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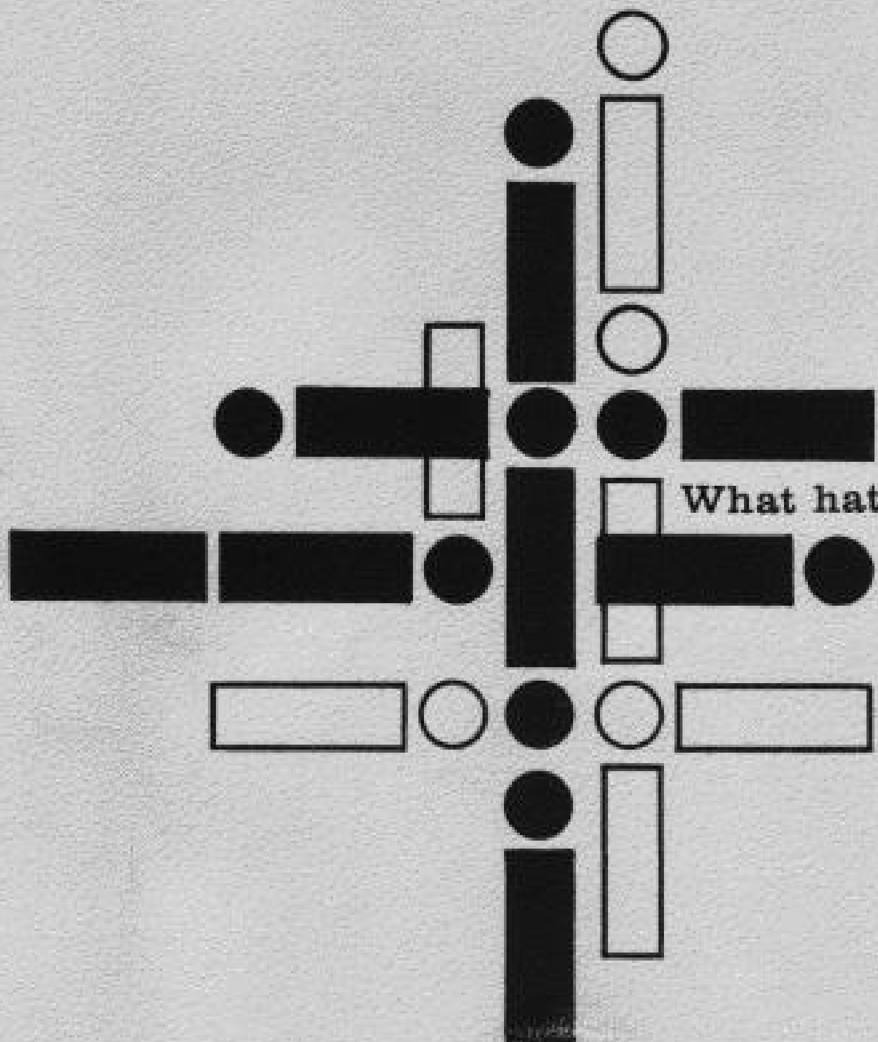

