The RCA 1600—a versatile computer

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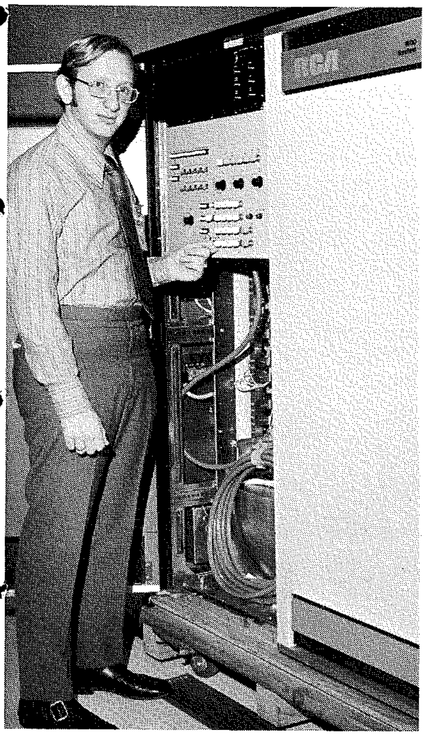
The 1600 computer provides a versatile means of dealing with a wide variety of applications that cannot be readily or economically handled by other products of RCA's computer line. Thus, it is an integral part of RCA's commitment to a total systems approach in data processing. In this paper, the 1600's wide acceptance is demonstrated through brief descriptions of specific applications. Hardware and software available with the system are explored, with emphasis on the 1600's open-ended design concept.



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received the BSEE in 1965 and the MSEE in 1968 from the University of Miami (Florida). He has completed courses in statistical communications at the Universtiy of Florida. Mr. Raij is currently working toward the MBA at Florida Atlantic University in Boca Raton. From 1966 to 1968, he was employed by IBM at Cape Kennedy, where he worked on hardware maintenance and later on system software support of Apollo/Saturn V ground computer systems. While with IBM, Mr. Raij also served as an instructor in computer programming. He was subsequently a part-time instructor in computer science at the Florida Institute of Technology (FIT) in Melbourne, Florida. He joined RCA at Palm Beach Gardens in 1968. Mr. Raij was assigned as a Senior Diagnostic Programming Specialist. He was recently promoted to Leader, Test Programming. He is a member of Eta Kappa Nu.

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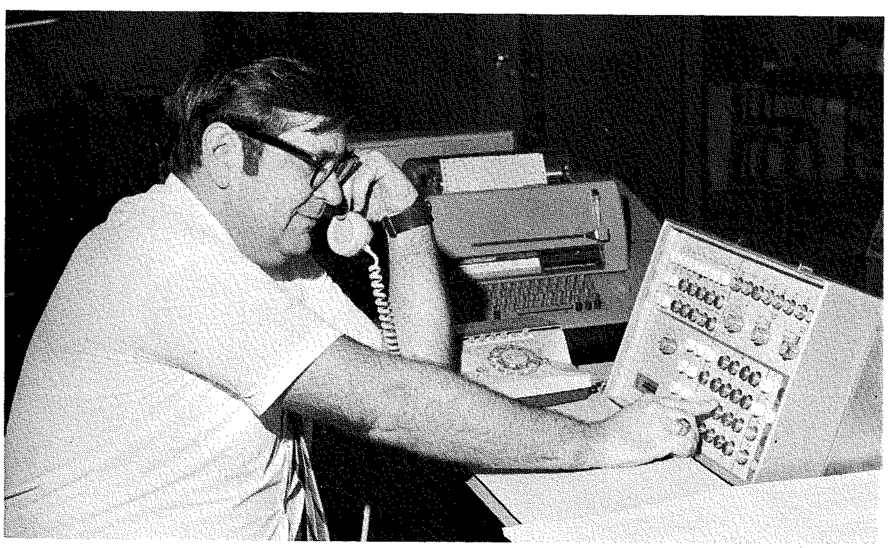
received his early experience in computer technology and computer switching networks during his four years in the U.S. Air Force. His experience began as an instructor in the 412L (SAGE) System. From 1962 to 1964, he was lead instructor in the 465L project, a command-control system for Strategic Air Command, teaching the theory of operation of AN/FSQ-7 message switching processor. Mr. Leppold received the BA in Mathematics from the University of South Florida at Tampa in 1966. He joined Computer Systems in 1967 where he served as diagnostic programmer on the RCA 1600 processor. In 1968, Mr. Leppold's prime responsibility was detailed analysis of operating and communications systems for 1600 applications. Presently he is assigned as a Senior Project Leader of the front-end communications processor project.

