

## AUTOMATIC TROUBLE ANALYSIS SYSTEM DESCRIPTION

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TROUBLE DATA INPUT . . . . .	11	1.01 This section provides a description of the Automatic Trouble Analysis System.	
MDT OPERATION . . . . .	13	1.02 Whenever this section is reissued, the reason for reissue will be listed in this paragraph.	
A. No. 1 Crossbar MDT . . . . .	13	1.03 The Automatic Trouble Analysis (ATA) System assists in the corrective maintenance functions within crossbar switching offices. This is accomplished by a computer system which categorizes office	
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troubles as reported by trouble recorders and trouble indicators, examines the trouble records associated with the equipment that was involved in different occurrences of the same category of troubles, and reports those items of equipment which are involved in a significant number of failures. ATA is one of the principle Operational Support Systems to be used in electromechanical switching control centers (SCC) for centralizing analysis and control of central office corrective maintenance activities.

**1.04** The ATA System utilizes a central computer connected via data links to a number of switching offices. Each switching office is equipped with a data collection device which collects the appropriate trouble data and transmits it to the central computer where analysis appropriate to that type of switching system is performed.

## **2. SYSTEM DESCRIPTION**

### **FUNCTIONAL OVERVIEW**

**2.01** Operationally, the ATA System (Fig. 1) can be split into three functional parts:

- (a) The central offices report troubles through maintenance data transmitters (MDT) which are connected to existing trouble recording or indicating equipment. The central office MDT terminal (keyboard printer) allows the craft on site to obtain information to localize troubles identified by the ATA central computer. Although the number of offices that can be served is primarily determined by trouble data load, there is a physical limit of 28 central office entities.
- (b) The ATA central computer operates upon the data from the central office MDTs, reports troubles to the central offices and control stations concerned, and maintains measurements and summaries of both central office and ATA System activity.
- (c) Keyboard printer locations, called administration or control stations and usually located in switching control centers, may be flexibly arranged to monitor or control the ATA System activity pertaining to all or to subsets of central offices. An optional measurements and summaries printer also may be provided as an adjunct to the keyboard printers for additional monitoring capability. Full-duplex data facilities link these

stations and the central offices to the ATA central computer.

### **A. Maintenance Data Transmitter**

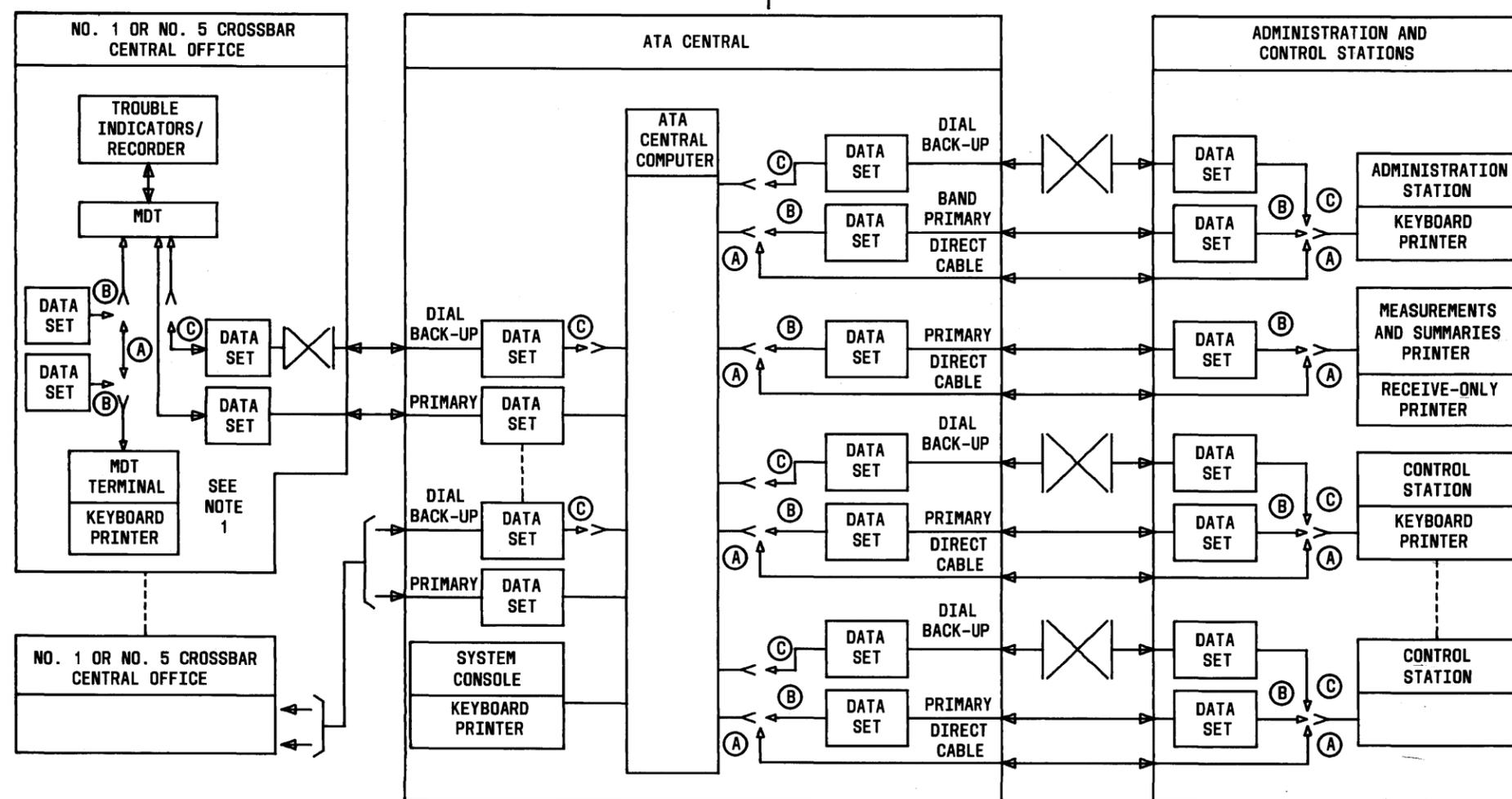
**2.02** The maintenance data transmitter (MDT) serves as the interface between the central office equipment and the ATA central computer. Trouble data is accessed through data concentrators connected to trouble indicator circuits in No. 1 crossbar offices, and through direct connections to the master test frame connector and trouble recorder circuits in No. 5 crossbar offices.

**2.03** The MDT also provides a communication link between the central computer and the MDT terminal(s). Input typed at an MDT terminal is sent to the central computer over the same data link as trouble record data. Buffering is provided in the MDT so that typed characters are not lost if a trouble record transmission is underway. Data from the central computer is printed at the MDT terminal and control station associated with a particular central office. Transmission of this data is inhibited for the period of time during which an input is being typed.

### **B. No. 1 Crossbar MDT**

**2.04** The No. 1 crossbar maintenance data transmitter (Fig. 2) is functionally divided into three areas: the controller (programmable scanner distributor or PSD), the data concentrators, and the trouble indicator interface. The controller performs the data handling and control functions necessary for transmitting trouble records and message data from the central office to the ATA central computer, and receiving exception reports and message data from the ATA central computer. The data concentrators are an interface between the trouble indicator lamp panels and the input data bus to the controller. The concentrator divides the trouble data leads from the lamp panels into groups which can be read by the controller. The trouble indicator interface provides the means by which the controller can recognize the presence and type of trouble record data. In addition, the interface provides the means by which the controller releases the trouble indicator.

**2.05** Trouble indicator data is obtained as soon as the trouble display lamps are locked in at the trouble indicator lamp panels. The controller directs a data concentrator to connect 120 data



OPTIONS:

- (A) = DISTANCE TO KEYBOARD PRINTER 200 FEET OR LESS.
- (B) = DISTANCE TO KEYBOARD PRINTER GREATER THAN 200 FEET.
- (C) = OPTIONAL DIAL BACK-UP DATA FACILITY.

NOTE:

NO. 1 CROSSBAR OFFICE MAY EQUIP TWO MDT TERMINALS PER MDT.

Fig. 1—ATA System Block Diagram

leads to the input data bus, reads data from these leads into a trouble data buffer, and then connects the next group of 120 leads. This action continues until the entire data field is read for that indicator. Depending on the type of trouble data (regular or test), and a mode setting within the MDT, the trouble indicator circuit may then be released.

**2.06** Provision is made for the No. 1 crossbar MDT to handle two MDT terminals. This allows keyboard messages to be handled from two locations in case the trouble indicator circuits associated with one MDT are separately located. An example of the need for this feature would be where an ANI trouble ticketer is located on a different floor than the other trouble indicators

and direct interaction with the ATA System from that location is desired.

