TELEMETRY PROCESSING SYSTEM
FOR THE
PACIFIC MISSILE TEST CENTER

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ABSTRACT

Since the late 1970's the telemetry processing and display requirements of the Pacific Missile Test Center have been handled by the Telemetry Data Handling System. With the increasing use of embedded computers on test vehicles and the requirements to process and display larger volumes of data at higher data rates, many programs will soon exceed the capabilities of the Telemetry Data Handling System. The Telemetry Processing System is a replacement of the Telemetry Data Handling System that will be brought on-line in the Pacific Missile Test Center's Telemetry Data Center in 1990. The Telemetry Processing System is required to meet the processing and display requirements of the Pacific Missile Test Center's range users for the next decade. A discussion of the functional implementation and performance requirements of Telemetry Processing System is presented.

INTRODUCTION

The mission of the Pacific Missile Test Center is the test and evaluation of high performance state-of-the-art airborne weapon systems for the NAVY, other Department of Defense Agencies, and the armed forces of allied nations. As part of the requirement for performing this mission, telemetry data from numerous sources must be received, recorded, processed, displayed, and analyzed.

The Telemetry Processing System is the next generation of telemetry processing and display that will be brought on-line at the Pacific Missile Test Center. The Telemetry Processing System is projected to have an operational life span of 10 years and is required to meet the telemetry processing and display requirements of the range users over that period. The Telemetry Processing System will have a maximum throughput of 700,000 parameters per second. In addition to having increased processing and display

capability in comparison to the current telemetry systems, the Telemetry Processing System will be more flexible and less manpower intensive in its operation. Due to the requirement to do more with less, computer automation will be utilized extensively in the setup, calibration, and operation of the system.

SYSTEM REQUIREMENTS

The Telemetry Processing System will be a stand-alone telemetry processing and display system that is also capable of providing telemetry parameters to other range systems and functions, such as the Range Central Site Computers, Range Operations Display System and Range Safety. The Telemetry Processing System will be capable of performing telemetry only operations without the assistance of any non-telemetry range systems. The Telemetry Processing System will be able to support two concurrent telemetry operations in any mix of real time and post flight scenarios. It will be composed of two or more identical systems that can be operated in parallel in order to provide support for range projects requiring fully redundant capability. In order to conduct the more than 3000 real time and post flight operations that the Pacific Missile Test Center supports each year, the ability to quickly reconfigure the system for different operations is paramount. The use of setup menus and computer automated equipment calibration and system verification will be essential to meet this requirement. Additionally, the Telemetry Processing System must be a highly flexible system that can easily be adapted to the varying processing and display requirements of the range users. The display capabilities of the Telemetry Processing System will include high resolution color graphics with displays that can easily be tailored to meet the requirements of individual users.

FUNCTIONAL IMPLEMENTATION

A simplified block diagram showing how the Telemetry Processing System will be integrated into the Range Instrumentation Complex is shown in Figure 1. A functional block diagram of the Telemetry Processing System is shown in Figure 2. The Telemetry Processing System will be required to provide selected real time telemetry parameters to other range systems via the Range Central Site Computer Systems (CYBER 175's and 860's). Examples of this would be Range Safety information or telemetry data required for display on the Range Operations Display System. The Telemetry Processing System will receive Time and Space Position data and other parameters that are desired by the range telemetry users from the Range Central Site Computers for display on the telemetry graphics systems. It should be emphasized that even though the Telemetry Processing System will be able to obtain and display limited range operations and control information, this will be done only as a convenience for the range telemetry users. The Telemetry Processing System is not a range operations and control system but rather a dedicated telemetry system.

The Telemetry Processing System can be broken down into four functional hardware groups. They are the Telemetry Front End, Telemetry Data Preprocessor, System Host Computer, and Graphics Display Systems.

A functional block diagram of the Telemetry Front End is shown in Figure 3. The Telemetry Front End will receive the incoming real time serial data streams from the Telemetry Data Collection Facility via fiber optic links or post flight data streams from playback of analog tapes. The Telemetry Front End performs data separation/ demultiplexing and outputs bit parallel, word serial data to the Telemetry Preprocessor for additional processing or pass-through directly to the System Host Computer. The Telemetry Front End will be capable of processing eight PCM data streams at rates up to 10 megabits per second, two PAM data streams at rates up to 250,000 channels per second, one FM multiplex stream, and four MIL-STD-1553 PCM encoded data streams. The equipment in the Telemetry Front End will be configured, calibrated and controlled via the System Host Computer.