In 1966, the Graphic Systems Division had assembled sufficient data to define a requirement for a small, special purpose machine to control their photocomposition unit. Additionally, other divisions of RCA had requirements for small, general purpose processors; Instructional Systems required an intelligent line concentrator in their computer-aided instruction system; Global Communications required a processor to function in message switching and store and forward applications; Consumer Electronics required a machine to automatically test and qualify integrated circuits that would be used in consumer products. What evolved from these needs was the RCA 1600 Processor—a small but flexible machine using the concepts of Elementary Operations (EO).[1] The concept of allowing the programmer to execute instructions at the EO level provides the capability of tailoring instructions to efficiently perform a desired task. This solution resulted in an extremely versatile machine capable of operating in many diverse applications.

Reprint RE-16-6-16
Final manuscript received December 16, 1970.

Sales audit system (SAS)

Figure 1 outlines the hardware configuration of the 1600 system operating in Miami, Florida, for a nationally known airline. At the customer's revenue accounting office, the 1600 receives, verifies, and stores on magnetic tape one million ticket sales a month. Input to this data entry application is the Sanders 720 Video Display System. Data for various ticket formats are accepted and verified concurrently by this system. Interfacing to the Sanders 720 Video Display System required no hardware modification to the 1600 system. In this application, the 1600 solved for the airline a critical ticket backlog problem at a substantial cost saving. And for RCA, the 1600



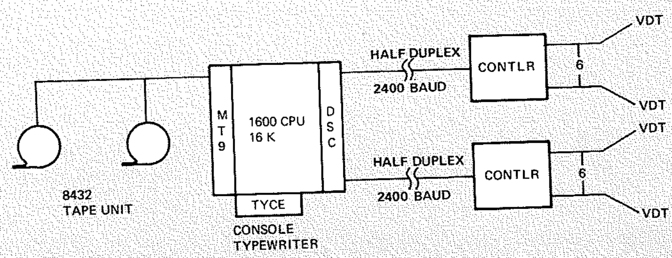


Fig. 1—Sales audit system (SAS).

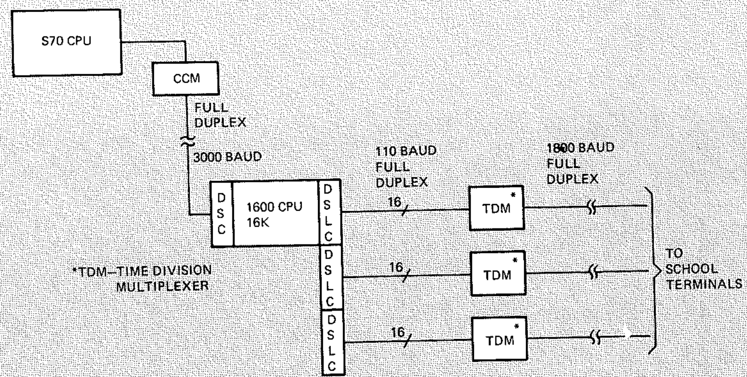


Fig. 2—Computer-aided instruction system I-70.

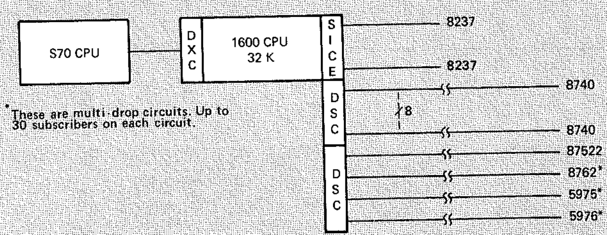


Fig. 3—Front end communication processor.

