western union

R. W. McFALL
CHAIRMAN OF THE BOARD
AND PRESIDENT

December 15, 1967

Honorable James D. O'Connell
Director of Telecommunications
Management
Executive Office of the President
Washington, D.C. 20504

Dear Mr. O'Connell:

In accordance with your request, we have prepared the accompanying briefing for the President's Task Force on Communication Policy relative to The Western Union Telegraph Company.

As I previously indicated to you and to Mr. Rostow, I would be pleased to meet with the Task Force or its staff anytime that I can be of assistance with respect to the important work which they are undertaking.

Sincerely,

R W McFall

Enc.

60 HUDSON STREET, NEW YORK, NEW YORK 10013

BRIEFING FOR

THE PRESIDENT'S TASK FORCE ON COMMUNICATION POLICY

BY

THE WESTERN UNION TELEGRAPH COMPANY

CHART 1

WESTERN UNION TELEGRAPH CO.

OVERALL STATISTICS

	1966	1956	1946	1936	1926
REVENUES (Millions)	$320	$252	$183	$ 98	$134
PLANT & EQ. IN SERVICE (Millions)	$695	$369	$392	$331	$262
PERSONNEL (Thousands)	27	38	57	52	63

MAJOR SERVICES

PUBLIC TELEGRAM — SERVICE STARTED . . . 1851 — CHART 3
PUBLIC WIRE SYSTEMS — SERVICE STARTED . 1885 — CHART 5
TELEX — SERVICE STARTED . . . . 1958 — CHART 6
BROADBAND — SERVICE STARTED . . . . 1964 — CHART 7
HOT-LINE — SERVICE STARTED . . . . 1967 — CHART 8
INFOCOM — SERVICE WILL START IN EARLY 1968 — CHART 9
CIRCUITRY . . . . — CHART 10

GROSS PLANT EXPANSION (MILLIONS) INCLUDING PLANT UNDER CONSTRUCTION

	1966	1965	1964	1963	1962
ADDITIONS	$149	$97	$73	$92	$139

TOTAL REQUIRED 1962-1966 INCLUSIVE	$550
LESS RECOVERIES FROM EQUIP. REMOVED	104
NET SPENT	$446

SOURCE OF FUNDS FOR 1962-1966 PLANT EXPANSION (MILLIONS)

INCOME	$ 28
DEPRECIATION & AMORTIZATION	181
DEBT FINANCING	168
EQUITY FINANCING	72
OTHER BALANCE SHEET ADJ.	(3)
	$446

NOTES FOR CHART #1

When Samuel F. B. Morse, inventor of the telegraph, transmitted the first telegram in 1844, he set in motion a series of events that have revolutionized the world's social and economic life.

The telegraph enabled man, for the first time, to conquer the barriers of time and space. It marked the first practical use made of electricity, and opened new paths for the young science of electricity which led to the development of the telephone, radio, television, microwave, the computer, and today's communications satellite.

With the new services which have been added within the last ten years, Western Union, today, is the world's largest and most modern record communications company.

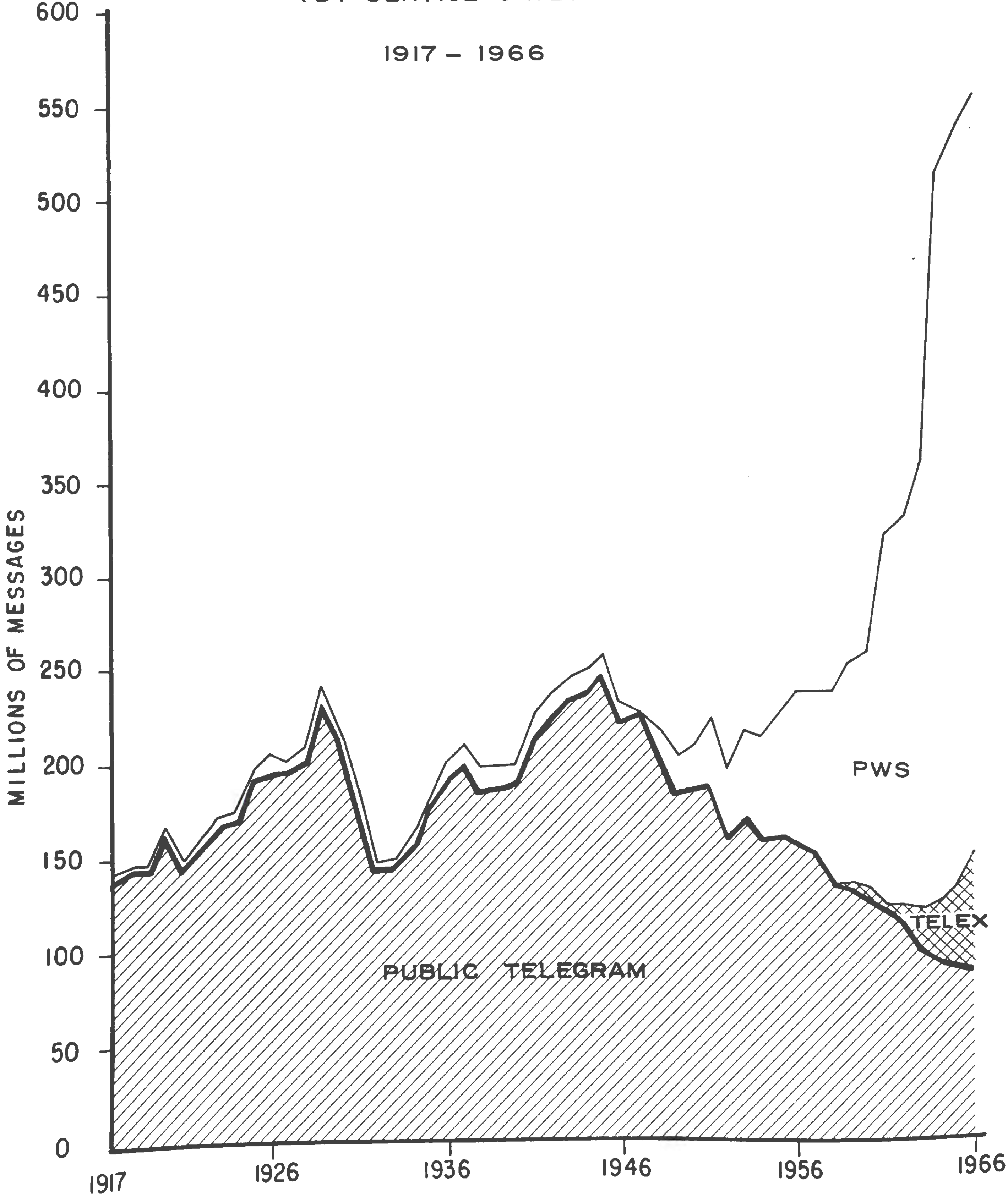
The development of these new growth services has substantially increased gross revenues, although, it has required a major plant expansion, necessitating capital outlays which were considerably beyond those funds generated by the Company's operations. This trend is likely to continue for the next several years.

(A detailed review of revenues and expenses, for each of the past ten years, is shown in the 1966 Annual Report to the stockholders, a copy of which is in the rear of this binder.)

CHART 2

WESTERN UNION RECORD VOLUME TRENDS

(BY SERVICE CATEGORY)



NOTES FOR CHART #2

As shown, the level of activity of the public telegram business diminished sharply during the Depression Years, but built up again during World War II. Subsequent to that time, it has been in a steady state of decline due to pressure on one side from improved long-distance telephone service, and on the other due to the growth of jet-speed airmail.

Although private wire systems were offered as early as 1885, they did not constitute any significant part of the total message volume until about 1950. Since that date, they have experienced phenominal growth, due in large measure to government communications such as Autodin (the automatic digital network).

Telex, introduced in this country in 1958, is growing rapidly; and now constitutes a significant part of the record communication traffic in the United States.

Broadband, Hot/Line and other new services mentioned in the first chart do not presently represent a substantial part of the Company's message volume, although these are expected to develop rapidly in the near future.

CHART 3

PUBLIC TELEGRAM

REVENUES (MILLIONS)	1966	1956	1946	1936	1926
MESSAGE	$149	$173	$133	$75	$118
MONEY ORDER	27	17	15	4	–
INSTANT GIFT	1	–	–	–	–
NUMBER OF OFFICES					
MAIN – W. U. OWNED	1,193	1,555	2,129	Not Avail.	Not Avail.
BRANCH – W. U. OWNED	399	666	1,291	Not Avail.	Not Avail.
JOINT OPR – R. R.	1,920	9,693	15,106	Not Avail.	Not Avail.
AGENCIES	8,702	10,732	12,262	Not Avail.	Not Avail.
TOTAL	12,214	22,646	30,788	Not Avail.	Not Avail.

PRESENT TERMINAL HANDLING (MARCH 1967 STUDY)

METHOD:	PERCENT ORIGINATING	PERCENT TERMINATING
OVER-THE-COUNTER	12.91	5.42
MESSENGER	4.83	33.07
TELEPHONE	30.72	23.02
TELEPRINTER TIE-LINE	23.89	23.52
FACSIMILE TIE-LINE	23.62	14.97
TEL(T)EX	4.03	Not Applic.

NOTES FOR CHART #3

Expanding upon the previous graph showing the volume trend for public telegram service, this chart shows the actual revenues developed by various components of this service over the last forty years.

In this connection, it is important to note that, although message revenues have declined substantially over the last ten years, money order traffic has been growing steadily. In fact, today, approximately 54% of the originating and 82% of the terminating over-the-counter transactions involve telegraphic money orders. This trend is expected to continue.

Recently, a line of "Instant Gifts" has been introduced to help stimulate the telegram business and to offer additional services to the public. Instant Gifts currently available include: DollyGram, CandyGram, MelodyGram, Perfume-by-Wire, Instant Money and Flowers-by-Western Union.

Although statistics are not readily available as to the number of telegraph offices which were in use thirty and more years ago, it is known that there has been a steady downward trend in the number of service locations. This shrinkage relates entirely to the smaller cities and rural areas which were previously entirely dependent upon Western Union for their outside communications. However, the growth and acceptance of long-distance telephone and airmail services -- with the corresponding decline in public telegram volumes -- have made it uneconomical to continue the operation of many of these offices. This trend is expected to continue. In fact, as will be pointed out later, a high percentage of the present offices are operating on an uneconomical basis.

In connection with the office problem mentioned above, it is important to note that only 13% of the originating traffic and 5½% of the terminating traffic is handled over-the-counter. The majority of the messages, both in and out of the system, are handled either by telephone or tieline -- both of which are capable of providing service remotely.

CHART 4

PUBLIC TELEGRAM (Cont.)

SPEED OF SERVICE (OCTOBER 1967)

MODE OF HANDLING	OBJECTIVE	TEST CITIES MEETING OBJ.
MESSENGER	90% OF MESSAGES DELIVERED IN 75 MIN.	76%
TIE-LINE	90% OF MESSAGES DELIVERED IN 60 MIN.	79%
TELEPHONE	90% OF MESSAGES DELIVERED IN 60 MIN.	87%

COMPOSITION (1966)

TYPE SERVICE	VOLUME (MILLIONS)	REVENUE (MILLIONS)
PUBLIC MESSAGES	70	$139
GOVERNMENT	2	6
PRESS	.5	3
MONEY ORDER	9	15
INT'L (LAND LINE HAUL)	11	13
TOTAL	92.5	$176

WORK FORCE (YEAR END 1966)

TYPE	NUMBER	PERCENT
SUPERVISORY	1051	6
BILLING, ACCOUNTING AND CLERICAL	2602	16
MESSENGERS	3500	22
OPERATORS, MAINT. AND ALL OTHERS	9039	56
TOTAL	16,192	

INVESTMENT IN PLANT (MILLIONS)

GROSS $202 LESS RESERVE $102 = $100 NET

NOTES FOR CHART #4

Years ago, the Company agreed with the FCC to the establishment of certain speed-of-service standards. Field personnel of the Commission monthly sample 200 or more messages going to each of 75 selected test cities. By checking the difference between the time the message was filed at the city of origination and the time that it was delivered, by any mode of handling, the FCC reports on the Company's speed-of-service performance. The figures shown are taken from the October 1967 reports.

Although we are devoting management attention and spending extra money in an effort to improve this performance, the Company has gone on record with the FCC as questioning the need for doing so. Today, if time is critical the individual usually makes a long-distance call. At the present time, our surveys indicate that the telegraph service is used because of the need for a record copy of the message. Accordingly, it may be both realistic and proper to establish new speed-of-service objectives.

Also shown on this chart is a breakdown of the composition of the present traffic. In addition to the numbers shown, it is important to look at the trends in each of these segments of the public telegram business. Our surveys indicate that the social part of the messages amounts to about 20% of the traffic, and that this segment of the Company's business has been relatively stable over recent years. There has been about an 8 or 9% per year decline in the business use of the public message. This decline is due to the aforementioned diversions to telephone and airmail plus the development, in recent years, of special business communications services such as private wire systems, Telex, etc. Government usage of the public telegram is actually increasing slightly, as is the land-line haul portions of the overseas cable traffic. As previously mentioned, the money order business is growing. However, in the aggregate, the public telegram business is currently declining at a rate of approximately 5 to 6% a year.

The work-force required to handle the public telegraph business is shown. However, the 16,000 employees do not include any significant number of marketing, engineering or installation personnel, inasmuch as these facilities are presently static.

However, from the material shown, it will be evident that, in comparison with the revenues currently being generated, the plant investment is relatively small, and the direct labor content is very high.

(At the request of DTM, we have included a diagram at the back of the binder which illustrates the reperforator switching system now being used in relaying the public telegraph messages.)

CHART 5

PRIVATE WIRE SYSTEMS

TYPICAL USERS

GOVERNMENT
- AUTODIN
- ADVANCED RECORD SYSTEM
- BOMB ALARM
- NASA-600
- ETC.

COMMERCIAL
- STOCK TICKER NETWORKS
- BANK WIRE
- BLUE CROSS
- DUN & BRADSTREET
- LOEB, RHOADES
- ETC.

TYPES OF COMMUNICATION SERVICE

TELEPRINTER (HIGH & LOW SPEED)
FACSIMILE
DATA (PUNCH CARDS, MAGNETIC TAPE, ETC.)
DIRECT DIGITAL TRANSMISSION BETWEEN COMPUTERS
OTHER

REVENUES (ALL SYSTEMS)

GOVERNMENT	$56 MILLION
COMMERCIAL	$36 MILLION
TOTAL	$92 MILLION

WORK FORCE 1258

INVESTMENT IN PLANT (MILLIONS)

GROSS $415 LESS RESERVE $141 = $274 NET

NOTES FOR CHART #5

Autodin is the world's largest computer-controlled communication system, and was designed and built by Western Union to meet the requirements of the Defense Communications Agency. This network employs large-scale computers at nine relay centers in the continental United States and Hawaii, and can serve up to 2,700 stations. Autodin users send and receive data in the form of punched cards, punched paper tape, magnetic tape, high-speed printer or conventional printed messages. All traffic is encrypted. Today, the system is handling approximately 4 million messages or data transmissions per week.

The Advanced Record System is the common-user, record communication system for the civilian-governmental agencies, and was built and designed for the General Services Administration. It ties together over 1,600 teleprinter terminals located in over 600 cities.

(Autodin and ARS are described in the January 1966 issue of "Technical Review," a copy of which is in the rear of this binder.)

Commercial private wire systems vary widely in the type of terminal devices and the nature of the traffic being carried between the stations making up each network. Further, a large percentage of the new PWS installations employs computers either as message switches or as elements of a business data processing system. Depending upon the subscriber's wishes, Western Union will furnish the necessary computer, or will interconnect a network employing computers that the customer owns or leases.

Ten years ago, the PWS revenues were about $30 million per year ($24 million commercial and $6 million governmental). Now, as shown, they've increased to $92 million ($36 million commercial and $56 million governmental).

The work-force shown covers operation and maintenance personnel only. It does not include engineering, marketing and installation personnel. In general, there's a ratio of about one person in each of these added categories for each Western Union employee currently engaged in operation and maintenance of these systems.

CHART 6

TELEX
(TELEPRINTER DIAL EXCHANGE SERVICE)

EQUIPMENT DISTRIBUTION

COUNTRY	NUMBER OF SUBSCRIBERS	PRESENT RATE OF GROWTH
W. GERMANY	56,170	25%/YR
GREAT BRITAIN	16,014	19%/YR
CANADA	13,500	17%/YR
JAPAN	13,417	18%/YR
FRANCE	8,713	14%/YR
ALL OTHER FOREIGN	200,000	Not Available
USA	21,870	20%/YR

SPECIAL OFFERINGS

TEL(T)EX IN USA AND CANADA

COMPUTER SERVICES IN USA ONLY

COMPARISON OF REVENUE GROWTH TELEX VS. TWX (MILLIONS)

DOMESTIC SERVICE	1966	1965	1964	1963	1962
TELEX	$25	18	13	7	2
TWX	$76	73	72	70	69

USA TELEX WORK FORCE 283

INVESTMENT IN USA TELEX PLANT (MILLIONS)

GROSS $81 LESS RESERVE $20 = $61 NET

NOTES FOR CHART #6

Telex is service which uses teleprinters equipped with dials like those on telephone instruments. A subscriber simply dials the number of any other subscriber in the United States or more than 120 other countries for the immediate, two-way exchange of messages and data. Telex started in western Europe following World War II. It was introduced in the United States on a limited test basis with the Canadian Telex network in 1958, and has grown steadily since that time.

There are a number of special services that the Telex subscriber has available to him; one of these is Tel(T)ex. With this service, a Telex user can send a telegram to a non-subscriber at a cost which is less than a regular telegram. He dials the Telex machine in the public telegraph office, in the city of destination, and pays only the regular Telex message rate plus a nominal delivery charge.

Another class of special services available to the Telex subscriber is that provided by the Western Union computer centers now in service in New York and nearing completion in Chicago, San Francisco and Atlanta. If a particular subscriber's line is busy, he may file the message with the computer and it will watch the circuit, and deliver the message as soon as the addressee's line is free. Another computer service permits handling of "book" messages, i.e., the same text being transmitted to a list of several addressees. The message text, together with the list of destination numbers, is accepted by the computer, and it subsequently broadcasts the message to as many as 100 Telex stations. A third type of special computer service involves translating the signals from a Telex station into a form suitable for transmission to any TWX subscriber. Thus, with this optional service, any Telex station can direct a message to any TWX station.

TWX is a teleprinter exchange service which was introduced by AT&T more than twenty years before Telex was offered in the United States by Western Union. Accordingly, as might be expected, there are more TWX subscribers than there are Telex users. However, the introduction of Telex, and the special services that it offers, has resulted in a decline, in recent years, in the number of TWX subscribers. However, revenues for this service continue to climb due to increasing message volume, as well as recent upward rate adjustments.

With respect to the Telex work-force, the 283 represent only the operation and maintenance personnel at the exchanges in the central offices plus a prorata share of the field forces' time spent in maintaining the subscribers' teleprinters. Engineering and marketing personnel, in a ratio of one to one, should be added to get the approximate total work-force associated with this service.

(Telex is further described in the July 1966 issue of "Technical Review," a copy of which is in the rear of this binder.)

CHART 7

BROADBAND

(2, 4 AND 48KC ALTERNATE VOICE-DATA SERVICE)

COVERAGE

SERVES 382 CUSTOMERS IN 39 CITIES

TYPICAL USAGE

BANDWIDTH (K. C.)	PERCENT CUSTOMERS
2	56
4	43
48	1

PRESENT REVENUE

APPROXIMATELY $1 MILLION

PRESENT WORK FORCE

APPROXIMATELY 10

PRESENT INVESTMENT IN PLANT (MILLIONS)

GROSS $12 LESS RESERVE $3 = $9 NET

NOTES FOR CHART #7

Broadband switching is versatile. It is one system that will handle all types of digital and analog signals with alternate record/voice capability.

The subscriber selects both circuit bandwidth and correspondent on a modern pushbutton telephone instrument. Once a connection has been established, the caller tells his correspondent to prepare to receive the transmission on an appropriate business machine or communications device. In this way, subscribers to this service exchange data from high-speed teleprinters, business machines, facsimile sets and computers, and alternately, but not simultaneously, telephone conversations as well. This voice coordination increases efficiency, and makes it possible for subscribers to use more than one type of equipment.

Charges for usage are in units of one-tenth of a minute with a one minute minimum.

Western Union is currently in the process of expanding the capacity of the Broadband exchange system by extending the service to additional cities and introducing 48 kilocycle service (equivalent to 12 voice grade channels) which will accommodate very high-speed transmission (over 5,000 characters per second) of data between computers and business machines.

The work-force figure represents only the operation and maintenance personnel at the central offices, plus a prorata share of the field forces' time spent in maintaining the terminal sets. In view of the marketing effort being given this new service, it is probable that a multiplier of five to one would more nearly approximate the total employee effort being applied to this project.

CHART 8

HOT-LINE

(POINT-TO-POINT, AUTOMATICALLY CONNECTED TELEPHONE)

COVERAGE

SERVES 383 CUSTOMERS IN 12 CITIES

PRESENT REVENUE

APPROXIMATELY $1.1 MILLION

PRESENT WORK FORCE

APPROXIMATELY 20

PRESENT INVESTMENT IN PLANT (MILLIONS)

GROSS $11 LESS RESERVE $3 = $8 NET

NOTES FOR CHART #8

Hot/Line is an economical two-point telephone service introduced on an experimental basis two years ago between New York and Chicago, and expanded during 1967 to a general service offering between twelve major cities.

It features automatic connections with no dialing and no minimum time charge. Subscribers share a dedicated group of voice grade trunk channels between two common service points.

When a subscriber lifts his hand set, the distant telephone rings instantly. If he should encounter a busy trunk channel, the central office equipment will automatically ring both parties as soon as a circuit is avilable.

Initial customer use of Hot/Line service exceeded expectations in both the frequency of calls and in total daily usage. Twenty systems are already in service at this time, with a total of over forty-one systems planned to be in service by the middle of 1968.

The work-force, again, relates only to operation and maintenance personnel. In view of the marketing effort being given this new service, it is probable that a multiplier of five to one would more nearly approximate the total employee effort being applied to this project.

(Additional information on Hot/Line is shown in the article on page 104 of the April 1967 issue of "Technical Review," a copy of which is in the rear of this binder.)

CHART 9

INFOCOM

(NETWORK OF PRIVATE SYSTEMS SHARING USE OF COMPUTER)

- NEW SERVICE TO BE INITIATED IN 1968.

- WILL REPLACE SLOW-SPEED PRIVATE NETWORKS (PWS) WITH HIGH-SPEED STORE AND FORWARD SYSTEM.

- SICOM IS SPECIAL INFOCOM OFFERING.

- CONCEPT IS BASED ON ECONOMIES OF SCALE INASMUCH AS SUBSCRIBERS SHARE COMMON COMPUTER.

- FURTHER SAVINGS MAY BE ACHIEVED IF SAME COMPUTERS ULTIMATELY HANDLE INFOCOM AND THE MODERNIZED PUBLIC TELEGRAM SERVICES.

NOTES FOR CHART #9

Today, the large volume of record messages sent over leased systems, Telex and in other new, different ways, has grown so rapidly that only one of every six messages handled by Western Union is a "yellow blank" telegram. To meet the constantly expanding communication needs of the public, industry and government, Western Union is engaged in a long-term program to build a nationwide communication system incorporating a series of computers linked by high-speed communication channels thatwill enable the Company, ultimately, to provide all systems and services with a single common plant.

The initial computer network consists of four centers at Atlanta, Chicago, New York and San Francisco, which are interconnected by high-speed broadband communication channels provided by Western Union's modern transcontinental microwave system. The network is designed to permit the introduction of new communication services for Telex, as previously described.

In addition, the computers being installed in Western Union's nationwide network have multiple-access capabilities which permit many users to work with the same computer at the same time. This will enable the Company to offer a new range of services at charges determined, basically, by how much of the network's capacity each customer uses.

For instance, a new computer-controlled shared-service communication system (called "Info-Com") offers subscribers the advantages of a private communication network without the need for major investments in space, equipment and manpower. Shared-service communication systems can be especially designed to meet the requirements of firms in a single industry. Such a system (called "Sicom" for Securities Industry Communications) is designed for firms in the securities industry. This system permits subscribers to interconnect their headquarters wire and order rooms, branches and correspondents, posts on the floors of the New York and American Stock Exchanges, and any other special points desired.

Western Union's long-term program calls for the placement of very large multiple-access computers at additional key centers across the country. When that is done, the public message and Telex services will be merged into a single computer-controlled system. The network then in place will provide computer capacity for offering many new shared-services to customers of all kinds.

CHART 10

CIRCUITRY

WESTERN UNION OWNED FACILITIES

POLE LINE & CABLE

MICROWAVE

INTERCONNECTIONS WITH BELL SYSTEM

LOCAL CIRCUITS

SUPERGROUPS

PLANS FOR BASEGROUPS & MASTERGROUPS

PLANS FOR TELPAK SHARING

PROPOSED DOMESTIC SATELLITE SERVICE

UTILIZATION OF FACILITIES

MAJORITY OF CIRCUITS USED IN SUPPORT OF OWN SERVICES BUT SOME LEASED TO OTHER CARRIERS AND INDIVIDUAL CUSTOMERS. THIS TOTALS ABOUT $2.5 MILLION PER YEAR.

RATES

SET BY TARIFF

NOTES FOR CHART #10

New communications systems and services require more and more reliable high-speed transmission channels. To provide them in large numbers, Western Union built a coast-to-coast microwave system in 1961, just one hundred years after it built the first continental telegraph line. Today, the Company owns and operates about 900 thousand circuit miles of pole line and cable facilities suitable for telegraph service, plus about 4.5 million circuit miles of high-quality microwave capable of handling telegraph, voice, data, facsimile and television.

In addition to its own facilities, Western Union presently spends annually approximately $22 million for lease of facilities from AT&T. Of this amount, $6.5 million is for local circuits that connect Western Union subscribers with our central offices in the same cities. In addition, approximately $15.5 million is presently spent to provide intercity trunk circuits where Western Union does not have microwave or other suitable facilities of its own. Until recently, these intercity circuits were leased as single 4 KC channels. However, the continued expansion of Western Union's new services has made it more economical to contract for super groups of 240 KC bandwidth each. Negotiations are underway whereby Western Union hopes to obtain 48 KC and 2400 KC facilities as our circuit requirements increase. Discussion of our relationships with the Bell System on circuitry would not be complete without mention of our efforts to obtain some form of sharing agreement to permit the government and other large customers to obtain incremental additions to their existing Telpaks from either carrier. Without such an agreement, Western Union is at a decided disadvantage in the marketing of its circuits.

Western Union has closely followed the development of satellite technology, and in November of 1966, filed applications for construction permits for a network of six regionally-located, multiple-access earth stations which -- working in conjunction with two large terminals in the New York and Los Angeles areas -- would provide needed expansion of Western Union's intercity transmission facilities. The FCC deferred action on these applications, pending resolution of Docket 16495 (the Domestic Satellite Inquiry). We hope that there will be early resolution of this matter, as these decisions will have a major influence on our facilities planning for the 1970 time period.

CHART 11

SPECIAL PROBLEM AREAS

(1) LACK OF NATIONAL POLICY REGARDING FUTURE OF COMMON CARRIERS.

(2) PROPOSALS REGARDING INTER-CARRIER RELATIONS

(3) UNFILLED CAPACITY OF MICROWAVE

(4) RESOLUTION OF SATELLITE SITUATION

(5) FCC COMPUTER INQUIRY

(6) NEED FOR GREATER FREEDOM IN HANDLING PUBLIC TELEGRAPH ORGANIZATION

(7) NEED FOR SIMPLIFIED RATE STRUCTURE IN PUBLIC TELEGRAPH.

(8) FOREIGN ATTACHMENT PROBLEM IN AUTODIN.

(9) CAPITAL REQUIREMENTS

NOTES FOR CHART #11

The Director of Telecommunications Management suggested that we list some of the problems that the Company faces, in order that you could have a better understanding of the Company's position. The topics shown are among the more important matters, each of which will have a significant effect on the future growth and direction of Western Union. These have not been listed in any particular order of priority. They are:

1. <u>Lack of National Policy Regarding Future of Common Carriers</u>

   A piecemeal approach to the various policy questions which are being studied by the Presidential Task Force is not likely to lead us toward any particular goal or objective as to future handling of the nation's communications. An attempt should be made to reach a national decision as to the desired objective, i.e., government versus private ownership; one versus several carriers; if we have several carriers, the basis of separation, etc. Once this is reached, the individual policy questions can be handled in a way that will move Western Union and all of the members of the industry toward an established goal.

2. <u>Proposals Regarding Inter-Carrier Relations</u>

   The FCC Telegraph Investigation, Docket 14650, recommended that AT&T sell TWX to Western Union, in order that we might become the domestic record communication carrier; and provide the public with a fully-integrated and improved record message service. These negotiations have been proceeding, but no target date has yet been established by which time the companies expect to have reached agreement. Obviously, this would be an extremely important step for Western Union; and one which would have an immediate effect on improving revenues and earnings.

   The report dealt at some length with the great disparity between the resources available to the Bell System and those available to Western Union in equalizing direct competition in the leased line services which the report recommends be permitted, at least for the time being, to continue. Various problems in this area are being discussed with AT&T, and progress is being made toward resolving some of them. We are hopeful that this process will, ultimately, result in substantial resolution of the problems cited by the Commission and the establishment of a viable competitive situation. The report recommended a further investigation of these problems by the Commission and, although resolution by direct discussion is the preferable route, it is possible that further Commission action may be necessary at some future date.

3. <u>Unfilled Capacity of Microwave</u>

Western Union's coast-to-coast microwave system costs approximately $90 million, and, at the present time, is running at substantially less than its capacity. The Company has all of the fixed costs (depreciation, amortization, etc.) that we would have if the system were full, plus the fact that the maintenance and operating costs are substantially the same regardless of percentage of the circuits that are in use. At the time the system was planned and built, it was anticipated that the government would have a requirement for a substantial part of this capacity, but this has not materialized. Until such time as other large users of circuitry can be found, or the general growth of the Company's requirements for its own services build up, the micorwave system will be uneconomical or, at best, marginally profitable.

4. <u>Resolution of Satellite Situation</u>

Domestic satellite service is attractive to Western Union as a means of meeting our transmission requirements between points that are off of our main microwave system. Our studies indicate that we could provide this needed circuitry more economically through a satellite system than we could by leasing terrestrial facilities from other carriers. Further, the multiple-access nature of the satellite system would permit Western Union to shift transmission capacity between various points on an hour-to-hour and day-by-day basis in a way which is completely impossible with terrestrial facilities.

5. <u>FCC Computer Inquiry</u>

Under Docket #16979, the FCC has initiated a broad inquiry into the inter-relationship between computers and common carrier facilities. Obviously, the Commission's study of the present and anticipated needs of computer technology will have a far-reaching effect on the marketing, technical and capital budget aspects of the Company's operations.

6. <u>Need for Greater Freedom in Handling Public Telegraph Organization</u>

As shown in Chart #3, there's been a steady decline in the number of Western Union offices handling public telegrams. However, anytime the open hours are reduced at one of these offices, or the volume of business drops to the point where we want to close the office, we have to get FCC permission to do so. The procedures which we have to go through in order to accomplish this are time-consuming, and, as a result, there has always been a lag between the local operating situation and the steps that we are permitted to take to reduce our operating expenses at marginal locations.

7. Need for Simplified Rate Structure in Public Telegraph

The present tariff concept is extremely cumbersome. For example, a recent analysis demonstrated that we could generate our monthly billings for Telex and PWS subscribers with only nine or ten steps. In contrast, the monthly billings for the public telegraph user involve over 100 different steps or procedural actions taken in the various sorting, counting and tariffing calculations for each and every message! All of this is done manually at the present time, and this adds substantially to the labor content of public telegraph business. A "postalized" or other simplified rate structure would permit substantial economies to be achieved in our present manual operation, plus facilitate automation when the computers take over the billing job in the modernized public message system.

8. Foreign Attachment Problem in Autodin

There are serious problems of equipment compatability, maintenance of service at satisfactory levels, and economic complications associated with the present DOD practices regarding their attachment of equipment to the Autodin system. DTM has been given a special set of briefing material dealing with this particular problem, as prepared by Western Union's Government Communications Systems Department.

9. Capital Requirements

Western Union is in the middle of a major program to modernize its public telegraph business, plus add and expand new services in the record and data communications field. Over $500 million has been invested by the Company in the past five years, and it will probably take somewhere near the same sum in the five years ahead. Further, the capital expenditure for the modernization of the public message operations will not generate new or added revenues, nor will the savings in improved efficiency be immediately felt. Raising this additional capital requires that the Company maintain a good level of profits from current operations, and this is extremely hard to achieve, in view of the decline of the traditional public telegraph business and the rising labor costs associated therewith.

CHART 12

SUMMARY & CONCLUSIONS

- WESTERN UNION HAS A WIDER VARIETY OF SERVICES THAN THE TELEPHONE COMPANIES AND, ON A PER-CUSTOMER BASIS, THE FACILITIES ARE CONSIDERABLY MORE COMPLEX AND THEREFORE MORE EXPENSIVE.

- THE TOTAL RECORD AND DATA COMMUNICATIONS BUSINESS IS GROWING BUT THE EXPANDING SERVICES REQUIRE SUBSTANTIAL CAPITAL OUTLAYS AND OPERATIONS ALONE CANNOT GENERATE THE FUNDS REQUIRED.

- THE PUBLIC TELEGRAM BUSINESS IS DECLINING AND THE VERY HIGH LABOR CONTENT MAKES CONTINUING RATE INCREASES NECESSARY UNTIL THE SYSTEM IS MODERNIZED (i.e. PLANT AUTOMATED AND RATE STRUCTURE REVISED).

NOTES FOR CHART #12

These comments are largely self-explanatory, but do represent the principal points that we would like to leave with you as a result of this briefing.

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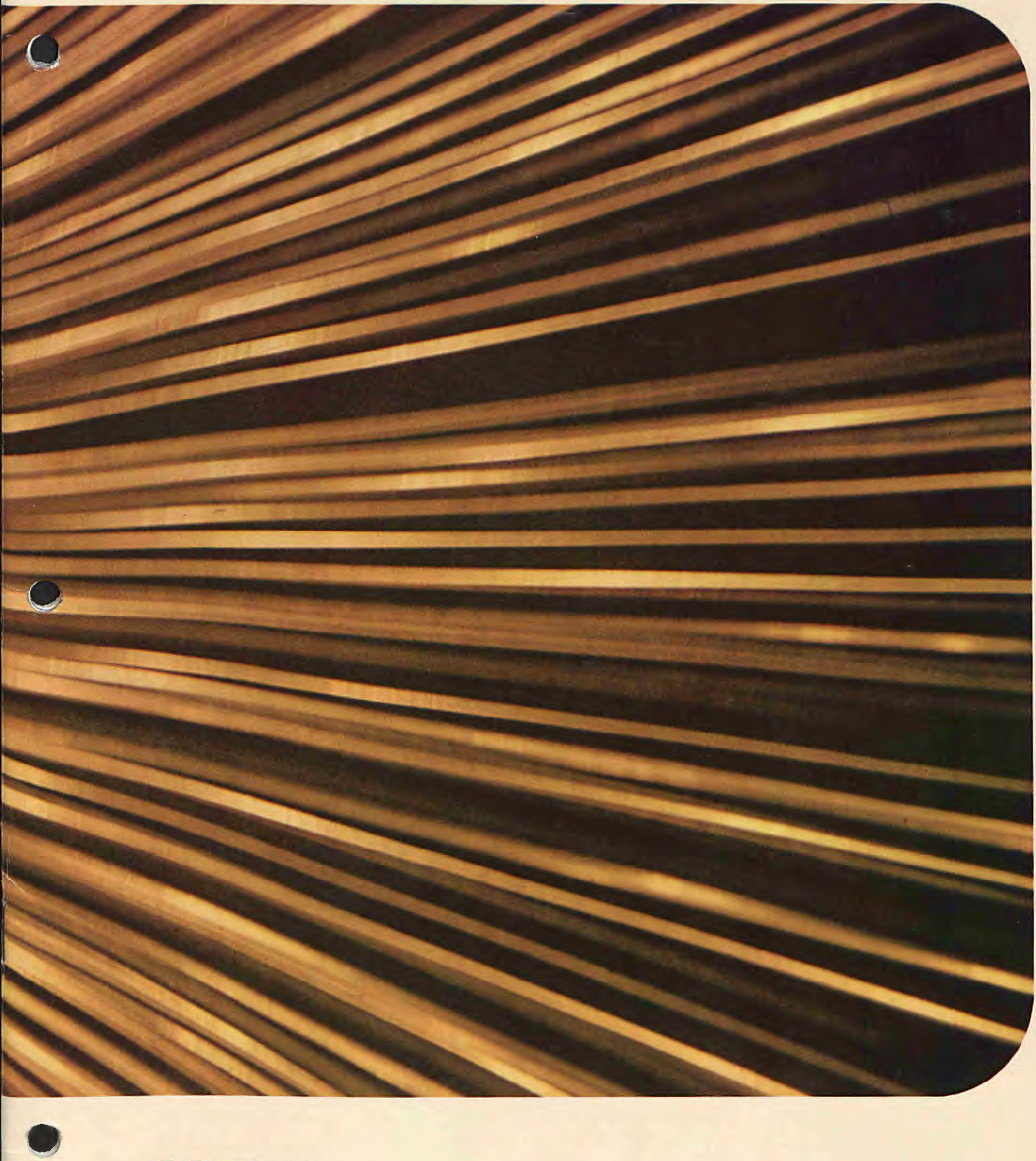


western union

ANNUAL REPORT 1966

The cover design symbolizes the increasing flow of information that characterizes the operation of modern business. The latest developments in communication and computer technology are being employed in Western Union's modernization program, which will broaden the range of communication and information services offered by your Company.

Annual Report for the Year 1966

CONTENTS

The Western Union Telegraph Company
Executive Office: 60 Hudson Street, New York, N.Y. 10013

TO THE SHAREHOLDERS:

Substantial progress was made during 1966 in carrying forward your Company's modernization and expansion program. A brief review here of the year's more significant developments against the background of the longer-term objectives of the program will provide perspective for the detailed report which follows. Your management is particularly pleased to report that improvements in earnings are being achieved at the same time that this broad program of building for the future goes on.

Western Union's modernization program is based on the application of the latest developments in communication and computer technology. The objectives of the program are to expand the Company's facilities, improve service, and broaden the range of communication and information systems and services offered to customers of all kinds — the public, business and government. Noteworthy progress in terms of these objectives is evident in continued expansion of Western Union's direct-dial Telex service; installation of computer centers to provide new services for Telex subscribers; expansion of the new Broadband Exchange and Hot/Line services; introduction of real-time (instant response) information services; and inauguration of new public services.

Completion of the new computer centers now being installed will make it possible to extend the new Telex services to subscribers nationwide, and to introduce new shared systems and services. Your Company's capabilities in the field of computer-operated communication and information systems and services will be greatly enlarged in the next phase of the modernization and expansion program, when it is planned to add large, advanced model computers which will permit the integration of the public message and Telex services into a single, unified record message system. The completed network will have substantial reserve computer capacity to broaden the offering of shared communication and information systems and services, nationwide.

Notwithstanding the increasing availability of shared systems and services, at charges based largely on usage, many customers will doubtless prefer to continue leasing individually designed systems dedicated to their private use. Expansion of the AUTODIN network for the Department of Defense is nearing completion; the initial Advanced Record System (ARS) of the General Services Administration is now in service; and new systems are being engineered and installed for industry.

Your Company's modernization and expansion program is far-reaching, and much work remains to be done. We are, however, making substantial progress toward our objectives, which hold the prospect of important benefits to Western Union and its customers.

R. W. McFall,
Chairman of the Board
and President

March 1, 1967

R. W. McFall

On November 22, 1966, following the retirement of Walter P. Marshall under the Company's General Pension Plan, President Russell W. McFall was elected to fill the post of chairman of the Board of Directors, in addition to continuing as president and chief executive officer.

Mr. Marshall, who became president of Western Union in 1948, was the youngest man up to then to head the Company. The Board, in expressing its best wishes to Mr. Marshall, recorded its appreciation of his outstanding service to Western Union in the following words:

"During an 18-year period, his leadership was instrumental in guiding the changing of Western Union's nationwide facilities from a completely manual system through various stages of mechanization, until today the Company stands on the threshold of a completely new era in communications. From the old concept of a company handling largely telegraphic messages, Walter Marshall hands over to his successors a broadly-based company, in an enviable position to take advantage of the great technological changes and opportunities flowing from developments in the computer and satellite communications fields."

FINANCIAL HIGHLIGHTS

	1966	1965
	(In millions)	
TOTAL REVENUES	$ 320.4	$ 305.7
INCOME BEFORE FEDERAL INCOME TAX	$ 21.9	$ 17.8
FEDERAL INCOME TAX	—	—
NET INCOME FOR THE YEAR	$ 21.9	$ 17.8
NET INCOME PER COMMON SHARE (after dividends on preferred shares)	$ 2.46	$ 2.30
DIVIDENDS DECLARED PER SHARE:		
Preferred shares:		
5.20% (issued in September 1965)	$ 5.20	$ 1.62
4.60% (issued in February 1966)	$ 4.20	—
Common shares	$ 1.40	$ 1.40
Your Revenue Dollar Was Derived From:		
Public services:		
Message services	$ .50	$ .52
Telex service	.08	.06
	.58	.58
Money order services	.08	.08
Other services	.03	.03
	.69	.69
Communication and information systems and services	.29	.30
	.98	.99
Interest, dividend, and other income	.02	.01
	$ 1.00	$ 1.00
Your Revenue Dollar Was Applied To:		
Salaries, wages, social security taxes, pensions, and other employee benefits	$ .52	$ .53
Other operating and maintenance expenses	.24	.24
Interest	.02	.02
Miscellaneous taxes	.02	.02
	.80	.81
Depreciation and amortization	.14	.14
	.94	.95
Dividends	.04	.03
Reinvestment in the business	.02	.02
	$ 1.00	$ 1.00
NUMBER OF COMMON SHARES OUTSTANDING (DECEMBER 31)	7,526,268	7,520,998
NUMBER OF COMMON SHAREHOLDERS (DECEMBER 31)	49,346	47,501
AVERAGE EARNINGS OF NONSUPERVISORY EMPLOYEES, OTHER THAN MESSENGERS (DECEMBER):		
Per hour	$ 2.98	$ 2.88
Per week	$127.28	$124.53
NUMBER OF EMPLOYEES AT YEAR END	27,348	26,485

FINANCIAL REVIEW

Operating Results

Net income for the year was $21,892,302 which compares with net income of $17,833,353 for 1965. Provision for federal income tax was not required in either year. (See Note C on page 20.) Net income was $4,058,949 higher than in 1965 despite the adverse effect of a ½-day work stoppage and 2-day strike called early in June by the Commercial Telegraphers' Union.

After deducting dividends of $3,400,908 declared on preferred shares issued in September 1965 and February 1966, net income per common share was equal to $2.46. In 1965, net income per common share was $2.30 after dividends of $566,230 declared on the preferred shares issued in 1965.

Total revenues amounted to $320,408,841, an increase of $14,723,086 over 1965. All categories of public services revenue were higher than in 1965, reflecting among other things the effect of the 3 percent general increase in public message service rates and certain selective increases effective on various dates during the first half of 1966. Telex revenues reached a new high of $25,033,308, greater by $6,597,664, or 36 percent, than revenues of $18,435,644 in 1965. Money order services revenue rose to $27,134,823, an increase of $3,280,951 over 1965.

Communication and information systems and services revenues of $96,389,101, compared to $93,837,765 in 1965, were adversely affected by the reduction of rentals resulting from extension of the service life (from 8 years to approximately 11 years) of the five initial AUTODIN centers in the Department of Defense system. The reduction in AUTODIN revenues had no significant effect on net income, as the reduction was offset for the most part by lower AUTODIN depreciation charges.

Total expenses for the year were $305,753,666, as against $292,623,297 for 1965, an increase of $13,130,369. This increase reflects higher wage rates resulting from the new two-year labor contracts which became effective June 1, 1966, and the increase in social security taxes due to the higher wage base and statutory rates effective January 1, 1966. Wages and related employee benefits absorbed 53.5 percent of operating revenues, compared with 53.9 percent in 1965 and 54.7 percent in 1964; average weekly earnings of employees continued to rise from $115.36 in 1964 to $124.53 in 1965, and to $127.28 in 1966.

Pension expense of $11,610,581, as shown in the Statement of Income, is $1,157,426 lower than in 1965, reflecting principally an increase of $1,168,624 in the portion capitalized in connection with the heavy construction program. This expense consisted of contributions of $6,846,047 to the Trust Fund under the Partial Funding Plan and $7,484,004 representing the portion of pensions paid from the general funds, less $2,719,470 charged primarily to construction. (See Note A on page 20.)

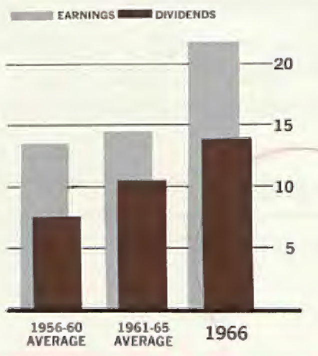
Projections by an independent consulting actuary indicate an aggregate of Trust Fund contributions and pension payments from general funds ranging from approximately $16 million in 1967 to a peak of about $22 million in 1975, such figures being gross before deduction for related federal income tax, with indeterminate portions to be charged to plant under construction. From the inception of the Trust Fund in 1955 to the end of 1966, contributions have amounted to $77,501,877, earnings of the Fund have totaled $11,404,831 and pension payments from the Fund aggregated $47,214,846.

Research and development expenditures for the year totaled $6,824,986, of which $5,021,159 was capitalized in accordance with the accounting regulations of the Federal Communications Commission. (See Note G on page 21.) The comparable amounts for 1965 were $5,913,593 and $3,156,450.

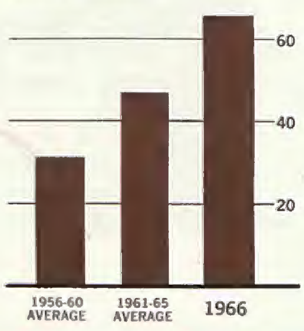
Dividends

Dividends on the common shares continued at the annual rate of $1.40 a share; the total amount declared on these shares was $10,533,892 for 1966.

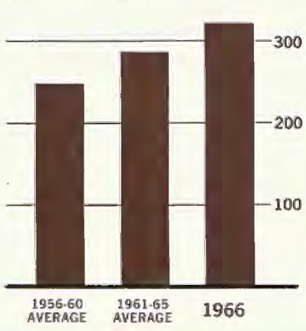
EARNINGS—DIVIDENDS
(Millions of Dollars)



CASH FLOW—
NET INCOME PLUS DEPRECIATION AND AMORTIZATION
(Millions of Dollars)



OPERATING REVENUES
(Millions of Dollars)



In addition, dividends of $1,820,000 were declared on the 5.20 percent shares and $1,580,908 on the 4.60 percent convertible preferred shares. Thus, the total amount paid out to the Company's shareholders for 1966 aggregated $13,934,800, or 64 percent of net income for the year.

Financial Position

Gross plant additions of $148,779,716 during the year were $51,787,829 greater than 1965 additions, mainly as a result of communication and information systems installations, including the AUTODIN and ARS networks, and continued expansion of the Telex system. After net credits of $29,176,767, largely for equipment removed from service and transferred to inventory (most of which was either reinstalled or is available for reinstallation), net plant additions were $119,602,949. After depreciation and amortization of $43,673,726 charged against earnings, the Company's investment in plant and equipment increased by $75,929,223 during 1966. This increase brought the investment in plant and equipment up to $526,191,675, of which $94,440,362, or 18 percent, represented plant under construction.

The Company's total capitalization—capital, funded debt, and other long-term obligations — was $576,229,791 at the end of the year. Funded debt and other long-term obligations amounted to $200,366,498, or 35 percent of the total capitalization.

Financing

In February 1966, a total of 376,059 shares of 4.60 percent convertible preferred were sold by means of a rights offering to the holders of common shares. These shares are convertible into common shares at an initial price of $57 per common share.

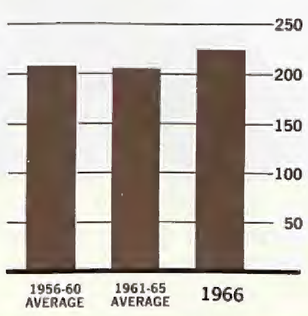
On August 1, 1966, a loan agreement was arranged with sixteen banks, which makes a maximum of $100 million available until December 31, 1967, with a standby fee of ¼ percent per annum payable on the unused portion. All borrowings will be evidenced by notes maturing December 31, 1969 and carrying interest at the prime commercial rate of The Chase Manhattan Bank, N.A., from time to time in effect through July 31, 1967, and at ¼ percent above the Chase prime rate from time to time in effect thereafter. As of February 20, 1967, the Company had borrowed a total of $22 million under the agreement.

In December 1966, the Company sold $50 million 6½ percent debentures due in 1989. A total of $43,850,000 of these were delivered to underwriters and paid for in December, and the proceeds were used in part to repay $40 million of notes payable to banks, which matured that month. The remaining $6,150,000 of debentures were sold to institutional investors for delivery and payment on March 15, 1967.

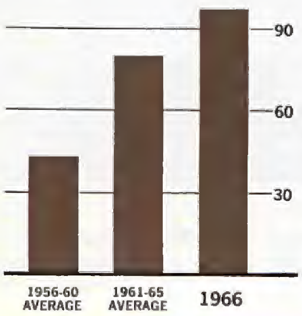
The proceeds of these financings have been or are being used for the Company's modernization and expansion program, except to the extent applied to the repayment of notes to banks. The program will necessitate additional financing in 1967. Further financing in subsequent years, including the refinancing of borrowings under the loan agreement, will be necessary, entirely apart from financing which may be required if and when negotiations with A.T.&T. should result in an agreement covering the purchase by Western Union of the Teletypewriter Exchange (TWX) Service and certain other record services of the Bell System.

The Board of Directors believes that some of the funds needed for the program will require the sale of equity securities, both because of the advisability of maintaining the total capitalization of the Company in an appropriate debt and equity relationship, and because of limitations on additional debt contained in the several debenture indentures, in the loan agreement and in the certificate of incorporation. (See Note D on page 20.) The times and amounts of financings, whether through the issuance of equity or debt securities or through borrowings under the loan agreement, will be determined in the light of market and other conditions. As this report goes to press, the Board is considering various plans for financing the Company's near-term capital requirements.

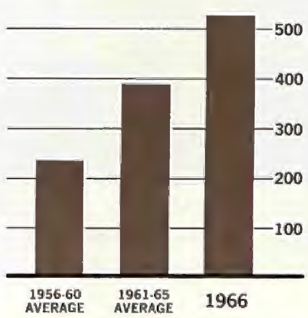
PUBLIC SERVICE REVENUES (INCLUDING MESSAGE, MONEY ORDER, TELEX AND OTHER SERVICES)
(Millions of Dollars)



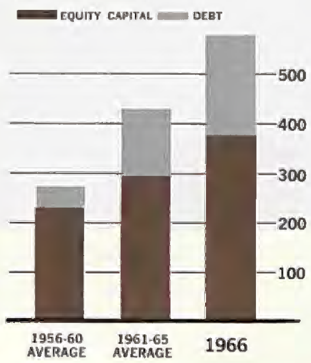
COMMUNICATION AND INFORMATION SYSTEMS AND SERVICES REVENUES
(Millions of Dollars)



PLANT INVESTMENT
(Millions of Dollars)



CAPITALIZATION
(Millions of Dollars)



Western Union's unique Information Services Computer Center at the Company's headquarters in New York City, after duplexing to double its capacity.

NEW SERVICES FOR GROWTH

New services are essential to the future of Western Union. Two years ago, the Company accelerated its program to develop, test and introduce new services, giving priority to the generation of additional sources of revenue.

The Company's progress in the development of new services is reviewed in this section. Western Union Telex, which was first introduced in 1958 on a limited test basis, is the oldest service discussed. The other services described are all less than five years old, and most were introduced within the past two years and, therefore, are still largely in the development stage.

Western Union Telex®

The annual rate of Telex revenues was $28.2 million at year-end 1966, when the number of Telex subscribers reached a high of 18,105. In addition, there was a backlog of 1,975 subscribers waiting for service, as compared with 1,274 at the end of 1965.

Telex subscribers can dial direct teleprinter connections with other subscribers in the continental United States, Canada and Mexico for the transmission of messages and data. Direct Telex service is also available to subscribers in Hawaii, Puerto Rico and 123 countries abroad by interconnection through the facilities of the international carriers. Western Union Telex subscribers can also send Tel(T)ex messages to non-subscribers by dialing special centers at 139 cities in the United States and Canada, and then transmitting their messages which are delivered as if they were telegrams.

Telex is a broadly based teleprinter exchange system which has many potential applications in both the communication and information fields. In 1966, for example, 40 multi-point installations of from 8 to 87 stations each were made for business firms in a variety of industries. With this type of Telex installation, regional and national firms obtain direct, efficient and economical communication service between headquarters, plants, branches and other offices, at charges based principally on actual usage.