The Telemetry Preprocessor will be used between the Telemetry Front End and the super mini-computer based System Host Computer. The Telemetry Preprocessor will perform many of the repetitive processes which are generally required for high speed telemetry data processing and remove this burden from the System Host Computer. The Telemetry Preprocessor will perform the following functions: Data ID tagging, data merging, programmable parameter selection, number conversion, Engineering Unit conversion, data compression, time annotation, digital filtering, generation of Current Value Table (CVT) data, and data scaling. The Telemetry Preprocessor will be able to directly throughput data (no changes in the data) from the Telemetry Front End to the System Host Computer at rates up to 1,000,000 parameters per second (32 bit parameter with 32 bit ID tag). The Telemetry Preprocessor will be able to perform Engineering Unit conversions at the rate of 1,000,000 conversions per second for first order conversions and 500,000 conversions per second for fifth order conversions.

The System Host Computer will be a high speed (10,000,000 instructions per second) super mini-computer that will provide a stand-alone general data processing capability for the Telemetry Processing System. A functional block diagram of the System Host Computer is shown in Figure 4. The System Host Computer will perform high speed data storage and recall, overall system setup, system verification and system control, interface to the Graphics Display Systems and interface to other systems in the range complex, notably the Range Central Site Computers (CYBER 175's and 860's). Through it’s high speed interfaces the System Host Computer will be able to transfer data at rates up to 10 megabytes per second.

The Graphics Display Systems will be high resolution color graphics workstations for the display and analysis of telemetry data. A block diagram of the Graphics Display System is shown in Figure 5. The Graphics Display Systems will be capable of displaying tabular data, dynamic bar charts, scrolling stripcharts, X versus Y plots, and overlays of multiple displays in both real time and post flight modes. A display screen snapshot capability will be included with color hardcopy provided via a color laser printer. A split screen capability, i. e. displaying multiple parameters and displays simultaneously on the graphics tubes, will be provided. Displays can be static or dynamic and the capability of manipulating these displays in real time will be provided. The types of manipulations available will include scale changes, overlays of multiple parameters, reassignment of colors, selection of displays, and deletion or addition of displays. The telemetry user will be provided with the capability of selecting different functions and/or options via special function keys, a mouse or a light pen. The keys, mouse, or light pen will be capable of being reprogrammed for different functions via software. Various data analysis software packages will be resident on the Graphics Display Systems and complete data bases will be available via the System Host Computer.

SOFTWARE

The Telemetry Processing System software can be broken down into three functional areas. They are the Preprocessor software, System Host Computer software, and the Graphics Display System software.

The Preprocessor software will be characterized by a high degree of modularity and ease of maintainability. The Preprocessor software will contain standard data compression algorithms such as N Average, Bit Match, Bit Change, Max-Min, Out of Limits Check, et. al. In addition, the system user will be provided the capability of writing custom algorithms in a high level language such as Fortran.

System setup, calibration, verification and overall system control will be implemented via software on the System Host Computer. All setups will be menu driven or at the operator’s option, predefined setup files may be used instead of the setup menus. Failure mode control software will reside on the System Host Computer. The purpose of this Failure Mode software is to provide real time operational capability even when certain components of the system fail and to provide the system operator with the ability to control how the system will fail over to the diminished operating state. Diagnostic software will be resident on the System Host Computer that not only provides diagnostic capability for the System Host Computer but will provide diagnostic capability for the entire Telemetry Processing System including front to back checkout of individual data streams. Additionally, resident on the System Host Computer will be Fortran, “C”, and Pascal compilers for development of custom software.

The Graphics Processing software will be resident in the graphics workstations. Data will be transferred from the System Host Computer to the graphics systems for processing and display via a network. Analysis software packages will be resident on the graphics systems for the display and analysis of telemetry data.

