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This project provided partial support for equipment upgrades of the Scripps Satellite Oceanography Center (SSOC). At the time this award was made, SSOC was using antiquated (circa 1976) computer technology to capture, archive, process and distribute satellite data, both in near-real time and retrospectively, in support of U.S. west coast oceanographic studies. I am pleased to report that the funds provided by the Office of Naval Research through this grant, in combination with other funds obtained from the National Aeronautics and Space Administration, the National Science Foundation, the University of California, and private industry, have been used to completely modernize SSOC. Because the main intent of ONR funding provided under N00014-90J-1024 was to provide for needed equipment upgrades, this final report emphasizes hardware and network infrastructure upgrades made possible by ONR funds.

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Arlington, VA 22217-5000

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16 October 91

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SUBJECT: Final Report for "Development of Real-Time Image and In Situ Data Analysis at Sea"
ONR Grant #N00014-90J-1024
Performance Period 1 October 89 - 30 September 91
Amount Funded: $90,000

OVERVIEW

This project provided partial support for equipment upgrades of the Scripps Satellite Oceanography Center (SSOC). At the time this award was made, SSOC was using antiquated (circa 1976) computer technology to capture, archive, process and distribute satellite data, both in near-real time and retrospectively, in support of U.S. west coast oceanographic studies. I am pleased to report that the funds provided by the Office of Naval Research through this grant, in combination with other funds obtained from the National Aeronautics and Space Administration, the National Science Foundation, the University of California, and private industry, have been used to completely modernize SSOC. Because the main intent of ONR funding provided under N00014-90J-1024 was to provide for needed equipment upgrades, this final report emphasizes hardware and network infrastructure upgrades made possible by ONR funds.

The Scripps Satellite Oceanography Center now occupies two locations: 1) a capture trailer which is located adjacent to SSOC's 5m steerable antenna near the NORPAX building on the Scripps campus; and 2) a new User Center which is located in the southwest wing of the Deep-Sea Drilling Project building just south of William A. Nierenberg Hall. Three computer systems were purchased as part of the SSOC reorganization and revitalization (Figure 1). The Deepdish System provides for continuous capture from multiple satellites. The Blackhole System is the analysis machine used either by researchers to process/analyze their data or by SSOC personnel to process job requests for remote users. The Oddie System is the data archive, browse and distribution system. All three systems are connected via the UCSD campus broadband internet to the San Diego Supercomputer Center and from here to the NSF, NASA, and internet backbones. This allows external users access to SSOC services, a necessity for newly developed capabilities such as SSABLE (see below).

THE DEEPDISH CAPTURE SYSTEM

Real-time support of oceanographic experiments is one of the most important functions of the Scripps Satellite Oceanography Center. To insure high quality service in this area the old capture system was replaced by a new frame and bit synchronizer and a UNIX-based HP9000/370 workstation equipped with magneto-optical disc and DAT tape (Figure 2). Also, the old Scientific Atlanta Orbital Tracker was replaced with a new Scientific Atlanta Orbital Tracker and the antenna subsystem was overhauled.

THE BLACKHOLE ANALYSIS SYSTEM

A new HP9000/350 workstation was installed at SSOC to perform satellite data analysis functions for users. Features include: 1) 1.2 Gbytes hard disc; 2) 660 Mbytes removable magneto-optical disc, 330 Mbytes per side; 3) XWINDOW compatible 1024x780 6 bit deep color display; 4) Metheus 1024x1024 24 bit color display; 5) 9 track (1600/6250 bpi) self-loading tape drive; 6) 1.3 Gbyte DAT tape; 7) MS-DOS compatible partition within the UNIX system and DOS diskette I/O capability; 8) HP Laserjet2 300 dots per inch printer; 9) HP Paintjet XL-Color inkjet printer for inexpensive quality prints; and 10) Focus Imagecoder RGB input direct to camera for high quality slide and photocopies (Figure 3). This system provides ample resources to efficiently handle most user computational needs. An economical upgrade path to a HP9000/380 will substantially improve speed and is planned for FY 92.

THE ODDIE SYSTEM FOR ONLINE ARCHIVE AND BROWSE

A new HP9000/380 image analysis workstation (Figure 4) with a 2.5 Gbyte hard disc (1.3 of this currently is on order), 32 volume autochanger for online access to 20 Gbytes of removable magneto-optical disc, XWINDOW 8 bit color display, and 9 track dual density 1600/6250 bpi provides the ingest and compute engine for the new SSABLE system. SSABLE provides users nation-

wide with direct access via internet to all passes captured at SSOC within 10 minutes of capture completion. Presently, SSABLE is in a national beta test period. At this time about 30 users from the U.S. and Canada are participating in SSABLE.