TWX Negotiations

Negotiations have been going on for the past year between A.T.&T. and Western Union, looking to the purchase of the Teletypewriter Exchange (TWX) Service and certain other record services of the Bell System. Substantial progress has been made in the negotiations, and it is hoped that a formal purchase agreement will result. While it is still too early to forecast the final outcome of the negotiations, it is not too soon to mention some of the potential benefits which would be derived from merging Western Union Telex and the TWX service in a single exchange-type record system. Integration of the Telex and TWX services would, if accomplished, substantially broaden the base for providing the public, industry, and government with new shared-use, computer-operated communication and information services of the kinds Western Union is already beginning to offer, and plans to expand.

New Services for Telex Subscribers

Western Union's first Information Services Computer Center was placed in operation at New York late in 1965, and its capacity was doubled in 1966. The center furnishes three new Automatic Computer Telex Services to 5,900 subscribers in eastern cities — a Telex-to-TWX message service; a relay service to Telex subscribers whose machines are busy when dialed; and a multiple address service permitting a Telex subscriber to send a single common message to as many as 100 Telex or TWX subscribers, or any combination of both. Additional computer centers are now being installed at Chicago, San Francisco and Atlanta. When in full operation, they will make the new automatic computer services available to Telex subscribers, nationwide.

Communication and Information Services

The computers in the new centers have multiple-access capabilities, and can be shared by many users to obtain a variety of communication and information systems and services. Law Research, Inc. is using Western Union computers on a shared-use basis to furnish its customers a real-time legal citation service, introduced in 1966. A Western Union teleprinter is used to dial a direct connection with the computer which furnishes case citations instantly upon request.

In addition, the Company has acquired a 33 percent stock interest in Information Science, Inc., which has developed and is offering a career information service. This service, called "PICS" (Personnel Information Communication System), uses computers to match the qualifications, earnings and other data about professional, technical and administrative people with the requirements of companies seeking such talents.

INFO-COM® is a new service being developed by Western Union engineers to meet an increasing need by industry for computer-operated message switching, data collection and similar services on a shared-use basis. Computers in the Company's new computer centers will be used to offer a variety of services to meet individual customer requirements as to message and data volume, speed of transmission, terminal equipment, and control of operating costs.

The Company is also planning to introduce another Western Union service known as "SICOM®," which has been designed exclusively for use by the securities industry. Brokerage and investment firms using the computer-operated SICOM system will be able to transmit orders and administrative messages directly between their offices, and to exchange trading floors.

Broadband Exchange® Service

This service, introduced on a test basis late in 1964, furnishes subscribers with a choice of high-quality voice grade or half voice grade channels for the rapid transmission of data in various forms, facsimile and other record communications, and for alternate voice communication. Charges for usage are in units of one-tenth of a minute, with a one-minute minimum.

Experience with Broadband Exchange Service has confirmed that there is a growing demand on the part of industry for reliable, broadband transmission channels at charges based largely on usage. At year-end 1966, nearly 240 broadband subscriber stations were in service, and broadband exchange revenues had reached an annual rate of $750,000. Multi-point installations, with up to 28 stations, were made for 50 firms, and there was a backlog at year end of 27 stations awaiting installation.

It is planned, during 1967, to increase the subscriber capacity of the broadband exchange system, extend the service to additional cities, and introduce 48 kilocycle service (equivalent to 12 voice grade channels), which will accommodate very high-speed transmission (over 5,000 characters per second) of data between computers and business machines.

Hot/Line

This service is an economical, two-point telephone service introduced less than two years ago, on an experimental basis, between New York and Chicago. It features automatic connections, with no dialing and no minimum time charge. Subscribers share a dedicated group of voice grade trunk channels between two common service points. When a subscriber lifts his handset, the distant telephone rings instantly. If he should encounter a busy trunk channel, his telephone will ring automatically as soon as a circuit is available.

Initial customer use of Hot/Line service exceeded expectations in both the frequency of calls and total daily usage. With redesign of the experimental equipment completed, extension to a number of major cities is planned in 1967.

New Public Services

A number of new public services have been introduced in recent years. In 1965, DollyGram® was added to CandyGram as an "instant gift." Flowers by Western Union, introduced the same year on a test basis in selected cities, is now offered nationwide. Telephone answering service, now available in more than 100 cities, was first tested at San Jose, California, in 1965.

In 1966, two additional services — MelodyGram® and Perfume-by-Wire® — were added to those offered through the nationwide network of Western Union public offices.

MelodyGram, introduced on October 31, is a unique social greeting which combines a personalized telegraph message, a recorded song and a deluxe greeting card. Ten different MelodyGrams provide a selection of songs appropriate to birthdays, weddings, anniversaries, births and other occasions.

Perfume-by-Wire, introduced on December 1, features a new floral fragrance, plus a matching cologne in a spray-type container. The perfume and cologne combination, packaged in a lined box reusable as a jewel case, is delivered with the sender's personal message on a specially-designed telegraph blank.

Extensive advertising is planned this year to support the Company's intensified marketing and promotion of public services, especially the new "instant gift" services.

Customer Systems

Some of Western Union's most advanced and complex systems have been custom designed, as explained in previous reports to the shareholders, to meet the specialized and exacting requirements of government. The largest of these — AUTODIN, the automatic digital data network serving the Department of Defense — was the first nationwide communication system to employ computers "on-line." This system was engineered for the high-speed transmission of data by magnetic tape, punched cards, automatic sending and receiving machines, and other data devices; and consisted initially of five major centers linking 300 stations from coast to coast. Those five centers were enlarged and three new centers were placed in operation during 1966; and a ninth center is being installed in Hawaii. When expansion has been completed this year, AUTODIN will be capable of serving up to 2,700 stations.

The Advanced Record System (ARS) is another unique network. It was designed especially for the General Services Administration, to serve civilian agencies of the federal government, and was placed in service during 1966. ARS, which also employs computers on-line, consists of three key switching centers and 24 district switching offices. It is now serving 23 civilian agencies of the federal government. Engineered for the transmission of facsimile, high-speed data and voice, in addition to interconnecting teleprinter stations, the network has an initial capacity of 2,250 stations, which can be expanded to 3,700.

Additional government projects completed or nearing completion include a digital color TV transmission system and an advanced, computer-operated, digital data communication system for the Department of Defense; two facsimile switching centers for the National Aeronautics and Space Administration (NASA); and a computer-operated communication processor at NASA's Marshall Space Flight Center.

New commercial systems placed in service during 1966 included nationwide, computer-operated systems for the 3-M Company and the Blue Cross Association. Transistorized systems of advanced design have been installed in the network of E. F. Hutton & Company, Inc., which has also been expanded to interconnect 70 of the firm's offices from coast to coast, and in the nationwide network serving Loeb, Rhoades & Co., which interconnects more than 100 cities. A special network is being engineered for the Trane Company, in which a combination of leased circuitry and Telex service will be used to link 140 stations with a computer at Trane's headquarters.

Western Union Systems Shared by Customers

In the past, business firms desiring communication and real-time information systems have been able to obtain them only on a leased basis, by having switching and processing equipment, as well as outstations, installed on their premises. Now this need can be met through the multiple-access computers being installed in the Company's new computer centers, which make computer capacity available for shared use.

The new AUTODIN center at Fort Detrick, Maryland, during "cut-over" in mid-1966.

This important development, which will also make shared-use systems and services available to many firms that previously could not afford them on a private leased basis, is expected to have substantial effects on both the size and composition of the market for communication systems. The recent selection by certain business firms of multi-point Telex and Broadband Exchange installations, rather than leased private systems, is an early indication of the changes that lie ahead.

Telex and Broadband Exchange services make it possible for customers to use Western Union computers at charges based largely on usage. This combination of data-oriented exchange communication systems and multiple-access computers provides the basis for offering new services to business generally.

Information Systems Computer Laboratory

Western Union's requirements for systems engineering and analysis, and for computer programming and testing, have increased rapidly with the employment of computers in private leased systems for customers and in Western Union systems shared by customers. The computer laboratory, which had outgrown its original space at Fair Lawn, New Jersey, has been relocated at Mahwah, New Jersey.

The new facility, with more than 100,000 square feet of space, is divided between the computer laboratory, where computers of various manufacturers are programmed and tested before being placed in service, and associated planning and engineering activities. Approximately 500 people have been transferred to the new facility in a consolidation of related functions.

Edward F. Doherty and **Seymour Mermelstein,** engineers, are checking equipment used in the Company's microwave system.

Engineers **Ronald P. Vicari** and **Francis M. Babina** at the Information Systems Computer Laboratory testing equipment for a computer system under actual operating conditions.

THE MODERNIZATION AND EXPANSION PROGRAM

Computers are the keystone of Western Union's program to integrate its public message system with the Telex network. The transmission of telegrams, money orders, and related services — from originating point to destination — is performed now through semi-automatic relay centers. Those functions can be performed more rapidly and efficiently by computers.

It is planned to install — after completion of the computer centers at New York, Chicago, San Francisco and Atlanta — large, multiple-access computers of the latest design at key locations across the country, and to link them by high-capacity, broadband transmission facilities. The computers in this network — which will permit complete integration of the public message services and Telex into a single, modern system — will perform both information and communication functions; provide multiple-access capabilities; and offer substantial operating economies.

The integrated network — planned for efficient and expanded communication services to the public, business and government — will, in addition, enable Western Union to offer, on a nationwide basis, new information systems and services to customers of many kinds.

THE NEW LOOK AT western union

The Company's new trademark, adopted a year ago, is now used in advertising, sales promotion material, reports, publications and other printed material. Application of the new corporate symbol — reflecting the Company's leadership in the modern communication/information field — has been standardized for universal identification of Western Union services, offices, equipment, stationery, and other property.

In addition, a modular design plan is being developed to standardize the renovation of existing offices and the building of new ones. The new modular plan is now being evaluated under day-to-day operating conditions at prototype offices, after which a manual of specifications, incorporating the new design concept, will be prepared for use in the modernization of public offices generally.

Jan Nuesslein is displaying a MelodyGram at the counter in one of the Company's new model offices. Western Union's "instant gift" services are featured in a special cabinet alongside the counter.

The Telegraph Investigation

On December 21, 1966, the Telephone and Telegraph Committees of the Federal Communications Commission issued their report terminating the Commission's inquiry into domestic telegraph services, which adopted the substance and, in large measure, the text of the report of the Commission's Common Carrier Bureau, issued on October 25, 1965. The Committees' recommendations would strengthen, in the public interest, competition in domestic telecommunications. They cover the same three broad areas as the staff's recommendations, which were described in the November 8, 1965 report to shareholders, and propose:

1. Establishment of an integrated record message service; selection of Western Union as the carrier to provide this service; and use by the Commission of its statutory powers and regulatory functions to prevail upon A.T.&T. and Western Union to effect an agreement on the purchase by Western Union of the Bell System's TWX service.

2. Promotional pricing for message telegraph service; after the establishment of an integrated record message service, development of a system of tariffs that will assure that the exchange telegraph, Tel(T)ex, and message telegraph services will be supplied on a promotional basis to maximize the usage of each type of service; and establishment of adequate speed and quality of service to accompany promotional pricing.

3. Establishment of inter-carrier relationships which would promote effective competition in the provision of private line services; in the absence of a determination that some other basis is more appropriate and desirable, use of full-cost pricing as a basis for minimum prices in the competitive private line fields; and the fixing by the Bell System and Western Union of rates that will yield a fair rate of return on those services that are directly competitive, except to match lower rates so fixed by the other.

TELPAK Tariffs

TELPAK service is an application of the package principle in the leased communication record, voice and alternate record/voice fields. It permits a customer, or group of customers, to lease a number of channels (or a single broadband channel) for high-volume voice and record services at rates substantially below those for regular private line services. A cost-of-services study submitted by A.T.&T. in the Federal Communications Commission's investigation of domestic telegraph services indicated that its private line telegraph services earned 1.4 percent and TELPAK earned only 0.3 percent, as against 10 percent earned on Bell System toll telephone services.

The Commission, following an investigation into the lawfulness of TELPAK regulations and rates, directed A.T.&T. to file revised tariff schedules which would unify rates for TELPAK A and B classifications (equivalent to 12 and 24 voice grade channels, respectively) with regular private line rates. The Commission also directed A.T.&T. to submit additional cost data on which the Commission might base a determination as to whether rates for TELPAK C and D classifications (equivalent to 60 and 240 voice grade channels, respectively) are compensatory, together with such revised tariff schedules as may be indicated by the data. The F.C.C.'s decision was upheld on appeal to the U.S. Court of Appeals for the District of Columbia.

In compliance with the Commission's decision, A.T.&T. has filed tariff revisions to become effective on May 1, 1967. These would, among other things, eliminate the TELEPAK A and B classifications, increase the rates for private line telegraph services, and introduce a new wideband service equivalent to 12 voice grade channels (approximately 48 kilocycles in bandwidth). While A.T.&T. has also submitted, with respect to TELPAK C and D classifications, the additional cost information and proposed rates requested by the Commission, it has requested that the new Telpak C and D rates not become effective until the latter part of 1967. Meanwhile, certain intervenors in the Commission's investigation of TELPAK regulations and rates have filed a petition with the United States Supreme Court for review of the decision of the Court of Appeals.

Satellites for Domestic Communications

The Communications Satellite Corporation (Comsat) was formed, pursuant to the Communications Satellite Act of 1962, to establish a global satellite communications system; to own and operate the United States portion of the system subject to regulation by the F.C.C.; and to lease channels to United States communication carriers and other authorized users.

Comsat's existing system is now being used only for overseas communications. In August 1966, Comsat submitted a technical plan to the F.C.C., calling for two satellites to be operational for domestic service by late 1969, and for earth stations to be located at appropriate sites across the country.

On November 7, 1966, Western Union applied to the Commission for authority to construct, own and operate five earth stations for the development, together with two shared earth stations, of a domestic satellite communications system. The application stated Western Union's intention to apply for a sixth station. On December 15, 1966, A.T.&T. submitted a plan to the F.C.C. for a domestic ground station system which would use communication satellites launched and owned by Comsat.

On January 5, 1967, the Commission returned Western Union's applications for earth stations as premature, stating that issues surrounding the establishment of a domestic satellite system are under active consideration. The action was without prejudice to the filing of future applications. Although a number of basic policy questions remain to be resolved by the Commission, a domestic communications satellite system will no doubt become operational at some future date; and, when available, it will provide facilities useful to Western Union in meeting the increasing demand for communication and information systems and services.

Use of Computers in Communication and Information Systems

The F.C.C. announced, on November 9, 1966, an inquiry into the regulatory and policy questions raised by the convergence and growing interdependence of the computer and communications. As stated in the Commission's Notice of Inquiry, "This convergence takes a variety of different forms and applications thereby making it difficult to sort them into simple discrete categories. It is impossible at this time to anticipate fully the nature of all of the policy and regulatory problems that future developments may generate. Nevertheless, it is desirable to focus on those problems that are presently definable within the existing state of this burgeoning industry."

Resolution of the problems being examined is important to your Company. Western Union, therefore, is an active participant in the inquiry and, on December 9, 1966, replied in detail to the Commission's invitation to all interested persons to comment and make suggestions with respect to its preliminary statement of the purpose of the inquiry — among other things, to obtain information, views and recommendations from a variety of sources; to consider regulatory and policy questions with reference to computer services furnished both by communications common carriers and by non-carriers; to consider the compatibility of the services and facilities offered by communications common carriers with the requirements of computer users; and to consider the lawfulness of offerings by communications common carriers in this area.

WESTERN UNION EMPLOYEES

The Company's modernization program and the development of new communication and information systems and services are increasing its need for engineers, computer programmers, technicians and other highly skilled employees. This need is being met both by recruiting people from outside the Company, and by developing the capabilities of present employees.

An expanded recruiting program during 1966 brought to Western Union experienced men and women with demonstrated ability in the information, computer and other special fields. The Company's recruiting program, conducted at colleges and universities across the country during the 1966-1967 scholastic year, added substantially to the number of younger employees in training for responsible positions.

Training programs for employees involved in the development and operation of new systems and services have also been expanded to increase their capabilities, and to increase their potential for promotion. Qualified employees are encouraged to take advanced courses at colleges and universities, and receive assistance when the courses are related to their work at Western Union.

Joseph A. Greco of the Information Systems and Services Department is conducting an orientation program for new employees.

ORGANIZATION CHANGES

Earl D. Hilburn was appointed vice president and special assistant to the president. Mr. Hilburn was deputy associate administrator of the National Aeronautics and Space Administration at Washington, D. C. He has a broad background in the electronics and aerospace industries, including the posts of vice president and general manager of Curtiss-Wright's Electronics Division; president of Burtek, Inc.; vice president of the Link Division of General Precision, Inc.; and vice president of government contracts for the Westinghouse Air Brake Company.

John M. Evans was appointed vice president and general counsel, succeeding John H. Waters who retired after forty years of distinguished service with Western Union. Mr. Evans previously was associate general counsel and secretary of El Paso Natural Gas Company, prior to which he had practiced law for fifteen years in New York.

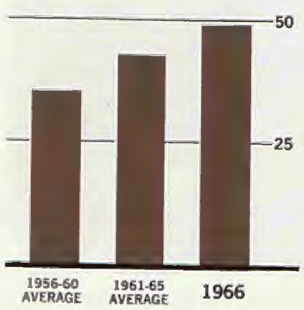
The success with which the abilities and judgment of experienced Western Union people have blended with the specialized knowledge and skills of those who more recently joined the Company is noteworthy. The Officers and Directors wish to express their appreciation for the effective teamwork of employees, and for the continued support and interest of the shareholders. These are vital to the broadening of Western Union's capabilities in the communication and information fields, and attainment of the Company's goals.

By order of the Board of Directors,

R. W. McFall,
Chairman of the Board
and President

WESTERN UNION SHAREHOLDERS

NUMBER OF COMMON SHAREHOLDERS
(Thousands)



The number of holders of Western Union common shares reached a new high of 49,300 at year-end 1966. The number of holders of preferred shares at year end was 14,200, of whom approximately 80 percent also held the Company's common shares.

western union

STATEMENT OF INCOME AND RETAINED EARNINGS

	Year Ended December 31, 1966	1965*
REVENUES AND OTHER INCOME		
Public services:		
Message services	$162,251,781	$160,781,557
Telex service	25,033,308	18,435,644
	187,285,089	179,217,201
Money order services	27,134,823	23,853,872
Other services	9,599,828	8,776,917
	224,019,740	211,847,990
Communication and information systems and services	96,389,101	93,837,765
Total revenues	320,408,841	305,685,755
Interest, dividend, and other income	7,237,127	4,770,895
Total	327,645,968	310,456,650
EXPENSES		
Operating, administrative, and general	181,027,793	170,917,588
Maintenance	43,191,594	41,680,086
	224,219,387	212,597,674
Depreciation and amortization	43,673,726	41,657,149
Pensions	11,610,581	12,768,007
Employees' disability, death, and other benefits	6,051,607	7,314,754
Social security taxes	6,286,861	5,055,841
Taxes, other than social security and federal income taxes	6,843,440	6,203,472
Interest	9,993,881	8,476,712
Interest charged to construction—(credit)	(2,925,817)	(1,450,312)
Total	305,753,666	292,623,297
INCOME BEFORE FEDERAL INCOME TAX	21,892,302	17,833,353
Federal income tax	—	—
NET INCOME FOR THE YEAR	21,892,302	17,833,353
RETAINED EARNINGS AT BEGINNING OF YEAR	114,549,518	107,800,815
	136,441,820	125,634,168
Deduct:		
Dividends declared:		
Preferred shares: 5.20% — $5.20 per share	1,820,000	566,230
4.60% — $4.20 per share	1,580,908	—
Common shares — $1.40 per share	10,533,892	10,518,420
Expenses of issuing preferred shares	1,180,566	—
	15,115,366	11,084,650
RETAINED EARNINGS AT END OF YEAR	$121,326,454	$114,549,518
NET INCOME PER COMMON SHARE, based on the number of shares outstanding at year end	$ 2.46	$ 2.30

*Restated for purposes of comparison.

SEE NOTES BEGINNING ON PAGE 20

western union

STATEMENT OF FINANCIAL POSITION

ASSETS

	December 31, 1966	1965*
PLANT AND EQUIPMENT, at original cost:		
Plant in service	$695,097,940	$638,733,999
Plant under construction	94,440,362	54,540,920
Gross plant investment	789,538,302	693,274,919
Allowance for depreciation and amortization	263,346,627	243,012,467
	526,191,675	450,262,452
CURRENT ASSETS:		
Cash	25,749,904	18,810,480
Marketable securities, at cost, which approximates market	18,561,350	49,735,537
Receivables, less $601,155 and $443,903 allowance for uncollectible accounts	43,262,095	38,667,391
Amount receivable for debentures issuable under future delivery contracts	6,150,000	—
Materials and supplies for construction, maintenance and operation, at average cost or salvage value	48,864,356	39,261,200
Prepaid rents, insurance and taxes	895,945	484,443
	143,483,650	146,959,051
INVESTMENTS AND OTHER ASSETS:		
Investments, at cost (1966 approximate market value $8,602,000)	2,590,215	1,916,068
Other assets	2,475,669	2,233,566
	5,065,884	4,149,634
	$674,741,209	$601,371,137

*Restated for purposes of comparison.

SEE NOTES BEGINNING ON PAGE 20

CAPITAL AND LIABILITIES

	December 31, 1966	December 31, 1965*
CAPITAL:		
Cumulative Preferred shares, par value $100, authorized 750,000 shares:		
5.20% series—350,000 shares issued and outstanding	$ 35,000,000	$ 35,000,000
4.60% convertible series—376,059 shares issued and outstanding	37,605,900	—
Common shares, par value $2.50, authorized 10,000,000 shares, outstanding 7,526,268 and 7,520,998 shares, plus stated capital in excess of par	175,333,475	175,203,902
Capital surplus	6,597,464	6,597,483
Retained earnings	121,326,454	114,549,518
	375,863,293	331,350,903
FUNDED DEBT AND OTHER LONG-TERM OBLIGATIONS:		
Debentures:		
4⅝% due June 1, 1980	25,300,000	26,400,000
5¼% due February 1, 1987	48,000,000	50,000,000
6½% due December 15, 1989	50,000,000	—
5% due March 1, 1992	75,000,000	75,000,000
Notes payable to banks	—	40,000,000
Other obligations	2,066,498	1,569,976
	200,366,498	192,969,976
CURRENT LIABILITIES:		
Accounts payable and accrued liabilities	59,436,182	44,044,563
Money orders payable	12,292,994	9,853,319
Sinking fund payments on funded debt, due within one year	1,100,000	1,100,000
Dividends payable	3,521,238	3,086,911
	76,350,414	58,084,793
DEFERRED CREDITS AND RESERVES	22,161,004	18,965,465
	$674,741,209	$601,371,137

*Restated for purposes of comparison.

SEE NOTES BEGINNING ON PAGE 20

STATEMENT OF INVESTMENT IN PLANT AND EQUIPMENT

	December 31, 1966	1965*
Plant In Service		
Wiretelegraph		
Real estate	$ 2,918,826	$ 2,936,928
Outside communication plant	114,860,489	121,434,841
Equipment furnished customers	274,747,698	228,187,463
Other inside communication plant	162,654,819	151,899,023
Office and work equipment	30,064,343	27,195,040
Improvements to leased plant	4,300,345	3,890,812
Miscellaneous physical property	819,211	233,345
Sub-total	590,365,731	535,777,452
Radiotelegraph		
Real estate	13,628,544	13,255,337
Outside communication plant	13,281,074	13,606,475
Inside communication plant	50,087,299	51,126,716
Office and work equipment	3,556,105	2,959,394
Other radiotelegraph plant	392,262	342,214
Sub-total	80,945,284	81,290,136
	671,311,015	617,067,588
Plant Under Construction	94,440,362	54,540,920
Total	765,751,377	671,608,508
Deduct:		
Allowance for depreciation:		
Wiretelegraph	227,461,026	213,235,753
Radiotelegraph	20,381,580	15,124,149
Sub-total	247,842,606	228,359,902
Net investment, excluding research and development	517,908,771	443,248,606
Research and development	23,786,925	21,666,411
Deduct — Allowance for amortization	15,504,021	14,652,565
Total	8,282,904	7,013,846
Net investment, plant and equipment	$526,191,675	$450,262,452
Average rates of depreciation:		
Wiretelegraph plant	6.60%	6.80%
Radiotelegraph plant	6.77%	6.82%

*Restated for purposes of comparison.

SEE NOTES BEGINNING ON PAGE 20

STATEMENT OF SOURCE OF FUNDS FOR PLANT EXPANSION

	Year Ended December 31, 1966	1965*
FUNDS REQUIRED:		
Gross plant additions	$148,779,716	$ 96,991,887
Less: Recovery of equipment removed from service and transferred to inventory for reinstallation or other disposition, including $4,068,998 in 1966 and $3,005,930 in 1965 realized from sale of scrap copper wire	29,176,767	22,226,474
Funds required for plant expansion	$119,602,949	$ 74,765,413
FUNDS PROVIDED:		
By operations:		
Net income	$ 21,892,302	$ 17,833,353
Dividends	(13,934,800)	(11,084,650)
Earnings retained in the business	7,957,502	6,748,703
Depreciation and amortization	43,673,726	41,657,149
	51,631,228	48,405,852
By financing:		
Sales of securities:		
Preferred shares, less expenses of issuance	36,425,334	35,000,000
Common shares issued under options	129,574	428,662
Debentures	50,000,000	—
Sinking fund payments on long-term debt	(3,100,000)	(1,100,000)
(Decrease) increase in notes payable to banks	(40,000,000)	25,000,000
	43,454,908	59,328,662
Other:		
Decrease (increase) in cash and marketable securities	24,234,763	(30,846,552)
Net change in other assets and liabilities	282,050	(2,122,549)
	24,516,813	(32,969,101)
Funds provided for plant expansion	$119,602,949	$ 74,765,413

*Restated for purposes of comparison.

SEE NOTES BEGINNING ON PAGE 20

NOTES TO FINANCIAL STATEMENTS

NOTE A — EMPLOYEES' PENSIONS AND BENEFITS

The Western Union General Plan, inaugurated in 1913 and modified from time to time, provides service and disability pensions, sickness benefits, accident benefits and expenses, and occupational death benefits. The plan, which is non-contributory, applies to all employees and officers of the Company. Effective June 1, 1966, the General Plan was amended to provide for an increase in pension benefits commencing in 1968 through the lowering, in steps, of current deductions from pensions of amounts now generally equal to one-third of a pensioner's social security benefits, until such deductions are eliminated in 1970.

In the opinion of the Company's counsel, the legal liability of the Company under the General Plan at any time is limited to the unexpended portion of the amounts theretofore appropriated and the Company is under no legal obligation to make additional appropriations or payments, except that under the provisions of labor union contracts expiring in 1968 (and under the provisions of prior contracts since 1945) the Company agreed, during the term of the contracts, to make appropriations with respect to employees covered by the contracts, in amounts sufficient to meet disbursements for benefits provided by the General Plan.

Pursuant to a plan established in 1955 for the partial funding of pensions under the General Plan, the Company is paying into a fund held by a trustee one-half of current service costs and an amount representing interest on approximately one-half of the present value of unfunded prior service costs as determined by the Company's independent consulting actuary. The Company reserves the right to reduce, suspend, or discontinue contributions for any reason at any time. The fund is available only to pay pension benefits under the General Plan, and can in no event revert to the Company. The market value of the assets in the fund held by the trustee, excluded from the Statement of Financial Position, amounted to approximately $44,000,000 at December 31, 1966.

Approximately one-half of current payments to retired employees are made from the trust fund and the balance of such pension payments, as well as other benefit payments provided by the General Plan, are paid from the general funds of the Company. For rate-making purposes, the Federal Communications Commission limits charges for pensions to amounts paid directly to pensioners or into a trust fund established solely for such purpose. Accordingly, the amount of pension expense shown in the Statement of Income reflects contributions to the trust fund of $6,846,047 and pensions paid from the general funds of the Company of $7,484,004, less $2,719,470 charged to plant and equipment.

NOTE B — LEASE AND OTHER CONTRACTUAL OBLIGATIONS

The Company's headquarters building in New York City and office buildings in Atlanta, Boston, Chicago, Los Angeles, New Orleans, St. Louis and Tampa are held under long-term leases expiring on various dates between 1975 and 1995. Most leases contain renewal options ranging from 25 to 65 years, with substantial rental reductions upon renewal. The aggregate annual rental during the initial terms of these leases is $960,000 (an aggregate present value of $10,169,000 for the remaining unexpired terms) before considering rental income from sub-leases, currently amounting to $412,000 per year. The Company is responsible for property taxes, insurance and maintenance under these leases.

The Company also leases substantially all of its main and branch offices, and warehouse buildings for terms generally expiring within five years. Rentals for these properties approximate $6,278,000 annually.

Payments for the use of facilities obtained from the Bell System telephone companies currently aggregate $17,539,000 per annum. The agreements relate to intercity circuits, local circuits and to facilities used for furnishing TELPAK private wire service. The inter-city agreements are subject to termination by either party on ten years notice, the local agreements on three years notice and the TELPAK contracts on five years notice. The agreements permit the Company to increase or reduce the facilities used, but in the case of the inter-city agreements any reduction may not reduce the amount paid by more than 20% from the previous year.

NOTE C — FEDERAL INCOME TAX

Federal income taxes are based upon taxable income or loss which in recent years has differed substantially from income reported in the Statement of Income. While this difference is derived from numerous adjustments, it results primarily from the use of accelerated depreciation methods for tax purposes whereas straight-line depreciation is recorded in the accounts.

The Company records depreciation and federal income taxes in its accounts in accordance with the accounting regulations of the Federal Communications Commission which, with the exception of the AUTODIN installation referred to below, give effect to the Commission's practice of recognizing for rate-making purposes the amount of tax reductions resulting from accelerated depreciation and investment tax credits as current reductions in federal income taxes.

Although tariff rates with respect to the AUTODIN installation were developed without regard to the effects of accelerated depreciation, the Federal Communications Commission denied the Company's request to provide for deferred federal income taxes in its accounts and therefore no such provisions have been made. Generally accepted accounting principles would have required provisions for deferred income taxes of $2,100,000 in 1965, $1,900,000 in 1966 and $9,400,000 cumulatively to December 31, 1966. As a result, net income would have been reduced by such amounts and increased by equivalent amounts in later years.

Investment tax credits applicable to eligible plant additions under the Revenue Act of 1962 were not used in 1966 and prior years due to the absence of tax liability against which to apply the credits. The estimated unused investment tax credit carryover, available for tax reduction in subsequent years, amounted to $4,700,000 at December 31, 1966.

NOTE D — CAPITAL

The provisions of the 5.20% cumulative preferred shares requires that the Company redeem, through a sinking fund at the par value of $100, 2½% of the shares or $875,000 per annum, on each July 1 from 1968 through 1977 and 3% of the shares or $1,050,000 per annum on each July 1 thereafter. The shares are subject to redemption, otherwise than for the sinking fund, at $105.20 per share through June 30, 1970, and thereafter at reductions of 20¢ per share on each successive July 1 and at $100 per share on and after July 1, 1995. Redemptions prior to July 1, 1977, otherwise than for the sinking fund, are subject to certain restrictions.

The 4.60% cumulative preferred shares have no sinking fund provision, are presently convertible into common shares at a price of $57 a common share, and are subject to redemption at $104.50 per share on or after April 1, 1968 and through March 31, 1971, and thereafter at reductions of 50¢ per share on each successive April 1, and at $100 per share on and after April 1, 1979. At December 31, 1966 there were 659,753 common shares reserved for issue upon exercise of conversion rights.

The provisions of the certificate of incorporation of the Company, as amended, relating to the cumulative preferred shares, impose limitations on the issuance of prior and parity ranking shares, the creation of liens and additional funded indebtedness, and the payment of cash dividends on common shares. The amount of retained earnings not restricted as to payment of cash dividends on common shares approximated $26,314,000 at December 31, 1966.

The indentures and bank loan agreement referred to in Note F impose certain limitations on the payment of dividends on both the cumulative preferred shares and the common shares. The amount of retained earnings not so restricted as to the payment of such dividends approximated $19,481,000 at December 31, 1966.

NOTE E — STOCK OPTION PLAN

Transactions during the year under the Officer and Key Employee Stock Option Plan are summarized below:

	Number of shares	Price range (95% to 100% of market at date of grant)
Options outstanding at December 31, 1965 (32,070 shares exercisable)	61,820	$17.60—$51.88
Options granted	16,650	$32.94—$50.50
Options exercised (aggregate amount received $129,574)	(5,270)	$17.60—$39.35
Options expired (available for re-grant)	(2,200)	$19.40—$45.25
Options outstanding at December 31, 1966 (34,913 shares exercisable)	71,000	$31.00—$51.88

There were 34,250 shares available for additional options at the beginning of 1966 and 19,800 such shares at the close of 1966.

NOTE F — FUNDED DEBT AND OTHER OBLIGATIONS

On December 15, 1966, the Company sold $50,000,000 of 6½% debentures of which $43,850,000 were issued and delivered on that date. The remaining $6,150,000 are to be issued and delivered on March 15, 1967.

The indenture relating to the 4⅝% debentures contains optional redemption provisions and requires annual sinking fund payments for the retirement of $1,100,000 of the debentures (through the operation of which sinking fund the original $38,500,000 of the issue has been reduced to $26,400,000). The indentures relating to the 5¼%, 5% and 6½% debentures also contain optional redemption provisions and require sinking fund payments commencing February 1, 1967 for annual retirement of $2,000,000 of the 5¼% debentures, March 1, 1969 for annual retirement of $2,700,000 of the 5% debentures, and December 14, 1971 for annual retirement of $2,500,000 of the 6½% debentures. The February 1, 1967 sinking fund requirement on the 5¼% debentures was satisfied prior to December 31, 1966 by the purchase and delivery to the trustee of $2,000,000 of the debentures.

On August 1, 1966, the Company entered into a loan agreement with 16 participating banks under which a maximum of $100 million is available until December 31, 1967. Notes issued under the agreement will mature December 31, 1969 and bear interest at the prime commercial rate of The Chase Manhattan Bank, N.A., from time to time in effect, to and including July 31, 1967, and at ¼ percent above the Chase prime rate from time to time in effect thereafter. A standby fee of ¼ percent per annum is applicable to the unused portion of the available credit. The loan agreement provides that the proceeds of any funded indebtedness issued by the Company after December 31, 1967, other than certain permitted indebtedness, must be applied to prepayment of the notes at the time outstanding.

The indentures and the bank loan agreement impose certain limitations on the creation of liens and additional indebtedness, on the incurring of certain rental obligations, on the payment of dividends (see Note D), and on certain investments. Additional funded indebtedness (with certain exceptions) is limited by a test of earnings in relation to fixed charges, and is also limited to an amount which will not cause funded debt to exceed approximately 40% of the total of funded debt, capital, surplus and retained earnings. Under the most restrictive of these provisions, after utilization of $50,000,000 of borrowing capacity in December 1966 by sale of debentures, the Company was permitted to incur additional funded indebtedness amounting to approximately $27,000,000 at December 31, 1966. Additional borrowing capacity thereafter is dependent upon subsequent earnings and debt ratios.

NOTE G — DEPRECIATION AND AMORTIZATION

The Company employs the straight-line method of providing for depreciation, based upon the estimated useful lives of the various classes of properties as determined by the Company's engineers and the Federal Communications Commission. The annual rates thus determined are applied to the total investment in the respective classes of properties.

Research and development expenditures relate to projects associable with specific installations as well as to nonspecific projects. The amounts associable with specific installations are depreciated at rates prescribed by the Federal Communications Commission and those not associable with specific projects are charged to expense in the year of expenditure to the extent of the related federal income tax benefit. The remainder is amortized over the succeeding ten-year period. Charges to expense in 1966 for current year expenditures amounted to $1,803,827 plus $1,044,139 covering amortization of nonspecific expenditures capitalized in prior years, a total of $2,847,966 as compared with a total of $3,651,325 in 1965.

NOTE H — INVESTMENTS

The Company's investments at December 31, 1966 comprised the following:

	Number of shares	% of Ownership	Cost	Approximate Market Value
Technical Operations, Inc.	141,234	19.1	$ 813,134	$4,431,217
Information Science, Inc.	33,928	33.0	674,147*	674,147
Gray Manufacturing Co.	75,816	15.6	634,028	559,143
Microwave Associates, Inc.	121,872	11.7	232,406	2,589,780
MITE Corporation	35,000	1.6	136,500	131,250
Communications Satellite Corp.	5,000	.05	100,000	216,250
			$2,590,215	$8,601,787

*Includes notes of $330,000.

OPINION OF INDEPENDENT ACCOUNTANTS

PRICE WATERHOUSE & CO.

60 Broad Street
New York 10004

February 10, 1967

To the Board of Directors and the Shareholders
of The Western Union Telegraph Company

We have examined the financial statements of The Western Union Telegraph Company appearing on pages 15 through 21 of this report. Our examination was made in accordance with generally accepted auditing standards and accordingly included such tests of the accounting records and such other auditing procedures as we considered necessary in the circumstances.

The Company is required to maintain its accounts in conformity with principles and methods of accounting prescribed by the Federal Communications Commission, which principles and methods differ from generally accepted accounting principles to the extent described in Note C.

In our opinion, except for the matter referred to in the preceding paragraph, the accompanying statements present fairly the financial position of The Western Union Telegraph Company at December 31, 1966, the results of its operations and the supplementary information on funds for the year, in conformity with generally accepted accounting principles applied on a basis consistent with that of the preceding year.

Price Waterhouse & Co.

RESULTS FOR YEAR:

(Amounts in thousands, except per share figures)

Operating revenues:

- Public services:
  - Message services
  - Telex service
  - Money order services
  - Other services
- Communication and information systems and services
- **Total revenues**

Other income:

- Interest, dividend, and other income
- **Total**

Expenses:

- Salaries, wages, social security taxes, pensions, and other employee benefits[1]
- Other operating and maintenance expenses[2]
- Depreciation and amortization
- Federal income tax
- Miscellaneous taxes
- Interest on debt[3]
- **Total**

Net income:

- Land-line system
- Ocean-cable system (sold September 30, 1963)
- **Total**

Dividends on preferred shares

Net income applicable to common shares

Per common share:[4]

- **Net income**
- **Dividends**

YEAR-END POSITION:

(Amounts in thousands):

Net plant investment

Working capital

Funded debt and other long-term obligations

Shareholders' equity (net worth)

EMPLOYMENT:

Number of employees — (December 31)

Number of pensioners — (December 31)

Salaries, wages, social security taxes, pensions, and other employee benefits in relation to operating revenues

Average earnings of employees:[5]

- **Hourly**
- **Weekly**

(1) In 1963, the Company commenced the practice of capitalizing the portion of social security taxes, pensions, and other employee benefits associable with plant under construction.

(2) Includes operating and maintenance, rentals of space and facilities, payments fo[illegible]e of circuits, materials and supplies, electric power, light, heat, telephone service, ag[illegible]s' commissions, postage, advertising, traveling, insurance, etc.

1966	1965	1964	1963	1962	1961	1960	1959	1958	1957
$162,252	160,782	163,203	164,396	169,769	176,265	178,184	182,643	174,187	183,018
25,033	18,435	13,477	7,652	2,570	726	315	140	33	—
187,285	179,217	176,680	172,048	172,339	176,991	178,499	182,783	174,220	183,018
27,135	23,853	22,482	21,110	20,508	20,147	19,877	19,255	18,466	18,668
9,600	8,777	7,799	7,965	8,046	8,175	7,726	7,527	7,319	7,732
224,020	211,847	206,961	201,123	200,893	205,313	206,102	209,565	200,005	209,418
96,389	93,838	92,449	85,699	63,225	60,414	56,263	51,284	40,724	36,131
320,409	305,685	299,410	286,822	264,118	265,727	262,365	260,849	240,729	245,549
7,237	4,771	4,243	4,926	2,612	2,126	2,980	3,792	3,994	3,690
327,646	310,456	303,653	291,748	266,730	267,853	265,345	264,641	244,723	249,239
171,276	164,800	163,764	164,009	167,909	167,861	164,578	160,509	154,015	156,839
76,893	72,937	71,668	68,165	63,659	60,312	58,852	54,391	52,389	53,640
43,674	41,657	39,261	32,853	22,895	21,759	20,727	17,984	16,359	16,447
—	—	(1,200)	586	(3,730)	2,400	4,350	11,000	4,975	5,765
6,843	6,203	6,121	5,707	5,110	5,088	4,865	4,503	4,394	3,809
7,068	7,026	6,878	3,971	482	1,005	1,769	1,499	1,528	1,528
305,754	292,623	286,492	275,291	256,325	258,425	255,141	249,886	233,660	238,028
21,892	17,833	17,161	16,457	10,405	9,428	10,204	14,755	11,063	11,211
—	—	—	411	202	393	812	1,930	1,598	1,283
21,892	17,833	17,161	16,868	10,607	9,821	11,016	16,685	12,661	12,494
3,401	566	—	—	—	—	—	—	—	—
$ 18,491	17,267	17,161	16,868	10,607	9,821	11,016	16,685	12,661	12,494
$ 2.46	2.30	2.29	2.25	1.42	1.45	1.72	2.62	2.01	2.01
1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.20	1.20	1.10
$526,192	450,262	417,154	401,300	378,569	278,282	249,348	241,569	233,033	222,783
67,133	88,874	54,814	64,463	66,091	43,491	32,824	34,932	36,166	30,478
200,366	192,970	169,083	170,241	147,837	33,002	39,181	35,780	38,326	39,892
375,863	331,351	289,174	282,532	285,511	285,346	239,596	237,174	226,986	220,539
27,348	26,485	26,520	27,891	29,953	31,398	32,397	33,152	33,691	35,966
10,087	9,781	9,217	8,641	8,158	7,654	7,113	6,660	6,142	5,737
53.5%	53.9	54.7	57.2	63.6	63.2	62.7	61.5	64.0	63.9
$ 2.98	2.88	2.77	2.69	2.57	2.49	2.43	2.27	2.24	2.09
127.28	124.53	115.36	111.69	105.78	103.25	100.27	95.38	92.98	85.65

(3) Chiefly on bonds and notes, less interest charged to plant under construction, effective with 1961.

(4) Based on shares outstanding at end of each year, except that 1961 is based on average number of shares outstanding during the year.

(5) Relates to nonsupervisory employees, except messengers, in mid-December each year.

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ANNUAL MEETING NOTICE . . . The annual meeting of shareholders will be held at the Palmer House, in downtown Chicago, on April 12, 1967, at 10:30 A.M. It is hoped that many shareholders in the mid-western area who have not been able to attend past annual meetings will find it convenient to attend the meeting this year.

Those unable to attend in person are urged to vote by proxy. A proxy statement and proxy form will be mailed to holders of common shares shortly.

	Listed	Transfer Agent	Registrar
COMMON SHARES	New York Stock Exchange Midwest Stock Exchange Pacific Coast Stock Exchange Philadelphia-Baltimore-Washington Stock Exchange	Treasurer, Western Union	Manufacturers Hanover Trust Company
5.20% CUMULATIVE PREFERRED SHARES	Not listed	Treasurer, Western Union	
4.60% CONVERTIBLE CUMULATIVE PREFERRED SHARES	New York Stock Exchange	Treasurer, Western Union	Manufacturers Hanover Trust Company
		Trustee	
4⅝% DEBENTURES DUE 1980	Not listed	Morgan Guaranty Trust Company	The Marine Midland Grace Trust Company
5¼% DEBENTURES DUE 1987	New York Stock Exchange	The Chase Manhattan Bank N.A.	The Bank of New York
6½% DEBENTURES DUE 1989	New York Stock Exchange	Manufacturers Hanover Trust Company	Manufacturers Hanover Trust Company
5% DEBENTURES DUE 1992	New York Stock Exchange	Chemical Bank New York Trust Company	The Bank of New York

western union

Technical Review

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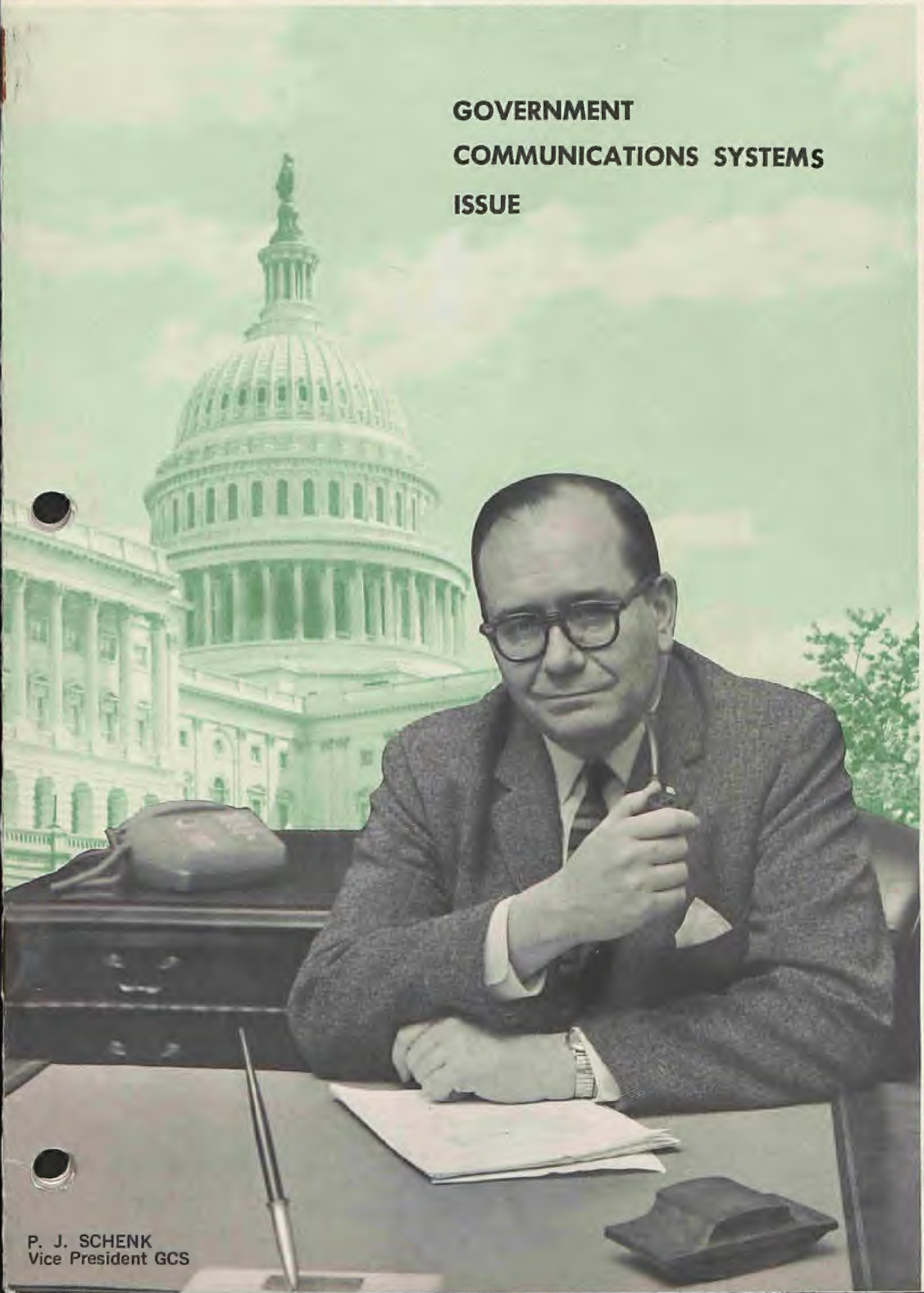
GOVERNMENT COMMUNICATIONS SYSTEMS ISSUE



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THE WESTERN UNION TECHNICAL REVIEW

Cover: The Government Communications Systems Department of Western Union located in Washington, D. C. is responsible for furnishing W.U. Systems and Services to agencies of the Federal Government.

The purpose of the TECHNICAL REVIEW is to present technological advances and their applications to communications.

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Technical Review

Volume 20
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JANUARY 1966

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The Federal Government, including the Department of Defense and the Civil Government Agencies, has many specialized and unique requirements for communications. Government communications must have very high reliability and must be immune to any form of catastrophic failure. They must operate in accordance with detailed specifications and routines. In spite of stringent operational requirements, Government communications systems are among the most advanced in the world and usually lead in the development and implementation of new communications concepts.

The Government Communications Systems Department has overall business management responsibility for furnishing Western Union systems and services to agencies of the Federal Government. GCS technical people work closely with their counterparts in government agencies to understand and, at times, to help develop requirements. They formulate conceptual system designs for applying Western Union's technology to the solution of government communications problems. Our colleagues in the Information Systems and Services Department support GCS by carrying out systems and equipment engineering.

government

We foresee an increasing need on the part of our Government customers for message-switched and circuit-switched data communications systems, together with high speed data terminals and transmission facilities. As Government operations become increasingly automated, we anticipate a greater interplay between data communications and other data processing functions.

The location of GCS Headquarters in Arlington, Virginia, in close proximity to the headquarters offices of most government agencies, provides an interface between the customer and those departments of our Company which are charged with providing the systems technical solutions, installation, maintenance, training, and accounting support.

GCS intends to provide the Federal Government with the most efficient data communications systems consistent with the capabilities of men and mechanisms. We look forward to a growing and profitable business and greater technical challenges for Western Union.

P J Schenk

P. J. SCHENK, VICE PRESIDENT
Government Communications Systems

high speed tape reader

—Stan A. Kirkowski

The tape transmitters used in early Western Union telegraphic systems were of the reciprocating pin variety where the sensing pins move in one direction seeking the information holes in the message tape and then retract, in conjunction with the advancement of the tape, to the next information character. To provide this reciprocating pin action in a tape transmitter, an elaborate and complicated mechanical system was required, plus motive power of sufficient magnitude to drive this system.

A comparison of the moving mechanisms used in reciprocating pin 24-B Transmitter and the star wheel 12080 Tape Reader is best illustrated in Figures 1 and 2. Compared to the Tape Reader, the 24-B Transmitter requires many more parts to perform the same tape reading operation. More parts in any unit require more adjustments, add to the weight of the unit, increase the cost of the unit, and decrease the reliability of the unit.

The need for elimination of these multicomponent mechanical systems of tape reading and their comparable heavy motors initiated the research that led to the development of Tape Reader 12080 with many less parts. It uses a simplified method of tape reading, and a new type of driving motor. A modification of the Tape Reader used in the AUTODIN system has been designated Tape Reader 12080.10.

Figure 1. 24-B Transmitter

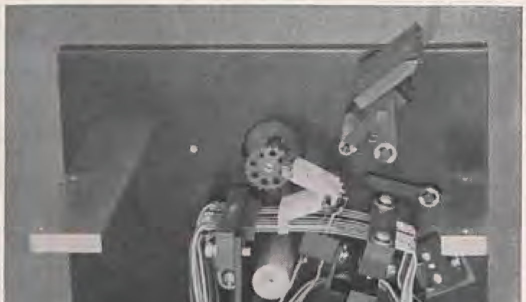

Figure 2. 12080 Tape Reader

Salient Features of the Tape Reader

Tape Reader 12080 is a high speed reader that provides parallel output of information from a tape.

The 12080 unit has the following fixed features: a feed sprocket wheel, "in-line" feed holes, star wheel sensing, the use of chad or chadless tape, a tight tape switch, tape-out sensing contacts, and a 50-point connector wired to accommodate all fixed and variable features. The variable features are: asynchronous parallel output to provide any output up to a rate of 200 characters per second, sensing for 5-, 6-, 7-, or 8 channel punched tape, tape stepping in either a unidirectional or bidirectional mode, and tape motion-sensing contacts.

In addition to the fixed features, Tape Reader 12080.10 has the following features selected from the variable group: operates at a rate of 10 characters per second, senses for 5-channel tape, has a unidirectional motor, and tape motion-sensing contacts. Tape Reader 12080.10 also has shielded wiring and the stepping motor is radiation shielded.

Stepping Motor

The Tape Reader is equipped with a single phase, high torque stepping motor which has two coils. The operation of the motor is similar to that of a polar relay, that is, the two coils are pulsed alternately. The motor shaft and sprocket wheel rotate 20 discrete steps per revolution and stop after each pulse in precise 18 degree increments. Each pulse transports the tape between two adjacent feed holes, a distance of 0.100″.

Stepping Circuits

There are many ways to drive the stepping motor, but laboratory investigation of various drive circuits indicated that two different circuits should be used. One circuit should be used for low speed operation (0 to 20 characters per second); the other for high speed operation (21 to 200 characters per second).

The low speed driving circuit consists of a capacitor and resistor which generate a pulse to step the motor for each charge or discharge portion of the cycle. The motor is effectively driven by a non-sinusoidal alternating current actuated by a polar relay. The capacitor and resistor are adjusted to provide critical damping.

The high speed driving circuit uses a pulse transformer which is driven by a flip-flop at its primary input. The secondary output will alternately turn on two transistors which drive the stepping motor coils. The "on" time for either power transistor is approximately 5 milliseconds (for operation at 200 steps/sec. or slower) and is determined by the number of laminations in the pulse transformer. Driven by a pulse transformer, a maximum rate of 300 steps per second "with load," and up to 500 steps per second "without load," is attainable with a proportional decrease in the power transistor "on" time. "With load" includes the damper, the feed wheel and the drag of the tape.

