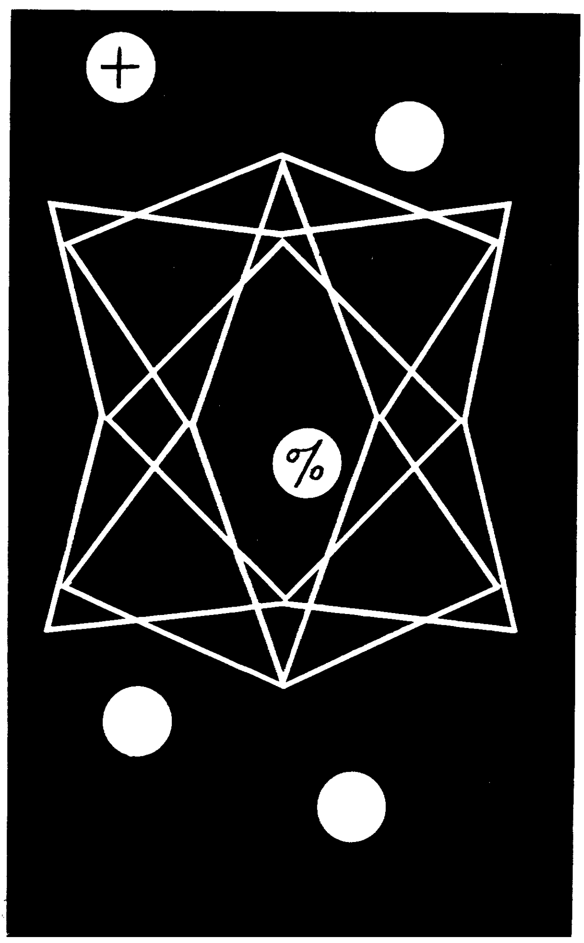
REPORT ON

MESSAGE SWITCHING

WITH THE

UNIVAC 490

REAL-TIME COMPUTER



MILITARY DEPARTMENT

Remington Rand

UNIVAC®

DIVISION OF SPERRY RAND CORPORATION

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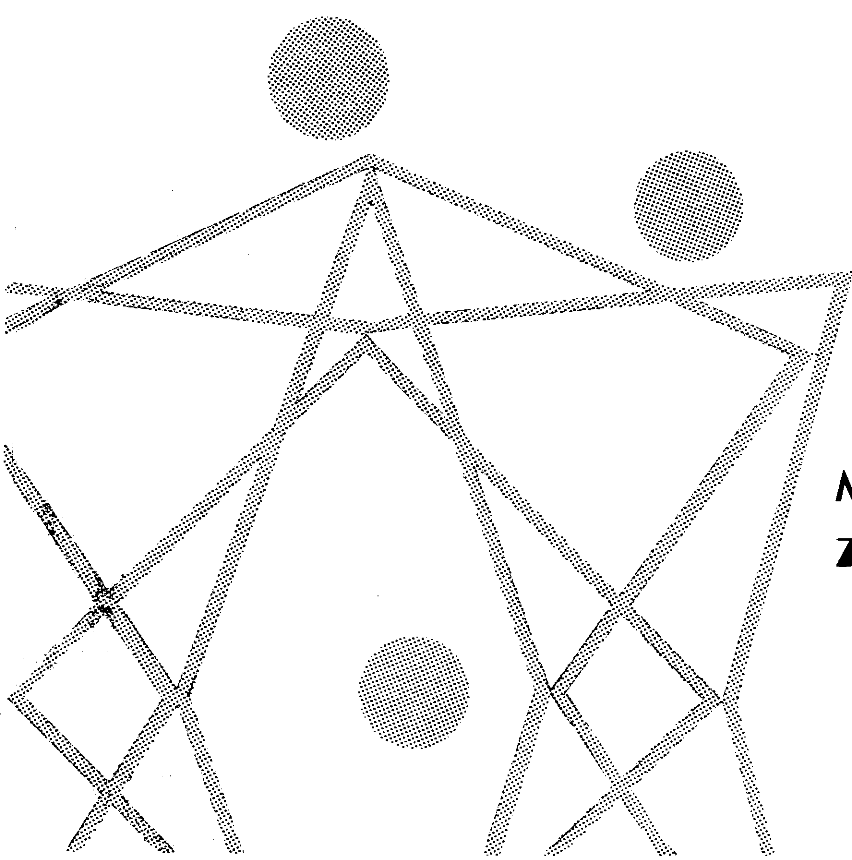