PLANNED IMPROVEMENTS

A number pre-planned system improvements are being considered for possible integration into the Telemetry Processing System over it's expected life span. These enhancements include: Addition of a dedicated post flight system, integration into the Range Real Time Network, interfacing with the Range Mass Storage System, higher speed front end equipment (20 to 30 megabits per second), improved bandwidth for on-line media storage in real time, increased on-line data storage utilizing optical media, additional MIL-STD-1553 processors/front end equipment, outboard high-speed I/O processors for data packet preparation and network communications, and additional graphics display capability.

SUMMARY

The overall design philosophy behind the Telemetry Processing System has been not to view it as a static system but rather as a dynamic system that is modular in nature and can achieve enhanced performance via the additional and/or replacement of functional blocks of hardware and/or software. It is estimated that the final system specification will be completed in October 1986 with contract award for the Telemetry Processing System in the late FY-87 early FY-88 time frame. The system delivery and integration will occur in FY-89 with the initial operational on-line date sometime in FY-90. The Telemetry Processing System procurement will be a competitive contract for delivery of a turnkey system.

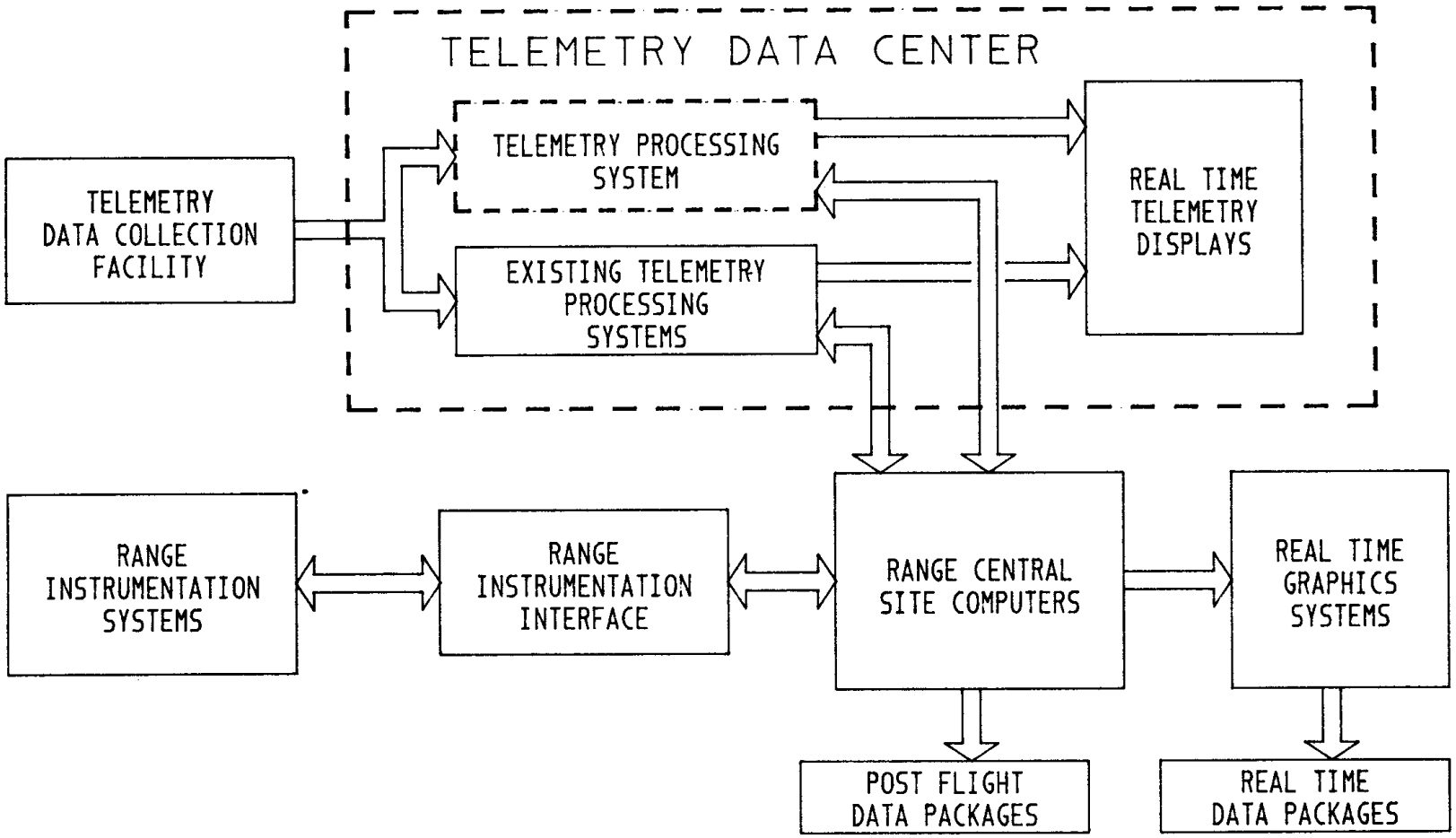

