XEROX

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DOVE Program Diagnostic Strategy

Version 5.0
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DRAFT

Xerox Corporation
Office Systems Division
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Introduction

1.1 Purpose

This document is intended to expand the DOVE Program Diagnostic Goals into a cohesive diagnostic strategy that defines a set of diagnostic design guidelines and detailed fault isolation strategies to the FRU level.

1.2 Scope

This strategy is applicable for both the DAISY and DAYBREAK configurations of the DOVE workstation. It documents an engineering strategy for implementing diagnostic capabilities that enables all published Dove Program Diagnostic Goals (see Reference Documents, Section 1.3) to be met, except as noted.

This document is the last document in a series to be published by the DOVE Diagnostic Team over a period spanning several months. [See DOVE Diagnostic Development Plan Rev. 01 published 4/13/84 by M. Dugan.] Additional diagnostic documentation will be included in subsequent design documents and manuals.

1.3 Reference documents

DAISY SRS - Version 07, 10/83

DAWN (Daybreak) SRS - Version 07, 10/83

DOVE Service Strategy - Revision C, 4/84.

DOVE Diagnostic Development Plan Revision 01, 04/13/84

Memo: Frederick to Printis - DAISY Program Review, 2/3/84

DAISY Diagnostic Package Version 01, 3/2/84

DAISY Diagnostic Package Response by A. Stafford, 4/02/84

DOVE Diagnostic Goals Document Version 05, 05/18/84

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1.5 Acronym definition

SRS	System Requirements Specification
PSR	Product Support Representative
FRU	Field Replaceable Unit
CRU	Customer Replaceable Unit (See detailed definition under 1.7)
PWBA	Printed Wire Board Assembly
IOP	Input Output Processor PWBA
UMC	Unit Manufacturing Cost
PC	Personal Computer - Refers to IBM Guidelines PC Emulation
FIP	Field Isolation Procedures
LED	Light Emitting Diode

1.6 Diagnostics definition

Diagnostics is defined as those workstation features, implemented by either hardware or software, whose purpose is to identify a hardware malfunction and aid the service person in isolating the problem to a field replaceable assembly. It also includes all software utilized in verifying that the machine has been returned to operating specifications.

1.7 Other definitions

PSR The DOVE PSR is defined by the Service Strategy as: An entry-level employee who is a graduate of a technical/vocational school or a two-year college. He has little industrial experience, is just entering the labor force, has strong customer relations orientation, and has sufficient knowledge/skills to pass hiring test battery.

DAYBREAK	LSI version of the DOVE workstation which utilizes a 2901 bit slice Mesa processor and gate arrays utilized for display and memory controllers.
DAISY	Custom VLSI version of the DOVE workstation which utilizes the A & S chips to implement the Mesa processor, display controller, and memory controller.
CRU	The DOVE CRUs are defined as a subset of the DOVE FRUs and are replaceable by the DOVE user level customer. CRUs will include all system components which the user is expected to install. Present DOVE CRUs are defined as: Display module and cables, keyboard and cable, mouse and cable.
Failures	Failures of DOVE system components referred to in this document are defined as hardware related failures only.

2

DOVE diagnostic elements

2.1 Diagnostic users

The following paragraphs identify the users of DOVE diagnostics, and define each user's level of diagnostic function.

Customer Personnel

Customer User	A workstation operator who may have little or no prior experience with workstations. May be totally unskilled or unwilling to perform system repair and/or maintenance (lowest technical skill level). May replace workstation components at the CRU level. Diagnostic function: to identify and isolate system failures to the local workstation or other network component for the purpose of customer user maintenance, system administrator support, or service notification.
Customer User Support	A customer supplied PSR who is experienced and has been defined by the customer as their support person. Can follow step-by-step procedures and has approximately the raw skill/capability of a Xerox PSR. May replace workstation components at the FRU level. Diagnostic function: to isolate/repair hardware failures at the FRU level and verify repair.
Customer System Administrator	A designated customer user assigned to administer the network services and to assist in isolating the local workstation or other network components for the purpose of service notification. Diagnostic function: to identify and isolate hardware failures to the local workstation or other network components for the purpose of customer user maintenance, systems analyst support, or service notification. Also isolates and identifies hardware/software interactive problems and network citizenship problems.

Xerox Personnel

Product Support Representative	The DOVE PSR is defined by the Service Strategy as an entry-level employee who is a graduate of a technical/vocational school or a two-year college. The PSR has little industrial experience, is just entering the labor force, has strong customer relations orientation, and has sufficient knowledge/skills to pass hiring test battery. May replace workstation components at the FRU level. Diagnostic function: to isolate/repair hardware failures and verify repair.
Customer Service Representative	The DOVE CSR is defined by the Service Strategy as a senior technical specialist who is a graduate of a technical/vocational Representative:school or a two-year college. The CSR has experience with network systems and OS/IP products. Diagnostic function: to isolate/repair hardware failures and verify repair. To provide first level support to the PSR with more in-depth, creative diagnostic skills.
Region Engineering Specialist	The RES is defined by the Service Strategy as a senior technical specialist who is a graduate of a vocational school or two-year college. The RES has experience with network systems, office systems, information processing products, and extensive CSR/PSR support and product support. Diagnostic function: to provide telephone and on-site technical support beyond the district for current products. Responsible for improvement and upgrade of product knowledge and product performance. Provides communication link between Field Engineering/Product Support in headquarters. Provides major account support through the CSR/PSR. Provides new product support.
NS/Consultant NS/Engineer	The NSC/NSE is defined by the Service Strategy as a senior technical specialist who is a graduate of a technical/vocational school or two-year college. The NSC/NSE has experience with network systems, office systems, system software, network integration, and network citizenship. Diagnostic function: to provide universal second level support for all hardware failures, hardware/software interactive problems and network citizenship problems.
Network Support Center	The NSC is staffed and equipped to provide detailed diagnostic recommendations via telephone. Diagnostic function: to provide second level telephone support to the PSR/CSR/RES/NSC/NSE with more in-depth, cumulative,

expert diagnostic skills for all hardware failures, hardware/software interactive problems, and network citizenship problems.

Mfg. Technician

A trained, skilled manufacturing technician.

Diagnostic function: to test and insure the compatibility and quality of components, subassemblies, and equipment mainframes in the areas of final assembly, PWA test, and PWA quality assurance.

System Analyst

The System Analyst is defined by the Service Strategy as a marketing support person with a background in software/hardware support and user applications maintenance.

Diagnostic function: to isolate and identify hardware/software interactive problems and network citizenship problems for the purpose of verifying the integrity of the network hardware prior to setting up or modifying the software applications.

The following table identifies the users and types of diagnostic packages, and indicates the general usage patterns for troubleshooting, verification of processor hardware operation, and interactive testing of peripheral operation.

Table 2.1 Diagnostic levels of access

Diagnostic Users [1]	Manual Proced Diag	Pre Boot Diag [3]	Short Boot Diag [3]	Full Boot Diag [3]	Util Diag	On Line Diag	Off Line Diag	Mfg Accept Test Diag	Error Log/ OS Diag *	Remote Diag (if avail) *
Customer User		●	●	●	●	●				
Customer User Support	●	●	●	●	●	●	●			
Customer System Administrator		●	●	●	●	●	●			
Product Support Rep (Xerox Direct Service)	●	●	●	●	●	●	●			
Customer Service Rep (Xerox Direct Service)	●	●	●	●	●	●	●			
Region Engineering Specialist	●	●	●	●	●	●	●		●	●
NS Consultant/ NS Engineer	●	●	●	●	●	●	●		●	●
Network Support Center	●	●	●	●	●	●	●		●	●
Manufacturing	●							●2	●	
System Analyst		●	●	●	●	●	●			

1 This table is intended only to identify most frequent use and does not preclude use by any user of any diagnostic package.

2 Includes all previous diagnostic packages.

3 Preboot and Short Boot Diagnostics shall run automatically at power on. Full Boot will run at power on as determined by the customer-selected option; all others at user option.

* Not planned for implementation.

2.2 Diagnostic operational modes

2.2.1 Activity

Manual Diagnostics are those documented procedures that require no software involvement. These procedures are documented in the service manual (FIPs).

Examples: Verification of Power Normal LED indication, power supply verification via test points, verification of connector pin condition, etc.

Interactive Diagnostics are those diagnostics that require user interaction during the checkout and verification of the subassembly under test.

Examples: Verification of proper display pattern during display testing section of boot diagnostics, verification of proper key indication during keyboard testing, etc.

Automatic Diagnostics are those diagnostics implemented in software that require no user intervention to answer questions or provide direction once the test is underway.

Examples: Memory tests, processor verification, rigid disk verification.

2.2.2 Location

Local Diagnostics are those diagnostics that execute within a workstation and are initiated/interrogated from the user interface of the workstation under test. ~~All diagnostics referred to in this diagnostic strategy document are assumed to be local diagnostics~~.

Remote Diagnostics are those diagnostics that execute within a workstation but are initiated/interrogated from a remote machine or workstation user interface. ~~Diagnostic development resources will not allow remote diagnostics to be implemented on DOVE~~.

2.3 Diagnostic user interfaces

- Check charts
- Power Normal indicator
- LED status indicators
- Cursor
- Speaker
- Optional maintenance panel
- Bitmap display

2.3.1 Check charts

Check charts are a part of the PSR documentation. They guide the PSR step by step in further isolating a hardware problem. They are used where hardware and software interfaces are inadequate or impractical. An example might be a DC power check chart.

2.3.2 Power Normal indicator

The Power Normal indicator indicates that DC power is ok. (Ref. Power Supply Specification 156P028XX.)

2.3.3 LED status indicators

There will be three LEDs located in the system unit, visible to the user. These will be used with Preboot Diagnostics to identify a failing FRU.

2.3.4 Cursor

The cursor displays a number or sets of numbers. These numbers are to be used in conjunction with check charts. The meaning of these numbers depends on the software which is run at the time the numbers are displayed.

Examples of the meanings of the numbers: error codes pointing to the FRU list
expected/observed data
expected/observed status
operating software error code pointing to the user action required

2.3.5 Speaker

The speaker will be used to identify success and error conditions when the use of the bitmap display cursor cannot be assumed to be reliable. The success and error conditions are differentiated by tone frequency.

2.3.6 Optional maintenance panel

The optional maintenance panel will be used for Manufacturing and Field Service to provide diagnostic test numbers and error data above and beyond the cursor. The optional maintenance panel is an external device that connects to the machine through an adaptor to the keyboard connector at the system unit. It will have an LED or LCD display capable of displaying four or more digits, similar to the Dandelion maintenance panel.

2.3.7 Bitmap display

The bitmap display will be used whenever the hardware required to run it has been thoroughly verified. Barring memory size restrictions, it will be used to display:

- system configuration
- menu selections
- messages
- prompts

- help text
- test names
- subtest names
- error data
- FRU data

2.4 Diagnostic packages

- Manual Procedures
- Preboot
- Boot
- Offline
- Online
- Operating System Diagnostics
- Acceptance Test Procedures
- Utilities
- Remote

2.4.1 Manual Procedures

The Manual Procedures consist of check charts and hardware adjustments. Both check charts and hardware adjustments will be supported by the diagnostic software to the extent possible. They will be incorporated into the User's Manual and the PSR Manual. Manual check charts and hardware adjustments will be provided by Field Service with inputs from the diagnostic group and Engineering.

Examples of check charts and adjustment procedures:

- AC power check
- DC power check
- Preboot check chart
- Boot check chart
- bitmap display adjustment procedure
- character printer adjustment procedures

2.4.2 Preboot Diagnostics

The purpose of Preboot Diagnostics is to verify sufficient hardware to load and run Boot software and to identify detected hardware errors. The Preboot Diagnostics reside in the IOP EPROM.

Preboot Diagnostics are written in 80186 assembly language. They use the status LEDs, the optional maintenance panel, the speaker, the cursor, and check charts for user interface. Preboot Diagnostics operate in the automatic mode. They are initiated any time the system is powered up or when the SYSTEM RESET switch is pressed (see Figure 2.1). Preboot Diagnostics take no more than ten seconds to run.