MILITARY DEPARTMENT

Remington Rand Univac®

DIVISION OF SPERRY RAND CORPORATION

UNIVAC PARK, ST. PAUL 16, MINNESOTA

Contents

A Report on

Message Switching with the Univac 490

The UNIVAC 490 Real-Time System was developed to fill the growing need in industrial and military management for high-speed data processing of large quantities of constantly changing data, transmitted great distances from a collection of identical or diverse sources. Message switching is a typical example of the many real-time, on-line situations in which the UNIVAC 490 Real-Time System can be employed. The following pages discuss how the UNIVAC 490 can direct operations of a communication network consisting of 250 stations, serviced by an 81D1 message switching center with 37 full duplex and 8 single Teletype® lines, *and still have* over 85 per cent of the central processor time available for other data processing activity.

The heart of the system is the UNIVAC 490 Computer, a stored-program computer designed for rapid handling of large quantities of complex data. This computer emphasizes random access storage and on-line communications with associated external equipment, including other computers, by transfer of data to and from core memory, on a real-time basis, independent of the main program. It provides high speed, large internal memory capacity, great programming flexibility, and a versatile input-output section. It requires little floor space, dissipates minimum power, and is light in weight.

Fundamental UNIVAC 490 Computer characteristics are:

- Internal high-speed core storage having a 6-microsecond cycle time, 1.9-microsecond access time, and either 16,384- or 32,768-word capacity
- Word length of 30 bits
- Optional operation with 15-bit half words
- Average instruction execution time of 12 microseconds
- Seven index registers
- Repertoire of 62 instructions, most of which provide for conditional program branches

- A 24-hour day clock for initiating operations at desired times
- Real-time and delta clocks for handling a wide variety of program times operations
- Bootstrap memory to provide automatic reading of new programs into the computer with protection against erasure.

Compilers and assembly routines for automatic programming techniques are also available to minimize the programming effort.

System Summary

Any recommendation of the UNIVAC 490 Real-Time System for employment in a typical message switching activity cannot be made solely on its ability to perform normal and routine functions. It discharges this responsibility in a more efficient manner than any other system — but more important, the UNIVAC 490 Real-Time System provides the first truly complete system ... one capable of solving many data processing problems presented in message switching which heretofore were either satisfied manually or not all. In addition the system has a reserve and expansion capability to perform other data processing operations and to handle message switching in an increasing volume over the years to come. Some features of the UNIVAC 490 system pertinent to message switching are:

- Billing — Stations can be billed monthly by actual number of words transmitted from totals accumulated for every station.
- Instantaneous or Deferred Message Handling — A message can be transmitted immediately or held until any time desired by the sender.
- Evaluation of Circuit Utilization — Statistical evaluation of circuit utilization can be completed either by circuit and/or station per circuit, per peak hour, day, and/or month.
- Multiple Address Message Handling — Multiple address messages, can be sent to the appropriate open circuits rather than being held for all circuits to be opened simultaneously.
- Numbering — A message numbering system helps assure that each station receives all messages sent to it.
- Message Retention — Messages directed to busy circuits are retained within the computer. Messages with illegal addresses are also retained, and the operator is so notified.
- Polling — The system features fast polling and computer control of each circuit.

- Direct Data Transmission — Data from communication lines goes directly to or from the computer memory.
- Minimum floor space requirements and reduced noise levels.
- Reserve capacity for other data processing and to handle anticipated growth.

System Operation

The UNIVAC 490 system employed in this typical situation handles 37 full duplex Teletype lines and eight single Teletype lines, four in and four out. (Figure 1 shows the system configuration for the message switching and