FIGURE 1.
RANGE INSTRUMENTATION COMPLEX

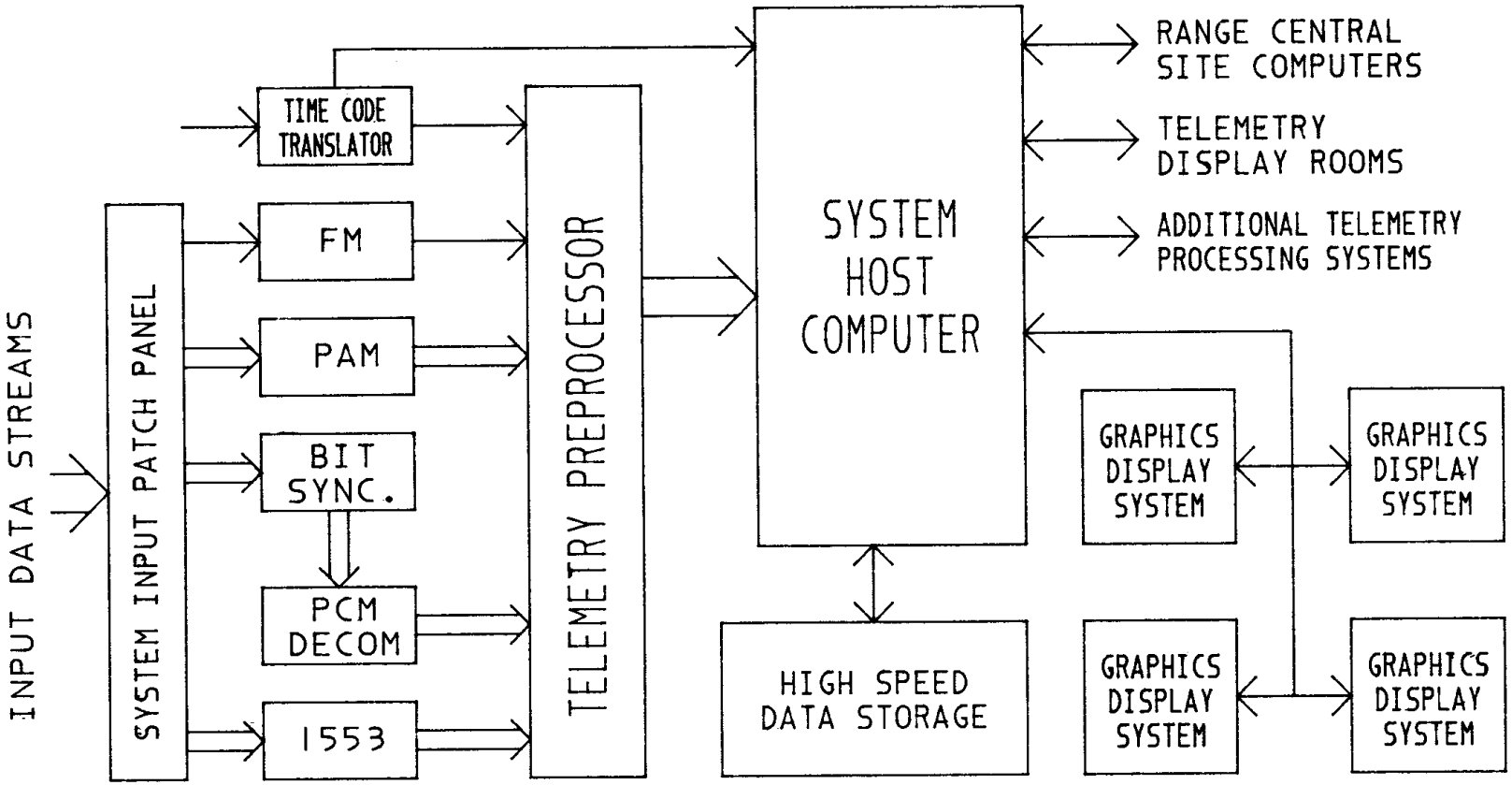

FIGURE 2.
TELEMETRY PROCESSING SYSTEM
FUNCTIONAL BLOCK DIAGRAM

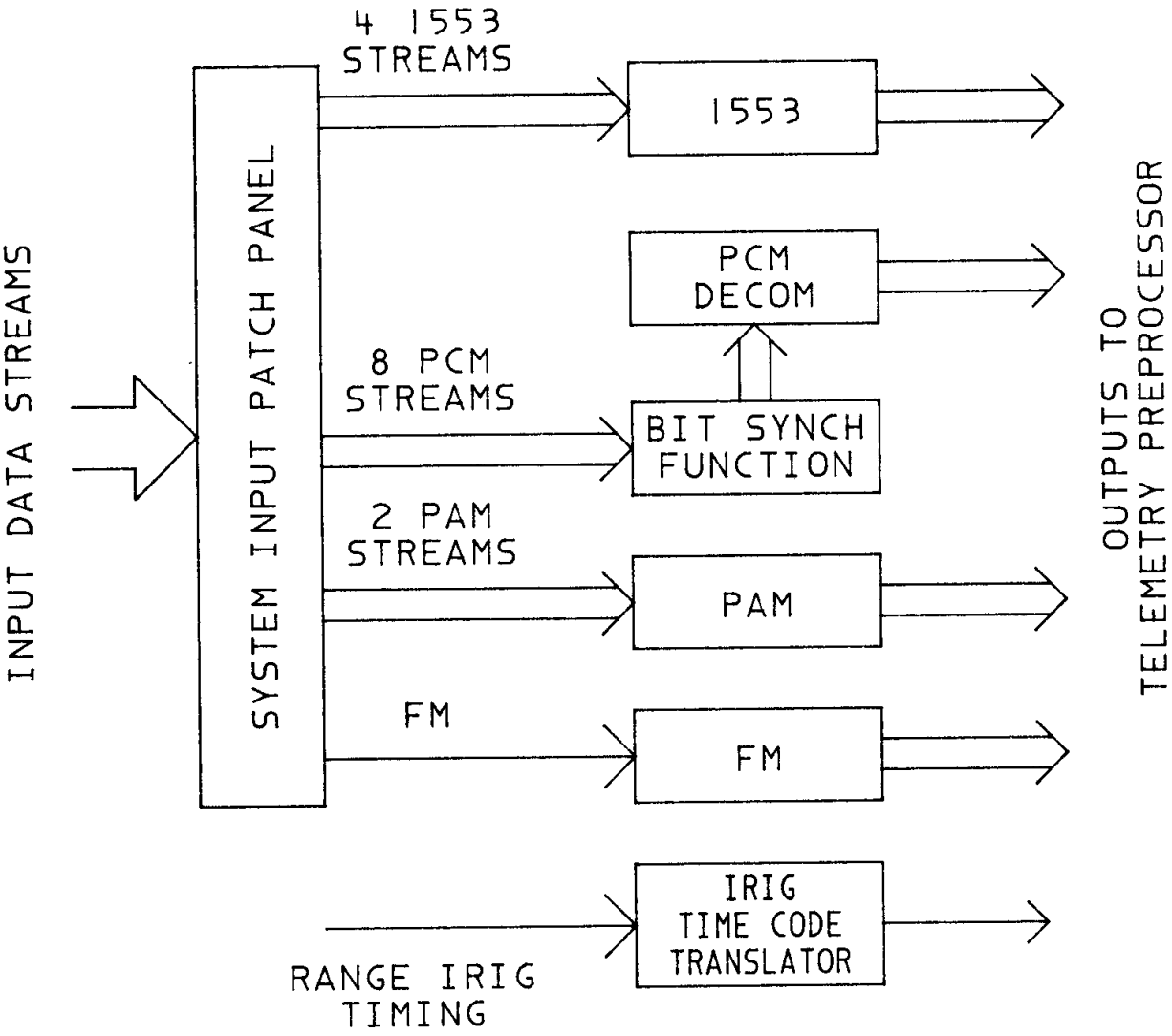

FIGURE 3.
TELEMETRY FRONT END

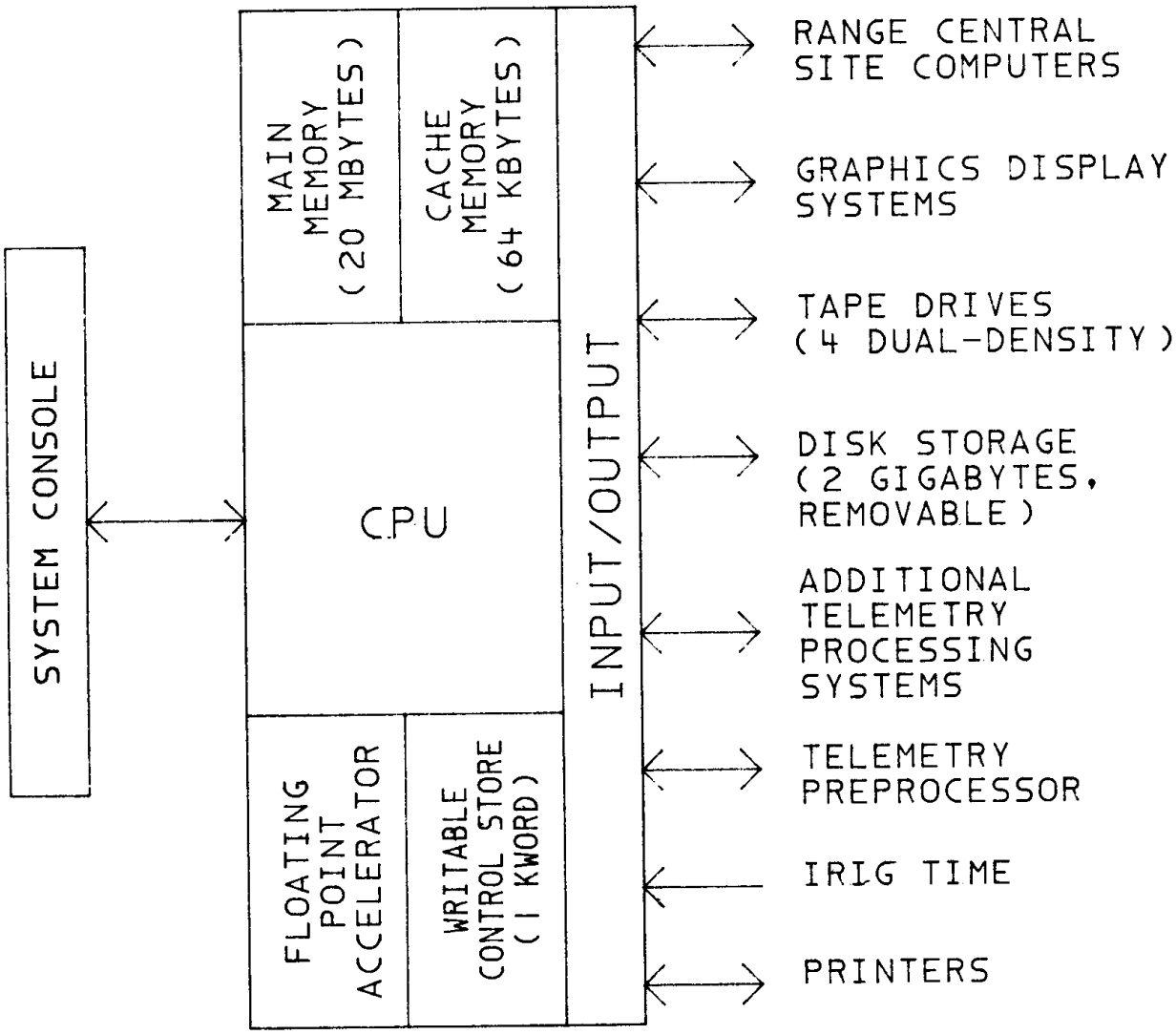

FIGURE 4.
SYSTEM HOST COMPUTER

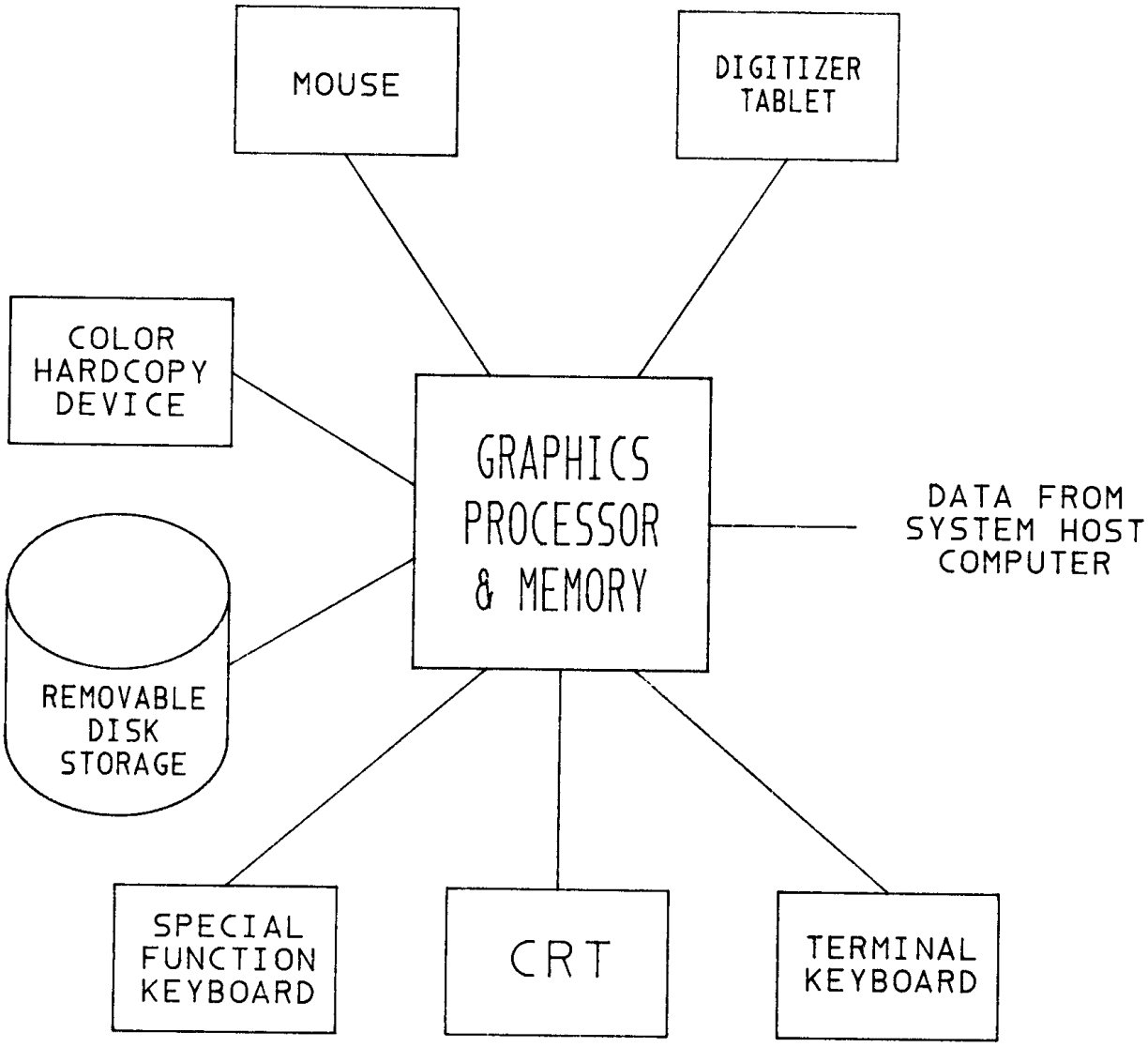

FIGURE 5.
GRAPHICS DISPLAY SYSTEM