Front Panel Status Indicator

The only visible indicators are two lights which are controlled by the service processor. One light is yellow and the other is green. These lights have three operational states and one non operational state. With no lights illuminated the system is not connected to an AC power source, or the circuit breaker in the rear of the system is off.

With the yellow light only illuminated, the system is connected to an ac power source and the standby portion of the service processor is powered and active, but the system is not running and the main system power is off.

With the green light only illuminated, the system is on.

With the green light illuminated and the yellow light flashing, the system is in an abnormal condition or is receiving a warning from one of the system level sensors. Details on this abnormal condition will be available on the system console.

6.2 Control Parameters

Various system control parameters such as whether the system "auto boot" (automatic boot after returning from system power failure), timing parameters related to "auto boot", or commands to margin system DC supply levels are controlled by the SPM. Any programmable control parameter is soft configured on the service processor avoiding the need for configuration switches. The SPM contains NOVRAM which may contain configuration parameters and system control passwords. Details of these system control parameters and their natures are available in the Service Processor and RWI specifications.

6.3 System Serial Ports

There are 4 RS-232C serial I/O ports at the rear of the main system cabinet. They are described below.

6.3.1 Console Terminal

A serial port is provided to act as the main system console and local diagnostics port. All system diagnostics can be performed from this port. System power ON/OFF and system RESET functions can be performed from the console by appropriate commands and passwords. This port also acts as the system console for the operating system.

6.3.2 Remote Console Port

A serial port intended for connection to a modem for remote system access and diagnostics is provided. All functions performed at the main system console are supported at this port.

6.3.3 Printer Port

A serial port intended for a system serial printer.

6.3.4 UPS Port

This port is used for serial communication with a UPS that supports an RS-232 link. Special software will be required to support whatever protocol is available from the UPS.

6.4 Environmental Monitors

The SPM provides facilities for monitoring several environmental parameters. These include: air temperatures in several locations, power supply output voltages, power supply status, UPS status. Abnormal conditions will be reported to the system console and cause the yellow LED on the front panel to flash.

Two temperature sensors are provided in each cabinet, one for inlet air and one for exhaust air. Additionally, in the logic cabinets there is a sensor in the PSM for monitoring the power supply inlet air temperature.

The +5, +12 and -12 volt outputs of the auxiliary and each main cabinet power supply are monitored. The power fail signal for each logic supply are also monitored.

7. System Hardware Diagnostics

System diagnostics consist of four levels of test, each level built on the previous. The first level is the system power-up test; the next is the board-level diagnostic; the third is the system confidence test and the last is the system exerciser. The diagnostic strategy implements the concept of incremental testing from a minimum hardware kernel. The various test levels depend on the prior level for assurance of a minimal operational capability.

Source of the diagnostic test levels are firmware, floppy disk, hard disk and remote access (modem or direct connect) and download. Firmware controls the initial power-up testing. Continued testing is possible through any of the remaining media including remote link. Power-up testing of devices not covered by the power-up firmware will be executed from hard disk with floppy and remote available as backup.

7.1 Power-up Tests

The power-up tests are a series of firmware-based tests run on each of the intelligent in the system. The tests on each board begin by checking the microprocessor chip, the checksum of the firmware, addressability, data line I/O, local memory and bus interface hardware. Actual access to the bus is denied until the power-up controller (in this case, the Service Module) enables each.

The Service module will test itself, then proceed to test the bus, memory, the I/O subsystem and then each of the processor modules. Each processor module will be waken-up, queried for status and allowed to complete its own power-up sequence.

When the board power-up sequence is complete, a short exerciser will be run. That test will begin tasks on a single processor, then incrementally added processors and tasks until the full system is active. Power-up will be complete after successful execution and system boot will begin.

Should a new board type be added to the system that cannot be handled by the Service Module firmware, additional code will reside on both hard disk and floppy to support that phase of power-up. This code can be added to the system by floppy or by remote transmission.

7.2 Board Diagnostics

Each board has diagnostic support required to assist in development and manufacturing of individual circuit boards. These diagnostics exercise all major functions within each of the PCBs.

The board diagnostics exist in both floppy and remote download form. They are intended to serve three separate levels of user and so are provided in those forms. The first level is the end user / customer confidence mode. This is a version that has all sequences predefined and tests each board in the system in an end to end order. It requires minimal user expertise and interaction.