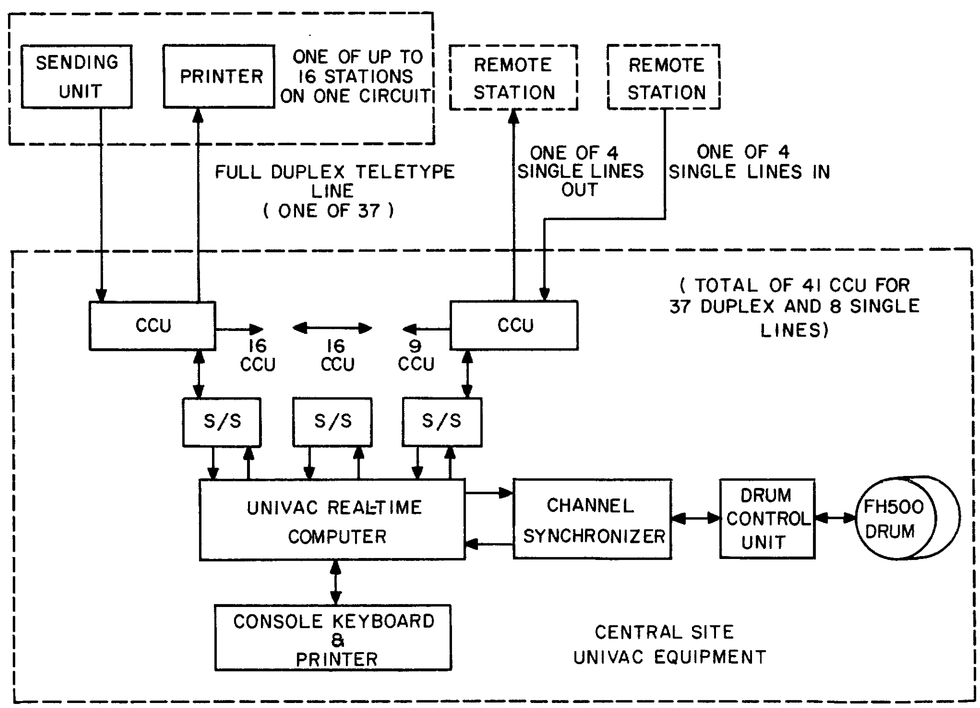

Figure 1. Univac 490 System Layout for Message Switching

related data processing operations.) The UNIVAC 490 equipment required for the operation is as follows:

- 1 - UNIVAC 490 with a 16,384 word memory, with console, console keyboard, and printer
- 1 - Channel Synchronizer for drum storage (CS)
- 1 - Control Unit for drum storage (CU)
- 1 - FH500 Drum
- 3 - Scanner/Selectors
- 41 - Communication Control Units — Telegraphic Full Duplex (CCU-TFD)

> Automatic Send/Receive units can be used at the remote stations with the operation of both transmitters and receivers controlled, either through stunt boxes or station control units, by the CCU-TFD and UNIVAC 490 internal program.

The polling of stations on a circuit is handled through the CCU-TFD under computer program control. Each station on every circuit is polled by the computer program in turn. If the remote station is not ready to send, that is, if no response is received from the station in a specific time period, the CCU-TFD notifies the computer and the computer program polls the next station on the circuit. If the station polled is ready to transmit, it sends the computer a *start of message* code followed by the message itself. When the CCU-TFD receives a character from the Teletype lines in its *input data register* it notifies the Scanner/Selector that it is ready to communicate with the computer. When the scanner reaches this station, it stops until the contents of the *input data register* have been transferred to the computer. This word consists of the one character of Teletype code in one-half of the 30-bit word and the index location specifying the location of the input buffer control word for this circuit and CCU in the other half.

The input buffer control word tells the computer where to store this Teletype character in core memory. (Each circuit has its own area in memory both for input and for output.) Information is automatically assembled or disassembled in these areas independent of the computer program. However, the location of these areas is under computer program control. After 50 characters of the incoming message have been assembled in core memory (independent of the computer program), the computer program is interrupted, i.e., signaled that 50 characters of the message have been read into memory and is ready for processing. (Again the 50 characters is arbitrary and is under computer program control.)

The computer program then stops any other processing and enters the routine for processing incoming messages. The computer program checks the message header information — originator code and addressee codes for accuracy. The computer program then numbers the message, cross referencing between originator message number and receiver message numbering, counts the number of characters, and sends the message to the appropriate circuit or circuits. If the header information should be incorrect, the message segment with all the following segments of this message is stored on the drum and the erring station and operator are notified. If any of the circuits are busy, the computer program also stores the message on the drum. When the next 50-character segment of a long message has been read into the computer, the computer program determines, from checking various counters, whether and where to send this segment — either to the proper circuits and/or store it on the drum also. In other words, the computer program does not wait until an entire message has been read in before disposing of it; message segments are sent out and/or stored as received.

The UNIVAC 490 handles messages for either immediate or deferred transmission. Messages which are specified for deferred transmission are stored on the drum and, with the use of an index and 24 hour clock, are forwarded at the designated time.

At the end of the month, if desired, the UNIVAC 490 computes the charge for each station based on the number of words transmitted. The program will also perform statistical studies on line usage and source error occurrence.