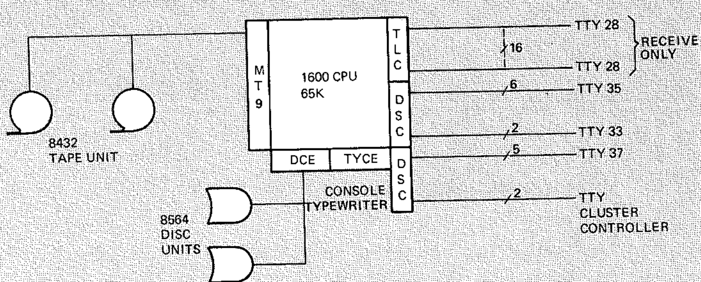


Fig. 4—Service-order processing system.

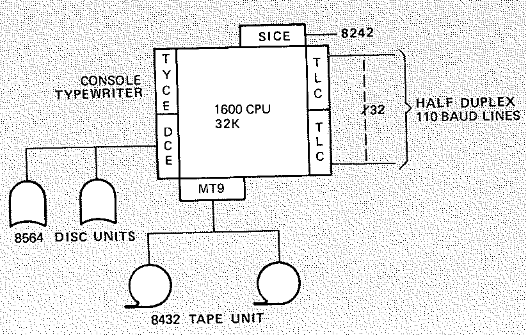


Fig. 5—Car rental control system.

gave Computer Systems a "foot in the door" to a potentially large computer systems customer.

Computer-aided instruction I-70

Fig. 2 illustrates the 1600 hardware configuration for RCA's I-70 Computer Aided Instruction System. In this application, the 1600 processor performed as a remote, intelligent line concentrator for the Spectra processor. The response time (i.e., the amount of time for the system to respond to a student's answer) is important in this environment. A response time of 1.5 seconds is not tolerable in a teaching situation. With 44 of the 48 student terminals on-line and active, the 1600 has an average response time of 0.9 second. In addition to sending messages to the student terminals, the 1600 validates each response received from the students and compares their response with the expected answer. If a student's response is incorrect, a message is transmitted to the student indicating a wrong answer. In addition, the wrong response is transmitted to the Spectra processor which maintains the student's performance on a lesson.

Front-end communications processor (FECP)

Fig. 3 describes the 1600 system configuration that the Government Marketing Office of Computer Systems is currently testing for a large government contract. Data to and from the front-end processor are controlled by the Spectra 70/60 on a poll/select option; that is, the Spectra processor requests data from specific subscribers and, in turn, selects subscribers individually. All polling, selection, and line-control functions are performed by the 1600 computer. Devices connected on the multi-drop circuits are polled sequentially, and are only selected when there are data for that subscriber. Effectively utilizing subscriber status tables and table look-up methods, 251 subscribers can be serviced by this 1600 FECP.

Store and forward-inquiry response

Service-order processing system (SOPS)

Currently, the RCA 1600 system is operating the service-order processing system for several telephone companies across the United States. Basically, SOPS provides the involved depart-

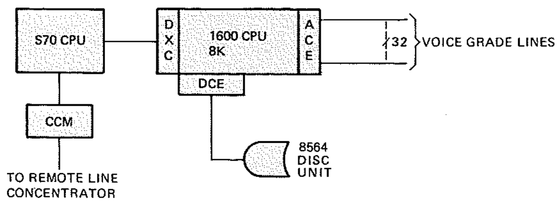


Fig. 6—Special-purpose controller I-71 (CAI).

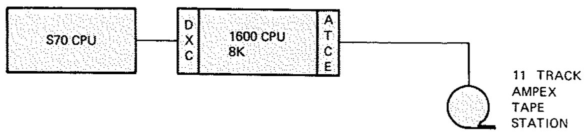


Fig. 7—Special-purpose controller for tape conversion.

ments of the telephone company with the paperwork necessary to carry out customer requests for new installations of telephone equipment.