THE SCRIPPS SATELLITE ARCHIVE AND BROWSE FOR LOCALIZED ENVIRONMENTS (SSABLE)

A brief description of the SSABLE System is included in this final report because the ONR Grant N00014-90J-1024 purchased some equipment used by SSABLE. SSABLE is a new interactive tool for browsing the Scripps Satellite Oceanography Center's (SSOC) archive of satellite data in your laboratory or office. The archive contains data from the NOAA/AVHRR (Advanced Very High Resolution Radiometer) series of satellites (TIROS-N, NOAA6-12) dating from 1979 to the present. SSOC maintains a capture station and data are continually added to the SSABLE system within ten minutes of capture completion.

SSABLE provides an easy to use point-and-click, mouse-driven user interface developed around the OSF/Motif widget set and the X Window protocol. All options are selected by either directly clicking the mouse on the desired push-button, or pulling down a sub-menu from a push-button. A "fill-in-the-blanks" window appears to guide the user in defining the operation. All SSABLE option menus have "Cancel" push-button to abort the operation. Users can search for data by time and day, geographic coordinate, or if the user knows the structure of the Scripps archive, by explicit archive number. A typical SSABLE display screen (Figure 5) shows satellite data, area of coverage, and some of SSABLE's point-and-click operations.

Once data have been selected which meet the user's needs, it can be ordered on a variety of media. A "scratch pad" is included inside SSABLE to temporarily save an image and rebrowse later. In this manner, complex composite searches can be performed. By viewing the SSABLE scratch pad, more operations become defined. Each operates on either the entire scratch pad or only the selected images in the scratch pad. Images are selected by high-lighting them with the mouse. Among the scratch pad defined operations are mailing and ordering. The contents of the scratch pad can be mailed to a user if a final decision on ordering has not yet been reached. If certain images are desired, they can be ordered from the scratch pad.

All data available to browse are Level 1 data with a spatial resolution of 1.1km at nadir. At present all data captured at SSOC since January 1, 1991 have been incorporated into SSABLE. Starting 15 September 91 four to six AVHRR passes will be automatically captured per day and integrated into SSABLE. The historical SSOC archives also are being incorporated into SSABLE. At present all available 1979 data and part of the 1980 data can be accessed through SSABLE.

Unlike many other digital browse systems, SSABLE does not require users to invest in expensive hardware and/or software. The only requirements to use SSABLE are: 1) have a bit-mapped display (monochrome or greater); 2) be running the X Window system; and 3) be on a network directly reachable from the SSABLE system. Merely use *telnet* to determine whether a given network is directly connected to the Internet.

SSABLE is network and machine independent; it will run identically on any machine which

meets the above requirements. SSABLE has been tested at Scripps Institution of Oceanography, University of British Columbia, University of Washington, Goddard Space Flight Center, NOAA Southwest Fisheries Center, Carnegie-Mellon University, University of Southern California, the Institute for Naval Oceanography, the Naval Postgraduate School, and Stanford University using HP workstations, SUN workstations, Silicon Graphics workstations, DEC 3100 workstations, Macintosh PCs with X Window, and NCD X terminals.
Users may order images on the following media: 9-track tape (1600 bpi or 6250 bpi), digital audio tape, cartridge tape, or optical disk. All data are in the Archive Tape Format as described in NOAA Technical Memorandum NESS 107.

For additional information please send email to "browse@oddie.ucsd.edu". Note, SSABLE's design is sufficiently extensible that it can straightforwardly accomodate other types of satellite data (e.g. GOES, CZCS, SeaWIFS).

REAL-TIME CAPTURE UPGRADES

Utilization of the above technology now makes it possible to automatically capture multiple AVHRR passes per day from all functioning NOAA satellites. Depending on orbit considerations, the number of passes collected per day now varies between 4 to 6. Within 10 minutes of each capture, the newly acquired data is incorporated into the SSABLE system and is ready for near-real time browsing by the entire earth sciences community connected to SSOC via internet. To the best of our knowledge, SSOC is the only facility in the world with this capability.

This approach to real-time capture, data management and distribution has resulted in cost savings to users. Extra pass collection charges (above the traditional one pass per day) have been dropped. Moreover, starting 1 January 92 (i.e. after completion of the SSABLE beta test period), all SSABLE accessible level 1 data will be reduced substantially in price.

