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# HP UPGRADE OPERATIONAL STREAMLINING

D. Edge, K. Emenheiser, B. Hanarahan, D. McCollums, P. Seery

Allied-Signal Aerospace Company
Seabrook, Maryland

R. Ricklefs

University of Texas
Austin, Texas

Abstract

New computer technology and resources must be successfully integrated into CDSLR station operations to manage new complex operational tracking requirements, support the on site production of new data products, support ongoing station performance improvements, and to support new station communication requirements.

The NASA CDSLR Network is in the process of upgrading station computer resources with HP UNIX workstations, designed to automate a wide range of operational station requirements. The primary HP upgrade objective was to relocate computer intensive data system tasks from the controller computer to a new advanced computer environment designed to meet the new data system requirements. The HP UNIX environment supports fully automated real time data communications, data management, data processing, and data quality control. Automated data compression procedures are used to improve the efficiency of station data communications. In addition, the UNIX environment supports a number of semi-automated technical and administrative operational station tasks. The x window user interface generates multiple simultaneous color graphics displays, providing direct operator visibility and control over a wide range of operational station functions.

# HP UPGRADE OPERATIONAL STREAMLINING

The successful integration of new HP computer resources into the Crustal Dynamics Project (CDP) Satellite Laser Ranging (SLR) Network as part of the HP Upgrade Project has led to critically needed improvements in data system capability and significant gains in network operational efficiency. This paper provides a brief description of the HP Upgrade Project strategy and progress to date in streamlining station operations.

The HP Upgrade Project was initiated in 1987 to prepare the CDP SLR Network to meet the operational challenges presented by multi-satellite tracking operations in the 1990's. The technical approach for the HP Upgrade Project was based on the recommendations of the CDP Computer Panel, which recognized that new station requirements to support up to ten operational satellites and to produce on site normal points could not be supported by existing station computer resources. The existing computer resources recorded tracking data on floppy disk or magnetic tape and required manpower intensive operations to reload the data back into the computer to support station data processing activity. In addition, data processing operations and satellite tracking operations could not be performed at the same time. Therefore, data processing operations had to be scheduled around periods of operational tracking and were typically performed at the end of an operational shift. These problems delayed the production of data products and severely limited network tracking productivity. The basic HP Upgrade Project strategy was to integrate a second computer system into the existing station configuration to provide the required additional computer resources.

In 1988 the first HP computer systems were purchased, and development of HP Upgrade prototype systems started at the Goddard Space Flight Center (GSFC) and at the University of Texas. The development of a parallel prototype at the University of Texas was necessary to address the unique requirements of a lunar tracking station. HP UNIX software development projects were shared between GSFC and the University of Texas to reduce critical software development timelines and to maintain design consistency.

The Moblas 7 and MLRS HP prototype systems were successfully tested in 1990. In 1991, the HP Upgrade was deployed to the remaining network operational Moblas systems and development started on HP Upgrades for TLRS 3, TLRS 4, and Hollas. The TLRS 3, TLRS 4, and Hollas HP Upgrades are expected to be completed in 1992.

In order to reduce the load on critical station manpower and computer resources, the HP data system was designed to provide fully automated data communications and data processing during multi-satellite operations. Figure 1 presents a simplified diagram of HP data system functions. The functions associated with real time tracking operations are divided between the controller and HP computers. Other Non real time HP functions, which include general station operations and automated post tracking functions complete the automated HP Data System Product Cycle. Depending on the number of observations in the pass, the HP Data System was designed to produce the normal point data product 1 to 5 minutes after the operator has closed out the operational data set. The time