In the past, service orders had been handcarried or, at best, transmitted by teletype to the appropriate departments. The previous system was subject to several disadvantages. Transmission of information was slow, extensive paper-tape handling was required, and manual logging was necessary to ensure that each affected department received all its orders.

The RCA 1600 system (Fig. 4) eliminates these problems. The service order is entered via a video communications terminal and is transmitted to the 1600 computer for validation and disc storage. The 1600 acknowledges acceptance of the order to the operator. On the day before the order is to be processed, pertinent information is transmitted to the various departments by teletype. After the order is completed, the computer is notified via teletypewriter and the order is updated, if changes are necessary. At the end of the day, all completed orders are written to magnetic tape for subsequent billing. Directory information is extracted and transmitted to a remote printer. Completed orders are purged from the disc files within three days after the completion date of the service order.

Inquiry response

The 1600 computer (described in Fig. 5) is being used by a car rental corporation to maintain a status file on each car entered into the Car Control System. Among the data stored on each car are its characteristics, history, and availability. Any change in the status of a vehicle is entered into the system via the remote terminal. With its associated data base, large amounts of information are available for other processors to digest and produce current statistical information for management. In addition, the customer receives fast and accurate billing information whenever the vehicle is returned. Rate information and total time the vehicle was used are calculated by the system and are relayed to the requesting data terminal.

Special-purpose controller

The following two examples of the 1600 processors operating in a limited environment illustrate the effectiveness of this small computer in solving specialized problems.

Computer-aided instruction I-71

As an integral part of RCA's I-71 computer-aided instruction (CAI) system, a small processor is required to transmit questions and/or audio responses to a selected student. Fig. 6 illustrates the 1600 hardware configuration used for this application. Control information is received from the Spectra 70 processor through the data exchange control (DXC). The 1600 analyzes the data; obtains the required word or words from the 8564 disc unit in digital form; and sends the data to the selected student via the audio control electronics (ACE). The ACE converts the digital data into an analog signal and sends the signal, via phone lines, to the headset of the selected student (1 of 32 lines). This technique of storing the vocabulary in digital form permits the storing of 2,000 different words on one 8564 disc unit.

Tape conversion

During a transition period of several years, a large bank and trust company in New York State had a requirement of translating, editing, and updating data files that were stored on 11-track magnetic tape to industry standard 9-track tape. RCA met this customer's needs by supplying them with three identical 1600 systems as described in Fig. 7. Data and control information is exchanged between the Spectra 70 processor and the 1600 via the data exchange control (DXC). The control information is decoded and the appropriate command or function is executed by the 1600. Code conversion and all tape commands are performed by the 1600 processor. On completion of the command, the 1600 notifies the Spectra processor of its status and the status of the tape controller.

Computer-controlled test

To gain on competition, a manufacturing plant in a dynamic industry must continually improve its manufacturing methods, building processes, and testing techniques. At the RCA Palm Beach Gardens facility, the 1600 is proving to be an effective tool in helping to cope with manufacturing test problems.[2] Two of the 1600 applications at this RCA plant warrant attention.

Central control processor

The central control processor for testing is shown in Fig. 8. This system is capable of loading processors of various types in 23 different test positions. Loading of design checks, diagnostics, and test routines is accomplished by utilizing the multiplexor or selector

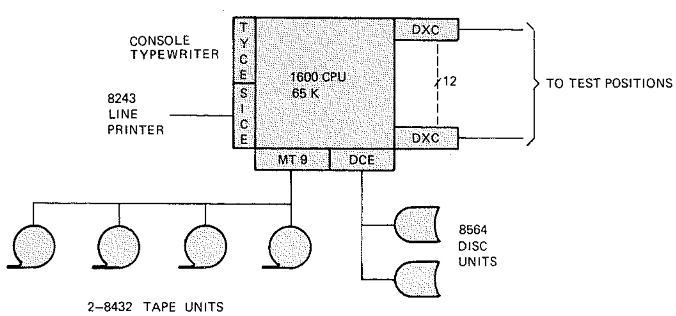


Fig. 8—1600 central control processor.

