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PRELIMINARY TECHNICAL SPECIFICATION FOR PARR DATA PROCESSING COMPUTER

January 1975

Prepared for

U.S. NAVY TORPEDO STATION
Keyport, Washington

Under Contract N00406-73-C-0631
Task Order 14

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1. SCOPE

This specification describes functional, hardware, and software requirements for an automatic data processing (ADP) computer for the Performance And Reliability Reporting (PARR) system. The ADP computer will provide for data acquisition from a variety of remote operational sites; maintenance of large data files; preparation of real-time (display screen) reports from information in the data files; and preparation of printed reports.

2. APPLICABLE DOCUMENTS

The following documents form part of this specification to the extent that they are referenced herein:

a. Bell System Technical Reference Specification, Data Set 202C, Publication 41203, September 1971

b. EIA Standard RS-232C, Interface Between Data Terminal Equipment and Data Communication Equipment Employing Serial Binary Data Exchange, August 1969

c. ANSI Standard x3.23-1968, COBOL

d. ANSI Standard x3.24-1968, Information Interchange, Code for

e. Department of Defense, COBOL Compiler Validation System

f. U.S. Naval Torpedo Station, PARR Remote Communications (undated, unnumbered report)

3. REQUIREMENTS

Requirements for implementing ADP for the PARR system will be expressed in terms of functional, hardware, and software needs. The functional requirements are derived from existing and planned functions of the PARR system, with hardware and software requirements then generated from the functional requirements. The set of hardware characteristics described herein is not mandatory; alternative hardware achieving the same ends and meeting PARR cost/integration criteria will be acceptable.

For ADP, data input and file maintenance will require from 5 to 10 programs, each tailored for a specific application (e.g., configuration control). Some 10 to 20 programs will be used for data retrieval, each formatted to provide support for a specific application (e.g., torpedo chronological history). A library of programs exists that has been developed for PARR over a period of five years, and which must be implemented on the PARR data computer with a minimum of modification (ref. 2f).

3.1 FUNCTIONAL REQUIREMENTS

The primary functional requirement of the PARR data system is to support a variety of local and remote data-input and retrieval demands simultaneously, providing up-to-date information in display or printed form (both periodically and on request). The following functions are required for the PARR data computer:

a. Real-time system supervision for on-line system operation. The response time to terminal inquiry shall be such that 90% of the responses will occur in less than 2 minutes when the system is being used by the maximum number of remote users.

b. Accessible data file storage. Permanent data storage shall be on magnetic tape and temporary storage on magnetic disk, with the attendant capabilities of file maintenance, loading, and unloading. Data input and retrieval shall be to/from mass storage devices. The projected requirement for file size is 150 million characters, including programs and data.

c. Data management control capability. There shall be a data-management access method controllable by application programs. Application programs shall be processable in both assembly and COBOL languages (per ref. 2c). Compilation and execution of at least 80% of the existing COBOL program library shall be possible with rewriting of less than

20% of the program statements. Multiple application programs shall be executable simultaneously.

d. Local report printing. Line printing on a printer at the central site shall be under the control of local terminals.

e. Local and remote terminal support. Communication shall be with both local and remote terminals. The terminals shall have the capability of directing the execution of computer programs controlling data input and output.

f. Availability of service. Service shall be available 90% of the time during a 5-day work week and a 14-hour work day. The system shall be available for preventive maintenance at least 4 hours each day.

g. System reliability. System reliability shall be 0.999, where reliability is the probability of completing a 2000-character asynchronous message transmission or reception at 1200 bits per second without error.

h. System mean time to repair (MTTR). System MTTR shall be 0.5 hour for all failures for which repair is by replaceable, plug-in modules stocked on-site or by software reloading or restarting. The MTTR shall be 48 hours maximum. High-cost items shall be identified, together with their expected frequency of failure and the stocking location.

3.2 HARDWARE REQUIREMENTS

Hardware items needed to fulfill the functional requirements of the PARR data system shall include a central processing unit (CPU), storage facility, communication facility, and printing facility.