The UNIVAC 490 system described herein will handle telegraphic speeds in excess of 200 words per minute in and out through each of the communications control units, thus it will not be obsolete when this telegraphic speed is available. Remington Rand UNIVAC has also developed communication control units to handle networks other than the full duplex Teletype speed network described for this application.

Communication Control Unit - Telegraphic Full Duplex

The Communication Control Unit — Telegraphic Full Duplex (CCU-TFD) operates as a teletypewriter circuit terminal and control device, and as an input/output device for the UNIVAC 490. The CCU-TFD terminates both incoming and outgoing lines of an 81D1 or similar teletypewriter circuit of up to 16 stations. With the computer program it controls the operation of both the transmitters and receivers on the circuit. The CCU-TFD is able to handle simultaneously both input and output messages or can interrupt computer output messages to send polling codes when input data from a sending station is ended. The unit may be connected directly to an input/output channel of the UNIVAC 490 or up to 16 units may be connected to the computer through a single Scanner/Selector.

The CCU-TFD accepts data from the teletypewriter circuit at any standard telegraphic rate, converts it to bit-parallel form, and presents it to the UNIVAC 490 along with a 15-bit index word which designates a "data input buffer control word." Input data on each circuit is assigned, by the computer program, a specific area in core memory and the index word specifies the location of the input buffer control word that designates this area.

Coincident and interlaced with the computer input function, an output data transfer may occur. The CCU-TFD, when so ordered by the computer, will request, receive, serialize, and transmit to the outgoing teletypewriter circuit the characters of an output message. In performing this function, the CCU-TFD will make use of a predetermined 15-bit output index word to designate the area of UNIVAC 490 core memory in which the output message is located.

When no data input is being handled and the CCU-TFD receives authorization from the computer program to perform polling, it will interrupt the outgoing message (if any) and send a poll code prefix consisting of two or three characters generated internally. These prefix characters are used to indicate that the next character is a polling or *transmitter start* code. The CCU-TFD will then obtain from the UNIVAC 490 core memory the polling code (designating one of the up to 16 transmitters on the circuit) which it will send on the Teletype line.

The CCU-TFD may also be used to terminate two single lines of which one is incoming and the other outgoing. When used in this manner, the polling can be disabled by the use of a switch.

Data Storage

CORE MEMORY

The UNIVAC 490 Real-Time Computer has an internal core memory capacity of 16,384 or 32,768 words. The 16,384 word capacity is employed in this specific case. The word length is 30 bits. The basic memory cycle is 6 microseconds with a 1.9 microsecond minimum access time. Operands are addressable either by 30-bit whole words or 16-bit half words. Memory words are independently accessible by the computer main control sections, external equipment, and other computers.

The computer core memory stores the program needed to accomplish the message switching operation. In addition to this, other areas of core memory are reserved for storage of functions and tables, to take advantage of the extremely fast, core memory access time.

Buffer Areas for Input and Output Teletype Circuits

With 37 full duplex and 8 single lines (four input and four output), 41 different areas must be reserved for input and 41 for output buffering of Teletype data in and out of the system. Each circuit has its own assembly area for input and disassembly area for output. Fifty words of memory have been reserved for each of 82 different Teletype lines. This is, of course, an arbitrary number and entirely under computer program control. Since only the upper half of each word is actually used, the lower half can be used for other constants.

Buffer Area for the FH500 Drum

Because all data read in or out of the computer from an external device is read directly into core memory, an area of memory must be reserved for the drum. One hundred words of memory are allowed for this purpose permitting 600 Teletype characters of data to be read or written on the drum with one drum access.

Polling Control Areas

Since the computer program will control and determine the polling sequence on each of the circuits, certain tables must be established for this purpose.

There is a polling counter for each circuit; this is a one-word counter with the lower half of the word containing the memory location of the polling code of the next station on this circuit to be polled and the upper half of the word containing the memory location of the last station. Each time a station on a circuit is polled, the lower half of this counter is up-dated to obtain the memory location of the next station.

Another requirement of the polling operation is establishment of a table of polling codes for each station on each circuit. For example, if a circuit has six stations, the table for this circuit will consist of six words; with ten stations, ten words and so on. Each word in the tables will consist of the following:

- Upper half of word - polling code for the station
- Lower half of word - number of times, if any, polling of the station should be skipped or coded to signify outage, etc.