What hath God wrought

125 years of Telegraph Progress

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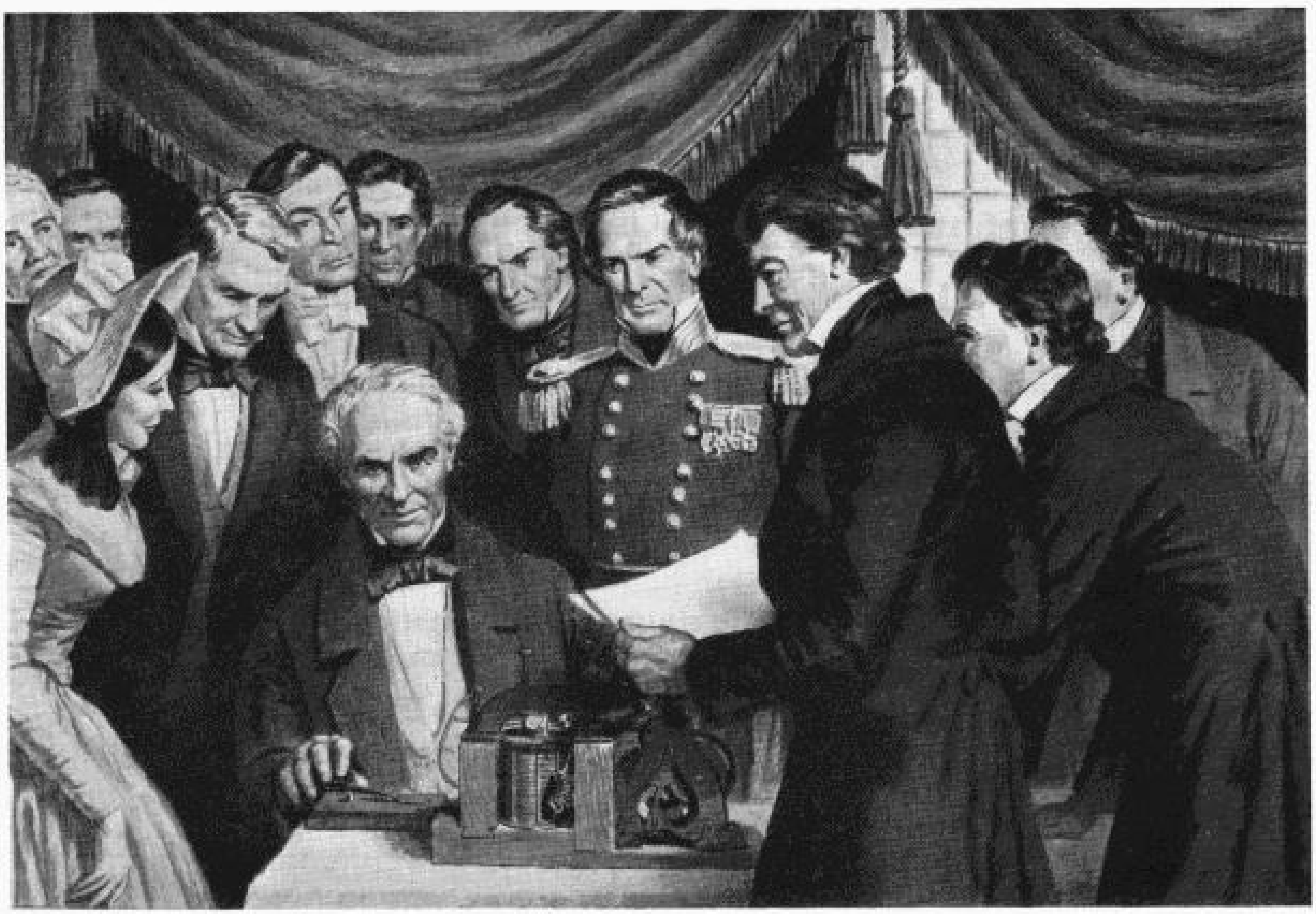
COVER: Artist's Concept of Morse Code in Modern Abstract Art

MORSE...
Pioneer of the Electronic Age

The Sending of the First Public



The above painting shows Samuel F. B. Morse, the telegraph's inventor, sending the first public telegram "What hath God wrought" to Baltimore, Md. from the nation's Capitol in Washington, D. C. This is the only painting of this historic scene, since the camera, which Morse helped to introduce, was then largely an experimental novelty. Annie Ellsworth, on the left, selected the first message.

Telegram Launched the Telegraph Industry

by William H. Watts

May 24, 1969—marks the 125th anniversary of the sending of the first public telegram by Samuel Finley Breese Morse, an epochal event that launched the electronic age.