3.2.1 Central Processing Unit

The CPU shall provide real-time supervision over that portion of the data system operations being managed at the CPU site. The CPU shall have the following features:

a. Capability of supporting the execution of at least 15 different programs in apparent real time.

b. A real-time clock available to application software for timing responses and pauses.

c. Memory protection to make selected information available only to selected users.

d. Instruction relocation to allow dynamic memory management.

e. Hardware interrupts in a priority structure for enhanced speed and efficiency of operations.

f. Input/output channels for communication with local and remote peripherals and terminals.

g. Paging or virtual memory to support program swapping or roll-in, roll-out operation.

h. Expandability to allow upgrading in capability at a future time.

These features are considered to comprise the minimum set required for the CPU to maintain control of operations and respond to the demands made upon it by peripheral and terminal equipment.

3.2.2 Storage Facility

Temporary and permanent storage hardware in the form of core or semiconductor main memory, disk, and tape shall be provided. There shall be short-term storage for processing, medium-term storage for access to programs and transient data, and long-term storage for data-file backup and security.

The storage facility shall provide a minimum of 64,000 characters of main memory storage, 2 million characters of fixed-head disk/drum storage, and 150 million characters of random-access disk storage.

3.2.3 Communication Facility

The communication facility shall include hardware for handling a total of 16 ports, including local terminals, remote terminals, and intersite communication channels.

Local terminals are those directly connected to the computer with no use of modems or commercial or private telephone lines. The local terminals shall be supportable at distances up to 500 feet from the central computer.

Remote terminals are those located anywhere in the world having access to the computer through telephone lines. The current PARR data system operating speeds

are 10 and 120 characters per second. Terminals at 10 characters per second operate with an 80-character line, one line per message; those at 120 with a 1000-character message.

Intersite communication shall include short distance (2,000 feet) and long distance (thousands of miles). Over the short distance, from the PARR office to the data processing center, either multiple-terminal or single-preprocessor channels shall be used. The long distance intersite link, for example from Seattle to Washington, D.C. or Hawaii, would require at least one high-speed dedicated channel.

3.2.4 Printing Facility

Because of the large volume of printed reports from the PARR system, a high-speed printing facility (at least 600 lines per minute) is required.

3.3 SOFTWARE REQUIREMENTS

ADP functions that shall be implemented by software are:

a. Real-time supervision. An executive or operating system that will use an interrupt structure, priority levels, and resource management capability to provide adequate inquiry/response operation in real time.

b. Data management control. A file management system that will interface with the executive and the storage hardware to store and retrieve small amounts of data within a large data base.

c. COBOL support. A COBOL program language compiler that will allow the conversion of existing programs and the development of standard-language programs.

d. Assembly language support. An assembly language compiler that will provide the efficient processing of repetitive operations that would be too time-consuming if programmed in COBOL.

3.3.1 Executive

The executive system shall provide input/output and processing support to programs operating under its control. A multiprogramming capability shall be provided to allow two or more independent programs to co-reside in the system and share the processing facilities. Multitask capability shall allow coordination among

subprograms for maximum efficiency. The following functions shall be provided in the executive:

a. System generation – Provides the capability to initially generate a loadable software system.

b. System initialization – Provides the capability to initially load computer programs, adapt the system to specific requirements, initialize the operation of the system, and reload quickly when necessary.

c. System/operator interface – Provides 1) the operator/task program communication capability, 2) interface with system control tasks to allow reconfiguration and recovery, and 3) terminal device interface with system control functions.

d. Processing support – Provides initial capabilities of date/time maintenance and on-line testing. This functional area shall be designed such that additional functions may be easily incorporated to provide enhanced processing support capabilities to applications programs.

e. Resource management – Maintains complete control of program utilization of system resources: main memory, peripheral devices, communications lines, and mass storage.

f. Security – Protects the computer from unauthorized access, modification, or information retrieval.