With 250 stations in the system, 250 words of memory will be reserved for polling codes and polling control counting for each station. If it is desired to poll each station in turn without the option of skipping polling on any station, 16 words of memory would be required to store the codes of the maximum 16 stations on a circuit. This same table could be used in determining the polling on all circuits.

Message Counter

A message counter is installed for each station. This counter records the following:

- Station Number (Call Directing Code)
- Number of messages transmitted today
- Number of messages received today
- Number of words transmitted month to date
- Next available address on drum to store message cross reference index for the station
- Number of words on drum allocated for the station

With four words needed per counter and 250 stations in the system, 1000 words of core memory are allocated for message counters. The counters are stored by circuit and by station within the circuit. The message counter has several purposes. First of all, it is used for verification of call directing codes of both the sender and receiver as specified in the message. (If a particular station call directing code cannot be located in this table, an error has occurred.) Secondly, the counter assigns message numbers to messages both received and sent by the station. Additionally, it specifies where to store the next cross reference message index on the drum. The counter also tallies the number of words transmitted by the station. At the end of the month, this count is used to determine the billing charge for each station and to determine circuit and/or station utilization for the month.

Index for Deferred Messages

Because the UNIVAC 490 is truly a real-time system, it is possible for a sender to specify either instantaneous message transmittal or that it be deferred until a later time. In the latter case, the message itself is stored on the drum and an index is set up in core memory. At given intervals, this table is searched to find any deferred messages that are due for transmittal. The index record for each deferred message stored in the drum consists of:

- Time of transmission
- Location on drum
- Number of words

Each deferred message index record requires two words of core memory.

Index for Busy Circuits

At times, outgoing messages will be slated for busy circuits. When this happens, the message must be stored on the drum until the circuit (or circuits) is available. To facilitate handling this situation, an index consisting of the following is set up for each "busy" circuit:

- Busy circuit code
- Time message sent

- Drum storage address
- Number of words

DRUM MEMORY

The FH500 Flying Head Drum can be used as auxiliary storage for the message switching operation. The FH500 drum has a random access capacity of 327,680 30-bit words or 9,830,400 bits of information. The average access time is 8.3 milliseconds. One of the features of this drum is the variable record format; it is possible to read or write a variable number of words on the drum with one access to the drum. The size of the record to be read or written is under program control.

The FH500 drum is used to store messages that must be retained because of errors, busy circuits, for deferred transmission, or for any other reason. The drum can also be used to accumulate error statistics for each station and for accumulating special statistics on line utilization. In addition it will be used to store the cross-index message numbering file. A record in this file consists of the following:

- Station Call Directing Code of receiver
- Message number of receiving station
- Station Call Directing Code of sender
- Message number of transmitter
- Time of transmission

A record is maintained of each message transmitted to each station. Based on 13,500 messages transmitted in a day with 10 per cent being multiple addresses, approximately 20,000 of these records could be stored on the drum if retained for 12 hours. (In actual practice, these records would be retained for only an hour or so.) An area on the drum is reserved for the records of each station permitting all message records for a given station to be found at consecutive addresses.

SUMMARY OF ESTIMATED DATA STORAGE

Core Memory	Words
Total Capacity	16,384
Input/Output buffer areas for Teletype lines	4,100
Input/Output buffer area for FH500	100
Polling Control words (based on use of 16 words without the option to skip polling)	300
Message counters	1,000
Index for deferred messages (based on 300 deferred messages)	600
Index for busy circuits	720
Index for error messages	300
Programming for message switching	1,200
Miscellaneous counters, etc.	500
TOTAL	8,820 words
REMAINING	7,564 words

FH500 Drum Storage	
Total Capacity	327,680
Cross index message numbering records (20,000 records x 4 words if retained for 12 hours)	80,000
Message retention (busy circuits, errors, deferred messages) allowing for 1,000 messages per hour following in these categories	55,000
TOTAL	135,000 words
For other data processing, growth, etc.	192,680 words

Console Keyboard and Printer

The Console Keyboard and Printer can be used for entering program changes, notification to the operator of errors, and message corrections.

Polling

The UNIVAC 490 system features fast polling. Up to 16 stations on each circuit are polled through the CCU-TFD under computer program control. The UNIVAC 490 determines which station should be polled on each circuit and when. Because of this computer program control, it is possible to skip a station (or stations) any given number of times (variable) for any reason. As a result those stations with a higher volume of messages can be polled more often, if desired, than the stations with less activity.