**2.07** In No. 1 crossbar, one MDT has the capacity to function with the following types and numbers of trouble indicator circuits: one originating trouble indicator, up to three terminating trouble indicators, one controller trouble indicator, two code compressor trouble indicators, one ANI trouble ticketer, and one Stuck Sender Trunk Identification System. When any of the above is exceeded, a second MDT is required.

### C. No. 5 Crossbar MDT

**2.08** The No. 5 crossbar maintenance data transmitter (Fig. 3) consists of two parts: the controller

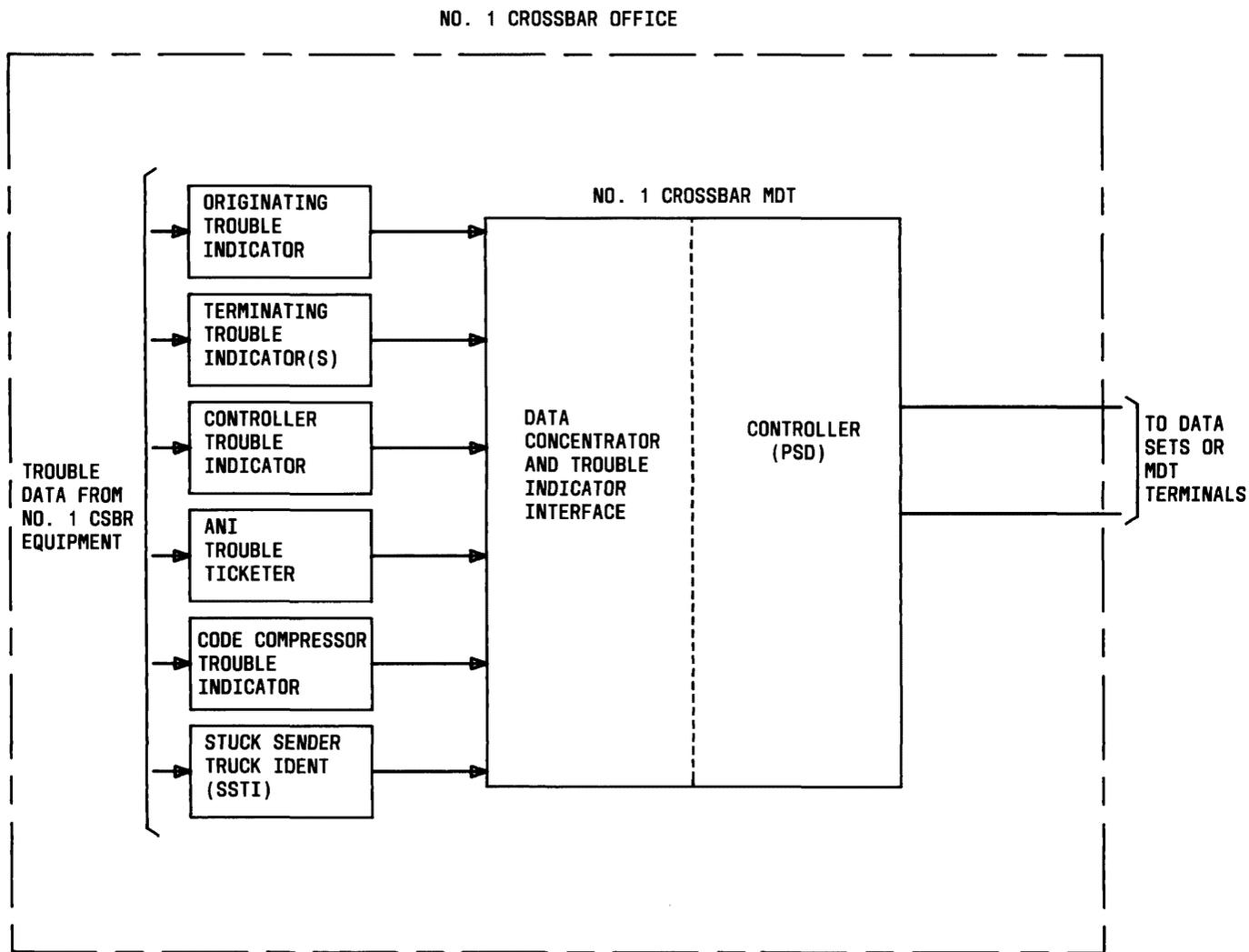


Fig. 2—MDT In No. 1 Crossbar Office

(programmable scanner distribution or PSD), and the interface to the No. 5 crossbar office (ATA interface or ATAI). The ATAI consists of a small amount of electromechanical circuitry that provides the alarm and control interface to No. 5 crossbar trouble indicating equipment.

**2.09** The input/output and control functions of the No. 5 crossbar MDT are similar to the No. 1 crossbar MDT, with the exception that there is no provision for operation with two MDT terminals. The No. 5 MDT serves one trouble recorder (one marker group).

**2.10** In No. 5 crossbar, data for the ATA System is obtained by delaying the start of trouble card perforation by 300 msec while the MDT "prescans" the data by operating the scan relays of the master test frame connector circuit. The trouble perforator can then be started, or more commonly, the perforation process is bypassed and the trouble recorder is released for the next user circuit. In this case, where a trouble card is not punched, the holding time of the MDT consists of only the 300 msec prescan period. Transmission of data from each card requires approximately 6.5 seconds to complete.

#### **D. Central Computer**

**2.11** A block diagram of the central computer is shown in Fig. 4. Dedicated data facilities from each of the MDTs and control stations terminate at the computer. In addition, optional dial backup facilities provide for operation in case of primary data facility failure.

**2.12** The central computer serves as the heart of the ATA System. The computer itself is a DEC\* PDP-11\* minicomputer, equipped with both a large capacity moving-head disk for retention of trouble data from the connected central offices, and a high speed fixed-head disk used for storage of frequently used data, and as a "swapping" device for the operating system. The PDP-11 is equipped with DJ-11 interface units which connect the computer with the data links to all central offices, the administration station, and the control stations. In addition, a keyboard printer is directly connected to the computer to serve as a system console for computer maintenance and operating system control. A magnetic tape unit is provided for program loading and program backup.

**2.13** The computer software consists of a time-sharing operating system, configuration data for the operating system, a set of application programs normally referred to as the ATA software, and application data used by the ATA software describing each of the central offices to be served. The operating system handles input/output buffering, task scheduling, file management and other common purpose tasks, while the ATA application programs handle analysis of data and user interaction. The configuration data for the operating system contains information describing the machine hardware configuration, I/O assignment, disk storage allocation, etc. The ATA application data contains information concerning the central offices served, analysis parameters for each central office, status and assignment of each of the offices and control stations, and other application dependent data.

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#### **E. Administration and Control Stations**

**2.14** The central computer has the capability of serving a flexible number and arrangement of control stations (keyboard printer only locations usually in the SCC) charged with monitoring or controlling the ATA activities in central offices. Since these control stations are keyboard printer only, they do not present trouble card or trouble indicator data to the ATA System, and do not require the extensive data base of a central office. All inputs from these locations are interpreted as commands, inquiring about the state of some portion of the ATA System, or modifying some of the parameters controlling the delivery of ATA service to the central offices.

**2.15** At least one control station must be established in the minimum ATA configuration. This keyboard printer is referred to as the administration station and has access to all commands in the ATA System. This terminal has the ability to set or modify the parameters governing the binning and matching process for each individual central office. It has the ability to independently direct different types of output to any central office or control station either in addition to or instead of its normal destination. These types of output include normal trouble (exception) reports, reports on the status of the central office MDTs, and measurements of central office activity specific to ATA. The administration station also has the ability to delegate the power to use certain