g. Peripheral device input/output functions – Control all task-program-requested peripheral I/O operations; provide capabilities for centralized, device-independent read, write, and control operations; and I/O request queuing, I/O initiation according to task priority, logical to physical device correlation, and I/O error recovery.

h. File control – Provides the standard system procedures for storing and maintaining data on direct-access mass storage (disk or auxiliary memory).

i. Communications line input/output functions – Provide a standard interface with communications I/O lines, I/O request analysis for input/output and control operations, I/O chain initiation, request queuing, interrupt handling, and buffer toggling for all communications lines.

j. Executive functions – Have exclusive control of all task program operations. In addition to controlling the initiation, execution, and sequencing of

application task programs in a multitask environment, the executive functions are responsible for creation and execution of system-oriented tasks for interrupt processing, hardware error recovery, real time clock control, etc.

k. Nonresident task program control – Provides the execution time loading of nonresident task programs from direct access mass storage or magnetic tape.

3.3.2 File Management

The file management system shall be compatible with the real-time executive and provide application programs with the capability to place data in mass storage, manipulate the data to form meaningful relationships, and retrieve the data when desired. The system shall be segmented into serially reusable segments to allow issuance of service requests independent of physical input or output.

The following functions shall be performed by the file management system:

a. Definition of records, blocks, and files

b. Control of data base access in a multiprogramming/multiuser environment.

c. Update of data base records by addition, replacement, and deletion

d. Access to data base records to reference and utilize the information, preferably in the indexed sequential mode with 2000 character blocks of records

e. Utility and support functions to allow file maintenance.

3.3.3 COBOL Program Language Compiler

A compiler shall be provided which satisfies the DoD COBOL Compiler Verification System and the ANSI COBOL standards referenced in Section 2. The compiler shall generate re-entrant code, and structure the code so that multiple tasks can be accomplished within one job by the operating system. A cross-compiler, compiled on one machine and run on another, shall be acceptable.

3.3.4 Assembly Language Compiler

A compiler shall be provided which can be used to generate efficient machine code from assembly-language source programs. It shall be possible to prepare routines in this code as macro-instruction which could be called from the main program to perform specific routine tasks.

4. QUALITY ASSURANCE

This section specifies quality assurance requirements for hardware and software of the PARR data processing computer. The quality assurance program shall include provisions for documentation of procedures and testing during design, production, installation and initial operation to assure that the requirements of Section 3 of this specification are met. Verification of the effectiveness of the quality assurance program will be provided through survey, monitoring, and testing performed by the Navy.

The test program shall include hardware and software validation and demonstration tests at the contractor's plant and at the operational site; and acceptance tests at the site; and acceptance tests at the site. Validation tests shall assure that each portion of the computer is in fact operational. Demonstration tests shall display all the functional capabilities of the computer. Acceptance tests shall be those upon which the Navy's decision to accept or reject the computer will be based.

4.1 FUNCTIONAL QUALITY ASSURANCE

Quality assurance of the PARR data processing computer functions shall provide confidence that the computer meets the requirements of Section 3.1 of this specification. The following demonstration tests shall be performed:

a. Real-time system supervision for on-line system operation. A saturation test with the maximum number of terminals either in operation or being simulated shall be performed in which access to a data base structured and sized comparable to that of the PARR system. Response time shall be as specified in Section 3.1.

b. Accessible data file storage. Data file transference from tape to disk and the reverse shall be demonstrated. A file that has been validated to be 150 million characters in length (not necessarily real data) shall be built on the disk and its presence there demonstrated. Ten sample sections of this file from beginning, middle and end of the file shall be dumped to tape, then printed to demonstrate the file size requirement.

c. Data management control capability. The ability to enter, change, and retrieve data from disk shall be shown.

d. Local report printing. The ability of local terminals to control report printers shall be verified.

e. Local and remote terminal support. The capability of supporting local and remote terminals with those terminals able to execute computer programs shall be shown.

f. Availability of service. Records kept during validation, demonstration, installation, and initial operation testing shall show that the availability requirement of Section 3.1 has been met.

g. System reliability. A reliability analysis based upon available contractor's experience shall indicate that the required reliability can be met. Records kept during demonstration, installation, and initial operation testing shall verify the analysis.

h. System mean time to repair (MTTR). A description of the planned maintenance support, including expected maintenance times and location of stocking of spare parts, shall demonstrate that the MTTR requirement can be met. Surveys of locations and records kept during the validation, demonstration, installation, and initial operation testing shall verify that this requirement has been met.