**required to compress the normal point data set and transmit the data product to headquarters is less than 1 minute.**

**The HP Data System has built in flexibility which allows interleaving of multiple satellite and calibration sets. The code has been written to allow for many different combinations of hardware settings. This has been accomplished via the use of different levels of ranging activity. By changing levels within the software, the operator may determine which calibration sets (with possibly different hardware characteristics) go with which satellite sets. Up to five different levels may be selected. This feature makes it possible to quickly switch from one satellite to another and back again using calibration sets which may be unique for each satellite. Figure 2 is an example of a single shift of Moblas 4 support scheduling multiple satellite and calibration operations. Scheduled ERS-1, Ajisai, Lageos, Etalon 1, Etalon 2, and Starlette passes are labeled E1, AJ, L1, MT, NT, and ST respectively. Scheduled calibration tracking is labeled C1. The activity scheduled at the bottom is the sum of scheduled satellite and calibration activities. The station is continuously ranging satellites or the calibration target for over 5 hours during the shift. The scheduling of multi-satellite operations has significantly increased the operational productivity of operational laser stations. Additional information concerning the scheduling of multi-satellite tracking operations is presented in another Eight International Workshop on Laser Ranging Instrumentation paper "SATCOP Mission Planning Software Package".**

**Control of all processing and maintenance operations is provided by a mouse and/or keyboard driven, user friendly multi-level menu interface. These menu controlled operations include data archiving, tuned IRV prediction communications, data product statistics review, station communications, semi-automated daily tracking operations reports, and other general station data communications. The user interface is written in the 'C' programming language and uses the Motif/x windows style and flavor. The use of this industry standard ensures that the user interface is consistent with other operating systems (in addition to UNIX) and is also consistent with widely available off-the-shelf commercial software.**

**The design prototype for the second "processing" computer system was a UNIX based HP 360 workstation. Low cost upgrades have brought the design prototype up the the current CDP SLR network configuration described in Figure 3. The HP 380 computer configuration includes two 332 MB hard disks to improve efficiency by directing data operations to one disk and operating system functions to the other disk. A 650 MB optical disk is included to provide on line data archiving, a efficient backup media, and to support major software system upgrades. The 67 MB cartridge tape is used as a low cost media for generating weekly full rate mailing tapes. The HP Paintjet printer supports local hard copy requirements. The 19.2k baud modem supports a wide range of station communication requirements including data communications and software system updates. The 16 inch color supports the X-Window environment and is the primary user control interface device for the HP Data System.**

**The Moblas, MLRS, TLRS, and Hollas systems all have unique controller computer hardware and software environments. Real time control functions may also vary station to station (MLRS is a lunar station, for example). The HP Upgrade development strategy was to minimize the impact on real time controller functions, requiring only real time data communications to the HP "processing computer" and off load as many non real time functions as possible from the controller to the "processing computer". A simplified functional block diagram for TLRS 3/4 is presented in figure 4. The controller**

(or tracking) computer performance in managing the real time computer interfaces was a key technical design problem for each station type.

Real time applications were developed in C in the HP UNIX environment to record and manage the flow of raw data measurements from the controller computer to the HP 380. Automated C and Fortran applications assemble, screen, and prepare the raw data measurements for automated data processing. Based on inputs from the system operator, automated data processing functions start as soon as the raw data set is complete.

The HP UNIX software environment, with includes FORTRAN and C applications, was selected to make maximum use of existing operational software, provide multi-vendor hardware portability, and to provide a robust industry x window user interface for station operations. The HP Upgrade Project software strategy was to develop real time applications in C and other data system applications in FORTRAN to make the best use of current operational software. The station user interface was developed in the HP UNIX x window environment to make the best use of the HP 380 workstation resources in controlling station operations.

In order to meet the new station normal point data system requirements and maintain data system integrity, operational data system software was rehosted from VAX/VMS Fortran to HP UNIX Fortran. The field data processing system was designed to use identical data processing algorithms and to perform the same basic data processing and data quality control functions as the operational headquarters system. These data processing functions include quality control of raw data measurements, calibration data processing, computation of satellite ranging corrections, analytical satellite data fitting, and satellite data compression to form normal points. The field data processing system was designed to produce the same operational quality control statistics and data products as the headquarters system. These data statistics and data products were carefully benchmarked against the operational headquarters data system before the HP Data System was declared operational. Some software system utilities used in the VAX/VMS environment had to be replaced with equivalent HP UNIX utilities during software rehosting.