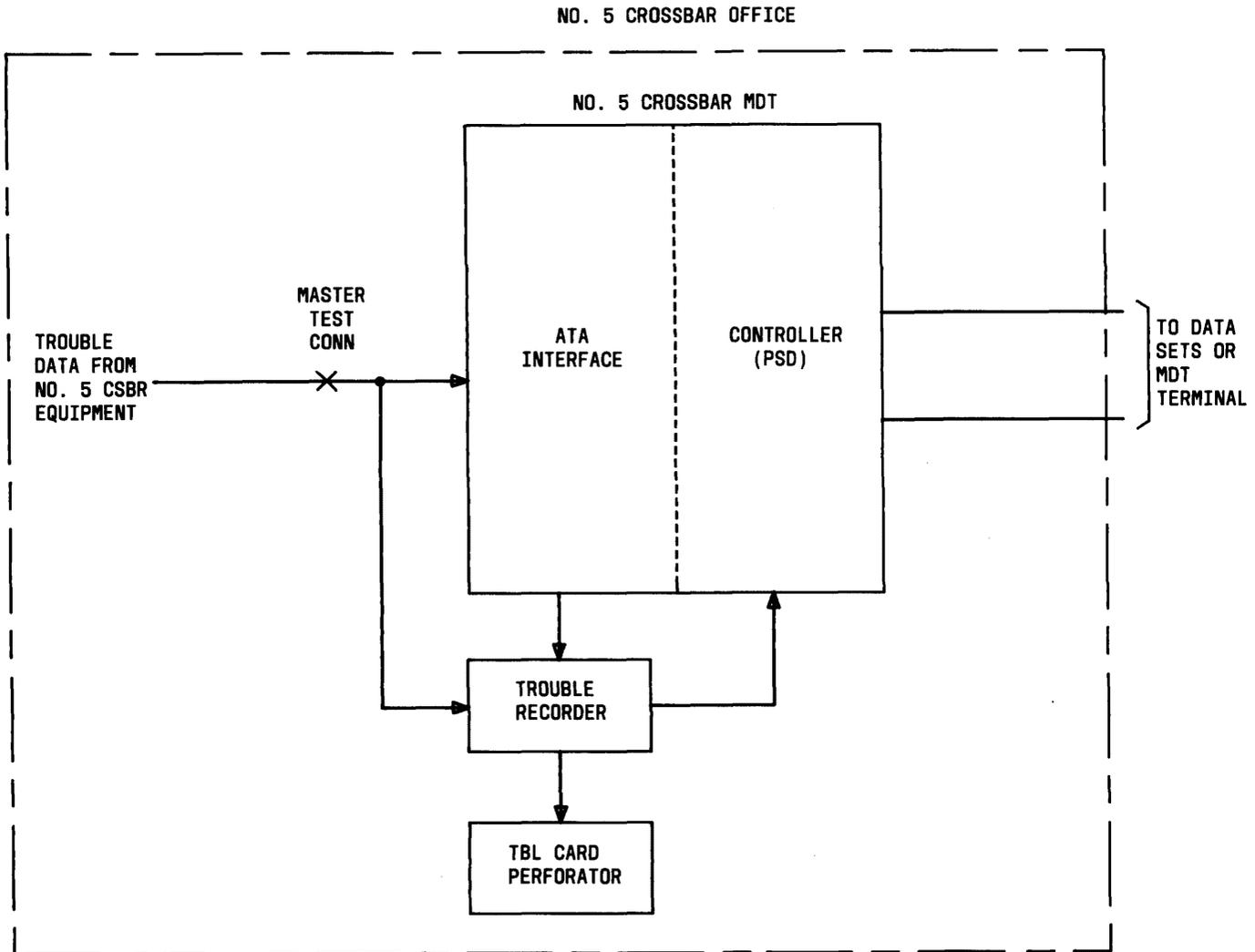


Fig. 3—MDT In No. 5 Crossbar Office

commands which modify the delivery of ATA service to the central offices and control stations, and the ability to establish a flexible hierarchy of authority by permitting these delegated commands to be exercised only over specified subsets of offices or control stations.

**2.16** The number and responsibilities of control stations are determined by user preference. Among the factors influencing this determination are the organization of the served offices, the vertical structure of the telephone company, the geographical distribution of central offices, and the volume of output expected.

## PHYSICAL EQUIPMENT

### A ATA Central Computer

**2.17** The ATA central computer is Digital Equipment Corporation (DEC) equipment. The major components are the PDP-11 processor with 96K of core memory, a 9-track magnetic tape system, a fixed head disk, a moving head disk, and a system console.

**2.18** The computer equipment, other than the system console and moving head disk, is provided in four DEC cabinets. These are bolted together to form a single lineup measuring 84"

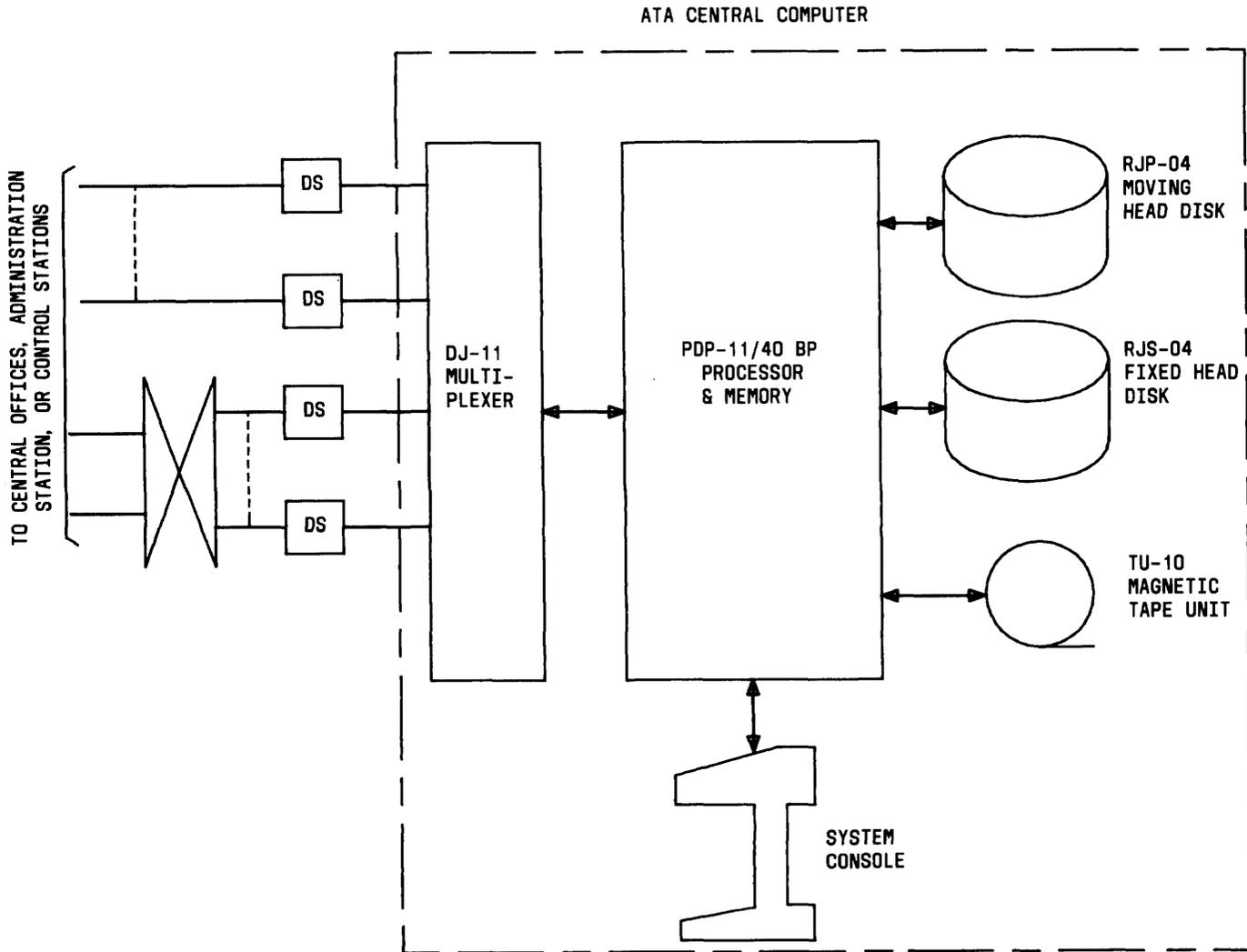


Fig. 4—Minicomputer Subsystem

long, 30" deep, and 72" high. Each cabinet has its own power cord with a three-prong twist-lock plug, and requires a 30A outlet for 120 Vac single-phase commercial power. The moving head disk is in a separate cabinet which measures 31" long, 32" deep and 40" high. It has a power cord with a five-prong interlocking plug which requires a 30A outlet for 208 Vac three-phase power. Power outlets should be within 10' of the cabinets to be served. There is a 25' cable that connects the moving head disk to the computer which establishes the maximum separation. The recommended floor plan arrangement is illustrated in Fig. 5.

2.19 The basic system includes two data channel multiplexers for 32 data channels. This can

be expanded with one or two more multiplexers for a total of 48 or 64 channels.

2.20 The central computer communicates to the central offices via 300-baud full-duplex channels. One 108E (or equivalent) data set is used per MDT. Communication to administration or control stations is also full duplex, however it can be 300 or 1200 baud. For 1200-baud channels, a 202T (or equivalent) data set is used. Manual dial backup arrangements can be provided at the computer site. This would always be a 300-baud channel using the 103J data sets (or equivalent). A data set cabinet should be provided to house the data sets and auxiliary data sets required for the ATA central. The cabinet must be located

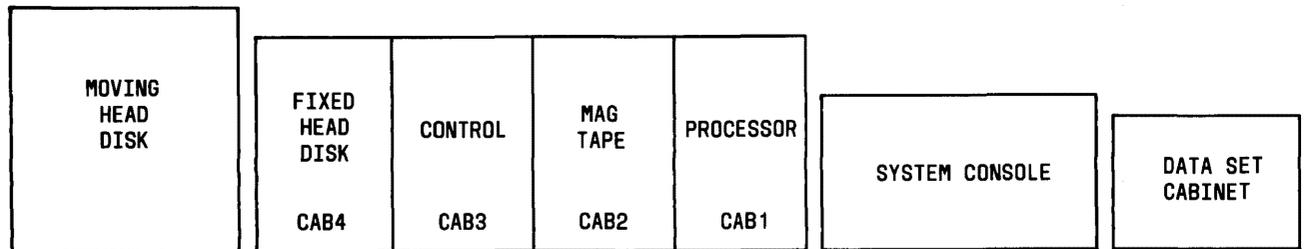


Fig. 5—ATA Central Computer Floor Plan

within 200 cable feet of the computer. The data sets and cabinet are not furnished as part of the basic system.