The stepping circuit for the 12080.10 Tape Reader (a variation of the high speed driving circuit) as it is applied in the AUTODIN system, is shown in Figure 3. (Even

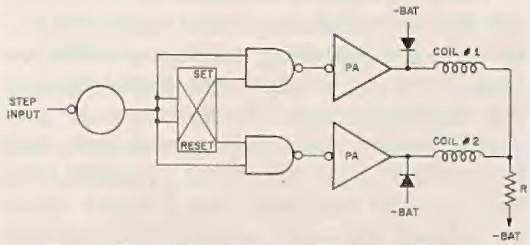

Figure 3. Schematic of Stepping Circuit

though the 12080.10 Tape Reader is considered a low speed reader, a high speed circuit was chosen to operate it because of future applications where the reading speed might be increased and the bidirectional mode might be utilized.) A train of step pulses applied to the input of the flip-flop is gated with the output of the flip-flop to energize alternately coils #1 and #2 of the stepping motor. A comparison of these pulses is shown in Figure 4. When the step pulses (A) are gated with the set output (B), the resultant energizing pulse applied to coil #1 is shown in (D). When the step pulses (A) are gated with the reset output (C), the resultant energizing pulse applied to coil #2 is shown in

(E). A common battery supply resistor (R) is used to prevent burnout of the coils, if failure of the circuit should leave both coils energized. If this condition should occur, the voltage across the coils will drop (in proportion to the relative magnitudes of R and the coil resistance) and yield a wattage dissipation well within the recommended safety value.

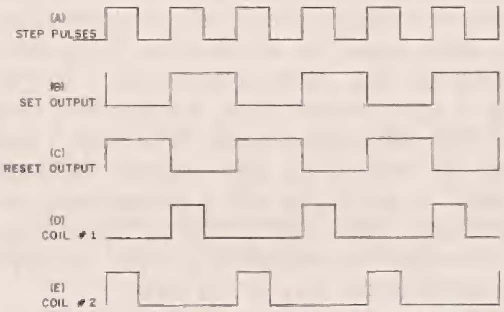

Figure 4. Train of Step Pulses applied to Flip-Flop

Tape Reading Contacts

The tape reading contacts in this reader are of the non-return-to-zero mode and operate in the following manner: 1) With no tape in the reader the sensing star wheels, the sensing levers (in the form of bell cranks made of insulating material), and the contact wires are in the upper or normally closed position. Two contact wires associated with each sensing level provide bifurcated contact operation. 2) With tape inserted under the tape lid, two conditions can occur: (a) When a no-hole condition is sensed, the star wheel rides the underside of the tape and the movable pair of contact wires are switched to the lower position as shown in Figure 5. (b) When a hole is sensed in the tape, the star wheel rises through the hole as shown in Figure 6 and the contact wires are switched upward to the upper position. Therefore, a closure to the upper contacts signifies a marking condition, and a closure to the lower contact signifies a spacing condition, and the contact assembly behaves as a form "C" contact. In addition a fine adjustment is built into the sensing wire block to produce the correct operating force for the sensing wires.

Tape-Out Pin

The end of tape is detected by a similarly shaped sensing lever that is equipped with a tape-out pin instead of a star wheel, and this tape-out pin rides the forward underside edge of the tape. When tape is latched under the tape lid, the tape depresses the tape-out pin and its lever. This lever switches the contact wires to the lower position and keeps the stepping circuit activated until the end of the tape passes over the tape-out pin. The tape-out pin then rises and opens the stepping circuit.

Tight Tape Switch

A tight tape condition to the tape reader is recognized by the tight tape roller, which is fastened to the tight tape arm, which in turn is pivoted in the tape lid bracket. With slack tape feeding into the Tape Reader, the tight tape roller, which rests on the moving tape, is in its lower position and the stepping circuit is in the operating position.

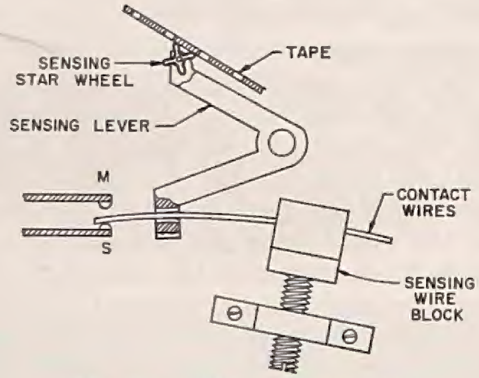

Figure 5. "No-hole" condition

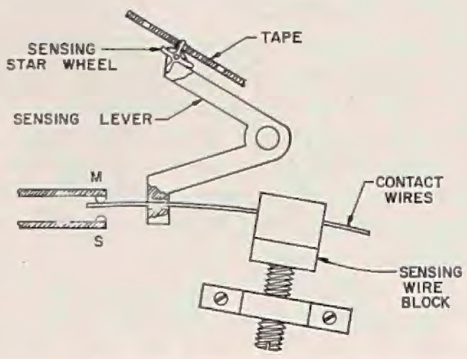

Figure 6. "Hole" condition

When a tight tape condition occurs, the tape raises the tight tape roller which rotates the switch lever against the switch arm located under the top plate, opening the stepping circuit. The transmission ceases until a slack tape condition again occurs.

Chad or Chadless Tape

When it was designed, Tape Reader 12080 was the only available tape reader employing star wheel sensing that could read chad or chadless tape. This was made possible by locating the sensing star wheels underneath the tape, rather than above it, so that the chads in the tape could be displaced upward.

Tape Motion Sensing

A special feature designed particularly for the AUTODIN Tape Reader is the motion sensing contact, shown in Figure 7.

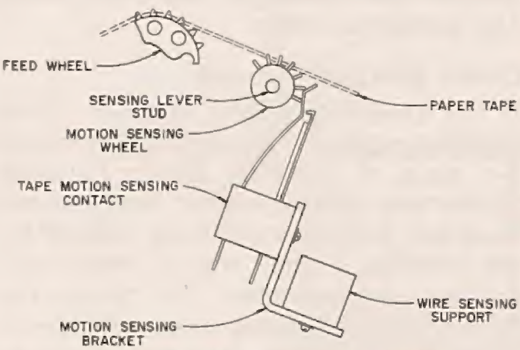

Figure 7. Tape Sensing Contact

The function of the motion sensing contact is to deliver an electrical pulse to the associated AUTODIN logic circuitry for every incremental step in the movement of the tape. The feed wheel pulls the tape. The tape, in turn, rotates the motion sensing wheel by means of engaging it in the feed holes of the tape. Thus, the rotation of the motion sensing wheel closes and opens the motion sensing contact as the tape is pulled hole by hole.

Potential for High Speed Reader

While the High Speed Tape Reader was first used in the AUTODIN program, it has many applications in other systems, both old and new installations. The Tape Reader is a light, compact, low-cost unit. It is extremely versatile, reliable, and almost free of maintenance. Because of its high speed capability, it has been selected for operation in the EDAC (Error Detection Automatic Correction) system. Consideration is also being given to the Tape Reader for use in the Plan 38 Switching System.

Acknowledgements

The author wishes to acknowledge the contributions of Mr. W. V. Johnson, Senior Engineer and Mr. Vincent Chan, Project Engineer, who were responsible for the design of the first prototype of Tape Reader, 12080.

STAN A. KIRKOWSKI, Senior Project Engineer in the Information Systems and Services Department, has specialized in mechanical equipment design for the company.

He received his Mechanical Engineering degree in 1950, and a Masters Degree in Industrial Engineering, majoring in Business Management in 1958, from Stevens Institute of Technology.

He joined Western Union in June of 1954 and from then through 1957 designed original equipment for the Apparatus Engineer and the Ocean Cable Division. He later was engaged in the development and engineering of the automatic switching systems for Plans 57 and 59. Mr. Kirkowski was responsible for the development of the Telegraphic Projector, the Chad Disposal Unit and the Tape Neck Belt Drive. He holds one patent and has several others pending.

ars

advanced record system

—Donald E. Carruth

In January 1966, Western Union completed for GSA, General Services Administration, a new network for the transmission of data and teleprinter information, known as ARS, the Advanced Record System. This system provides a single, integrated common-user record communication system for Federal agencies. It ties together over 1,600 teleprinter terminals located in more than 600 cities throughout the United States. It is also capable of handling wideband communications among government subscribers using appropriate high-speed data terminals.

In order to transmit messages and data information in "real time" from user to user, a Circuit Switch Network (CSN) is provided. In order to transmit multiple address messages and to provide interconnection with other existing telecommunications systems, a group of Message Switching Centers (MSC) are provided to perform the "store and forward" function of the ARS. Thus, the ARS is a combined network composed of a nation-wide automatic Circuit Switching Network (CSN) and three automatic Message Switching Centers (MSC).

The system provides subscribers with point-to-point transmission and receipt of the conventional teleprinter messages, as well as a medium for handling data information from magnetic tape, punched cards, facsimile, or other terminal devices. Thus, these subscribers are offered the full range of message switching services provided by Western Union.

As part of the Federal Telecommunication System, the Advanced Record System will meet all forseeable future agency requirements for services such as teleprinter, high-speed data, facsimile, and special voice service, on both a day-to-day and emergency basis.

Circuit Switching Network

The Circuit Switching Network (CSN) handles message transmission through two types of switching centers: junction offices and district offices. Both narrowband and wideband switching capabilities are provided in each type of office. Subscribers communicating directly via the Circuit Switch Network must use speed- and code-compatible machines. Communication between non-compatible machines involves the use of an MSC in conjunction with the CSN.

Initially, the CSN consists of three junction offices (high echelon centers) and twenty-four district offices (low echelon centers) located throughout the country. All junction offices (J/Os) have interconnecting trunk groups and each district office (D/O) has separate trunk groups to two of the three junction offices. Under the present trunking configuration, the Central Junction Office has separate trunk groups to all junction and district offices in the system. Initially, the transmission link between junction offices is inherently wideband; however, part of it is channelized down to voice bandwidth (4 KC) circuits. Some of these circuits are further channelized down to handle the narrowband (teleprinter) traffic at transmission rates up to 150 bauds.

The junction and district offices are designed to switch both narrow and wideband channels at each location. For the sake of economy and convenience all three junction offices (and their respective MSCs) are co-located with the Western Union microwave transmission network junction points. Thus, this network can supply the necessary bandwidth for either narrowband or wideband transmission.

Common control equipment is provided in both junction and district offices, and it is shared by both the wideband and narrowband switching portions of each office. The common control equipments mentioned throughout the following text material perform the various functions of message path scanning, selection, and ultimately, subscriber to subscriber connections.

of the other two J/Os by appropriately-sized trunk groups. Separate trunk groups of suitable bandwidth are provided for both narrowband and wideband traffic, since the design of the offices provides separate switching matrices for each type of service. This arrangement requires that each D/O be connected by two trunk groups (one narrowband and one wideband) to its primary (usually closest) J/O. Similarly, each D/O is connected to the central J/O to provide an alternate routing capability and to enhance system reliability.

Groups of dedicated trunks of suitable bandwidth are used for communication between the MSC and the CSN at the junction sites. Narrowband trunks for subscribers using Baudot code and ASCII are provided in accordance with corresponding traffic requirements. Presently, there are no wideband subscribers served by the MSC via the CSN. Thus, there are no

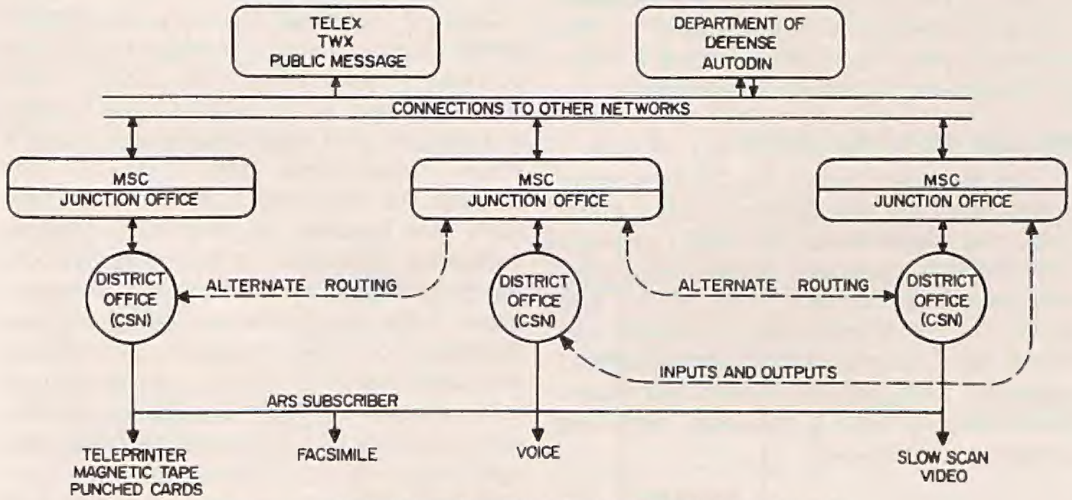

Figure 1. Overall Configuration for Advanced Record System

Interconnections of CSN with MSC

Figure 1 shows the overall configuration of the ARS, and illustrates the interconnections between the MSCs, the junction offices (J/Os), and the district offices (D/Os) and the CSN. Each MSC is connected to each of the other two MSCs by a full-duplex 2400-bit per second dedicated channel, employing AUTODIN-type line coordination and signaling methods. Similarly, each J/O is connected to each

wideband trunks between the MSCs and their respective co-located J/Os. As stated above, the MSC-J/O sites are located at the junction points of the Western Union transcontinental Microwave System; the eastern site is located at Romney, West Virginia, the central site at Berwick, Kansas and the western site at Mt. Aukum, California. These sites are provided with emergence no-break power equipment and living accommodations for GSA operating

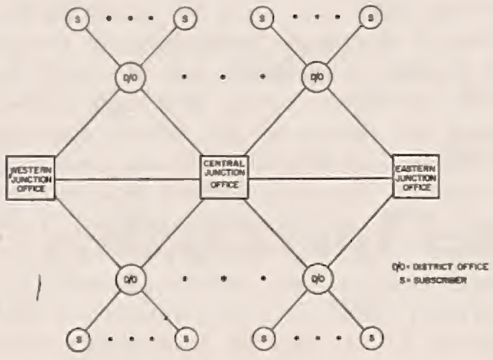

Figure 2. Interconnection of Junction Office with District Office and Subscriber

personnel. They are located outside prime target areas and are specially constructed to minimize radiation exposure to personnel and equipment.

Subscribers gain access to the CSN by means of D/Os. Figure 2 shows the central J/O and a representative group of D/Os and subscribers. Subscribers gain access to the MSCs via the CSN. However direct connection of subscribers to the MSCs is permitted. An example of this is a dedicated wideband subscriber.

Message Switching Center

The Message Switching Centers serve subscribers via the CSN, providing them with the capabilities of book message transmission, code and speed conversion, and deferred delivery. The MSCs also serve as the interconnection points between the ARS and other communications networks, and perform the ancillary functions necessary in a message switching system.

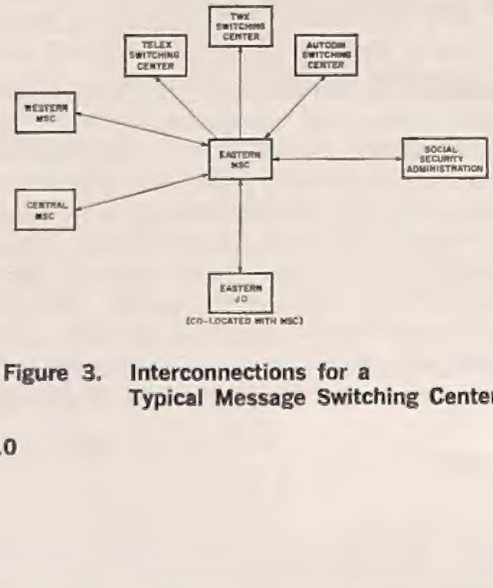

Figure 3. Interconnections for a Typical Message Switching Center

Figure 3 illustrates the interconnections for a typical Message Switching Center, the Eastern MSC. Two-way communication is indicated between this Eastern MSC and each of the other two MSCs, an AUTODIN Switching Center, and the co-located junction office. A special dedicated full-duplex 2400-bit per second connection to the Social Security Administration located in Baltimore is also provided at this MSC and at the Central MSC. Outgoing-only trunks to nearby Telex and TWX switching centers provide refile capability into these networks. Refile into Western Union's public message system is also possible. This capability is provided as a manual refile by means of Model 35 ASR teleprinters located in strategically placed Western Union Public Message Offices.

District and Junction Offices

Common control equipment adequate to provide an overall 1-percent grade of service is provided in both junction and district offices. It is shared by both the (broadband) wideband and narrowband switching portions of each office. The common control equipment in the J/Os is more sophisticated than that in D/Os. Figures 4 and 5 show, respectively, the message flow through the D/O and J/O. The J/Os perform the function of long haul tandem switching, analogous to toll-center switching in a telephone network. In addition, these J/Os are connected by direct ties (trunks) to their respective collocated message switches. The D/Os, with their less complex common control equipment, are necessary to concentrate the relatively light subscriber line traffic for more economical trunk usage, and to permit flexible connections of these trunks to any line. They also serve, by means of link circuits, to make the necessary connections for local calls.

The additional capabilities of the common control equipment at each J/O permit the examination of a number of alternate routes to find suitable paths within the network to handle overflow traffic. In addition, the common control at a J/O monitors the setting up of the connection all the way to the termination D/O or MSC.

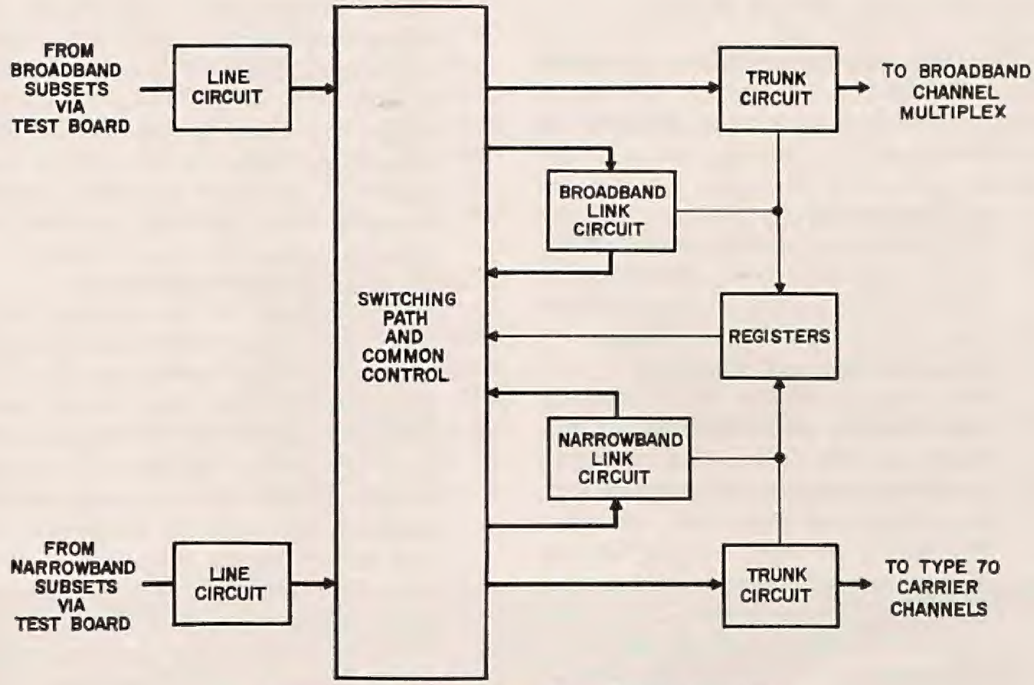

Figure 4. Message Flow Through District Office

Should the connection fail to be set up correctly, because of abnormal conditions in the transmission network or other reasons, the J/O attempts the call several times, each time over an alternate route. All available routes are tried in order to get the call through to its destination. These operations are carried on at high speed by electronic circuitry without the need for any re-initiation by the subscriber.

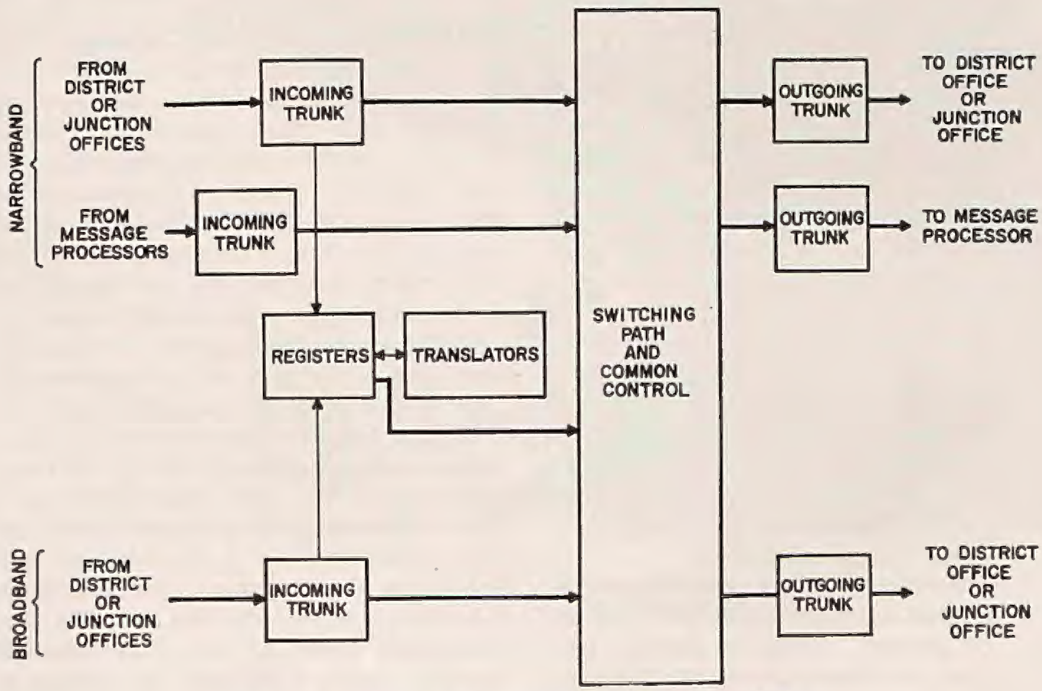

Figure 5. Message Flow Through the Junction Office

Special Features of CSN Design

The CSN equipment has been designed and manufactured by the Federal Laboratories of IT&T. The special features of the design are:

- ***Solid State Circuits***
  The CSN is composed principally of solid state electronic switching circuits; cross points in the matrices are glass-enclosed reed relays.
- ***Expandability and Flexibility***
  Particular emphasis was placed on expandability and flexibility in the design of the CSN. Plug-in matrix modules are employed for the switching arrays and most other circuitry. The wiring changes needed for expansion within the common controls are minimized by providing independently-wired sub-racks that are interconnected by means of plug-in cables. Inter-bay wiring is also accomplished by means of plug-in cables so that additional racks can be added at minimum cost and effort as the office expands. The design also allows relatively easy modification of the offices to incorporate additional capabilities, as described in more detail later in this article.
- ***Message Protection***
  In order to insure message protection, an answerback checking capability is included in the design of the switching offices. The sending subscriber initiates a WRU sequence both before and after message transmission. A confirming "Answerback" from the called subscriber is received and recorded at the beginning and end of the message, insuring that the connection was good both before and after the message transmission, and that the desired party was reached. The answerback checking is performed in the sending D/O.
- ***Many Classes of Service***
  The offices also are instrumented for a large number of different "classes of service." Class of Service indicates the type of terminal equipment to assure compatibility of calling and called outstations. Assignments of subscriber lines to a class of service are programmable by means of plug boards. This allows great flexibility within the CSN. It also allows for subscribers with a community of interest to be given the same class marking, thus creating, in effect, a network within the total network.
- ***Pre-Programmed Plug Boards***
  Reconfiguration of the network (for class of service, alternate routing, or other options) can be done quickly in emergency or other critical situations by means of pre-programmed plug boards. As many of these as are needed can be prepared in advance and held in readiness. A new board can be installed in less than one minute's time.
- ***Status Indicators***
  Both J/Os and D/Os are equipped with status indicators for all major units of equipment. Failures of equipment to set up connections are displayed on a trouble indicator panel. Also, a comprehensive system of audible and visual alarms continuously monitor the switching system equipment.

Components of MSC

The Message Switching Center provides the necessary computation, data storage, control, and input/output capabilities needed to perform the required ARS message switching functions. The heart of the MSC is the UNIVAC 418 Real Time Processor. Figure 6 is a photograph of a 418 installation; it shows the processor, the console subsystem, the 1004 Printer and Card Processor, the magnetic tape subsystem, and a number of Communications Line Terminal (CLT) cabinets. The 418 Processor controls the computation, Input-Output, and storage tasks for the Message Switching Center. The 1004 serves as a high speed printer for error and status logging, while the drum is the in-transit storage device. The tape transports contain the several journal records. The DLT, CLT, and Multiplexer units perform the interface function required between the processor and the several communication lines.

Figure 7 is a block diagram of the hardware of the MSC, showing the interconnection of the equipments. Exact quantities of each peripheral unit, connected to the central processor are indicated. The software of the MSC constitutes the computer programs, operation manuals, training and maintenance manuals and test procedures.

The hardware and software complements for each of the three MSCs are essentially the same. The chief difference is in the number of units of communication line terminal (CLT) equipment. This number is determined by the trunking requirements between each MSC and its collocated J/O. Thus, the make up of each complement (1) permits any single MSC to handle all of the network message switching tasks during periods of light traffic, (2) allows any one MSC to serve as a back-up to the other two during maintenance periods, (3) results in efficiencies in operation and programming and (4) simplifies personnel training.

The major capabilities of the MSC's include:

- Book message delivery
- Speed and code conversion
- Deferred delivery
- Interconnection to foreign networks
- Message accounting and analysis

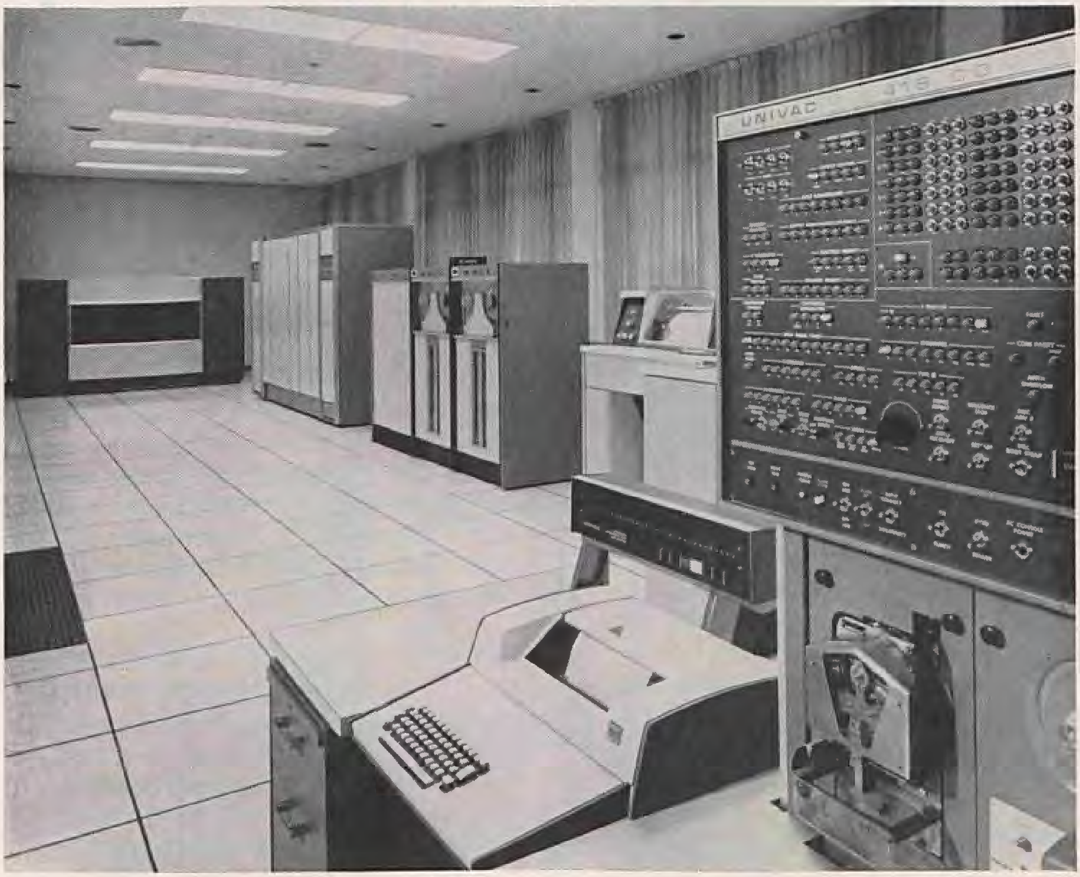

Figure 6. Typical Message Switching Center

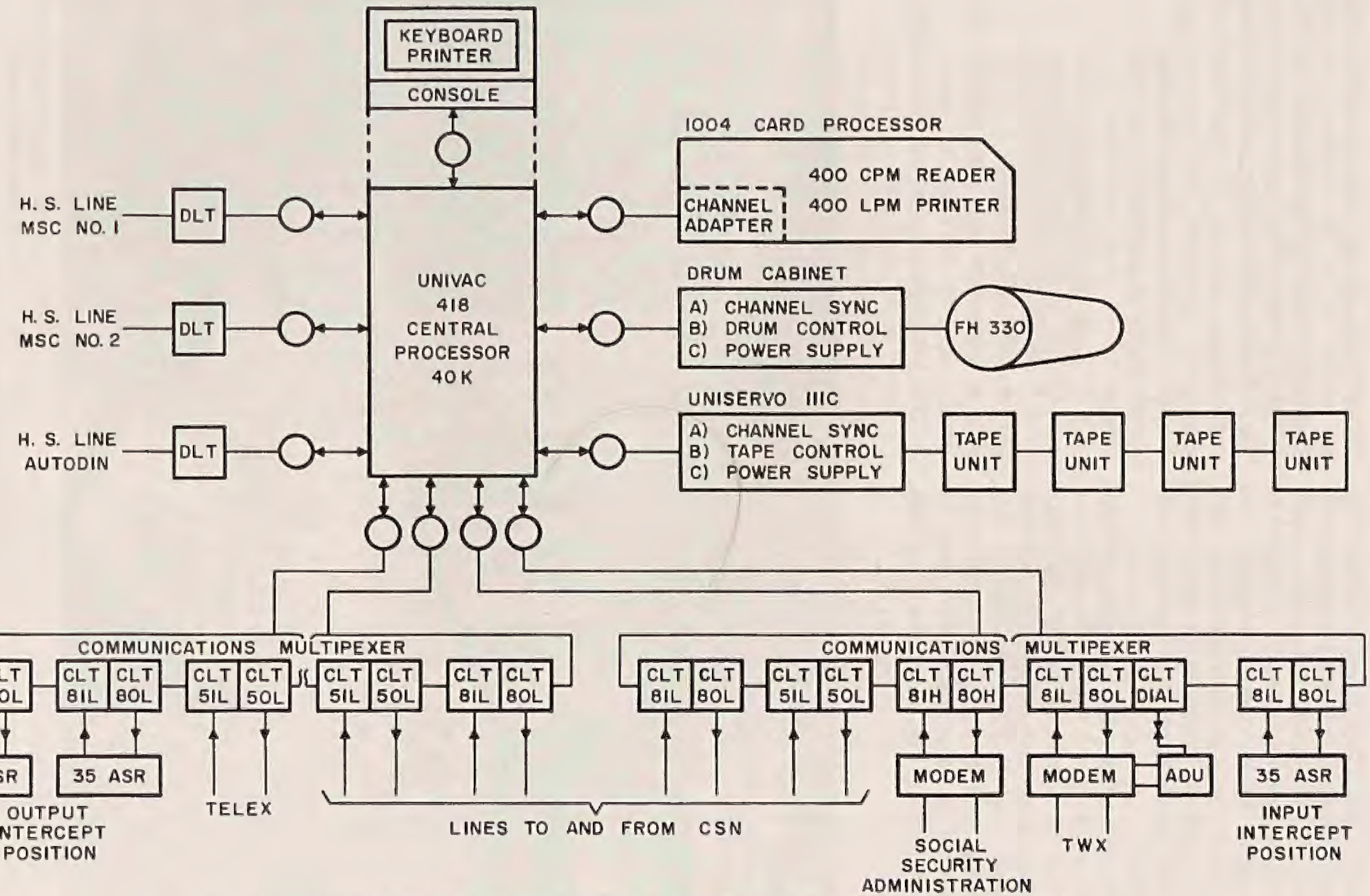

Figure 7. Block Diagram of Interconnections of Components in Message Switching Center

Operation of ARS

The MSC receives traffic addressed to it via the CSN as does an ordinary teleprinter subscriber. After the connection is set-up, the MSC delivers its answerback to the sender, receives and stores the message, again delivers its answerback, and finally effects a disconnect. The processor then proceeds to call, via the CSN, the one or more addresses and make delivery to them. As before, the answerback checks are made both before and after the transmission. The processor makes the necessary speed, code, and format conversions required by each addressee. It also performs necessary journalling, error detection, validation, supervisory and retrieval services as required.

An outline of the operation of the system follows in a description of the types of calls made in the system.

Types of Calls

Calls made within the Circuit Switch Network (CSN) may be classified as either broadband or narrowband in nature. For communication within the CSN, the narrowband mode of operation is used. This type of transmission does not exceed 75 baud for Baudot machines or 110 baud for ASCII machines, therefore it is considered to be narrowband. Since the point of separation between wideband and narrowband transmission for the system has been chosen as 150 baud, facsimile, voice and high speed data transmissions are referred to as wideband or broadband. These transmissions will use rates from 150 baud up to a maximum of 36 kilobits per second.

a) **Narrowband Call Between Subscribers in Same (DO)**
A subscriber establishes a connection to another subscriber by requesting a connection to the district office. If a line is available, a connection is made to the control equipment. Connection to a district office provides signaling which allows the calling subscriber to proceed with the desired subscriber's address code. Comparisons are made at the district office to verify the compatibility of the called and calling machines. After verification and seizure of the called subscriber's line and equipment, the district office transmits the "Who Are You" challenge, to which the called subscriber equipment automatically replies with the programmed "Answer-Back."

b) **Narrowband Call to a Subscriber in a Distant District Office via an Alternate Junction Office**
This type of call starts with the same initial steps given in the previous call (a). Beyond these steps, which established the connection to the originating district office, the call attempt is made to the preferred junction office which normally serves both subscribers. If the call path from this junction to the final district is busy, the call is passed through the preferred office to a second or alternate junction office.

c) **Narrowband Call to an MSC**
The process of setting up the district subscriber line to the junction office is as follows: The calling subscriber forwards an MSC address code, and a junction office trunk is seized. Class of service information is then sent via the trunk and stored at the junction office. Assuming that the addressed MSC is directly connected to this junction office, common controls there seize a trunk connected to the MSC.

d) **Narrowband Call from MSC**
When an MSC operator places a call to a subscriber through the co-located junction and district offices, a connection to the junction office equipment signals the MSC that such a connection has been established. Recognition of this type of call and the resulting junction office signaling, is followed by MSC to junction signaling of subscribers address information.

A more detailed description of these calls will be published in a subsequent article on the Circuit Switch Network, which will appear in the April 1966 issue of the TECHNICAL REVIEW.

Computer Programs

The computer programs for the MSC consist of an Executive Program, an Operational Program, a Utility Program, and a Facility Program. The four programs are closely inter-related in function.

The Executive Program controls and sequences the Operational and Facility Programs and the major portions of the Utility Program. The Operational Program, working under executive control performs the real time message processing. The Utility Program performs general data handling operations such as printing tapes and assembling programs. The Facility Program provides "system assurance"; it creates test message data, furnishes that data to the Operational Program and records and reduces the test results. Thus, it is an exerciser of the other three programs.

The Operational Program performs the on-line message handling functions under executive control as described above. The Executive Program may remain functional during the time that the MSC is not responsible for switching messages. Upon supervisory request it may call from tape and initiate programs of the Utility Program. It controls the various Utility Programs operating concurrently with any other portion of the system.

The Facility Program is a specialized set of software tools designed to exercise the Operational Program for testing purposes. The Facility Program consists of input message tape generation, operational interface and report generation routines. The functions are under control of the Executive Program in testing the operational routines when the MSC is not responsible for on-line switching of messages.

The Executive Program also reacts to the call of the computer operator, and in conjunction with the Operational Program, restores the MSC to a message-switching condition. The normal Start-up procedure, or the more extraordinary Recovery/Start-over programs, are the means by which this is accomplished.

An occasionally-used mode of MSC operation involves concurrent operation of the Operational Program with a portion of the Utility Program. Use of this mode is usually restricted to periods of light message traffic. In this mode, the Executive Program gives first priority to the Operational Program by sequencing its outstanding tasks and I/O requests ahead of the corresponding utility tasks and I/O requests. The utility routines occupy an overlay area in core at this time.

The total program package occupies about 40,000 words of core storage. The UNIVAC 418 processor has a capacity of over 65,000 words, allowing for considerable future program expansion.

Terminal Equipments

Terminal equipments in ARS may be narrowband or broadband:

Narrowband

—if they operate at data rates of 150 bits per second or less, and

Wideband

—if they operate at data rates higher than 150 bits per second.

The most common narrowband terminal units used in ARS are teleprinters. Model 33 or 35 ASR units are used for subscribers who require ASCII code, while Model 28 or 32 units serve Baudot code subscribers. Low-speed punched card and paper tape terminals can also be used as narrowband ARS terminal equipment. Wideband subscribers of ARS may employ any known terminal device which will operate within 48 kc bandwidth. Of course, network signaling standards must be observed. Thus, terminal devices employing such media as high speed punched cards, paper tape, hard copy, magnetic tape are readily accommodated. Voice, facsimile and slow-scan video terminals can also be handled.

Broadband Switching Capabilities

Broadband switching capability is achieved in the wideband portion of the CSN, in conjunction with appropriate wideband facilities. ARS provides a high grade, data-voice transmission network within the system. It also provides a time measured service to its agency customers on a call-up basis. Users of facsimile, high speed data terminals or data processing machines may establish voice or automatically coordinated connections to send and receive data via the CSN. Voice instruments establish the initial connection between stations, provide voice communication, and coordinate the subsequent use of the communication path for transmission of high speed data and/or facsimile. This system allows for selective switching between agency customers; consequently, customers are billed only for the line time used. Initially, the system is capable of switching circuits of 4-, 8-, 16- or 48 kc bandwidth on a four wire basis. With the addition of special switching matrices, the offices will be able to switch even higher bandwidths.

Local circuits will be extended to subscribers on a four-wire basis. These circuits will be engineered for the specific bandwidth requirements of the agency customer. Automatic safeguards will be included to insure that non-compatible subscribers will not be connected. Suitable indications of unsuccessful calls will also be provided.

Additional Capabilities

The ARS hardware and software are modular in design so that expansion, or addition of new capabilities is easy. For instance, new message switching and circuit switching services, or new types of terminal equipment can be readily added. Specific additional capabilities include:

- Extended Geographic Coverage
- Greater Traffic Capacity
- Conference and Broadcast Capabilities
- Hot/Line Services
- Abbreviated Keying
- Touch-tone 4-wire Subsets
- Data File Storage and Retrieval
- Real Time Computer Inquiry
- Computer-to-Computer Transmission
- Automatic Terminal Equipment Control
- Special Trunks for High Volume Users
- Facsimile and Other High Speed Terminals

Acknowledgements

The author wishes to acknowledge gratitude to Mr. B. Rider for his guidance and direction in assembling the information for this article—and to Mr. R. H. Leonard and his staff who were responsible for the system design of ARS.

DONALD E. CARRUTH, Director Computer Systems in the Government Communications Systems Department, is responsible for the hardware and software aspects of the computer-controlled communications systems produced for government agencies. Previously, he served as Program Manager for the Advanced Record System.

Prior to joining Western Union in 1964, Mr. Carruth was Manager of the Digital Command Department at Litton Industries. He was responsible for the marketing and engineering activities related to real-time computer systems.

His managerial and technical experience in communications has involved both message switching systems and ground-to-satellite radio links controlled by computers.

Mr. Carruth received a BSEE degree from the University of Maryland in 1957.

form-feed message delivery system

—John R. Cowan

The USAF Form-Feed Message Delivery System was developed by Western Union for use in the Air Force Communications Center at the Pentagon in Washington, D. C. Many messages received in this Communications Center require distribution to more than one addressee. The Form-Feed Message Delivery System is used to automate the in-office handling of these messages and speed their delivery to the recipient.

Figure 1. Operating Table for Form Feed Message Delivery System

Problems on Delivery

Prior to installation of the Form-Feed Message Delivery System, messages were received on printed-perforated tape, and retransmitted into a teleprinter equipped with a roll of multilith paper. The messages were manually watched as they were transcribed to the multilith to insure that no more than 20 lines of text were printed within certain boundaries of the roll of paper. When 20 lines were printed, the paper was torn out of the teleprinter as a sheet. Heading and ending information was manually placed on each sheet. The sheet was then given to the reproduction staff for compiling the necessary copies for distribution. This handling between the time of receipt of the message in the Communications Center and its delivery to the reproduction staff caused unacceptable delay in getting the information to its recipients.

In order to reduce message processing time and to automate the message delivery system, Western Union developed a system which would transmit a preset maximum number of lines of text to a fan-fold, perforated continuous sheet of multilith paper. These perforations permit the continuous sheet to be separated into separate pages. A message received in this manner could then be reproduced by placing these individual, multilith pages directly in the reproducing machine with no manual cutting, editing, pasting or other such handling of the paper. The resultant efficiency reduces the number of personnel required to handle the messages and also reduces the time between receipt of the message in the Communications Center and its final reproduction and delivery.

Components

The USAF Form-Feed Message Delivery System is comprised of an Operating Table and a special Teleprinter Console. The Operating Table transmits to, and controls the Teleprinter Console. The Teleprinter Console houses the receiving teleprinter and the mechanism which feeds out the individual sheets of multilith paper.

a) Operating Table
This Operating Table comprises an LBXD-2 Transmitter-Distributor, an Automatic Message Numbering Machine, a KSR Monitor Teleprinter and a Card Chassis, as illustrated in Figure 1. The Card Chassis contains forty-three Western Union standard transistorized logic cards, the low-voltage power supplies and associated transmitting relays. The logic circuits perform all the functions required to read and control the message tape and to control what is transmitted to the line.

b) Teleprinter Console
Teleprinter Console 12177-A, shown in Figure 2, is the receiving terminal of the system. The console houses a 100 wpm Model 28 Teleprinter, a Stunt Box, a "Form-Feed" mechanism, and a Wiring Cabinet. A box of perforated fan-fold, standard-size sheets of multilith paper is stored in the bottom of the console and are fed through the back of the teleprinter to the sprocket-fed platen. The Stunt Box is coded so that a pair of contacts close when the "Form-Feed" sequence, [consisting of four consecutive carriage-return characters (CR)], is received from the Operating Table. The closing of the contacts causes a rotary solenoid to energize and activate the "Form-Feed" mechanism, which places a new sheet of paper in the teleprinter.

Figure 2. Teleprinter Console

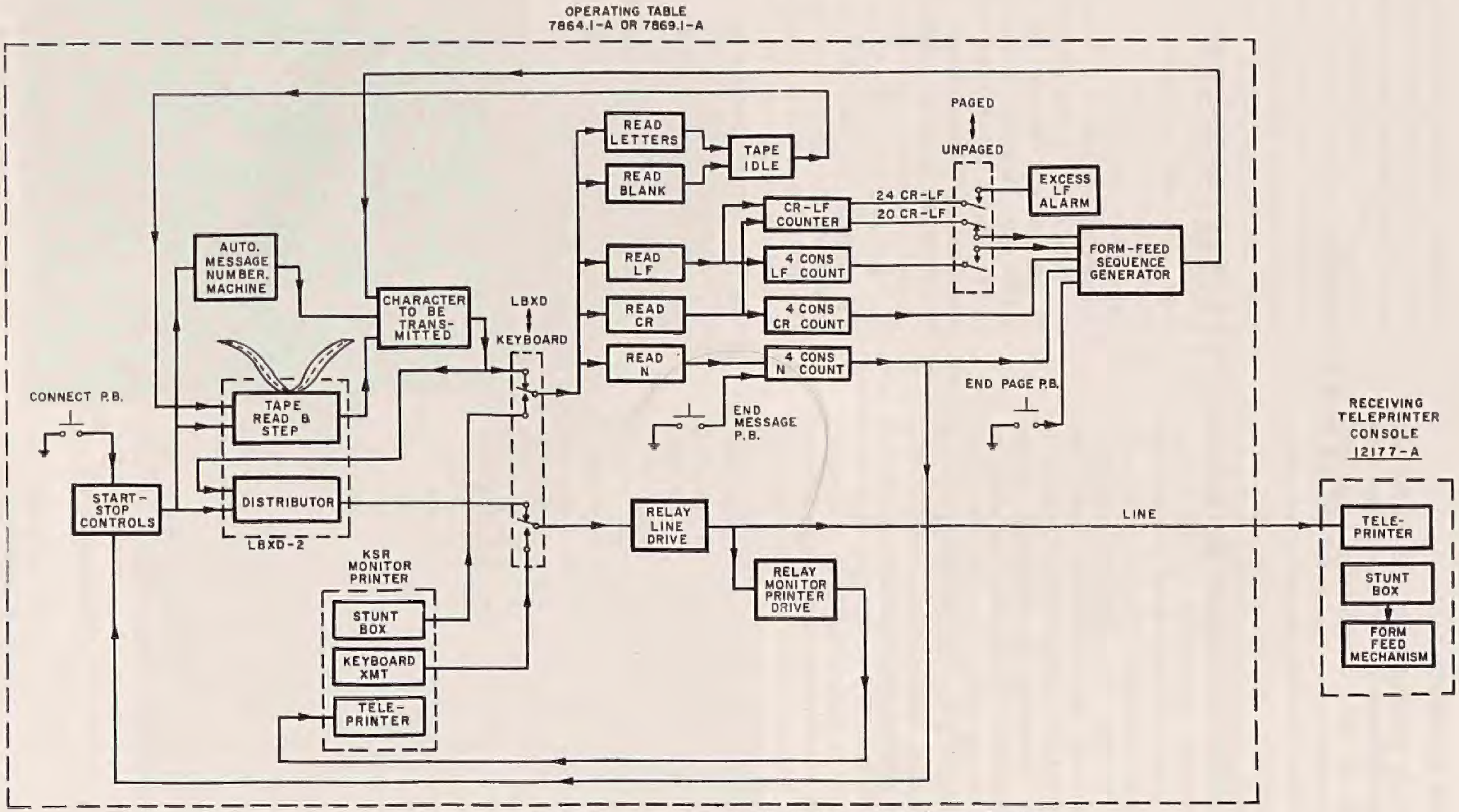

Figure 2. Block Diagram of Form-Feed Message Delivery System

Operation

A block diagram of the system operation is shown in Figure 3. When the perforated tape is placed in the LBXD-2 Transmitter-Distributor, it reads and "idles past" all LETTERS and BLANK characters and stops on the first character of the message. When the CONNECT pushbutton is pressed, the table functions begin with a message number being transmitted from the Automatic Message Numbering Machine. After the message number is completed, the message on the tape is transmitted to the line. The reading of four consecutive N characters (End-of-Message sequence) in the tape causes the Operating Table to terminate transmission and reset the table circuitry.

The automatic numbering machine precedes each message with a sequential number. This is a safeguard which precludes the possibility of loosing a message due to line or equipment failures. Four characters can be easily coded to precede the number as desired by the customer.

The tape must be stopped at various times during message transmission in order to automatically transmit the "Form-Feed" sequence which consists of four consecutive CRs. This sequence causes the receiving Teleprinter Console to feed out a new sheet of multilith paper. The conditions which will cause the automatic transmission of four consecutive CRs are as follows:

a) Transmission of four consecutive LFs, if the Operating Table is in the "PAGED" mode. (Four consecutive LFs indicate a page number will follow.)

b) Transmission of twenty lines of the message, if the Operating Table is in the "UNPAGED" mode.

c) Transmission of four consecutive Ns (End-of-Message sequence.)

The four Line Feed (LF) characters and four End-of-Message (N) characters are read by means of independent solid state shift registers. The twenty Line Feed characters are read by a 5-stage binary counter.

After the automatic transmission of four consecutive CRs, there is a four second pause before message transmission is allowed to resume. This pause prevents the transmission of characters while the receiving teleprinter feeds out a new sheet of multilith paper.

By means of a manual switch the table can be set up to operate in either the PAGED or UNPAGED mode.

a) PAGED Mode

The Operating Table is placed in the "PAGED" mode of operation if the messages which are to be transmitted are in such a form that after twenty-four lines or less of message text, a series of four or more LF characters occur which are followed by a page number. In the old system, the four or more consecutive LFs provided a space in which to separate the continuous roll of multilith paper to form individual pages of the message with the page number at the top of each sheet. In the new USAF Delivery System, under normal operating conditions, the number of lines of message text which is transmitted to one page of multilith paper will vary from one to twenty-four lines, depending on where the four consecutive LFs and page designation occur. If twenty-four lines of text are transmitted on one page before transmission of four or more consecutive LFs, then transmission will be stopped and an alarm sounded. Transmission will be resumed after the "END PAGE" pushbutton is pressed. This silences the alarm and automatically transmits four consecutive CRs.

b) UNPAGED Mode

The Operating Table is placed in the "UNPAGED" mode of operation if the messages which are to be transmitted have no page separation or page numbering as mentioned above. In this case the number of lines of message text which are transmitted to one page of multilith paper will always be twenty lines with the possible exception of the last page.

Excess Line Feeds are deleted from transmission. This insures an even twenty lines of text on each page.

Flexibility of System

Eight systems of the original version were put into operation for the Air Force and six new systems will be installed in the Joint Chiefs of Staff Communications Center. The Form Feed Message Delivery System has proven to be a tremendous asset in expediting the delivery of Communications Center messages. Further, the flexibility of the equipment lends itself to almost any type of installation.

A new, more advanced version of the system has just been engineered for general Communications Center use. This new system incorporates all the features available in the previous system and in addition provides the following:

a) Line Signal adaptation to either make-break (neutral) signals or polar signals.

b) "PAGED" messages can be sent in the "UNPAGED" mode. When this option is used, the page designations appearing in the message tape will be automatically deleted from the final received copy. Each page will contain an equal number of 20 lines of information. The last page may contain less than 20 lines.

c) Text "overlining" is prevented by insuring that a transmitted carriage return character is followed by a Line Feed Character.

d) A tape reperforator is located at the Operating Table to provide a continuous perforated tape of all transmitted messages. (This item is included at the customer's option.) The tape may be used if re-runs of messages are required.

Unique Feature

The unique feature of this system is the absence of any control wires between the Operating Table and the remote Receiving Teleprinter. The Receiving Teleprinter is controlled entirely by means of characters transmitted over the one sending line.

An "END OF MESSAGE" pushbutton is provided at the Operating Table which will automatically transmit the four consecutive CRs and disconnect the Operating Table from the line if a message is incomplete.

A "KBD-IN" switch is provided which allows transmission to the line to originate from the KSR Monitor Printer keyboard. Characters which are transmitted from the keyboard are recognized and counted where necessary. The keyboard is primarily used for correcting errors in the tape.

Figure 4. Advanced Version of Operating Table

JOHN COWAN was a Senior Project Engineer in the Information Systems and Services Department. He joined Western Union in June, 1960 and had been engaged primarily in the design of Solid-State Switching Systems. Some of the projects he had been associated with are EDAC, TELTEX, Optical Character Reader, On-Line Translator, and various Reperforator Switching Systems.

Mr. Cowan was a Radio Technician in the U. S. Army Signal Corps in 1957-58 and received his BEE degree from Pratt Institute in 1960.

Mr. Cowan is no longer employed by Western Union. His work on the U.S.A.F. Message Delivery System is being continued by his supervisor, Mr. R. K. Lewis, Jr.

western union technical review

—Mary C. Killilea

Our Company's technical publication serves the Federal Government in documenting for it the growth of Western Union in the field of record and voice telecommunications. It also bridges the transition of our Company's growth from this field of telecommunications, to its future role in the Information Revolution.

The Western Union TECHNICAL REVIEW enters its 20th volume with this issue, January 1966. It has grown from an in-company publication to one of world-wide readership. This issue will be mailed to subscribers in 19 countries outside the United States. These readers are subscribers who request our publication because of the educational material it publishes in the areas of our public and private message services.

Originally, the publication was written for and distributed to management, supervisory and engineering personnel at headquarters and in the field. A few copies were distributed to transportation people because of our interests in their rights-of-way. The circulation of the first issue, Vol. 1, No. 1, July 1947—was 2047 copies. The anticipated circulation of this issue, Vol. 20, No. 1, January 1966 is about 10,000 copies. Our audited readership has grown from approximately 2,000 to over 8,000 copies—a 400 percent increase.

Our technical publication is basically printed for our Western Union personnel, for the purpose of presenting technological advances and their application to the broad field of communications. It is published quarterly by the Information Systems and Services Department in January, April, July and October. Because of its educational value, about 10 percent of the circulation is distributed to universities and colleges, to technical libraries in related companies in industry and to many agencies of the Federal Government. Because of the interest of many of Western Union's customers in our public and private services, about 8 percent of our circulation is also distributed to our customers at a paid subscription rate. These paid subscribers are interested in our technical publication, so that they, too, may be educated in our technological advances and their application to our services. The growth in our paid subscriptions has increased over 200 percent since 1962.

The success and the growth of Western Union's TECHNICAL REVIEW is best illustrated in the number of "Letters to the Editor" received daily, from our readership—and to the recognition of Western Union's management in our capability to "Serve."