The next level is field service mode. These tests provide the field engineer with the capability of defining test sequences and formats and isolates failures to the Field Replaceable Unit (FRU). This level resides on the customer floppy in transparent mode or can be executed through the remote diagnostic system.

The most detailed level is the Manufacturing mode. This level includes all of the loops, data and address manipulation and detail reporting to support debug of each individual board. Diagnostics can be run from a test bed or within a system and can be executed from floppy or by direct link. Fault isolation is to the subfunction level with loop and trace (verbose) mode available to support isolation to the component level.

7.3 System Level Confidence Test

The System Level Confidence Test is an extension of the board level diagnostic. At this level, the boards are judged working. Each function within the system is then executed on a one by one basic to prove that the system functions as a unit. Each known combination is run and then compared to expected results. This is a single process test procedure. Any fault at this level should be isolatable to a single FRU 80% of the time and within two FRUs 90% of the time. This is not available at initial System90 release.

7.4 System Exerciser

The System Exerciser is a worst case test mode. It consists of a series of multitasking UNIX like kernels on each processor module and on the service module. Tasks are initiated and monitored by the Service Module. In the canned mode, tasks are first run only on one processor, then two and so on until the entire system is running full out doing diverse jobs. These include HD reads (& writes when authorized), port I/O, memory tests and contention, tape writes and reads as well as processor functions. If the system can pass this test, it will run UNIX.

In a manual mode, separate functions or devices can be selected in order to stress a particular portion. Multiple tasks can be queued to again present worst case. This series of tests can be run floppy based or remotely through direct link or modem.

The intended usage is manufacturing burn-in in automatic mode as well as on site wring out of a new or suspect system. The exerciser would be available to the customer in a nondestructive mode only. This is not available at initial System90 release.

7.5 Remote Diagnostics

All system hardware diagnostics can be run via the remote console port. This allows service personnel to remotely isolate failed system components. This can be via direct RS-232 link or by modem from an off site location. Downloads are guaranteed accurate by use of CRC algorithms. The system can also act as a remote monitor for floppy based execution. This is not supported at initial product release.

8. System Power

8.1 AC Power Requirements

The system is designed to operate from a 220 VAC nominal, single phase line. The system will function over a line voltage range of 187 to 264 VAC. Any utility nominal line voltage +/- 10% which falls outside this range will require either a step up or step down transformer for connection to the system.

The nominal line frequency may be 50 or 60 Hz. The range is 47 to 63 Hz.

The system is provided with a line cord with a NEMA L6-30P plug. Each cabinet in the system requires its own 30 amp branch circuit.

8.2 DC Logic Power Supply

The power supply module (PSM) resides in each logic cabinet at the rear of the removable media module (RMM). A single multiple output switch mode power supply has +5 volt, +12 volt and -12 volt outputs. This supply is capable of supporting the boards present in the card cage, the system cooling fans and the 4 peripherals in the RMM.

Peripherals in the peripheral cabinet are separately powered.

8.3 SPM Power Supply

A portion of the SPM and all of the RWI are powered by a separate, auxiliary supply. This supply is on if the system is connected to a live circuit and the main circuit breaker is ON. The auxiliary and main supplies are diode OR'ed on the SPM for redundancy.

8.4 Power Supply Control

The system power supply is controlled by the service processor through the RWI. The service processor can turn system power on and off, margin DC voltages (for manufacturing testing only), and sense DC levels.

The SPM also monitors the Power Fail signal from each of the main power supplies and directs the system shutdown in the event of a utility power failure.

8.5 Uninterruptible Power Supply

The system supports connection to an uninterruptible AC power system. A simple TTL signal interface is supported as well as an RS-232C port for serial communication with the

UPS. Special software will be required for serial communication.

9. System IARM

The System90 is intended to meet certain installability, availability, reliability, and maintainability (IARM) objectives.

9.1 Installability

The System90 will be installed, configured, and made operational in one day or less.

It is anticipated that communications circuits, local terminal and printer wiring, and AC power wiring be prepared at the site before installation time.

9.2 Availability

Several features of the System90 address system availability. The system minimizes common points of failure, provides protected main memory storage, provides error checking on system bus transmissions, and provides for uninterruptible power systems.