One hundred and twenty-five years ago, on May 24, Samuel F. B. Morse, a 53-year-old artist turned inventor, seated himself before his electro-magnetic telegraph in the small chamber of the U.S. Supreme Court, then located in the Capitol building at Washington.

Gathered around Morse, to witness the telegram-sending inaugural, were Congressmen and friends, including such distinguished guests as Henry Clay, who had just been nominated for the presidency by the Whig Party; Mrs. Dolley Madison, wife of James Madison, fourth president of the United States; and Miss Annie Ellsworth, daughter of the U.S. Patent Commissioner, to whom Morse had given the honor of selecting the text of the first telegram. The contents were not to be disclosed until the time of its actual transmission to avoid any suspicion of a pre-arranged message. Figure I is a photo of this inaugural.

At the receiving end of the pole-supported iron transmission wire, 40 miles away, was Morse's partner and financial backer, Alfred Vail. Vail, too, was surrounded by a curious crowd as he checked the operation of his receiving and sending instruments in the Pratt Street depot of the Baltimore and Ohio Railroad in Baltimore.

At Washington the crowd quieted as Miss Ellsworth approached Morse and handed him her "secret" telegram. It read: "What hath God wrought!" a quotation from the Holy Bible, Book of Numbers: Chapter 23, Verse 23.

Morse studied the message, smiled, and nodded his approval. He was a deeply religious man and this biblical quotation was perfect for the occasion.

Then, Morse slowly tapped out the message, letter by letter, on the sending key, in dot-dash Morse code. At Baltimore, a steel stylus on Vail's recorder indented the dots and dashes on a moving paper tape. The message was transmitted in one minute, at 8:45 A.M.; the Electronic Age had begun.

Immediately, Vail sent back the same message to Morse. A telegraphic exchange then followed between Morse and Vail concerning the latest news in each city including a report on the time and weather. Today, the original message tape can be seen in the Library of Congress. Fig. 1 is a photograph of this tape.

The new electro-magnetic telegraph pointed the way for radio, television, computers, satellites—even space travel owes an electronic debt to Morse. And, by annihilating time and distance in communications, the telegraph placed in operation a new force in the social, economic and educational world.

Figure 1—Photograph of the original message tape, "What hath God wrought."

Morse the Inventor

Despite the progress of his many rivals in the telegraph field, Samuel F. B. Morse, shown in Figure 2 was the only one to spark the final, practical ideas. While every element in his invention was old, the "combination" was new enough to patent. And so were the harvester of McCormick, the telephone of Bell, the wireless of Marconi and the flying machine of the Wrights—all composites. As one expert put it: "All inventions of civilized man are composites."—And the telegraph was no exception.

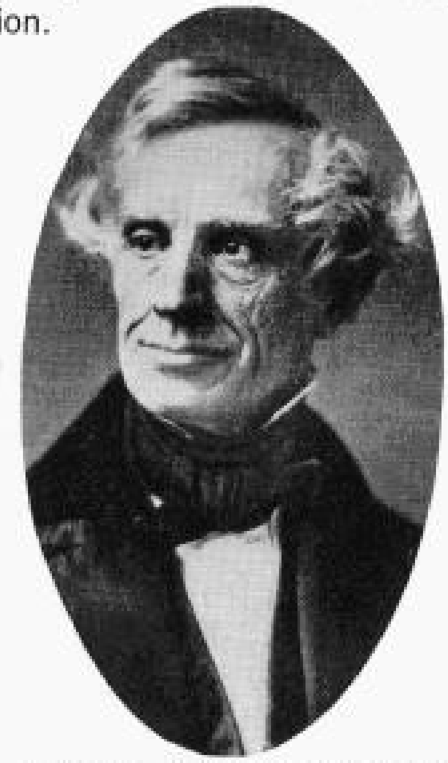


Figure 2—Samuel F. B. Morse

Morse was not a scientist. In fact he had no special knowledge of electricity, chemistry or machinery. He was not even a good mechanic. Yet, he gave to the world one of its greatest inventions—the first practical recording telegraph—and his biographer, Prime, stated that "of all the great inventions that have made their authors immortal and conferred enduring benefits upon mankind, no one was so completely grasped at its inception as this."