Preboot Diagnostics consist of:

- IOP RAM verification
- keyboard UART timer verification
- interrupt controller verification
- keyboard turnaround test
- mouse coordinates test
- 80186 timer 2 verification
- IOP EPROM verification
- configuration EEPROM verification
- memory controller/IOP interface verification
- display cursor verification

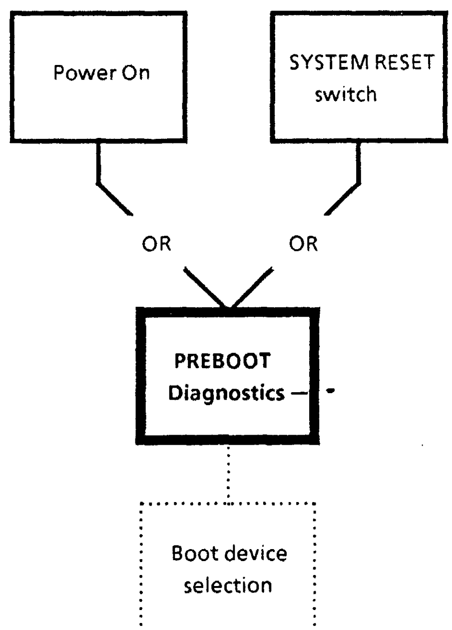

Figure 2.1 Preboot Diagnostics

2.4.3 Boot Diagnostics

The purpose of the Boot Diagnostics is to verify the hardware required to load and run Mesa software, to verify IOP hardware not accessible to the Mesa software, and to isolate and identify detected hardware errors. The Boot Diagnostics reside on any of the boot devices. Short Boot Diagnostics shall take no longer than ninety seconds for the minimum configuration plus 15 seconds for each additional 512 kbytes of memory. The full Boot Diagnostics shall take no longer than eight minutes for the minimum configuration plus 3 minutes for each additional 512 kbytes of memory.

The Boot Diagnostics provide the user with the option to run some of the tests for a desired number of passes to identify intermittent problems.

The Boot Diagnostics are written in 80186 assembly language and in Mesa processor microcode. These diagnostics use the cursor, the optional maintenance panel, the speaker, and check charts for the user interface. They normally operate in automatic mode and can also be used in interactive mode for circuit board repair.

The Boot Diagnostics can be initiated in three ways:

1. If the system configuration has the "*Always run Boot Diagnostics*" bit set, then a short version of the Boot Diagnostics is run automatically immediately after a Boot file has been selected.

   Note: If the system configuration has the "*Always run Boot Diagnostics*" bit reset, no Boot Diagnostics are executed.

2. If the diagnostic boot file is selected, the full version of the Boot Diagnostics is run .

3. If the boot device is selected using the keyboard (special diagnostic boot), the full version of the Boot Diagnostics is run (see Figure 2.2).

   Note: There is an optional boot device selection available in Preboot. This boot device selection uses the keyboard rather than the boot icons to select the boot device, and automatically loads the Boot Diagnostics.

Boot Diagnostics consist of:

- control store verification
- memory controller verification
- main memory verification
- Mesa processor verification
- rigid disk memory addressing verification
- rigid disk FIFO verification
- Ethernet memory addressing verification
- keyboard UART timer verification
- interrupt controller verification
- arbiter verification
- host ID Prom verification
- PC Emulation option verification
- display test patterns (while running the Display memory test)

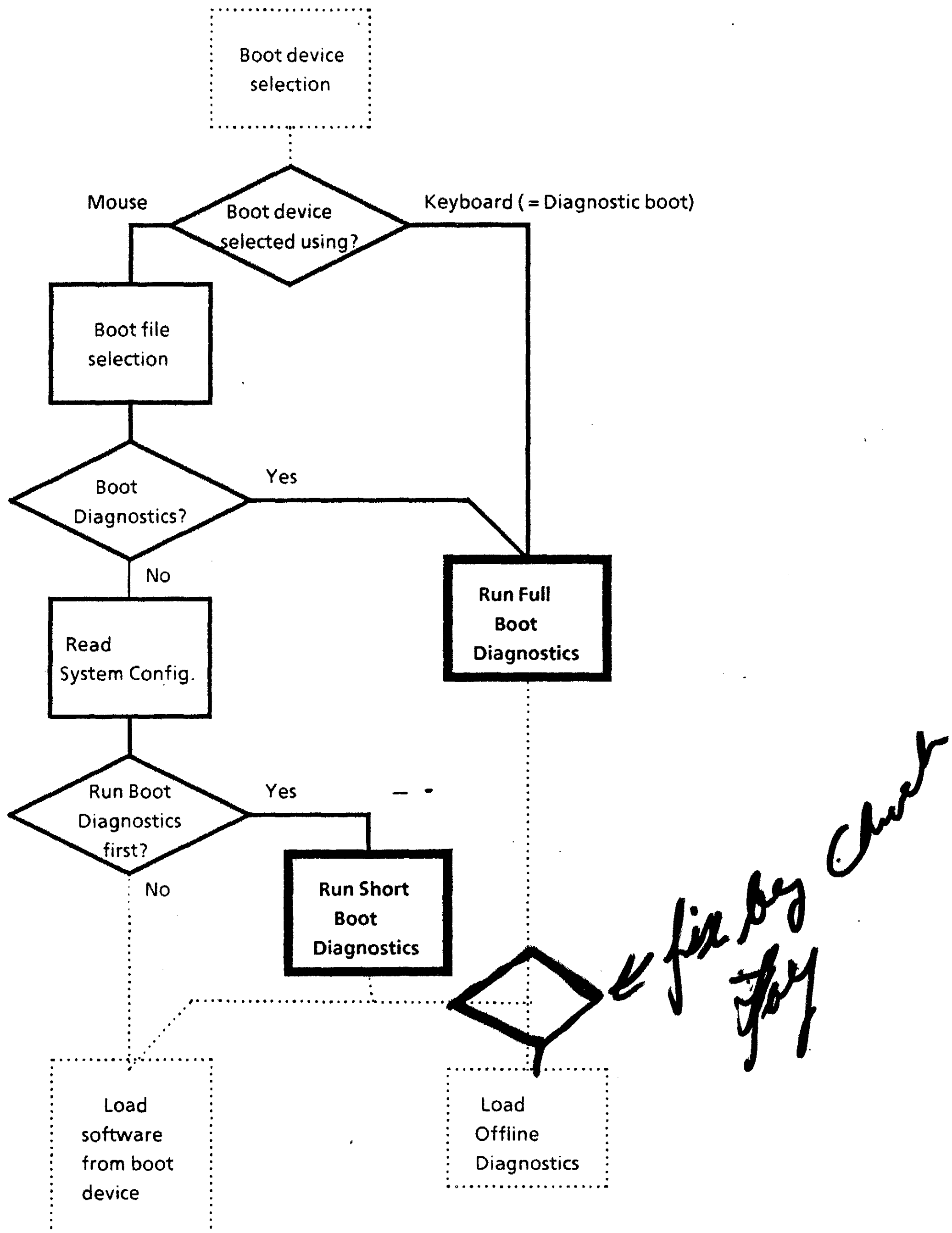

Figure 2.2 Boot Diagnostics

2.4.4. Offline Diagnostics

The purpose of the Offline Diagnostics is to verify the peripheral hardware and to isolate and identify peripheral detected hardware errors. The Offline Diagnostics take control of the entire work station using UtilityPilot for an operating system. The Offline Diagnostics must be booted from one of the boot devices.

The Offline Diagnostics provide the user with the option to run some of the tests for a desired number of passes to identify intermittent problems.

The Offline Diagnostics are mostly written in Mesa and some 80186 assembly language. They use the bitmap display for user interface. Offline Diagnostics operate both in the automatic and interactive modes. They are always initiated in the interactive mode. They start by displaying the system configuration and request the operator to validate it. After the configuration has been validated the operator is presented with a menu to run all of the Peripheral Diagnostics automatically or to select an individual Peripheral Diagnostic. Offline Diagnostics consist of tests for:

- rigid disk
- Ethernet
- floppy disk
- RS-232-C
- keyboard, mouse, and speaker
- bitmap display
- character printer
- configuration EE prom verification (validity checks)

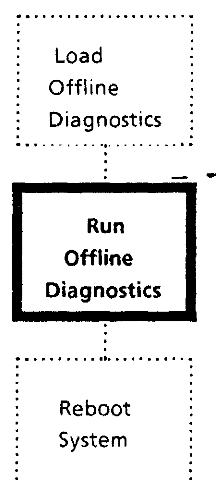

Figure 2.3 Offline Diagnostics

2.4.5 Online Diagnostics

The purpose of the Online Diagnostics is to verify the peripheral hardware and to isolate and identify peripheral detected hardware errors. The Online Diagnostics are run like any other application on the basic workstation. They are written in Mesa and use the bitmap display for user interface. The Online Diagnostics are run only when the user selects them. They operate strictly in the interactive mode (see Figure 2.4).

Online Diagnostics consist of tests for:

- Ethernet
- floppy disk
- RS-232-C
- keyboard, mouse, and speaker
- bitmap display

- character printer
- PC emulation

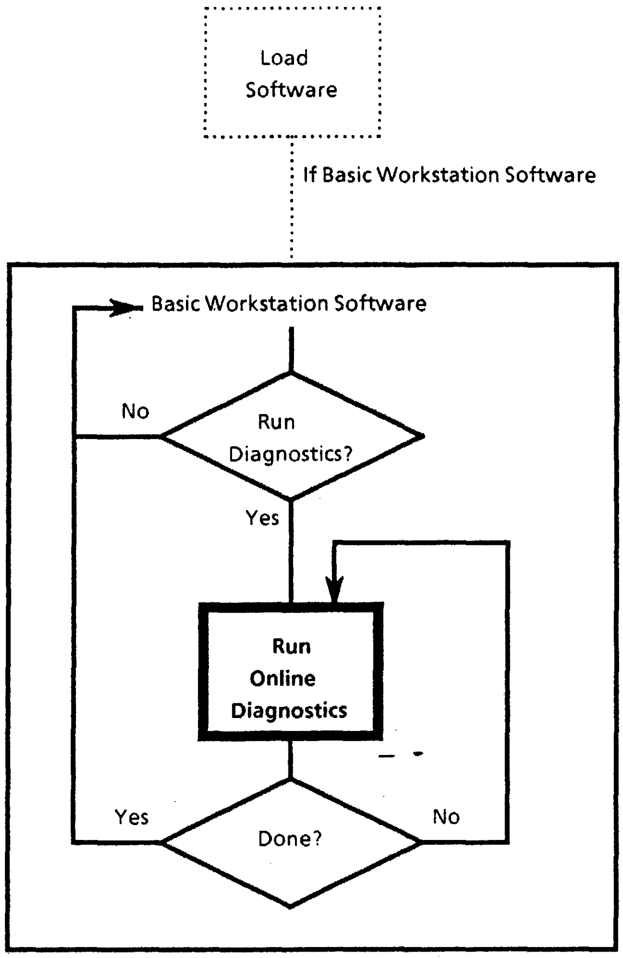

Figure 2.4 Online Diagnostics

Note: The major differences between the Offline and the Online Diagnostics are:

- Boot Diagnostics are always executed before running the Offline Diagnostics.
- The Offline Diagnostics isolate to a smaller FRU count than the Online Diagnostics.
- The Offline Diagnostics make use of the diagnostic turnaround plugs.

2.4.6 Operating System Error Logging

The Operating System Error Logging consists of two sections, Error Logging and Error Log Analysis.

Error Logging:

Error Logging logs all encountered IO device errors while the Operating System is running. It is imbedded in the Pilot Operating System. The errors are logged in two places:

- on the system where the errors occur
- on a designated remote file server

Error Log Analysis:

The purpose of Error Log Analysis is to analyze and summarize the Operating System IO Device errors into real and potential problems. Error Log Analysis does not identify a FRU list; it depends on the PSR to run the appropriate diagnostic for the FRU list.

Error Log Analysis can be invoked in several ways: it is invoked automatically by the Offline Diagnostics when a service call is required (TBD); it is also invoked when the PSR or a customer support person requests to run Error Analysis (special password required).

The Operating System Error Logging is written in Mesa. It uses the bitmap display for the user interface.

Note: Operating System Diagnostics represent a long-term development project. They will be worked on only after more fundamental diagnostics such as Preboot, Boot, Offline, and Online are in place. As a result, they are not planned for DAYBREAK or DAISY IMO.