The HP Data System Upgrade has been successfully operating at Moblas 4, Moblas 5, Moblas 7, and MLRS for over a year, producing on site normal points, generated within minutes of operational satellite tracking. Starting in April 1992, multi-satellite operations were successfully integrated into the HP Upgrade Data System, contributing to recent record data production by Moblas 4 and Moblas 8. Upgrades to the HP workstation CPU's have been successfully accomplished in the field without software system modifications and have enabled the HP Data System to accommodate massive increases in data volume associated with multi-satellite operations and two shift network support for TOPEX. Remote software system updates have been performed using modem communications, without impacting station operations. The automation of the Data System has helped free up critical station manpower resources needed to sustain nearly continuous tracking operations associated with multi-satellite support. The HP Upgrade is the first major step in streamlining CDP SLR operations. Strategic technical planning to replace the controller computer, providing necessary computer resources to automate other station functions, is in progress. In addition, direct computer network communications to CDP SLR network stations is expected to be established in the near future, providing advanced communication resources to automate remote software system management activities and global data communications.

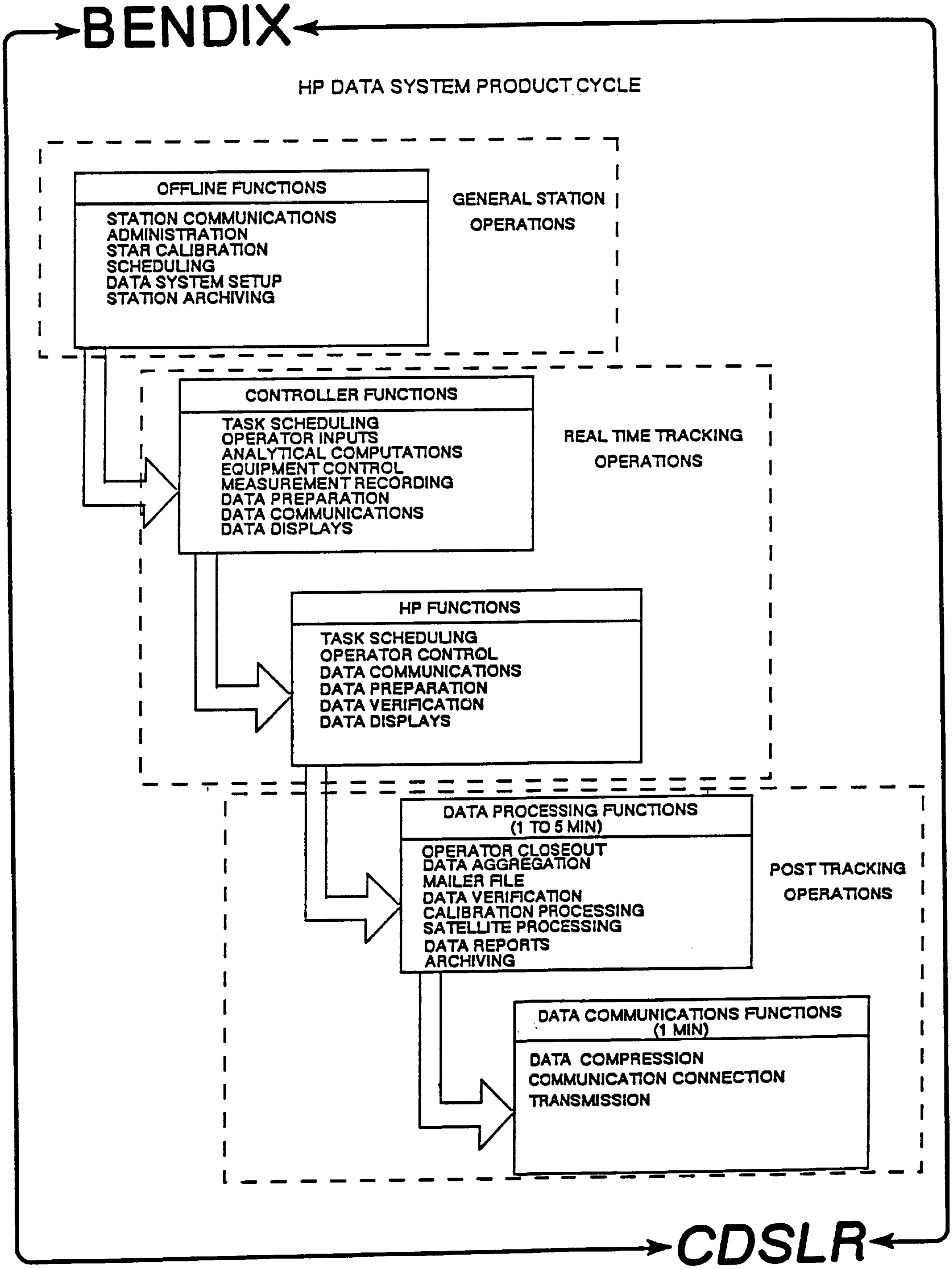
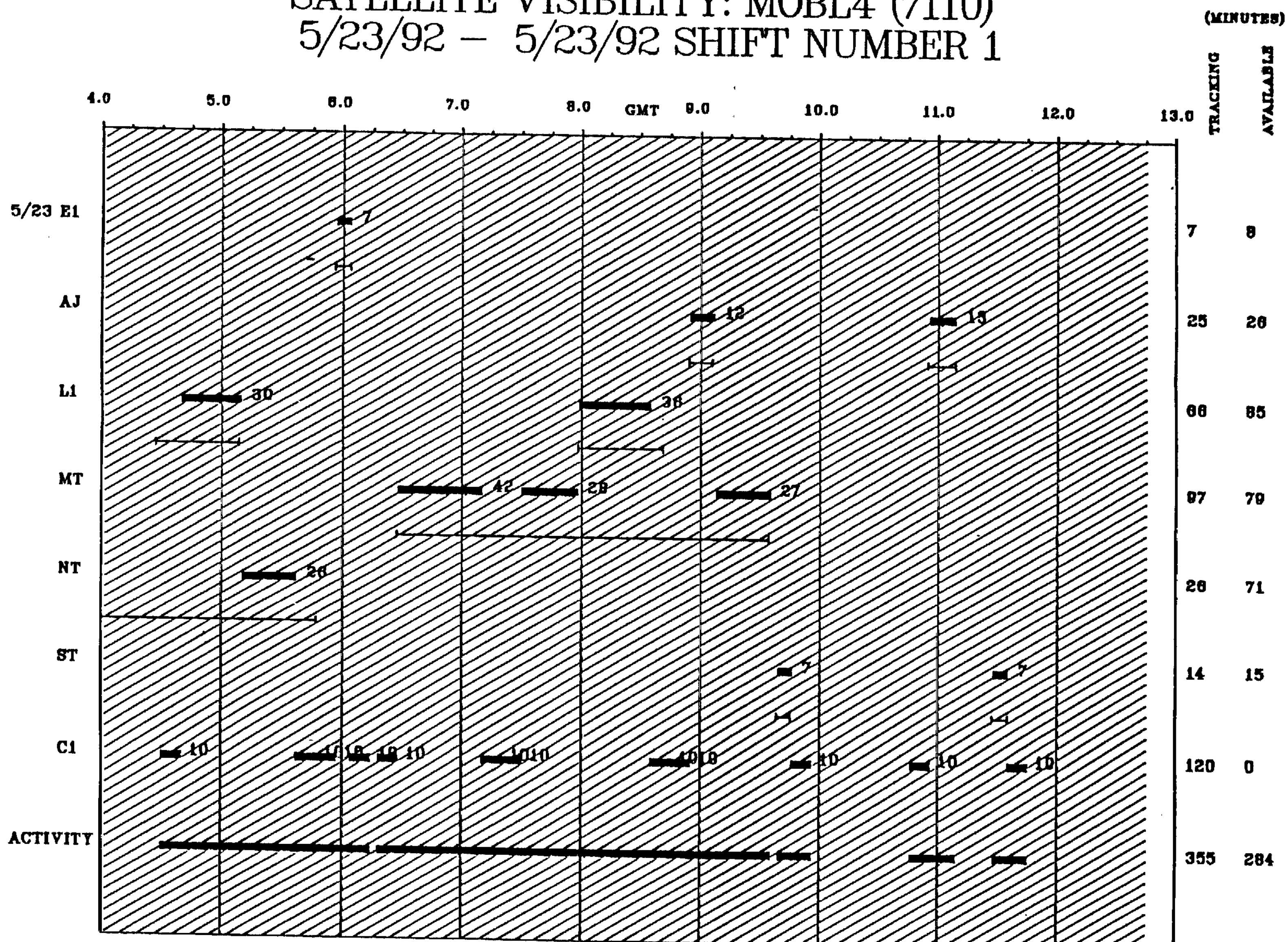