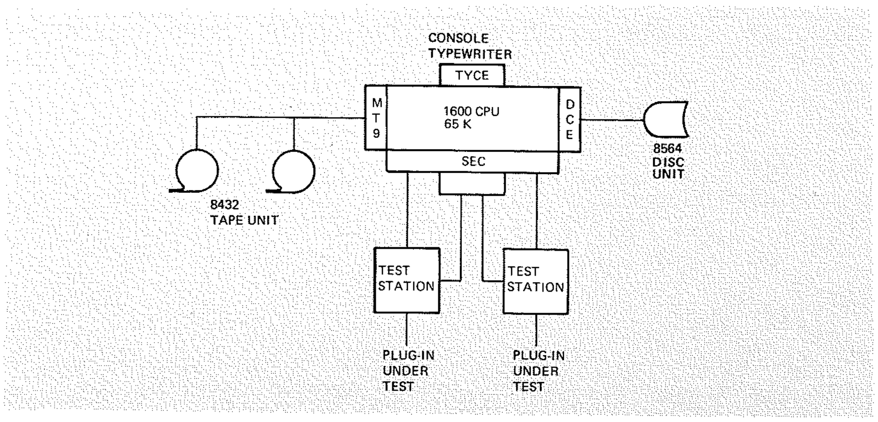


Fig. 9—NTS plug-in test system.

channels of the processor under test. Reduction of test equipment, effective control of released factory test routines, and current status information for management are among the benefits derived from this system.

Plug-in test system

Fig. 9 shows the configuration of the plug-in test system. This test system is capable of performing DC functional, DC parametric, and coarse propagation-delay tests on 90-pin plug-ins. The logic circuits may be either ECL, T^2L or T^3L, or combinations of these. Design Automation, using Roth's *D*-cube algorithm and Seshu's sequential analyzer, generates tests and diagnostics for the plug-ins. An auxiliary program converts the output from Design Automation to formats compatible with the 1600 plug-in test system. During production, data logging is accomplished on magnetic tape and/or the station console. In addition, test engineers may manually write tests using a test language tailored to this application.

Remote job entry

Versatility of the RCA 1600 computer operating in a remote job entry environment is demonstrated in the applications described below.

Spectra 70 to 1600 processor

Fig. 10 shows the 1600 being remote to a Spectra 70/55 processor located in Murray Hill, New Jersey. Line control between the Spectra 70 and the 1600 processor closely follows the 8740 line control procedures. Data compression and decompression techniques are used to utilize the communication facility effectively.

RCA 6 to 1600

A large supermarket chain has on order twenty-seven 1600 processors to operate as satellite computers for collection of divisional summary data. Fig. 11 outlines the typical hardware complement for a satellite installation. During the day, inventory data are collected, sorted, updated and stored on the 8564 disc units. In the evening, a data link is established with the RCA 6, and the accumulated data are sent to the central facility. From this information, daily and weekly reports are generated and are transmitted back to the satellite processor for printing.

IBM 360 to 1600 processor

Fig. 12 shows the 1600 interfacing to an IBM 360/65 for a textile manufacturer in North Carolina. The 1600 processor is replacing an IBM 360/20 acting as a satellite processor. Line control between the processors is binary synchronous communication in EBCDIC transparent mode. In addition to data compression and decompression routines, multi-leaving of input and output transactions from the 1600 is available.

Data communications

Most of these applications solve customer problems that could not be readily or economically handled with other products of the RCA computer line. The 1600 processor has an attractive price/performance ratio in applications involving data communications and special purpose controllers.

In the data communications environment, the 1600 performs exceptionally well with the group of control electronics outlined below:

Data set control (DSC)—enables the 1600 processor to exchange data, on a character interrupt basis with a maximum of 8 EIA standard data sets.