4.2 HARDWARE QUALITY ASSURANCE

Hardware shall be designed using good industrial design techniques, incorporating operational performance margins; and produced using good industrial quality control techniques to assure conformance with the design requirements. All hardware, including cables and connectors, shall be thoroughly tested to assure that functional, reliability, maintainability, and safety requirements are met.

4.2.1 Central Processing Unit (CPU)

The CPU shall be tested in a real-time, on-line environment and design documentation validated to show that the requirements of Section 3.2.1 have been met. The following shall be demonstrated:

a. Simultaneous operation of 15 different programs and terminals

b. Application program time-outs

c. Failure of invalid data access

d. Dynamic memory management

e. Priority preemption

f. Remote and local terminal operation

g. Growth capability

4.2.2 Storage Facility

The storage facility shall be tested in a real-time, on-line environment, and design documentation validated to show that the requirements of Section 3.2.2 have been met. The following shall be demonstrated:

a. The availability of adequate core, disc, and tape storage

b. Interfacing and data transfer among the storage media.

4.2.3 Communication Facility

The communication facility shall be tested in a real-time, on-line environment, and design documentation validated to show that the requirements of Section 3.2.3 have been met. The following shall be demonstrated:

a. Simultaneous operation of 16 terminals over RS-232C interfaces (ref. 2b)

b. Local terminals with no modems or telephone lines

c. Remote terminals transmission at 10 characters per second over data set 103, and 120 characters per second over data set 202C (ref 2a), using character and batch message operation in the ANSI code (ref 2d).

d. A capability for intersite communication.

4.2.4 Printing Facility

A high-speed printing facility (at least 600 lines per minute) shall be demonstrated.

4.3 SOFTWARE QUALITY ASSURANCE

The computer programs forming the management nucleus of the computer shall be designed and built using good commercial-configuration and software quality-control techniques. The programs shall be checked and validated against contractor standards and demonstrated as being able to perform the functions listed in Section 3.3. Errors encountered shall be reported by normal error notices and not cause system halts.

4.3.1 Executive Program

The executive program shall be tested in a real-time environment and descriptive documentation validated to show that the requirements of Section 3.3.1 have been met. The following shall be demonstrated:

a. Generation of a loadable system

b. The system generated can be loaded and executed, halted, changed, reloaded, and then executed

c. A system/operator interface allowing limited system control

d. Processing support of date/time and console system testing

e. Resource management by queuing demands for unavailable resources

f. Security, by denying access to an unauthorized attempt at access

g. Peripheral input/output control by peripheral operation

h. File control by storing and retrieving data

i. Communication input/output control by terminal operations.

4.3.2 File Management

The file management software shall be tested in a real-time environment and descriptive documentation validated to show that the requirements of Section 3.3.2 have been met. The following shall be demonstrated:

a. Files and records can be defined

b. Data base access can be controlled

c. Data base records can be updated

d. Data base records can be accessed in groups (indexed sequentially)

e. File maintenance functions are available.

4.3.3 COBOL Program Language

The COBOL compiler shall be tested and validated in accordance with the Department of Defense COBOL Compiler Validation System (ref. 2e). The compiler shall be validated to be in accordance with 90% of the ANSI Standard x3.23-1968 COBOL requirements.

To demonstrate the applicability of the COBOL compiler to PARR Data Processing Computer Applications, it shall be able to compile an operational program from current COBOL language form with modification of less than 20% of the instructions.

4.3.4 Assembly Language

The assembly language compiler shall demonstrate the capability of providing an efficient technique of performing specific routine tasks by a macro-instruction.

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