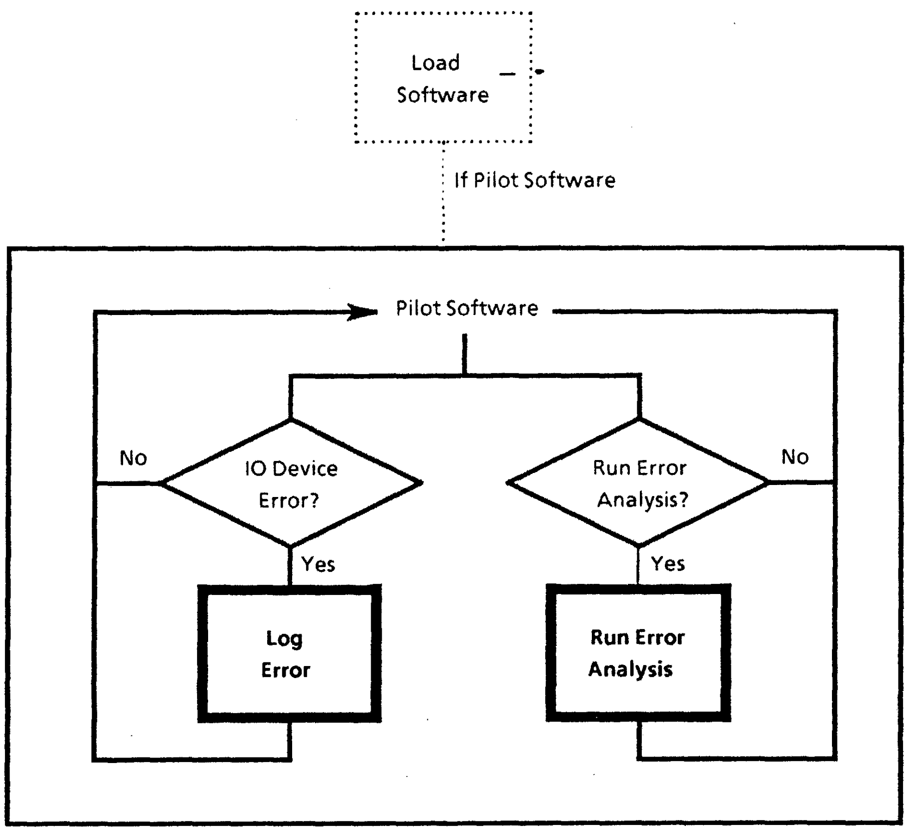

Figure 2.5 Operating System Error Logging

2.4.7 Acceptance Test Procedures

The purpose of the Acceptance Test Procedures is to test a number of machines simultaneously for an extended period of time with minimum user intervention. They will primarily be used in manufacturing.

The Acceptance Test Procedures are entirely written in Mesa and use the bitmap display for the user interface. They operate in the automatic mode.

Acceptance Test Procedures consist of:

- running Boot Diagnostics
- running R-Disk formatter
- running R-Disk volume initializer
- extended burn-in which consists of:
  - rigid disk storage exerciser
  - floppy exerciser
  - Ethernet Echo Test

2.4.8 Utilities

Utilities are not diagnostics. They are mentioned here because some utilities are either very closely related to diagnostics or require diagnostics to be run before the utility is invoked.

The Utilities are written in Mesa. They use the bitmap display for the user interface and operate strictly in the interactive mode.

Examples of some of the Utilities:

- format rigid disk
- physical volume scavenger
- format floppy disk
- copy floppy disk
- clean floppy heads
- set system configuration

2.4.9 Remote

Remote Diagnostics consist of software which allows controlling the execution of Offline Diagnostics from a remote workstation.

Note: Remote Diagnostics is a new capability not previously provided on the Dandelion. It is an attractive, useful, but non-essential capability. Hence it is not required for DAYBREAK or DAISY IMO. More fundamental diagnostics such as Preboot, Boot, Offline, and Online will take precedence in the implementation plan.

Remote executable diagnostics are:

- Offline Diagnostics

C. Destructive Diagnostic or Utility for the purpose of initial system installation, disk drive replacement, or upgrade.

D. Destructive Diagnostic or Utility for the purpose of troubleshooting or peripheral testing.

2.5.4 Level Four

Password required

Availability:

A. Xerox
   a. NSE/NSC
   b. System Specialist
   c. Manufacturing

Diagnostic type:

A. Required diagnostic at Power On

B. Optional Nondestructive Diagnostic, Online Diagnostic, Offline Diagnostic or Utility selectable by all users for extended diagnostics of the system or peripheral testing.

C. Destructive Diagnostic or Utility for the purpose of initial system installation, disk drive replacement, or upgrade.

D. Destructive Diagnostic or Utility for the purpose of troubleshooting or peripheral testing.

E. Error Logging

F. Remote Diagnostics

3

DOVE diagnostics by functional subsystem

This section describes the actual DOVE hardware including special diagnostic hardware and the diagnostic tools. It describes the type of diagnostics used to isolate hardware failures within each hardware subsystem, and it identifies the FRU list involved.

3.1 Power supply

The power supply provides all the DC voltages required by the workstation. The power supply is a single FRU.

The power supply has the following diagnostics hardware:

- power normal LED
- test points for each voltage

The diagnostics used to isolate power supply problems are:

- Manual Procedures

  The Manual Procedures assist the PSR in isolating AC and DC power problems.

3.2 Input Output Processor (IOP)

The Input Output Processor hardware consists of :

- 80186 processor
- 16 kbyte EPROM
- 16 kbyte RAM
- interrupt controllers
- timer
- arbiter
- host ID PROM
- system configuration EEPROM

The Input Output Processor has the following diagnostics hardware:

- three general purpose LED status indicators
- EEPROM (for system configuration and bad memory pages)

The diagnostics used to isolate hardware errors in the IOP subsystem are:

- Preboot Diagnostics
- Boot Diagnostics
- Offline Diagnostics

Preboot Diagnostics:

Preboot Diagnostics are used to verify the following IOP hardware: the 80186 processor, the 16 kbyte EPROM, the 16 kbyte RAM, the timer, the interrupt controllers, the arbiter, the host ID PROM, and the configuration EEPROM.

The FRU associated with the IOP subsystem Preboot Diagnostics is the IOP PWBA, the 6 kbyte EPROM, and the configuration EEPROM.

Boot Diagnostics:

Boot Diagnostics are used to verify the following IOP hardware: the interrupt controllers, the timer, and the arbiter.

The FRU list associated with the IOP subsystem Preboot Diagnostics is the IOP PWBA.

Offline Diagnostics:

The Offline Diagnostics are used to verify the IOP EEPROM.

The FRU list associated with the IOP subsystem Offline Diagnostics is the IOP PWBA and the configuration EEPROM.

3.3 Mesa processor

The Mesa processor hardware consists of:

- control store
- processor (2901 based for DAYBREAK or S-chip based for DAISY)
- Mesa processor control logic on the IOP

The DAYBREAK Mesa processor has the following diagnostics hardware:

- read control store logic
- read memory map registers
- processor reset
- processor enabled and disabled under program control

The DAISY Mesa processor has the following diagnostics hardware:

- read control store logic
- read memory map registers
- S-chip socketed
- S-chip enabled and disabled under program control
- history buffer interface

The diagnostics used to isolate hardware errors in the Mesa processor subsystem are:

- Boot Diagnostics

  Boot Diagnostics are used to verify the following Mesa processor hardware: control store, the processor (2901 for DAYBREAK or S-chip for DAISY), and the Mesa processor control logic on the IOP.

  The FRUs associated with the Mesa processor Boot Diagnostics are the IOP PWBA, the Mesa processor PWBA, and the backplane.

3.4 Main memory

The DAYBREAK main memory hardware consists of:

- part of the DCM PWBA
- MEB PWBA

The DAISY main memory hardware consists of:

- A-chip for each megabyte of memory
- first megabyte, part of Mesa processor PWBA
- main memory will contain from 1/2 megabyte to 4 megabytes
- Memory Chip on Sockets

DAYBREAK diagnostic hardware:

- force parity
- memory status register

DAISY diagnostic hardware:

- A-chip force parity
- A-chip read timing control
- A-chip write timing control
- A-chip refresh timing control
- A-chip retains last accessed data
- A-chip retains last accessed address
- IOP EEPROM (to maintain bad memory page log)
- Memory Chip on Sockets

Diagnostics used for the main memory:

- Boot Diagnostics

Diagnostics isolation:

Boot Diagnostics will isolate to the memory chip ~~whenever possible~~ OK, otherwise to the board level and to the A-chip.

The FRUs associated with the main memory Boot Diagnostics for DAYBREAK are the DMC PWBA, the MEB PWBA, and memory chips for DAYBREAK.

The FRUs associated with the main memory Boot Diagnostics for DAISY are the Mesa processor PWBA, memory chips, and the A-chip.

3.5 Rigid disk subsystem

The rigid disk subsystem hardware consists of:

- rigid disk DMA controller(on IOP)
- rigid disk interrupt controller logic (on IOP)
- rigid disk FIFO (on IOP)
- rigid disk processor (on IOP)
- rigid disk cable
- rigid disk drive
- drive media

Diagnostic hardware:

- diagnostic cylinder
- special read/write operations for CRC/ECC generator/checker
- RDC prom IOP-RDC processor communication tests

Diagnostic hardware tools:

- external data loopback plug

The diagnostics used to verify and isolate hardware errors in the rigid disk subsystem are (see Table 3.1):

- Boot Diagnostics
- Offline Diagnostics
- Operating System Diagnostics
- Manual Procedures

Boot Diagnostics:

The Boot rigid disk diagnostics are used to verify that portion of the rigid disk subsystem which cannot be verified or is difficult to verify using Mesa software. The Boot Diagnostics verify rigid disk DMA main memory addressing, rigid disk DMA main memory data path, the rigid disk DMA controller, the rigid disk interrupt controller logic, and the rigid disk FIFO.

The Boot Diagnostics use the cursor on the bitmap display in conjunction with Manual Procedures to identify the diagnostic tests, data, and the fault codes.

The FRUs associated with the rigid disk subsystem Boot Diagnostics are the IOP PWBA, the Mesa processor PWBA, and the backplane.

Offline Diagnostics:

The Offline Diagnostics for the rigid disk subsystem consist of the Confidence Test, the Exerciser, and Surface Verification.

Confidence Test:

The Confidence Test does a thorough verification of the rigid disk. It looks for hard errors and excessive soft errors. It tests the rigid disk processor, the rigid disk cable, the drive and the drive media (user files).

The Confidence Test is nondestructive. It is run by a customer before placing a service call, by the PSR after rigid disk subsystem repair, and any time System Verification is run. The Confidence Test uses the bitmap display for test description, error data, and FRU data .

The Confidence Test requires that a physical volume has been created on the disk. For extended error data, errors are kept in an error log and executed commands are kept in a trace table.

The Confidence Test identifies the following FRUs: the IOP PWBA, the rigid disk cable, the drive, and the drive media.

Exerciser:

The Exerciser exercises the rigid disk hardware thoroughly. It looks for hard errors and excessive soft errors. It tests the rigid disk processor, the cable, and the drive.

The Exerciser is a destructive test. It is run by Manufacturing before formatting the disk, and by the PSR after replacing a rigid disk drive. The Exerciser uses the bitmap display for test description, error data, and FRU data.

For extended error data, errors are kept in an error log and executed commands are kept in a trace table.

The Exerciser identifies the following FRUs: the IOP PWBA, the cable, and the drive.

Surface Verification:

Surface Verification verifies the integrity of the media (customer data) on the entire disk surface. It looks for hard and soft media errors.

Surface Verification is a nondestructive test. It is run by the analyst or the PSR to check for media problems. It displays all media errors on the bitmap display.

Surface Verification maintains extended media error data in an error log and executed IO commands a trace table.

Operating System Diagnostics:

The Operating System Diagnostics log all encountered rigid disk subsystem errors when the Operating System is running. They also analyze and summarize these errors on request (see 2.4.6).

Note: Operating System Diagnostics are not planned for DAYBREAK or DAISY IMO, due to resource limits and priorities.

Manual Procedures:

Manual Procedures will be used in guiding the PSR in isolating rigid disk cable problems (opens, shorts, bad connections). They may also be used to further isolate between the drive and the IOP using a pulse probe and a Digital Volt Meter (TBD).