FINANCIAL

All funds ($90,000) were spent prior to 30 September 91.

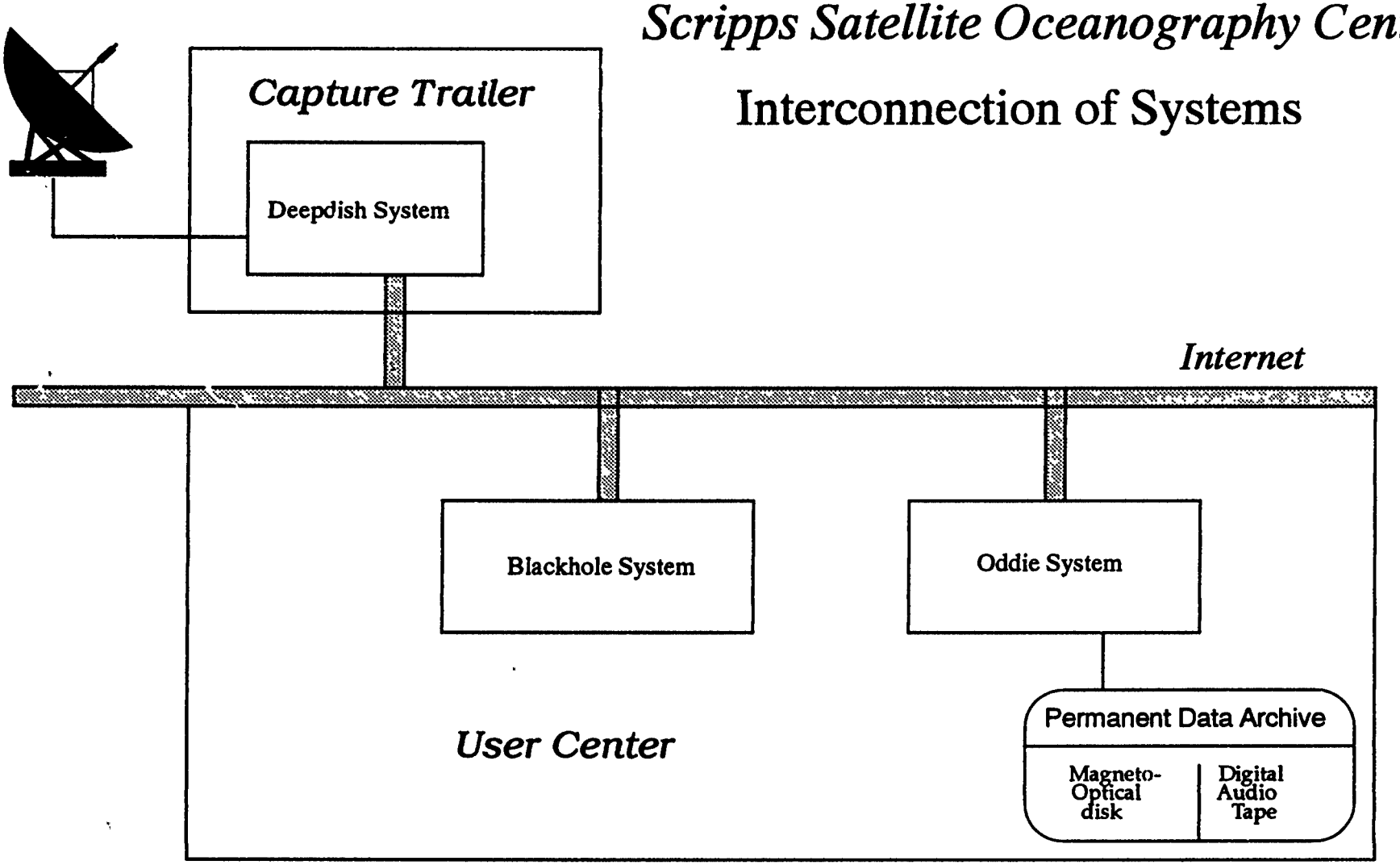
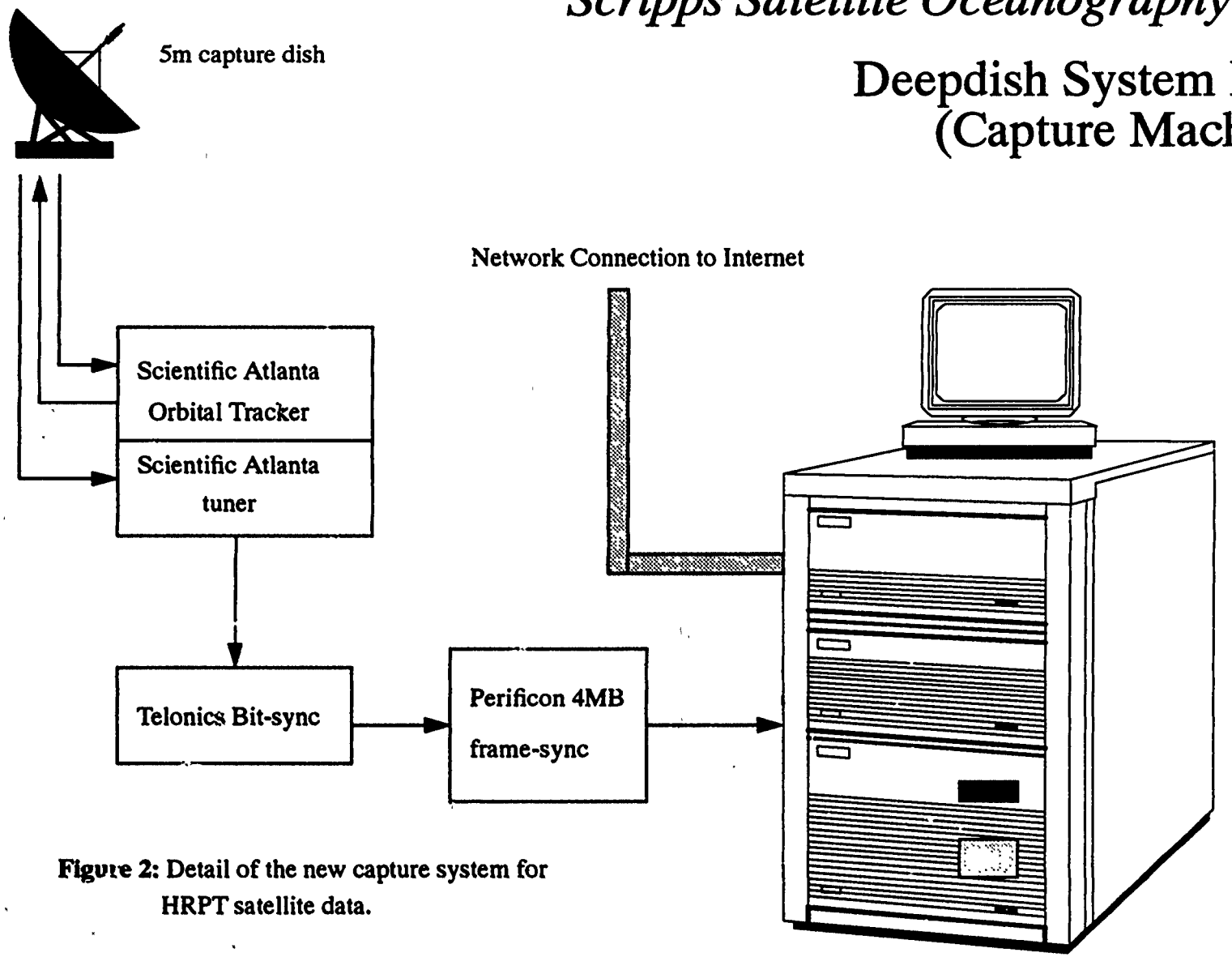