BENDIX
HP DATA SYSTEM PRODUCT CYCLE
OFFLINE FUNCTIONS
STATION COMMUNICATIONS
ADMINISTRATION
STAR CALIBRATION
SCHEDULING
DATA SYSTEM SETUP
STATION ARCHIVING
GENERAL STATION OPERATIONS
CONTROLLER FUNCTIONS
TASK SCHEDULING
OPERATOR INPUTS
ANALYTICAL COMPUTATIONS
EQUIPMENT CONTROL
MEASUREMENT RECORDING
DATA PREPARATION
DATA COMMUNICATIONS
DATA DISPLAYS
REAL TIME TRACKING OPERATIONS
HP FUNCTIONS
TASK SCHEDULING
OPERATOR CONTROL
DATA COMMUNICATIONS
DATA PREPARATION
DATA VERIFICATION
DATA DISPLAYS
DATA PROCESSING FUNCTIONS (1 TO 5 MIN)
OPERATOR CLOSEOUT
DATA AGGREGATION
MAILER FILE
DATA VERIFICATION
CALIBRATION PROCESSING
SATELLITE PROCESSING
DATA REPORTS
ARCHIVING
POST TRACKING OPERATIONS
DATA COMMUNICATIONS FUNCTIONS (1 MIN)
DATA COMPRESSION
COMMUNICATION CONNECTION
TRANSMISSION
CDSLR

FIGURE 1

BENDIX

# SATELLITE VISIBILITY: MOBL4 (7110)
## 5/23/92 – 5/23/92 SHIFT NUMBER 1




date created: 5/15/92
BFEC/CDSLR DSG Bucey Conklin

THICK SOLID CURVE IS ACTUAL TRACKING.
ATTACHED THIN CURVE IS PRE/POST CAL TIMES.
NOTATION ON PASS IS MINUTES OF PASS TRACKED.

SINGLE THIN LINE IS ACTUAL VISIBLE PASS.

SHADED SECTION IS NIGHT.