The Editor

autodin
—conus expansion

—HAROLD F. CALEY AND

FRED W. SCHULTZ

The AUTODIN system, designed and developed by Western Union with the support of RCA, IBM and many other electronic companies, was made operational in early 1962.[1 2 3] Since then, many new features and capabilities have been added under the direction of the Defense Communications Agency (DCA). The expansion of the domestic portion of the AUTODIN system, AUTODIN-CONUS, will be described in this article. The expansion of the overseas portion of the AUTODIN System will be described in another article on page 34 of this January 1966 issue. Some of the management techniques employed to insure the technical adequacy and the timely implementation of the overall system will be included.

AUTODIN-CONUS

AUTODIN is the world's largest computer-controlled communications system operated for and managed by the DCA. It provides both direct user-to-user and store-and-forward communications service for the Department of Defense and other government agencies.

The original AUTODIN network consisted of five switching centers each serving a group of tributaries and interconnected by high speed trunks or intra- and inter-area exchange of traffic. Figure 1 illustrates the initial configuration of the AUTODIN-CONUS system.

This system was the result of the original COMLOGNET and subsequent AF DATACOM system. It is a replacement for several manual data networks.

Some of the operational characteristics and services provided by the system are:

- Direct user-to-user circuit switching,
- Store-and-forward message switching,
- Compatibility of transmission media, terminal equipment, codes, speeds and formats,
- Automatic error detection and correction,
- Message processing by precedence,
- Maximum security protection,
- Choice of service modes to satisfy subscriber requirements,
- Automatic alternate routing,
- Message accounting and protection,
- Automatic processing of single and multiple-address messages.

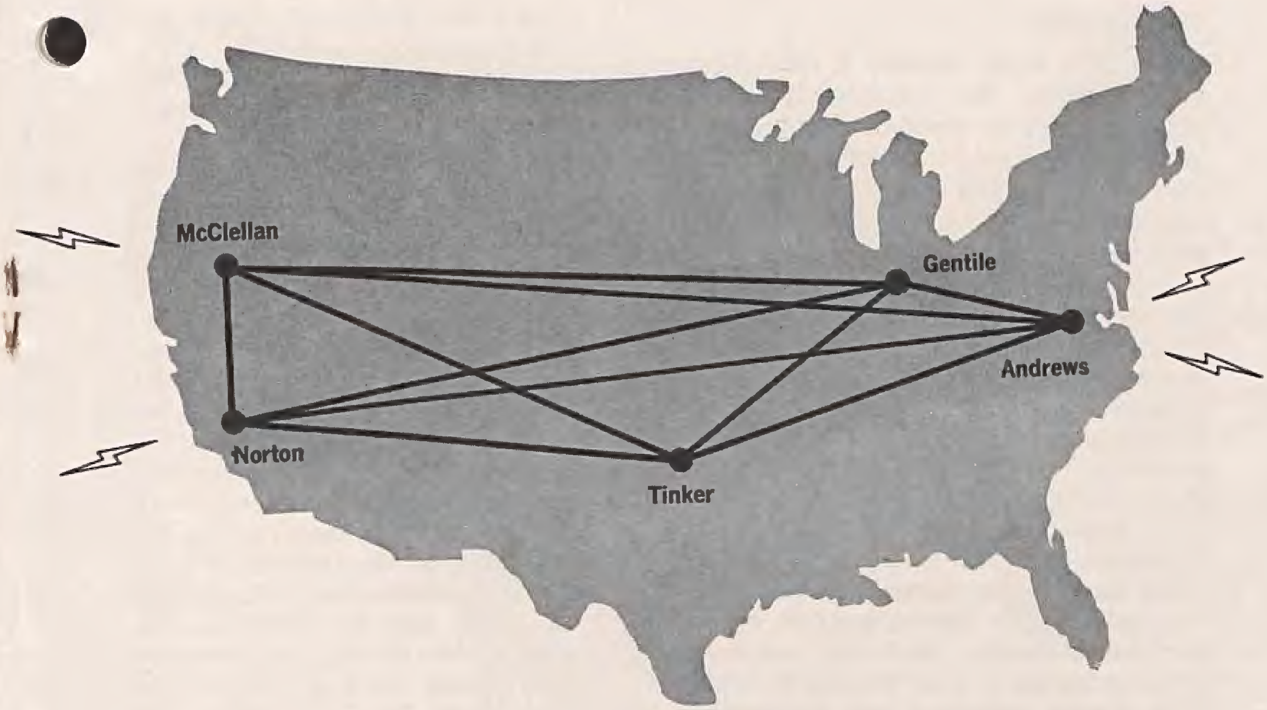

Figure 1. Initial AUTODIN Configuration

DCA Study

In its initial configuration, the automatic portion of the AUTODIN system was equipped to accommodate a total of 550 tributaries and interconnecting trunks, located within the continental United States. This network of tributaries and trunks was used primarily for the exchange of digital data processed in whole, or in part, by business machines and computers at one or both ends of the line (originator and addressee). Shortly after the activation of the initial network, the system was adopted by DCA as its digital communications network. That agency, in turn, immediately evaluated the capabilities and performance characteristics of the system, compared them with its teletype systems, and late in 1963, obtained approval of a plan to expand the AUTODIN system. Their plan was to provide a capability to absorb all of the record communications traffic generated by the various military departments and agencies into the AUTODIN system, and to inactivate several major teletype networks then in operation. Their plan provided for a number of electronic switching centers at overseas locations, as well as for the expansion of the CONUS portion of the system then in operation. The contract for the overseas centers was awarded to Western Union in February, 1964.[4]

Western Union's Responsibility

In our role as prime contractor, Western Union has total system responsibility. This means that all changes required for the Expansion and/or the adaptation of new equipment were monitored throughout the development, testing, and implementation phases by Western Union engineers. Intra-system compatability, operator flexibility, maintainability, human factors, and economic considerations were all features that were evaluated and controlled by this means. In exercising these responsibilities, it was necessary for knowledgeable Western Union personnel to participate in the evaluation and selection of technical approaches in the recommendations of new peripheral equipment.

The Expansion

The DCA study revealed a need for a system within the continental United States capable of accommodating in excess of 2,000 lines. To satisfy this requirement and allow for normal growth of a system of this type, Western Union is expanding the line terminating capacity, of the CONUS system from its initial configuration of 550 lines to a total of 2,700 lines. This is being done by providing each of the original five centers with the ability to accommodate 300 lines and by adding four additional centers of 300-line capacity each. The Expanded Configuration is shown in Figure 2.

To accomplish this without declaring a significant portion of the system obsolete, it was necessary to change the basic interface between the communications media and the automatic electronic switching center processors, from the original character storage technique to a bit storage technique and to revise the line servicing procedures. Thus, Bit Buffers Units (BBUs) and Buffer Control Units (BCUs) were added and the Accumulation Distribution Units (ADUs) were modified to accommodate these changes.

Added Features

Additional features were added to improve the system capacity, performance, and operational characteristics and to take advantage of the latest advancement in the state of the art. These added features are:

A. Switching Equipment

1. System Console
   The system console was changed from a display of conditions on all lines simultaneously, to a program-controlled display of one channel at a time. The intermediate storage capability had to be substantially expanded. In order to permit an operator to exercise surveillance, over a larger number of channels, the system console was modified to provide:
   - Channel status information on a one channel-at-a-time basis,
   - Automatic display of various system conditions,
   - Easily operated controls for the required display and reset functions.
   - Considerable expanded capability to accommodate additional indications not provided previously in this program and an improved monitor printer.
2. Analex High Speed Printer
   The Analex High Speed Printer provides a printing capability of 1,000 lines per minute. It is now being installed in the new centers and also is replacing the original printer provided in the existing centers. It has a dual interface capability; one for connection to the transfer channel of the Communication Data Processor (CDP), and the other for connection to the Recovery and Management System being provided at the new centers. The Tape Search Unit provided at the original centers is being modified to permit it to print out on the high speed printer. Thus the speed of operation of the Tape Search Unit is considerably increased.
3. Tape Stations
   The new centers are being equipped with CDC Model 9103 Tape Stations, instead of the tape stations initially provided in the complement of switching centers. These tape stations offer numerous advantages over the previous tape stations. They provide greater packing density, read-after-write, check of both vertical parity for each character and horizontal parity for each record and numerous mechanical and technical improvements which will improve the operational performance.
4. Intermediate Storage Facilities
   The new centers are being equipped with two Librascope magnetic discs memory units called Mass Memory Units (MMUs), which function in the same manner as the drum storage units in the original centers. These units are capable of accommodating 12 million bits of intermedi-

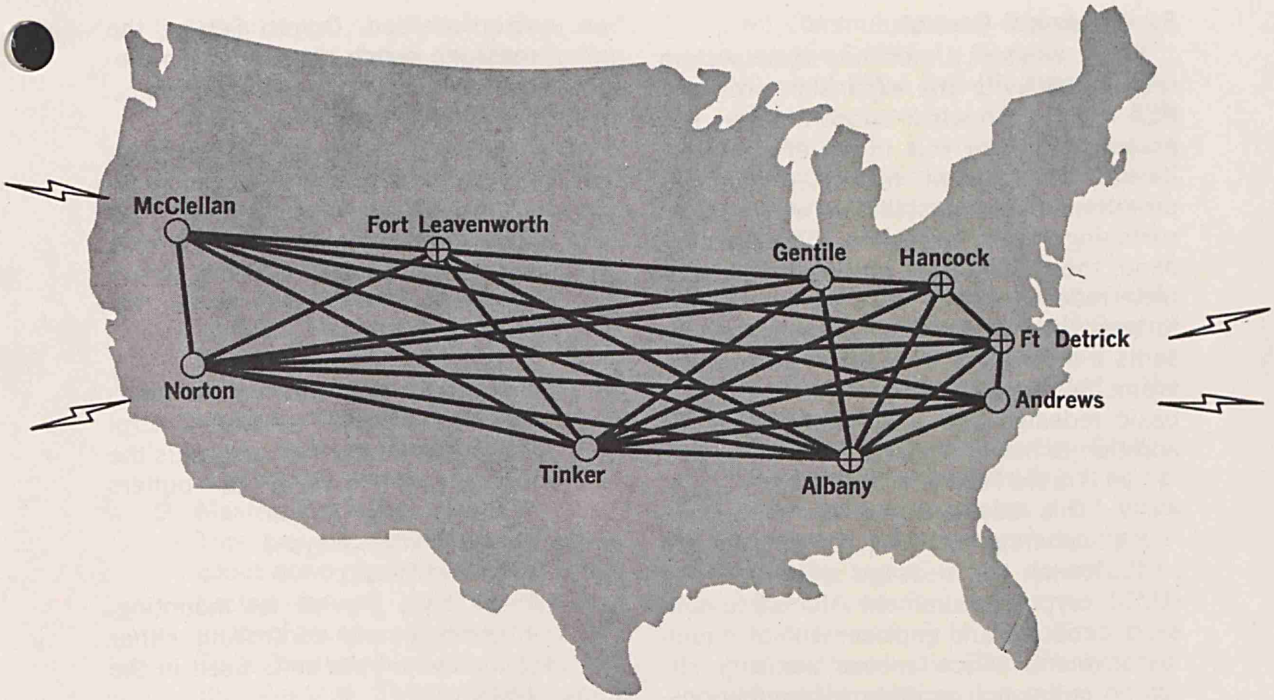

Figure 2. Expanded Configuration

ate storage per unit and they are expandable to double this capacity. At the existing centers, one Mass Memory Unit has been provided to expand the intermediate storage capability of these centers. The possibility of further expanding the intermediate storage capacity of all centers is now being studied.

5. Monitor Printers
An asynchronous Monitor Printer, provided by Kleinschmidt, is being used in the new centers, in lieu of the Flexowriter printers provided with the original centers. This substitution will increase the printout capability approximately four fold and will reduce maintenance problems considerably. Each of the new centers is being provided with three of these printers and a follow-on order provides for one such printer at each of the original centers.
6. ADU Data Memory Stacks
All locations have been provided with additional memory stacks to expand the data handling capability of the respective ADUs.
7. Automatic Selection Center
This feature provides for automatic routing of Circuit Switching Unit (CSU) terminal-originated traffic through the Message Switching Unit (MSU), in all cases where the addressee is not normally served by a CSU. Originally, the originating operator was required to determine the type of terminal serving the originator and select the transmission path accordingly.
8. Recovery and Management System
An RCA Model 301 Computer is being provided at the new centers to perform the tape search function offline statistical tasks, and ultimately the off-line recoveries. By separate order, the Tape Search Units at the original centers are also being modified to permit greater utilization and flexibility.
9. Software Modifications
In order to accommodate the modified equipment and the new peripheral devices, it was necessary to completely reaccomplish the software package.

B. Technical Control

While Western Union has total system responsibility for the expansion program, RCA, as the principal subcontractor, has assumed a major role in the engineering, design, development, testing, production, programming and installation of the actual switching center hardware. On the other hand, the requirement for an almost complete redesign of the Tech Control System to meet newly established criteria represents a most significant effort in this program. Some of the areas which required basic redesign and engineering effort, in addition to new installation effort are:

1. Traffic Patching Bay (Red)
   This bay provides the necessary patching facilities for circuits between the message switch and the crypto equipment for alternate routing and replacement of equipment. Miscellaneous auxiliary circuits such as dummy terminations, and spare equipment appearances are present. Circuits are provided for shunt monitoring of the sync and information lines and interruption of the information link by push button control from the crypto control and monitor controls.
2. Clocking Bay (Red)
   This bay provides the line clock (one cycle per bit signal) for clocking send cryptos and the output buffers of the message switch. There is a separate output for each send line. The receive clock for start-stop buffers (16 cycles per bit) is also provided from this bay. The chassis for loss of set detection of the synchronous crypto units are mounted in this bay.
3. Relay Rack
   This rack provides the relays for switching the ADU-Buffer equipment into and out of active communications circuits. When the spare ADU-Buffer equipment is substituted for a failed unit, all patches on the Traffic Patch Bay associated with the unit are preserved when the switch is made. The controls for switching are of the interlocked type and are remoted to a supervisor position. Crypto Set on the message switch circuits is also preserved during the substitution.
4. Power Bay (Red)
   This bay provides the DC power required in the Red area of the Technical Control. This bay provides standby equipment with automatic switching capability. The bay comes equipped with its own power distribution panel.
5. Distribution Frame (Red)
   This frame provides for the interconnection of all Technical Control equipment in the Red area plus the inputs and outputs of the buffers in the message switch.
6. Crypto Control Bays
   (Red and Black)
   These bays provide for mounting, interfacing, and controlling either of the two crypto units used in the system.
7. Crypto Control Console
   (Red and Black)
   This console provides the displays and controls for both the manual and semi-automatic synchronization of the crypto devices. A push button circuit selection is provided so that line signals can be monitored on the red side to determine if crypto set has been achieved. The monitoring device is a character framing and reading unit which is capable of framing on the idle line character, reading certain control characters and constantly checking the parity of the line signals. Means are provided to synchronize the crypto units in groups or in mass. In the event of special crypto synchronization problems, the circuit selection can be utilized to place a teleprinter on the line before the crypto units to talk to the distant end of the circuit.
8. Monitor Console (Red and Black)
   This console provides the central point for the control and supervision in the Tech Control area. Access is provided to all communication circuits by push button, and to all auxiliary communications such

as intercom, base telephone, and inter-center phone. By interrupting the line, a teleprinter associated with the console, can be used to talk to all outstations and centers. DC test equipment such as Bias and Distortion (B&D) meters, pattern generator, oscilliscope, character reader, parity checker and line monitors are mounted in this console. The master alarm displays for the switching center clock, power supplies, bias detectors from the receiving sync adapters and crypto calls, and display for loss of sync are located on this console.

9. Master Clock Bay (Black)
This bay provides the oscillators, count down, and distribution of the timing for all synchronous and asynchronous equipment in the Tech Control, Modem, Crypto and the Message Switch Buffer units. Redundancy is provided in all components of the bay to provide continuous service in the event of internal failure. Means are provided to check each oscillator against each other and against external standards. Complete alarm checkings of all failure detection circuits is also provided.
10. Synchronizing Adapter Bay (Black)
This bay provides the per line equipment which generates a bit clock for each synchronous receiving circuit by sampling the dc output of the Modem and comparing it to a time base from the Master Clock. These Sync Adapters will compensate for up to a 50 percent bias and distortion of the receive bits. A threshold type of distortion indication is available from each Sync Adapter and is remoted to the Monitor Console.
11. Equipment Patching Bay (Black)
This bay provides dc power in the Black area and is identical to the power bays provided in the Red area.
12. Audio Filter Bay (Black)
This bay provides the filters in a shielded enclosure for filtering of all communications channels leaving the Switching Center.
13. Control Filter Bay (Red and Black)
This bay provides the filters and isolators in a shielded enclosure for control, timing and unencrypted circuits that must pass between the red and black areas.
14. Distribution Frame (Black)
This frame provides for the interconnections between Tech Control equipment in the Black area. It is similar to the frame provided in the Red area.
15. Synchronizing Adapter Bay (Red)
This bay provides the per line equipment which generates a bit clock for each synchronous sending circuit by sampling the dc output of the Circuit Switching Unit (CSU) and comparing it to a time base from the Master Clock. A Synchronizer is required on every output line of the CSU since the output will always assume the phase of the new input line, which is connected to the output line.

Expansion of the Technical Controls in the present AESCs to increase the synchronous line capability and to add a large volume of asynchronous (teleprinter) lines to each AESC, requires the following:

- Expansion of existing frames,
- Expansion of patching facilities,
- Expansion of dc power bays,
- Expansion of synchronizing adapter equipment,
- Expansion of crypto control console displays,
- Addition of crypto bays for both types of crypto units,
- Modification of monitor console to house asynchronous test equipment,
- Clocking bay added to provide more send clock capability, and receive (asynchronous) clocking,
- Conformance with recently established security criteria.

New Mode V Teleprinter Operation

The plan for expansion of the CONUS AUTODIN system included a requirement to serve many 60-, 75- and 100 words per minute teleprinter terminals. At the outset of the AUTODIN program, it was considered necessary for the receiving terminal to exercise control over the sending station. This was accomplished by means of a line coordination system which, in addition to providing automatic error detection and correction, also permitted the receiving station to start and stop the sending station. This technique is referred to as Mode I operation. Special terminals were developed to operate in this mode permitting selection of input/output devices, depending upon the type of traffic being handled. This selection permitted the delivery of a message to one or more of the following: card, paper tape, page copy, or magnetic tape.

Additionally, the AUTODIN system was designed to accommodate standard teleprinter input/output without control of the sender or transmitter by the receiver. This method is called Mode II. However, in its original development plan AUTODIN was used for only a few low volume teleprinter users.

At the outset of the Expansion Program, it became obvious that in order to maintain a high degree of operational performance it would be necessary to exercise control over teleprinter input in a manner similar to that exercised over Mode I terminals. To accommodate this requirement, a new Communications Mode now commonly referred to as Mode V is being provided as a third mode of operation in the CONUS System.

To permit this mode of operation, Western Union developed a Control Unit which is being provided at the teleprinter location. This unit operates as an integral part of the teleprinter. The control procedures and interface characteristics are designed to operate in either an encrypted or unencrypted environment on a full duplex basis. The control procedures make use of a special signalling technique which makes the Mode V system transparent to the complete teleprinter character set.

Mode V provides the following facilities:

1) A means for the receiver to start and stop the transmitter.
2) A means for the transmitter to interrogate the receiver and obtain the status of each message transmitted.
3) A means for the transmitter to receive a "reject message" signal from the receiver if the message is incomplete or otherwise not acceptable.
4) A means for detection of facility, cryptographic, or equipment failures.

Two operating conditions are accommodated with Mode V, the standard duplex condition and an emergency condition.

Standard Duplex

The standard condition of operation normally is used. In this condition, the terminating apparatus can send and receive data simultaneously, and as a consequence both legs of the full duplex channel are used for the transmission of control sequences as well as for data. Return control sequences are interspersed with data on the legs. Thus when it is necessary to acknowledge receipt of an inbound message, the outbound message is interrupted in order to send the return control signal. The receive apparatus filters out the control signals so they do not appear on the printed copy of the message being received and acknowledges all the control sequences as required.

Emergency

The emergency condition is for use when only one leg of the full duplex channel is operable, or when equipment failure requires the use of this channel. This Mode is identical to Mode II operation. The control sequences normally used in Mode V are omitted, and transmission proceeds from one message to the next without receipt of acknowledgements. The message format, line code, and line speeds are identical to those used on the line when operating in the normal controlled condition.

Work Progress Charts

Within Western Union, the Expansion Program has involved almost every department of our headquarters and field organization. However, the principal interface between the various Western Union elements and the customer has been through the Government Communications Systems Department, the engineering project manager, and the installations and maintenance groups within the Technical Facilities Department.

Charts were developed to monitor all of the major tasks and sub-tasks in the broad sense. These fell into four major categories, namely; engineering, programming, production, and installation. Separate major task charts are maintained for Western Union and RCA, as a means of clearly defining the responsibilities, and to simplify the reporting procedures. Each of these major tasks was further divided into subtasks to simplify the procedures and permit identification of significant milestones within major tasks. In addition to the management charts mentioned above, PERT-type flow-charts, shown in Figure 3, were developed for the entire job with much of the field implementation charted to the exact number of minutes or hours required for each identifiable field action.

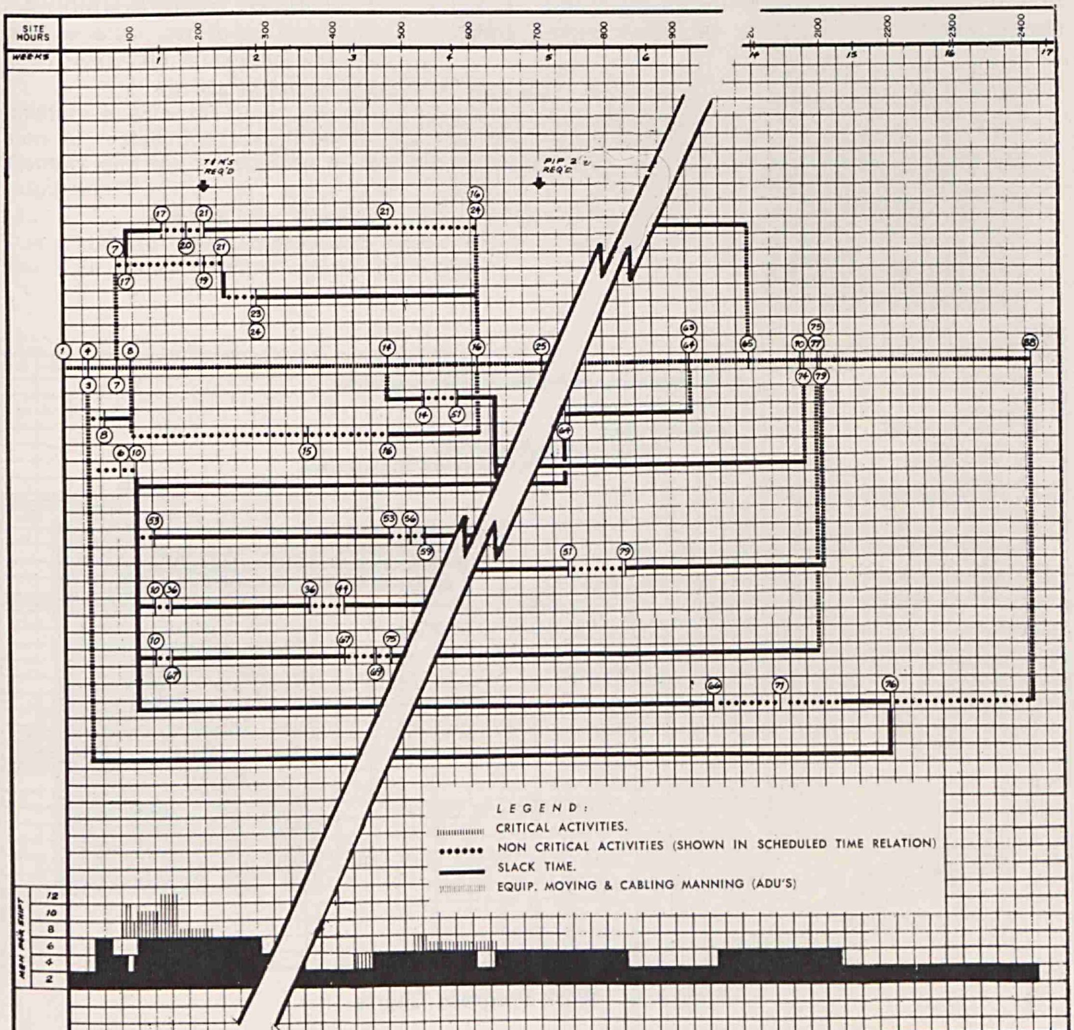

Figure 3. PERT Flow Chart

At the outset of the program, major tasks and subtasks were identified as illustrated in Figure 4. These tasks were assigned to the various activities within the respective departments, or to subcontractors. Reporting procedures were established, monthly reports were published and distributed to all activities, regular meetings were held to examine problem areas and develop courses of action to be followed.

The use of these various management tools aided the individual department heads in their decision making.

Status of Expansion

All the original centers have been modified to the extent that government-provided space and other support facilities have permitted.

In summary, it is our belief that the Expansion Program, when completed, will provide the the Government Agencies with a greatly enhanced system. While the problems have been manifold, the successful implementation of the Program to date has resulted from the cooperative effort of the many contributing elements within Western Union beginning with the Marketing and Contract Management Groups and extending through Engineering and Technical Facilities, Accounting and Finance and Field Divisions. We recognize that the field effort which involved the simultaneous installation of Tech Control, Crypto Facilities, Communications Media and Terminal Facilities represents an unprecedent effort in the annals of Western Union history.

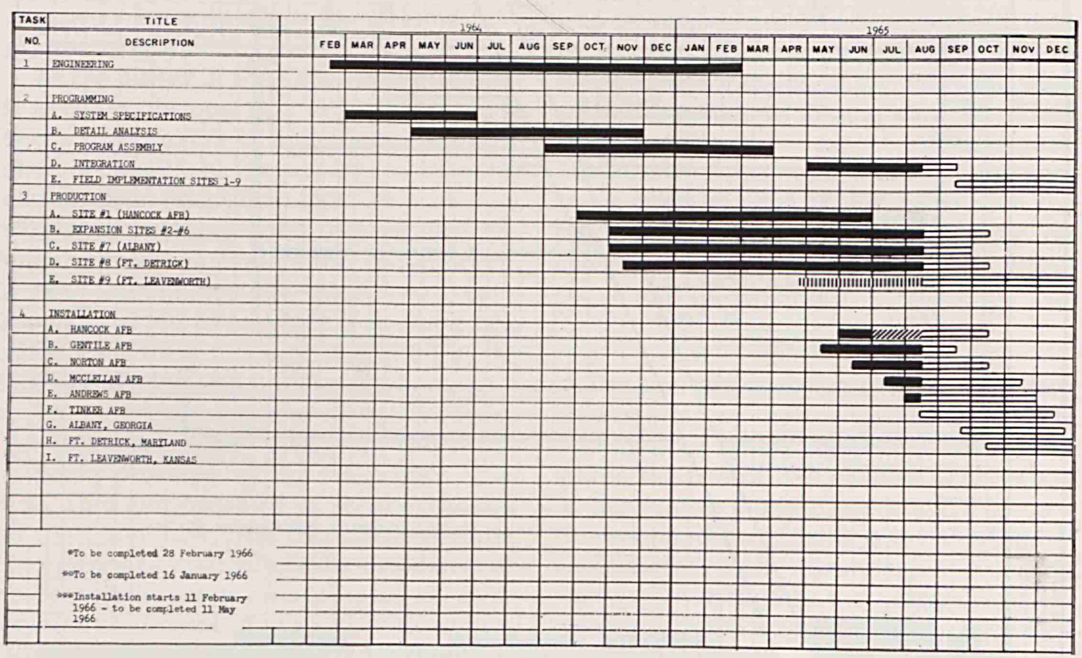

Figure 4 Work Progress Charts

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2. **AUTODIN**—System Description Part 1—Network and Subscriber Terminals H. A. Jansson, Western Union TECHNICAL REVIEW, VOL 18, No 1 January 1964
3. **AUTODIN**—System Description Part 2—Circuit and Message Switching Centers H. A. Jansson, Western Union TECHNICAL REVIEW, VOL 18, No 2 April 1964
4. **AUTODIN**—Systems to be Expanded, Western Union TECHNICAL REVIEW, VOL 18, No 2 April 1964

HAROLD F. CALEY, Director of AUTODIN, in the Information Systems and Services Department has been concerned with the engineering phases of this project since 1959. He has had an active part in the development of data processing equipment and data processing services.

Mr. Caley joined Western Union after completing military service in 1946. His activities included the preparation of installation specifications for the Plan 21 Switching Centers and the supervision of the installation of radio beam equipment.

He has been Chairman of the Electronic Industries Association for Data Transmission Equipment and Chairman of the IEEE Data Communications Committee.

FRED W. SCHULTZ, system implementation manager in the Government Communications Systems Department, is Program Manager for the AUTODIN Expansion Program.

Prior to joining Western Union, Mr. Schultz was Advisory Engineer in the Communications System Development Laboratories at IBM. Prior to that, he served as a Communications Command and Staff Officer in the United States Air Force. During his Air Force career, he participated in the development implementation, and operational management of many new communications systems, such as Western Union's Plan 51, Plan 55, and AF DATACOM Systems.

Mr. Schultz received his BS Degree from the University of Maryland. He also attended several technical schools while in the USAF, received his commission as a 2nd Lt. at Yale University, and attended the Air Command and Staff School at the Air University, Montgomery, Alabama.

autodin —overseas expansion

—Ralph M. Pool

The initial AUTODIN configuration adopted by DCA in 1963 as the nucleus for a planned world-wide network was called AUTODIN-CONUS. It comprised five automatic electronic switch centers of the Continental United States (CONUS). This CONUS portion was approved, in 1964, by the Department of Defense and is now being expanded by Western Union[1,2,3]. The Overseas expansion or the world-wide portion, is the subject of the article.

AUTODIN is a world-wide, high-speed common user data communications system. In the United States it is operated by Western Union and in the Overseas areas it is operated by specific Military Departments. Originally, it was designed to meet the growing USAF demands for faster logistic support of the ever-expanding, complex, global air operations. AUTODIN now serves as an integral part of the Defense Communications Agency world-wide communications complex.

AUTODIN-Overseas provides data communications from overseas points to government agencies of the United States. The Department of Defense has purchased ten new switching centers overseas — three in Europe, five in the Pacific area, one in Panama, and one in Alaska as shown in Figure 1. The automatic digital message switching centers (ADMSCs) were designed, installed, and are being tested by The Philco Corporation. Philco will provide maintenance of these centers for a period of one year after they have been cutover to active service.

Western Union Responsibility

Western Union is providing engineering assistance to the Defense Communications Agency in the procurement of both the main switching center complex, and the tributary or subscriber equipment. This systems assistance will continue through the final cutover to active service of the overseas portion of AUTODIN. To furnish this assistance, Western Union established an AUTODIN Overseas Project Office in Arlington, Virginia in midsummer of 1963. The project office is directly responsible to the Defense Communications Engineering Office (DECEO), a field engineering organization of the Defense Communications Agency. The procuring agency for this effort is designated as Air Force Systems Command.

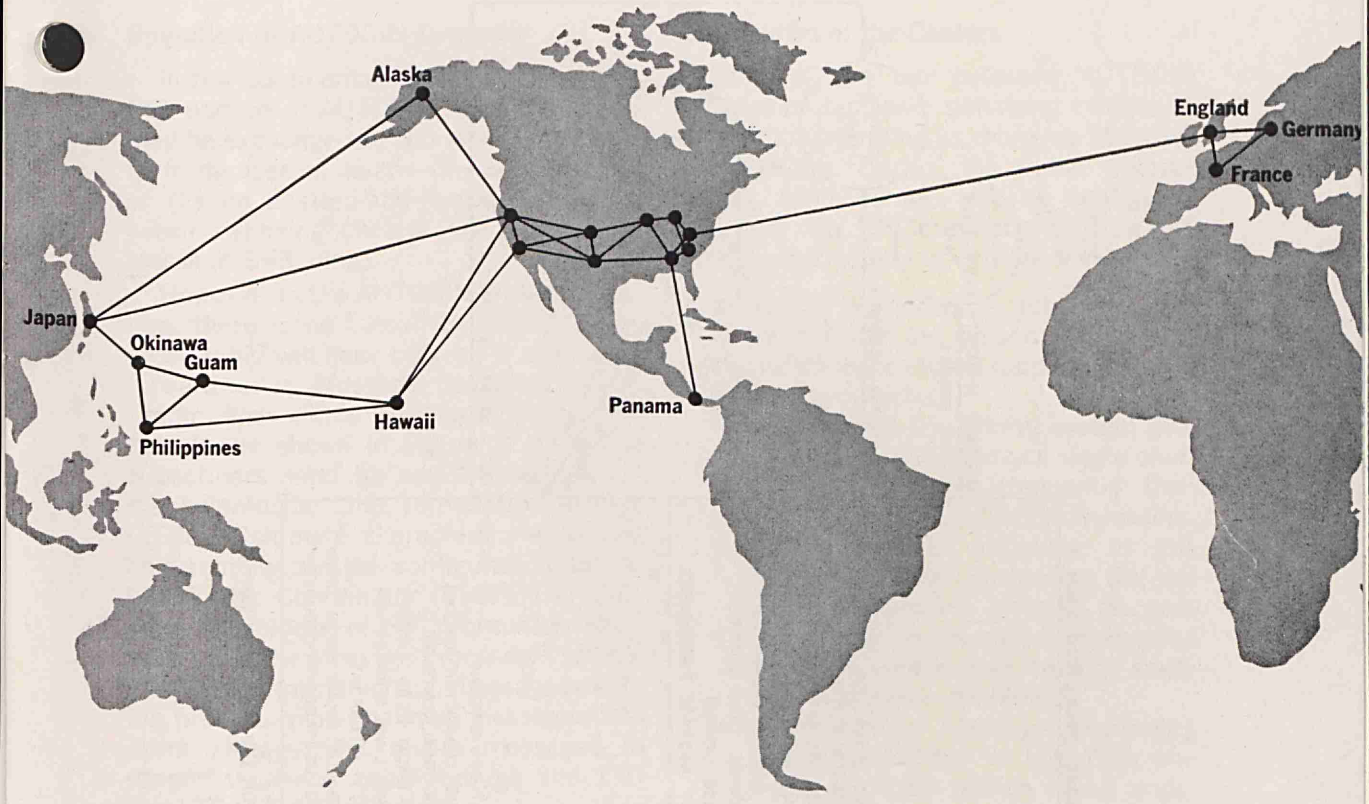


Figure 1. AUTODIN Overseas Worldwide Data Communications System

Western Union's Overseas Office

The AUTODIN Overseas Project Office is a division of Western Union's Information Systems and Services Department and is staffed by engineering personnel from each of Western Union's major departments. These personnel represent the field divisions as well as the Headquarter's research and engineering departments of Western Union. In addition, communications engineers with a variety of technical knowledge have been recruited from the military and industry.

The major task within the Western Union AUTODIN Project Office is to provide the systems engineering services to support the Defense Communications Agency in implementing the AUTODIN program in overseas areas. The Project Office is responsive to the Defense Communication Agency (DCA) in performing these broad system engineering and systems integration functions. The duties and responsibilities of the Western Union office include:

1. To provide technical procurement specification for switching center equipment, high- and low-speed modems, crypto ancillary units, teleprinter control units and the Digital Subscriber Terminal Equipment (DSTE) or tributary equipment.

2. To assist DCA in evaluating bidders' proposals.

3. To provide monitoring of in-plant technical design of all major equipment for the Government.

4. To perform systems analyses for compatibility of each supplier's equipment and for compatibility of each off-line computer.

5. To assist in site selection, design, and construction of the ten overseas switching centers.

6. To participate in the Government acceptance test for each switching center.

7. To provide continuing systems engineering assistance to DCA in their overseas headquarters during the implementing cutover stages.

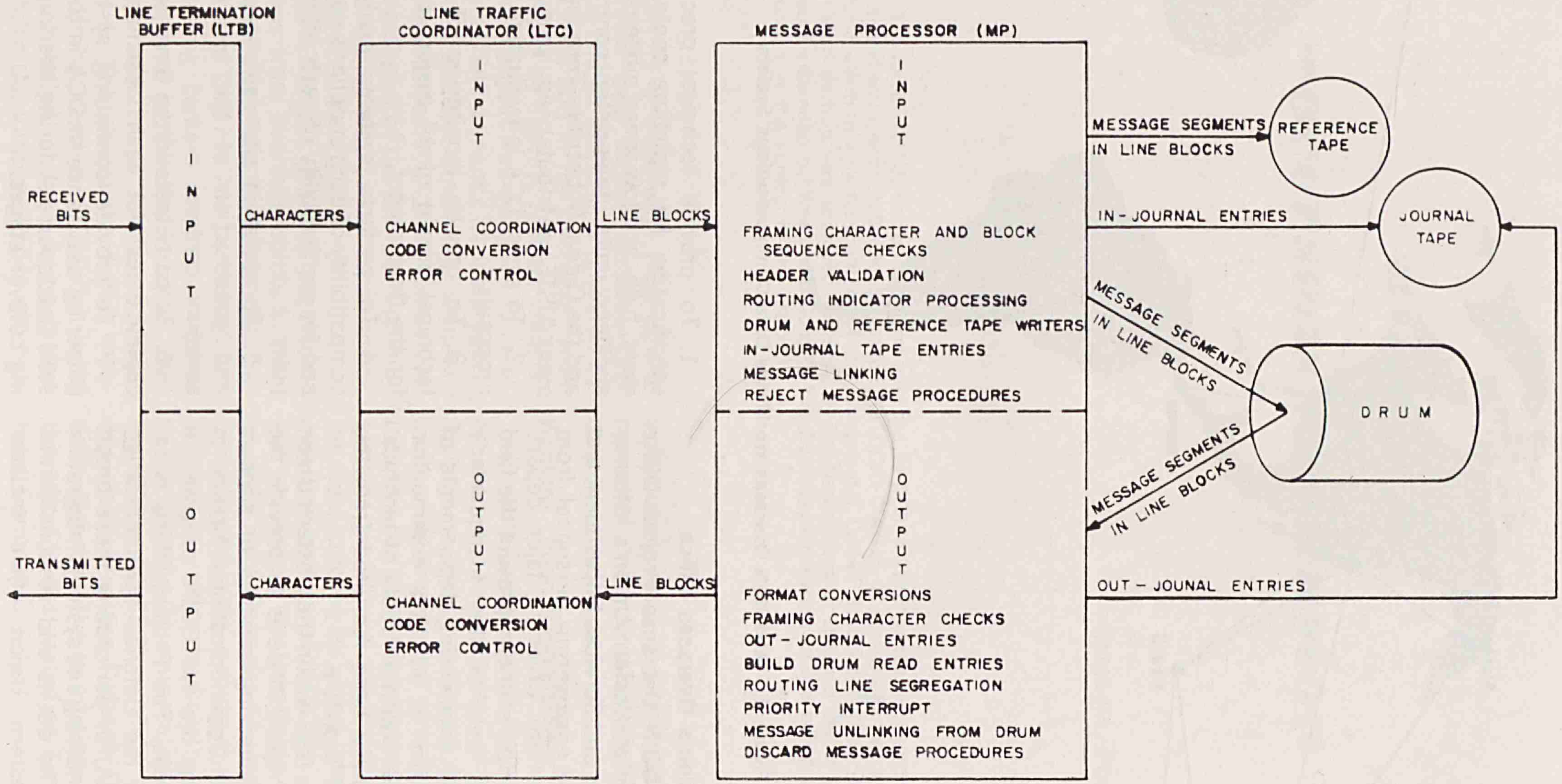


Figure 2. Traffic Flow within the Switching Center

Operation of AUTODIN Overseas

In the Continental United States (CONUS) portion of AUTODIN, message traffic may be exchanged in two ways: (1) directly from user to user—Circuit Switching or (2) on a store-and-forward basis between switching centers and the user—Message Switching.

However, in the AUTODIN Overseas system, there is no Circuit Switching. Overseas traffic will flow only on a store-and-forward or a Message Switching basis. Traffic flow within the switching center complex is shown in Figure 2. Tributary subscribers send bit serial stream information into the Line Termination Buffers (LTBs). Complete characters are formed and sent in parallel configuration to the Line Traffic Coordinator (LTCs). The LTCs send line blocks of 80 information characters into the Message Processors (MPs). The MPs perform the main message switching process, place delayed messages into drum storage and queue messages in proper sequence back through the LTC and LTB to the destination.

The AUTODIN Overseas system accepts traffic asynchronously at 45-, 75-, and 150 bauds, and synchronously at 300-, 600-, 1200-, and 4800 bauds. When the system is installed in early 1967, the tributary operating speed is expected to be limited to 1200 bauds. The AUTODIN Overseas system will exchange traffic on a store-and-forward basis between users operating at different speeds, i.e., one user at 75 baud and another user at 1200 baud. The switching center can accept International Telegraphic Alphabet (ITA #2) traffic and messages in the new American Standard Code of Information Interchange (ASCII). It will accept traffic from an ITA #2 user and code convert it into ASCII and deliver it to an ASCII coded tributary. Code conversion from ASCII to ITA #2 will be performed prior to final delivery, as required.

Reliability built into the equipment keeps errors to a bare minimum. Reliability is assured by parity checks, controlled environmental conditions, and spare or standby equipment that can be instantly and automatically switched into the system should equipment fail.

Capabilities of the Centers

Each of the ten overseas AUTODIN automatic electronic switching centers is capable of providing as many as 200-user terminations. During the initial cutover period, some centers will be configured to accept only 100 terminations. The capability of the switching centers include:

- Ability to accept a total input of 76,000 bits per second.
- Ability to handle an output of 86,000 bits per second.
- Accuracy of the overall system prevents the occurrence of a single character error more frequently than once in every 100,000 characters.
- Reliability and accuracy of the switching center equipment will not allow a character error to be generated and transmitted undetected more frequently than once in every 100,000 billion characters.
- Prevention of message misrouting with a probability of less than one message in 10 million being undetected.
- Automatic change of message configuration. The logic and software program package will automatically change the format and code of messages when necessary. (For example, to send a narrative form of message from a tributary, using ITA #2 code, to a destination using punch cards, the switching centers perform message conversion by putting it into 80-character blocks and adding or deleting characters for line feed and carriage return as may be necessary.)
- Provision for routing codes, to send single or multiple-address messages, is available to the user, by means of programming in the system. Collective routing codes may be used to select a preassigned list of destinations if desired.
- Provision for automatic alternate routing is provided if a major circuit route or trunk becomes inoperable.
- Provision for normal journal records, header checking of each message, and priority handling is provided.

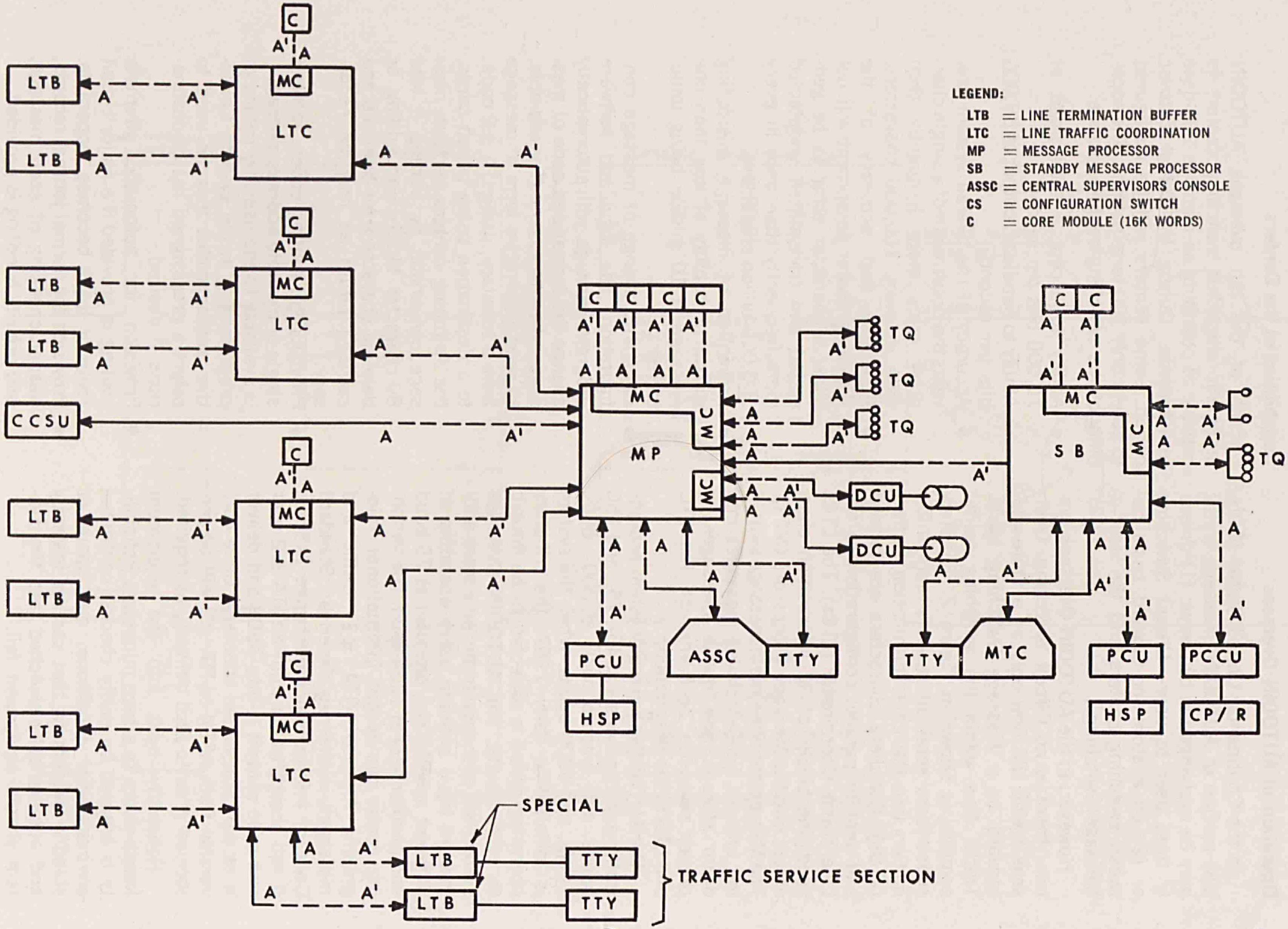


Figure 3. Block Diagram of a 200-Line ADMS

Unique Features of ADMSC

The AUTODIN Overseas ADMSCs have many unique features:

1. Modular Design.

One such feature is the modular construction of the ADMSC using the Model 102 processor. A typical center has six basic processors (5 on-line and 1 standby) and ten 16,000-word core memory banks (8 on-line and 2 standby). Four processors will serve as buffer storage for the input/output terminations, channel acknowledgement and coordination, and character processing.

A block diagram of the flow of traffic through a typical 200-line ADMSC is shown in Figure 3. A typical 200-line switching center has 6 processors, 18 magnetic tape drives, 10 core memory banks, 2 eleven million character magnetic drums, and other peripheral equipment, such as high speed printers, tech control and system supervisors consoles. The processors, when used in this configuration, are called Line Traffic Coordinators or LTCs. The fifth model 102 processor serves as the main Message Processor (MP), performing message servicing, operation supervision, such as directing a message to a magnetic drum or magnetic tape unit for interim storage and directing the printout of supervisors messages and data pertaining to traffic flow. The sixth processor is the standby processor (SB) which performs only off-line functions while in a standby status. Some of the off-line functions are the ability to perform any function of the other five online processors and/or to act as an off-line processor in a maintenance program or to debug a software program.

2. Economy.

Because of the many identical pieces of equipment, the switching center complex provides economies in manufacture, maintenance provisioning, maintenance training, and system simplicity. For instance the Model 102 Processor functions equally well as a Line Traffic Coordinator providing the buffering for 50 lines. It also serves as a Message Processor in directing the flow of data bits within the computer complex.

A third configuration of the basic Model 102 Processor is in the standby or off-line condition. The ability to check out a particular software program, to process or checkout a maintenance routine, can all be done with this redundant processor. Ease of maintenance is illustrated in Figure 4. The logic cards in the Model 102 Processor are shown when door is swung open. Maintenance provisioning is simplified because of the large quantities of similar modules. Maintenance training time is likewise reduced for this reason.

Additionally, ease of operation results from the speed and efficiency with which the ADMSC can recover and restart in the event of a catastrophic failure. Economies are achieved in the transmission area as well. Alternate use of data-voice trunks are utilized from a coherent voice-switched network during heavy traffic periods.

These additional circuits are called up manually or by software techniques as required.

3. Crossbar Switching Matrix.

Another unique feature of the ADMSC is its ability to detect a malfunctioning piece of equipment, switch it off-line by means of a crossbar switching matrix and replace it with a spare unit. Every possible systems configuration that can be effected by the crossbar switching matrix can be ordered either by program action via a processor or by manual action from the supervisory console. Thus, by means of the software program, the standby processor may be placed into service automatically as a Line Traffic Coordinator or Message Processor. The crossbar switches are also capable of allowing any magnetic tape drive to be assigned to any of the magnetic tape controllers. The equipment in the switching centers is designed to be interconnected in such a manner that maximum use is made of the crossbar matrix to interconnect various subsystems. Through such maximum utilization of the crossbar switching matrix, system reliability is greatly improved and a high degree of flexibility is attained within the ADMS.

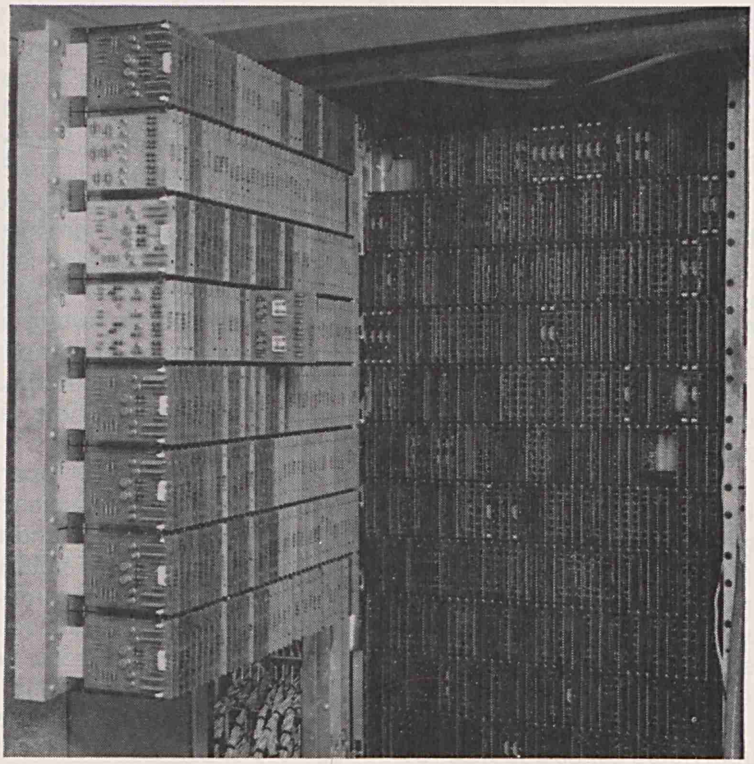


Figure 4. Model 102 Processor—(rear view) with Back Door swung open to show ease of maintenance and access to logic cards

Line Termination Buffers

The Line Termination Buffers (LTB), serve as gateway points for data information into the switching center. LTBs may be synchronous or asynchronous and are configured in groups of 14. The buffers perform the first manipulation on a received piece of data information. The information is changed from bit serial stream into an assembled character within the buffer unit. The character is then ready for parallel transfer into the Line Traffic Coordinator (LTC).

The asynchronous line termination buffer may assemble 5-bit or 8-bit characters to match a particular line. They are capable of being timed at 45-, 75-, and 150 bauds. The synchronous Line Termination Buffers operate at 150-, 300-, 600-, and 1200 bauds. The asynchronous buffers will also recognize open circuit conditions on both sides of the line. The synchronous buffers will recognize a no-transition condition on either side of the line.

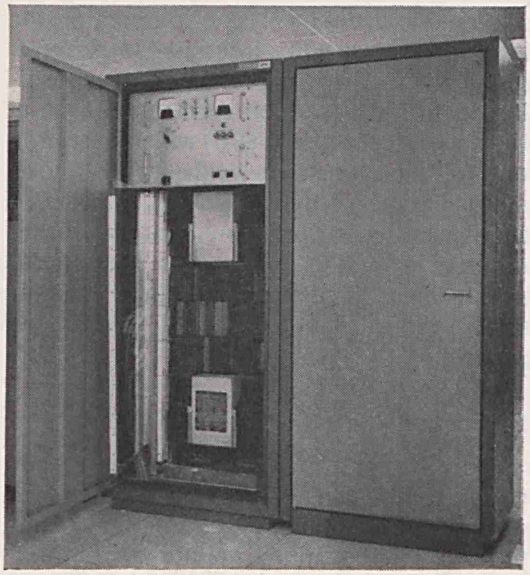


Figure 5a. Memory Bank showing Core Storage Unit at Bottom—(an enlarged view of the core storage unit is shown on the opposite page)

Line Traffic Coordinator

The Line Traffic Coordinator (LTC) is a Model 102 Message Processor providing channel coordination, character processing, and storage for the Automatic Digital Message Switch (ADMS) input/output. In a typical 200-line switching center there are four LTCs, each of which interfaces the Message Processor (MP) via a processor Configuration Switch unit.