Morse entered Yale College, at the age of 14, where he proved to be an indifferent student. There he was known as "Geography" Morse and reported that he enjoyed debating, shooting, "raising balloons" and reading French. He also reported, in letters home, his liking for "brandy, and wine and segars." At Yale, Morse discovered the two dominating interests of his life—painting and the science of electro-magnetism. Art was not a subject of study at Yale and all that Morse learned about it during his college years was self-taught.

Morse the Painter

Morse began painting in his junior year at Yale when he discovered that portrait sketching and painting could provide ready spending money, an item that was in short supply much of his life.

Morse attended Professor Day's lectures on electricity at Yale and wrote home excitedly of having held hands with the rest of the class to experience his first electric shock.

When Morse was graduated from Yale in 1810 he reached his first great career decision—he would become a professional artist and study abroad under master teachers. In 1811, Morse sailed for England with Washington Allston, the eminent American painter, who became his teacher.

Morse was swift to master his craft. At London's Royal Academy exhibition, in 1813, his large painting, "The Dying Hercules," a canvas 8 feet by 6½ feet was ranked among the first twelve out of 2,000 paintings in the exhibit.* The small clay model, shown in Figure 3, that he made for the painting took the prize for sculpture at the Adelphi Society of Arts. Both the painting, and model, are now in the Yale Gallery of Fine Arts.

Returning home in 1816, Morse gained fame as a portrait painter. He went abroad again in 1829 and continued his art studies for three years before turning homeward, once again, in 1832—the year of his telegraph idea—a year art was to give way to invention.

The small packet ship "Sully," on which Morse sailed from Le Havre, France, on October 6, 1832, holds a special place in history as the true birthplace of the telegraph, a ship, incidentally, of which there are no known drawings or paintings.

Communications Concept Of Morse

When Morse boarded the "Sully" he was forty-one years old and an American painter at the top of his profession. When he stepped off the boat at the foot of Rector Street, in New York, he was the author of a communications concept that was to change the course of world events and his own career as an artist.

Among the Americans on board the "Sully" was Dr. Charles T. Jackson of Boston who men-

*W.U Technical Education Bulletin #102 "Morse the Yankee Portrait Painter"

Figure 3—"The Dying Hercules", a clay sculpture by Samuel F. B. Morse exhibited at Royal Academy in London in 1813

tioned the then recent invention of the electromagnet to a group of men in the ship's dining salon. Explaining the magnet idea Dr. Jackson said:

"It consists of a piece of iron bent in the shape of a horseshoe and wound with wire. When an electric current is sent through the wire, the magnet will pick up a small bar of iron. Electricity travels instantly through the entire length of wire, and causes the magnet to act."

Morse displayed immediate interest and asked if electricity could be made to go over many miles of wire almost instantaneously. Dr. Jackson said that was correct and Morse, already thinking in terms of communication by electricity, said:

"If the presence of electricity can be made visible in any part of the circuit, I see no reason why intelligence may not be transmitted instantaneously by electricity."

Taking from his pocket his artist's sketch book, he began jotting down his basic ideas. The original sketches he made that evening, showing his idea of sending messages over a wire by using a code of dots and dashes corresponding to numbers, are preserved today in the Smithsonian Institution.

Morse's sketch also shows a design for an electromagnetic recorder to receive dots and dashes on a paper tape and a plan to enclose the wire in a clay tube and lay it underground.

The Picture Frame Instrument

When Morse reached New York he had to paint to earn a living and was unable to do much work on his invention until he was appointed, in the Fall of 1835, to a professorship of the Literature of Arts of Design at New York University in Washington Square. This gave him a small salary and the leisure to build his first telegraph instrument—a crude affair, built on a picture frame with an ordinary lead pencil, suspended by a pendulum, to mark the dots and dashes on a moving paper tape drawn by the wooden wheels of an old clock. Figure 4 illustrates the picture frame instrument.

