**RCA's Automatic Store and Forward Message Switching System**

by

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**INTRODUCTION**

AutoData is an automatic, fully transistorized store and forward message switching system. It is designed for use in common user communication networks in which message traffic in digital form may be relayed throughout the world. When the message switching system is used, many advantages may be obtained, some of which are:

- Economic utilization of communication facilities
- Automatic transfer of messages through the network
- Effective utilization of communication facilities operating at different data rates, with different codes, and with different coordination procedures
- High degree of message protection all with,
- Building block expansibility to provide increased service as required.

The design features of the system are presented by first describing the configuration of a communication network, then explaining the basic switching center functions, outlining the main system design considerations, and finally reviewing the flow of messages through a typical switching center.

**THE COMMUNICATION NETWORK**

Figure 1 shows the elements of a typical communication network using AutoData Message Switching Centers. Messages originate and terminate at subscriber terminal stations (T1 through Tn) that are connected to the centers by tributary channels, or at Electronic Data Processing Equipment (EDPE) stations which may be local or remote from the centers. The switching centers are interconnected with trunk channels. All communication channels and their associated line terminal equipments are of types currently available in the communication industry.

![Typical Communication Network Diagram](image)

**Figure 1**

The message traffic handled by the communication equipment discussed here is always in digital form. Each message consists of three parts: header, text, and ending (See Figure 2). The header contains all the information needed to route the message. The text comprises the intelligence to be transmitted. The ending discreetly marks the termination of the message. The header and ending must consist of characters of information organized in a manner such that they can be interpreted by the switching center. The text may consist of plain text characters, encrypted characters, or bit-stream traffic organized into checkable pseudocharacters.

Messages are interchanged through the network by sending them first to the nearest switching center. They are automatically relayed among the switching centers and finally distributed to the destinations listed in the headers.
A message may be relayed among different types of communication equipment, such as teletype, punched card transceivers, as well as the new high-speed digital data transmission devices which will be available soon. These equipments have widely varying characteristics. The data transfer rates will vary from around 30 to 3000 bauds. Data characters will be represented in a variety of codes varying from 5 to 8 elements, with different redundancy features. The control procedure used on the various channels will differ. Some will provide closed-loop control while others provide no return path for signalling; some will be fully automatic while others are manual. The modes of transmission will include several types of keying: For example, DC keying, tone keying, frequency-shift keying, and phase-shift keying and will be over wire line, microwave, or radio circuits. The AutoData equipment provides compatibility between these many types of communication devices.

**SWITCHING CENTER FUNCTIONS**

A simplified functional diagram of a Message Switching Center is shown in Figure 3.

The **Input** function receives message characters from the various incoming channels and accumulates them into blocks conditioned for processing. This input function includes character and block checks and exercises control over the transfer of messages over the incoming communication channels. These accuracy checks together with the ability to repeat blocks allows errors in transmission to be corrected automatically.

The **Message Processing** function interprets the heading of each message and directs it to the appropriate outgoing channel. As the blocks of a message are received from the **Input**, they are transferred to the **Intransit Store**; only when the message is complete does it become a candidate for transmission. As each outgoing channel becomes available, the **Message Processing** function transfers to the **Output** the oldest message in the highest precedence category for that output channel. A stored program data processor is used for this function. This provides great logical power, a high degree of flexibility and very fast message handling speeds within the center.

The **Intransit Store** function provides a reservoir for messages when their outgoing channels are busy. It is this function that provides the "store and forward" capability of the switching center. It permits any subscriber to send his message without waiting for a through connection. It permits one incoming message to be delivered to any number of addressees. It allows messages to be transmitted out in sequence by priority as well as by age. It further allows top priority traffic to automatically interrupt lower priority messages and provides the means for repeating the interrupted messages.

The **Output** function coordinates the transfer of outbound traffic on each tributary and trunk channel. Storage capability is provided for each channel to maintain continuous transmission. Repeats of traffic blocks are provided by the output function as requested by the next switching center or tributary equipment.

Messages to and from local EDPE and other High Speed Input-Output devices have access to the switching center by way of the **Message Processor**. Local Low Speed Input-Output equipment is handled like any other tributary channel.

**DESIGN FEATURES**

Some of the more important design features of the message switching system are illustrated in Figure 4. These features are fully automatic.
except in a few cases where the subscriber terminal equipment does not permit.

The communication channels are shown terminating in an equipment complex called Technical Control. Technical Control contains switching facilities which provide flexibility in the connection of the various types of buffer units to the corresponding types of communication channels. In some installations this switching capability is manual and in others it is semiautomatic. A further refinement provides for patching one communication channel directly to another. This allows any subscriber to be connected directly to any other subscriber in the network; a direct connection of this type is convenient in cases where large volumes of traffic are to be transmitted to a single destination. Needless to say, this capability can be exercised only when both terminals and all the intervening communication channels are compatible.