The major function of the LTC concerns control and coordination of communications channels and the traffic received from and sent to these channels.

To facilitate these functions the memory in the LTC contains a stored program which handles channel coordination for each transmission mode, associated tables, and variable sized buffer areas to store the incoming and outgoing data. In coordination the receipt and transmission of data, the LTC provides for bulk storage of the traffic. Line blocks of data are accumulated and exchanged between the LTC and the MP. The number of blocks accumulated for a particular line is dependent upon the speed of the line. Validity checks are made on all transferred traffic. Code translation (to and from the internal ASCII) is performed and channel coordination characters are recognized and acted upon.

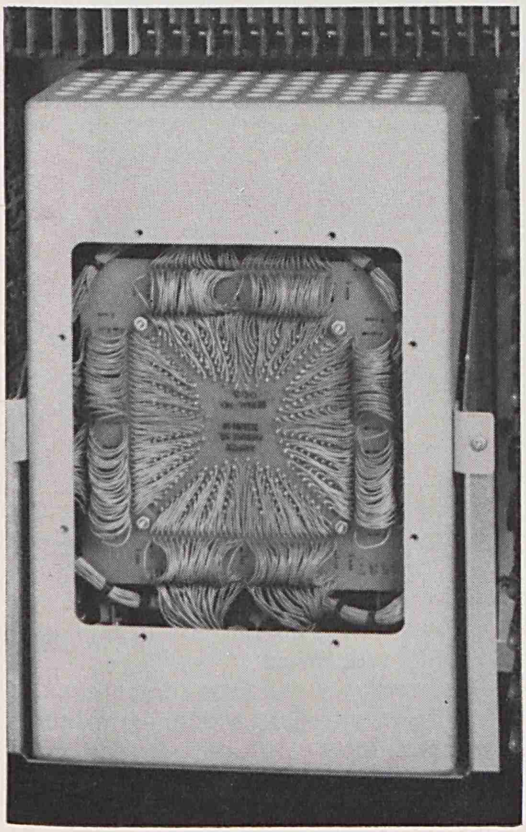


Figure 5b. 16K Magnet Core Storage Unit Model 173

Message Processor

The Model 102 Message Processor used in the AUTODIN Overseas system provides the main function to the system—routing the message. In addition, various other functions necessary in the processing of the message take place. Two of these functions are message protection and statistical information storage for off-line record keeping. To do all its jobs, the MP requires four 16,000 computer-word core storage unit shown in Figures 5a and 5b, two magnetic drums, a central supervisor's control console, a high-speed printer and access to 12 magnetic tape drives.

An Analex High Speed Printer is shown in Figure 6.

The program stored in the MP core memory banks assists in the transfer of data from the LTBs via the LTC to the MP and in turn to intransit storage on the magnetic drums, as shown in Figure 1. If the 11-million character drum storage unit (more than 4000 average length messages) becomes full, the magnetic tape drive units are pressed into service as secondary storage units. The message, in the store-and-forward system, awaits its turn by precedence to be forwarded to its destination. High priority messages are given special treatment. These tape units, plus the Reference and Journal tape units, are shown in Figure 1.

Directing the data to the proper output lines from the drum via the Line Traffic Coordinator is a function of the Message Processor. The magnetic tape unit assigned to store the journal records is also directed by the Message Processor program. This journal record is a necessity for off-line manipulation to obtain traffic data. Complete copies of all messages are stored on the Reference Tape unit.

Figure 6. Model 153 Analex High Speed Printer

Configuration Switch

The Configuration Switch shown in Figure 7 is the heart of the AUTODIN Overseas system. It provides a very novel and unique method of upgrading reliability. Basically, it provides: (1) that single functional units of equipment be automatically disconnected electrically from the online system. Some of these units may be core memory modules, line termination buffer groups, tape controllers, and magnetic tape units. The equipment is disconnected through programming control or manual intervention at the supervisor's console shown in Figure 8, and (2) the vehicle for rapidly changing circuits between functional units with a minimum of down time.

The Configuration Switch functions between;

- Line Termination Buffers and Line Traffic Coordinator processor.
- Line Traffic Coordinator processor and any other processor.
- Core memory modules and processors.
- Magnetic drum primary storage units and processors.
- Processors and tape controllers.
- Tape controllers and tape transports.
- Processors and various peripheral devices including maintenance and central supervisor's console, high speed printers, and printers for the service supervisor's position.

If a manual or program change is attempted which would provide an invalid connection, the control circuit is denied the execute cycle and an alarm condition is created. A system of checks and cross checks are also in effect during normal operation. The Line Traffic Coordinator continually indicates to the Message Processor that it is functioning normally. The Message Processor in turn is sending a similar indication to a hardware monitor. Should the Message Processor fail, the hardware monitor will detect it and, in turn, select a processor to replace the MP. The new MP will have the ability to control the Configuration Switch. During configuration switching operation the program within the Line Traffic Coordinator initiates signals automatically to the tributaries to hold their traffic.

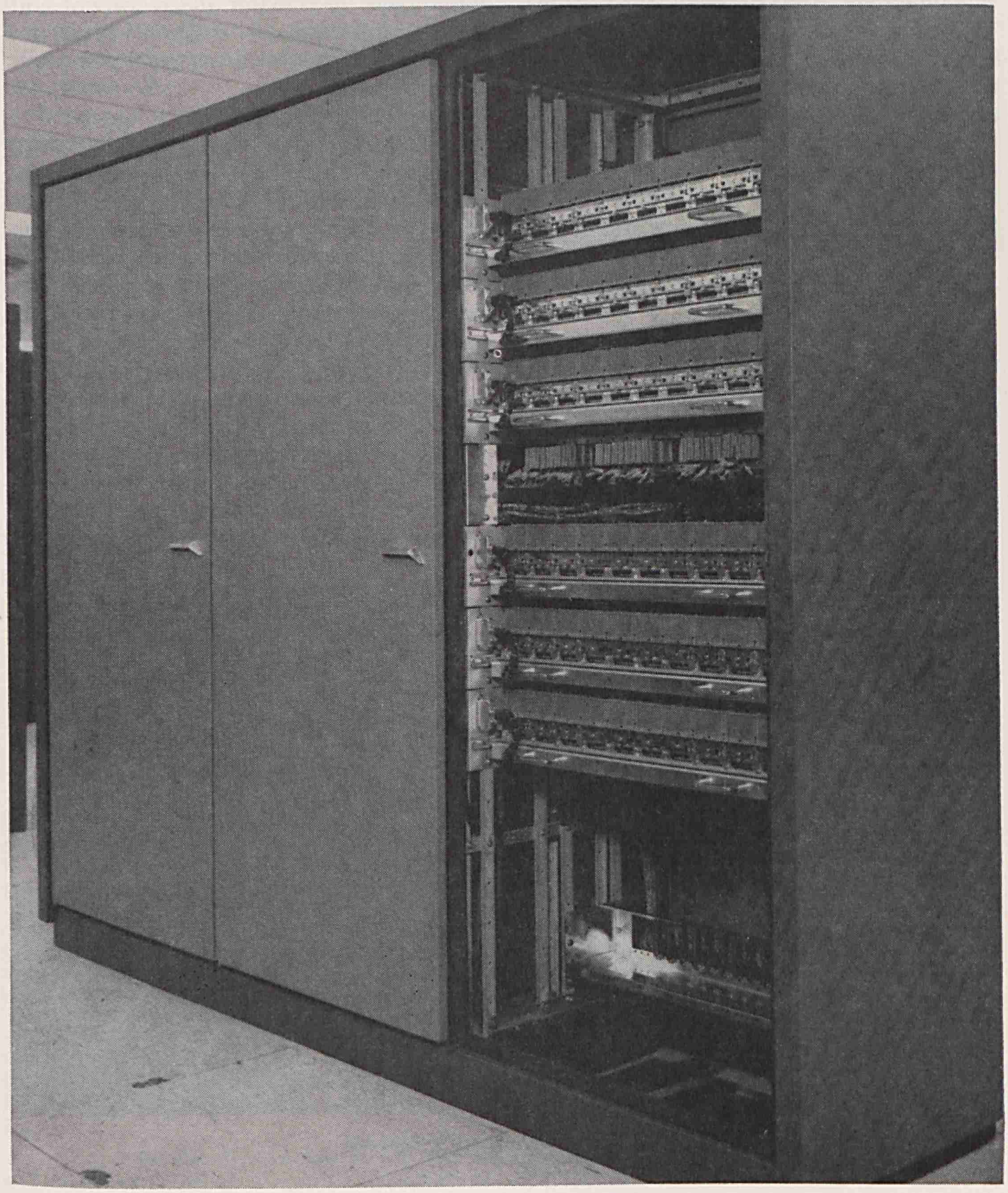


Figure 7. Configuration Switch

Sense Point Scanner

The Sense Point Scanner (SPS) is a scanning device that detects faults not directly associated with the Configuration Switching unit. The SPS reports the status of sense points to the processor giving the location of the fault area. The processor can classify the fault and light the proper indicator lights at the central supervisor's console (ASSC). The SPS is capable of watching over 2000 of these sense points.

The sense points are of two general types: one, which watches each line for incoming and outgoing failures and patching abnormalities; another, which senses the main ac power system condition, the main dc power condition, the critical power bus, the master clock, and environmental (temperature and humidity) conditions within the switching center.

Technical Control

The function of the Technical Control area is to maintain continuity of service with other communications centers and tributaries. The Tech Control also controls and regulates the external transmission facilities to the ADMSC complex. It is the most modern of a family of digital technical control complexes and employs the latest testing and measuring devices available.

A Tech Control console, which is in the communications subsystem area, will provide a means for monitoring all incoming and outgoing signals. Provisions are available on the console to test, coordinate and monitor the orderly control of the transmission facilities. The Tech Control area will contain entrance, black and red dc patch bays for transfer and testing of both lines and equipment. Isolation is provided in the Tech Control area for the red and black signals.

The master station timing system, for the Automatic Digital Message Switching Center is located in the communications subsystem area. The timing system supplies the timing base for all synchronous and asynchronous equipment speeds and serves as a master or timing source to compare each tributary operating out of the switch. This station clock oscillator uses a frequency synthesizer to derive the various desired timing rates. The stability of this timing source is in the order of one part in one hundred million. Each overseas ADMSC is expected to have a VLF receiver available for establishing and maintaining an accurate, stable station timing system.

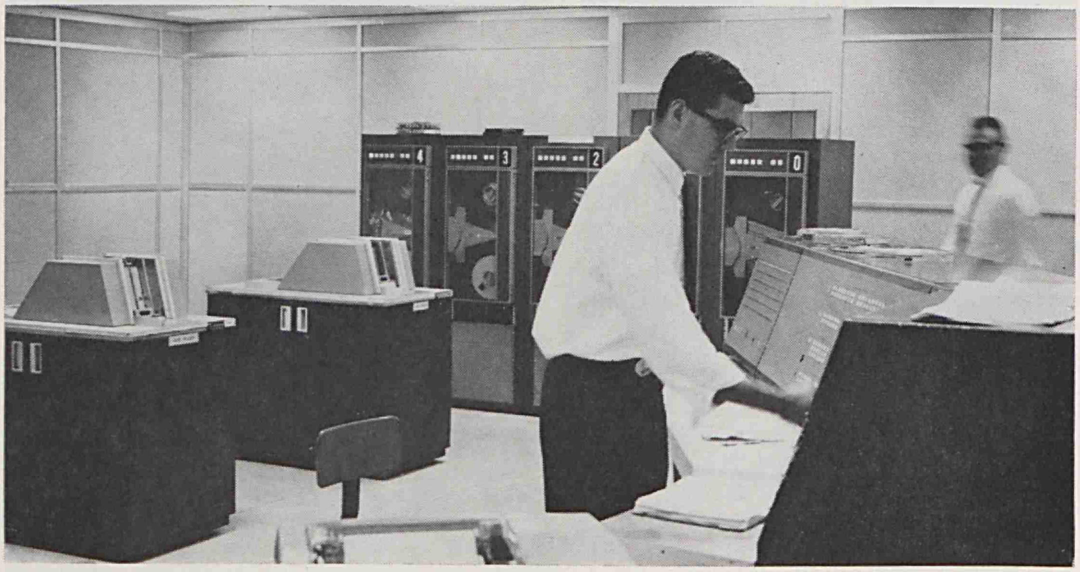


Figure 8. Supervisor's Console

Intermarriage of Communications with Computers

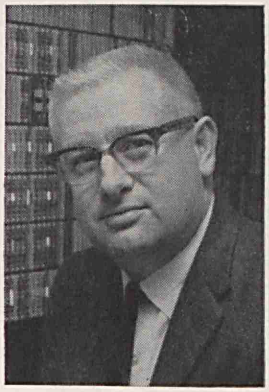
The world-wide AUTODIN network is another step toward the intermarriage of sophisticated communications equipment and data computers. The Overseas system when integrated with the CONUS system will provide the Department of Defense with a world-wide capacity of over producing 40 million punched cards daily or the equivalent of approximately 600 million words per day. This is a dramatic example of modern day data communications accomplishments.

What are some of the problems to be solved in the next generation of communications equipment? Perhaps the distribution of data communications at different speeds and format for several agencies within a local geographical area is a reality at the present time.

Further research studies on existing systems should reduce software memory space and provide more efficient use of the computer. This may result in increased standby real time of the computer. The standby time should be utilized for off-line manipulations. Such an off-line use during non-peak hours might take the form of an information repository for warehouse inventories, maintenance spare parts inventories, manpower and other administrative data. Just as the present Message Processors distribute parts of data information to many terminals, this new information repository would enable subscribers or a central administrative office to gather, store, process, program, retrieve, and distribute this information on the broadest possible scale.

References:

1. **AUTODIN**—System Description, Part I Network and Subscriber Terminals—H. A. Jansson, Western Union TECHNICAL REVIEW, January 1964 Vol. 18 No. 1.
2. **AUTODIN**—System Description Part II—Circuit and Message Switching Centers—H. A. Jansson, Western Union TECHNICAL REVIEW, April 1964 Vol. 18 No 2.
3. **AUTODIN**—Switching System—Technical Control Facility—F. B. Falknor, Western Union TECHNICAL REVIEW, October 1963 Vol. 17 No. 4.
4. Message Protection in the AUTODIN Message Switch—R. L. Snyder, Western Union TECHNICAL REVIEW, July 1964 Vol. 18, No. 3.
5. **AUTODIN**—System Description DCS—Defense Communications Agency—Defense Communications Engineering Office (DECEO) Engry Publication H500-2-65.



RALPH M. POOL, Director of AUTODIN Overseas, in the Information Systems and Services Department, is responsible for the AUTODIN Overseas Project. He is responsible for system integration, system planning, cutover for service, procurement evaluation, and monitoring.

Mr. Pool joined Western Union in 1947. During his field career, he has been responsible for the systems planning and cutovers, including Plans 21, 51, 55, and 111, bomb alarm sensors, line-of-sight microwaves, and AUTODIN Users.

Mr. Pool received a BSEE from Northeastern University, Boston, Massachusetts, in 1947. He graduated from the United States Army Air Corps, Navigation and Radar School, Hondo, Texas, with honors and outstanding achievement in 1944.

He has been active in the Institute of Electrical and Electronics Engineers and the Armed Forces Communications and Electronics Association.

Vice President's Message
Announcements

Schenk, P. J.: Western Union Serves the Federal Government
Western Union TECHNICAL REVIEW, Vol. 20, No. 1 (January 1966)
pp. 2 to 3

Since the Federal Government has many specialized needs for message-switched and circuit-switched data communications systems, Western Union established the Government Communications Systems Department, with headquarters in Arlington, Va.

This announcement defines the objectives of the Government Communications Systems Department.

AUTODIN
Tape Transmitters
Circuits
Stepping Motors

Kirkowski, S. A.: High Speed Tape Reader
Western Union TECHNICAL REVIEW, Vol. 20, No. 1 (January 1966)
pp. 4 to 7

The High Speed Tape Reader was designed by Western Union for the AUTODIN system. It has many applications in other systems such as EDAC and the Plan 38 Switching System.

It is a light, compact, low-cost unit, extremely versatile, reliable and almost free of maintenance.

The salient features of the Tape Reader, including its special motion sensing contact, are described in this article. A stepping circuit used in the unit permits the reading speed to be varied and the bi-directional mode to be utilized.

GSA—Advanced Record System
Switching Systems
Computer Techniques
Data Processing

Carruth, D. E.: ARS Advanced Record System
Western Union TECHNICAL REVIEW, Vol. 20, No. 1 (January 1966)
pp. 8 to 17

The Advanced Record System was developed for the General Services Administration to provide a single, integrated common-user record communication system for the various agencies of the Federal Government.

This is a general article covering the interconnection of the two major components of the system, the Circuit Switching Network and the Message Switching Centers. It includes block diagrams of the Message Flow through the District Office and through the Junction Office. The special features of the Circuit Switching Network are outlined and the interconnection of the hardware components of the Message Switching Center are described briefly. Some of the Narrowband calls made within the Circuit Switch Network are cited as well as a definition of the Computer Programs used in the Message Switching Center.

Switching Systems
PWS
Message Switching

Cowan, J. R.: Form-Feed Message Delivery System
Western Union TECHNICAL REVIEW, Vol. 20, No. 1 (January 1966)
pp. 18 to 22

The Form-Feed Message Delivery System was developed by Western Union for the United States Air Force to automate the in-office handling of these messages and to speed their delivery to the addressees. Many such messages require distribution to more than one addressee.

This article points out some of the delivery problems which were overcome by this system. A description of the components and the operation of the system is included.

The unique feature of the system is the absence of any control wires between the Operating Table and the Receiving Teleprinter.

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History
Production
Announcements

Killilea, M. C.: Growth of the Western Union TECHNICAL REVIEW
Western Union TECHNICAL REVIEW, Vol. 20, No. 1 (January 1966)
pg. 23

This announcement describes the circulation growth of Western Union's technical publication.

AUTODIN
Switching Systems
Management Techniques
Technical Control

Caley, H. F. and Schultz, F. W.: AUTODIN—CONUS Expansion
Western Union TECHNICAL REVIEW, Vol. 20, No. 1 (January 1966)
pp. 24 to 33

The AUTODIN system, designed and developed by Western Union with the support of RCA, IBM and many other electronic companies was made operational in early 1962. Many new features and capabilities have been added since then under the direction of the Defense Communications Agency (DCA).

These added features and the expansion of the domestic portion of the AUTODIN system, AUTODIN-CONUS are included in this article. Some of the management techniques employed to insure the technical adequancy and the timely implementation of the overall system are outlined.

AUTODIN
Switching Systems
Management Techniques
Technical Control

Pool, R. M.: AUTODIN—Overseas Expansion
Western Union TECHNICAL REVIEW, Vol. 20, No. 1 (January 1966)
pp. 34 to 45

This article covers the expansion of the world-wide portion of AUTODIN. The Department of Defense purchased 10 new switching centers overseas to provide data communications from these points to government agencies in the United States.

Western Union's responsibility in serving the government is spelled out in this article. It also includes the operation of the centers, some special features of the centers, a description of the modern equipment used, and the function of the Technical Control area.

The initial AUTODIN configuration, adopted by the Defense Communications Agency in 1963 and called AUTODIN-CONUS, is the nucleus for the world-wide network.

Announcements
Trademarks

Western Union's New Trademark
Western Union TECHNICAL REVIEW, Vol. 20, No. 1 (January 1966)
p. 48

Western Union's new trademark appears on the TECHNICAL REVIEW cover of the January 1966 issue.

It will appear on all company publications.

western union

western union's new trademark

Western Union's new trademark appears on the front and back covers of this issue of the TECHNICAL REVIEW. The new logo will soon appear on advertising, sales promotion brochures, trucks, signs in Western Union offices and on company publications.*

The bold, modern design is symbolic of strength, stability and progress. The initials, WU, long associated with the name Western Union, are a formal part of the new trademark identification.

*Logo from Logogram—meaning word letter a phonogram representing a word

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For Index January 1964 — October 1965
see Vol. 19, No. 4

western union

JANUARY 1966

VOLUME 20 NO. 1

western union
serves
the federal government

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high speed
tape reader

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form feed
message delivery system

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advanced record system

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expansion of
AUTODIN-CONUS

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expansion of
AUTODIN-OVERSEAS

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western union

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Technical Review

volume 20 number 3 july 1966

contents

Cover: Artist rendition of ESK relay strip used in modular construction for the TWK Telex subscribers.

Printed in U.S.A.

Telex The Bridge to World

International communications has exhibited tremendous strides forward in the past 20 years. The importance of record communications is constantly increasing because of the difficulties of voice language barriers in the international field.

Telex has provided a common media for record communications among the nations of Europe. The International Consultative Committee, CCITT, is an international body which determines the standard signalling techniques and the operating criteria which shall be used among nations. This world body has modified its standards to keep pace with the ever changing nature of the communications technology. Therefore, it is natural that the Telex service should follow or adhere to these universally accepted techniques. This service necessarily grows as the world's need for record communication grows.

Today, Western Union Telex subscribers in the United States can dial directly other Telex subscribers in Europe. They can also contact Telex subscribers around the world via semi-automatic means. GENTEX, international cablegrams, sent from cities in West Germany to cities in the United States, are

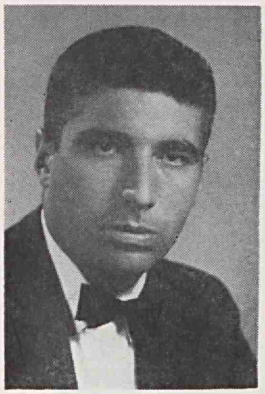
Communications

J. H. Weems, Jr.

transmitted via Telex. International cablegrams from cities in the United States can be transmitted via Telex to the international common carriers. Besides these, a fully integrated Telex system is provided between the United States, Mexican, and Canadian subscribers. Western Union is involved in all the above services.

Thus, it may be concluded that some of the present record communication modes, as well as those anticipated future modes, will help bridge world communications. Telex is often referred to as the BRIDGE TO WORLD COMMUNICATIONS.

J H Weems, Jr.



planning western union's telex system

—Kenneth M. Jockers

The growth and acceptance of the Western Union Telex Network is a demonstration of the continuing and increasing needs for record communications in American business. In 1958 Western Union Telex started in New York[1] as a satellite of the then existing Canadian Telex network. The equipment chosen for this first experimental offering was a Siemens' TW39, the same equipment used in Canada. Since the Canadian network, at this time, had over a thousand subscribers, it was obvious that the Western Union System, started in New York, would be very popular.

The immediate acceptance of the service in New York led to the installation of other exchange types in Chicago and San Francisco. Soon afterwards Los Angeles was added to the complex.

Up to this point Western Union's plans for further growth were based on the technical experience of the Canadian system and its principal equipment supplier, Siemens. Various types of equipment were installed in four cities. It soon became apparent that the responsibility for stipulating future equipment types and systems' development would necessarily be that of Western Union's engineering department.

Technical Considerations

The service now offered by Western Union Telex is basically a 50 baud, teleprinter exchange service using standard CCITT codes. The transmission is digital, either makebreak or polar from subscribers. On all trunks polar signals are transmitted utilizing space division Type 60 or 65 carrier. The exchanges are not limited to code and the minimum bit rate limitation is 5 ms. The Type 60 or 65 carrier makes the system limited to a minimum bit rate of 20 ms, and a maximum of six tandem sections. Under this arrangement no regeneration is required.

The billing of Telex subscribers is based on time and distance and is recorded as a bulk charge on a counter associated with each subscriber. The time and distance is obtained by translating the dialed digits into a pulse rate, which is then applied to the subscriber's counter. This technique of billing is simple and economical.

Phase I

The first phase in the planning of the three level Telex network featured the equipment tried at New York, Chicago, San Francisco and Los Angeles. The first level, junction office level, used TWM2 equipment, and all first level offices were fully interconnected. In order to improve trunk utilization, automatic alternate routing was provided to meet our requirement in TWM2 equipment. The second level, district office level, incorporated TW39 equipment, and concentrated its tandem traffic on one trunk bundle to its parent exchange. The TW56 concentrator and also TW39 equipment is used in the third level, sub-district office level, to con-

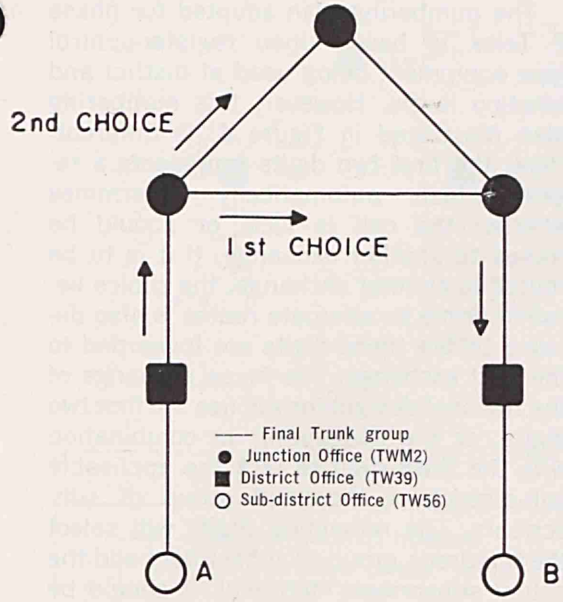


Figure 1. Phase I Simplified System

centrate subscribers into a parent district or junction office. A simplified first phase systems approach is indicated in Figure 1. Also shown in this figure is the alternate choice routing on a call originating in sub-district A, for a subscriber terminated in sub-district B.

Phase II

As the request for Telex service approached 10,000 subscribers, it became apparent that the equipment deemed applicable to the first phase would have to be supplemented or modified to fit into the expanded needs or the second phase of the Telex network. The features required for new exchange equipment proposed for phase 2, for a system of 100,000 subscribers, are as follows:

1. Full availability on trunk groups in order to increase the trunk utilization efficiency.[2]

2. Complete flexibility in alternate routing in order to gain the maximum advantage of high usage and final trunk groups in planning an economical system.

3. Two-out-of-five coded transmission of control signals between exchanges in order to decrease the connection set up time; therefore decreasing the holding time on common control equipment and decreasing the quantity of units required.

4. Subscriber classification by providing a two digit combination, for each subscriber, which precedes the control signals. This classification is compared with the destination subscribers classification in order to allow the connection or not.

5. Flexible subscriber concentrations in order to accommodate various traffic loads and an expandable tandem directional matrix that can handle heavy trunk loads.

6. The capability to terminate up to 30 sub-districts in a district.

7. Installation to a great extent on a plug-in basis in order to decrease installation time, effort and expense. Simplified grading and mixing patterns are also required.

8. In maintenance, much consideration was given to such things as: line and trunk routiners, trouble display and print out equipment, automatic fault diagnostic routine with lock-out, and plug-in functional units plus redundancy in all common control units.

These features are now being provided in our CSR4 and TWK4 equipment, described in this issue of the TECHNICAL REVIEW and in a new line of equipment called TWKD. Different type exchanges have been considered because of the economical advantages gained through engineering specific exchanges for particular system's levels and capacities. The CSR4 exchange can be used to terminate 8,000 subscribers or equivalent trunk groups; therefore designating its use as a junction or large district. The TWKD is a tandem exchange that can work in conjunction with sub-districts terminating approximately 2500 subscribers; therefore fixing its place at the medium size district level. The TWK4 is a modular type exchange that grows in increments of 50 to a maximum capacity of 200 subscribers; therefore making it a sub-district. Figure 2 indicates the simplified system for the second phase. A typical alternate route choice is illustrated in Figure 2 for comparison with Figure 1.

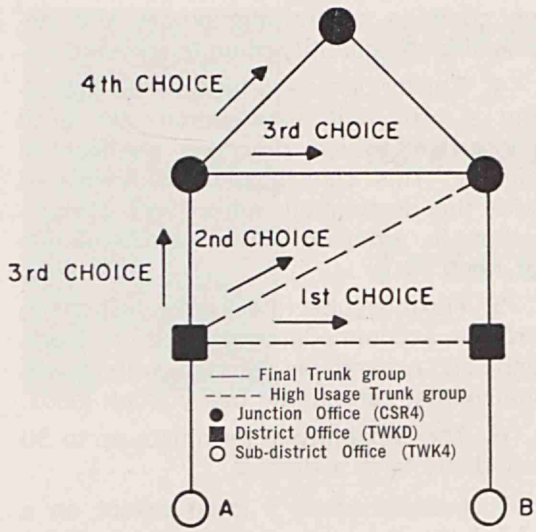


Figure 2. Phase II Simplified System

Numbering Plan

The numbering plan adopted for phase 1 Telex was based upon the type of equipment then used. This plan, illustrated in Figure 3 was essentially a step-by-step plan where each digit performed an actual routing process and was usually absorbed after being used. The first digit 0 was used by the TW39 district exchange as a local call discriminator. If the first digit is zero then the call was routed to the district exchange's parent junction and the zero (0) is absorbed. The junction then looks at the second digit to decide if the call should remain in its junction area. If the call is to be handled by this junction then the second digit is absorbed and the third digit is examined to select a district and then absorbed. The fourth digit is then used to select a sub-district, and the remaining digits are transmitted to the sub-district to select the actual subscriber. If the call is a local call, the subscriber can determine this from the first three digits in the directory. If they are the same as the calling party, then only the digits to the right of the hyphen are dialed. The absence of the first digit zero indicates that the call is to be locally routed. Under this numbering system a district can only terminate theoretically 9 sub-districts.

The numbering plan adopted for phase 2 Telex is based upon register-control type equipment being used at district and junction levels. However, this numbering plan illustrated in Figure 4, is different. Here, the first two digits represents a region which automatically determines whether the call is local or should be routed to another exchange. If it is to be routed to another exchange, the choice between prime or alternate routes is also decided before these digits are forwarded to the next exchange. The home exchange of the regional designator will use the first two digits, or the designator, in combination with the third digit to pick the applicable sub-district or thousand group of subscribers. The remaining digits will select the hundreds group of subscribers and the actual subscribers' terminal. It should be noted that more than one regional designator can be used for the same home exchange; therefore making the number of sub-districts expandable beyond the previously mentioned eight.

This new numbering plan has the following advantages.

1. Eliminates the dialing of the digit zero (0) on transient calls which are approximately 90 percent of all calls.

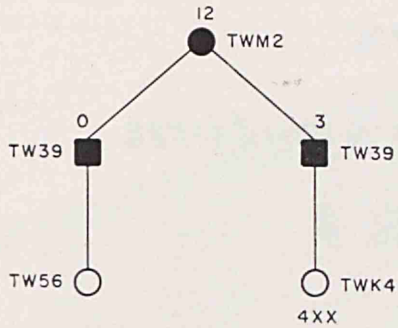
2. The full combination of digits is dialed on all calls.

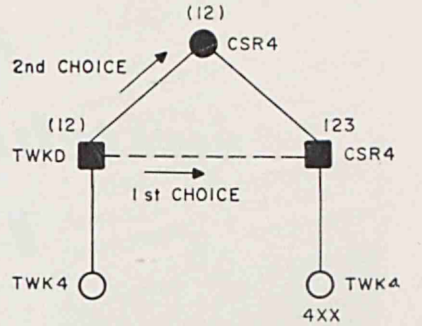
3. Since the regional designator is read and retransmitted on transient calls, more effective use is made of high usage and final trunk groups.

4. Allows greater flexibility in assignment of sub districts, because more than one regional designator may be assigned to the same region.

New Horizons

Planning the Western Union Telex network is not static, rather it is constantly changing. Because private business and government are our customers, the Western Union Telex network must keep up-to-date with modern business requirements. New services are constantly being planned. These new services using new codes and new baud rates will further enhance the overall system.





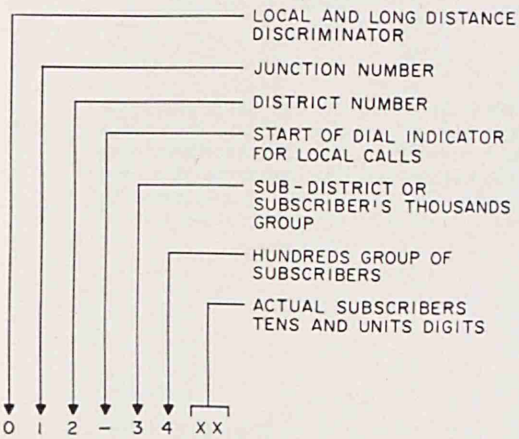


Figure 3. Phase I Numbering System

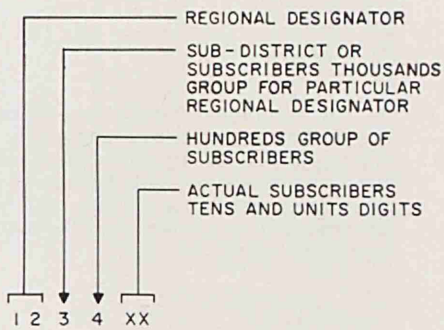
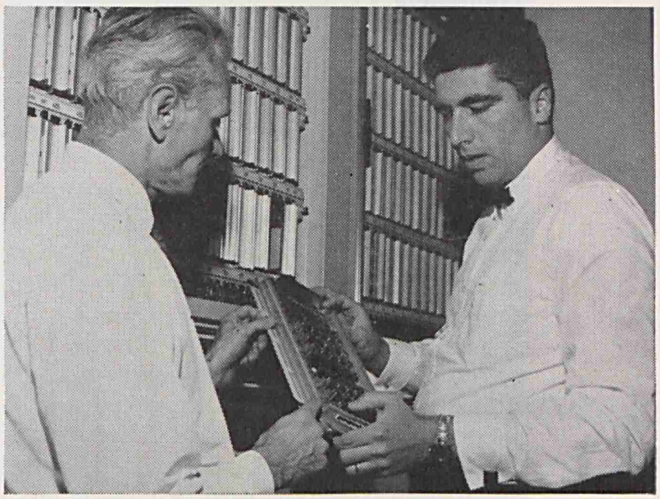


Figure 4. Phase II Numbering System

As the system grows and technologies advance, it is expected that new exchange types with more demonstrable economies may be incorporated in the overall plan. Registers, markers and translators with computer techniques, more sophisticated methods of billing, pulse code modulation, solid state matrices, and automatic load leveling are but a few of the areas under investigation for the future.

References

1. Telex in New York, Philip R. Easterlin, Western Union Technical Review, Vol. 13, No. 2, April 1959.
2. Traffic Evaluation, K. M. Jockers, Western Union Technical Review, Vol. 17, No. 4, October 1963.



Kenneth Jockers is shown above (on the right) discussing one of the modules for the new TWKD exchange with Hans Dobermann of Siemens while on a recent visit to Siemens, in Munich, West Germany.

Kenneth M. Jockers, Telex Systems planning engineer in the Information Systems and Services Department, has been responsible for the basic planning of the Telex system and for the development and implementation of the new equipment, such as the CSR4, TWK4, TWM2 and Type 600 exchanges.

telex switching system TWK4

—John J. Wunner Jr.

The Automatic Teleprinter Exchange, TWK4, is a sub-district level exchange connected to a parent exchange (district office or junction office) by means of trunks. The basic TWK4 has facilities to terminate up to 50 subscribers with up to 12 two-way Trunk Repeaters and 3 Local Repeaters (for connections within the TWK4 service area). By adding more units, the TWK4 can be expanded to terminate a maximum of 200 subscribers with up to 48 Trunk Repeaters and 12 Local Repeaters.

Equipment

The TWK4 equipment is contained in steel cabinets which stand seven feet high. Two cabinets are required for an exchange of up to 50 subscribers: a Common Control cabinet and a subscriber cabinet. The Common Control cabinet contains the facilities for zoning, dial digit evaluation and class-of-service evaluation. The subscriber cabinet contains the subscriber facilities, Repeaters and Storages. One cabinet is required for each additional 50 subscribers. A configuration of five cabinets for a maximum of 200 subscribers is shown in Figure 1.

The Supervisory Panel, located in the upper part of each subscriber cabinet, contains the automatic circuit breakers, heavy-duty subscriber line and bias resistors, blocking buttons, busy lamps (for the Repeaters and Storages) and two milliammeters (for monitoring the subscriber and trunk lines.) Installed below the Supervisory panel are the subscriber pulse rate counters.

The lower part of the subscriber cabinet contains seven shelf frames, one of which is shown in Figure 2, which accommodate the individual equipment units (modules) of the system, and which interconnect electrically the modules of one shelf. The shelf frames also terminate the connections

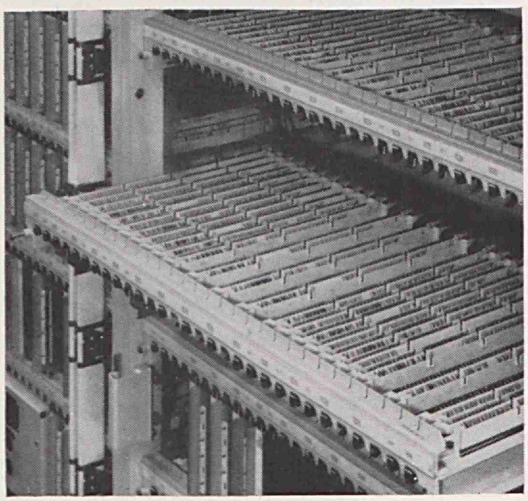


Figure 2. Shelf Frame

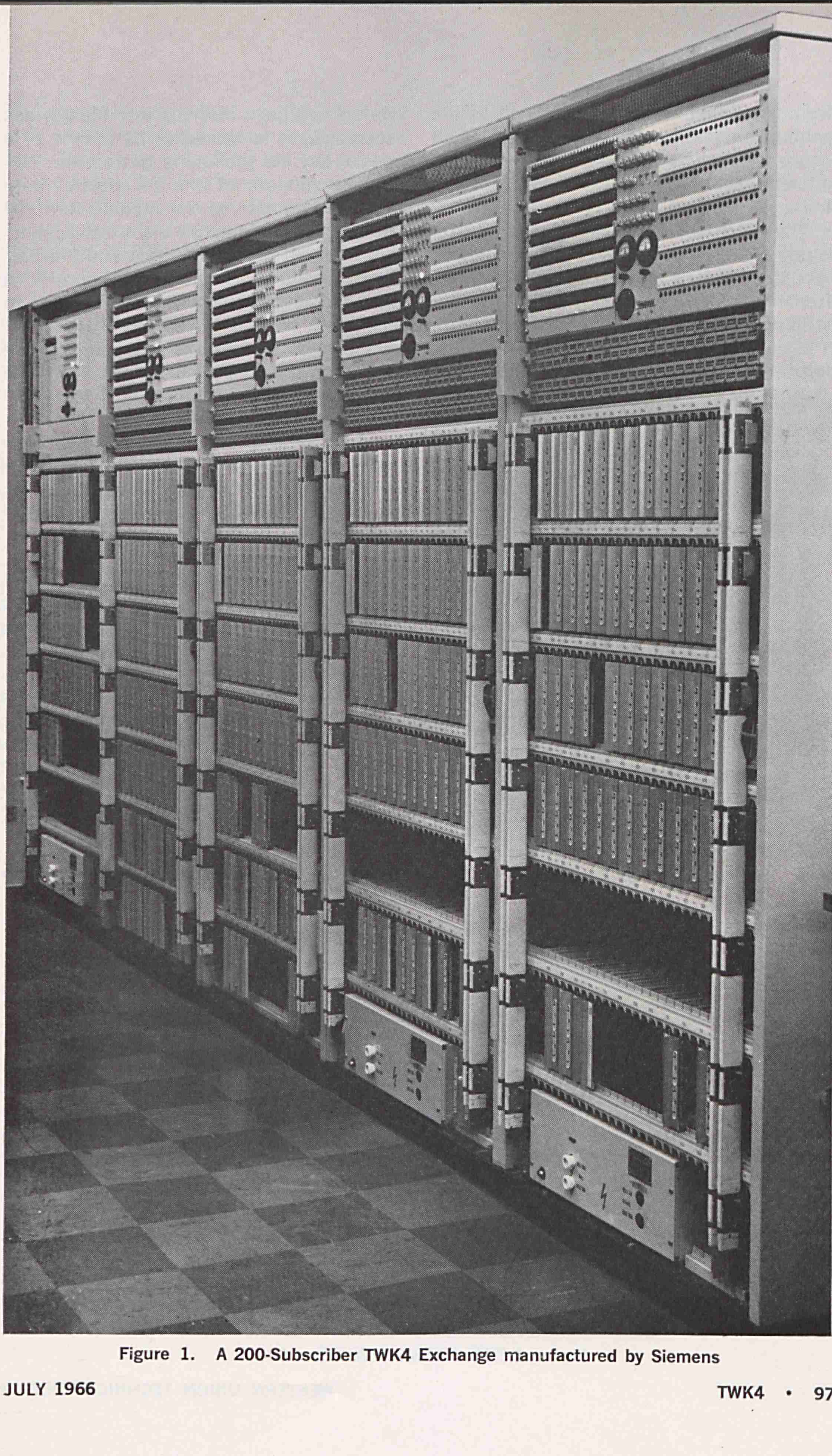


Figure 1. A 200-Subscriber TWK4 Exchange manufactured by Siemens

from the Supervisory Panel as well as the connections from adjacent cabinets. Shelf connectors, shown in Figure 3, are used to interconnect electrically each of the shelf frames.

The electrical components, such as relays, resistors, diodes, etc. are mounted in modules, each of which consists of a metal frame provided with a 104-point terminal strip connector. This connector mates with a keylock receptacle installed on the shelf frame as shown in Figure 4. After the module has been inserted into the keylock receptacle, it is locked in by means of a special key. As the key is turned, the 104 double contacts of the receptacle mate with the contacts of the module terminal strip, thus providing an electrical connection between the shelf frame and the particular module, as shown in Figure 5. A mechanical interlock allows the module to be locked in only when the 104 terminals of the module are aligned with the 104 terminals of the connector. This also

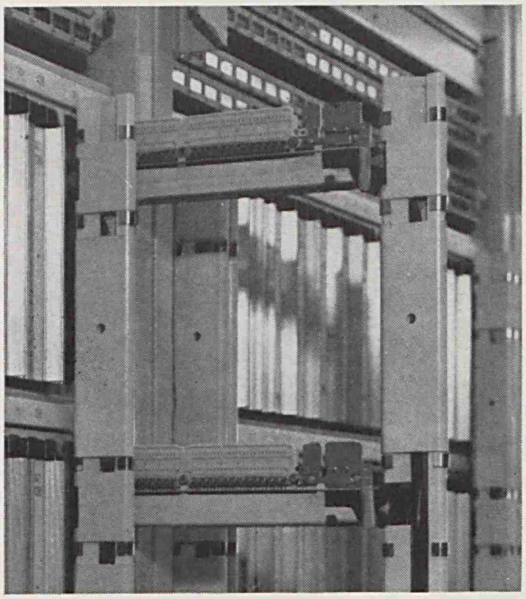


Fig. 3. Shelf Connector

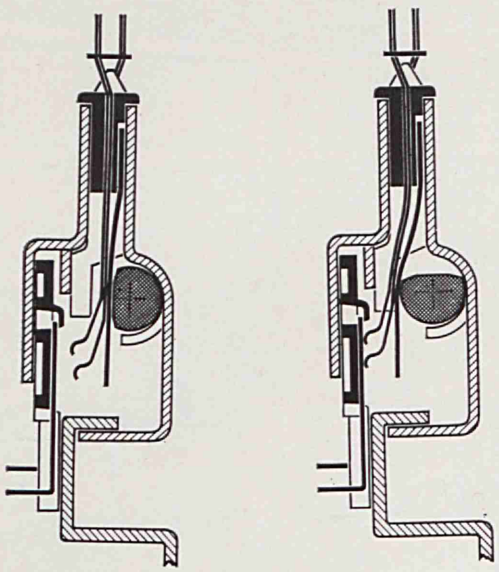


Fig. 5. Mechanical Interlock of Shelf Frame and Module

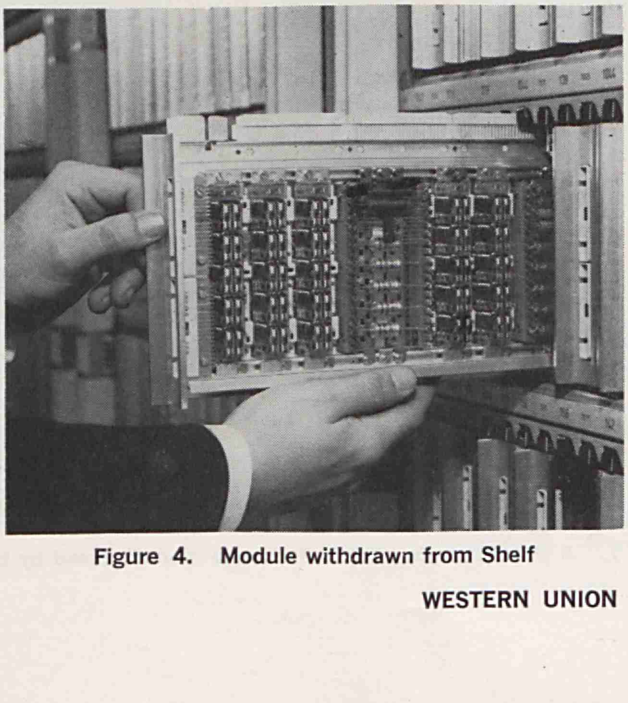


Figure 4. Module withdrawn from Shelf

ensures that a module can be removed only when the electrical connections have been broken by unlocking the key.

The subscriber and trunk lines are connected to the Supervisory Panel from a terminal box via two cables, each of which is fitted with a 104-point terminal strip connector.

The TWK4 lends itself to mass production due to the fact that each module is machine-wired under the control of a programmed tape and computer. The components, such as module frames, shelves and 104-point terminal strip connectors are of standard construction, differing only in wiring, thus reducing manufacturing costs.

Another contributing factor to the low cost of the TWK4 is the use of the ESK relay. A 5-unit relay strip is shown in Figure 6. Almost all functional relays in the TWK4 are of the ESK type. Only the telegraph relays in the Repeaters are different; these are polar relays of the conventional design. The ESK relays used are basically of the same simple construction, differing from each other only in coil resistance and contact arrangement. The simplicity of the relay design is due primarily to the fact that the two moving parts of a relay, the armature and the contact springs, are here combined into a single unit as shown in Figure 7. This arrangement is also responsible for the extremely high switching speed (normally less than 2 milliseconds).

When the ESK relay is energized, the contact armatures move towards the polar strips; however, the contacts mate before the armatures touch the polar strips. Since each contact is actually an armature, the force with which each contact armature is accelerated is independent of the number of contacts. The fact that these relays are assembled in groups of five, permits economical production, and at the same time, presents a unit which is sufficiently flexible to fulfill most switching circuit requirements.

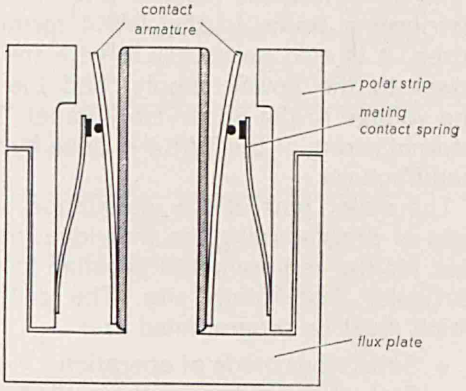


Figure 7. Simplified Relay Design

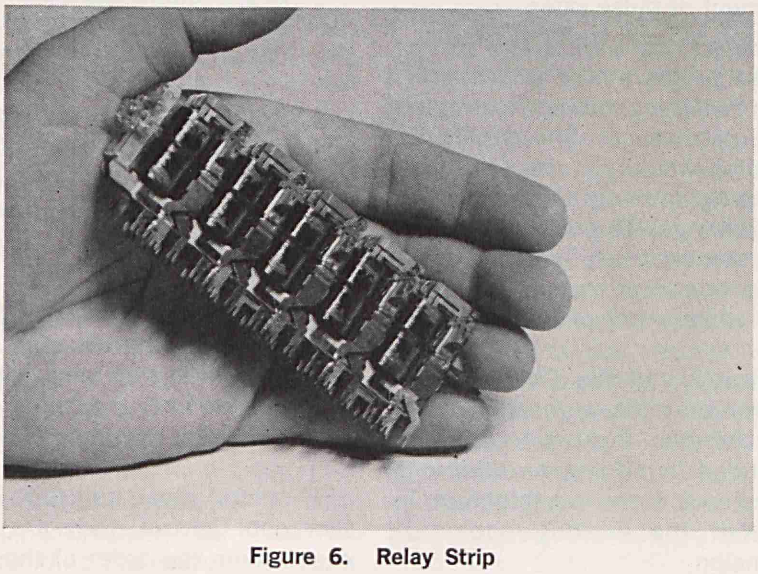


Figure 6. Relay Strip

Ease of Installation

A typical TWK4 exchange can be completely installed and made ready for testing within a period of three to five days. Approximately two weeks are allowed for a thorough testing of the TWK4 functions and for additional training of the field personnel who will be responsible for the maintenance of the TWK4.

Although the compact construction and computer-controlled wiring of the modules tend to make the TWK4 Exchange more intricate than other Telex exchanges, the installation is quite easy. The only major wiring required at the site is the wiring necessary to connect the subscriber and trunk lines from the main or intermediate distributing frame to the TWK4 terminal boxes. It is also necessary to wire the ac power to the power supply, and the dc line voltage to the Supervisory Panel. The internal wiring of the TWK4 is done by the manufacturer.

The major part of the installation consists of programming the individual modules for the requirements peculiar to the particular installation site. The criteria which must be programmed are:

- Subscriber mode of operation
- Evaluation of two or three digits on an incoming call
- Evaluation of three or four digits on an outgoing call
- Evaluation of collective numbers
- Assignment of pulse rates
- Evaluation of local traffic digits.

Most of the programming is performed by inserting switching diodes on printed circuit diode matrix cards. Should there be a change which would require an adjustment in the programming, this method facilitates the change. This type of change occurs for instance, when Telex service is extended to a new location, and an adjustment in the assignment of pulse rates is necessary.

The construction of the TWK4 is such that when, for example, a location which has a 50-subscriber, 2-cabinet configuration is expanded by adding an additional subscriber cabinet, there is a minimum interference with the existing equipment during expansion.

Special Features

- **Common Control**

The primary feature of the TWK4 Exchange is the use of a central control device called the Common Control, which coordinates all the functions of the exchange, as illustrated in Figure 8. Each control process is governed by one of the following programs in the Common Control which is selected by a request from one of the units of the TWK4:

Outgoing Seizure

This program connects a calling subscriber to a Trunk Repeater and arranges the connection of a Storage to the chosen Trunk Repeater.

Incoming Seizure

This program arranges the connection of a Storage to the particular Trunk Repeater which has been seized by the parent exchange.

End-of-Selection/Through Connection

This program arranges the actual connection of a call and causes the release of the units used in setting up the connection.

End-of-Selection/Zone Information

This program arranges for the transmission, and monitors the interpretation of the zoning information required to select the correct pulse rate.

End-of-Selection/Local Traffic

This program arranges to have a call transferred from a Trunk Repeater to a Local Repeater during the interdigit time.

End-of-Selection/Collective Number

This program transfers the functions of marking the subscriber to be connected from the Dial Evaluator to the Collective Number Evaluator.

If several requests are to be met by the Common Control, they are handled successively in the order of their importance.

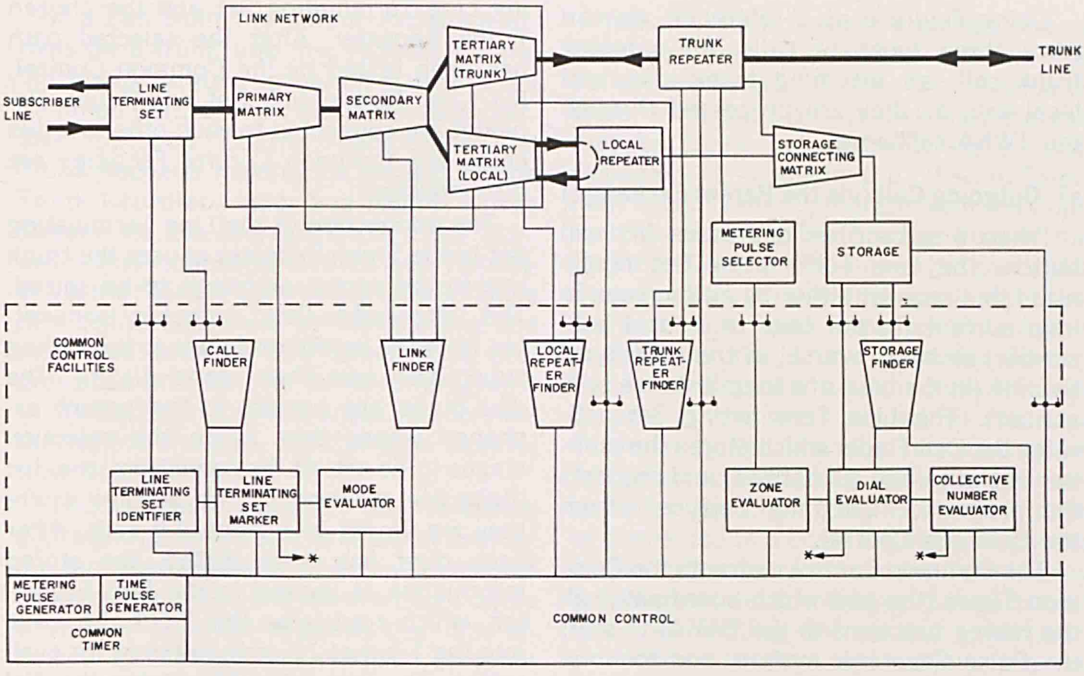


Figure 8. Block Diagram of the TWK4 Exchange

When a call is accepted by the TWK4 Exchange, it may request as many as four different programs from the Common Control during the setting up of a connection. The Common Control is designed to process programs quickly since it must be available to run other programs for calls being processed at the same time. Auxiliary units such as finders, markers, identifiers and evaluators as illustrated in Figure 8, are available to the Common Control, for use in running the various programs.