Late in the winter of 1836, Morse showed his invention to a university colleague, Dr. Leonard D. Gale, who was a lecturer on chemistry.

Dr. Gale described the event this way:

"Morse came to my lecture room and said he had a machine in his lecture room, or studio, which he wished to show me. I accompanied him to his room and there saw, resting on a table, a single pair Galvanic battery, an electro-magnet, an arrangement of pencil, a paper-covered roller, pinion wheels, levers, etc., for marking letters and figures to be used for sending and receiving words and sentences through long distances."

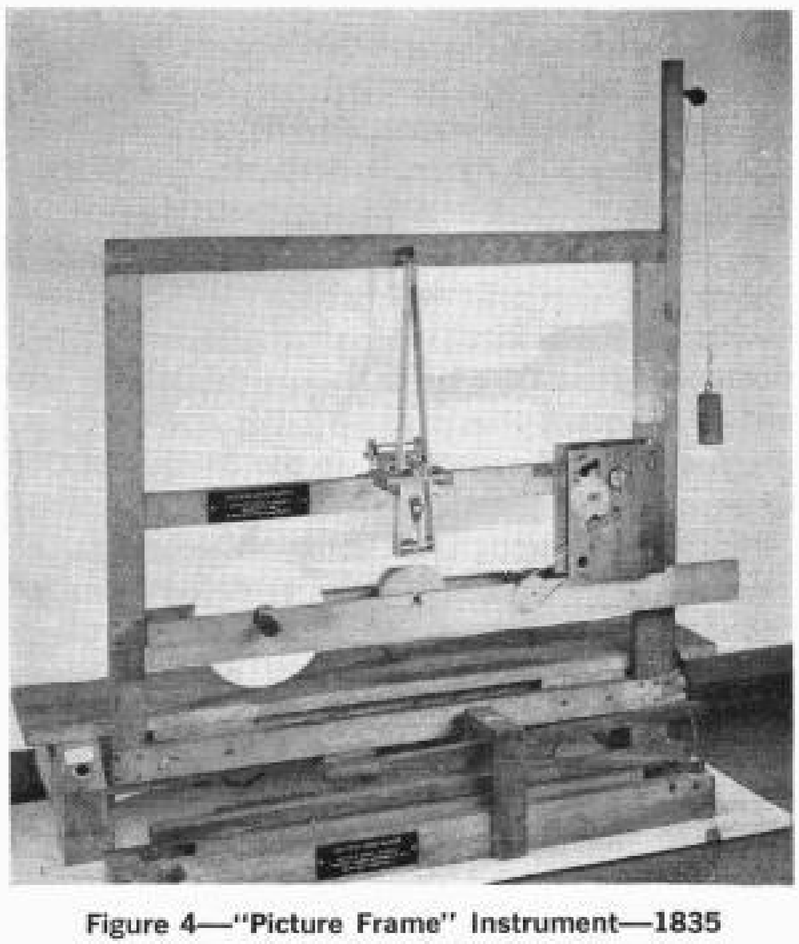


Figure 4—"Picture Frame" Instrument—1835

Gale informed Morse that he observed two deficiencies in his telegraph instrument: the one-cup battery did not generate sufficient power to project an electric signal over a great distance and the magnet, with only a few turns of wire, was equally weak.

Morse made the changes and then demonstrated his model before a group of his friends, in his rooms at the university, on September 2, 1837. One of those present was Alfred Vail, son of Judge Stephen Vail, head of the Speedwell Iron Works at Morristown, New Jersey.