The system design minimizes common points of failure which would be fatal to the system. The common points of failure in the system are such that their failures do not dominate the overall failure rates of the system.

Main system memory storage is protected by error detection and correction which corrects any single bit error, detects any double bit error, and detects some multiple bit errors.

All transmissions on System90 busses are parity checked for data integrity. System bus protocols allow modules to retry bus cycles to attempt recovering from a failed cycle.

9.3 Reliability

The reliability of the System90 is high for a machine in its class. The range of system reliability is as great as the range of configurations. System MTBF is expected to range between 500 and 4000 hours depending on actual configuration.

Also note that many system hardware failures will not be fatal to the entire system. Many system failures are detected and resolved by deconfiguring a failed component before they become catastrophic to the system.

The level of system wide monitoring supported through the SPM will enable detailed evaluation of the system environment and health. The SPM monitors each bus operation and detects transmission and protocol failures. Failed modules can be isolated using this information. The SPM also periodically monitors system environment. An increase in average system temperature over time can be used to signal air filter replacement. A change in the inlet to outlet air temperature delta will indicate a system problem such as a fan failure. Drift in the DC power voltage levels is monitored and any level out of tolerance is reported to the operator so that maintenance may be scheduled to prevent failure. Inlet air temperature is monitored for compliance with the environmental specifications.

9.4 Maintainability

The System90 addresses maintainability in several areas. Local and remote diagnostic access and high degree of serviceability.

System diagnostics can be run to isolate 90% of all hard failures to a field replaceable unit (FRU). These system diagnostics can be run either locally or remotely by trained service personnel. System level diagnostics must be run off line.

Also, any module that detects itself as being bad while the system is on-line will deconfigure itself and report the failure to the system operator.

Any failed FRU can be replaced by trained service personnel in thirty minutes or less.

All major system components with the exception of system chassis are considered to be field replaceable. Included as FRUs are all major logic assemblies, peripherals, and power supplies.

Hot (powered up) service is not supported.

10. Environmental and Safety

The System90 is compliant with various environmental, safety, and regulatory agency requirements.

10.1 Environmental

The System90 is intended to operate in copy room type environment. It does not require special cooling, raised flooring, etc.

The following environmental specifications are met by the system.

- Temperature (operating)

  5 to 40 degrees centigrade at sea level, with maximum change of 10 degrees centigrade per hour. Maximum operating environment temperature is dependent on altitude, and a graph will be provided to indicate maximum operating temperature from 0 to 10,000 feet.

- Temperature (non-operating)

  -20 to 60 degrees centigrade with maximum change of 20 degrees centigrade per hour.

- Humidity (operating)

  20 to 80 percent relative humidity (non-condensing) with maximum change of 10 percent per hour.

- Humidity (non-operating)

  5 to 95 percent relative humidity (non-condensing).

- Altitude (operating)

  5,000 feet (1500 meters).

- Altitude (non-operating)

  40,000 feet (12,000 meters).

- Acoustic Emissions

  Less than 65 dBA.

- Power Requirements

  220 VAC 50/60 Hz. A 30 amp line cord and plug is provided. Typical system configurations will require between 10 and 23 amps.

- Size The dimensions of a single cabinet are: 47" H x 22" W x 37.75" D.
- Weight

  The weight of a single cabinet is 700 lbs. Maximum.

10.2 Safety and Regulatory

The System90 is compliant with the following safety and regulatory agencies: Federal Communications Commission, Underwriters Laboratories, Canadian Standards Association, and international safety and regulatory (ie - German TUV and IEC).

Specifically the system will comply with the following domestic and international safety and emissions standards.

- FCC Class A

  Federal Communications Commissions standards for acceptable radio frequency emissions; Part 15, subpart J, Class A.

- UL 478

  Underwriter Laboratories safety certification for "Electronic Data Processing Units and Systems". The system will in general be designed to meet the 5th edition, with the exception of section 9A.

- CSA C22.2-220

  Canadian Standards Associations safety standards for "Data Processing Equipment".

- VDE 871 Level B

  German regulatory approval of radio interference suppression of radio frequency equipment for industrial, scientific, medical, and similar purposes. VDE will not be available with initial product release.

- IEC 950 (TUV)

  International Electrotechnical Commission standards on "Safety of Data Processing Equipment".