CDSLR

FIGURE 2

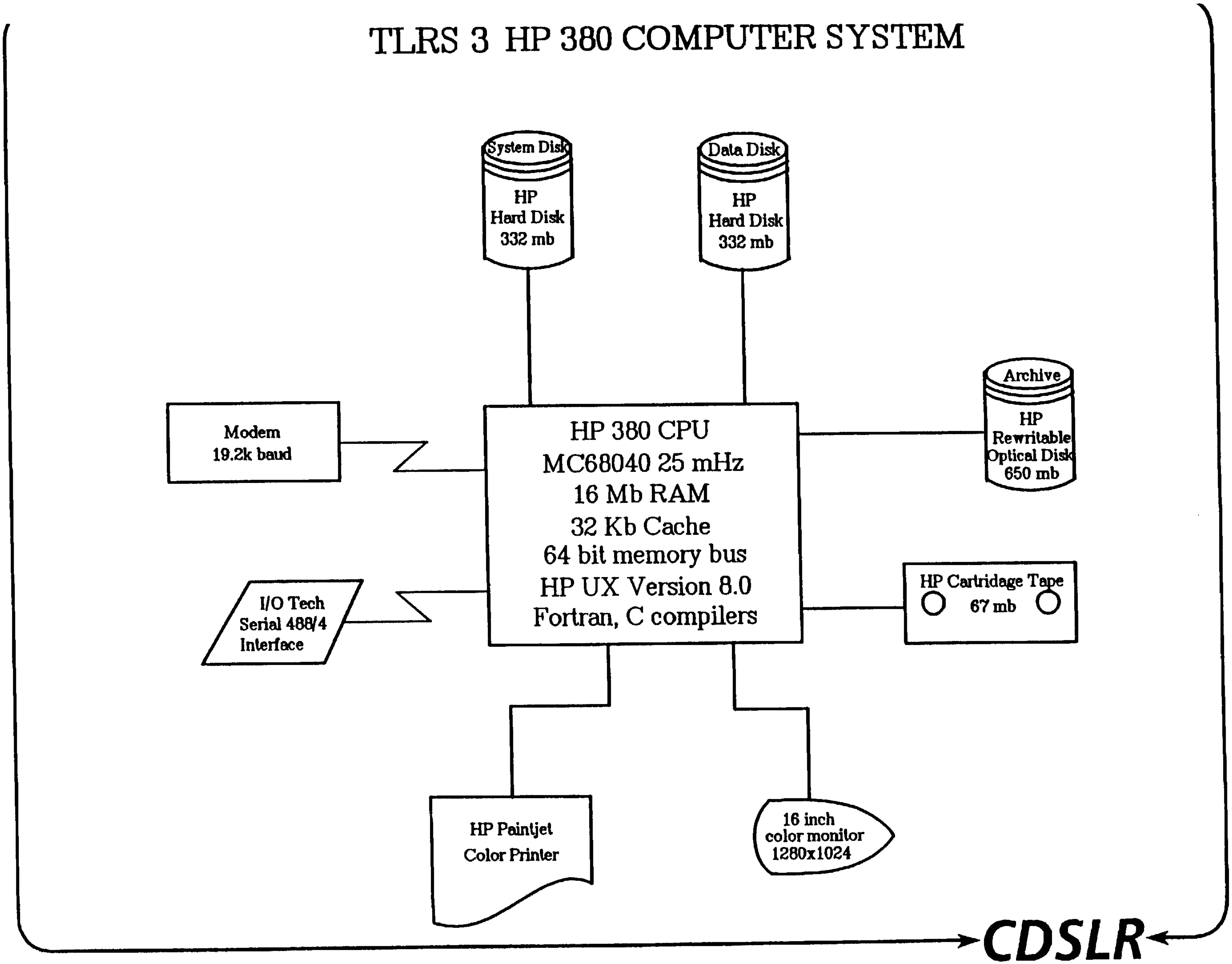

TLRS 3 HP 380 COMPUTER SYSTEM
System Disk
HP
Hard Disk
332 mb
Data Disk
HP
Hard Disk
332 mb
Archive
HP
Rewritable
Optical Disk
650 mb
Modem
19.2k baud
HP 380 CPU
MC68040 25 mHz
16 Mb RAM
32 Kb Cache
64 bit memory bus
HP UX Version 8.0
Fortran, C compilers
I/O Tech
Serial 488/4
Interface
HP Cartridage Tape
67 mb
HP Paintjet
Color Printer
16 inch
color monitor
1280x1024
CDSLR