Table 3.1 Rigid disk subsystem and associated diagnostics

Rigid Disk Hardware	*Boot	Offline Diagnostics			Operating System	Manual Procedures
		Confidence Test	Exerciser	Surface Verification		
DMA Controller	X	X	X		X	
DMA Interrupt	X	X	X		X	
FIFO	X	X	X		X	
305 Processor		X	X		X	
305 Interrupt		X	X		X	
Cable		X	X		X	X
Drive		X	X		X	XTBD
Media		X		X	X	

*Uses diagnostic hardware

3.6 Ethernet subsystem

The Ethernet hardware consists of:

- Ethernet data link controller (on IOP)
- Ethernet interrupt controller logic (on IOP)
- Ethernet serial interface (on IOP)
- transceiver cable
- transceiver
- coax cable

Diagnostic hardware:

- Ethernet data link controller internal diagnostic turnaround
- Ethernet data link controller 170 byte status access
- Ethernet serial interface internal diagnostic turnaround

Diagnostic hardware tools:

- built in TDR
- controller turnaround plug
- transceiver turnaround plug
- transceiver 12v LED

The diagnostics used to verify and isolate hardware errors in the Ethernet subsystem are (see Table 3.2):

- Boot Diagnostics
- Offline Diagnostics
- Online Diagnostics
- Operating System Diagnostics
- Manual Procedures

Boot Diagnostics:

The Boot Diagnostics are used to verify that portion of the Ethernet subsystem which cannot be verified or is difficult to verify using Mesa software. The Boot Diagnostics verify Ethernet main memory addressing, the Ethernet data link controller diagnostic turnaround, and the Ethernet interrupt controller logic.

The Boot Diagnostics use the cursor on the bitmap display in conjunction with Manual Procedures to identify the diagnostic tests and the FRU list.

The FRUs associated with the Ethernet subsystem Boot Diagnostics are the IOP PWBA, the Mesa processor PWBA, and the backplane.

Offline Diagnostics:

The Offline Diagnostics for the Ethernet subsystem consist of the Communications Test and the Turnaround Tests.

Note: The Offline Diagnostics will use the build in TDR for diagnosing net problems, and that software is not planned for DAYBREAK or DAISY IMO, due to resource limits and priorities.

Communications Test:

The Communications Test does a thorough verification of the Ethernet subsystem. It looks for hard errors and excessive soft errors. It tests the Ethernet data link controller, the Ethernet serial interface diagnostic turnaround, the Ethernet serial interface, the transceiver cable, the transceiver, and the coax cable.

The Communications Test is nondestructive. It is run by a customer before placing a service call, by the PSR after Ethernet subsystem repair, and any time System Verification is run. The Communications Test uses the bitmap display for test description, error data, and FRU data .

For extended error data, errors are kept in an error log and executed commands are kept in a trace table.

The Communications Test identifies the following FRUs: the IOP PWBA, the transceiver cable, the transceiver, and the coax cable.

Controller Turnaround Test:

The Controller Turnaround Test fur~~ther~~ isolates a problem to the transceiver, the transceiver cable, or the IOP. It uses the controller turnaround plug. It looks for hard errors and intermittent errors.

The Controller Turnaround Test is run by the PSR after the Communications Test identifies a possible transceiver interface error. The Turnaround Test uses the bitmap display for test description, error data, and FRU data.

For extended error data, errors are kept in an error log and executed commands are kept in a trace table.

The Turnaround Test identifies the following FRUs: the IOP PWBA, the transceiver cable, and the transceiver.

Transceiver Turnaround Test:

The Transceiver Turnaround Test further isolates a problem to the transceiver or the coax cable. It uses the transceiver turnaround plug. It looks for hard errors and intermittent errors.

The Transceiver Turnaround Test is run by PSR after the Communications Test identifies a possible transceiver or Ethernet cable error. The Turnaround Test uses the bitmap display for test description, error data, and FRU data.

For extended error data, errors are kept in an error log and executed commands are kept in a trace table.

The Transceiver Turnaround Test identifies the following FRUs: the transceiver and the coax cable.

Online Diagnostics:

The Online Diagnostics for the Ethernet subsystem consist of the Communications Test.

Communications Test:

The Communications Test does a thorough verification of the Ethernet subsystem. It looks for hard errors and excessive soft errors. It tests the Ethernet data link controller, the Ethernet serial interface diagnostic turnaround, the Ethernet serial interface, the transceiver cable, the transceiver, and the coax cable.

The Communications Test is nondestructive. It is run by a customer before placing a service call, and by the PSR after Ethernet subsystem repair. The Communications Test uses the bitmap display for test description, error data, and FRU data .

For extended error data, errors are kept in an error log and executed commands are kept in a trace table.

The Communications Test identifies the following FRUs: the IOP PWBA, the transceiver cable, the transceiver, and the coax cable.

Operating System Diagnostics:

The Operating System Diagnostics log all encountered Ethernet subsystem errors when the Operating System is running. They also analyze and summarize these errors on request.

Note: Operating System Diagnostics are not planned for DAYBREAK or DAISY IMO , due to resource limits and priorities.

Manual Procedures:

Manual Procedures are used in conjunction with the Turnaround Tests to isolate between the IOP PWBA, the transceiver cable, the transceiver, and the coax cable. They may also be used in guiding the PSR in isolating transceiver cable problems (opens, shorts, bad connections).

Table 3.2 Ethernet subsystem and associated diagnostics

Ethernet Hardware	*Boot	*Offline Diagnostics		*Online Diagnostics	Operating System	Manual Procedures
		*Communications Test	*Turnaround Test	*Communications Test		
Data Link Controller	X	X		X	X	
Ethernet Interrupt	X	X		X	X	
Serial Interface Controller		X	X	X	X	
Transceiver Cable		X	X	X	X	X
Transceiver		X	X	X	X	
Coax Cable		X		X		

* Uses diagnostic hardware

3.7 Floppy disk subsystem

The floppy disk subsystem hardware consists of:

- DMA controller (on IOP)
- data separator (on IOP)
- floppy controller (on IOP)
- floppy interrupt controller logic (on IOP)
- drive cable
- drive

Diagnostic tool:

- Diagnostic diskette (This diskette contains a known data pattern on the last cylinder. This data pattern is verified before writing on the diskette.)

The diagnostics used to verify and isolate hardware errors in the floppy disk subsystem are (see Table 3.3):

- Preboot Diagnostics
- Offline Diagnostics
- Online Diagnostics
- Operating System Diagnostics
- Manual Procedures

Preboot Diagnostics:

The Preboot Diagnostics include a floppy head-cleaning utility. This utility, resident in EPROMs, will allow cleaning the heads without booting software from any boot device. This is necessary for instance when the rigid disk is down and diagnostics can't be booted from the floppy because the heads need cleaning.

Offline Diagnostics:

The Offline Diagnostics for the floppy disk subsystem consist of the Confidence Test and the Exerciser.

Confidence Test:

The Confidence Test does a thorough verification of the floppy disk. It looks for hard errors and excessive soft errors. It tests the DMA controller, the data separator, the floppy controller, the floppy interrupt controller logic, the drive cable, and the drive.

The Confidence Test is nondestructive. It is run by a customer before placing a service call, by the PSR after rigid disk subsystem repair, and any time System Verification is run. The Confidence Test uses the bitmap display for test description, error data, and FRU data.

To be run, the Confidence Test requires a diagnostic floppy diskette.

For extended error data, errors are kept in an error log and executed commands are kept in a trace table.

The Confidence Test identifies the following FRUs: the IOP PWBA, the drive cable, and the drive.

The Confidence Test identifies the following CRU: floppy unit.

Exerciser:

The Exerciser exercises the floppy disk hardware thoroughly. It looks for hard errors and excessive soft errors. It tests the DMA controller, the data separator, the floppy controller, the interrupt controller logic, the drive cable, and the drive.

The Exerciser is a destructive test. It is run by Manufacturing and by the PSR after replacing an IOP PWBA or a floppy disk drive. The Exerciser uses the bitmap display for test description, error data, and FRU data.

For extended error data, errors are kept in an error log and executed commands are kept in a trace table.

The Exerciser identifies the following FRUs: the IOP PWBA, the drive cable, and the drive.

Online Diagnostics:

The Online Diagnostics for the floppy disk subsystem consist of the Confidence Test.

Confidence Test:

The Confidence Test does a thorough verification of the floppy disk. It looks for hard errors and excessive soft errors. It tests the DMA controller, the data separator, the floppy controller, the floppy interrupt controller logic, the drive cable, and the drive.

The Confidence Test is nondestructive. It is run by a customer before placing a service call, by the PSR after rigid disk subsystem repair, and any time System Verification is run. The Confidence Test uses the bitmap display for test description, error data, and FRU data.

To be run, the Confidence Test requires a diagnostic floppy diskette.

For extended error data, errors are kept in an error log and executed commands are kept in a trace table.

The Confidence Test identifies the following FRUs: the IOP PWBA, the drive cable, and the drive.

The Confidence Test identifies the following CRU: floppy unit.

Operating System Diagnostics:

The Operating System Diagnostics log all encountered floppy disk subsystem errors when the Operating System is running. They also analyze and summarize these errors on request.

Note: Operating System Diagnostics are not planned for DAYBREAK or DAISY IMO, due to resource limits and priorities.

Manual Procedures:

Manual Procedures will be used in guiding the PSR in isolating floppy disk cable problems (opens, shorts, bad connections). They may also be used to further isolate between the drive and the IOP using a pulse probe and a DVM (TBD).

Table 3.3 Floppy disk subsystem and associated diagnostics

Floppy Disk Hardware	Offline Diagnostics		Online Diagnostics	Operating System	Manual Procedures
	Confidence Test	Exerciser	Confidence Test		
DMA	X	X	X	X	
Data Separator	X	X	X	X	
Floppy Controller	X	X	X	X	
Interrupts	X	X	X	X	
Drive Cable	X	X	X	X	X
Drive	X	X	X	X	XTBD

3.8 RS-232-C subsystem

The RS-232-C hardware consists of:

- RS-232-C controller (2 channels on IOP)
- RS-232-C interrupt controller logic (on IOP)
- RS-232-C cable
- external device

Diagnostic tools:

- RS-232-C turnaround plug
- DTE port can be looped back to the DCE port with the standard RS-232-C cable

The diagnostics used to verify and isolate hardware errors in the RS-232-C subsystem are (see Table 3.4):

- Offline Diagnostics
- Online Diagnostics
- Operating System Diagnostics
- Manual Procedures

Offline Diagnostics:

The Offline Diagnostics for the RS-232-C subsystem consist of the Communications Test, the Single Channel Turnaround Test and the Dual Channel Turnaround test.

Communications Test:

The Communications Test does a thorough verification of the RS-232-C subsystem. It looks for hard errors and excessive soft errors. It tests the RS-232-C controller, the RS-232-C interrupt controller logic, the RS-232-C cable, and parts of the external device.

The Communications Test is nondestructive. It is run by a customer before placing a service call, by the PSR after RS-232-C subsystem repair, and any time System Verification is run. The Communications Test uses the bitmap display for test description, error data, and FRU data .

For extended error data, errors are kept in an error log and executed commands are kept in a trace table.

The Communications Test identifies the following FRUs: the IOP PWBA, the RS-232-C cable, and the external device. Note: If a character printer is connected to one of the channels, see the Character Printer Diagnostic description.

Single Channel Turnaround Test:

The Single Channel Turnaround Test further isolates a problem to the IOP PWBA, the cable, or the external device. It uses the RS-232-C turnaround plug. It looks for hard and intermittent errors.

The Single Channel Turnaround Test is run by the PSR after the Communications Test identifies an RS-232-C interface problem. The Single Channel Turnaround Test uses the the bitmap display for test description, error data and FRU data.

For extended error data, errors are kept in an error log and executed commands are kept in a trace table.

The Single Channel Turnaround Test identifies the following FRUs: the IOP PWBA, the RS-232-C cable, and the external device.

Dual Channel Turnaround Test:

The Dual Channel Turnaround Test further isolates a problem to the IOP PWBA, the cable, or the external device. It uses the RS-232-C cable for turnaround. It looks for hard and intermittent errors.

The Dual Channel Turnaround Test is run by the PSR after the Communications Test identifies an RS-232-C problem. The Dual Channel Turnaround Test uses the the bitmap display for test description, error data and FRU data.

For extended error data, errors are kept in an error log and executed commands are kept in a trace table.

The Dual Channel Turnaround Test identifies the following FRUs: the IOP PWBA, the RS-232-C cable, and the external device.

Note: The Dual Channel Turnaround Test is not planned for DAYBREAK or DAISY IMO, due to resource limits and priorities.

Online Diagnostics:

The Online Diagnostics for the RS-232-C subsystem consist of the Communications Test.