#### B. Administration and Control Stations

**2.21** Control stations consisting of keyboard printers such as the DATASPEED® 40/2 or equivalent are used for communication with the ATA central computer. The first control station assigned to the central computer is defined as the administration station for the ATA Systems software. The administration station has the ability to interact with certain control features of the ATA System software that a regular control station cannot access; unless so permitted by the administration station.

**2.22** When the volume of printed output of a station reaches an excessive level, a receive-only (RO) printer called a measurements and summaries printer may be provided. Generally, this printer would be set up to monitor measurements and summaries messages for all central offices in an ATA System.

**2.23** As indicated by option A in Fig. 1, stations located within 200 cable feet of the computer do not require data sets. For distances greater than 200 feet, 108D sets (or equivalent) for 300 baud, or 202T sets (or equivalent) for 1200-baud dedicated channels are required. Manual backup arrangements such as the 103J (or equivalent) data sets are recommended for reliability.

#### C. MDT for No. 1 Crossbar

**2.24** The MDT equipment for the No. 1 crossbar office consists of a programmable scanner

distributor unit (PSD), a make-busy and alarm unit, and A, B, and C trouble indicator concentrator units. MDT operation also requires one or two MDT terminals and appropriate data sets. (See Fig. 6.)

**2.25** The PSD is an 18-inch unit designed to mount on a 23-inch relay rack. It consists of 256 scan points, 64 distribute points, 1K random access memory (RAM), four ports for EIA-type input/output (I/O) devices, and a 132H power converter. A programmable controller unit is mounted on the PSD and provides a 3K, 16-bit programmable read-only memory (PROM). Since the PSD unit contains switches and lamps, it should be located at a convenient height. A two-inch space above and below this unit is not to be used to insure proper cooling.

**2.26** The make-busy and alarm unit is a single two-inch mounting plate. It consists of wire-spring relays, lamps, switches, and terminal strips. This unit is shown above the PSD unit with two inches of space between the units.

**2.27** The A trouble indicator concentrator unit is a 22-inch relay rack mounted unit. The unit consists primarily of multicontact wire-spring relays with a few control relays and "D"-type terminal strips. A small cross-connect terminal strip is also provided for associating terminating marker indications with a marker group. The concentrator terminates all leads from the PSD to the three possible trouble indicator concentrator units. Leads to the PSD are plug-ended at the PSD end.

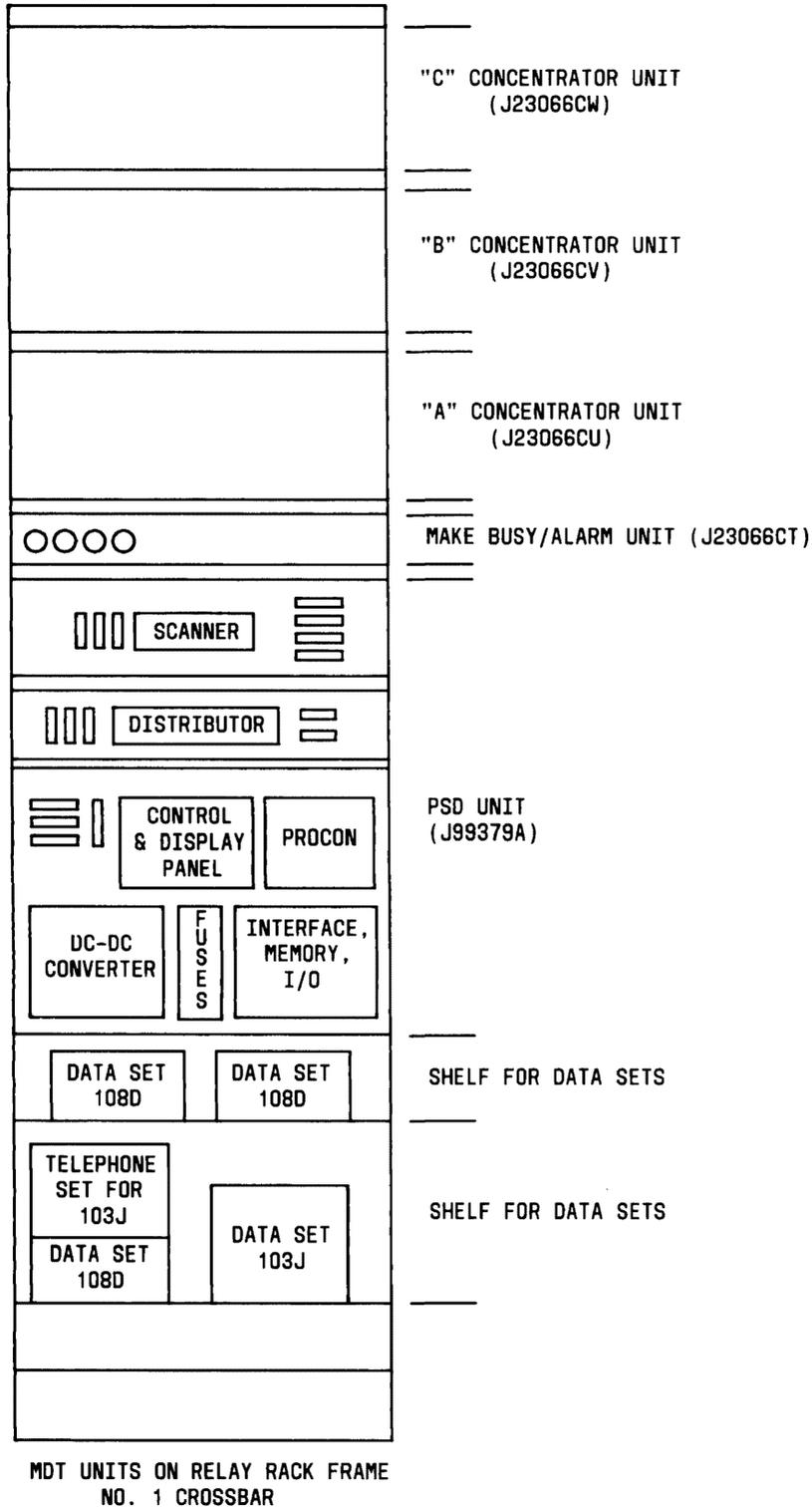


Fig. 6—MDT Units on Relay Rack Frame No. 1 Crossbar

**2.28** The A trouble indicator concentrator unit serves to concentrate leads from the originating trouble indicator frame (OTI) and the first terminating trouble indicator frame (TTI-0), for scanning by the PSD. The mounting location of this unit is not critical, but it is usually located near the OTI and first TTI frames.

**2.29** The B trouble indicator concentrator unit is a 20-inch relay rack mounted unit. It is required when the ATA System serves an automatic number identification trouble ticketer (ANI-TT), a Stuck Sender Trunk Identification System (SSTI), one or two code compressor trouble indicators (CCTI), or a controller trouble indicator (CTI). All leads from this unit associated with the PSD are cabled via the A trouble indicator concentrator unit.

**2.30** The C trouble indicator concentrator unit is a 20-inch relay rack mounted unit. It is required when the ATA System serves a second, or second and third terminating trouble indicator frame (TTI-1, TTI-2). All leads from this unit associated with the PSD are also cabled via the A trouble indicator concentrator unit. This unit is usually located near the TTI-1 and TTI-2 frames. This unit is similar to the trouble indicator concentrator unit but has fewer "D"-type terminal strips.

**2.31** One or two MDT terminals may be used with the PSD. In buildings where equipment served by the PSD is located on more than one floor or widely separated on the same floor, the second MDT terminal may be used. An indicator lamp located in the vicinity of each MDT terminal indicates to the maintenance staff when the office alarms are associated with messages on the MDT terminal.

#### **D. MDT for No. 5 Crossbar**

**2.32** The MDT equipment for No. 5 crossbar marker groups consists of a programmable scanner distributor (PSD), an ATA interface unit (ATAI), a MDT terminal, and appropriate data sets. See Fig. 7.