- **Local Traffic**

To reduce the holding time on trunks, a message between two subscribers connected to the same TWK4 can be handled exclusively by the facilities of the TWK4 exchange. In this case, the functions of transmitting the telegraph signals of the calling subscriber to the called subscriber and vice versa and of supervising the connection, are performed by the Local Repeater, thus avoiding the use of two Trunk Repeaters for this type of call.

- **Class of Service Information**

The TWK4 exchange is capable of sending and receiving class-of-service information and receiving dial information in a two-out-of-five code. The coded class of service information can be used to insure compatibility of the calling and the called subscribers. When a subscriber of the TWK4 exchange is connected to a Trunk Repeater, his class-of-service code is automatically transmitted to the parent exchange. Comparison of the class-of-service codes is made at the exchange of the called subscriber. When the TWK4 receives an incoming call, it makes a comparison of the class-of-service codes of the called and calling subscriber, before making the connection. It should be noted that this feature is optional. While every TWK4 exchange has the capability of class-of-service operation, it may be omitted by programming the associated modules accordingly.

Types of Calls

Using Figure 8 as a reference, we can trace three types of calls: an outgoing trunk call, an incoming trunk call, and local call, as they are processed through the TWK4 exchange.

a) Outgoing Call (via the Parent Exchange)

When a subscriber depresses his call button, the Line Terminating Set recognizes this request either by an increase in loop current (in the case of a local subscriber) or by a reversal in the polarity of the line (in the case of a long-distance subscriber). The Line Terminating Set activates the Call Finder which stores the number of the calling subscriber, and requests the program, "Outgoing Seizure," from the Common Control.

The Common Control instructs the Common Timer (the unit which coordinates all the timing functions in the TWK4) to start the Pulse Generator motors, and then via the Call Finder, instructs the Line Terminating Set Marker to mark the subscriber-side output of the Link Network. This Link Network, which provides the connecting paths from the Line Terminating Sets to the Trunk Repeaters, is a three stage, four-wire matrix utilizing ESK relays for each crosspoint. Then, the Line Terminating Set Marker, via the Mode Evaluator, informs the Common Control of the mode-of-operation (local or long-distance) of the calling subscriber. The Common Control stores this information for later reference.

The Common Control then chooses, via the Trunk Repeater Finder, a free Trunk Repeater. The Trunk Repeater Finder marks the repeater-side output of the Link Network. Next, the Common Control chooses, via the Storage Finder, a free Storage which is then connected to the Trunk Repeater via the Storage Connecting Matrix. The Storage performs the function of reading and storing each dial digit as it is passed from the calling subscriber to the Trunk Repeater.

Information regarding the subscriber mode-of-operation is transferred to the Trunk Repeater, which adjusts its circuits accordingly. The Common Control instructs the Link Finder to select a free connecting path in the Link Network between the calling Line Terminating Set and the chosen Trunk Repeater. After the selected path has been tested by the Common Control, the Line Terminating Set and Trunk Repeater are connected to each other. At this point, the Common Control Facilities are disconnected.

The connection of the Line Terminating Set to the Trunk Repeater causes the trunk line to the parent exchange to be seized. The "Proceed-to-Dial" signal is transmitted from the parent exchange to the calling subscriber, who then starts dialing. The dial digits are passed to the parent exchange where they cause the selection stages to be set. At the same time, the dial digits are received by the Storage where they are stored in a 2-out-of-5 code. After each digit has been dialed, the stored information is passed to the Dial Evaluator, which translates the 2-out-of-5 code into the 1-out-of-10 code required for evaluation. The Dial Evaluator passes the dial information to the Zone Evaluator which determines the rate zone of the desired connection (the metering pulse rate) when it has received enough dial digits. The Common Control is again seized at this point and runs the program "End-of-Selection/Zone Information" to provide for the transmission and interpretation of the rate zone information. When the rate zone information has been transferred to the Metering Pulse Selector, the Common Control again releases. The Metering Pulse Selector will, upon receiving the call-connected signal from the Trunk Repeater, connect the applicable pulse rate to the calling subscriber's pulse rate counter. When an invalid combination of digits is dialed, the call is immediately disconnected.

Upon reception of the call-connected signal from the parent exchange, the Metering Pulse Selector begins transmitting the metering pulses to the subscriber's pulse rate counter via the Link Network, and message transmission commences. The Trunk Repeater supervises the condition of the connection and upon detection of the disconnect signal, releases the connection without resorting to the Common Control.

b) Incoming Call (via the Parent Exchange)

If a call from the parent exchange arrives on a trunk line, the request for the "Incoming Seizure" program is sent to the Common Control from the Trunk Repeater. The Common Control determines the Trunk Repeater making the request via the Trunk Repeater Finder and locates a free Storage via the Storage Finder. The Storage is then connected to the Trunk Repeater via the Storage Connecting Matrix. Since this connection must be made within the inter-digit time of 600 msec., this program has priority over all other programs in the Common Control. Upon the connection of the Storage, the Common Control is disconnected.

The Storage accepts the incoming digits and passes them to the Dial Evaluator for interpretation. The Dial Evaluator decodes the digits and, when enough digits have been received, requests the "End-of-Selection/Through Connection" program from the Common Control which then instructs the Dial Evaluator to pass the number of the called subscriber to the Line Terminating Set Marker. If the Dial Evaluator recognizes, from the digits dialed, that the call is to be connected to a collective number subscriber, it requests the "End-of-Selection/Collective Number" program from the Common Control. In this case, the Line Terminating Set Marker receives the information on the position to be connected from the Collective Number Evaluator. The two ends of the Link Network are marked via the Line Terminating Set Marker and the Trunk Repeater Finder. The Link Finder determines a free link which is then tested by the Common Control. Before the actual through-connection is made, the Common Control carries out a "busy-condition" check of the called subscriber, determines the operating mode of the called Line Terminating Set and passes this information on to the Trunk Repeater. The call is then through-connected.

The Common Control, Dial Evaluator and Storage are then released. Supervision of the line and interpretation of the clearing signal are handled by the Repeater in the same way as described for an outgoing call.

c) Local Call

Initially, the processes are the same as described for an outgoing call via the parent exchange. If the Dial Evaluator finds, from the digits dialed, that the call may be connected internally via a Local Repeater, it requests the "End-of-Selection/Local Traffic" program from the Common Control. Via the Storage Finder, the Common Control determines the particular Storage associated with this call and then, the particular Trunk Repeater. Potential is applied via the Trunk Repeater Finder, the Trunk Repeater and the Link Network to one of the wires routed to the Line Terminating Set. The Line Terminating Set Identifier connected to this wire now determines the Line Terminating Set to be re-connected to a Local Repeater. It passes on this information to the Line Terminating Set Marker, thus marking the particular Line Terminating Set on the subscriber-side output of the Link Network. Via the Local Repeater Finder, the Common Control locates a free Local Repeater. The Local Repeater Finder marks the repeater-side output of the Link Network. The connection between the Line Terminating Set and the Trunk Repeater is released, whereby the trunk line is also released and the seized selection stages in the parent exchange are cleared. The Storage is disconnected from the Trunk Repeater, causing it to clear any digits stored up to this point, and is re-connected to the Local Repeater. The Common Control tests the link chosen by the Link Finder. The link between the Line Terminating Set and the Local Repeater is then through-connected. The Common Control Facilities are released. All the above processes take place in the inter-digit time.

From this point on, the call is processed in the same manner as the "Incoming Call" described previously except that the call is now on a Local Repeater. In addition the Dial Evaluator determines from the digits dialed if the call is to be connected free-of-charge or at the fixed local rate. For a chargeable call, the metering pulses are fed directly into the Local Repeater and then, via the Link Network, to the calling subscriber's rate counter.

Summary

The TWK4 satisfies Western Union's requirement for a sub-district exchange which can most economically provide Telex service to those small cities in the United States which are located in areas of potential growth. The TWK4 will be installed to replace the TW56, which has a smaller capacity (20 subscribers). It will also be installed in completely new locations. As the number of Telex subscribers grows in a TWK4 service area, the TWK4 facilities may be expanded, in steps, to meet any need to a maximum of 200 subscribers. It is planned, that within a couple years approximately 200 TWK4 exchanges will be in operation at the sub-district level, terminating about half of the total number of subscribers in the Telex system at that time.

At the present time, preliminary designs are being considered for a new exchange, the TWKD, which has many of the design features of the TWK4. The TWKD exchange will serve the Telex system at the district level.

The TWKD is a tandem switching exchange using mostly ESK relays in the circuit design. The construction will be similar to the TWK4, in that the electrical components will be mounted on slide-in modules which are inserted into shelves for electrical connection to other units. The design will differ in that enclosed racks will be used rather than stand-up cabinets. The use of an enclosed rack will allow more height for mounting the equipment than would be available in a TWK4 type cabinet.

The TWKD will have a maximum capacity of 792 Trunk Repeaters and will route in up to 20 directions, using a four-stage folded matrix, with up to five alternate route possibilities for certain trunk groups. The designations of the individual Trunk Repeaters to the various directions can be freely chosen by means of programming diodes on printed circuit diode matrix cards.

The TWKD Register will have the capability of receiving 2-out-of-5 dial information or dial pulses; it also may or may not send and receive class-of-service (COS) information. If the TWKD is programmed to receive COS, it can use this information to determine a particular route.

The TWKD will be used to terminate all types of the presently used sub-districts, namely TWK4, TW56, and TW39; and in most cases each TWKD will have a TWK4 co-located with it to serve local subscribers.

JOHN J. WUNNER, JR. has been a member of the Telex Section, Information Systems and Services Department, since joining Western Union in June 1965. His work has primarily been concerned with the testing and evaluation of the TWK exchanges and preparation of the operations specifications of the TWK type exchanges.

Mr. Wunner received his Bachelor of Electrical Engineering degree from Manhattan College.

From the
Editor's Desk

our special telex issue

Our Response to Challenge

We, in Western Union, today take as a challenge what seemed, only a few years ago, a fantastic speculation. The challenge is the need to put in place a nationwide data communication network that will give anyone in business or government instant access to computer-stored information. Some of what has been done to date to meet this challenge has been documented, in this special issue on Telex, by some of our most knowledgeable engineers.

Western Union Telex has grown phenomenally during the eight years since its introduction. As this issue goes to press, there are more than 16,000 subscribers, with 1,350 additional waiting for service; and Telex revenues have reached a $25 million annual rate.

We are now preparing to become a nationwide information utility, providing a broad range of communication/information systems and services to customers of all kinds; and there appears to be almost no limit to the potential for future growth of Telex service. All who have contributed to its growth up to the present must now face the new challenges of the "information revolution."

This special issue on Expanded Telex Services is the largest issue in the history of Technical Review. It is a tribute to our authors who are experts in the Telex field — and a tribute to all others who are helping to create a new future for Western Union Telex.

Mary C. Killilea

pulse rate monitor

—Melvyn M. Feldman

The Pulse Rate Monitor is a device used to sample pulses to the pulse generator. When a generator is seized, and when the AUTO-STOP STEP switch is in the AUTO position the monitor samples all pulse rates. When the generator is released, the last pulse rate sampled is indicated on a pulse lamp on the monitor panel.

In Telex exchanges timing of pulses is a vital factor. Western Union recently developed a new Pulse Generator Rate Monitor 11346, which insures correct pulse generator outputs and samples electronically all pulses sent via the pulse generator.

It is important to note that in each Telex exchange, there are two pulse generators. One generator is normally on-line; the other is used as fall back. If the fall back is used, an office alarm condition occurs.

The monitor is designed so that an alarm is registered if, (1) pulse rates vary by more than a predetermined frequency, (2) a no-pulse condition occurs (open or grounded lead), or (3) a continuous pulse condition exists.

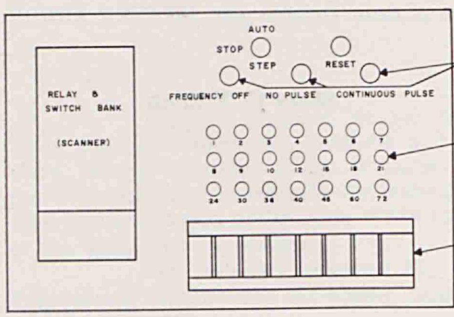


Figure 1. Front Panel of Pulse Rate Monitor.

Figure 1 shows the arrangement of the indicators on the Pulse Generator Monitor Panel. The panel shows four basic sections: 1) an electromechanical scanner, to the left, 2) a control section consisting of an AUTO-STOP-STEP switch and RESET button, 3) an alarm section consisting of: 3 lamps labelled FREQUENCY-OFF, NO-PULSE, and CONTINUOUS-PULSE plus 21 pulse lamps labelled with specific pulse rates, and 4) a sampler section consisting of electronic logic cards. The numbers associated with the pulse lamps indicate the pulse rate sampled in pulses per minute.

Automatic Sampling

The Rate Monitor automatically samples all pulse rates to the Pulse Generator, as viewed in the scanner. If a fault condition occurs, while the Pulse Generator is seized, the alarm relay on the monitor is operated. This causes an audible and visual alarm, the scanner stops scanning and one of the 3 alarm lamps lights up. One of the 21 pulse indicating lamps lights up too, indicating the pulse rate which faulted. Thus, the maintainer can pinpoint the pulse rate in trouble and take corrective action. The AUTO-STOP-STEP switch is then thrown to the STOP position.

When the fault is cleared, the RESET button is depressed. This clears the exchange alarm and again allows the monitor to sample the pulse rate.

If the fault has not been cleared when the RESET button is depressed, the alarm will be reinitiated. If no alarm condition occurs, when this button is depressed, the AUTO-STOP-STEP switch is thrown to AUTO position, thus restarting the scanner.

western union

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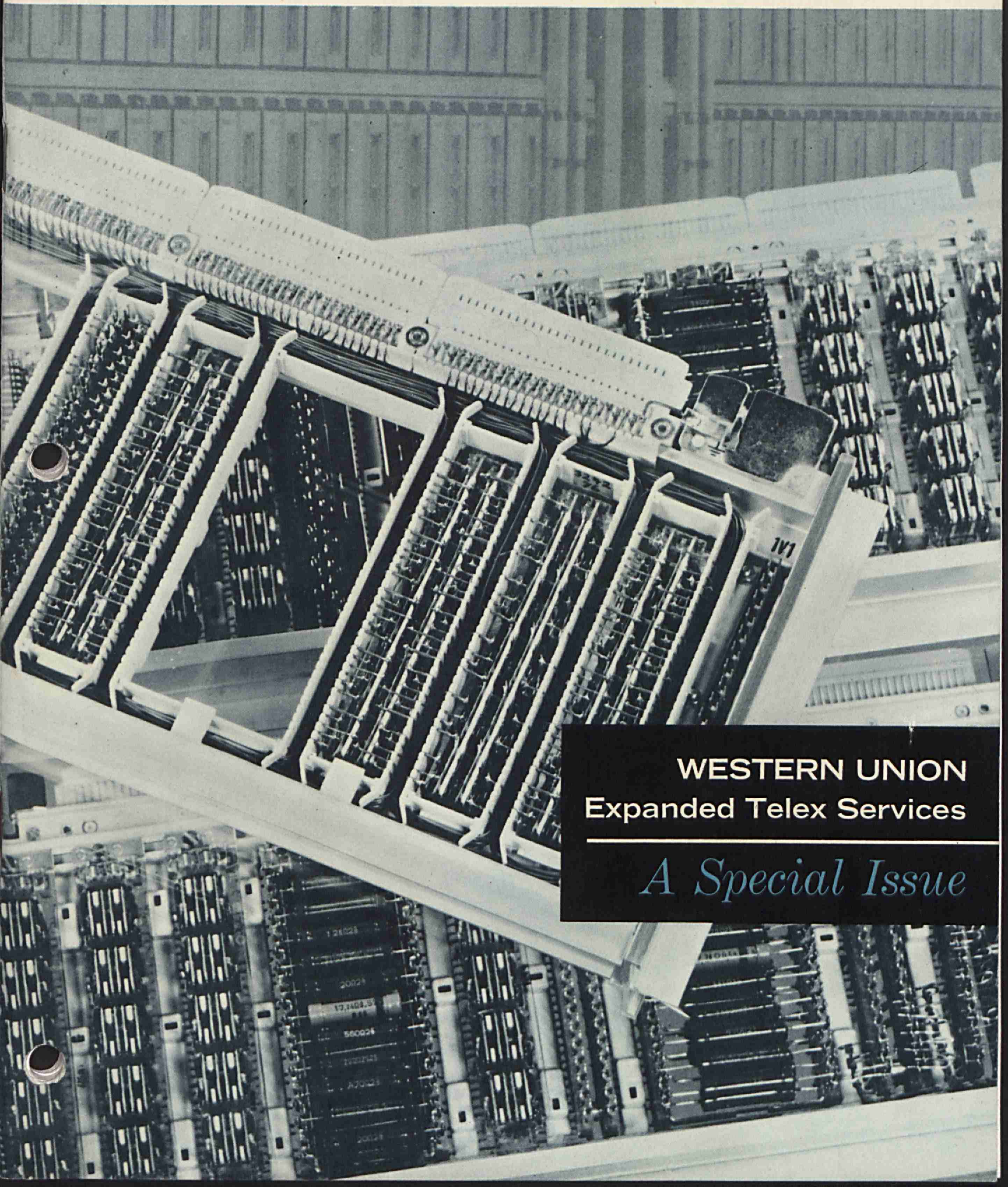

WESTERN UNION
Expanded Telex Services

A Special Issue

Manual Sampling

In addition to automatic sampling, a specific pulse rate can be sampled manually by alternately moving the AUTO-STOP-STEP switch from the STOP to the STEP position. Each time this is performed, the switch steps once.

Alarms

The three alarm lights indicate the following three alarm conditions:

a) FREQUENCY-OFF is an alarm condition which is indicated when a pulse frequency varies by more than a predetermined amount. If the frequency is greater than that limit, the following steps take place: 1) the FREQUENCY OFF lamp lights, 2) the monitor stops scanning, 3) the office alarm is actuated and 4) the lamp associated with the sampled pulse lights up.

b) NO PULSE is a condition which occurs when an open circuit or ground is on a pulse output lead.

If the no pulse condition persists for 40 seconds, the NO PULSE lamp comes on and consequently the office alarm is actuated. The lamp associated with the sampled pulse will also be on.

c) A CONTINUOUS PULSE alarm indicates that the −60 volts lead is shorted to a pulse output lead. If, within 40 seconds, the condition is not cleared, the CONTINUOUS PULSE lamp will light and the office alarm is actuated. As in the alarms of NO-PULSE and FREQUENCY-OFF, the lamp associated with the sampled pulse will also be on.

Controls

The controls at the top of the panel constitute a lever switch and a reset button.

b) When a definite pulse rate is sampled, the AUTO-STOP-STEP switch is used to step the scanner to this desired pulse rate. This is done by throwing the switch alternately between the STEP and STOP positions. When the desired pulse rate is reached, the AUTO-STOP-STEP is left in the STOP position. Then the pulse rate will be continously sampled.

b) Each time an alarm condition occurs, and after the alarm condition is cleared, the RESET button is depressed; thus, removing the ground from the monitor alarm relays and resetting the logic. This turns off the alarm lamp.

The Pulse Generator Rate Monitor gives instant indication of on-line trouble in TELEX exchanges. Mitigation of these troubles is more quickly rendered; thus, more efficient Telex service for our subscribers is provided.

MELVYN M. FELDMAN, Project Engineer in the Information Systems and Services Department is responsible for all Electronic and Mechanical Packaging related to the Telex program.

He joined Western Union in 1956 as a draftsman, and was later promoted to Engineering Assistant. In this capacity he assisted in the design of Plan 55, 57 and 59 Projects.

Prior to joining the company in 1956, Mr. Feldman enlisted in the United States Navy and served as a navigator aboard an ammunition ship in Korea for four years.

Mr. Feldman received his Associate Arts and Science Degree in Structural Technology in 1960 and is working towards his Bachelor of Science Degree in Physics at Brooklyn College in New York City.

outstation options

—Peter J. Lavitola

To meet the increasing needs of Telex subscribers, Western Union is now offering a variety of options related to operating outstation equipment. These new options provide more efficient service in meeting the data communication needs of our customers.

Three different types of options are presently offered in Telex.

- Control of Auxiliary Devices
- Tape Transmitter Control
- Automatic Dialer

Control of Auxiliary Devices

Auxiliary devices may be a computer or other business machine, or a second printer.

1) Computer or business machine

A Telex subscriber can send and receive messages directly from a computer or other business machine used as an auxiliary device. It is usually connected to the Telex line via a Line Adapter, as shown in Figure 1. This adapter serves as a buffer to isolate Telex from the many different signalling levels of the subscriber's equipment, such as a computer or other business machine.

When Line Adapter 11671-A is used, the auxiliary device is operated in an Inquiry mode and cannot initiate calls to the Telex exchange. However a call can be initiated from the Telex printer, associated with the auxiliary device, or from another distant subscriber. In either case, once the connection is established, two-way conversation on a half-duplex basis takes place between the auxiliary device and the remote location.

Control of Auxiliary Device

A Telex subscriber may control an auxiliary device from the local Telex station or from a remote location. This control cuts-in or cuts-out the auxiliary device from the Telex transmission. To cut-in after a Telex connection has been established, the operator depresses the IN button on the Crypto Data Plate, located on the front of the printer. Depressing the button energizes the Crypto Control, shown in Figure 1, and switches the auxiliary device from an off-line to an on-line condition. To cut-out the device after transmission is completed, the OUT button on the plate is depressed, and the auxiliary device is returned to an off-line condition.

To accomplish this IN-OUT feature from a remote Telex location, a pair of contacts are installed on the Telex set associated with the auxiliary device. These contacts close upon receipt of a selected single character from the remote location. The Crypto Control is energized and the auxiliary device is cut in. A message can then be sent from the remote location to the auxiliary device or vice versa. When the message has been transmitted, a Telex disconnect may be initiated. The Crypto Control is deenergized, and the auxiliary device is returned to the off-line condition.

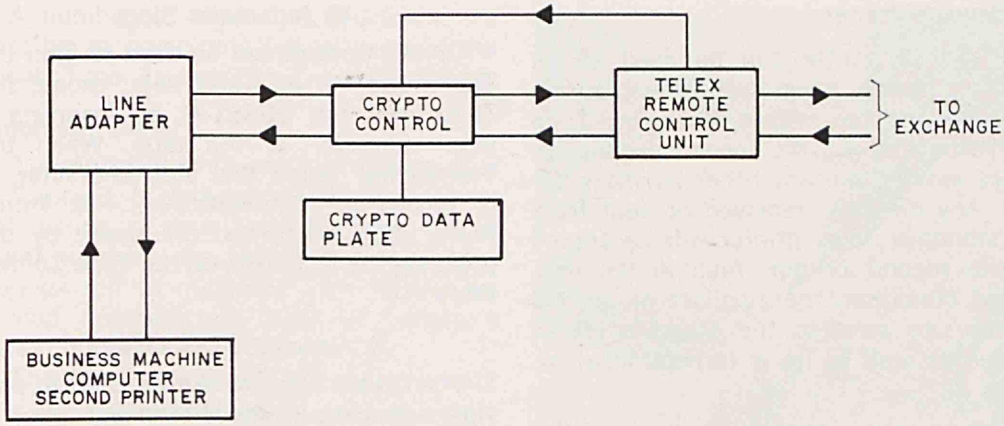

Figure 1. Equipment for Control of Auxiliary Devices

Control of Telex set

Certain control features are available on the Telex set when an auxiliary device is used.

a) When the Telex subscriber wishes to receive coded information, such as encrypted messages or data which may contain the upper case D character (who-are-you), a means must be provided to prevent the answer-back of the called subscriber from being tripped. Blind circuits are available on the Model 28 and Model 32 Telex printers to perform this function.

The answer-back blinding circuit is energized after the initial exchange of answer-backs, when a single character is transmitted to the receiving machine. After that, the reception of an upper case D will not trip the answer-back.

By depressing the OUT button of the Crypto Data Plate, the blind circuit is released to allow a final exchange of answer-backs before disconnecting.

b) When a Telex subscriber wishes to send or receive information at a different speed or with a different format than that normally used, the printer may be blinded from copying any information. Crypto Control 11932-A and Crypto Data Plate 12422 are used for this option, with the Crypto Data Plate providing the manual control and visual indication of the blinded condition. The printer blind circuit can be cut-in either manually or on a single character selection.

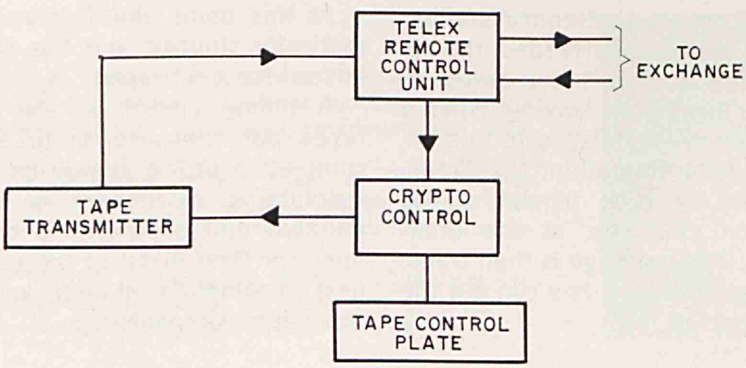

Figure 2. Equipment for Tape Transmitter Control

2) Second Printer

A second printer can be used as an auxiliary device, when it is connected via the Line Adapter, shown in Figure 1, to the Telex printer. This second printer operates exactly like any other auxiliary device. Any message received or sent from the standard Telex printer will be copied by the second printer. Also in the connected condition, the auxiliary or second printer can send to the standard Telex printer as well as to a remote location.

Tape Transmitter Control

The Telex ASR sets have a Tape Transmitter/Reperforator in addition to the printer. The Transmitter is used to send messages which have been punched on paper tape. The reperforator is used to prepare these punched tape messages, but it can also be used to make a tape copy of incoming messages. The control of the tape in the Transmitter may be accomplished at a local Telex station or at a remote Telex unit.

The Crypto Control may be used for Automatic Start, Automatic Stop or Automatic Disconnect.

The Control Plate is a supervisory unit and has two pushbuttons (IN and OUT), an indicator light and a switch for editing tape.

a) Automatic Start

The Transmitter of all Telex sets, except the Telex ASR Set 10661-A (Siemens T-100 Printer), can be started from a remote location upon receipt of a single character. This option permits reception of a message from an unattended station. When a station is to be unattended, the operator must throw the start-stop switch to the START position before leaving. When a Telex connection is established to this position from a distant location, the Transmitter will turn on upon receipt of the single selection character at the unattended station. The message is then transmitted and when the tape has run out the transmitter turns off.

b) Automatic Stop

Crypto Control can be used to stop the Transmitter of all Telex sets, except the Telex ASR Set 10661-A, by inserting a stop character in the tape. When the Transmitter reads this stop character, it is turned off automatically. The Transmitter may be turned on again, by depressing the IN button on the Tape Control Plate.

c) Automatic Disconnect

The Crypto Control can be used to provide automatic Telex disconnect when a tight-tape or tape-out condition is recognized. It automatically initiates the disconnect at the end of the message.

When a Telex printer is modified for this option, it is often desirable to disable the automatic disconnect feature, so that more than one tape can be sent or information can be added manually from the keyboard after the tape has been transmitted.

In order to disable the automatic disconnect feature, the Tape Edit switch on the control plate should be thrown to the EDIT position.

Multimessage Tape Transmission

In Multimessage Transmission a number of messages are punched on one continuous tape. At the end of each message, a FIGS D is punched. The destination for the first message is then dialed up and answer-backs are exchanged.

When the operator starts the Transmitter, the first message is transmitted in the normal manner until the first FIGS D is read in the tape.

At this point, the Transmitter is automatically stopped and the called party's answer-back is tripped.

A timing circuit, at the calling end, times out five seconds to allow for the completion of the answer-back. After five seconds, a disconnect is automatically initiated and an alarm is sounded. The operator then dials up the number of the next destination station and the same procedure is repeated.

A number of modes of operation are possible by combining two or more of the above Tape Transmitter Control options.

Automatic Dialer

The MAGICALL* Electronic Dialer, shown in Figure 3, is designed to eliminate manual dialing of each Telex number. Up to 1000 numbers can be stored on one continuous roll of magnetic tape. These recorded numbers are used to initiate a Telex connection.

The Automatic Dialer has a Dial-In-Unit and separate power supply not shown in the illustration of a typical installation in Figure 3. The magnetic tape on which the numbers are recorded is housed in a removable cartridge within the Dialer Unit. Numbers are recorded on the magnetic tape by means of the Dial-In-Unit. This unit is plugged into the main Dialer Unit **only** during the recording procedure.

In order to make a Telex call with the MAGICALL Electronic Dialer the operator must:

1) Locate the desired number between the guide lines of the dialer Unit.
2) Depress START button on the Telex Remote Control Unit and wait for the DIAL lamp on the Remote Control Unit to come on (Proceed to Dial signal).

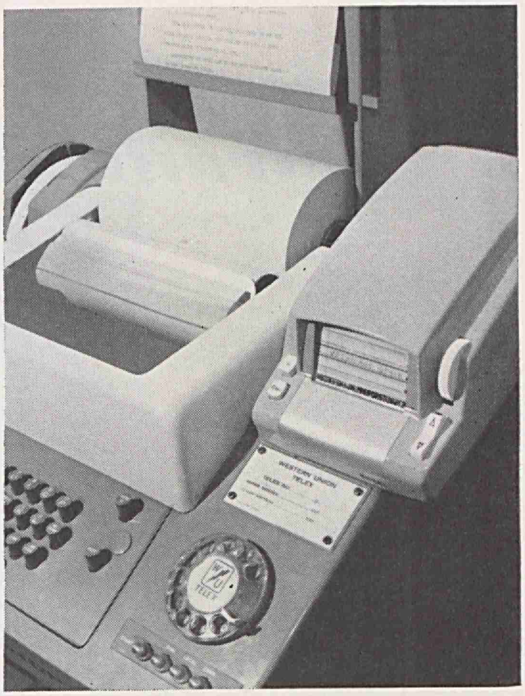

Figure 3. Automatic Dialers mounted on Telex Set

3) When the DIAL lamp lights the operator depresses the CALL button on the MAGICALL Dialer Unit. The dial digits of the subscriber being called are then generated into the Telex exchange by the Dialer Unit.
4) When a connection is made the Telex set is turned on in the normal manner.

* MAGICALL is the trademark for the Automatic Dialer manufactured by the DASA Corporation.

PETER J. LAVITOLA, an Engineer in Information Systems and Services Department, has been concerned with the design and development of Outstation Equipment for Telex Subscribers.

Since he joined Western Union in 1964, he has assisted in the development of outstation equipment for GSA and with the design and development of the Second Answer-Back Unit for Teltex Receiving Positions.

Mr. Lavitola received his degree in Electrical Engineering from Manhattan College in 1964, and is currently doing graduate studies at Newark College of Engineering.

traffic recording methods

—Emil Panzaru

In the Western Union's Telex System, a constant study of Telex traffic volume is used to ascertain whether the equipment is maintaining its predetermined grade of service. Grade of service is a measure of service quality and depends upon switching equipment available to a system. This grade may vary at any point in the circuit switching network. Therefore, knowledge of traffic flow pattern in the network is essential to provide a grade of service which is both economical in equipment layout and satisfactory to our customers. The theory of traffic analysis has been discussed in the TECHNICAL REVIEW, in earlier issues. [1, 2]

The recording equipment used by Western Union in obtaining data on Telex traffic consists of Erlangmeters and Traffic Recorders as shown in Figure 1. However, in large Telex centers such as the TWM2 exchanges, a 12-Value Integrator replaces the Traffic Recorders.

Erlangmeter

The basic unit used in measuring the volume of traffic is the erlang, named after A. K. Erlang, a Danish expert on telephone traffic. One erlang of traffic is equivalent to one hour of uninterrupted seizure of a switching unit.[3] Thus, if a trunk line linking two Telex exchanges is used continuously for one hour, the traffic volume measured at the trunk repeater is one erlang. In most cases, groups of trunks are used. If each repeater in a 20-trunk group is used for 30 minutes in a given one hour period, the Erlangmeter records 10 erlangs ($30/60 \times 20 = 10$). The Erlangmeter is a current integrating device similar to a watt-hour meter.

A schematic of the basic circuit in the Erlangmeter is shown in Figure 2. Erlangmeters are usually mounted on a traffic evaluation rack. This rack is used to interconnect the registration points of the switching units to traffic metering equipment.

The metering current per switching unit is approximately 30 ma. Thus each switching unit (repeater, switch, common control unit, etc.) contributes this amount of current during the period of seizure. The instantaneous sum of these currents is proportional to the momentary volume of traffic, to which the momentary rpm of the low impedance metering motor is proportional. This motor activates the 6-digit counter and, in conjunction with the auxiliary motor, it activates the pulse sender. The pulse sender is used with auxiliary metering equipment and its frequency is also proportional to the momentary traffic volume.

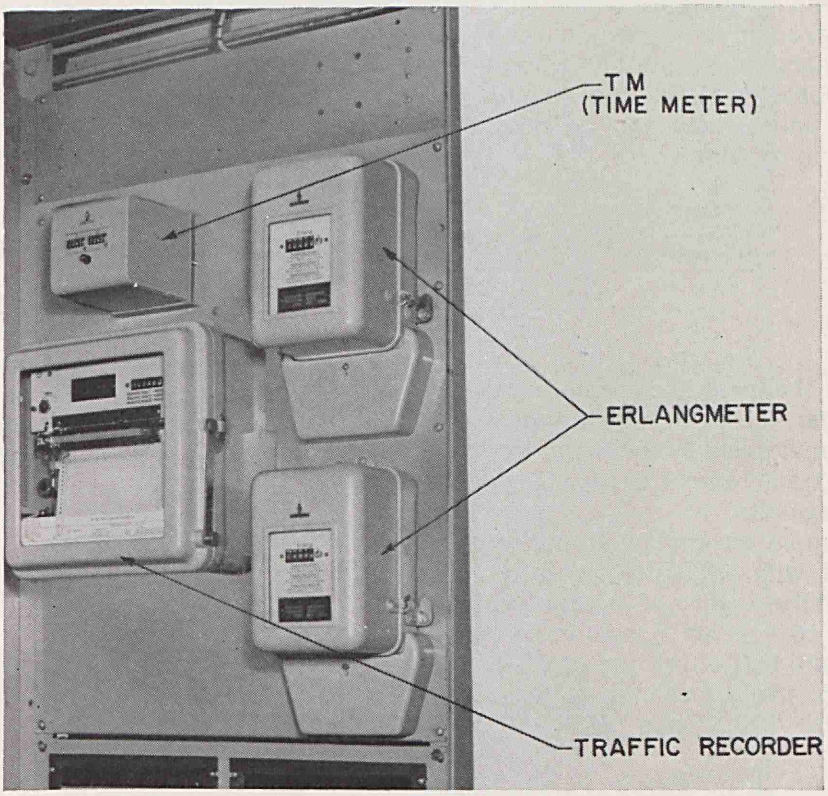

Figure 1. Mounted Erlangmeters, Traffic Recorder and Time Meter

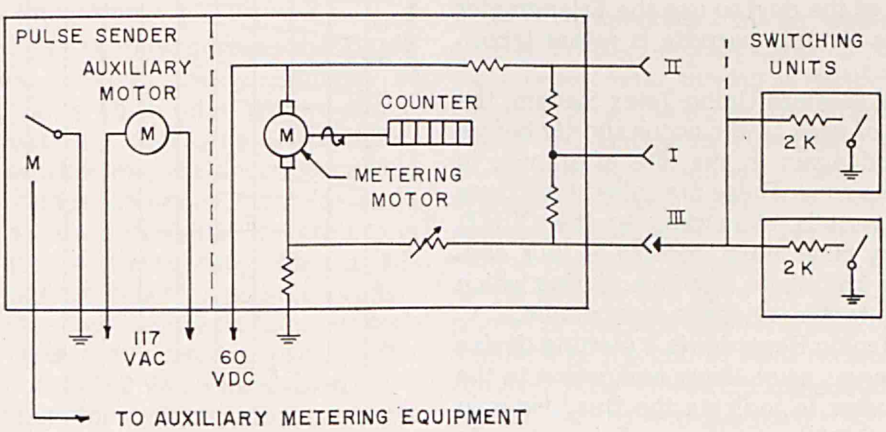

Figure 2. Schematic of Erlangmeter Circuit.

The number of switching units which may be measured by an Erlangmeter depends upon the measuring range of the Erlangmeter (inputs I, II or III). Each range has a corresponding range factor, specifing the Erlang/unit reading on the counter, and the Erlang/pulse emitted by the pulse sender. Table I shows the number of switching units which can be measured (metered) in each range.

TABLE I

Measuring Range	Range Factor (erlang/pulse)	No. of Units Measured
I	0.1	5-100
II	0.5	25-500
III	0.02	1-20

The net change in the reading of the 6-digit counter, during a particular one-hour period, is multiplied by the range factor to obtain the traffic volume carried by a group of switching units.

For example, assume an Erlangmeter to be loaded with 20 trunk repeaters via range III. If the reading of its counter at the beginning of a given one-hour period is 071145, and that at the end of the period is 071545, the net change in the meter reading is 400. Thus $400(0.02) = 8$ erlangs.

Traffic Recorder

The cumulative data registered by an Erlangmeter is not sufficient, to determine the number of switching units, required in a given group to maintain a certain grade of service. This cumulative data has to be interpreted in terms of the peak traffic periods of the day; to use the Erlangmeter readings for this purpose is rather laborious.

In the Western Union Telex System, the periods of peak traffic occur shortly before noon and again in the late afternoon, in each time zone. These are called the "Busy Hour" periods. According to the CCITT, the Busy Hour must consist of four consecutive 15-minute intervals, during which the total traffic volume is a maximum.

The Traffic Recorder is a plotting device which serves as auxiliary equipment to the Erlangmeter to indicate the Busy Hour in any given 24 hours. Figure 3 is a sample graph from the Traffic Recorder.

As the recording paper advances downward, in step with the time-indexed left margin a stylus deflects to the right, printing one dot for each received pulse. The stylus returns left to its starting position, every 15 minutes.

Each pulse causes a 0.2 millimeter deflection. Thus, the total deflection in any 15-minute interval depends upon the number of pulses received during this interval. By inspection, one can determine the Busy Hour by selecting the four longest consecutive lines on the graph as indicated in Figure 3.

The total horizontal length of these lines in millimeters is used to find the number of Erlangmeter pulses generated during the Busy Hour. This number is multiplied by the appropriate range factor on the Erlangmeter to establish the traffic volume in erlangs.

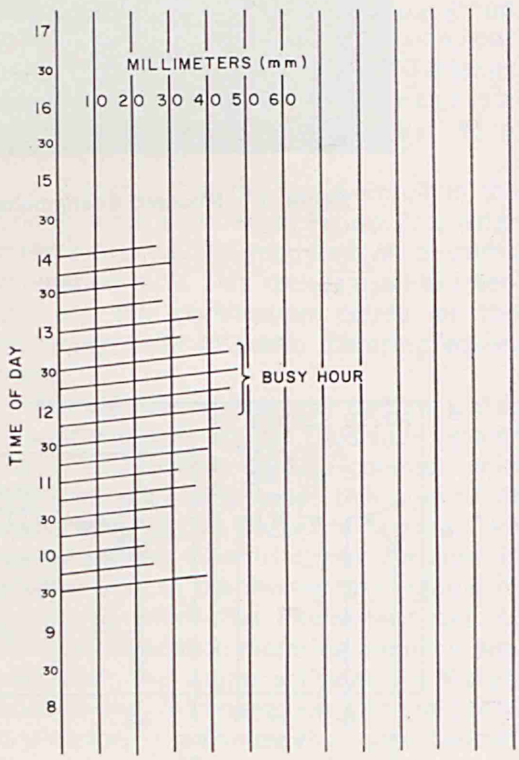

Figure 3. Sample Graph from Traffic Recorder

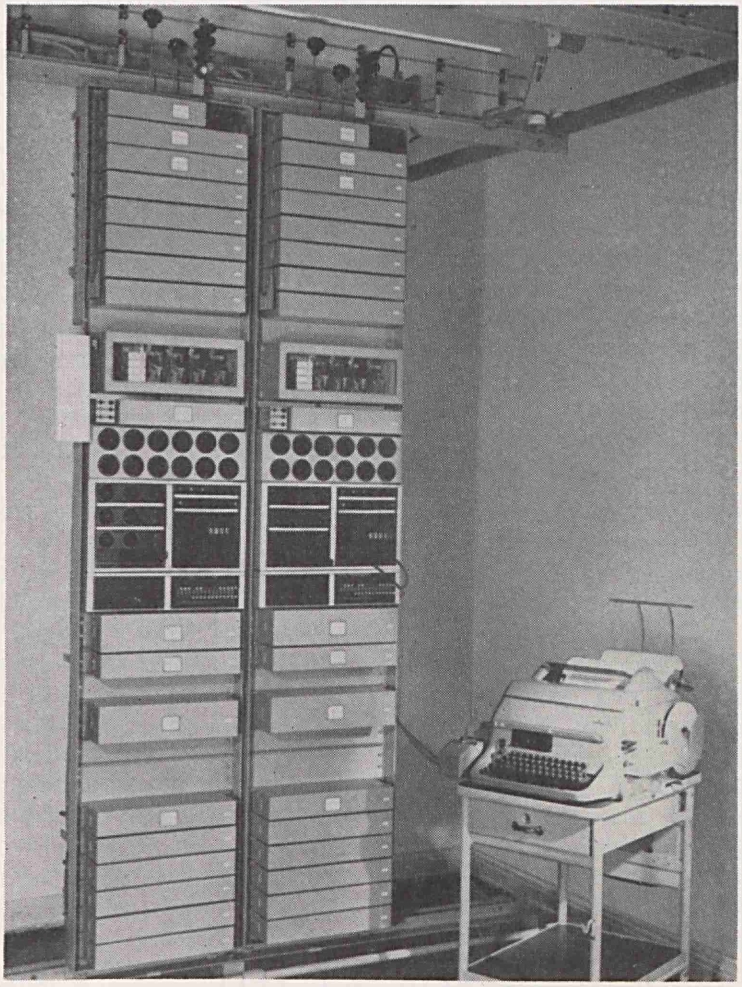

Figure. 4. 12-Value Integrator

12-Value Integrator

Large Telex centers, such as the TWM2 Exchanges, contain many groups of switching units which often require simultaneous metering. Since the Erlangmeter-Traffic Recorder method described above becomes rather time consuming for large exchanges, the 12-Value Integrator is used. Figure 4 shows two adjacent 12-Value Integrator racks. The page printer, shown on the right, connects to either rack and its receive function is part of the operation of the 12-Value Integrator.

This integrator collects, stores and records periodically, Telex traffic data generated by as many as 12 Erlangmeters. These Erlangmeters may be located in a central TWM2 Junction Office or in a remote Telex center serving as district to the junction. In either case, the Erlangmeter pulses are continually stored and counted in 12 storage counters. Each counter serves one Erlangmeter. The number of pulses stored by each counter during a 15-minute period is processed by a scanning device and fed to a page printer. Thus, the printer produces a new recording every 15 minutes. At the end of each recording, all counters return to zero. Consequently, the printer records only the pulses stored in a particular 15-minute interval. The Time and Date unit defines this interval.

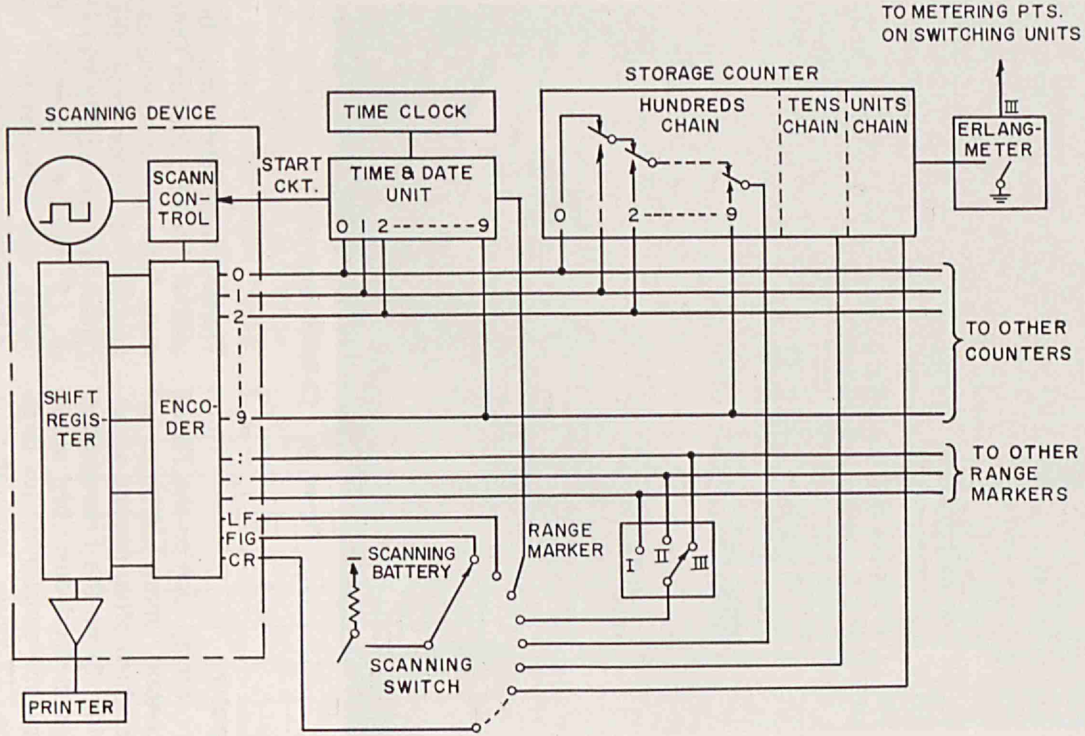

Figure 5. Simplified Scanning Circuit

Scanning Circuit

Basic to the operation of the 12-Value Integrator, is the Scanning Device. The simplified scanning circuit is shown in Figure 5. This scanner consists of a shift register which performs a "parallel-to-series" conversion, an Encoder which serves to load in parallel, the five binary stages of the shift register, and a Scanning Control section. When a negative potential is applied to any one of 16 loading terminals on the Encoder, the shift register feeds out a teleprinter character, corresponding to the symbol on the terminal. The output of the shift register is applied to an amplifier, which provides a 50-baud, make-break circuit for the associated page printer.

The Storage Counter (one of 12) consists of three counting relay chains. The pulse sender of an Erlangmeter is coupled to the units-counting chain. The capacity of the Storage Counter is 999. The contact network of the hundreds-counting chain is shown in detail to illustrate how the scanning battery is returned to the Encoder.

The Time and Date unit is activated by clock pulses generated by a master time clock, at a frequency of one pulse per minute. The unit consists of four selectors which perform the registration of minutes, hours, days and months.

During registration, the wipers of these selectors also provide a loading path to the Encoder. The Time and Date unit issues a start pulse to the Scanning Device every 15 minutes.

The scanning process simply involves the stepping of the scanning switch in a predetermined sequence, whereby the wiper returns the negative battery to the Encoder. The range marker is a manual switch, which indicates the range used on the Erlangmeter. Thus, every 15 minutes, the printer produces a record showing the date and time of the record, plus the number of pulses stored by each Storage Counter during a particular 15-minute interval.

Page Printer Recording

Figure 6 is a typical page printer copy of three recordings.

The first three columns on this page copy, indicate Office Code, Date and Time of Day respectively.

Following the "time of day" information, the remaining columns represent the readings from the 12 respective Storage Counters. Each column displays the traffic load carried by a particular group of switching units for a ¼ hour period. At the end of one day, the Busy Hour in any column is determined by selecting four consecutive numbers in the column of

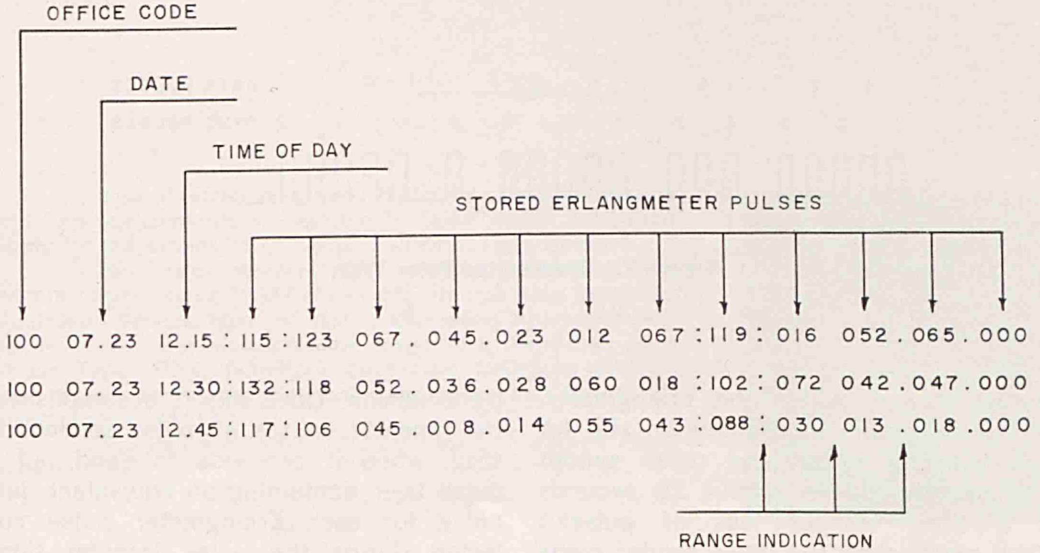

Figure 6. Typical Page Printer Copy

interest, such that their total is a maximum. This total number is then multiplied by the corresponding range factor to establish the load in erlangs. A space, dot or semicolon, preceding the numbers, indicates the operating range of the Erlangmeter serving the particular group of switching units. (Range I—space; Range II—dot; Range III—semicolon.) The office code is used to indicate the office where the traffic is being measured. In this particular illustration, the 100 code identifies the New York Junction exchange.

Recording from District Office

A Telex junction exchange may have a number of peripheral Telex centers, serving as District Offices. In order to centralize the recording of Telex Traffic, the traffic data measured by means of Erlangmeters in a district exchange is transmitted to the Junction Office and recorded by means of the 12-value Integrator. The transmission process makes use of the pulse-storing property of an Erlangmeter and the start-stop function of its pulse sender. This pulse sender can be stopped and started by the auxiliary equipment, without interfering with the metering clock of the Erlangmeter. When the pulse sender is stopped, the next six pulses are stored in a mechanical storage device, within the Erlangmeter. (Under maximum load condition and for any metering range, the pulse sender may be stopped for about 20 seconds at a time, without loss of pulses.) When reactivated, the pulse sender reads off the stored pulses and sends them out to auxiliary equipment at a constant frequency (100 ms pulse: 400 ms interval). Once the mechanical storage is depleted, the frequency of the pulse sender is again determined by the instantaneous traffic load.

A specially designed repeater in the distant exchange serves as auxiliary equipment to a maximum of 12 Erlangmeters. This repeater is subject to pushbutton control from the control panel of the 12-Value Integrator in the central TWM2 exchange to which it connects by means of a trunk carrier. Thus, upon request from the central exchange, this repeater collects the stored pulses from the Erlangmeters and transmits them in block form to the 12-Value Integrator. The transmission principle is similar to time-division multiplex and is controlled from the 12-Value Integrator.

More specifically, the sending repeater periodically requests that each Erlangmeter releases one pulse from its mechanical storage, by controlling the start-stop operation of all pulse senders simultaneously. This permits a parallel transfer of pulses from the storage of the Erlangmeters to the sending repeater. In the sending repeater, each transferred pulse is momentarily stored and positioned in a scanning circuit, in preparation for serial transmission. Once this is accomplished, the repeater causes all pulse senders to stop, while it proceeds to send out a pulse train containing an equivalent data pulse for each Erlangmeter pulse collected during the pulse transfer time. The position of a data pulse in the

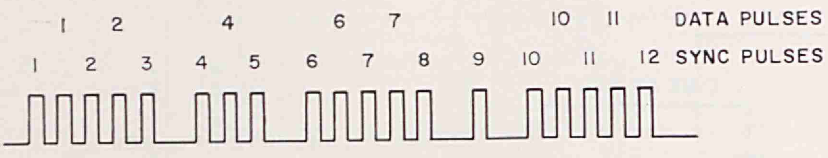

Figure 7. Transmitted Pulse Train

transmitted pulse train identifies a particular Erlangmeter in the distant Exchange. Each data pulse is 50 ms in length and is preceded by a 50 ms sync pulse. If only some of the 12 Erlangmeters have pulses in storage when the repeater requests a pulse transfer, data pulses may be missing from the transmitted pulse train, as shown in Figure 7.

If none of the Erlangmeters contain at least one pulse in storage when the sending repeater requests a pulse transfer (a condition existing during low-traffic periods), the repeater waits until one of the 12 Erlangmeters in the distant exchange can send out one pulse. Thus, each transmitted pulse train contains at least one data pulse.