Communications Test:

The Communications Test does a thorough verification of the RS-232-C subsystem. It looks for hard errors and excessive soft errors. It tests the RS-232-C controller, the RS-232-C interrupt controller logic, the RS-232-C cable, and parts of the external device.

The Communications Test is nondestructive. It is run by a customer before placing a service call, and by the PSR after RS-232-C subsystem repair. The Communications Test uses the bitmap display for test description, error data, and FRU data .

For extended error data, errors are kept in an error log and executed commands are kept in a trace table.

The Communications Test identifies the following FRUs: the IOP PWBA, the RS-232-C cable, and the external device.

Operating System Diagnostics:

The Operating System Diagnostics log all encountered RS-232-C subsystem errors when the Operating System is running. They also analyze and summarize these errors on request.

Note: Operating System Diagnostics are not planned for DAYBREAK or DAISY IMO , due to resource limits and priorities.

Manual Procedures:

Manual Procedures will be used in guiding the PSR in isolating RS-232-C cable problems (opens, shorts, bad connections).

Table 3.4 RS-232-C subsystem and associated diagnostics

RS-232-C Hardware	*Offline Diagnostics		*Online Diagnostics	Operating System	Manual Procedures
	Communi-cations Test	*Turnaround Test	Communi-cations Test		
RS-232-C Controller	X	X	X	X	
Interrupts	X	X	X	X	
RS-232-C Cable	X	X	X	X	X
External Device	X	X	X	X	

*Uses diagnostic hardware

3.9 Keyboard/mouse/speaker subsystem

The keyboard/mouse/speaker subsystem hardware consists of:

- keyboard UART (on IOP)
- keyboard interrupt controller logic (on IOP)
- keyboard
- keyboard cable
- mouse
- speaker logic (on IOP)
- speaker

Diagnostic hardware:

- keyboard UART internal loopback
- keyboard transmits mouse coordinates every half second

The diagnostics used to verify and isolate hardware errors in the keyboard/mouse/speaker subsystem are (see Table 3.5):

- Preboot Diagnostics
- Offline Diagnostics
- Online Diagnostics
- Manual Procedures

Preboot Diagnostics:

The Preboot Diagnostics are used to verify the keyboard UART, the keyboard interrupt controller logic, keyboard/mouse coordinates transmission, the speaker logic, and the speaker. The keyboard UART verification uses the keyboard UART turnaround logic.

The Preboot Diagnostics use the cursor on the bitmap display in conjunction with Manual Procedures to identify the diagnostic tests and the FRU list.

The FRUs associated with the keyboard/mouse/speaker subsystem Preboot Diagnostics are the IOP PWBA, the keyboard, the keyboard cable, the mouse, and the speaker.

The CRUs associated with the keyboard/mouse/speaker subsystem Preboot Diagnostics are the keyboard, the keyboard cable, the mouse, and the display (for speaker).

Offline and Online Diagnostics:

The Offline and Online Diagnostics for the keyboard/mouse/speaker subsystem consist of the Keyboard/Mouse/Speaker Test.

Keyboard/Mouse/Speaker Test:

The Keyboard/Mouse/Speaker Test does a thorough verification of the keyboard/ mouse/speaker subsystem. All errors are detected by the user. It displays the key depressions on the keyboard, the mouse X and Y coordinate motion, and speaker tone including frequency.

This test is nondestructive. It is run by a customer before placing a service call, by the PSR after keyboard/mouse/speaker subsystem repair, and any time System Verification is run. The Keyboard/Mouse/Speaker Test depends on Manual Procedures for FRU data .

The FRUs associated with the keyboard/mouse/speaker subsystem are the IOP PWBA, the keyboard, the keyboard cable, the mouse, and the speaker.

The CRUs associated with the keyboard/mouse/speaker subsystem are the keyboard, the keyboard cable, the mouse, and the display (for speaker).

Table 3.5 Keyboard/mouse/speaker subsystems and associated diagnostics

Keyboard/ Mouse/ Speaker Hardware	*Preboot Diagnostics	*Offline Diagnostics Keyboard/ Mouse/ Speaker Test	*Online Diagnostics Keyboard/ Mouse/ Speaker Test	Manual Procedures
Keyboard UART	X	X	X	
Keyboard Interrupt	X	X	X	
Keyboard		X	X	X
Mouse		X	X	X
Speaker Logic		X	X	
Speaker		X	X	X

*Uses diagnostic hardware

3.10 Display subsystem

The DAYBREAK display subsystem hardware consists of:

- DCM PWBA
- display

The DAISY display subsystem hardware consists of:

- display controller (on Mesa processor PWBA)
- display

DAYBREAK diagnostic hardware :

- write and read display controller horizontal and vertical event control store
- read data-chip status register
- read cursor status register
- read display memory interface chip status register
- read 4 bits of video data

DAISY diagnostic hardware :

- read cursor registers

The diagnostics used to verify and isolate hardware errors in the display subsystem are (see Table 3.6):

- Offline Diagnostics
- Online Diagnostics
- Manual Procedures

Offline and Online Diagnostics:

The Offline and Online Diagnostics for the display subsystem consist of the Display Test.

Display Test:

The Display Test shows display alignment patterns. These patterns can be used to visually detect display malfunctions and/or to align the display.

This test is nondestructive. It is run by a customer before placing a service call, by the PSR after displaying subsystem repair, and any time System Verification is run. The Display Test depends on Manual Procedures for FRU data .

The identified FRUs for DAYBREAK are: the DCM PWBA and the display.

The identified FRUs for DAISY are: the IOP PWBA, the Mesa processor PWBA, and the display.

The identified CRUs both for DAYBREAK and DAISY are: the display.

Table 3.6 Display subsystems and associated diagnostics

Display Hardware	*Offline Diagnostics Display Test	*Online Diagnostics Display Test	Manual Procedures
A-chip	X	X	
Display	X	X	X

*Uses diagnostic hardware

3.11 Character printer subsystem

The character printer subsystem hardware consists of:

- RS-232-C controller (on IOP)
- RS-232-C interrupt controller logic (on IOP)
- ~~cable~~ external cable
- character printer
- diagnostic tools:
  RS-232-C turnaround plug

The diagnostics used to verify and isolate hardware errors in the character printer subsystem are (see Table 3.7):

- Offline Diagnostics
- Online Diagnostics
- Operating System Diagnostics
- Manual Procedures

Offline Diagnostics:

The Offline Diagnostics for the character printer subsystem consist of the Confidence Test, the Single Channel turnaround test, and the alignment tests.

Confidence Test:

The Confidence Test tests all the options of the character printer. It looks for hard errors and intermittent errors. It tests the RS-232-C controller, the RS-232-C interrupt controller logic, the character printer cable, and the character printer. The majority of the hardware errors must be identified visually with the assistance of manual procedures.

The Confidence Test is run by a customer before placing a service call, by the PSR after character printer subsystem repair, and any time system verification is run. It uses the bitmap display for test description, error data, and FRU data.

For extended error data, errors are kept in an error log and executed commands are kept in a trace table.

The Confidence Test identifies the following FRUs: the IOP PWBA, the character printer cable, and the character printer.

The Confidence Test identifies the following CRUs: the character printer cable, and the character printer.

Single Channel Turnaround Test:

The Single Channel Turnaround Test further isolates a problem to the IOP PWBA, the cable, or the character printer. It uses the RS-232-C turnaround plug. It looks for hard and intermittent errors.

The Single Channel Turnaround Test is run by the PSR after the Confidence Test identifies a RS-232-C interface problem. The Single Channel Turnaround Test uses the the bitmap display for test description, error data and FRU data.

For extended error data, errors are kept in an error log and executed commands are kept in a trace table.

The Single Channel Turnaround Test identifies the following FRUs: the IOP PWBA, the RS-232-C cable, and the character printer.

Alignment Tests:

The Alignment Test displays alignment patterns. These patterns can be used to visually detect mechanical alignment problems. These tests are run by the PSR when the Confidence Test identifies an alignment problem.

Online Diagnostics:

The Online Diagnostics for the character printer subsystem consist of the Confidence Test.

Confidence Test:

The Confidence Test tests all the options of the character printer. It looks for hard errors and intermittent errors. It tests the RS-232-C controller, the RS-232-C interrupt controller logic, the character printer cable, and the character printer. The majority of the hardware errors must be identified visually with the assistance of Manual Procedures.

The Confidence Test is run by a customer before placing a service call, by the PSR after character printer subsystem repair, and any time System Verification is run. It uses the bitmap display for test description, error data, and FRU data .

For extended error data, errors are kept in an error log and executed commands are kept in a trace table.

The Confidence Test identifies the following FRUs: the IOP PWBA, the character printer cable, and the character printer.

It identifies the following CRUs: the character printer cable, and the character printer.

Operating System Diagnostics:

The Operating System Diagnostics log all encountered character printer subsystem errors when the Operating System is running. They also analyze and summarize these errors on request.

Note: Operating System Diagnostics are not planned for DAYBREAK or DAISY IMO , due to resource limits and priorities.

Table 3.7 Character printer subsystem and associated diagnostics

Character Printer	Offline Diagnostics Confidence Test	Online Diagnostics Confidence Test	Operating System Diagnostics	Manual Procedures
RS-232-C	X	X	X	
RS-232-C Interrupt	X	X	X	
Cable	X	X		X
Character Printer	X	X	X	

3.12 PC emulation option

The PC emulation option PWBA consists of:

- Intel 80186 processor
- IO trapper hardware
- display trapper hardware

The diagnostics used to verify and isolate hardware errors in the PC emulation option are:

- Boot Diagnostics
- Online Diagnostics

Boot Diagnostics:

Boot Diagnostics are used to verify the 80186 processor, the IO trapper hardware, and the display trapper hardware. Note: There is no special 80186 instruction test, instead the assumption is that the 80186 processor is functional after being used to verify the IO trapper hardware and the display trapper hardware.

Boot Diagnostics are run by the PSR after PC emulation subsystem repair. They use the cursor for test description, error data, and FRU data.

Boot Diagnostics identify the following FRUs: the IOP PWBA, the PCE option PWBA, and the memory processor PWBA for DAISY, or DCM PWBA for DAYBREAK.

Online Diagnostics:

The Online Diagnostics for the PC emulation option consist of the Confidence Test.

Confidence Test:

The Confidence Test tests all the options of the PC emulation option. It looks for hard errors and intermittent errors.
It is run by a customer before placing a service call, and by the PSR after PC emulation subsystem repair. The Confidence Test uses the bitmap display for test description, error data, and FRU data.

The Confidence Test identifies the following FRUs: the IOP PWBA, the PCE option PWBA, and the memory processor PWBA for DAISY, or DCM PWBA for DAYBREAK.

4 DOVE diagnostic applications

4.1 Manufacturing QA Acceptance (extended)

The purpose of the Manufacturing Quality Assurance Acceptance (extended) is to verify that the system has been assembled properly and is ready to ship. The Acceptance Test determines the reliability of the system, based upon pre-defined criteria, to quantify whether the system passes or fails. Passing this test indicates that the system is reliable for customer usage. The test monitors the health (reliability) of the electronics, notifies an operator of conditions requiring attention, and recommends maintenance action. It determines the reliability of the electronics by observing its previous error trends and then, by extrapolation, predicts future error trends.

The personnel expected to operate the Acceptance Test in manufacturing is a skilled technician.

4.2 Installation verification

The purpose of an installation verification diagnostic is to insure that all components of a system that have been installed are operating properly. The installer will run Preboot and Boot to check out the base unit followed by Offline Diagnostics set to run automatically until completion. The diagnostic should exercise the base unit and every peripheral attached to the base system that is set up in the configuration EEPROM. All subsystems that don't respond, indicate not ready, or have a fault, will be indicated on the display at completion of testing. Subsystems that indicate not ready or don't respond, can be selected to run by the installer. All fault indications are to be repaired using fault isolation procedures described below.

The users of installation diagnostics are all the users described in Section 2.1 of this document.

4.3 Fault isolation

The purpose of the fault isolation diagnostic is to find a fault in the system that has caused the operator to request service. The diagnostic packages that are used for fault isolation are Preboot, Boot, Offline, Online, Operating System Diagnostics, Acceptance Test Procedures, Utilities, and Remote. These procedures are described in Section 2.4 of this document. Fault isolation diagnostics should be able to pinpoint the fault to a single FRU eighty percent of the time, two FRUs fifteen percent of the time, three or more FRUs 4.9 percent of the time, and the system is not diagnosable 0.1 percent of the time. Fault isolation diagnostics should run for the shortest time possible so the PSR goal for MTTR is met. The MTTR goal for a PSR is for the average repair to take less than fifteen minutes for a single system failure, and in 99.8 per cent of the cases the MTTR shall not exceed 45 minutes. The PSR is expected to be able to complete ninety five percent of Dove service calls without assistance.