**2.33** The PSD is a 14-inch relay rack mounted unit. It consists of a 16-bit nonself-checking programmable controller, with 2K of PROM memory, 160 scan points, 24 distribute points, a power converter (132H), 1K of 8-bit RAM memory, and

three ports for EIA-type I/O devices. A lamp is provided near the MDT terminal to indicate to the maintenance staff when the office alarms are associated with messages on the MDT terminal.

**2.34** The ATAI unit is a four-inch relay rack mounted unit with wire-spring relays and unit terminal strips for connecting mainly to the alarm and test circuits in the office. The ATAI unit is always mounted above the PSD. These two units together require 22 inches of relay rack space. Interconnections between units are run via connectorized cables.

#### **E. MDT Terminals and Data Sets**

**2.35** The keyboard printers such as the DEC LA36 or General Electric Terminet used for the MDT terminals, must be 300-baud devices. One 108D (or equivalent) data set is required at the central office for the 300 baud dedicated facility between MDT and ATA central computer. For increased reliability, a 103J (or equivalent) data set can be provided for a dial backup facility. When the MDT terminals are located further than 200 cable feet from the PSD, they must also be connected via data sets such as the 108D at the PSD and the 108E at the MDT terminal.

### **3. METHOD OF OPERATION**

#### **TROUBLE DATA INPUT**

**3.01** The format of data for transmission to and from the ATA central computer is the same for No. 1 and No. 5 crossbar MDTs. The data stream consists of a leading character indicating the start of a message, followed by a number of characters dependent upon the message being transmitted, and terminated by a special character signifying the end of the message. The second and third characters identify the category of data and source of the data. Categories of data include: (1) trouble data associated with either trouble indicators or trouble recorder input, (2) command messages that are used for "handshake" communications between the MDT and the central computer, (3) messages for setting MDT modes of operation, (4) messages informing the central computer of software-detected errors within the MDT, and (5) scan point verification data that is useful in determining hardware faults within the MDT. As an example of the source, the third character may

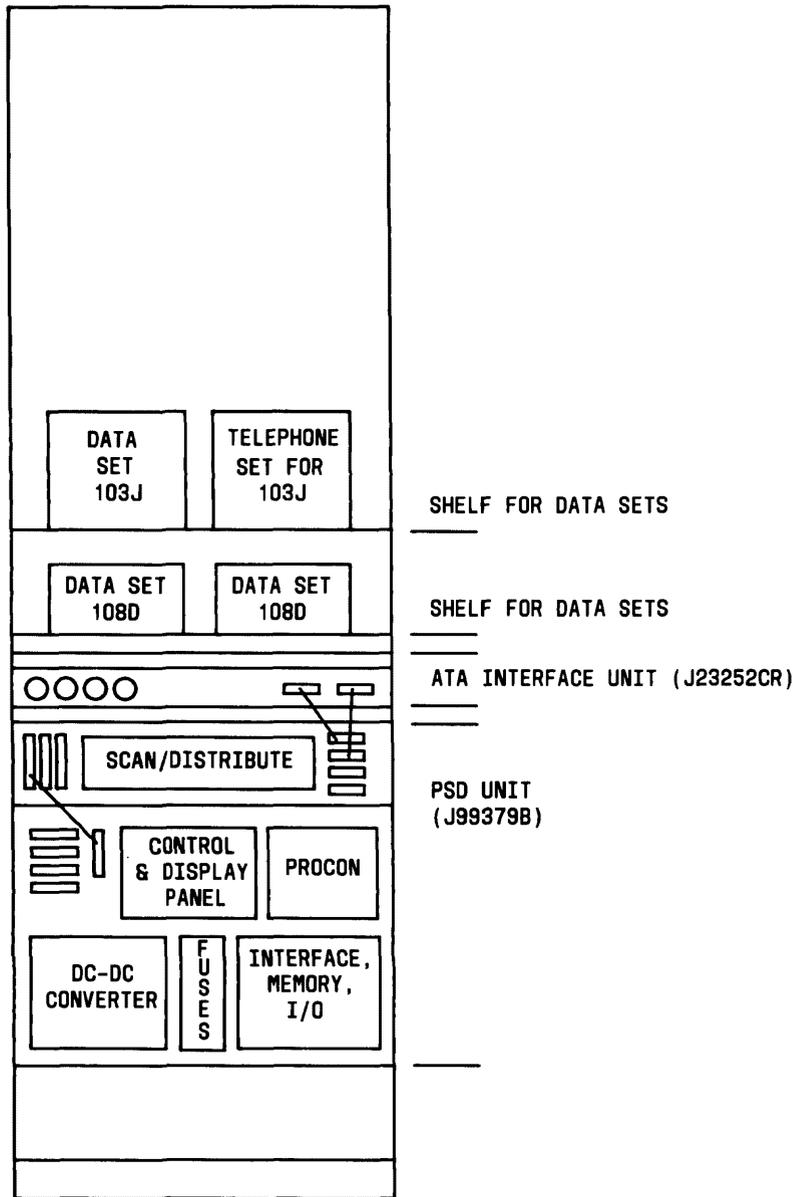


Fig. 7—MDT Units on Relay Rack Frame No. 5 Crossbar

identify which trouble indicator circuit originated a trouble transmission in a No. 1 crossbar MDT.

**3.02** The length of a data transmission is variable, and can be as short as five characters in the case of a single keyboard character being sent to the central computer, or as long as 196 characters in the case of a No. 5 crossbar trouble card image being transmitted.

**3.03** There are three general categories of trouble data that can be sent to the MDT by the central office equipment. These categories are regular, test, and special. Regular refers to trouble data recorded as a result of a service failure detected by a common control circuit. Test refers to data recorded as the result of a manually or automatically generated test call at a test frame or trouble indicator frame. Special data resembles

the regular category since it is not initiated by a test call but it contains a user-provided indication which signifies that the data is a result of a custom "trap" circuit arrangement. Special data may then be displayed or perforated if specified for the test category, but if it is transmitted to the central computer, it is discarded without analysis.

#### MDT OPERATION

**3.04** Although the MDTs for No. 1 and No. 5 crossbar offices have different physical units, they are similar in both internal organization and function. Each utilizes a programmable controller and a programmable scanner and distributor (PSD) to provide internal control and interaction with electromechanical interface circuitry.

##### A. No. 1 Crossbar MDT

**3.05** The MDT for No. 1 crossbar utilizes separate scan and distribute point matrix units. The scan point matrix consists of 256 scan points of which 166 are dedicated for the data concentrators, 57 for trouble indicator circuit status and control, and 6 for alarms and make-busy. The distribute point matrix consists of 64 distribute points, of which 46 are dedicated for use by the data concentrators, 12 for the trouble indicator circuit control, and 6 for the alarm and make-busy.

**3.06** The No. 1 crossbar ATA interface circuit is an auxiliary electromechanical unit that provides two basic functions; alarm/make-busy and trouble data lead concentration. The trouble data lead concentration function provides for connections between the trouble indicator circuit data leads and the 120 scan point data bus of the PSD. The alarm/make-busy function provides:

- (a) Connection to office alarms, alarm release, and alarm cut-off
- (b) Lamps indicating make-busy, alarm, and exception report received
- (c) Make-busy, isolating the trouble indicators from the MDT
- (d) Automatic reinitialization of the MDT in the event of internal failure
- (e) Enabling of the trouble indicator alarms when the MDT is made busy.

##### B. No. 5 Crossbar MDT

**3.07** The MDT for No. 5 crossbar utilizes 160 scan points and 24 distribute points assembled as a combined unit. Of the 160 scan points, 124 are devoted to scan data from the trouble recorder.

**3.08** The interface with electromechanical circuits is either made directly, in the case of the trouble recorder data leads, or through the ATA interface circuit (ATAI). The ATAI provides:

- (a) Office alarm connections, alarm release, and alarm cutoff
- (b) Lamps indicating make-busy, alarm, alarm cutoff, and exception report received
- (c) Make-busy functions, which restore all trouble recorder control to the office when the No. 5 MDT is out of service
- (d) Reinitialization of the MDT control when internal failures are detected
- (e) Disabling of alarms currently associated with trouble recorder usage, except when a trouble card is actually punched.

##### C. Common Features

**3.09** The programmable controller is a 16-bit nonself-checking microprocessor which contains a preprogrammed read-only memory (ROM). This program allows the programmable controller to direct all of the functions of the MDTs. It is nonalterable and may be changed only by replacing the ROM circuit boards. The programmable controller for the No. 1 crossbar MDT utilizes a 3072-word ROM, while the No. 5 crossbar MDT programmable controller uses a 2048-word ROM.

**3.10** In each system, the programmable controller is incorporated into a programmable scanner distributor (PSD) which provides (a) control, display, and power for the programmable controller as well as the electronic logic circuitry of the PSD; (b) a matrix of scan points and distribute points for interfacing with electromechanical indications in the central office; (c) input/output ports for control of the MDT terminals and the data sets to the central computer; (d) and a 1024-word 8-bit random access memory for buffering, scratch pad, and status and pointer retention.