Once a pulse train has been transmitted, the process repeats itself, and the repetition rate (approx. 2.6 per sec. per pulse train) prevents the Erlangmeters in the distant exchange from overloading their mechanical storages.

In the central TWM2 office, the receiving repeater associated with the 12-Value Integrator suppresses the sync pulses (used only for control of time-division), and passes the data pulses to the 12 Storage Counters. The position of a data pulse in the received pulse train determines the counter upon which the respective pulse is stored. Thus, an Erlangmeter pulse generated by the first Erlangmeter in the distant exchange (each Erlangmeter is assigned an individual send-position with respect to the sending repeater) causes the first Storage Counter in the 12-Value Integrator to receive and store an equivalent data pulse. The scanning and recording process of this data is identical to the one described above for the local traffic. The office code tabulated in Figure 6, identifies the district exchange where the traffic load was measured.

Thus, all traffic data measured in a District Office (DO) can be recorded in an associated junction office.

Presently, plans are being considered to use the perforator attachment on the ASR set serving the 12-Value Integrator to obtain traffic recordings on tape, as well. Thus, at the end of a day, the tape can be fed into a computer which is programmed to spell out the Busy Hours for a particular recording period. Furthermore, all junction offices may transmit their traffic recordings to a computer center, where the analysis of Telex traffic for the entire system can be made.

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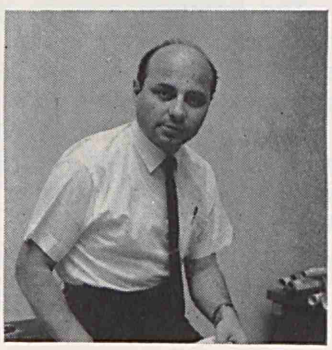
1. Traffic Evaluation for Western Union Telex Network, Part I, K. M. Jockers, Vol. 17, No. 4, Oct. 1963
2. Traffic Evaluation for Western Union Telex Network, Part II, K. M. Jockers, Vol. 18, No. 1, Jan. 1964
3. Measuring Equipment for Observation of Traffic and Quality of Service in Telephone Dial Offices—published by Siemens Halske AG—Berlin

EMIL PANZARU, Engineer in the Information Systems and Services Department, assisted in Telex Traffic Evaluation Study for the expansion of Western Union's Telex Network.

His major assignment is in the applications and system design, using TWM2 equipment. He has done extensive studies on various types of Traffic Evaluation equipment. Recently, he was responsible for the design of a Translator, used in the Type 600-A, Automatic Four Wire Switching System. This system serves the National Aeronautics and Space Administration (NASA).

Mr. Panzaru joined Western Union Telegraph Company in 1955.



telex interface
for use with
computers

—Earl C. Mansfield

Because computer "on line" and "real time" systems are being offered to many geographically separated users simultaneously with the growth of common carrier circuit switching systems a need developed for an interfacing arrangement which would permit the interconnection of the two types of systems. This article describes one such interfacing arrangement currently being used in the Western Union Telex system.

The Telex Interface is used to interface a single Long Distance subscriber Exchange line with a computer. The Interface may be mounted in the pedestal of a standard Model 32 Telex Set, shown in Figure 1.

This Interface not only permits the computer to automatically initiate calls to Telex subscribers but also allows the subscribers to send messages to the computer. The layout and the interconnections between the various units within the Interface is shown in Figure 2.

The Interface permits isolation of the computer from the Telex Exchange, as shown in the schematic diagram of the signal path, in Figure 3.

At present the model 32 KSR or ASR set can be provided with an Interface. In addition to housing the Interface, the Model 32 is used for:

a) Off-line testing of the computer lines and programs, as an alternate means of communication with the Telex System during computer down-time
b) Answer-back of incoming calls which is important in automatic Telex system testing
c) Maintenance testing with the Telex Exchange.

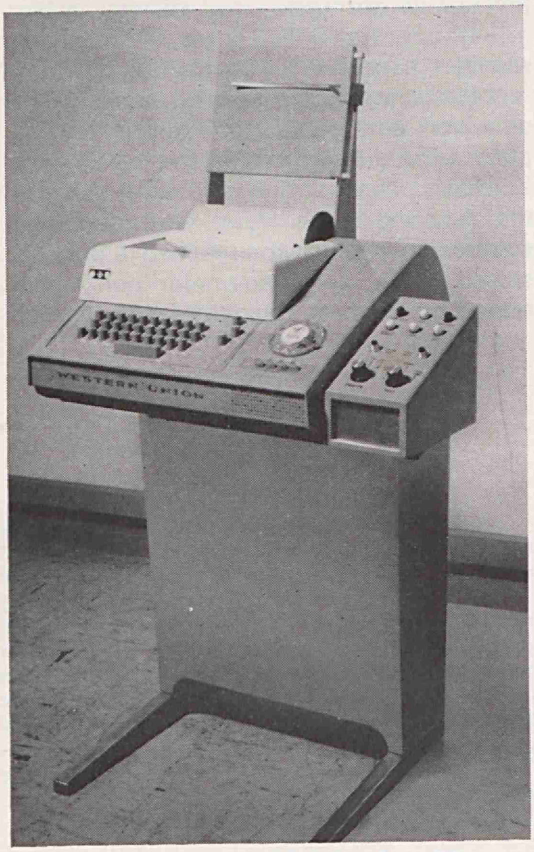


Figure 1. Model 32 Telex Set with mounted Supervisory Panel

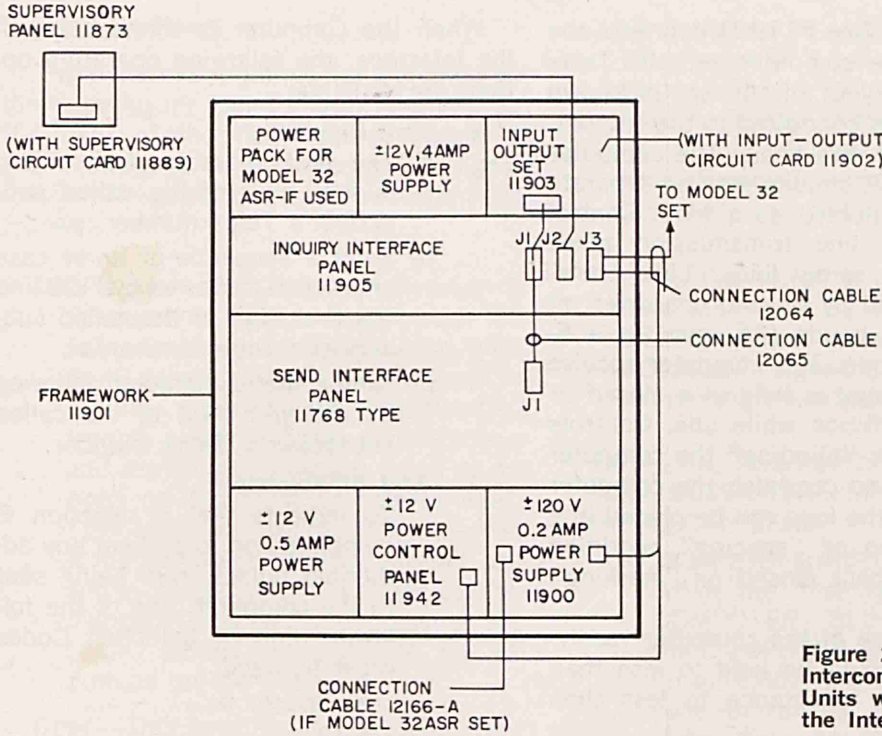


Figure 2. Interconnection of Units within the Interface

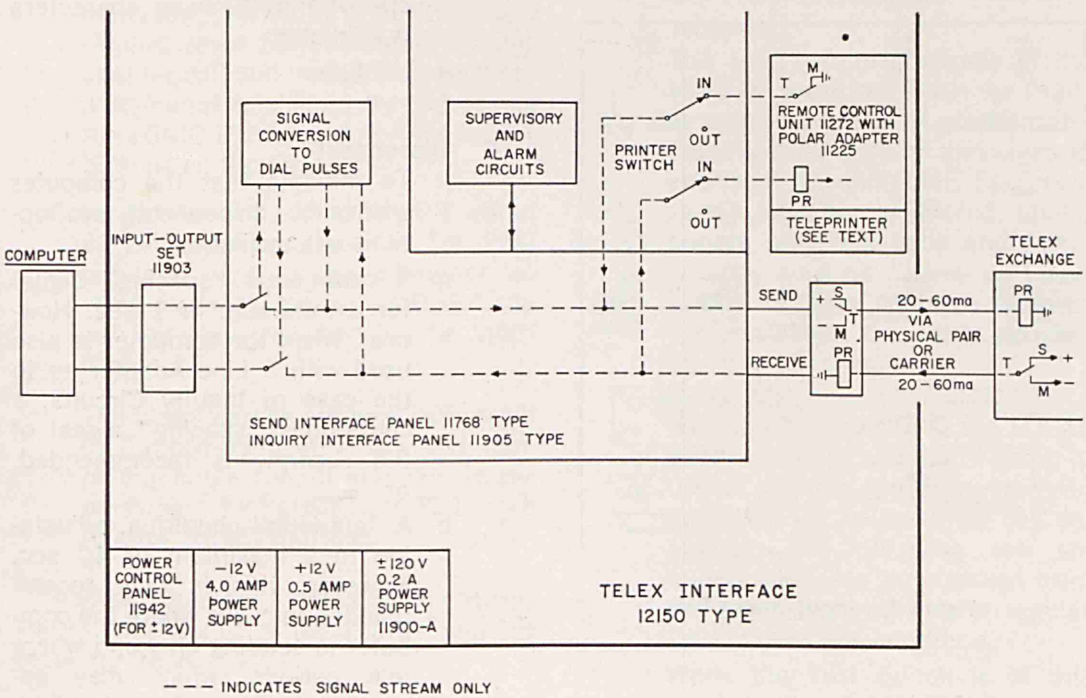


Figure 3. Schematic Diagram of Signal Path from the Computer to the Telex Exchange

Input-Output Set #11903 connects the Interface to the computer and the Telex Exchange. A layout of the set is shown in Figure 4. It is connected to the computer on a 2- or 4-wire basis. The computer send and receive circuits may be separate or may be connected as a loop. Control signalling and line transmission takes place via the same lines. Line transmission is serial by bit and character, at a speed of 50 bauds (66 wpm) in a 5-level Baudot code. The computer receive line or loop circuit is held in a closed or "marking" condition while idle. Controls are provided for "blinding" the computer lines. In the blind condition the computer receive line or the loop can be placed in a permanent open or "spacing" condition or in a permanent closed or "marking" condition.

The resistance of the computer receiving element should be held to less than 500 ohms; the inductance to less than 0.5 henries.

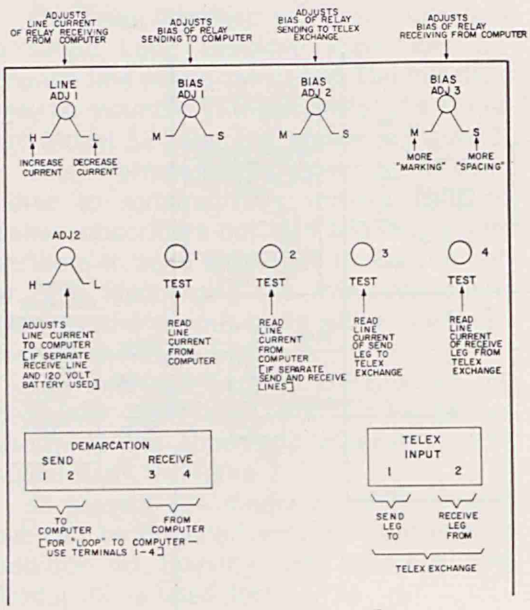


Figure 4. Input-Output Set

When the computer is connected with the Interface, the following operating options are available:

1 Call Request
   a- The first character transmitted is first digit of the called subscriber's Telex number, or
   b- Send a sequence of lower case characters, followed by FIGS and the first digit of the called subscriber's Telex number, or
   c- Send a single character, followed by the first digit of the called subscriber's Telex number.

2 End of Selection
   To indicate that a selection is complete and to prevent any additional pulses from being sent to the computer, one of the following End of Selection Codes must be used:
   a- Space, or
   b- Z.

3 Confirmation of Connection
   To confirm to the computer that a connection to the called subscriber has been established, one of the following characters is available:
   a- LTRS, or
   b- "V"

4 Disconnect
   To indicate that the computer wishes to disconnect, two options are available:
   a- A continuous "spacing" signal for a minimum of 1 sec. However, when the computer is also used with a Line Adapter as in the case of Inquiry Circuits, a continuous "spacing" signal of 2.5 seconds is recommended, or
   b- A "marking" condition, adjustable to a maximum of 40 sec. However, this is only recommended in cases where the computer is sending only and where idle periods, which may approach a Disconnect interval, are not anticipated.

Supervisory Panel

Three alarm conditions are indicated on the Supervisory Panel shown mounted on the right of the Telex set in Figure 1 when failure to receive the proper signal exists. These alarms are activated as follows:

DIAL ALARM—This lamp is lit when a "Proceed to Select" signal from the Telex Exchange is not received within 40 seconds after a Call Request is initiated. Normally, this indicates that trouble exists between the Interface and the Telex Exchange, (such as an open on the send or receive line). This alarm is automatically cleared if the computer initiates another call and is connected. This alarm can be manually cleared by depressing the LOGIC RESET and ALARM RESET buttons on the Panel.

BUSY—This lamp is lit when the computer fails to send the next digit within the allotted time after a Present Next Digit (PND) pulse or if a BUSY condition occurs in the Telex system. This alarm can be automatically or manually cleared. It is automatically cleared when the computer initiates another call and makes a connection. It is manually cleared by depressing the LOGIC RESET and ALARM RESET buttons on the Panel.

CONN ALARM—This lamp is lit if within 40 ± 4 seconds after the 1st PND pulse is sent to the computer no "Call Connect" signal or BUSY signal has been received by the Interface.

The alarm can be automatically reset by the computer initiating, and completing a new call, or manually by depressing the LOGIC RESET and ALARM RESET buttons.

Two switches are located on the Supervisory Panel; one for the Printer and the other for Test.

PRINTER—This switch cuts the Telex set in and out. When the switch is in the IN position, the Model 32 Telex set, equipped with a set of parts, will be turned ON by a CALL CONNECT signal. The Printer switch must be in the IN position during computer downtime to provide identification or answer back to a calling subscriber.

When the switch is in its OUT position, the Model 32 Telex set will be off and will not respond to a "CALL CONNECT" signal. Consequently, no monitoring takes place.

TEST—The Test switch has three positions: COMPUTER BLINDED, NORMAL and LOCAL SEND.

a) COMPUTER BLINDED
When the Test switch is in the COMPUTER BLINDED position, the COMPUTER BLINDED lamp is on indicating the computer cannot send or receive calls. The associated Telex set can receive calls and send messages to any regular subscriber in the Telex system. This test checks the printer operation and the facilities to and from the Telex Exchange.

b) NORMAL
The Test switch is usually in the NORMAL position. When the Printer switch is in the IN position, the Telex set will copy all messages to and from the computer. Test messages may be monitored, maintainers may talk back and forth, circuits may be "lined up" and signals may be adjusted between the computer, the Telex set and the Telex Exchange.

c) LOCAL SEND
With the Test switch in the LOCAL SEND position and the Printer in the IN position, the computer can be tested for its incoming call sequence. The outgoing call sequence can also be checked from the point equivalent to a regular CALL CONNECT condition.

When the Test switch is in this position, the LOCAL SEND lamp is lit.

How a Call is Made

Figure 5 is a Flow Chart of the various steps in initiating a call from the computer:

1 IDLE

The computer checks to insure that the termination is idle. This indicates that no incoming call is requested, that the Send and Receive lines have been closed or are in a "marking" condition, for at least 2 seconds, and no other call is being set up from that terminal.

2 Call Request

The computer calls the Telex subscriber by transmitting the first digit of his number, at 50 bauds, in a 5-level 7.5 unit Baudot code, using one of the options mentioned previously.

3 Proceed to Select

The Interface reads only code combinations corresponding to digits. It does not read upper or lower case printed characters. When the Interface reads the first digit in Baudot code from the computer, the digit is stored and a call is made to the Telex Exchange.

(Call Request signal is a battery reversal on the send leg from the Interface to the relay in the Telex Exchange. Battery reversal is called "marking" when it goes from positive to negative potential. This negative potential is a marking condition.)

When the Telex Exchange recognizes the call signal, it returns a "Proceed to Select" signal to the Interface. The Interface converts the stored Baudot digit to dial pulses and transmits the dial pulses to the Telex Exchange.

(When the dial pulses have been transmitted, a 600 ms "marking" signal is sent to the Telex Exchange. This signal is known as Interdigit Dial Time.)

4 Present Next Digit (PND) to computer

At the beginning of the above Interdigit Dial Time interval, the computer receives a 20 ms "spacing" pulse, a PND pulse, which is equivalent to the start pulse of a LETTERS character in the Baudot code.

Two interface configurations permit a variation in the allowable response time of the computer to the PND pulse. The basic unit allows a maximum delay of 380 ms. The second version allows a delay of approximately 3 sec.

5 Sends 2nd Digit

The computer reads the PND pulse and "sends the next digit" in the called Telex subscriber's number.

6 Receives 2nd PND Pulse

When the Interface recognizes that the 2nd digit has been converted to dial pulses and sent to the Telex Exchange, a second PND pulse is sent to the computer.

7 Sends 3rd Digit and Subsequent Digits

The computer transmits the 3rd digit and the subsequent digits within the alloted time after each PND pulse.

(If this time is exceeded, the Interface sends a signal to the Computer to disconnect and the BUSY lamp on the Supervisory Panel lights.)

8 Receives Last PND Pulse

After the computer sends the remaining digits in the called Telex subscriber's number, it sends the

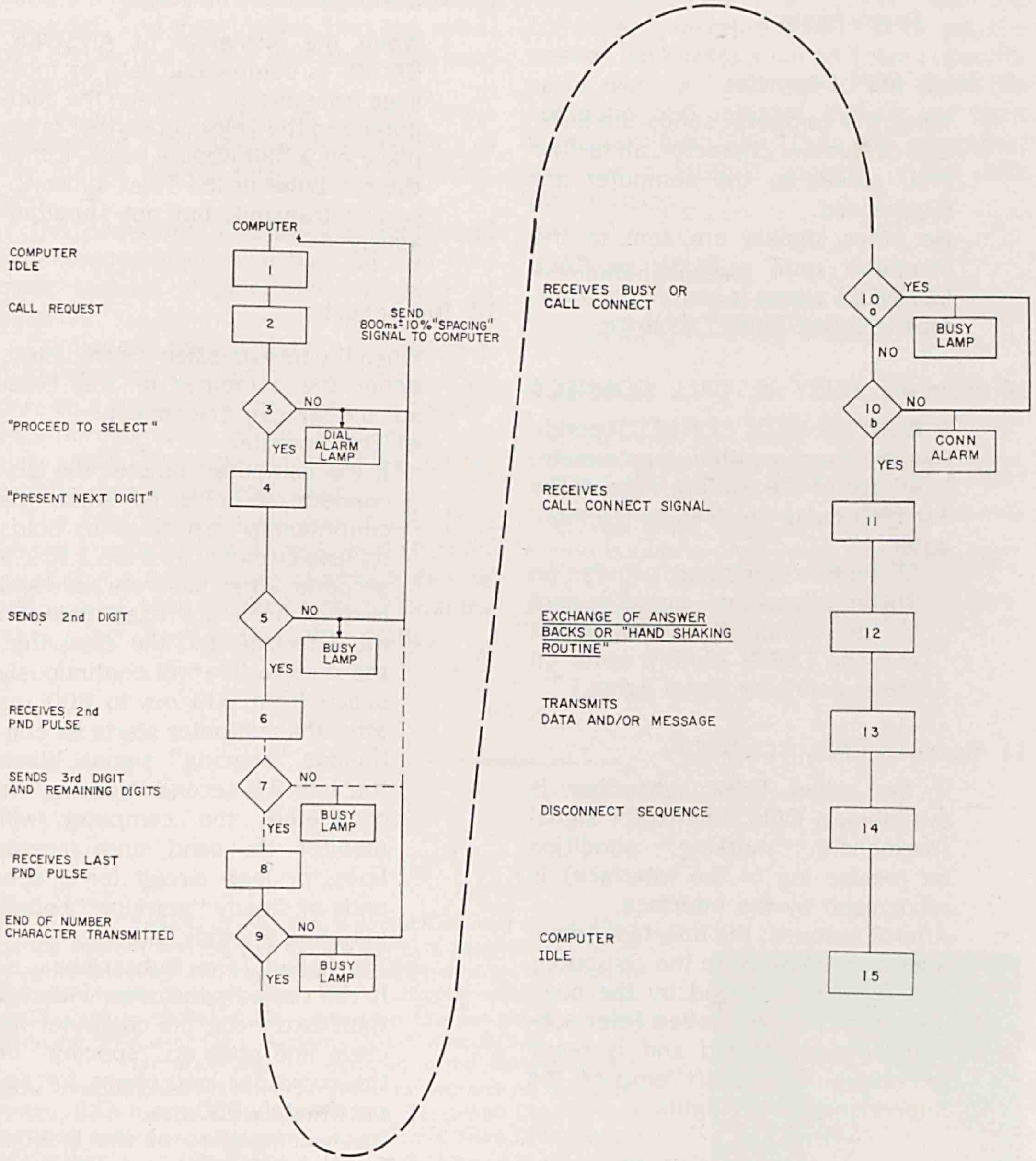


Figure 5. Flow Chart Showing Steps in Initiating a Call from a Computer

End-of-Number EON character, within the allotted time after the PND pulse following the last digit of the number.

(If this time is exceeded, the computer is disconnected and a BUSY lamp on the supervisory Panel lights.)

9 Sends EON Character

When the computer sends the EON, End of Number character, all further PND pulses to the computer are suppressed.

No other signals are sent to the computer until a BUSY or CALL CONNECT signal is sent to the Interface from the Telex Exchange.

10 Receives BUSY or CALL CONNECT

A BUSY or CALL CONNECT condition must occur within approximately 40 sec of the leading edge of the 1st PND pulse received by the computer.

(If neither condition occurs, an 800 ms "spacing" signal is sent to the computer to disconnect and the CONN ALARM lamp on the supervisory Panel lights.)

11 Receives CALL CONNECT

If the called Telex subscriber is available, a CALL CONNECT signal (permanent "marking" condition on receive leg of the Interface) is recognized by the Interface.

After 2 seconds, the Interface transmits a V character to the computer. The V character read by the computer indicates the called Telex subscriber is connected and is ready to receive. The CONN lamp on the Supervisory Panel lights.

12 Exchange of ANSWER-BACKS

The computer now engages in its routine for the exchange of ANSWER-BACKS. Prior to transmitting the WRU sequence, FIGS D, a single preselected character, preferably upper case, is sent by the computer to deactivate the answerback of the Model 32 set associated with the Interface. The WRU sequence is now sent to activate the answer back of the distant Telex set.

13 Transmits Data or Message

When the exchange of ANSWER-BACKS is completed, data or message transmission between the computer and the Telex subscriber takes place on a half-duplex basis. Either the computer or the Telex subscriber can transmit, but not simultaneously.

14 Disconnect

When the transmission is completed, either the computer or the Telex subscriber can disconnect.

a) By Computer

If the computer initiates the Disconnect, it holds its send line continuously "spacing" or holds its loop circuit open from 1 to 2.5 seconds. When separate send and receive lines are used between the Interface and the computer, the receive line will continuously space from 200 ms to 800 ms after the computer starts its continuous "spacing" signal. When the 1 to 2.5 second "spacing" is completed, the computer will monitor its send and receive lines, or loop circuit for 2 seconds of steady "marking" before initiating another call.

b) By Called Telex Subscriber

If the Called subscriber initiates the Disconnect, the computer receive line goes on "spacing" or the computer loop opens for approximately 900 ms.

Upon completion of the Disconnect, the computer must monitor it's loop or its send and receive legs, for at least 2 seconds of steady "marking" before initiating another call.

15 IDLE (same as 1)

Operational Guidelines

The following points should be considered for smooth operation of the Interface with the computer.

The 2-second idle line test is used as a guard against the computer attempting to initiate a call if a line or power failure has occurred, and also insures that the previous connection to the Exchange has been completely cleared.

The computer should be capable of reassembling a message upon recognition of any failure during selection or transmission.

The computer should be programmed to take supervisory action if any call fails more than a predetermined number of times.

Continuous polling should not be used. If any polling is done, it should be done only on a pre-programmed basis. This permits normal usage of the Telex sets, and also allows the Telex stations to deliver priority data to the computer.

The approximate busy hour traffic load for the computer should be known. This insures that a good grade of service can be maintained, both for the computer, and for other subscribers in the same group.

Auxiliary Equipment

On Model 32 Telex sets, a set of parts #505022 are included to permit blocking of the answer-back and prevent the set from responding to the WRU sequence FIGS D.

This set of parts is required when the computer generates a FIGS D to get the answer back from a called Telex subscriber or when a Telex subscriber calls the computer and initiates the answer back by transmitting FIGS D to the computer, or when a FIGS D appears in the data transmission.

Acknowledgements

This article has been composed with the assistance of Brian M. Smith, who was instrumental in the logic, electronic design and testing of the Telex Interface.

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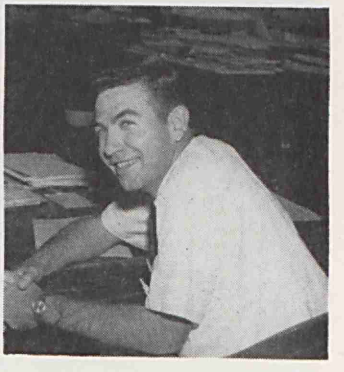
Mr. Mansfield has assisted in the development of some international systems. In 1956, he worked on Switching System 23-A for the Canadian National Telegraph Co. More recently he helped set up a semi-automatic overseas Telex System for Western Union International, Inc. He designed and developed Interface arrangements to permit Western Union International, Inc. operation with both manual and automatic TWX (D-TWX).

Mr. Mansfield received a BA degree in Liberal Arts and a BS degree in Electrical Engineering, from Columbia University in 1954.

He is a member of the IEEE and is associated with the professional groups on Electronic Computers, Communications Technology and Systems and Cybernetics.



information services computer center

—Sergio Wernikoff

Figure 1. Computer Center at W. U. Headquarters

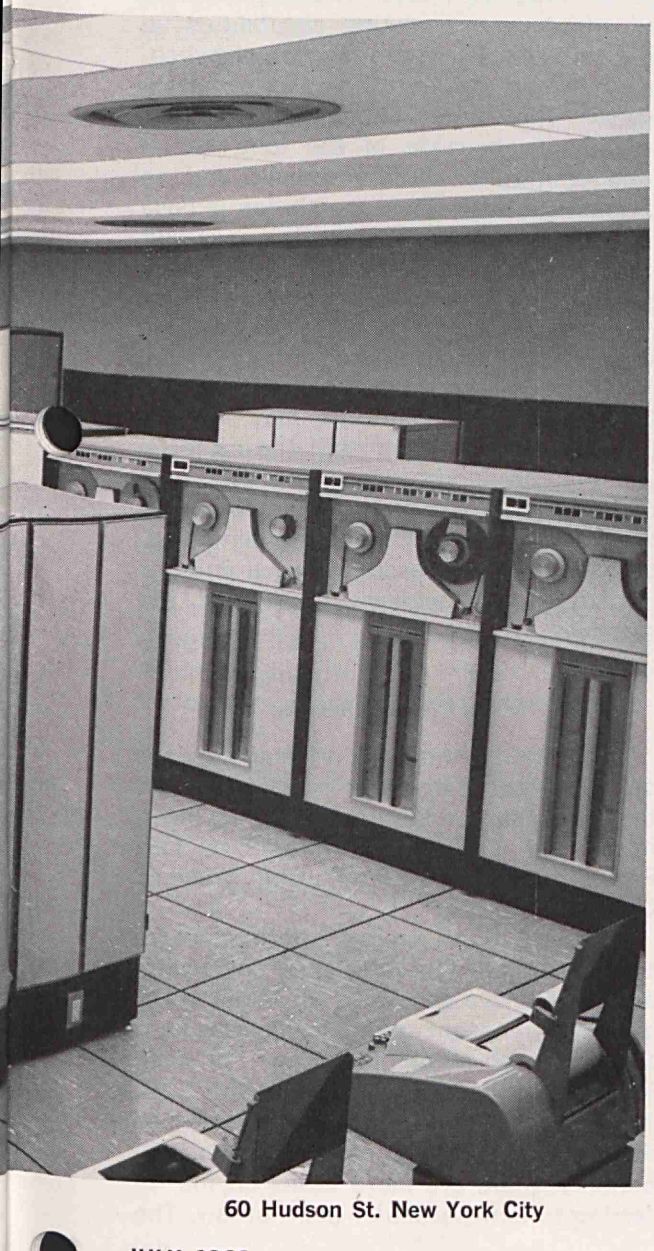
Western Union officially inaugurated its first, real-time public service computer center linked with its coast-to-coast Telex system in December 1965.

The new Information Services Computer Center marks the beginning of the company's transition into a national information utility, which serves the information service needs of business and government.

This first center shown in Fig. 1 located at Western Union Headquarters 60 Hudson St., in New York City, serves thousands of customers through the Telex network. More computers are planned for other centers at key cities.

Designed to provide a variety of new Info-MAC (Information Multiple Access Computer) communication and information services, the computer center began officially serving about 1,500 Telex customers in eight Eastern cities and now has increased this service to 3,000 customers since May 1966. Computer-center service for all Western Union Telex customers nationwide is scheduled for operation and will serve more than 16,000 United States Telex customers.

The program calls for the ultimate integration of the public message network consisting of company-owned and operated computers using high-speed data channels at key cities. The integrated Telex-public message network will combine maximum flexibility, speed and accuracy.



60 Hudson St. New York City

Services of the Center

The services presently offered through the ISCC are known as Automatic Computer Telex Services (ACTS) and Info-Mac Services. ACTS provide Telex subscribers with the ability to transmit messages on a store-and-forward basis to:

a. AT&T's TWX subscribers equipped with unattended operation and unique answer-back in the continental United States, except Alaska.

b. Telex subscribers anywhere in the continental United States, except Alaska; also in Canada and in Mexico; and

c. Up to 100 Telex and/or TWX subscribers, in any combination, who should receive the same message text.

These services overcome some of the limitations inherent in systems which only provide circuit switching capabilities, such as Telex or TWX.

Telex-to-TWX

The first service, Telex-to-TWX, is designed to overcome the incompatibility of two nationwide circuit switching networks.

Previously, there were two communities of subscribers, those of Western Union's Telex network and those of AT&T's TWX network. Subscribers of one network could not use their station equipment to communicate with subscribers of the other network. With the Telex-to-TWX relay service in the ISCC, Telex subscribers can now transmit messages to one or more TWX stations. The restrictions that TWX subscribers be equipped with unattended service and unique answer-back are imposed for message protection.

Although only a small percentage of the TWX subscribers are presently equipped with these features, the number is continually increasing.

Telex-to-Telex

The second service, Telex-to-Telex, is designed to overcome the problem arising from busy stations in a circuit switching network. Let us assume three stations are connected to one network. Anytime subscriber A calls subscriber B, there is a probability that subscriber B is busy with a connection to subscriber C. The only way subscriber A can transmit his message is to continue trying to place his call, until he finds the line of subscriber B idle. This process in inefficient for both the subscriber and the equipment. Now, with the ISCC, when subscriber A, encounters a busy signal, he may dial the computer center. Since a large number of trunks exist between the computer and the circuit switching network, the probability of encountering a busy signal is considerably less. Therefore, subscriber A has a much greater chance of transmitting a message on the first call to the computer center. The ISCC will, at periodic intervals, attempt to automatically transmit the message. Each time the ISCC encounters a series of three consecutive busy signals, it waits three minutes prior to re-initiating the delivery procedure. This latter feature minimizes the use of the circuit switching network equipment for calls that cannot be completed.

Multiple Address

The third service, Telex-to-Multiple-Telex and/or TWX addressees, is designed to overcome the point-to-point nature of circuit switching networks. Some networks provide for conferencing capabilities so that several subscribers of a circuit switching network can be connected simultaneously. This is impractical for many requirements because of the long set-up time required for conference calls, and the problems arising when one station is busy or out of service. Generally, a circuit switching network is used to establish an electrical path between two stations. In order to overcome this limitation, a Telex subscriber, wishing to transmit the same text to more than one subscriber of the Telex and/or TWX networks, may now dial the ISCC once and transmit the message including all addressees. The ISCC will then automatically transmit the message to each addressee. Privacy is maintained, because each addressee receives only his portion of the address section of the message.

Legal Citation Service

In addition to the Telex oriented services described above, the first Info-MAC, called the Legal Citation Service (LCS), has been introduced. LCS will be offered by Law Research Services, Inc. using Western Union's facilities.

The LCS is an on-line information retrieval service. The user can rapidly and accurately have access to the latest references of precedent setting legal cases for a large number of points of law. For each inquiry that the user transmits to the ISCC, he receives all the applicable references for a maximum of ten cases, plus an indication if there are more cases on file referring to that particular point of law. The cases are arranged in chronological order, with the most recent cases always the first to be transmitted to the user. This service reduces the research time of lawyers and others involved in judicial cases. It also provides most recent information, which is not usually available, for a considerable time after a law decision has been handed down.

Automatic Computer Telex Services

When a Telex subscriber wishes to use any of the ACT services described above, he dials "1040," the number for the computer center. When he is connected with the computer, the ISCC sends the following identifying message:

WU ISCC	07/18/66	123456	(Figs D)
Computer Center Identification	Date	ISCC Internal Message Number	Request of Calling Subscribers' Answer-back

When the subscriber's station receives the (Figs D) sequence, its answer-back is automatically activated. Following this exchange of answer-backs, the subscriber may now proceed to transmit his message. The originating subscriber's message must be transmitted in a pre-established format which is illustrated in Figure 2. Every message must contain the following control signals:

a. The Start of Message (ZC<≡)

b. At least one valid routing line

c. The End of Routing signal (.)

d. The Beginning of Text Signal (<≡BT<≡)

e. The End of Message Signal (NNNN)

legend {carriage return <
{line-feed ≡

```
Line 1: ZC<≡
Line 2: TLX 12081 W U ISCC NYK <≡
        TWX 2018431005 W U SYST ENG PAR.<≡
Line 3: TO 12081 COMPUTER CENTER PERSONNEL <≡
Line 4: BT <≡
Line 5: MESSAGE TEXT
Line 6: NNNN                  carriage return  < } legend
                              line-feed        ≡ }
```

Figure 2. ISCC MESSAGE FORMAT

Line 1: ZC<≡ is the Start of Message

Line 2: These are the routing lines. "TLX" indicates the addressee is a Telex customer; the number which follows is the Telex number of the addressee, and the characters following the number are the addressee's answer-back. "TWX" indicates that the addressee is a subscriber of AT&T's TWX network; the number is the TWX number of the addressee and the characters following the number are the addressee's answer-back. The period (.) preceding the carriage-return line-feed of this line is the "End of Routing" symbol and the last routing line.

Line 3: This line allows the originating subscriber to add secondary information, so as to facilitate delivery of the message at the destination station. The Telex number is repeated so that this secondary information can be correlated with the proper routing line.

Line 4: The sequence "BT" or Beginning of Text indicates the end of the secondary routing information, as well as, the start of the information to be transmitted from the originator to the destination.

Line 5: The text of the message starts on line 5. The following characters (ZC<≡), (Figures D) or (NNNN) cannot appear in the message.

Line 6: This line is the end of message sequence and it consists of four consecutive "N" characters (NNNN).

As the message enters the computer, the computer program checks it for all the control signals. In the case of routing lines, the computer only checks that the information appears generally correct. In Telex messages, it checks to be sure that the subscriber's number is four to eight digits in length. The computer program also checks for characters following the number, which are generally accepted as the answer-back characters.

If all checks are met, the computer transmits the following acceptance message to the calling subscriber:

ACCEPTED WESTERN UNION INFORMATION SERVICES COMPUTER CENTER

If all the checks are not met, the computer will automatically transmit a rejection message, indicating which control sequence was omitted. For example, if the originator of the message accidentally omits the "Beginning of Text" sequence, the ISCC sends the following service message:

UNABLE TO PROCESS—NO BEGINNING OF TEXT PLEASE CORRECT AND RESEND WESTERN UNION INFORMATION SERVICES COMPUTER CENTER

Following the transmission of the acceptance or rejection message, the ISCC will initiate a disconnect signal, as only one message is permitted per connection.

When the ISCC program recognizes that it has received a valid message, and before it has completed the acceptance message to the originator, the computer initiates the steps to transmit the message.

If the addressee of the message is a Telex subscriber, as in the above example, the computer checks for an idle output trunk. The computer seizes the trunk and as soon as it receives a "Go Ahead" from the Telex exchange, it transmits the dial digits to the Telex exchange via the Telex interface unit. If the called subscriber is idle and the computer receives a "Call Connected Signal", the ISCC waits for two seconds to allow the subscriber's motor, to come up to speed, and then transmits the "Who Are You?" signal (Figures D). The "Who Are You?" signal will automatically activate the answer-back of the called subscriber. This answer-back, when received by the computer, is compared with the one that appeared in the routing line. The comparison is made on the basis of all printing characters, with the exception of the "Space" character. If the answer-back comparison is correct, the computer will initiate transmission of the message to the addressee, and will send the following pre-message header:

VIA WU ISCC	07/18/66	123456
Computer Center Identification	Date	ISCC Internal Message Number (Assigned When Message Entered the System)

Following this header, the computer transmits only the address portion for this particular addressee plus the complete text of the message.

At the end of transmission, the computer again requests the answer-back of the station for confirmation that the message was received by the addressee. Should a disconnect occur after the transmission was initiated, or if the computer does not receive the answer-back requested at the end of the transmission, the ISCC will automatically re-dial the subscriber and add to the message a "suspected duplicate" notice.

If the call was placed via an output trunk and a busy signal was encountered, the ISCC will attempt twice more to deliver the message. If after the third attempt, the subscriber is still busy, the computer center will place the message in a "Busy Table" and wait three minutes before attempting delivery. This process is continued for one hour. If a message remains within the system over that length of time, the message with an indication of the unserviced routing lines are sent to the Output Intercept position. If the answer-back of the called station and that of the routing line does not check correctly, after three successive attempts, the message is also transmitted to the Output Intercept Position.

A message is only sent to the Output Intercept Position once, with all the unserviced routing lines indicated by special code. Figure 3 is a typical print-out of a troublesome message at the Output Intercept Position.

```
Line 1: 095314 0001227

Line 2: R TWX 123456789 ABC CORP <≡

Line 3: A TLX 12281 CCC CORP NYK<≡

Line 4: U TLX 278991 BBB CORP CGO<≡

Line 5: ZC<≡
        TLX 125581 ISCC-SPO NYK <≡
        TWX 123456789 ABC CORP <≡
        TWX 2018431005 DEF MNFG CO<≡
        TLX 12281 CCC CORP NYK<≡
        TLX 278991 BBB CORP CGO.<≡

        BT<≡
        TEXT

Line 6: NNNN

Line 7: AB
```

Figure 3. A typical PRINTOUT ISCC Output Intercept Position

Explanation

Line 1: The time that the message is being delivered to the Output Intercept Position and the Original Message Number assigned when the message first entered the system.

Line 2: The "R" indicates that the routing Line is incorrect. In this case the reason it is incorrect is that the TWX number only has nine digits instead of the required ten.

Line 3: The "A" indicates that the answer-back in this routing line does not check with the one of the station when that particular Telex number is called.

Line 4: The "U" indicates that the system has been unsuccessful in delivering the message to the addressee due to always receiving a busy signal for the maximum period of time that a message is allowed within the system.

Lines 5-6: The original message as it entered the ISCC.

Line 7: Output Intercept Position answer-back, which assures the ISCC that this position is operational.

At the present time, the TWX deliveries are handled on a torn-tape basis. Therefore, if the computer recognizes that it has a TWX delivery, it immediately seeks an idle Model 28 ASR set used for TWX relay positions. At these positions, the messages appear on both "hard-copy" and printed perforated tape. The tape is punched in 5-level TWX code rather than the Telex code. Thus, the generated tape is used to transmit directly from standard 5-level TWX stations leased from AT&T under that company's tariffs. At the end of the transmission of a message to a TWX relay position, the ISCC requests the answer-back from the relay position to check that the relay position is operative. Arrangements are presently being made with the appropriate Bell System operating companies so that in the expanded system this transfer to the TWX network will be on a fully-automatic basis.

During the output processing of messages, the first-in first-out rules are maintained for each class of service.

If a station is busy, delivery is delayed until it is available. Deliveries depend on the number of trunks connected to the computer at any given time. Since each delivery over a particular output trunk is independent of other output trunks, the other output trunks may be occupied with deliveries of the same message to different addressees or handling completely different messages.

Anytime that the ISCC detects an abnormality, such as a subscriber starting to transmit a message and then disconnecting, fault errors, bad answer-back comparison output, busy signals, etc. it automatically transmits a coded message to the high-speed printer. This message indicates to the operating personnel the time and type occurred, the trunk number over which it occurred and information regarding the originator—if it was an input error, or the addressee—if it was an output error.

```
Line  1: LCS-
Line  2: 0000000602
Line  3: 1456772464
Line  4: 0000001056
Line  5: 0000001061
Line  6: ?
Line  7: 0000000005.
Line  8: WESTERN UNION LEGAL CITATION SERVICE
Line  9: 0000000602
Line 10: FRANK256 NYS2D 189. 45 MISC2D 171
Line 11: GENER257 NYS2D 120, 45 MISC2D 451
Line 12: TACA 256 NYS2D 129, 15 NY2D 97, 204 NE2D 329
Line 13: JAY S256 NYS2D 600, 15 NY2D 141, 204 NE2D 638
Line 14: 1456772464
Line 15: CITATION SET UNAVAILABLE
Line 16: 0000001056
Line 17: PHILI234 NYS2D 948, 37 MISC2D 150
Line 18: ATLAN195 NYS2D 820, 20 MISC2D 390
Line 19: ALLEN153 NYS2D 779, 1 AD2D 599, REVERSED 161
                  NYS2D 418, 2 NY2D 534, 6
Line 20: ALR2D 1309, SCHWA221 NYS2D 917, 31 MISC2D 768
Line 21: 0000001061
Line 22: INVALID INQUIRY DESIGNATOR
Line 23: END
```

Figure 4. A typical PRINTOUT for the Legal Citation Service

Explanation

Line: 1: This is the service designator for the Legal Citation Service and consists of "LCS-".

Lines 2-5: These are the inquiry numbers for which the customer is requesting citation cases.

Line 6: This is the "End of Inquiry Designator".

Line 7: This is the Charge Number. Each user is assigned a charge number for billing purposes, similar to a credit card number.

Line 8: This is initial response from the ISCC identifying the service.

Lines 9-22: These are the originator's inquiry number repeated plus the response. Note that all the inquiry numbers that can be serviced are serviced. In the case of errors, Lines 14 and 21 different messages are sent to the user to facilitate his reaction.

Line 23: The word "END" is transmitted followed by a disconnect signal. In this way the customer knows that the ISCC has reacted to all his inquiries.

Legal Citation Service

In the case of the Legal Citation Service, the customer calls the ISCC and the computer responds in the same manner as described above. The calling subscriber then enters his inquiry in the format shown in Figure 4. Every inquiry must contain:

a. The Start of Message (inquiry) LCS-
b. At least one valid inquiry number
c. The end of inquiry signal (?)
d. A valid charge number

The inquiry service is recognized by the "Start of Message" sequence characters, LCS-. Upon recognition of this sequence, the ISCC analyzes each inquiry number to be sure that it passes the mathematical checks. After receipt of the "End of Inquiry" (?) sequence, it checks the charge number. Having completed all the checks, the ISCC then automatically initiates the retrieval of the legal citation cases from its mass storage. The response is transmitted to the originating subscriber on the same call; that is, the computer does not call-back the originator in order to send the replies to the inquiry numbers.

If a subscriber sends a mixture of correct and incorrect inquiry numbers to the center, the ISCC will service all those that are valid and will indicate to the customer those that are incorrect. A typical printout for an LCS inquiry is shown in Figure 4.

If the customer sends an invalid charge number, the ISCC will not service any inquiries, but will transmit the following message:

WESTERN UNION LEGAL CITATION SERVICE
INVALID CHARGE DESIGNATOR

When the inquiry has been serviced, the computer will automatically originate a disconnect signal.

Data is recorded on the UNIVAC Fastrand II mass storage drum by means of an off-line program. Law Research Services, Inc. prepares the original data on punched cards and then transfers it to magnetic tape. The reels of magnetic tape are then read into the Fastrand drum by a special program that is designed to obtain the maximum efficiency of the storage capacity available.

Hardware

The ISCC consists of two complete systems; an on-line system to handle traffic and an off-line system to de-bug new programs and for fall-back. Each system consists of:

a. A Univac 418-II Computer, equipped with storage for 65,536 (18-bit) words, a 2-microsecond memory cycle, a console typewriter and an alarm. The computer stores programs required to validate message headers, to perform dialing procedures, to check answer-backs, to read-write from the drum, to write records on magnetic tape, to interface with the communications lines, etc.

b. A magnetic tape sub-system consisting of a controller, power supply and four magnetic tape units. Tapes may be written at any of three densities, 200-,556-, or 800-characters per inch with transfer rates of 27-, 71-, or 102 kc respectively.

Five different types of records are maintained on magnetic tape. These tapes are the Reference, Input, Output, Error and LCS Journals. The Reference Journal is a complete copy of every message that enters the system. The Input Journal is a record of the header of each message, and the time required to receive the header and text portion of the message. The Output Journal is a record of each delivered message. The Error Journal is a record of every abnormality encountered by the ISCC, while accepting or transmitting a message. The LCS Journal is a record of every inquiry.

In addition, the tape stations are used to read in the program each morning, as well as to store special off-line programs, such as billing and message retrieval and recovery.

c. A fast-access magnetic drum, the Univac FH-330 Drum, is used to store special programs, which can be called in from the computer console and for the storage of messages while they are in-transit. Approximately 2,000 messages may be stored on the drum. When a message is completely processed, its location on the drum becomes available for another message. The drum has a capacity of 262,144 (18 bit) computer words. Each word may be accessed in about 7.5 milliseconds.

d. The multiplexer is basically the interface between the computer and the communication lines. A communications multiplexer will be capable of accommodating 32 full-duplex lines of 2400 bits/seconds. It is presently equipped to handle 30 full-duplex lines, each capable of operating at speeds up to 300 bits per second. Each line may operate at any speed and code. Bits are received serially, stored to form a character and then transferred in parallel to the computer. The reverse process exists on output.

e. A Univac 1004-IA printer/card reader operates at 200 lines/200 cards per minute. The printer section is used mainly for on-line reports to the operating personnel, the same information recorded in the Error Journal, and for off-line reports such as billing. The card reader is used mainly during the de-bugging of the program, and also to enter corrections.

Figure 5, illustrates the number of units for a single system. In addition to these units, the computer center is also equipped with:

a. A Univac 1004 card punch is used during the preparation of the programs and to generate the charge to numbers for the Legal Citation Service.

b. A Univac Mass Storage drum, known as a Fastrand II is shown in Figure 6. This unit is capable of storing 44,040,192 (18 bit) computer words. Each group of 56 words can be accessed in an average of 92 milliseconds.

c. A bank of 6 transfer switches allow either tape sub-system, multiplexer, and FH-330 to be connected to either 418 computer. In addition, it connects the Fastrand unit to that computer handling on-line traffic. Each unit can be switched independently of any other unit, but only one tape system, multiplexer, or FH-330 can be connected to a computer at a time.

d. Twelve Telex interface units are used to convert normal Telex Baudot characters, to dial pulses for a Telex call. They also perform some of the signalling interfaces required between the computer and the Telex network.

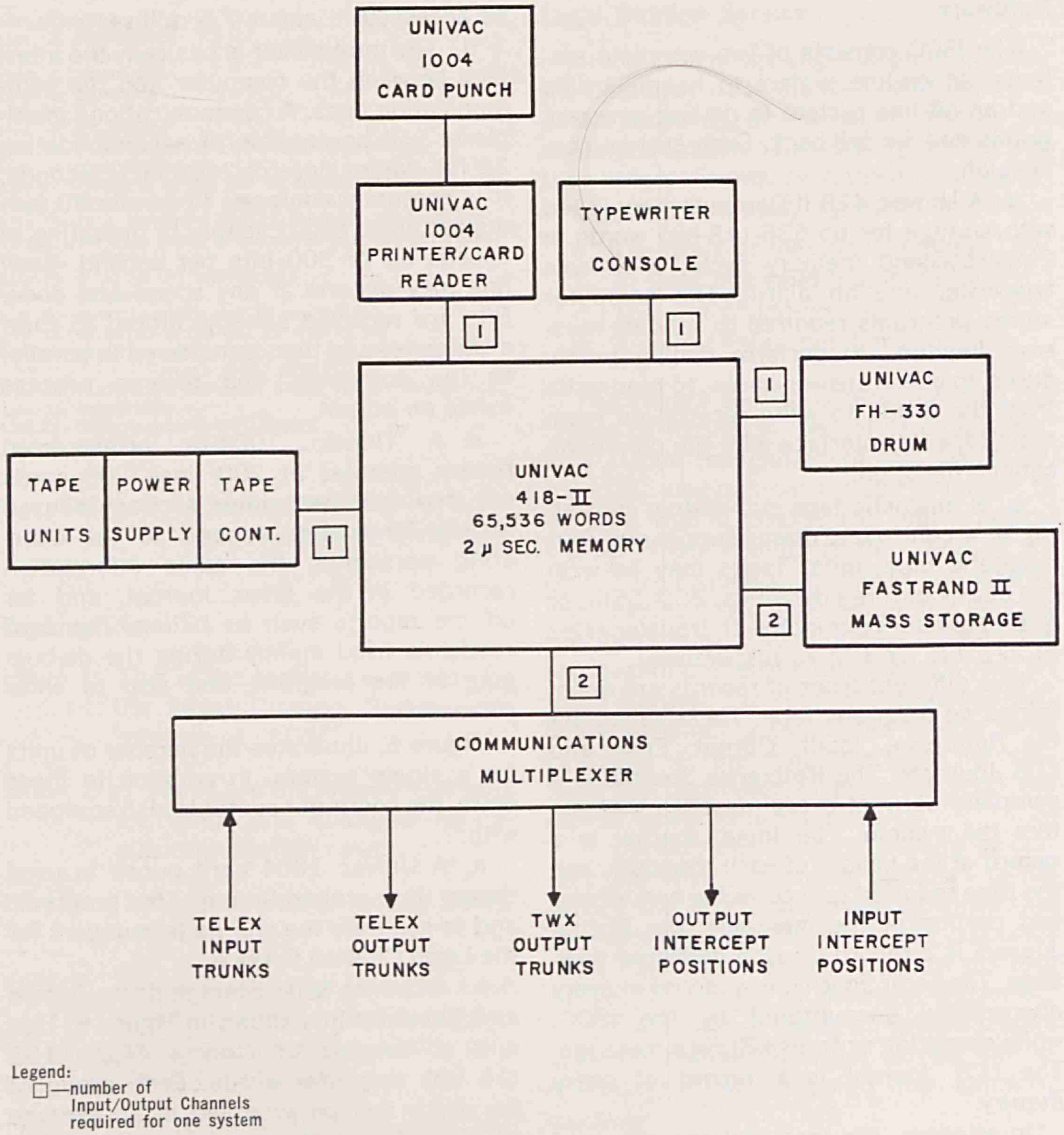


Figure 5. Interconnection Diagram of an On-Line System

e. Three Model 35 ASR sets, two Model 32 ASR Telex sets, and three Model 28 ASR sets with a printing perforator under the dome are equipped with answer-back capabilities. In addition three TWX Model 28 ASR sets are leased from AT&T under their tariffs. All these units are used by the supervisory personnel to communicate with the users of the ISCC or to perform the TWX relay function.

f. Additional teletype equipment, interfaces, keypunches, etc. are used with the off-line system for testing and preparation of programs.

Expansion

During the latter part of 1966 and early 1967, the Information Services Computer System—Phase I (ISCS-I) will be cut over. This integrated system consisting of five Computer Centers with processors and concentrators tied together by high speed lines will cover the major industrial and business areas in the United States. The system will have a Univac 418 processor, another complete system for fall back and the 418 main frame as a concentrator in New York, Chicago and San Francisco. In Dallas and Atlanta only concentrators will be used.

The following service will be offered initially with this system:

- The ACTS services on a nationwide basis
- Mechanization of Tel(T)ex
- Legal Citation Service for Law Research Services, Inc.
- Private Shared Network Services
- Data Collection

This initial system will be the back bone upon which we can further expand and in later phases provide other inquiry, retrieval, transactions and data processing services, in addition to automating the Western Union public message handling system.

SERGIO WERNIKOFF, Director in the Information Systems and Services Department, has been responsible for the overall system engineering for the Information Service Computer Center.

He participated in the installation of the first Telex exchange and many Private Wire Systems. He was active in the planning of such projects as AUTODIN and the Advanced Record System for GSA.