Figure 1: Overview with internet connections of SSOC's computer systems.

Scripps Satellite Oceanography Center

Deepdish System Diagram (Capture Machine)



HP9000/370 Workstation with:

1024x780 Monochrome display

650 MB Hard disk

300 MB Hard disk

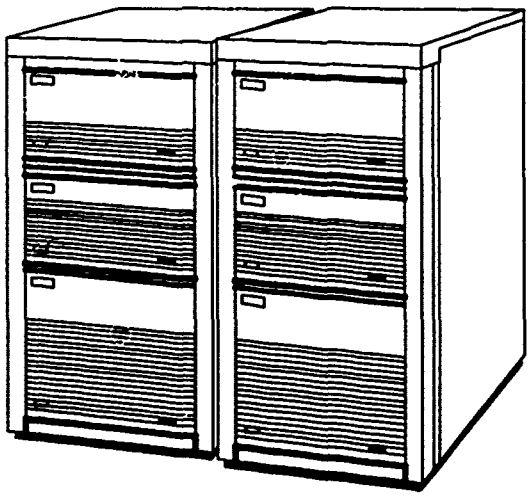
Magneto-optical disk drive

Digital Audio Tape drive

Figure 2: Detail of the new capture system for HRPT satellite data.

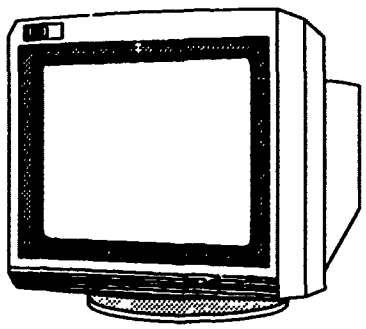
Scripps Satellite Oceanography Center

Blackhole System Diagram (Analysis Machine)



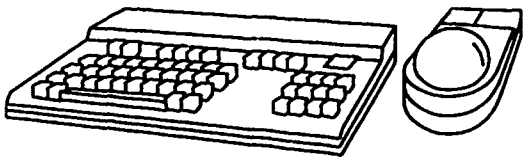
HP 350 Workstation

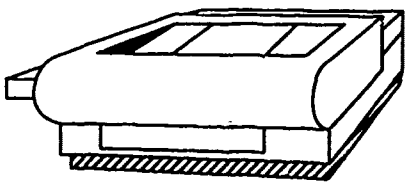
Motorola 68020 CPU
2 - 512 MB hard disks
330 MB optical disk drive
1.3 GB Digital Audio Tape(DAT) drive
9 track autoloading tape drive
Cartridge tape drive



1024x780 6 bit color display
Keyboard, Mouse
X window capability

Metheus 1024x1024 24 bit color display
True color capability
Focus Imagecorder - RGB input device with camera mount





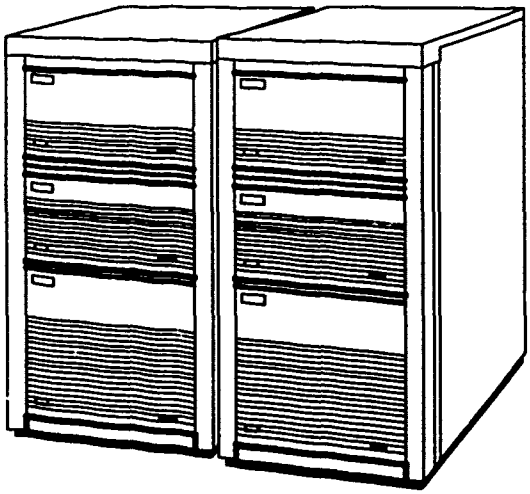
HP laser jet 2 - 300 DPI Black and White

HP Paintjet XL - Color ink jet printer

Figure 3: New system configuration for Blackhole.

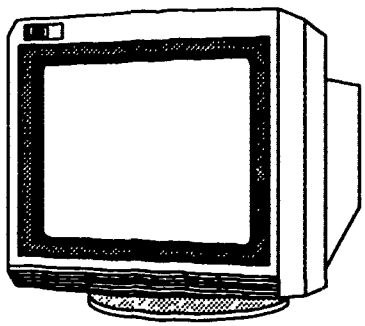
Scripps Satellite Oceanography Center

Oddie System Diagram (Archive Machine)

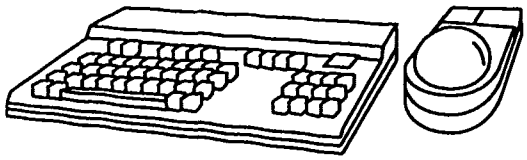


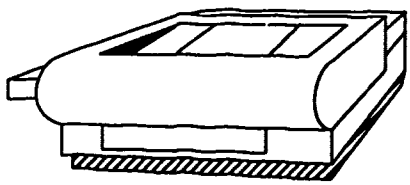
HP 380 Workstation

Motorola 68040 CPU
2 -300 MB hard disks
650 MB hard disk
2 -330 MB optical disk drives
32 volume optical disk autochanger
20 GB storage
1.3 GB Digital Audio Tape(DAT) drive
9 track tape drive
Cartridge tape drive



1280x1024 8 bit color display
Keyboard, Mouse
X window capability





HP laser jet 3
300 DPI B&W with PostScript

Figure 4: New system configuration for Oddie.

Figure 5: SSable's Introductory Screen.