Data set line control (DSLC)—enables the 1600 processor to exchange data, on a bit interrupt basis with a maximum of 16 EIA standard data sets.

Telegraph line control (TLC)—enables the 1600 processor to exchange data, on a bit interrupt basis with a maximum of 16 direct current circuits.

RCA's 1600 computer may control in excess of 80 low-speed half-duplex lines (300 baud or less) via the data set line control (DSLC) electronics (EIA interface) and/or the telegraph line control (TLC) electronics (direct current interface). Utilizing the data set control (DSC) electronics, high speed circuits up to 50,000 baud may be serviced by the 1600 processor. Also, the 1600 can control a maximum of forty 1200-baud half-duplex circuits or twenty 2400-baud half-duplex circuits. Communication data links up to 230,400 baud can be serviced by the 1600 via the 8656 single channel communication controller. Outlined below are some of the remote devices currently interfaced by the 1600 processor via its communication control electronics.

RCA devices

5975—Low Speed Card Punch
5976—Low Speed Card Reader
8653—Communication Controller, Single Channel
8656—Communication Controller, Single Channel
8668—Communication Controller, Multichannel
8762—Data Terminal

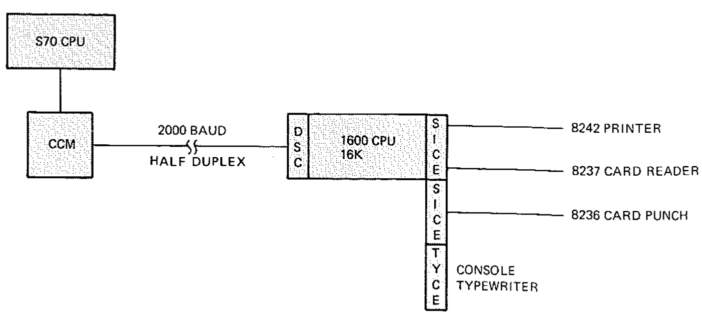


Fig. 10—Remote job entry—Spectra 70 to 1600.

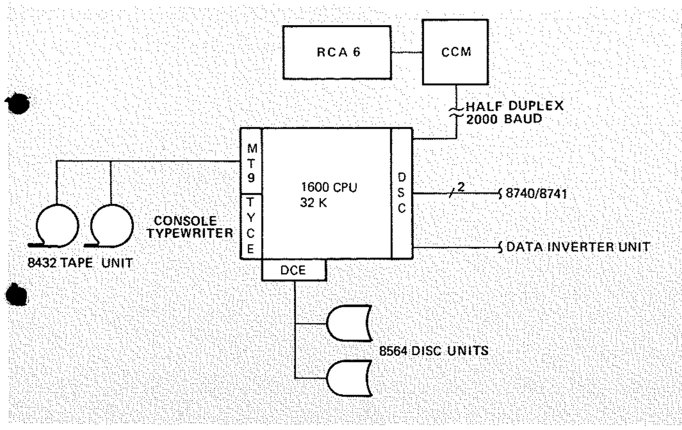


Fig. 11—Satellite processor—RCA 6 to 1600.

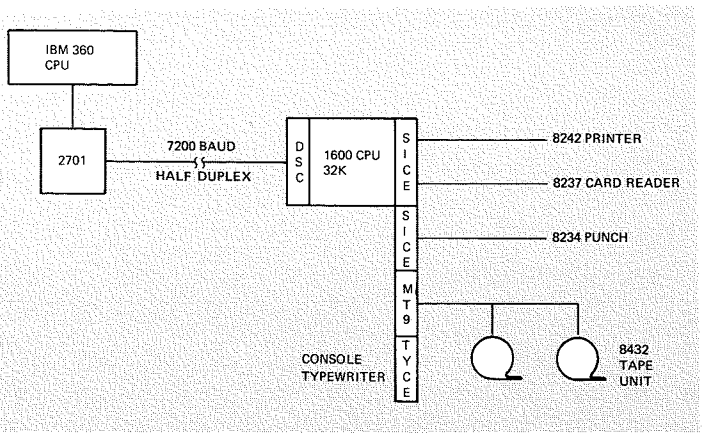


Fig. 12—Remote job entry—IBM 360 to 1600.