**3.11** The control program incorporated in the programmable controller of both MDTs is organized on a task basis in which the elements of the various functions performed by the MDT are accomplished in discrete and independent steps. The initialization task is only performed in response to system failure or command, but the remaining tasks are performed on an overall cycle time of 6.4 ms. Thus, each of the tasks typically is structured so that the operations required may be performed on data, one character or unit at a time. Buffer areas between tasks are extensively used for communication.

#### **D. Programmed Tasks**

**3.12** There are 10 tasks involved in the MDT control described in the following paragraphs.

**3.13 *Initialization:*** The initialization task is entered upon detection of severe MDT internal failure, failure of communication to the central computer, by manual action from the MDT control panel, and upon restoral of power to the MDT. The initialization task clears or resets all appropriate temporary data in the MDT, verifies the health of the MDT circuitry and the programmable controller, and establishes the proper handshaking with the central computer, requesting that the MDT be set to the appropriate operating mode for the correct system configuration.

**3.14 *Executive:*** The executive functions as a task dispenser and controls the orderly progression of all remaining tasks. In addition, the executive monitors the time required to execute the remaining tasks and administers an internal sanity timer to protect against undetected internal failures. The remaining tasks are each executed once during each cycle under the control of the executive.

**3.15 *Data Link Receive:*** This task scans the data link to the ATA central computer, identifies each incoming message according to its header, and places the data received in an appropriate buffer for operation by other tasks.

**3.16 *Data Link Transmit:*** This task administers the transmission of data to the central computer. Data stored in buffers by other tasks is presented to the I/O control circuitry at an appropriate rate, and header information

appropriate for each message or character precedes each message.

**3.17 *Trouble Data Scan and Control:*** This task performs the scanning of trouble data input leads from the interface circuits to the central office. It also provides the appropriate control signals for the trouble recording or indicating circuits for each system. Data received from the central office is placed in buffers for translation by the character formatting task.

**3.18 *Character Formatting:*** The character formatting task administers the translation of the trouble data received in the trouble data scan and control task into a form suitable for transmission to the central computer by the data link transmit task.

**3.19 *Keyboard Receive:*** The keyboard receive task scans the input/output port of the MDT for messages originating at the MDT terminal(s), and places the characters received in a print buffer for echoing at the terminal by the printer send task. The characters received are also buffered for transmission over the data link to the central computer by the data link send task.

**3.20 *Printer Send:*** This task controls the printing of characters at the MDT terminal(s), in response to data placed in its buffer by the keyboard receive or data link receive tasks.

**3.21 *Command Processor:*** The command processor executes commands placed into its buffer by the data link receive program, as received from the central computer. It also formats all command data which is to be transmitted to the central computer by the data link send task.

**3.22 *Maintenance:*** This task performs maintenance actions and routines in response to the control panel and switches associated with the MDT. These include the testing of the internal sanity timer and the execution of a data scanning operation for scan point verification.

#### **DATA TRANSMISSION**

**3.23** All data transmission between the central computer and central offices (MDTs) or control stations is done over full-duplex data facilities. Facilities between MDTs and the central computer

are limited to 300 baud, while control stations may be operated at 300 or 1200 baud.

**3.24** All data between an MDT and the central computer is transmitted in the following format;

SOM MSCL MSID data1 data2...data(n) EOM

Where SOM is a start of message character; MSCL indicates the message class and is used to differentiate between trouble record data, command messages, etc; MSID identifies the source or destination of the message and denotes the trouble indicator circuit or MDT terminal in No. 1 crossbar. The data characters form the text of the message, and their number may vary from one to several hundred, depending upon the message itself. The EOM character denotes the end of message. Each character is composed of 10 bits, including one start bit, one stop, one parity, one control bit, and six bits of data.

**3.25** Communications between the central computer and either MDTs or control stations also use a 10-bit format for each keyboard printer character, including one start, one stop, one parity, and seven data bits. Standard ASCII coding is used for all keyboard printers.

## CENTRAL COMPUTER OPERATION

### A. General Software Overview

**3.26** The software of the ATA System is composed of UNIX (a Bell System multiuser, time-shared operating system used with DEC PDP-11 series computers), and the ATA application programs, together with their respective data bases. The operating system provides a "real-time" environment for the application programs, sharing both time and resources on the basis of the work which is to be done.

**3.27** The ATA central computer monitors all lines to central offices and control stations looking for valid inputs. Inputs may be of two forms; commands which direct the system to perform some function, and trouble data which the system will analyze.

**3.28** The major function of the ATA System is the analysis of trouble data. As trouble inputs enter the system, they are analyzed using

office data specific to the central office from which the trouble input originated. This office data contains information which will direct the logical interpretation of the trouble input, translating specific punch or lamp indications to progress indications, frame identities, etc. A logic tree causes the central computer to perform a sequence of decisions based on the indications present in the trouble data in order to categorize the trouble represented into one category or bin.

**3.29** Depending upon the bin in which a trouble is categorized, it may be matched against a number of other troubles in the same bin from that office to determine whether specific units of equipment can be associated with the trouble. The trouble can receive special treatment which may involve an immediate report to the office, retention of the trouble input for possible later reference with no immediate analysis, or the removal of the trouble indication from the system with no further action.

**3.30** In addition to the analysis of troubles and the generation of reports which initiate central office repair action, the central computer will maintain a record of all such reported troubles. These records may be updated to indicate the results of repair action, and may be interrogated to determine the status of pending corrective maintenance. In addition, a daily summary is automatically produced which will identify all trouble reports issued and status updates entered. This summary is supplemented by a brief analysis of the types of repair action taken, and the effectiveness of maintenance activity in clearing reported problems.

**3.31** The central computer also provides maintenance information regarding the state of the ATA System itself, including the total amount of space used by retained records, any observed problems internal to the software, and measures of the total load observed from all offices connected to the system. The ATA central computer software includes audit, recovery, overload purge, and system generation capabilities to assist in maintaining a viable central system and data base.

**3.32** The central computer is equipped with a DEC keyboard printer which serves as a system console. This system console is the prime input station for all messages pertaining to the operating system. From this terminal, commands

can be entered to load program tapes, to create backup tapes, and to validate the integrity of the overall file system used by both operating system and application software. The terminal is also used to interrogate the software-produced error log in which abnormalities encountered in processing ATA data are noted for possible maintenance action.

**3.33** The system console cannot interact with the ATA application software other than to start and stop ATA processing. All ATA System interaction takes place through the administration station, control station, and central office MDT terminals.

## **B. Program Description**

**3.34** The actual process of analyzing and reporting central office troubles is performed by the ATA application programs operating within the UNIX operating system. The term "application programs" is intended to include all of those programs, exclusive of UNIX, involved in the actual operation of the ATA System. The following is a description of each of the ATA application programs.

### ***Logger***

**3.35** The logger routine examines input from central offices looking for data streams with the characteristics of trouble card or trouble display images. Those images meeting the requirements are placed on the spooler (a disk file used for temporary storage) organized by site. The logger is active whenever there is data arriving over the input lines.

### ***Bin Program***

**3.36** The bin program examines the trouble data representing trouble cards or trouble displays, formats this data according to the card description for the originating central office (CO), and then analyzes the data according to the tree for the CO. The formatted trouble data is called a trouble record entry (TRE). Depending on the bin determined for the TRE and the bin option flags set in the bin, the TRE will be passed to the immediate action (IA) program, to the sort and match program (SM), or discarded.

**3.37** Each bin of each CO has the capability of holding a maximum of four TREs awaiting action by the sort and match program. Should the bin program find that four TREs are already

awaiting SM action, additional TREs for that bin are discarded until the SM program has served the bin. This mechanism functions as an automatic load limiter during periods of processing overload when the SM program cannot keep up with the volume of analysis required.

**3.38** In addition to determining the proper processing path for binned troubles, the bin program monitors the rate of TRE input from each CO to determine offices experiencing unusually heavy rates, monitors for pumpers (hard faults in common control equipment), and monitors for evidence of excessive delays in the overall processing system.

**3.39** TREs passed to the IA program are examined for data to be entered in the exception report directory (ERD). A link is established in the ERD to the TRE for later reference. A header consisting of headings designating the equipment is formatted, followed by a line of data from the TRE with each item entered under a column heading. This report, called an immediate action (IA) report, is then passed to the queue scanner program for distribution to the appropriate terminals and stations.

**3.40** Should the TRE be part of a continuing IA sequence, such as a pumper, then the heading is printed only once and the ERD link points only to the most recent TRE. A link is established in that TRE to the next most recent, and so on, so that all TREs associated with a single IA sequence are linked together for later reference. IA report data is passed to the queue scanner for high priority transmission to the appropriate MDT terminals.