The users of fault isolation diagnostics are the customer user, customer user support person, Product Support Representative, Customer Support Representative, Region Engineering Specialist, Network System Consultant, Network System Engineer, Network Support Center, Manufacturing Technician, System Administrator, and System Analyst. These users are described in Section 2.1 of this document. Some of the users described above will only be able to run a subset of the fault isolation diagnostics because of the limited training given them.

4.4 Extended fault isolation

The purpose of the extended fault isolation diagnostic is to find a fault in the system that has caused numerous service calls and has not been detected by the normal fault isolation diagnostic. Many of these faults are intermittents and the only method of finding them is to run a diagnostic that will execute for several hours while logging the errors encountered. The extended fault isolation diagnostics are Boot and Offline Diagnostics that are used in a looping or automatic mode to do in-depth testing and logging of errors that occur during the testing.

The users of extended fault isolation diagnostics are the customer user support person, Product Support Representative, Customer Support Representative, Region Engineering Specialist, Network System Consultant, Network System Engineer, Network Support Center, Manufacturing Technician, System Administrator, and System Analyst.

4.5 Repair verification

The purpose of the repair verification diagnostics is to insure that any fault which has required service has been fixed and that in repairing the fault, no other faults have been created. An example of this would be if an IOP PWBA had been replaced because of a rigid disk controller failure, then the controllers for the display, keyboard, floppy disk, RS-232, and Ethernet must be verified. These diagnostics are the same as fault isolation diagnostics, but for verification the short version would be used in testing the subsystems that hadn't failed on the replaced FRU. Service procedures will instruct the technician which tests to run following a repair.

The users of repair verification diagnostics are the customer user support person, Product Support Representative, Customer Support Representative, Region Engineering Specialist, Network System Consultant, Network System Engineer, Network Support Center, and Manufacturing Technician.

4.6 Peripheral isolation

The purpose of the peripheral isolation diagnostic is to determine whether the subsystem fault that was detected is in the peripheral or in the peripheral controller. This is sometimes done with internal loopback and sometimes by external loopback tools or cables in conjunction with Boot and Offline Diagnostics. When neither the internal nor external loopbacks are practical the peripheral isolation is done by manual procedures and check charts.

The users of Pheripheral Diagnostics are the customer user support person, Product Support Representative, Customer Support Representative, Region Engineering Specialist, Network System Consultant, Network System Engineer, Network Support Center, and Manufacturing Technician.

4.7 Communications isolation and verification

The purpose of the communications isolation and verification diagnostic is to determine directly or remotely if the system and the network to which it is attached are functioning properly. This is done with Online Diagnostics that perform echo and/or direct communication with or through repeaters, communication services, file services, dial up services, workstations, print services, and gateways.

Communications isolation and verification diagnostics are a subset of Online diagnostics and are used by the Customer User Support Person, Product Support Representative, Customer Support Representative, Region Engineering Specialist, Network System Consultant, Network System Engineer, Network Support Center, Manufacturing Technician, System Administrator, and System Analyst.

4.8 Utilities

Utilities are a a collection of software packages that are used in conjunction with diagnostics and other system software. Some examples of Utilities are rigid and floppy disk scavenging, rigid and floppy disk formatting, floppy disk head cleaning, floppy disk copying, EEPROM configuration bit setting, and option slot diagnostic and printer diagnostics. Utilities are written in Mesa, use the display for the user interface, and operate in the interactive mode.

The users of Utilities are the Customer User Support Person, Product Support Representative, Customer Support Representative, Region Engineering Specialist, Network System Consultant, Network System Engineer, Network Support Center, Manufacturing Technician, System Administrator, and System Analyst.

5

DOVE diagnostic validation

5.1 Diagnostic validation

To insure the diagnostic effectiveness of repairing the DOVE machine when a single failure occurs in the system, DOVE designers shall initiate a plan to do fault insertion testing of the system. The fault insertion testing plan should be thorough enough to demonstrate diagnostic's ability to meet its plan of repairing with a single FRU eighty percent of the time, two FRUs fifteen percent of the time, and three or more FRUs 4.9 percent of the time. It is estimated that the system will be non-repairable 0.1 percent of the time. The test result must also demonstrate the ability of the system to meet the Mean Time To Repair for a PSR service call. The Mean Time To Repair goal for a PSR is for the average service call to be less than fifteen minutes for a single system failure in 99.8 percent of the cases, and shall not exceed 45 minutes. The PSR is expected to repair ninety-five percent of all service calls.

There shall be provisions in the testing plan which include preliminary fault insertion testing on the prototype hardware and early software, on the preproduction hardware, and on the final production hardware before IMO. The results of the testing will be used to improve the hardware and software where the diagnostic effectiveness has not met the diagnostic plan. The result will also be used by Service to project service cost impact where the diagnostic plan will never be met because of the impact to UMC.

An example of a test plan can be found in Appendix E. A minimum number of 300 faults must be inserted. The number of faults inserted in each subsystem is proportional to the probability of a fault occurring in that subsystem. Below is a list of the subsystems and the minimum number of faults to be inserted in each subsystem.

Subsystem	Minimum number of faults inserted
186 bus	TBD
MPB-DCM bus	TBD
IOP-S-chip bus	TBD
IOP-PCE bus	TBD
Expansion address bus	TBD
Expansion data bus	TBD
Memory system	TBD
Rigid disk	TBD

Subsystem	Minimum number of faults inserted
Ethernet	TBD
PCE	TBD
Power system	TBD
Floppy disk	TBD
Keyboard	TBD
Display	TBD
RS-232-C DCE	TBD
RS-232-C DTE	TBD

6

DOVE diagnostic implementation plan

6.1 Diagnostic sources

6.1.1 Sources of diagnostic hardware

- Some diagnostics hardware has been included in the DOVE system design. This includes internal turnaround capabilities and provisions for support of external diagnostic tools.
- Turnaround plugs or special cables can be ordered through Distribution.
- The optional maintenance panel can be ordered through TBD.

6.1.2 Sources of diagnostic software

- Manual Procedures ~~are~~ will be described in the Field Service documentation.
- Preboot Diagnostics are located in the IOP EPROMs.
- Boot Diagnostics are available from several sources: floppy disk, Ethernet, and rigid disk.
- Offline Diagnostics reside on, rigid ← possible Ethernet boot servers or floppy disks.
- Online Diagnostics reside on the local rigid disk.

6.2 Diagnostic testing and verification

Diagnostics will be upgraded as the needs dictate. Therefore the testing and verification will be on-going.

However, in each phase of the design verification and qualification tests [A, B, and C] the diagnostics will be tested. In the C-Qualification Test, faults will be induced to test and validate the procedures, insure faults are correctly identified, and the process completed within the allocated time. Qualification testing applies only to the initial release of diagnostics.

Diagnostics will be tested during the engineering build of the machines over a period of five months and during the initial manufacturing startup of over six months.

6.3 Diagnostic distribution and updates

The various types of diagnostics will be distributed differently.

Except for the maintenance panel and the turnaround cables, the diagnostic hardware will be contained in the system. Updates may occur and will be released as change notices with the part number of the hardware updated to reflect this change. The maintenance panel and turnaround cables must be ordered separately.

The diagnostic software will be upgraded and released periodically. Diagnostics updates will be distributed on floppy disks or over the Ethernet, with the exception of Preboot updates. Preboot changes require a hardware change, that is, replacing the EPROMs.

6.4 Diagnostic documentation

Each level of diagnostic software will be documented, including a discussion of the hardware tested, the options available to users of the diagnostics, the meaning of all error messages and codes, and suggested recovery actions. Preboot Diagnostics will be described in both customer and field service documentation. Engineering will provide manufacturing with appropriate documentation defining the contents of each version of the EPROMs. Boot, Offline, and Online Diagnostics will be documented by Engineering as a part of each Office Systems release. In additions, there will be customer and field service documentation for Boot, Offline, and Online Diagnostics. The Acceptance Tests Package will be described by Engineering in a document for use by manufacturing.

Whenever changes are made to any diagnostics, the systems documentation indentured list will reflect the proper diagnostic number.

6.5 Diagnostic documentation release control

After the initial release, all subsequent releases will be controlled either by the hardware or the software release control mechanism. In either case, there will be some form of review board committee to understand the impact of the benefits versus the cost of the pending release.

6.6 Diagnostic availability and implementation priorities

This document outlines all the diagnostics which are currently envisioned for DOVE. Not all of them will be available for the DAYBREAK launch, due largely to software development priorities and resource constraints. Assuming no redirection from OSD Core Systems, all the diagnostic software described in this document will be implemented for DOVE, but will be released at different times. The current implementation priorities and schedules for diagnostic software are, in descending order of priority:

Planned for DAYBREAK launch:

1. Preboot, Boot, Offline (rigid disk),
   Online (floppy disk, RS-232-C port, Ethernet, keyboard and mouse, display, optional local printer, PC emulation option card)

2. Acceptance tests

3. Offline (Ethernet)

4. Offline (keyboard and mouse, display)

5. Memory error management (mapping out bad pages; requires hooks in the debugger substitute, the initial IOP code, and the boot diagnostics; see Appendix E)

Planned for DAISY launch:

6. Offline (floppy disk)

7. Offline (RS-232-C port, TTY port)

8. Remote interface to offline diagnostic

9. Offline (optional local printer)

Post DAISY launch:

10. Operating system diagnostics (automatic soft error logging, perhaps by a network diagnostic monitoring service)

A

Appendix A DOVE machine configuration management

This section describes how the various DOVE configurations are detected and managed by the system software that runs on the machine. There are two elements to be considered with regard to configuration management. The first is the medium that is used to store the information. This information must obviously be machine readable, and of a semi-permanent nature. That is, it should remain in the system when the power is turned off, and it must be able to be readily changed, although on an infrequent basis. The second element is the actual information that is to be stored in the medium and how it is to be managed. Section A.1 will consider the configuration storage medium requirements, Section A.2 some implementations, and Section A.3 will discuss the information contained therein and how it is managed.

A.1 Configuration storage medium

Since there are a variety of peripherals, I/O devices, and memory sizes that can be connected to a DOVE machine, there needs to be some method for the system software and diagnostics to dynamically determine what the current configuration is. In addition, due to some differences between software that runs on a DAISY machine as opposed to a DAYBREAK machine, it also needs to be determined on which of the two DOVE machines the software is running.

Thus, there are to be some number of bits available to the IOP indicating the nature of the peripherals, as well as a special bit denoting either the DAISY or DAYBREAK machine. These bits will be infrequently read by the software, and will be changed by a human each time the configuration or implementation of the machine is physically changed. This information needs to be retained after the machine is powered down. The implementation should provide a convenient, error-free method of setting the bits, and be realized with as little UMC and board area as possible.

At present, there is a need for about 30 configuration bits identified. These include the DAISY/DAYBREAK bit, and bits for memory size, rigid disk type, floppy disk presence and type, display type, Ethernet presence, keyboard type, and other optional devices present. Since the DAISY/DAYBREAK bit is a special type, it is implemented by the particular Mesa processor which is plugged into the card-cage. The IOP will read the bit from the backplane.

There are several possibilities for implementing the storage of configuration information, including the rigid disk, the floppy disk, using unique cables, DIP switches, and EEProms. For various reasons, it has been decided that EEProms will be used for the configuration information medium [reference: *DOVE Machine Configuration,* DOVE Diagnostic Team design note, May 14, 1984].

An EEProm is an EProm that can be electrically erased and written. Like an EProm, it retains its contents after the power has been turned off. (A similar device is called a non-volatile RAM, or NOVRAM. This device essentially is a RAM with a shadow EEProm. Before the power is turned off, the RAM information has to be transferred to the EEProm, and re-read after power is turned on again. Extra external circuitry is needed to control these transfers, and they are usually of higher cost. Thus, this form of memory is not considered further.)

An EEProm is included as an IOP I/O device and can be read when needed. The EEProm can be written under control of IOP software. A special software tool will be needed to insert or change the configuration information. This method provides flexibility by providing a substantial amount of information at a relatively low cost.