FIGURE 3

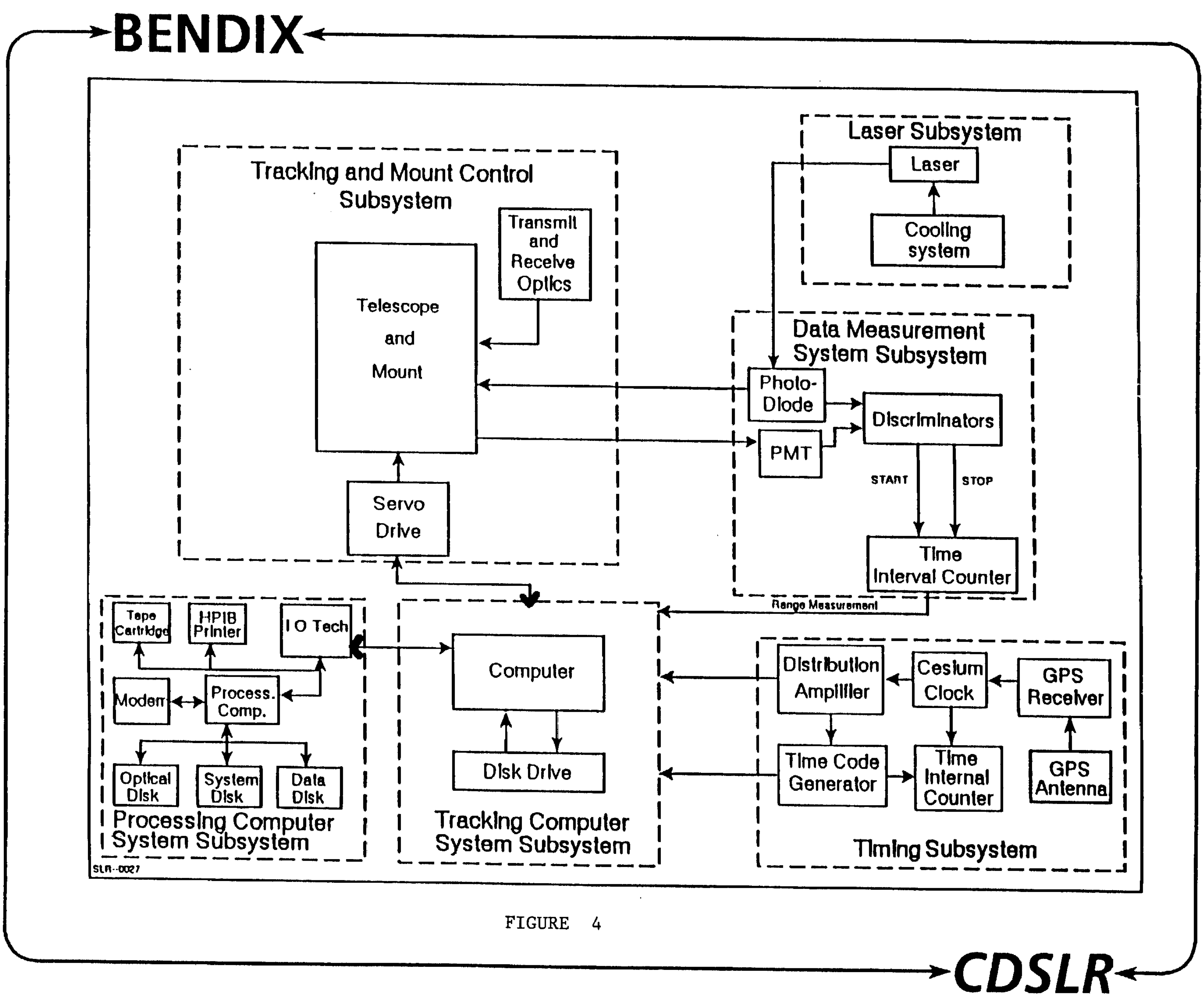

BENDIX
CDSLR
Tracking and Mount Control Subsystem
Transmit and Receive Optics
Telescope and Mount
Servo Drive
Laser Subsystem
Laser
Cooling system
Data Measurement System Subsystem
Photo-Diode
PMT
Discriminators
START
STOP
Time Interval Counter
Range Measurement
Tape Cartridge
HPIB Printer
I O Tech
Modem
Process. Comp.
Optical Disk
System Disk
Data Disk
Processing Computer System Subsystem
Computer
Disk Drive
Tracking Computer System Subsystem
Distribution Amplifier
Cesium Clock
GPS Receiver
Time Code Generator
Time Internal Counter
GPS Antenna
Timing Subsystem
SLR-0027

FIGURE 4