Mr. Wernikoff received his degree in Electrical Engineering from Case Institute of Technology in 1957. He is a member of ACM, Association of Computer Machinery.

automatic test routiners

—F. John Zepecki

Automatic Test Routiners are used in Telex exchanges to provide automatic checking of major components and interconnections to detect equipment failures. The use of Automatic Test Routiners provides a periodic quality control check of every component in the Telex network. Their continued use is expected to optimize maintenance procedures, since maintenance personnel will be relieved of the task of routine checking. Thus, the faulty equipment can be repaired at the same time that other equipment is being checked by the Routiner.

Two types of Test Routiners are presently being tested, those for the CSR4 and the TWM2.

CSR4 Routiner

The CSR4 Routiner is designed to automatically test trunks to other Telex exchanges, subscriber's lines terminated on the CSR4, and subscriber lines of sub-district exchanges terminated on the CSR4. It checks for the proper operation of the switching equipment, as well as for signal distortion on the send and receive legs of the tested circuit. The Routiner may be programmed to test one circuit repeatedly, or to sequentially test each circuit in a group. In the Telex exchange, it appears as a combination of Register, RAL (Register Access to Link) Matrix, and Originating Link.

Test Procedure

Before the CSR4 Routiner can test, the following pre-test routine must be performed.

The Power switch is turned "On," and so is the On-Line switch which connects the Routiner to the necessary exchange circuits. The circuitry is reset. The type of test and the number of the circuit are then selected by depressing one of three interlocking pushbuttons. The repetitive or sequential mode is selected by means of the Mode switch. The printer associated with the Routiner is turned on and the test is begun by depressing the printer Start button.

Trunk Test Sequence

In the trunk test sequence, the Routiner is programmed to test a particular trunk. It selects this trunk and "marks" its send leg to the distant exchange to request service. Upon receipt of a "proceed to select" pulse, the Routiner generates a special service code, which connects it to a special service trunk termination. This termination then loops the send and receive legs together as a "CALL CONNECT" signal. The Routiner generates a test signal which is looped back onto the trunk receive leg. The results of this test, including trunk identification and percent signal distortion are printed out on a teleprinter.

Upon completion of this sub-program, the Routiner sends a command signal to the special trunk termination causing it to open the trunk loop, and then connect a pulse generator to the trunk receive leg. The Routiner again measures for signal distortion, and prints out the test results. The connection is released.

If the Routiner has been programmed for sequential operation, it will seize the next trunk in the group and proceed to test it. But if the Routiner is programmed for repetitive operation, it will continue to seize and test the same trunk to facilitate the adjustment of the distortion level.

Local Line Test Sequence

In the local line test sequence, the Routiner can test either local (current-no current loop) or long distance (± 120V polar) subscribers. The Routiner is first programmed to select a subscriber line. Upon establishing a connection, the Routiner transmits an undistorted "FIGS D" (who-are-you) signal to the subscriber, tripping his automatic answer back. A printout is provided on the associated teleprinter for a signal distortion of more than 5 percent. Upon completion of this sub-program, the Routiner transmits a "FIGS D" signal at distortions of 25 percent and 35 percent. Each time it checks for an answer back. And if none is received, a printout is sent to the associated teleprinter indicating that no answer back was received. The Routiner then disconnects the call.

The test will be repeated for the same line if the Routiner is in the repeat mode. If it is in the sequential mode, it will proceed to the next line in the group.

Remote Line Test

In the remote line test sequence, the Routiner is programmed to select a distant subscriber line. However, in this case, a trunk number must also be included. The Routiner will seize this trunk and transmit the selected subscriber's code digits. When connection to the subscriber is made, the test routine will be the same as the local lines test. The results of this test, in addition to the results of the test on the trunk being used, determine the quality of the remote subscriber's circuit.

TWM2 Routiner

The TWM2 Routiner is designed to automatically test outgoing trunk circuits to other exchanges which are equipped with special test terminations, and the Final Selector and subscriber circuits of the TWM2 exchange. The Routiner checks for the proper operation of the switching equipment as well as for excessive signal distortion on the send or receive legs of the circuit under test. It accesses the trunk via the Repeater racks and accesses the subscriber lines via the Final Selector racks. These racks are wired to the Routiner. If ten consecutive faults occur in the course of a test, an alarm will be sounded.

At the beginning of each test sequence, the Routiner is programmed by depressing the pushbuttons on the control panel. Buttons are provided to select the type and group of circuits to be tested, and to connect the Routiner to these circuits. Additional controls are provided to set up a test manually, to start a test immediately or with a time delay, and to cause a test to repeat. A reset button is also provided to cancel a test program at any point.

Trunk Test Sequence

In the trunk test sequence, the Routiner attempts to seize a selected outgoing or two-way repeater in the outgoing direction. If it is unable to do so, it will wait 1½ minutes and again attempt seizure. If it is still unable to do so, the fault printout (–00–) will be sent to the associated teleprinter. After the repeater is seized, the Routiner checks for the confirmation pulse (first revertive pulse) and the "Proceed-to-select" pulse (the second revertive pulse), if the trunk is connected to another junction office. Failure to receive the first pulse will result in fault printout (–01–), while failure to receive the second pulse will yield the fault printout (–02–).

Upon receipt of these pulses, the Routiner generates the dial code of the special test termination in the distant exchange. If the Routiner is checking a trunk to another TWM2 exchange, the test termination would be that exchange's Routiner. If a busy signal is received during or after dialing, a fault code (–03–) is generated and the Routiner will hold the trunk connection for four to five minutes while trying to seize the distant test equipment. If no connection is established in 5 minutes, an alarm is sounded to indicate a fault in the distant exchanges termination.

When a connection is established, the Routiner transmits a test signal which is analyzed by the distant test equipment, to determine if the distortion exceeds the allowable limit. If it does, the fault code (–04–) is printed out on the associated printer. When this sub-program is completed, the Routiner transmits a command signal to the distant office test termination to generate a test signal. The distortion level of this signal is determined by the Routiner and if it exceeds the allowable limit, the fault code (–05–) is printed.

The connection is broken by the Routiner and the printout of fault code (–06–) indicates an inability to disconnect. If the repeater under test returns to the idle state and is available for seizure too soon after the disconnect, fault code (–07–) is printed out.

A final check is made to assure that the repeater's seize wire has been opened. If it has not been opened, the code (—08—) is generated. Upon completion of the test, the Routiner steps to the next repeater and reinitiates the test sequence.

Line Test Sequence

In the line test sequence, the Routiner attempts to seize a specified Final Selector. If it is busy, the code (–++–00) is generated, but if it is idle and cannot be seized the fault code (–++–01) is printed out. When it is seized, the Final Selector tries to seize a Marker unit. If it is unable to do so, or if the connection is improperly made, the fault code (–++–02) is generated.

If the subscriber is busy, the code (–××–00) is generated and the Final Selector is stepped to the next subscriber. The code digits (–××–) are the dial digits of the selected subscriber. When an idle subscriber is selected, a connect signal is transmitted, but if his teleprinter does not turn on, the fault code (–××–03) is printed out. When the connection is established, the subscriber is sent an information code to tell him that a test will be performed on his equipment. During the transmission of this message, the subscriber's send leg is monitored. If there are voltage fluctuations on his send leg, the fault code (–××–04) is printed out on an associated teleprinter. Then, the characters "FIGS D" (who-are-you) are transmitted to the subscriber with a preset amount of signal distortion. A check is made to assure that his answer back has been received. If it has not, the fault code (–××–05) or (–××–07) is generated to indicate an excessive amount of distortion. The subscriber's answer back signals are checked for distortion and the fault code (–××–06) or (–××–08) is printed out when the distortion level is too high. The Routiner then releases the connection.

If the subscriber's circuit does not return to the idle state, the fault code (–××–09) is generated. Upon release, the Routiner reseizes the Final Selector and proceeds with the test of the next subscriber in the group. The same Final Selector is used to test four subscriber circuits, before the Routiner releases it and seizes the next Final Selector on the rack.

F. John Zepecki is an Engineer in the Telex Section of the Information Systems and Services Department. Since joining Western Union in June 1964, Mr. Zepecki has been engaged in the development and testing of equipment for use in Telex exchanges and outstations. His work has included the design and testing of the Telex TW56 Concentrator Test Set, and a solid state Metering Pulse Generator for Telex exchanges.

Mr. Zepecki received his degree of Bachelor of Engineering from Stevens Institute of Technology in 1964, and is presently working toward his Masters degree in Electrical Engineering at Newark College of Engineering.

patents recently issued to western union

Assignee	Patent
H. J. Goonan and J. K. Fitzpatrick	3,194,467 Waveguide Flanging System
H. C. Likel	3,215,946 Series Energized Transistorized Circuit for Amplifying and Inverting Polar Input Signals
Robert Steeneck	3,225,331 Diode Matrix for Decoding Pulse Signals
P. F. J. Recca	3,232,604 Card Feed Mechanism
William V. Johnson and George A. Tompkins, Jr.	3,235,197 Motor Driven Tape Scanner and Rewinder
R. Steeneck	3,242,385 Universal Network Assemblage
R. C. Taylor and F. L. O'Brien	3,251,005 Transistor Stabilized Oscillator with Tapped Coil

CSR4 exchange

—James S. Chin and Jan J. Gomerman

The Communications Switching Reed Exchange is a common control automatic switching system utilizing matrices as switching stages. The common control type switching system implies that the input and output terminations are identified and seized before the transmission path between them is set up.

To increase the traffic capacity of the present Telex System, a new type of switching center, called the Communications Switching Reed Exchange CSR4, is being installed in various cities within the United States.

The design of the network allows it to be installed as either a high echelon junction office or a low echelon district office, without any change in major equipment.

The switching center is laid out in terms of register groups. Each register group is required to handle a corresponding number of line, link, trunk, sender and receiver groups. A register group contains a maximum of 28 registers and serves one line, one link and one trunk group.

The CSR4 system is capable of handling four types of calls: line originating to line terminating, line originating to trunk terminating, trunk originating to line terminating, and trunk originating to trunk terminating. The line calls are "local" subscribers' calls which are terminated directly on this exchange. The trunk calls are calls received from or destined to "remote" subscribers, terminated on other exchanges.

The CSR4 exchange contains two types of switch matrix; the directional matrix and the concentration matrix. The directional matrix is the heart of the switching section. All calls through the exchange have to be routed through this matrix network. The input terminals appear on the "J" or left side of the matrix while the output terminals are on the "L" or right side of the switch. The concentration matrix provides the connecting paths between "local" subscribers and a limited number of link circuits.

The processing of each call requires the following four major steps:

1) Originating connection
2) Digit evaluation
3) Terminating connection
4) Register control

The basic units used to process calls through the CSR4 exchange are shown in the block diagram in Figure 1.

Originating Connection

For each originating call, an incoming trunk or line circuit is connected to a register. For a trunk call, the path selector is responsible for this connection, while for a line call the marker is responsible.

On a trunk originating call, the request is sensed by the path selector over path #16, as shown in Figure 1. The path selector immediately scans all originating trunk groups and seizes the requesting trunk. Next, it scans the register group serving this trunk group and seizes an idle unit. The scanning and selection process will be explained further in another section of this

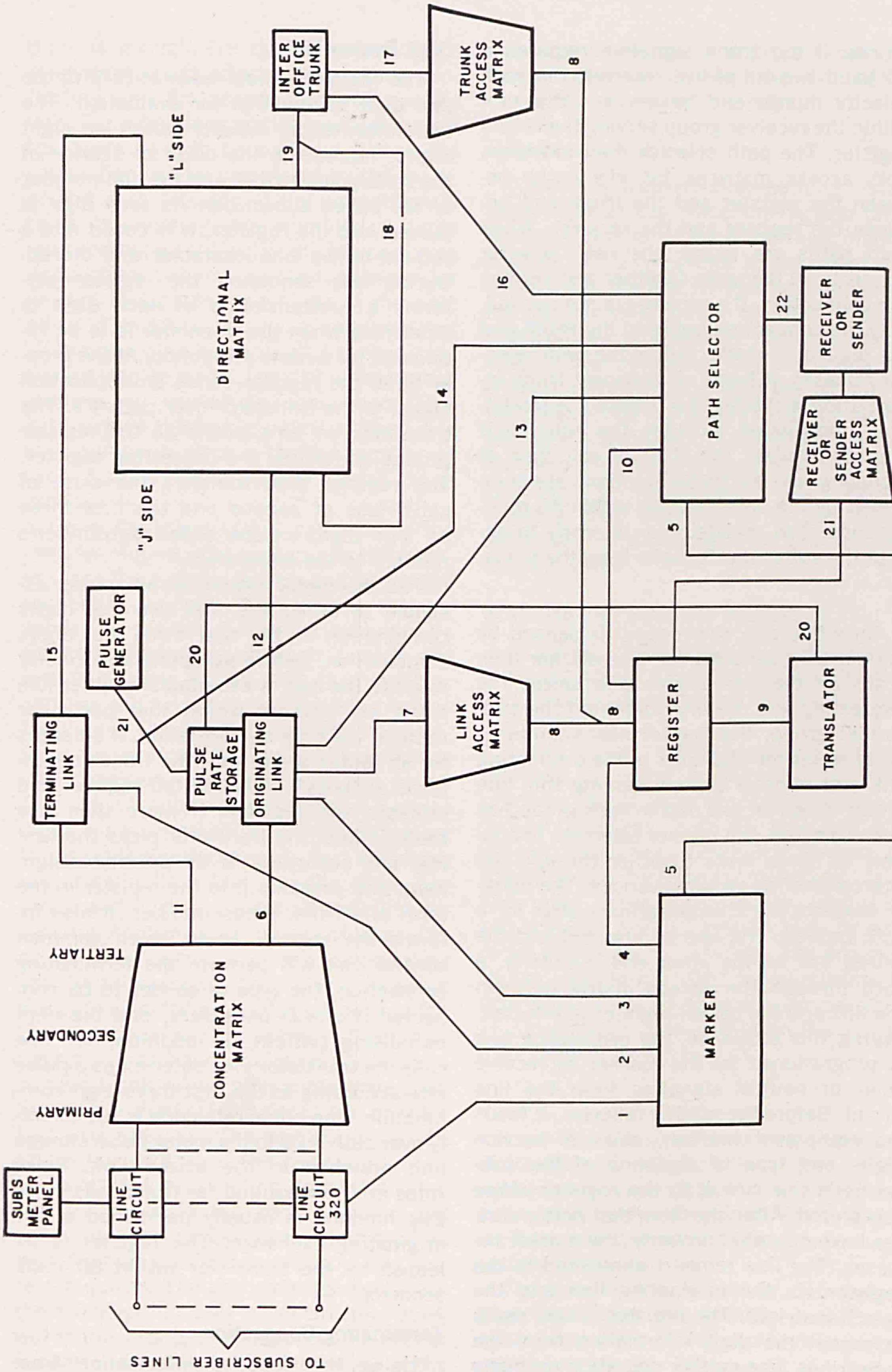


Figure 1. Block Diagram of CSR4 Exchange

article. If the trunk signaling requires a 50 baud two-out-of-five receiver, the path selector hunts and seizes an idle unit within the receiver group serving the seized register. The path selector then examines both access matrices for idle paths between the register and the trunk and between the register and the receiver. When both paths are found, the path selector connects all the units together and verifies the connection. If a receiver is not needed, only the connection between the trunk and the register is made. Before the path selector releases, it feeds all pertinent trunk information to the register, where it is stored. This information includes the equipment identity number, the class of call, type of signaling, etc. All these functions are completed by the path selector within 80 milliseconds. The register is now ready to accept the subscriber's digits from the trunk.

On a line call, the request is sensed by the marker over path #1. The marker then scans all the line groups and seizes the requesting line. Having identified the subscriber group, the marker now simultaneously scans for idle units in the originating link and register groups serving this line group. When an idle unit in each group has been selected, the marker attempts to connect all three units together through the interconnecting switch matrices. The marker inspects the concentration matrix for a path between the line on one end and the seized link on the other end. Similarly, a path through the access matrix between the link and the seized register is selected. During this sequence, the originating link is programmed by the marker to receive polar or neutral signaling from the line circuit. Before the marker releases, it feeds the equipment number, class of service digits and type of signaling of the subscriber's line circuit to the register where it is stored. After checking that both matrices have operated properly, the marker releases. The line remains connected to the register via the originating link and the switch matrices. The register is now ready to accept the digit information from the subscriber. The marker operation normally takes 100 milliseconds.

Digit Evaluation

The register is now ready to receive the dial digit information for evaluation. The dial information, usually seven or eight digits, represents the class of service of the calling subscriber and the dial number of the called subscriber. As each digit is pulsed into the register, it is coded into a two-out-of-five bits character and stored. During this sequence, the register performs a pretranslation of each digit to determine when the translator is to be requested for a route evaluation. At the proper time, the register sends an application signal to the translator over path #9. The translator, in turn, scans all the register groups and seizes the requesting register. The register then transfers the class of call, class of service and the first three or four digits of the called subscriber's number to the translator.

The translator examines all routes assigned to either the first two dial digits combination or the first three dial digits combination. Before assigning a particular route to the call, it ascertains whether idle paths are present within that particular route at the time of translation. If all paths for all routes are in use, the translator returns a "busy" signal to the register and releases the register. If more than one route is idle, the translator picks the first idle one according to its priority assignment and presents it to the register in the form of a trunk group number. It also informs the register as to which common control unit will perform the terminating connection, the type of sender to be connected if one is necessary, and the digit outpulsing pattern. In addition, for line calls the translator also determines a pulse rate according to the first three-digit combination. The pulse rate code is fed directly over path #20 to the meter pulse storage unit attached to the seized link. Pulse rates are not required for trunk calls since this function is usually performed at the originating exchange. The register is released by the translator within 80 milliseconds.

Terminating Connection

Using the decoded information from the translator, the register decides whether there is enough dial digit information already received to effect a terminating connection with the chosen common control unit. For a line terminating connection, all the digits have to be received before the connection can be completed by the marker and path selector. If the connection is trunk terminating, the number of digits required before the path selector performs its functions depends on the type of sender needed to outpulse the digits to the next office. The 50 baud sender requires that all but one digit be received before a connection can be made. The dial pulse sender requires an immediate connection. This is to reduce the holding time of the units to a minimum since a limited number of each type is being shared by all trunk groups.

On a line terminating connection, the register requests the marker and the marker scans the register groups and seizes the requesting register. The seized register sends the marker the called subscriber's equipment number, which is usually the last four digits of the dial digit number, and the calling subscriber's class of service digits. The marker hunts for and selects the desired line circuit, checks for an idle condition, and compares the called and calling subscribers' class of service digits for compatability before proceeding to set up the connection. It next seizes an idle terminating link serving this line group and locates a path through the associated concentration matrix between the called line circuit and the terminating link. Simultaneously, the marker requests the path selector for a connection through the directional matrix between the terminating link and the originating link or incoming trunk. When both paths have been found, the marker completes the connection and releases. The connection is left under the control of the register.

On a trunk terminating connection, the register requests the path selector and sends it a two-digit route identification plus the type of sender and outpulsing pattern required. The path selector deciphers the trunk group and picks an idle trunk within this group. It also selects the proper sender and then proceeds to locate paths through the directional and sender access matrices. Once this is done, the path selector releases leaving the connection under the control of the register.

Register Control

After the transmission path is established through the office, the register takes over the control of each call and insures that the call is completed to the called subscriber. For the line terminating sequence, the register monitors the circuits, to insure that both subscribers are connected properly, before releasing. For the trunk sequence, the register checks the circuits to the other office and sends forth the necessary dial information to complete the connection to the remote subscriber. If a busy condition is encountered, the register sends a busy signal back to the calling subscriber and proceeds to knock down the connection.

Scanning and Selection Process

Scanning of the common control equipment is similar for links, trunks, senders and receivers but it varies slightly for lines and registers.

Links, trunks, senders and receivers are selected by using a four-step scanning process. These steps are group selection, cabinet selection, subrack selection and position selection. Lines are chosen by scanning the thousands, hundreds, tens and units digits, respectively. Registers are scanned first by groups then by subracks and lastly by cabinets. The common control equipment uses memory units to distribute selection as evenly as possible. The scanning is inhibited when the associated register group is busy.

Links

Each link group consists of a maximum of 12 cabinets or racks. Six of these cabinets contain originating links and the other six contain terminating links. The originating links and terminating links are scanned at different times.

The proper link group is determined from the calling line identity in the case of an originating link group and from the called line identity in the case of a terminating link group. Then one of six cabinets within this link group is chosen. A link cabinet consists of three link subracks and these are scanned next. After a subrack is selected, one of ten positions in this subrack is chosen. If blocking is encountered in the concentrator switch, a second attempt is made by the marker to connect up the line to another link position.

Trunks

An incoming trunk group consists of a maximum of 3 cabinets. Each cabinet contains 6 subracks. An outgoing trunk group can have up to 2 trunk group relays assigned to it. Since each trunk group relay has 3 contacts, the maximum number of subracks in an outgoing trunk group is 6. Each trunk subrack can hold up to 15 trunks. First, the group is selected and then the subrack and position are chosen.

Senders and Receivers

There are 16 senders or receivers and 6 senders or receivers per subrack. First the type of sender or receiver is chosen. Then a subrack containing this type is picked followed by the selection of the actual unit.

Lines

A line group consists of 960 lines. Lines are scanned in the following sequence: Groups, hundreds, tens, and units digits.

Registers

One out of a maximum of twelve register groups is chosen first. There are six cabinets per group and five subracks (each one representing an individual register) per cabinet. A particular subrack position in each of the six cabinets is chosen first and then one of the six cabinets in the group is selected.

Components of CSR4

The following is a brief description of the major units comprising the CSR4 exchange.

Marker

The marker is a common control unit used to set up calls to the "local" subscribers through the proper concentration matrix. Since each matrix is limited to a maximum number of 320 "local" subscribers, more than one matrix switch may be used. To find the proper matrix, the marker using the selection process described above, pinpoints the subscriber's line circuit and its associated link unit. Then with the proper polarities applied on both the line side and the link side, the marker examines all the matrices and selects the one with the applied voltages. A similar process is carried through for terminating calls. The marker also programs the links to handle the particular type of line signaling that the subscriber is using. A special feature of the marker enables calls, destined for heavily loaded circuits, to be switched to special trunks set up to handle the heavy load. This helps to maintain the 1 percent grade of service offered to Telex subscribers. During the busy hour the marker is capable of handling 18,000 calls per hour.

Path Selector

The path selector handles three types of requests. These requests originate from either an incoming trunk, a register or a marker. On an incoming trunk request, the path selector connects the trunk to a register and the proper receiver (if needed) to this register via register access matrices. On a register request, the path selector connects an originating link or incoming trunk to an outgoing trunk via the directional matrix. If a sender is required, the path selector connects the proper one to the register via a register access matrix. On a marker request, the path selector is needed for either a terminating link call or a special service call. On a terminating link call, the path selector connects a terminating link to an originating link or incoming trunk via the directional matrix. On a special service call, the path selector connects an originating link or incoming trunk to a special service trunk via the directional matrix.

An important characteristic of the path selector is one which prevents faulty first-choice trunks from blocking a trunk group in light traffic. In periods of low usage, a memory unit is employed in the trunk selection process to alternate the first choice trunks.

A traffic limitation imposed on the path selector is that the maximum number of applications for the path selector per busy hour cannot exceed 18,000.

Translator

The translator analyzes the first two or three digits of the called subscriber's number and examines simultaneously all the routes assigned to this digit combination. The route can be made busy for other reasons than total occupancy of the trunk. These include "class of service" and "class of call" restrictions. For a call destined to another office, the translator assigns the outpulsing pattern of the digits being sent to the next office and selects the type of sender to be used. For zoning purposes the translator evaluates the first three digits and chooses the assigned pulse rate.

Register

The register receives information from either a subscriber in its own exchange or a register in a distant exchange. When receiving from a subscriber, it is accessed from an originating link via a register access matrix. When receiving from a distant office register, the register is accessed from an incoming trunk via a register access matrix.

The register sends a 25 millisecond revertive pulse to indicate that it is ready to receive digits from a distant office. The register is equipped with a dial pulse receiver. In order to receive 50 baud (2-out-of-5) signals from ITT offices, a separate receiver is attached to the register by the path selector. The register has the capacity of storing up to ten digits.

An important characteristic of the register is its capability of generating its own class of service when processing calls from non-ITT offices. The fixed number assigned indicates that the calling party is a 50 baud Telex subscriber.

Links

Line originating calls utilize an originating link and line terminating calls use a terminating link.

The originating link interfaces with the concentration matrix, the directional matrix and a register access matrix. This gives it access to line circuits, trunk circuits and registers. It repeats the signals from the concentration and directional matrices to the register. The subscribers appearing on the line side of the concentration matrix may use either loop or polar operation but the originating link provides only polar operation out to the trunk side of the directional matrix. In the call-connected condition, the originating link recognizes a disconnect signal from either party and proceeds to remove the potential holding the concentration matrix. The originating link is also responsible for sending meter pulses to the calling subscriber's meter.

The terminating link has access to lines and trunks via the concentration and directional matrices. Like the originating link, it converts loop or polar subscribers to polar operation. It is responsible for applying the hold potential to both the concentration and the directional matrices. In the call-connected condition, the terminating link does not itself recognize subscriber termination of a call. The incoming circuit detects the disconnect signal and opens its signaling wires. This is detected by the terminating link which then removes the hold potential from the concentration and directional matrices.

Senders and Receivers

The office works with dial pulse and 50 baud, 2:5 senders and with a 50 baud, 2:5 receiver. The path selector connects these units to the register through register access matrices.

The dial pulse sender is used to forward address information to non-ITT offices. It converts the 2:5 digits received from the register to a 1:10 code and sends them to the distant exchange in dial pulse trains.

The 50 baud, 2:5 sender is used to forward address information to the other ITT offices. It accepts one digit at a time in 2:5 from the register and transmits to the distant office in 2:5 at 50 baud in an eight-element code. This code consists of the following: START, 0,1,2,4,7,STOP, STOP.

The 50 baud, 2:5 receiver is connected to the register when addressing data is being received from an ITT office. It accepts one digit at a time, serially, consisting of eight bits in the following order: START, 0, 1, 2, 4, 7, STOP, STOP. These data bits are transferred in parallel, on a five-wire bus to the register via the register receiver matrix.

Trunks

The trunk circuits provide the interface between the carrier equipment and the switching equipment. They use polar signaling and are capable of two-way operation.

In the incoming mode, the trunk appears on the J side of the directional matrix. It is connected to the register via the register access matrix in response to a seizure by a distant office trunk. In the outgoing mode, the trunk appears on the L side of the directional matrix and provides the forward seize signal to attach the next office in the routing sequence.

When in the call-connected condition, the outgoing trunk is responsible for holding the directional matrix; but the signal to release the matrix comes from the incoming trunk or originating link.

Matrices

There are two types of matrices used in the system: the distributional type and the concentration type. The distributional matrix implies that there are an equal number of input and output terminals. The concentration matrix implies that a certain number of inputs are reduced through "grading" to provide a smaller number of outputs. The "grading" of each matrix depends on the traffic capacity and where it is used. In the CSR4, the directional matrix represents the distributional type while the other matrices are of the concentration type.

The directional matrix can be either a 3-stage or a 5-stage network depending on the maximum number of inputs needed. If more than 200 terminations are needed the 5-stage network is used. The exact layout of the matrix switch is quite involved; however, a simplified layout of a 9-input, 3-stage matrix is shown in Figure 2. The 5-stage matrix can be considered a 3-stage network with the center stage a 3-stage matrix in itself rather than a single stage.

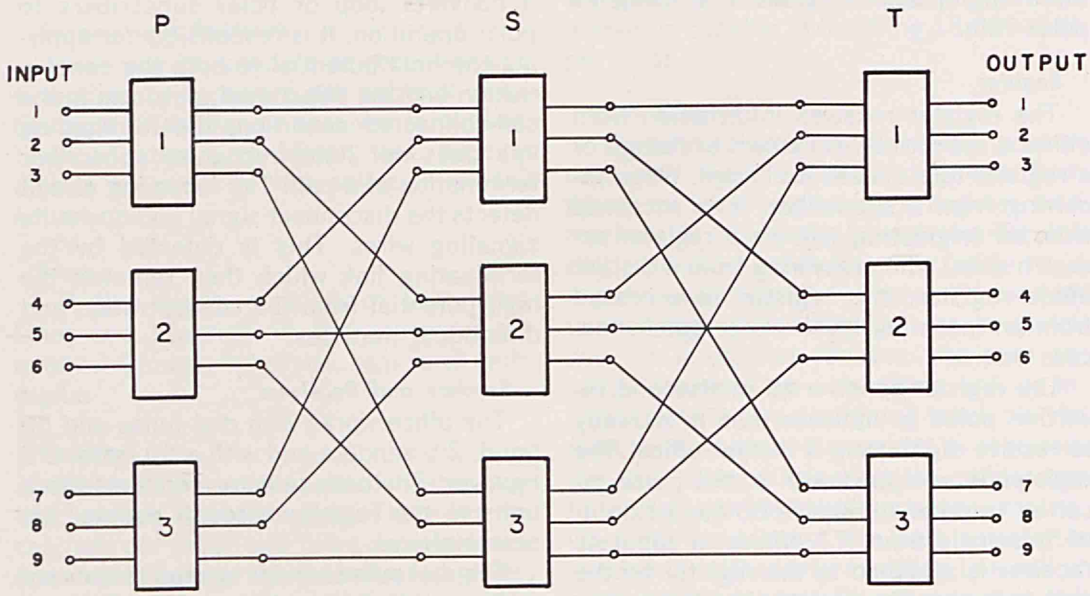


Figure 2. Simplified Layout of a 3-Stage Matrix

The concentration and access matrices are of the 3-stage variety with the "grading" being done between the primary and secondary stages.

Figure 2 illustrates the many possible paths between the input and output terminals. Any one input is fanned out through the primary (P) stage to each secondary (S) stage, which in turn branches out through each tertiary (T) stage to a particular output. As the size and number of each matrix increases, the combinations of paths increases geometrically, and thus provides a very low percentage of blocking.

The basic building block of the directional and concentration matrices is a 5 by 5 array of reed relays while the access matrices are made up of 4 by 4 arrays.

Line Circuits

The line circuit provides an interface between the subscriber's lines and the exchange. It can be strapped to accept either polar or neutral signaling. The line circuit notifies the marker whenever a subscriber requests service. If a fault condition exists on the subscriber's lines, the line circuit goes into a lockout condition which isolates the subscriber from the exchange until the trouble is cleared up.

Special Features of the CSR4 System

The CSR4 system has several unique features.

- Multiple alternate routing
- Full accessibility of all trunks
- Fault printouts from major common control units to identify trouble
- Class of service restriction
- Narrowband and/or wideband transmission
- Optional dial pulse or keyboard signaling
- Modular construction

JAMES S. CHIN, Project Engineer in the Information Systems and Services Department, is responsible for the system testing and installation of the new Telex exchanges for the expanded Telex System.

He joined Western Union in 1960 and has been engaged in designing and installing test equipment for the Telex exchanges.

Mr. Chin received his B.E.E. degree from Rensselaer Polytechnic Institute in 1959.

JAN J. GOMERMAN, an Engineer in the Telex Section of the Information Systems and Services Department, has been responsible for various design changes in the TWM2 Telex exchange. He is presently concerned with the acceptance and installation of the CSR4 exchange.

He joined Western Union in 1964, after receiving a B.E.E. degree from the City College of New York. He is currently studying for a Masters degree in Electrical Engineering at New York University.

Telex
Switching Systems
Circuit Switching
Line Switching

Wunner, John J., Jr.: Telex Switching System TWK4

Western Union TECHNICAL REVIEW, Vol. 20, No. 3 (July 1966)
pp. 96-104

This article describes a new type Automatic Teleprinter Exchange, which is in the Telex system at the sub-district level, and is connected to a district or junction office via a trunk line group.

Telex
Monitors
System Maintenance
Test Facilities
Display Device

Feldman, Melvyn M.: Pulse Rate Monitor

Western Union TECHNICAL REVIEW, Vol. 20, No. 3 (July 1966)
pp. 106-107

Western Union has developed a Pulse Generator Rate Monitor. This article describes that monitor, which checks the pulse generator outputs and electronically samples pulses sent via the pulse generator. When various fault conditions are detected, an office alarm condition occurs.

Telex
Subscriber Terminals
Data Communications
Terminal Equipment

Lavitola, Peter J.: Outstation Options

Western Union TECHNICAL REVIEW, Vol. 20, No. 3 (July 1966)
pp. 108-111

In order to meet the data communication needs of its customers, Western Union offers the following options in Telex: Control of Auxiliary Devices; Tape Transmitter Control; and Automatic Dialer. This paper outlines each of those options.

Telex
Traffic Evaluation
Traffic Load
Instruments

Panzaru, Emil: Traffic Recording Methods

Western Union TECHNICAL REVIEW, Vol. 20, No. 3 (July 1966)
pp. 112-119

At Western Union, Erlangmeters, Traffic Recorders and 12-Value Integrators are used to study Telex traffic volume. This article describes the methods and instruments used.

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Telex
Computer Techniques
Data Switching
Switching System
Devices

Mansfield, Earl C.: Telex Interface

Western Union TECHNICAL REVIEW, Vol. 20, No. 3 (July 1966)
pp. 120-127

The Telex Interface, as described in this paper, not only permits the computer to initiate calls to Telex subscribers, but also allows subscribers to send messages to the computer.

Telex
Computers
Public Services
Message Switching

Wernikoff, Sergio: Information Services Computer Center

Western Union TECHNICAL REVIEW, Vol. 20, No. 3 (July 1966)
pp. 128-137

This article describes the services offered in the Western Union Information Services Computer Center, which is the first development in the ultimate integration of computerized Telex with the Public Message services.

Telex
Test Instruments
System Maintenance
Quality Control

Zepecki, F. John: Automatic Test Routiners

Western Union TECHNICAL REVIEW, Vol. 20, No. 3 (July 1966)
pp. 138-140

Automatic Test Routiners provide a periodic quality control check of every component in a Telex network. The two types of Test Routiners, CSR4 and TWM2, are described in this article.

Telex
Switching Systems
Circuit Switching
Line Switching

Chin, James S. and Jan J. Gomerman: CSR4 Exchange

Western Union TECHNICAL REVIEW, Vol. 20, No. 3 (July 1966)
pp. 142-149

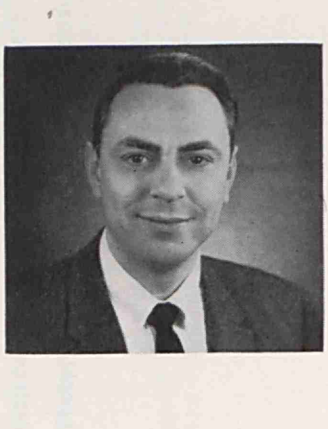
This article describes the Communications Switch Reed exchange, which is Western Union's new type of switching center in the Telex system. This type of exchange is being used at the Junction and District levels.

experience and teamwork

A solid record of experience in planning, designing, and engineering, the Western Union's Telex system coupled with the experience in testing, installation, and maintenance of it is documented in this special issue of Telex. The teamwork exemplified by the authors is testimony to our unique position in the field.

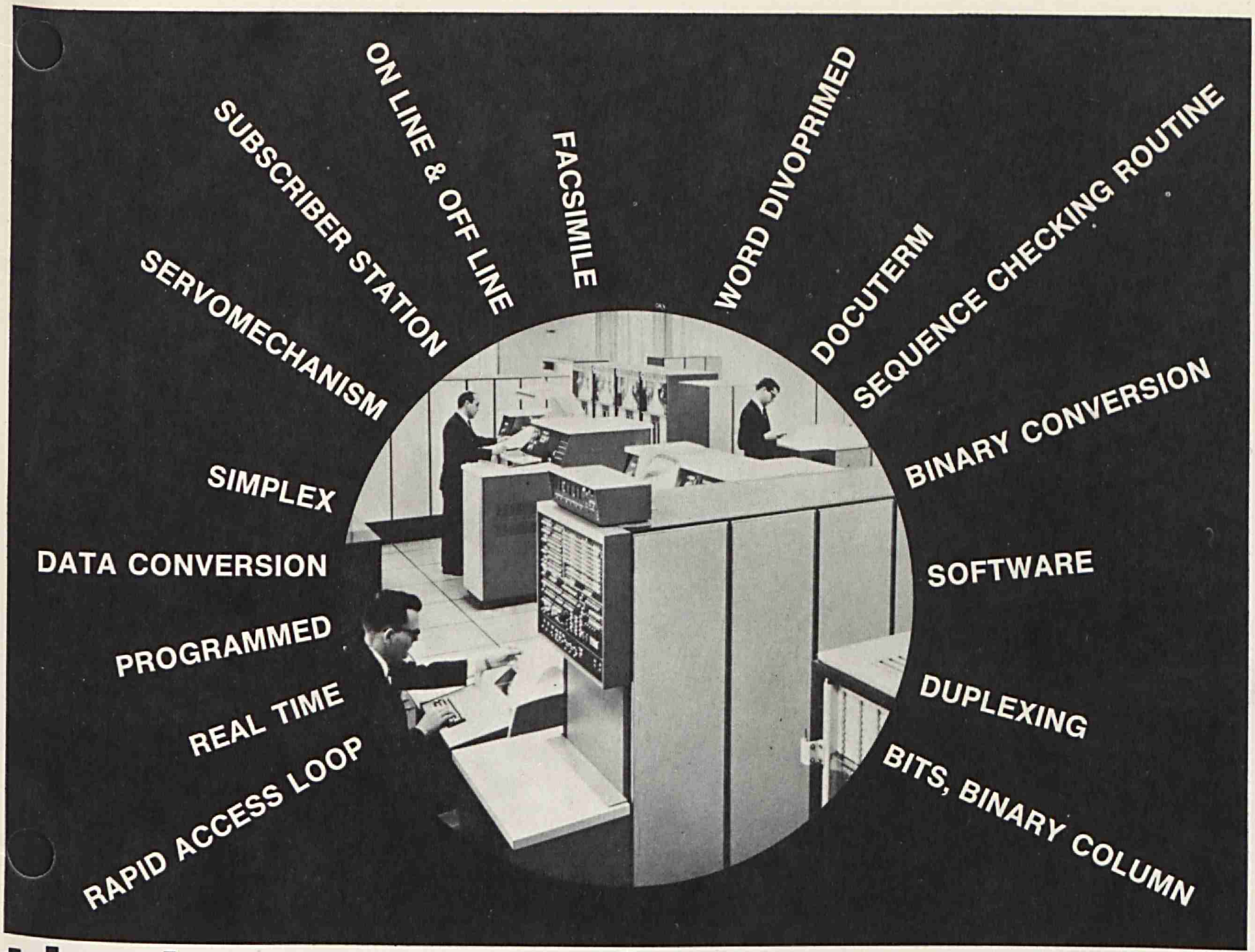
Projects like the CSR4 and TWK4 exchanges, the Information Services Computer Center, and various interfaces require experience and ingenuity to be successful. CSR4, Communications Switch Reed Exchange, was prompted by the need for a more universal exchange type in our present Telex network. The new TWK4 exchanges envision expansion of our exchange terminal facilities from 50 to 200 subscribers per unit. Our new Information Services Computer Center, ISCC, integrates our growing public services with our computerized Telex operation. The Telex interface units permit subscribers to send messages to the computer and also allows the computer to initiate calls to Telex subscribers.

Our engineers are constantly seeking the right answers to communications problems. This know-how is based on many years of experience plus the ability to evaluate new equipment for our Telex subscribers. The dedicated teamwork of our Telex group has helped immeasurably to produce the reliable information systems and services we proudly present today.



R H McConnell

R. H. McCONNELL
Assistant Vice President
Equipment Planning and Engineering
I. S. & S. Department



the language of western union

The rush of data has brought a new language to Western Union.

Computer Centers, like the one operating in New York, will be installed in Chicago and San Francisco. These centers will broaden the services available to Telex users nationwide.

By 1970, our entire public message service will be computerized and integrated with the Telex system.

New Services Coming

Time sharing of linked computers will carry the productive potential of data processing equipment to practically everyone.

Standard software programs for information processing services, inquiry service, and dozens of other business problems will be "plugging in."

Through new information services businessmen will be able to query our computers directly for answers to special problems.

Building On Experience

Quite logically, these changes are an outgrowth of our experience in creating some of the nation's most unusual information systems.

AUTODIN (Automatic Digital Network) created for the Department of Defense, outranks all other systems.

Civilian agencies of the Federal government now use a nationwide datamessage network known as the Advanced Record System, engineered and installed by Western Union for General Services Administration.

Business Turns To Experience

Many companies are taking advantage of our unique experience in management information systems.

Dun & Bradstreet now handles credit information faster than ever with a computerized switching system that ties together offices in 77 cities.

In addition, Western Union engineers design real time computerized information systems for the insurance, lumber, manufacturing and other industries.

A New Computer Lab

New ideas for future growth are thoroughly tested in our Information Systems Computer Laboratory. Here new concepts for information systems are developed, programs for real time operation, and tests of complete systems are created...programming for computers, and peripheral equipment... prior to customer delivery is planned. There's no other lab with this capability.

If you are planning to communicate you will find that Western Union speaks your language.

All the details on the full range of Western Union services are available if you call your local representative or wire collect to Western Union, 60 Hudson Street, New York, N.Y. 10013.

western union

western union

JULY 1966

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New York, N.Y. 10013

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Supplement I to material
furnished the Task Force
by WU on 12/15/67

NEED FOR BASIC REVISIONS IN PUBLIC TELEGRAPH RATE STRUCTURE

The notes accompanying Chart 11 titled "Special Problem Areas," in our briefing material previously supplied to the Task Force, include the following comment:

> "The present tariff concept is extremely cumbersome. For example, a recent analysis demonstrated that we could generate our monthly billings for Telex and PWS subscribers with only nine or ten steps. In contrast, the monthly billings for the public telegraph user involve over 100 different steps or procedural actions taken in the various sorting, counting and tariffing calculations for each and every message! All of this is done manually at the present time, and this adds substantially to the labor content of public telegraph business. A "postalized" or other simplified rate structure would permit substantial economies to be achieved in our present manual operation, plus facilitate automation when the computers take over the billing job in the modernized public message system."

In further amplification of the above, the latest estimates of the fully-allocated costs for the handling of public telegraph messages in 1967 show the following distribution:

1. Terminal Handling - (i.e., getting the message from the sender to the originating WU office by telephone, tieline or messenger, and then delivering the message to the addressee from the WU office at the city of destination)..............47%

2. Cross-Office Handling - (i.e., the physical handling of the messages by WU personnel within the offices at the cities of origination and destination).................................23%

3. Billing, Accounting and Other Related Costs............22%

4. Transmission Costs - (including intercity circuits plus operation of the various reperforator centers)................................8%

Total...........100%

This analysis confirms the assumption that there's a substantial area of possible cost-saving in the billing, accounting and related expenses provided that a simplified rate structure can be agreed upon. However, it further illustrates that only 8% of our actual costs of providing this service are in any way distance-related!

Present study is being directed toward the possibility of developing a totally new tariff approach for this service. One possibility being examined would be two "postalized" or flat rates. One rate would apply to all intercity messages, and the other rate would be applicable to all intracity messages (which wouldn't have to enter the nationwide network). These two basic rates would apply to over-the-counter, tieline or telephone handling at both the originating and delivery locations. If physical pick-up and/or delivery were desired, there would be an added flat rate charge for these services.

The equitability of charging for the physical handling of telegrams is illustrated by the fact that tieline and telephone handling cost us an average of 30¢ and 50¢ per transaction respectively, while messenger handling costs average over 80¢ per pick-up or delivery with individual transactions often running in the $1.50 to $2.00 range. Under this proposal, intercity transmission costs (which are only a small fraction of the total, and which are declining steadily due to the improvements in technology) would be averaged-out. Further, the person who wanted physical pick-up and/or delivery (which costs represent a large and growing fraction of the total due to the steady increases in wage costs) would pay for this special handling rather than have it subsidized by the other users of the public telegraph service.

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2/2/68

Supplement II to material furnished the Task Force by WU on 12/15/67

ECONOMIES OF SCALE IN MICROWAVE TRANSMISSION SYSTEMS

The route-mile cost of these systems varies considerably due to local differences in the length of the hops, the land acquisition costs, and the site improvements required such as access road construction, power line extensions, etc. However, the following are representative:

System Density	Capital Cost Per VF Route Mile
600 Channels	$22.35
1800 "	10.85
3600 "	7.95
5400 "	7.25
7200 "	6.70

Costs rise steeply as you go below 600 channels. Costs decline very slowly above 7200 channels.

These estimates are based on a frequency diversity system operating in the 6 ghz band.

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2/2/68

Revision of Supplement III,
dated 2/2/68, to material
furnished the Task Force
by WU on 12/15/67

COST COMPARISON - SATELLITE VS. AT&T SUPERGROUP

Western Union has intercity trunk circuit requirements between points which are not on our own microwave system. Our alternative ways of meeting these needs are:

1. Expand our own microwave system -- we do this as it is economically advantageous. However, the problem is that our requirements are generally in the 60 VF (240 khz) bandwidth, or less, and this is not sufficient "fill" to warrant expansion of our microwave facilities.

2. Rent Supergroups (60 VF) from AT&T -- we can obtain this raw bandwidth from the Bell System at a cost of $20/month/airline mile (or 33 1/3¢ per VF airline mile per month) provided we furnish our own multiplexing equipment. This is the way we are presently meeting most of our off-line requirements.

3. Participate in a domestic satellite service with multiple-access message and data earth stations in locations which are centers of traffic density but which are off of our established microwave beam route. This is economically attractive as shown in the following analysis.

The Comsat Pilot Program for Domestic Service includes two nominal 42' earth stations at locations in Oregon and Alabama. These stations would handle our traffic between these locations and the two nominal 85' earth stations in the vicinity of New York City and Los Angeles.

The capacity of one satellite transponder would be equivalent to seven (7) leased supergroup between the cities. This is equivalent to linking each of the locations with one supergroup with an additional one between Los Angeles and New York City, however, it is not limited to these specific connections.

To lease this seven supergroup network would cost Western Union $3,000,000 annually (12,500 miles x $20 x 12 months).

Number of Supergroups		Airline Mileage	Total Mileage
1	Oregon to New York City	2300	2300
1	Oregon to Alabama	2000	2000
1	Oregon to Los Angeles	800	800
1	Alabama to Los Angeles	1800	1800
1	Alabama to New York City	800	800
2	Los Angeles to New York City	2400	4800
7	Supergroups		12,500 Miles

We believe that equipment service via satellite would be less expensive to Western Union as follows:

NOTE: * indicates that capital cost figure includes 6% interest on average value of the earth stations over a two-year construction period.

** indicates that operating expense figure includes 6% interest carrying charge on full value of the stations over a one-year period.

Amortization of two 42' earth stations (Comsat's initial estimate of capital cost for both was $1,700,000; WU believes this will be closer to $6,000,000.* Initial planning is based on 50% ownership by Comsat and 50% by the Carrier, with utilization by WU only. (Various amortization periods have been mentioned between 5 and 15 years. To be conservative, take the higher cost and shortest period of useful life. ---
$6,000,000 x 50% x 1/5) .... $ 600,000

Amortization of Carrier owned MUX at two 42' earth stations
(WU estimate of capital cost is $200,000.* 100% Western Union owned. Use 5 year life. ---
$200,000 x 100% x 1/5) .... $ 40,000

Amortization of utilized share of two 85' earth stations. (The latest estimate of capital cost for both are $12,400,000.* Initial planning is based on 50% ownership by Comsat and 50% by the Carriers. The 85' earth stations will initially work with one WU assigned satellite transponder of the 24 in the system. Use 5 year life. ---
$12,400,000 x 50% x 1/24 x 1/5) .... $ 52,000

Amortization of Carrier MUX at two 85' earth stations.
(WU estimate of capital cost is $200,000.* 100% Western Union owned. Use 5 year life. ---
$200,000 x 100% x 1/5) .... $ 40,000

Annual operating expense of two 42' earth stations including MUX.
(WU estimate $1,285,000.** Prorating expense in proportion to capital investment MUX expense is $42,000 and earth station expense is $1,243,000. Earth station expense shared 50% Comsat, 50% Carrier. MUX expense 100% to Carrier. Carrier portion 100% WU.---
$42,000 x 100% + $1,243,000 x 50% x 100%) $664,000

Annual operating expense of two 85' earth stations and MUX.
(Estimated at $2,775,000.**
MUX $42,000, earth station $2,733,000. Earth station expense 50% Comsat and 50% Carrier; WU earth station portion 1/24 of carrier portion. MUX expense 100% WU.---
$42,000 + $2,733,000 x 50% x 1/24) .... $ 99,000

Annual rental of one transponder (preliminary indication by Comsat - this figure subject to further negotiation) .... $600,000/Yr.

$2,095,000

Total cost saving to WU approximately - (Note that this would be increased if either the above equipment estimates are reduced or if a longer amortization period were used.) $905,000/Yr.

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2/19/68

Supplement IV to material
furnished the Task Force
by WU on 12/15/67

BENEFITS OF COMPETITION

The Task Force staff requested that we cite a number of representative examples of service benefits that communication customers in this country have obtained as a result of direct competition between the carriers. These include:

1. Individually Designed Private Wire Systems

   Private wire telegraph services have been available for many years. However, in the late 1940's, WU decided to custom-engineer these to meet the individual traffic needs of customers rather than force the user to choose from a limited number of highly-standardized systems as had heretofore been offered by WU and as still is the practice of other carriers. Early examples of the customers who benefited from these offerings included: United Airlines, Sylvania, E. F. Hutton, Sears Roebuck, Weyerhaeuser, Bank Wire, etc. This willingness to adapt system configuration to the customer rather than force the customer to adapt to an existing system has been largely responsible for the rapid growth of WU's PWS business. Still, today, WU is recognized by both commercial and governmental users as being the carrier most willing to custom-engineer and construct special purpose communication systems.

2. Telex

   In 1958 WU introduced Telex, a direct-dial teleprinter exchange service, in competition with the manual TWX service which had been offered in the U.S. for over 25 years by the Bell System. TWX has since incorporated direct-dial service for U.S. and Canadian customers, although Telex today still is ahead in that this direct-dial feature is now provided to more than 120 countries.

3. Telex Computer Communications Services

   These new, unique services are now available to most Telex subscribers, and are being extended throughout the nation.

   ....Telegram Message Service - Tel(T)ex: for the automatic switching to WU central offices of telegrams to non-Telex subscribers for delivery as telegrams.

   ....TWX Connections: to send messages to TWX subscribers.

.........Multiple-Address Service: to send the same message text to many Telex and TWX subscribers, as well as non-subscribers via Tel(T)ex.

.........Busy Station Service: to send messages to Telex subscribers when their machines are busy.

........."Collect" Telex Service: to send a reverse-charge message to any Telex subscriber in the U.S.

.........Computer Dialing Service: to send a number of messages on one connection without disconnecting and redialing after each message is sent.

4. Broadband Exchange

In 1964 WU introduced its Broadband service to compete with the Bell System's Dataphone. This is described on Chart 7 of the original briefing material, and is still the only exchange service specifically designed to handle all types of digital and analog signals with alternate record/ voice capability.

5. Hot/Line

This service is described in Chart 8 of the original briefing material, and is the only two-point telephone service currently available which features automatic connections with no dialing and no minimum time charges. Depending upon the locations and the amount of usage, this service offers significant economic savings as well as operating convenience to the subscribers.

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EDH:es
3/4/68

Supplement V to material
furnished the Task Force
by WU on 12/15/67

COMPARATIVE STATISTICS - WU VS INTERNATIONAL RECORD CARRIERS

The Task Force staff has requested some comparative information on the size, revenues and profits of the telegraph companies. The following has been taken from the summary published by the FCC titled "Statistics of Principal Domestic and Overseas Telegraph Carriers Reporting Annually to the Commission, As At December 31, 1966 and for the Year Then Ended." (This is the most recent summary currently available, but the 1967 statistics should be published within 60-90 days.)

Company	Net Plant ($M)	Gross Rev. ($M)	Net Income ($M)	Total Empl. Oct. 1966	Total Offices	Total Telg. Messages (M)
RCAC	76.6	57.8	12.4	3,489	47	10.8
AC&R (incl. IT&T & P.W.)	54.6	37.0	5.1	1,926	36	7.7
WUI	16.2	21.9	2.7	1,367	33	6.6
Tropical Radio	3.2	4.6	1.1	634	22	1.3
US-Liberia Radio	*	.1	*	21	4	*
All Intl. Telg.	150.7	121.5	21.4	7,437	142	26.6
WU	515.9	319.3	21.4	27,198	12,214	81.6
All Telg.	666.7	440.8	42.8	34,635	12,356	108.3

* NOTE: Too small to show in units used for this summary.

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EDH:es
3/4/68

Supplement VI to material
furnished the Task Force
by WU on 12/15/67

BREAKDOWN OF GOVERNMENT PWS BY DEPARTMENT OR AGENCY

The staff of the Director of Telecommunications Management has requested a breakdown by customer of the $56 million Total Government Private Wire Systems shown on Chart 5. This is:

Department of Defense (Autodin, Bomb Alarm, DIRC, EMATS, etc.)	$46.0	million
Government Services Administration (This is for ARS System which serves GSA, Social Security, Veterans Administration, HEW, Agriculture, OEO, NCIC and 35 other agencies.)	5.0	"
National Aeronautics and Space Administration	1.2	"
Department of Commerce/Weather Bureau	1.0	"
Miscellaneous (USIA, AEC, FAA, CIA, etc.)	2.8	"
TOTAL	$56.0	million

NOTE: 1968 governmental revenues are projected at about $72 million, but distribution will be in about the above proportion.

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3/4/68