Two possible EEProm implementations have been considered. A final decision has not yet been made of which implementation to use. The first etch of the IOP will support both cases. The next section discusses two possible EEProm implementations and makes a recommendation for a preferred scheme.

A.2 EEProm implementation alternatives

An EEProm is a cost-effective way to store a significant amount of readable and writeable non-volatile information. All the EEProms described below are +5V only, and thus do not require any special power supply voltages. They are relatively easy to read and write. The types considered below are either parallel in/out, or serial in/out. The serial EEProms are more complicated to access from a software point of view, but have low cost and small board area. EEProms still tend to be single-sourced devices and not compatible from manufacturer to manufacturer.

Case 1: 64 x 16 Serial EEProm

In this implementation, the National NMC 9346 serial EEProm is used. The EEProm is organized as a 64 x 16 memory, which is serially accessed. This provides 1K bits of storage. The part is packaged in 8-pin DIPs and requires a small amount of board space. This part is a larger version of the NMC 9306 which is organized as 16 x 16. (The latter EEProm is not usable due to a frequency limitation of the part.) The advantages of this scheme are its low cost (approximately $3.50) and small board area (about 1 sq. in.). The disadvantage is that the part is not yet in production. Full production is planned for October-November 1984. (The NMC 9306 is already in full production, so it is not anticipated that there will be production problems with the larger part.) An additional disadvantage is that the software overhead to access the part is higher than the parallel devices. This access is, however, infrequently made.

Case 2: 2K x 8 Parallel EEProm

In this implementation, the Intel 9817A is used. The EEProm is organized as a 2K x 8 memory and is read and written in parallel. The main advantage is that the software access is simple, and that there is a large amount of memory storage available. The main disadvantages are the cost of the scheme (about $16.00) and the board area required (about 3 sq. in). Extra address decoding circuitry is needed, and the part is a 28-pin device.

Table A.1 compares the two scheme designs using the various parameters mentioned above.

Table A.1 EEProm implementation comparison

Parameter	Case 1	Case 2
Access method	Serial	Parallel
Organization	64 x 16	2K x 8
UMC	$3.50	$16
Board area (sq. in.)	1	3

Discussion

From the above table it can be seen that the serial implementation clearly has an advantage over the other schemes in terms of UMC and board area. The extra software overhead to access the information is not thought to be a problem, since it is infrequently done and is part of a special tool. It is felt that 1K worth of bits is more than adequate for storing configuration information. (It might not be adequate for storing memory and disk bad pages, however.) The only significant risk is that the part is not yet in production.

Recommendation: It is recommended that the serial implementation (Case 1) be incorporated into the second etch. This is due to cost and area advantages. (Note that every extra $1 UMC translates into about $80,000 extra program UMC over the life of the DOVE program.) At the time of second etch, we will know if there is still any risk due to the production status of the National part. If there still is, the backup implementation can be the other case. Meanwhile, as mentioned above, the first etch will implement both alternatives. This recommendation will be implemented unless there is redirection resulting from a DOVE Diagnostic Team consensus, or from the Program.

A.3 Configuration information description and management

The configuration utility

There will be a floppy- or Ethernet-bootable configuration utility that will allow initializing and modifying the configuration EEPROM. Setting the EEPROM is a manual, menu-driven process. The configuration utility will not be able to do it automatically, because the hardware is not completely self-identifying. This utility will be based on UtilityPilot and written in Mesa. It will be similar to the disk initialization utility, and could possibly be incorporated into that utility.

A safe default configuration

The management of the configuration EEPROM must be carefully thought out to avoid any circular dependencies. One such circular dependency could occur if the EEPROM were required to be initialized before the configuration utility program could be booted to initialize it. The strategy to avoid this predicament is to substitute a safe default configuration whenever the EEPROM is found to be invalid or uninitialized. The default configuration must allow the configuration utility to be booted and run.

The important parameters of the safe default configuration are memory size, display, floppy disk, and Ethernet. It should be safe to set the memory to the smallest allowable size, the display to "experiment," the floppy disk to "both types present," and the Ethernet to present. Note that two backplane signals will identify the processor type (currently either DAYBREAK or DAISY).

For the display, "experiment" instructs the IOP boot code to experiment with the display controller to determine which crystal oscillator is installed and thus which type of display is expected. This involves timing the interval between vertical retrace interrupts. For each supported display, this interval will be different. Once the display type has been identified, the display controller can be correctly initialized to allow use of the display by the configuration utility.

For the floppy disk, "both types present" means that both types of floppy disks should be assumed to be present. This would allow the user to boot from whichever type of floppy is present, if there is one.

An alternate strategy for the floppy would be to reserve a fixed location in a sector on cylinder 0, head 0, of every floppy diskette for floppy drive type information. This would require that all DOVE floppies be formatted identically on the track on cylinder 0 under head 0, so that no knowledge of the floppy drive type would be required to read that track.

The safe default configuration should allow a configuration utility program to be booted from either type of floppy or Ethernet and use the display, regardless of type. This strategy requires the ability to distinguish invalid and uninitialized EEPROMs from valid EEPROMs. By including a word of checksum followed by its complement in the EEPROM, it should be virtually impossible for an uninitialized or otherwise invalid EEPROM to appear valid.

Managing the EEPROM contents

Managing the contents of the configuration EEPROM can be divided into three phases:

1. setting it initially when the machine is configured prior to shipping.
2. reading it during system initialization while booting.
3. changing it whenever the hardware configuration (or other EEPROM information) is changed.

Setting it before shipping

When a DOVE workstation is configured prior to shipping, the configuration utility should be run to set the EEPROM correctly. This is when the safe default configuration will be used most.

Reading it during booting

The IOP booting code in EPROM will read the configuration EEPROM early in booting in order to present the user with the correct set of boot device choices, among other things. It will verify the checksum and its complement in the EEPROM before trusting it. If the checksum or complement is incorrect, the booting code will post an error indication in the LED status indicators. A keystroke from the user is required to continue after an EEPROM error is indicated. This will cause the booting code to try to complete the booting process using the safe default configuration. The user should try to boot the configuration utility and attempt to reset the configuration EEPROM, assuming the checksum problem is only transitory. If the problem is persistent, then the IOP (the FRU containing the EEPROM) will have to be replaced, and the new EEPROM reset.

There should be a way to force the booting code to use the safe default configuration. This would be necessary, for instance, if the EEPROM checksum and complement are valid but the indicated configuration is set incorrectly. It should be possible to circumvent the EEPROM manually by holding down a special key during booting.

Changing it when the hardware is changed

When the hardware configuration is changed, the configuration utility should be run to change the EEPROM appropriately. It should be possible to change the EEPROM *before* changing the hardware, if that is ever required, since the EEPROM will probably be read during initialization only.

Rigid disk backup

If possible, the EEPROM configuration information should be backed up on the rigid disk. This facilitates restoring the configuration information to the EEPROM after replacing the IOP/RDC board, which contains the EEPROM.

It should be possible to reserve a sector on the rigid disk for backing up the EEPROM contents. A good candidate is the sector where we currently put the first page of the initial microcode. The initial microcode could start on the following page on DOVE machines, since this location is allowed to be processor-dependent. It should be possible to read this page without knowing the type of disk. If not, a less attractive alternative would be to require the user to manually specify the type of the disk to the configuration utility.

Note that it would probably be unwise to store the configuration information only on the disk, and not include an EEPROM on DOVE. One reason is the significantly lower reliability of disk memory compared to EEPROM memory. Couple that with the fact that there would then be no place to back up the configuration information, and reliable maintenance of this information could become a significant problem. Replacing the disk would result in the loss of the information. A third reason is that it may not be possible to read a particular sector on all disks without knowing the disk type. An EEPROM or other storage medium other than the disk is *required* if the latter is true, because it would be unacceptable to ask the user the disk type on every hard boot.

Contents of configuration EEPROM

The configuration EEPROM should include the following kinds of information:

- display type
- keyboard type
- rigid disk presence and type
- floppy disk presence and type

- main memory size
- virtual memory size
- Ethernet presence
- RS-232-C channel A and B device types and attributes
- option board types and attributes, including PC emulation
- booting options (default boot device, whether to run Boot Diagnostics)
- memory lock mode (hardware or software)
- address of last main memory parity error and count
- list of bad main memory pages
- checksum and its complement

B

Appendix B
DOVE scavenging and formatting

This section discusses how rigid disk scavenging and formatting should be handled in relation to DOVE offline disk diagnostics. On the DANDELION, both physical volume scavenging and formatting were functions built into the offline disk diagnostics. For DOVE, the proposal is to package scavenging and formatting in a separate boot file from the full offline rigid disk diagnostics. This should make it possible to release new offline disk diagnostics only when the diagnostics themselves change, not when scavenging or formatting changes.

B.1 Scavenging

DANDELION offline disk diagnostics include the ability to run the Pilot physical volume (PV) scavenger. The PV scavenger is a program that can restore damaged operating system data on the rigid disk. This data is required to be intact and valid in order to access the user data on the disk. Damage to this or other data on the disk can result from rigid disk hardware failures. Hence scavenging is a step that may be required to return a workstation to service after a rigid disk hardware failure has been repaired.

One mode of operation of the PV scavenger is called "risky repair mode." Because of the risks of this "last-chance" scavenging mode, it is imperative that the disk hardware be healthy before the scavenger is run. Otherwise the scavenger can fail catastrophically. The only way to guarantee healthy hardware is to incorporate this mode of scavenging into the diagnostics, so that the diagnostics must be run immediately before invoking the PV scavenger in risky repair mode.

One disadvantage of incorporating scavenging into the offline disk diagnostics is that new diagnostics must be released to the field with every release in which the scavenger changes. Field Service would prefer to release new diagnostics only when new diagnostic features are added or the hardware itself is changed.

Another disadvantage is that the scavenging software takes up valuable main memory that could otherwise be used for additional diagnostic functions. The amount of memory involved is modest.

For DOVE, a separate boot file will be produced for non-diagnostic ("utility") functions such as scavenging. This boot file will of necessity contain a subset of the offline disk diagnostics, so that the disk hardware can still be validated immediately prior to running the PV scavenger in risk repair mode. Other levels of scavenging from the hierarchy of scavengers can also be packaged in this same boot file. Pilot's logical volume (LV) scavenger and page scavenger should be included.

Separating scavenging from the main offline disk diagnostic boot file in this way will allow fewer field updates to offline disk diagnostics, as well as room in memory for a modest increase in diagnostic functions.

B.2 Formatting

DANDELION offline disk diagnostics also include the ability to run the Pilot disk formatter. The formatter program is used to initialize the disk with sector marks and header fields for each sector. It also records the disk sectors that are unuseable due to media flaws. This formatting is normally done once by manufacturing for each new disk, and never again.

On rare occasions the formatting information on the disk is accidentally overwritten and invalidated, for instance as a result of a hardware failure. These rare instances require reformatting before the disk can be used again. The act of formatting a disk causes all prior ifnormation stored on that disk to be lost, so gratuitous formatting is to be avoided at all costs. Similar to scavenging, it is important that the disk hardware be completely healthy before formatting a disk. Hence disk formatting was included in the DANDELION offline disk diagnostics boot file.

For DOVE, the formatting function will be included in the disk utility boot file, for the same reasons that scavenging has also been moved to this new boot file.

D

Appendix D
DOVE disk data integrity

D.1 Introduction

This section describes the DOVE strategy for minimizing data loss on the rigid and floppy disk drives during power cycling of the machine. The power cycling will occur when the user or service person turns the machine off and on, or when power to the building in which the machine is installed is lost. The latter case is of a random nature, and thus precautions that could be taken in the former case cannot be used.

What is the problem? When power is lost to the machine, a point is reached when the logical elements are no longer operating in their normal operating regions. If the machine is not carefully designed, the power loss could cause unwanted write operations on the disk, thus damaging the data on the device. This problem applies to both the rigid and floppy drives, although the impact of any loss is far more serious on the rigid drive. Consequently, the amount of protection is much larger on the rigid drive. Similarly, if the circuits are not well behaved at power-up, similar destructive write actions could occur.

The rest of this appendix describes what is provided in the DOVE design to minimize any data loss. It will be seen that there is a high degree of protection built into the DOVE system to minimize data loss on the magnetic media. It is not possible to totally eliminate the possibility of data loss; the attempt is to reduce the probability to an acceptable low level. In most cases, power cycling will cause no loss or damage of data. In a small percentage of the cases when power loss is unexpected, a single sector can be damaged. More than one sector will never be damaged. This single sector damage can, to some extent, be repaired by a scavenger program.