### ***Sort and Match Program***

**3.41** TREs passed to the SM program are analyzed to identify those items or combinations of equipment which must be matched. TREs are linked to a pointer record, and are classified as active TREs. They will remain active until they either combine with other active TREs in the bin to cause an exception report, or until they are purged from the system. As these TREs are received, they are matched against other TREs in the bin to see if they have caused a threshold to be exceeded. The threshold specifies the number of times a specific item or combination of items of equipment (called a sort) must occur to indicate probable trouble.

**3.42** If a threshold is exceeded, all TREs contributing are marked as passive TREs, and are no longer used in matching. A report record is constructed which identifies the equipment within the sort. The address of this report record is passed to the exception report generator.

#### ***Exception Report Generator Program***

**3.43** The exception report generator (ERG) examines report records produced by the sort and match routine and formats the exception reports (ERs) that are put out by the ATA System. The matched sort value and ER information is taken from the last TRE contributing to the report. After formatting, the exception report is queued for normal priority processing by the queue scanner program.

**3.44** In addition to formatting, the ERG establishes an entry in the exception report directory (ERD) for each report record. If a new report record contains the same sort identification as an existing report, the trouble is considered a repeat of a previously issued report. In this case, the existing ERD entry is updated and only the TREs associated with the most recent occurrence are retained as passive records. The previous TREs (associated with prior report) are marked as void TREs, to be later purged from the system. Information is placed in the ERD entry for the time of generation, the bin involved, the report number (including number of repeats), and the link to the associated report record. In addition, space is available in the ERD entry for certain craft input about the status of the exception report.

#### ***Purge Programs***

**3.45** Purge programs are required to free the system of information which is no longer valid or needed. Records in the main record store (MRS) are purged by age, by updated records, or under an emergency action. The purge processes are:

- (a) **Active Purge**—Each bin has a basic purge period which is set in the bin information. Each day this program checks all of the active records in the system for age and voids any which have exceeded the purge time.
- (b) **Emergency Purge**—The number of records in the MRS is constantly monitored and

checked against certain alarm points. If the size approaches the maximum, this program is called upon to purge all active and match records in the system to give more room in the MRS.

- (c) **MRS Purge**—If the rate of audit calls exceeds a threshold, the data base is declared scribbled and this program is scheduled to completely reinitialize the MRS.

- (d) **Report Record Purge**—This process purges report records and their associated passive records. Any process requesting record purge communicates its needs to this program through a pipe (a directional message file provided by UNIX).

#### ***Audit Programs***

**3.46** The ATA audit package consists of a main scheduling process and several programs which check and correct irregularities in the data base. Whenever an ATA process finds a data inconsistency, it notifies the main audit process through a pipe which then determines the type of action required and schedules the proper audit program. If the rate of audit requests exceeds a certain threshold, the data base is declared scribbled and is reinitialized by the MRS purge process. The following is a list of audit programs.

- (a) **Bin Audit**—This program checks all of the records associated with one bin and central office site. Defective records found are purged from the system.
- (b) **ERD Audit**—This program checks and corrects the information in an exception report directory entry and the associated report record.
- (c) **Lock Audit**—During the course of their work, ATA processes lock certain areas of the data base to prevent interwrite problems. This program checks the locks currently set for validity and clears any false locks.
- (d) **Map Audit**—The MRS bit map controls allocation of MRS records. This program traces all of the references to records in all of the pointer records and checks for proper record allocation in the bit map. If differences occur, the bit map is adjusted accordingly.

(e) Pointer Repack—Whenever Analysis II finds that the pointer records in a bin have enough void slots to warrant a repack, thus freeing at least one pointer record, a call is made through the audit pipe requesting a repack be done on the bin.

### ***Exception Report Summary Program***

**3.47** The exception report summary routine provides a summary of all the exception reports (ERs) and immediate action reports (IAs) that have occurred or been altered within a 24-hour period (midnight to midnight). This summary is provided for each central office and consists of pertinent data for each ER and IA as well as summary data for all ERs and IAs. The data provided for each report consists of the type of report (ER/IA), the report number and issue, the report create, reissue, and update time, the report bin name, and any central office (CO) craft comments or trouble codes entered via the interactive update command. The report summary data provides a daily and monthly count of the number of each type of CO craft status, the number of reports that are Issue 1, Issue 2, and Issue 3 or greater, and the number of each type of equipment apparatus trouble code used. In addition to summaries, this routine provides the control necessary for purging ERD reports. When the time reflecting the latest activity of an ER/IA exceeds the purge period time for the site, both the exception report directory entry and associated MRS records for the ER/IA are essentially purged from the system.

### ***Measurements***

**3.48** The measurement routines provide a variety of data to indicate the ATA status of a particular central office. This information includes the number of TREs, the number of bins used, the number of reports generated (both IA and ER), the number of TREs put into each bin, and a list to reflect certain bin and throttle controls that would affect automatic output. This information is produced on both an hourly and 24-hour basis where the hourly report reflects measurements for the previous hour and the 24-hour report reflects the total of each of the hourly reports. Interactive control is provided to either stop or limit the amount of measurement information outputted.

### ***MDT Handler***

**3.49** The MDT message handler routine is fed through a named pipe by the logger. This handler takes the various types of control messages coming in from the MDT sites on the system and performs whatever functions are required. These control messages include the following:

- (a) MDT trouble messages.
- (b) The message generated when the MDT status is changed automatically, such as during initialization or in response to external conditions such as make-busy.
- (c) The message generated when the MDT status is changed by an interactive command.
- (d) The message generated when a scan point verification test is used.

All of these messages result in output at the particular central office MDT terminal and in most cases at all control stations monitoring that MDT.

### ***Kronos***

**3.50** Kronos is a routine which schedules ATA programs on a time basis. It is activated every 15 minutes, determines if there are any programs scheduled to be run, and executes those programs that are scheduled. The time intervals allowed for scheduling include every 15-minute interval or a particular 15-minute interval, every hour or a particular hour, or every day or a particular day of the week or month. Examples of programs scheduled by kronos include measurements (every hour) and the exception report summary (every day).

### ***ATA Shell***

**3.51** Command messages are detected by UNIX and sent to the ATA shell for initial processing. The first task for the shell is to link the input data into a pure command stream. This involves the incorporation of any line or character editing and removal of any line and/or character delete characters that may be present. In addition, if the message is from a multiplexed line, certain control characters must be deleted and the associated multiplexed packets of data must be put together into a pure text string. Once the command string

is formed, a pointer is established to each key word, argument, and delimiter of the command. These pointers serve two functions; first they are used by the shell to determine which command has been requested and secondly they are used by the requested command to determine proper operation. If the shell determines that the command is legitimate, an argument list consisting of the originating site, line, and keyboard printer number plus the requested site number, is built for the command and the desired command is executed.

### **Queue Scanner Program**

**3.52** The queue scanner program receives all data to be printed at ATA keyboard printers, whether they are central office or control station sites. Data may come from either high priority or normal priority handling. In either case, the type of data examined, and on the basis of internal tables, the proper destination is determined. This table may designate that data of a certain type for a particular site be sent to only that site, while another type of data, such as an IA report, or the response to a command, may be sent to a number of sites. The ability to modify this table allows control stations to monitor classes of action at selected sets of central office sites. Messages for each site are handled independently, so a large amount of data for one site does not delay the prompt transmission of data to other sites. Both a high priority and a normal priority channel are provided for each keyboard printer. In the absence of high priority data to be transmitted, low priority lines of data are sent to the site for printing. High priority data will cause suspension of normal priority data at the end of the message in progress. In addition, to prevent output being printed while someone is attempting to type a command, a special character received from a keyboard printer will cause suspension of printing for 30 seconds.

### **MDT TERMINAL, ADMINISTRATION AND CONTROL STATION OPERATION**

**3.53** The ATA System provides operating personnel with commands for interacting with the system for the purpose of updating information in the system, inquiring about previously reported troubles, or modifying some of the analysis parameters used by the ATA software in the processing and reporting of trouble data.

**3.54** All interaction with the central computer, whether from central offices or control stations, follows ESS standards. Commands are interpreted and checked within the ATA application software, preventing any ATA terminal from affecting the UNIX operating system. Only the system console has any power to interact with UNIX.

**3.55** The system will hold output once the beginning of a command has been received from that terminal so operating personnel will not be distracted by intermixed input and output. Special control characters are available to eliminate output which is unproductive, and to hold output for a specified period of time to allow commands to be entered.

**3.56** Commands, when entered, are examined for correctness by the ATA application software. When errors are encountered, error messages indicating the particular section of the command which was in error are returned whenever possible.