Technical control also includes test equipment for monitoring and maintaining the various communication channels.

The Input function of Figure 5 is composed of the Buffers, Buffer Commutator, Code Converters and the Input Store.

The Buffers provide independent termination for the various communication channels. A family of buffers is available for use with the various types of communication terminal equipment. This permits different data rates, different coding and different control signalling to be used on the various channels. The present system is designed to handle data rates from 30 to 3000 bauds on each channel with a maximum of 50 incoming channels. The number of channels may be increased in groups of 25 if some of the channels operate at the lower baud rates.

The Buffer Commutator causes all the buffers to be examined every 1 1/2 milliseconds. This speed is fast enough to require storage of only one character in each buffer.

A family of Code Converters is available, one for each code conversion required. Each converter is shared by all the channels using its assigned code, converting characters in that code to characters in the common language code of the center. Some channels, such as trunk channels may use the common language code. Characters from these channels, of course, bypass the code converters.

The Input Store consists of a magnetic core high-speed memory with storage areas assigned to the individual incoming channels. The exact storage location for each incoming character is obtained from tally information also stored in the high-speed memory. The tally system also provides the basis for channel coordination.

The philosophy of channel coordination used here is one of control by the receiver. As each block of characters is received, control characters are sent over the return channel either requesting the next block of characters or requesting a rerun of the same block. In this manner, no block is accepted unless it passes all the checks provided on that channel. Message numbering is available to provide protection on those channels operating without feedback control.

The Communication Data Processor (Figure 6) incorporates a wide variety of advanced programming and logic features:

- Basic Memory consists of 16,000 56-bit
words accessible on a 1-1/2 μs cycle
- Provision is made for overlapping operation of two memory units
- Instructions are of variable length with provision for index registers for relative addressing, and address substitution to achieve direct addressing
- Data tagging is provided for automatic identification of messages as well as for data separation
- Simultaneous operation is provided. The number of routines that can take place simultaneously is not fixed, but is a function of the relative speed of any associated devices involved and the complexity of the individual routines. Such simultaneous operation is particularly useful for file searches and general "housekeeping" as well as for servicing on-line input/output devices.

Figure 6

As many of the required system operating features are included in the CDP as possible. Some of the system requirements that are programmed are:

- Routing of messages according to single, multiple, and collective routing addresses
- Transmission by priority and age
- Interruption for top priority traffic
- Alarms for messages not processed out within a time period specified by priority
- Intercept on magnetic tape of selected traffic
- Editing and format conversion
- Collection and display of statistics
- Automatic routing by both routing address and priority.

These are some of the special functions provided by the Communication Data Processor in addition to its primary function of transferring traffic blocks from the input store to the intermediate store and later to the output.

The Output function (Figure 7) comprises the Output Store, Code Converters, Buffer Com- mutator, and Output Buffers. These elements are the direct counterpart of the corresponding input elements.

Messages to and from magnetic tapes associated with local subscriber Electronic Data Processing Equipment, are accommodated through one of a series of Tape Station Converter Units. These units provide the needed signal and code conversion.

Figure 7

MESSAGE PROTECTION

Figure 8 illustrates the message protection and duality features in greater detail. Journal and Reference Magnetic Tapes are maintained under control of the Communication Data Processor. The Reference Tape contains a copy of every message received by the center. Each message is tagged to make recovery easy. The Journal Tape contains an abbreviated record of each message that has been relayed by the center. These records include a discreet message tag corresponding to the tag in the Reference Tape, time of processing in and out, channels and channel sequence number, if used.

The Ledger Balance subsystem maintains a file on a magnetic drum of all messages currently passing through the center. Each message is logged as it enters and as it leaves. This file is continuously searched for messages that have been in the center too long. Any overdue messages found are directed to the operator for expediting.

CONTINUITY OF OPERATION

This equipment is intended for communication
use and therefore requires much higher standards of reliability than are currently available in data processing equipment. Although transistor circuitry of proven reliability is being used in the construction of the switching center equipment, an occasional failure can be expected.

Elements of the system that are common to all channels are duplicated to provide back-up capability. One Communication Data Processor has enough capacity to handle all the switching center channels and normally carries the entire traffic load. A second processor is provided which is kept in idling status—exercising and performing subordinate tasks for the operating unit. Both processors have access to the high speed memories of the other, as well as all input/output stores, magnetic drums and magnetic tapes. The operating Communication Data Processor continuously updates address lists in the idling machine so it is always ready to assume the traffic load.

No automatic back up is provided for those elements whose failure would effect only a single channel or a small group of channels. The buffers fall in this category.

Figure 9 is a photograph of a scale model of a 50-channel AutoData Message Switching System. This equipment is presently being constructed by RCA for use by the military.

This system will provide interconnection between existing communication networks that are presently considered incompatible and will provide communication between computers on a fully automatic basis.