Each station on a circuit is assigned a specific polling character. This poll code character will turn on the transmitter at the station indicating readiness to transmit.

Polling on any given circuit takes place as follows: when no data input is being handled on this circuit, the computer program sends a function word to the CCU-TFD to initiate the polling. The CCU-TFD interrupts the outgoing message (if any) on the circuit, generates and sends on the outgoing Teletype line a poll code prefix consisting of two or three characters like Blank, Pause (one character time delay), and Space. After transmitting the poll code prefix characters, the CCU-TFD then obtains from computer core memory the poll code for the station to be polled. While this poll code is being transmitted, the computer updates the polling counter for the circuit; in other words, it prepares to poll the next station on the line. While awaiting a response, the computer program could, of course, poll the other lines or continue other processing.

If the CCU-TFD does not receive a response from the station just polled in a specific time (that is, the station is not ready to transmit), it sends an *external interrupt* to the computer. The computer program being executed at that time is automatically interrupted, the program determines the cause of the *interrupt* and initiates the polling of the next station to be polled by sending a function word to the CCU-TFD. The whole cycle is then repeated.

If a station polled is ready to transmit, it sends a *start of message* code followed by the message itself. During this time, of course, no polling would take place on the particular circuit. When the message has been completely read into the computer, the CCU-TFD detects the *end of message* and sends an *external interrupt* indicating this fact to the computer and polling is again initiated. The same procedure is followed for each circuit.

In summary, the main features of the UNIVAC 490 system polling are:

- Speed of polling — For example: During an idle period, each station could be polled approximately every 10 seconds with 10 stations on a line or about every 15 seconds with 15 stations on a line. Assuming that each station was polled every 10 seconds on the average, during idle periods, this would utilize about 12 seconds of computer time in a peak traffic hour.

- Flexibility of polling under complete program control.

- Efficiency of polling — Under computer control, rather than a source external to the computer, the error recovery procedure is simplified in case of computer power failure. At worst, only one message from each circuit would have to be re-transmitted.

Message Format and Call Directing Codes

The UNIVAC 490 can handle any type of format. However, the typical message format would be:

1. Conditioning codes such as "Figs - H - Ltrs."
2. Call directing codes
3. End of address such as "Carriage Return - Line Feed - Letters"
4. Control directing codes of sender, time sent, message number of sender, message number of receiver, and control directing codes of receiver(s).
5. Body of message
6. End of message - "Figs - H - Ltrs"

Either a two or three alpha-character control directing code can be used. Any assignment of the three-character code to the station is acceptable to the computer but programming is simplified when the first two characters of the control directing codes represent the station's circuit. The last character of the control directing codes then indicates the specific station on the circuit. The computer can, however, handle any size or assignment of call directing codes.

Station Number Verification — Message Numbering

A message numbering system is used to ensure that no message will fail to arrive at a given station without detection of this failure. In the assignment of numbers to each message, the computer program checks the originator code and all addressee codes to verify the correctness of the addresses. Each message transmitted to the computer is identified at the source by originator code and time sent. When the message is received, the computer program locates the message counter for the originator station. The message counters are stored in core memory by circuit and station sequence with one counter for each station in the system. The message counter has the following information:

- Station call directing code
- Number of messages transmitted today
- Number of messages received today
- Number of words transmitted month to date
- Next available address on drum for this station
- Number of words on drum allocated for this station

If the originator code cannot be located in this file, an error has probably been made by the originator in preparing the message. If this is the case, the computer program checks the addressee codes in the message for validity. After this is completed and any other errors are detected, the message is stored on the drum in an area reserved for this purpose. The originator code, time, and address on the drum are stored in an index in core memory, and the operator and/or station sending the message can be notified via Teletype by an error message originated by the computer program.

When the correction has been received in the computer, the program locates the original message that has been temporarily stored on the drum and corrects it. The program then proceeds along the same path as if an error had not been made. It should be noted that a further programming option would be to tally the number of errors made by each station. If the error level went beyond a predetermined nominal level, the station involved would be alerted to this fact.

Continuing with the computer program, the originator code is located in the message counter file, and the *number of messages sent today* field is updated by one. If the message is single address, the message counter location for this station is located in core memory. Again, if a match is not found for this station code, an error has occurred and the error routine is executed. Assuming the counter for this station is located, the *number of messages received today* field is updated by one, and this information is added to the message. The receiving station will then know who sent the message, the time it was transmitted, and how many messages it has received to date. As the message is being transmitted by the computer, a record is composed and stored in the next available record on the drum reserved for this station. This record consists of the following information.