**3.57** Among the more frequently used commands are OUTPUT, UPDATE, and VERIFY. The OUTPUT command allows operating personnel to request a repeat of a previously reported exception report (ER) or immediate action (IA) report, to request detailed trouble records or trouble indications that contributed to ERs or IAs, to request information on trouble record cards or indications in bins that have not yet produced a report, and to request summaries of the days report activity. After taking action on an ER or IA, entries may be made for UPDATE of the repair status of the trouble and pertinent information to be stored in the ATA System with the report. Subsequent requests for these updated reports will contain the added information. A request may be made for an output message for a specified ER, when any single new trouble record card or indication occurs which matches those that caused the ER to be generated. This can be useful in verifying that corrective action fixed the trouble which caused the reports to be generated.

**3.58** Other commands permit stopping or restarting the printing of IA reports resulting from persistent pumper conditions. Precautions have been taken to prevent totally disabling the printing of these important reports.

**3.59** For special circumstances, the ATA System provides commands that permit altering some

of the analysis parameters and reporting methods. A command can be used to inhibit or restart printing a specific ER. Limited controls are available for altering thresholds used in sorting and matching when special treatment is warranted. Specific bins may be arranged to never produce ERs or be arranged to give only periodic summaries of the trouble record cards. The retention period of trouble record cards or indications may be varied as well as the maximum number of records to be stored in specified bins at any one time for sorting and matching. The advantages of these capabilities may be for special treatment of particular trouble types (stuck senders, traps, etc) or to accommodate unique central office conditions. Some or all of these commands may be delegated from the administration station to any MDT terminal or control station.

### **Alarms**

**3.60** Every 15 minutes, a time message is sent to each keyboard printer giving assurance that the system is still operational. A message transmission capability is provided by the ATA System which allows a keyboard printer to enter a message for printing at another keyboard printer. This power can be restricted to messages originating from the administrative station or other specified control stations, or may be delegated to each central office and control station, allowing full communication between keyboard printers throughout the system.

**3.61** The ATA System has the capability of operating central office alarms under the control of the central computer. Exception reports are accompanied by a spurt minor alarm, in which the minor alarm is initiated, and then retired approximately five seconds later. This alarm is accompanied by an aisle pilot and beehive lamp located near the MDT terminal directing attention to the report.

**3.62** Major alarms are initiated when a pumper is encountered or when a trouble input has entered a bin which has been selected for major alarm treatment. The central computer initiates the major alarm at the central office accompanied by the aisle pilot and beehive lamp directing attention to the MDT terminal. This major alarm, initiated by the central computer, can be retired only by the entry of a brief command at the MDT terminal thus assuring that the maintenance forces have responded. Major alarms caused by power, carrier,

or MDT failures lock under control of an alarm release key on the MDT.

## **4. MAINTENANCE ARRANGEMENTS**

### **A. Maintenance Data Transmitter**

**4.01** Certain nonfatal internal failures or abnormal conditions detected within the MDT cause transmission of maintenance messages to the central computer, which expands them into test messages and transmits them to both the MDT terminal and selected control stations. In the case of serious internal failures or failure of the data link, the MDT will automatically reinitialize; remove itself from service, routing troubles to the trouble indicator or trouble recorder; activate an office major alarm; and attempt to reestablish a viable connection with the central computer.

**4.02** A limited maintenance capability has been incorporated into the MDT. In the case of failure, lamps on the MDT will display the class of failure (ie, controller, I/O etc), and the type of processing in progress at the time of failure (initialization, normal processing). A combination of manual action, MDT maintenance programs, and central computer programs can be used to verify scan point integrity. Requests can be typed at an MDT terminal to cause the central computer to operate or release distribute points.

**4.03** The MDT operates the office alarms in two distinct ways. Internal failures of the MDT itself cause the actuation of a major alarm and the operation of the aisle pilot for the aisle in which the MDT is located. A command from the central computer can also activate or release the office major alarm or minor alarms. In these cases, the aisle pilots actuated are those associated with the MDT terminal. The release of these alarms is accomplished by the central computer, either automatically or as the result of a typed command. Trouble locating procedures are given in Section 190-106-301 for No. 5 crossbar and Section 190-106-311 for No. 1 crossbar.

**4.04** It is intended that failures within the PSD unit be repaired by plug-in replacements. Both programmable controller and power converters can be replaced as units. All other circuits (ie, scan, distribute, random access memory, and input/output) are replaced on a circuit pack level.

**4.05** Two levels of maintenance have been developed to diagnose MDT faults. The first level utilizes the MDT terminal working with the central computer, as well as lamps and switches located on the PSD control panel. The second level of maintenance utilizes a test unit which plugs into card slots in the programmable controller. Its function is to isolate failures within the PSD to a particular replaceable unit. Trouble location procedures are given in Section 190-107-301.

**4.06** The interface circuitry connecting the MDTs to the No. 1 or No. 5 crossbar office equipment uses conventional relay technology and requires no new maintenance tools or techniques.

### **B. Central Computer**

**4.07** Extensive central computer maintenance features are not provided, since the ATA System is not directly involved in switching telephone traffic. The local office still has the use of the trouble indicators or trouble recorders if the ATA System becomes unavailable.

**4.08** The ATA application software incorporates an extensive system of audits to detect the presence of mutilations within the ATA data base, whether caused by program malfunction or hardware failure. Each audit called and the result of the audit are logged into a special file which may be examined from the system console. In addition, the administration station will receive an abbreviated notification of the audit.

**4.09** Problems more serious than a mutilated data base will soon cause the failure of the ATA software in such a manner that one of the application program modules will die. This, too, will be announced to the system console. Recovery procedures are specified in Section 190-105-310 Computer Operating Procedures.

**4.10** The operating system will also provide messages to the system console in case of failures affecting the capability of the operating system to function. These messages are listed in Section 190-105-301.

**4.11** In the case of failures within the application programs, central offices will be notified of the failures, and when possible, troubles will be transferred to the trouble recorder or trouble indicators. Failures of the operating system

programs will preclude the application programs from taking any meaningful action. In the case of either type of software failure, the system can be easily restarted from the system console. Should the problem continue, Digital Equipment Corporation diagnostic programs are used to isolate possible hardware failures within the system.

### **C. System Maintenance**

**4.12** The detection and isolation of failures which may have arisen in any of the several parts of the ATA System is accomplished by a combination of the methods previously described. When there is doubt about the current health of the computer system, either with respect to a single central office or all central offices, there are simple commands and operations which validate the various portions of the system. Problems can thus be rapidly isolated to the central office, the data facilities, or the central computer. Additional commands are available to the system console to enable the failures occurring at the central computer to be attributed to the application software, the operating system, or the hardware. ATA operating procedures are given in Section 190-105-302.

## **5. SYSTEM DOCUMENTATION**

### **A. Central Computer Operations**

**5.01** The following sections will document computer operator actions and responsibilities with the ATA System, including system generation, backup, recovery and maintenance procedures, and interaction with the ATA operating system.

<b>SECTION</b>	<b>TITLE</b>
190-105-310	ATA Computer—Operating Procedures
190-105-311	ATA Computer—System Generation
190-105-313	ATA Computer—Input/Output Messages

### **B. Central Office Operations**

**5.02** The following sections will cover the operation with the ATA System from a central office. The content and interpretation of exception reports, the various types of reports, commands which can be used to obtain information about specific troubles,

**SECTION 190-105-101**

<b>SECTION</b>	<b>TITLE</b>
	and commands which will modify ATA operation are described.
190-105-301	ATA—Input/Output Messages
190-105-302	ATA—Operating Procedures
218-105-302	No. 5 Crossbar—Trouble Reference Guide
216-600-301	No. 1 Crossbar—ORIG TBL IND Trouble Reference Guide
216-600-302	No. 1 Crossbar—TERM TBL IND Trouble Reference Guide
216-600-303	No. 1 Crossbar—ANI TBL TICKETER Trouble Reference Guide
216-600-304	No. 1 Crossbar—CONTL TBL IND Trouble Reference Guide
216-600-305	No. 1 Crossbar—CODE COMPRES-SOR TBL IND Trouble Reference Guide
216-600-306	No. 1 Crossbar—Stuck Sender Trunk Ident. Trouble Reference Guide

<b>SECTION</b>	<b>TITLE</b>
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**C. MDT Maintenance**

**5.03** The following sections describe the operation of the maintenance data transmitter and its interconnections with the No. 5 crossbar and No. 1 crossbar offices. Test procedures for the isolation of troubles are described.

190-106-101	MDT Description—No. 5 Crossbar
190-106-111	MDT Description—No. 1 Crossbar
190-106-301	MDT—Trouble Sectionalizing—No. 5 Crossbar
190-106-311	MDT—Trouble Sectionalizing—No. 1 Crossbar
190-107-101	Programmable Scanner Distributor—Description
190-107-301	Programmable Scanner Distributor—Trouble Locating Procedures.

**D. ATA Equipment**

**5.04** The following section describes the general outline for the ATA System equipment design requirements.

824-100-103	ATA System (J1P035)
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