87522—Video Data Terminal
8752—Video Data Terminal
8740—Remote Printer
Modular Video Display System
RCA 1600 to RCA 1600

Foreign devices

Teletype Corporation Model 28 TTY
Teletype Corporation Model 33 TTY
Teletype Corporation Model 35 TTY
Teletype Corporation Model 37 TTY
Teletype Corporation Video Cluster Controller
Univac Data Communication Terminal 2000
IBM 360/50 BSC USASCII Non-transparent
IBM 360/65 BSC EBCDIC Non-transparent and transparent
Sanders 720 Video Display System

Control electronics

As other requirements developed, the 1600's open-ended design permitted RCA to respond quickly to these potential markets. Flexible, low-cost control electronics (listed below) were designed and added to the 1600's system complement of support peripherals:

Audio Control Electronics	ACE
AMA Paper Tape Reader	AMA
Ampex Tape Control Electronics	ATCE
Disc Control Electronics	DCE
Data Line Control Electronics	DLC
Fixed Head Disc Control Electronics	DRUM
Data Set Control Electronics	DSC
Data Set Line Control Electronics	DSLC
Data Exchange Control Electronics	DXC
9-Level Magnetic Tape Control Electronics	MT9
9-Level Magnetic Tape Control Electronics (200/800 BPI)	MT9M
7-Level Magnetic Tape Control Electronics	MT7
Special Equipment Control Electronics	SEC
Standard Interface Control Electronics	SICE
Synchronous Line Adapter (AUTODIN)	SLA
Terminal Control Panel (AUTODIN)	TCP
Telegraph Line Control Electronics	TLC
Timer Control Electronics	TCE
Console Typewriter Control Electronics	TYCE

Software

Appropriate system and maintenance software to support the open-ended design of the RCA 1600 system was required. Accordingly, a modular input/output driver system (IODS) was developed by the Test Programming Group at the Palm Beach Product Laboratory to be used in the hardware check routines for testing the different control electronics that may be connected to the 1600 processor. The IODS was made available to customers as a physical level language for input/output control, when it became apparent that standard operating software for the 1600 would not provide support for all 1600 peripherals. The IODS utilizes the macro capabilities of the 1600 macro assembler, XMAP, to generate a tailored software system at assembly time. The IODS is an assortment of modules or I/O drivers that control and issue I/O commands to the control electronics used on the RCA 1600 computer. Similar to the open-ended concepts used in the design of hardware, IODS, at program assembly time, selects only those I/O drivers that are required for a given system. As new control electronics are designed, a new I/O driver is written and is included in the IODS library.

To meet Communications Systems' and Planning's request for a general purpose communications operating system for the RCA 1600, a second software system was developed. This system is called the multi-function communication system (MFCS). The primary building block for this system is IODS. The MFCS is used primarily in a data communications environment and allows the application programmer to execute I/O at the logical level. Dynamic memory allocation techniques are used by MFCS. Line-control operations (polling, selection, error reporting, etc.) are performed by the separate line programs required for a given system. Each line program is self-contained and completely modular. The user is required to perform header analysis, code translation, and/or data processing that may be required for a given application.

Concluding remarks

The RCA 1600 processor has been widely accepted as a versatile machine in aiding RCA customers find practical solutions to their data communication and special purpose applications. Communication control procedures, processing requirements, and input/output facilities must be evaluated for each application. Based on the "customer appeal" of the 1600, Computer Systems Marketing is using this computer to establish a "beach-head" with customers that utilize larger computers in their data processing applications.

References

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2. Levy, S. N., "Impact of mini-computers on manufacturing," RCA Reprint RE-16-3-6; *RCA Engineer*, Vol. 16, No. 3 (Oct/Nov 1970) pp. 3-5.