- Station control directing codes of receiver
- Received message number for this station
- Station control directing codes of sender
- Sending message number of transmitter
- Time of transmission

At the remote receiving station, the operator can check off the message number against a check list. When the operator discovers that a message number has been skipped — for example, message number 50 is received and the following message is number 52 — he can send a message via Teletype notifying the computer that message 51 has not been received. The computer program then finds the source of the message from the index and asks the sender to retransmit, or the message can be stored intact on the drum as received for just such a purpose. In the latter case, messages would be stored for only a short period and erased when it could be expected that all stations had received the message.

The high-speed operation of the UNIVAC 490 makes it possible to program many types of checks to catch errors that would otherwise either go unnoticed or cause confusion.

As a byproduct of the billing operation, the UNIVAC 490 Real-Time Computer can calculate total circuit utilization and/or utilization of circuit by station. Circuit utilization can be analyzed by peak hour, day, and/or month. The fast operating speed, the capacity of the drum, and the real-time clock make it possible for the UNIVAC 490 to accumulate and calculate any number of different statistics relating to operation of the Switching Center.

Statistical Analysis

The UNIVAC 490 system has the speed and memory capacity to also accumulate many types of information as a byproduct of the message switching operation. For example, from the accumulation of word count for billing, it is possible to determine circuit utilization by month, peak hour, peak ten-minute periods, or by all these intervals. Since word counts are accumulated by station, the computer program would accumulate all word counts for all stations on a given circuit to get the total words transmitted on the circuit during the period under study. From the word count, the computer program can tabulate the time a circuit is used on either input and/or output during a peak hour or any other time period. It can also accumulate time statistics on circuit outages and busy circuits. The UNIVAC 490 can compile statistics on invalid station codes received in messages from each station and notify the station when the number of errors is excessive. Other statistics that can be accumulated include: percent of circuit use by each station on the circuit, average length of messages for each station; or almost any other type of information regarding the message switching operation.

Timing

The computer timing for this message switching operation has been based on a typical example of volume figures for peak hours. The following is a summary of these figures:

Summary of Volume Figures per Peak Hour

Words received by computer	122,365
Words transmitted	130,893
Messages received	2,225
Messages transmitted	2,380

Summary of Estimated Computer Processing Times per Peak Hour	Seconds
Buffering data in and out on Teletype lines	22
Write and read from drum messages retained for busy circuits	9
Transfer 785,385 characters to output transmitting clock	29
Pack and unpack messages for busy units	18
Polling time based on polling each station every ten seconds, with full skip options, during idle periods	12
Other programming time based on 1,000 steps per message	27
Time to access and write on drum the cross reference indices	24
Time to transfer, pack, access drum for all messages to be retained if desired	112
Miscellaneous programming time	200
TOTAL	451
	or about 7-1/2 minutes per peak hour.

In the timing estimates, no allowance was made for overlap of drum accessing time with processing. This overlap would decrease the time. In addition, ample allowance (200 seconds) is made for programming.

During non-peak hours, station polling will occur more frequently, and the computer time will be correspondingly higher for this function. The computer time for message handling will, however, be decreased by considerably more time than the time added for this function.

Because the UNIVAC 490 requires only eight minutes out of every hour to handle the message switching operation, it possesses reserve capacity not only to deal with increased volumes, but also to perform other data processing functions either related or unrelated to the message switching operation.

System Expansion

COMMUNICATION SYSTEMS

As indicated earlier the UNIVAC 490 Real-Time System can be applied to many types of communication systems used to transmit information between remote input/output devices and the UNIVAC 490. Remington Rand UNIVAC has developed communication control units to handle various types of Teletype speed and telephone speed communication networks. Some of these are:

Party Line Communication System (PLCS) - This system is comprised of one Master Control Unit and up to eight remote control units. The PLCS provides bi-directional communication between the UNIVAC 490 at the central site and data handling equipment at each of the eight remote locations: The communications facility is a voice-band channel with full duplex capability. The channel terminations are digital subsets rated at 1,800 bits per second or better. Data transmission between the UNIVAC 490 and a remote station is initiated by selective polling of each remote control unit in sequence. A polled remote responds by transferring data supplied by the data handling equipment to the Master Control Unit or with a *No Data* control code. The *No Data* control code causes the Master Control Unit to poll the next remote on the line. The number of PLCS needed in a system depends on the application.