D.2 Areas of protection

There are several areas in the machine that need to be addressed to effect protection on the disk drives. In addition, software tools are needed to implement repair actions after some data loss has occured (so-called scavenging operations). This section discusses each of the following areas for both the rigid and floppy disk drives: power supply, disk controller, disk drive, and software.

D.2.1 Power supply

When the AC power is lost to the system, the power supply has to immediately sense this occurrence and signal the IOP. In this way, the IOP can reset all its logic to an inactive state, so that the disk controllers will be well behaved during the power loss. The power supply generates a "power normal" signal indicating that all DC outputs are up and usable after the turn-on period, and also to indicate imminent loss of output during turn-off or AC input power failure. After turn-on, *power normal* becomes logically active between 50 and 250 milliseconds after all voltages have exceeded 94% of their normal values. During AC turn-off or power loss, *power normal* will go logically inactive before any output decreases to 94% of the nominal value. (The power will actually disappear about 1 ms after *power normal* becomes active.) The full cycle is repeated if a momentary power outage occurs.

The *power normal* signal is provided to the IOP for its use. It provides the capability for the IOP to hold all controllers (in particular, the rigid disk and floppy controllers) in a reset state while the power is stabilizing at turn-on, and while the power is disappearing during turn-off. No further actions can occur during this reset state. An interesting situation is when there is actual disk-write activity as the power is being turned off. In this situation, it is impossible to prevent some data loss. The *power normal* signal allows this data loss to be minimized to one sector only (see below).

D.2.2 Disk controller

As mentioned above, when the controller is reset by the system reset signal, no controller activity can occur. All control signals are in their inactive states. In the case of the disk controllers, the most critical signal is the WriteGate signal. Disk write operations can only occur when this signal is active. Resetting the system will stop all controller activity, and thus the WriteGate signal will not be activated. More importantly, the system reset signal gates the WriteGate signals *directly*. This ensures that the WriteGate signal is immediately (within 50 ns) aborted when the system reset becomes active. Thus, if WriteGate was active when the power loss occurred, the write operation will be aborted and the data loss minimized to the particular sector being written. The usual effect will be that the sector will have an invalid CRC which will need to be repaired by a scavenger (see below). This applies to both the rigid disk and floppy disk controllers. Note that in the case of the rigid disk, the sector damage could be in the label or data field, or both. (If the drive was being formatted, damage could occur to the header; but there is no user information on the track, and recovery can be effected by reformatting.)

D.2.3 Disk drive

The disk drives have additional protection built into them to prevent spurious writes during power up and power down. The DOVE Rigid Disk Drive Specification states that "Power ON/OFF sequencing of the DC power supplies shall not impact data integrity of the recorded information." The drives usually implement this by internally disabling the WriteGate signal to the drive when the DC power starts dropping. The Quantum drives internally disable WriteGate when the +5V drops 10% of its nominal value, and/or the +12V drops 20%. Note that this internal disabling of the WriteGate signal is over and above the controller disable.

In addition, the Quantum and Micropolis drives retract the heads to a landing area after power loss. The Seagate drive does not retract the heads or have a landing area, but has a dynamic brake to quickly bring the spindle to a stop. Other drives have a landing zone, but require software to move the heads there before power down. Note that it is still possible to damage the sector on which a write operation had started at time of the power outage.

There is no internal drive protection on the floppy disk drives. Reliance is placed on the controller protection. (Floppies can also be individually write-protected.)

On power-up, the rigid drives internally disable the WriteGate signal until the drives become ready. At this point, the DC power is guaranteed to be stable.

D.2.4 Software

There is no software to actually prevent spurious writing on the disks. The software discussed here is intended to repair the damage which occurs in the infrequent occasions that a sector is lost, as described above. These software tools are called scavengers, and their purpose is to rebuild the disk data structures. The full discussion of scavengers is beyond the scope of this section, but the particular operation with regard to repairing the bad sectors above will be described.

A scavenger can rewrite these bad sectors and repair the invalid CRC. The data that was intended for the end of the sector cannot, of course, be rewritten, but the sector once more becomes a readable sector. Certain critical sectors on the rigid disk volume, such as the Physical Volume Root page, is redundantly written on the volume. The scavenger will repair such a damaged sector by retrieving the information from the redundant copy of that particular sector. Other sectors are handled differently depending upon whether the file with the bad sector is a Star file or a Tajo file. The current Star scavenger (File Check) does not attempt to repair the file that contains the bad sector. It actually deletes the entire file from the desktop. It is not known whether future File Check programs will improve on this. The Tajo scavenger will leave the rest of the file intact, and all that is lost is the part of the sector that was not written. If the damage occurred in a code sector, then full recovery can be achieved by reinstalling the software.

Currently, no floppy scavenger exists. Thus, it is not known what level of repair will be provided in the future.

will be fixed to show implemented

E

Appendix E DOVE diagnostic validation plan

E.1 Scope

This plan defines the procedures to be followed during the DOVE workstation diagnostic validation. This documentation will include only electronic faults on subsystems unique to the DOVE workstation.

E.2 Objectives and criteria

This test has two primary objectives, Mean Time To Repair (MTTR) and Probability of Automatic Diagnosis (PAD). The diagnostic validation testing will cover the DOVE workstation including controllers, pheripherals, and Xerox offered options at the time of testing.

E.2.1 MTTR

The DOVE workstation is required to meet an MTTR average of not more than fifteen minutes for a single system failure in 99.8 per cent of the cases and shall not exceed 45 minutes. MTTR includes diagnostic, removal of covers, removal and replacement of the failed FRU, verification of repair, and replacement of covers. It does not include other times which may be associated with a service call such as administrative time, parts procurement time, operator training, etc.

E.2.2 PAD

The DOVE workstation is required to meet the PAD to repair with a single FRU eighty percent of the time, two FRUs fifteen percent of the time, and three or more FRUs 4.9 percent of the time. It is estimated that the system will be ~~non-repairable~~ 0.1 percent of the time.

non diagnostic

E.3 System requirements

One system will be required. Two sets of fully socketed PWAs are required to facilitate IC fault insertion.

E.4 Test requirements

E.4.1 Pre-test requirements

When the system is received for testing, the following steps will be taken.

- Functional verification of system operation with the standard PWAs.
- Functional verification of system operation with the spare PWAs.

Software must be available to do Mesa level applications as well as diagnostics.

All necessary tools, spares, and documentation must be in the test lab prior to test start.

E.4.2 Functional responsibility

E.4.2.1 Engineering

Provide manpower and the basic test system of IMO configuration. No configuration changes will be permitted after the test has started.

Two sets of socketed PWAs should be provided by Development Engineering. The original PWAs will be used as spares for replacement of the indicated failing FRU.

The diagnostic implementors must supply an error code dictionary and pertinent data to Engineering for review prior to the start of test.

E.4.2.2 Service

Service shall provide service documentation where applicable. A Service test observer is optional.

E.4.3 Test philosophy

The testing intent is to measure the maintainability parameters which are exclusively or predominantly a function of system design. Service response time, logistics time, etc., are not pertinent to this demonstration. A field simulation will be maintained only to the extent necessary to ensure valid measurements of engineering maintainability parameters.

The testing of an inserted fault is scored as a success or failure depending on whether or not the fault is properly diagnosed. The fault code must indicate the FRU, or if there are multiple FRUs, then the code should indicate the probability of each of the FRUs. If the tests find the failed fault, and the code predicates the failed FRU or FRUs, the test is scored as a success; if not, it is scored as a failure. Repair times and the faulty parts will be recorded. All parts used and all steps performed must be recorded.

E.4.4 Test schedule

The diagnostic validation will be run in three phases. The first phase will test prototype hardware, the second phase will test preproduction hardware, and the third phase will test

IMO hardware. The first two phases will be used for pinpointing shortcomings in the hardware and software so corrections to the hardware and software can be made for IMO. Failure to meet MTTR and PAD is not critical for the first two phases, but it is required that MTTR and PAD be met for the IMO test phase.

At the conclusion of each phase of testing, Engineering will publish a report stating whether the present phase of testing has demonstrated that MTTR and PAD have exceeded the goals by a significant margin, met the goals, or have not met the goals. A report stating that the present phase of testing has not met the goals must include a plan to correct the shortcomings in hardware and/or software.

E.4.5 Test details

E.4.5.1 System verification

Prior to inserting a fault, proper system operation will be verified to ensure that only a single fault is present at any given time. The required verification will include:

- Boot Diagnostic
- Mesa level software applications

E.4.5.2 Fault selection

A random number technique will be used to select a single fault from the fault list developed by Engineering and Service. The list must contain sufficient faults to provide the required sample of 300 faults with allowance for invalidations. The selection process is controlled so that frequencies reflect the anticipated reliability levels. The number of faults inserted in each subsystem is proportional to the probability of a fault occurring in that subsystem. For example, if 300 faults are inserted in the system, and the probability of failure in the subsystem being tested is 10 percent, then 30 faults will be inserted in that subsystem.

E.4.5.3 Fault insertion

The selected fault will be inserted in the system by the engineering test group. In the case of socketed PWAs, a device lead may be bent or cut to induce the fault. Care will be taken to ensure the presence of a hard fault. Other techniques such as disconnecting wires, adding insulators, etc., will be used as required to generate the desired faults.

E.4.5.4 Fault verification

Once the fault has been inserted, the system verification will be reported to ensure that a fault symptom is present. If no symptom is displayed, the original configuration will be restored and a new fault selected. If there is reason to believe that the symptom displayed is not due to the inserted fault, the original configuration will be restored and the system reverified before proceeding. Failure of the diagnostics to detect an inserted fault will be scored on the data sheet as not diagnosable.

If the system fails the verification but the PSR has repaired the inserted fault, it will be assumed that a second fault occurred after the PSR completed his task. Therefore, this fault would be recorded as valid data.

If the system passes the verification but the PSR has not repaired the inserted fault, the data point will be considered invalid and marked invalid.

E.4.5.9 System restoration

The system will then be restored to the original configuration and steps E.4.5.1 through E.4.5.9 repeated until the 300 samples required have been obtained.

E.4.6 Invalid data

Data will be invalidated only if a second fault is determined to be present.

E.4.7 Test report

A final report will be issued no later than two weeks after test completion. The report will include all data as well as any pertinent observations from the test.

F

Appendix F
DOVE hardware needs for serviceability

F.1 E^{2}PROM

Presently there are two options for the E^{2}PROM configuration control chip. The one that is chosen will determine what is in the chip and how it is used. There is a need for configuration control, bad memory management, and bad disk page logging in the E^{2}PROM. The order in which they are mentioned is their order of priority. All data in the E^{2}PROM should be backed up on the rigid disk.

F.2 Configuration control

There are 10 items that need to be described in the E^{2}PROM. Most of the subsystems need only a couple of bits to describe the known variations, but for programming reasons it is best to use words, bytes, or nibble bit groups. If the 2k X 8 E^{2}PROM is used, the byte method is most practical. In the case of 64 X 16, the method used will be mandated by the amount of information that is needed to be stored. Some of the things that need to be placed in the E^{2}PROM are default boot devices (rigid disk, Ethernet, RS-232, and floppy disk), Ethernet configurations (Ethernet present, standard Ethernet, optical, and cheaper net), displays (15-inch, 17-inch, 19-inch, and color), keyboard types (English, German, French, Swedish, Norwegian, Danish, Italian, Finnish, Japanese, and Chinese), floppy disks (present and type), memory sizes, RS-232-C-DTE (set up and usage), RS-232-C-DCE (set up and usage), option slots (set up and usage), and E^{2}Prom checksum.

F.3 Bad memory management

It can be shown that 60 percent of the memory service calls can be saved by mapping out bad memory. In another 20 percent of the failures the problem can be corrected by mapping out 128 pages. It should be noted that mapping out 128 pages would slow down the system considerably in the basic workstation configuration but would have little effect on a four megabyte system. Mapping out 128 pages is not acceptable for the long run but will allow the user to operate until a service call can be made. The customer who performs his own service can elect to fix the mapped out memory or leave it.

Another aspect of bad memory management is trapping and logging of parity memory crashes. This would require pilot to trap and record the last page in memory accessed when a parity error occurs. Soft errors are random and some are repeatable; the repeatable soft errors will cause frustration especially when the system gets up to four megabytes. To make memory mapping completely functional and effective, pilot must start using none