Communication Control Unit - 7 bit code - Polling Half-Duplex (CCU-PHD). The CCU-7-PHD is a bi-directional, asynchronous telegraphic digital communication device. It may be located at the central or remote site. At the computer site, the CCU-PHD is located electrically between a communication channel terminal device and an input/output register of the UNIVAC 490. One centrally located unit can control eight or more remotely located devices. In operation, the polling codes are generated by the UNIVAC 490 computer and are passed through the centrally located CCU-PHD to the remote units. This control unit may be adapted to either Teletype data rates or medium speed data rates (750 bits/second maximum) by means of plug-in modular timing devices.

In addition to the two communication systems described above, control units have been developed for various types of point-to-point and line-switched networks.

Any combination of these communication systems can be handled by one UNIVAC 490 computer.

MESSAGE SWITCHING APPLICATIONS

Since the message switching operation required only eight minutes out of every peak hour of traffic, 52 minutes of computer time is available for other data processing. This data processing could be in the form of any type of on-line data retrieval and updating, or batch-processing. In the system described only 5 of the 12 input/output channels were used (this could be reduced to 3 by cascading the scanner/selectors into one channel) so that up to 7 additional random access drums could be added to the system without requiring any additional channels.

Besides being an ideal on-line processor, the UNIVAC 490 has all the capabilities of an efficient batch-processor. It features fast operating times and a complete line of standard peripheral equipment. One of the outstanding characteristics of the UNIVAC 490 Real-Time System is its capacity to process real-time and batch-processing applications simultaneously through the use of program interrupts. Whenever data for a real-time transaction is entered into the computer, the batch-processing program may be interrupted to permit handling the high priority real-time transaction. When the transaction is completed, the computer program returns to the batch-processing operation.

Another outstanding feature of the system is its capability to cable two or three UNIVAC 490's together without requiring special *black boxes* in between. The UNIVAC 490 has two input/output channels for this direct inter-computer communication permitting two or three computers to share information received and/or processed by one of the computers.

OTHER EQUIPMENT OPTIONS

There are many types of equipment, other than those previously mentioned, that can be used with the UNIVAC 490 System.

Transfer Switching Unit

This unit allows peripheral equipment to be switched between different input/output channels of the computer. It also allows peripheral equipment in a system to be switched between on-line and off-line positions. In a dual computer system, the Transfer Switching Unit may be utilized to manually switch a peripheral unit between the input/output channels of the two computers. Any piece of peripheral equipment may be switched between any other two equipments as the system configuration may require.

Uniset

The Uniset is a general-purpose, remote input/output device that allows rapid and accurate interrogation of the computer. The Uniset consists essentially of an alphanumeric keyboard, a format control panel, printer, card mount and data keys. The keyboard consists of 10 numeric, 26 alphabetic, and 10 special character keys. Relevant fixed information is stored on a series of transparent cards. When a given card is inserted in the Uniset by the operator, this information is identified to the computer. Variable information can be entered into the keyboard. The keyboard and printer are also available without the card mount feature.

Drum Storage

In additon to the FH-500 drum, a larger FH-880 drum is also available. One drum control unit and channel synchronizer can handle from one to eight drums. This drum system features large capacity (786,432 thirty-bit words) and high-speed random access (17 milliseconds average).

On-Line High-Speed Printer

Six hundred lines per minute.

High-Speed Card Reader (700 cards/minute)

Up to 12 High-Speed Card Readers can be connected to an input/output channel through a card control unit and channel synchronizer.

Read-Punch Unit (150 cards/minute)

Up to 12 Read-Punch Units can be connected to an input/output channel through a card control unit and channel synchronizer.

Magnetic Tape Storage

The Tape System consists of a tape control unit, channel synchronizer and from 1 to 12 Uniservo IIA magnetic tape handlers. (The faster speed Uniservo III is also available on the UNIVAC 490 Real-Time System.) Each Uniservo IIA Tape System operates at a transfer rate of 25,000 characters/second. However, by the use of three control units, for example, the effective transfer rate can be increased to 75,000 characters/second. With this configuration, any combination of reading and writing on three tapes can occur simultaneously with computer processing. Either metallic or Mylar® tape may be used. Checks are incorporated to provide and maintain accuracy of information as it is read or recorded.

Remington Rand

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UNIVAC PARK, ST. PAUL 16, MINNESOTA