Influence of Stephen Vail

Young Vail became Morse's partner, providing needed funds and mechanical ability that Morse lacked. New and better instruments were built in the fall of 1837 and, on January 6, 1838, at Morristown, Morse and Vail called in Judge Vail to view the latest model. Vail had changed the position of the magnet and armature so that a vertical motion of the marking stylus made possible the registration of real dots and dashes. To test the machine Judge Vail wrote out a message, "A patient waiter is no loser." He handed it to his son and told him that if he could send it to Morse he would be convinced. When Morse, at a distant end of the factory building, received and read aloud the message, Judge Vail was delighted. It was the first telegram to be received directly in dot-dash form.

Equipped with an improved recorder and a new battery built by Professor Gale, the telegraph was publicly exhibited for the first time, on January 10 and 11, 1838, to the people of Morristown and Morris Township.

On January 23 it was shown to hundreds of people in New York in the Geological Cabinet room at New York University.

A story on the showing, in the Journal of Commerce, said: "Intelligence was instantaneously transmitted through a circuit of ten miles, and legibly written on a cylinder at the extremity of the circuit." The story added that Professor Morse, using letters instead of numbers, transmitted "10 words per minute, which is more than double the number which can be transmitted by means of the dictionary."

Following the triumphant New York demonstration, Morse and Vail packed up their machine and headed for Washington, stopping on the way at Philadelphia to give a demonstration to a committee of the Franklin Institute.

At Washington, on February 20, 1838, the telegraph was again demonstrated in the room of the Committee of Commerce in the Capitol, before President Van Buren, his Cabinet, and other officials.

The demonstration was a success and the committee chairman, F.O.J. Smith of Maine, later to become another Morse partner, was instructed to report an appropriation bill for $30,000 to construct an experimental line from Washington to Baltimore.

The path to success seemed assured but Congress balked at spending that much money on what some skeptical members called "a crazy scheme." The bill did not reach a second reading.

Congress Passes the Telegraph Bill

It was not until several years later that Congress was to take action. On February 21, 1843 the House passed the telegraph bill appropriating $30,000 to build the first line. The next hurdle was the Senate and Morse was again hopeful, visiting the chamber each day. But, on March 3, the end of the session neared, and there were 140 bills ahead of the telegraph bill. Friends told Morse the jammed Senate calendar could not possibly permit the bill's passage. Morse, a crushed and defeated man, returned to his hotel room. He had only his railroad fare home and 37 cents in his pocket.

The next morning he received a caller, Annie Ellsworth, who gave him the glad news that his bill had been passed shortly before adjournment. Overjoyed, Morse told her that she would have the honor of composing the first message to be sent over the completed line.

Beginning of the Communications Industry

When the first public telegram was sent on May 24, 1844 it marked the beginning of the communication industry. The experimental line was exhibited to the public without charge for a year. Morse tried to sell his invention to the government for $100,000 but officials declined on the ground that the telegraph was no more than an interesting toy and would never be self-supporting. It remained for private enterprise to make the benefits of the telegraph available to the world.

Morse and his associates extended the Washington-Baltimore line to New York City in 1846. Others obtained licenses from Morse and built lines between New York and Buffalo, New York and Boston, and other eastern cities. Soon, practically every city in the country became interested in the money-making possibilities of telegraphy and a number of short lines, all privately owned, were constructed.

The early Morse telegraph receivers actually recorded messages on paper tape in dots and dashes. It was not until 1856, and later, that Morse operators, used to the code, began the practice of by-passing the tape by receiving messages by ear.

It is interesting to note that three features Morse tried out on the Washington-Baltimore line, and later discarded are today in use: They are the moving paper tape on which the message is recorded; the mechanical sending of code impulses like today's automatic transmitter, and the laying of telegraph lines underground.

The hand-operated Morse key and sounder, shown in Figure 5, dominated world communications for the better part of a century. When the teleprinter, with its tripled speed and simple typing operation, was introduced nationally in the 1920's, Morse began to fade into the background to be replaced by high-speed printing and facsimile methods including computers and satellites.

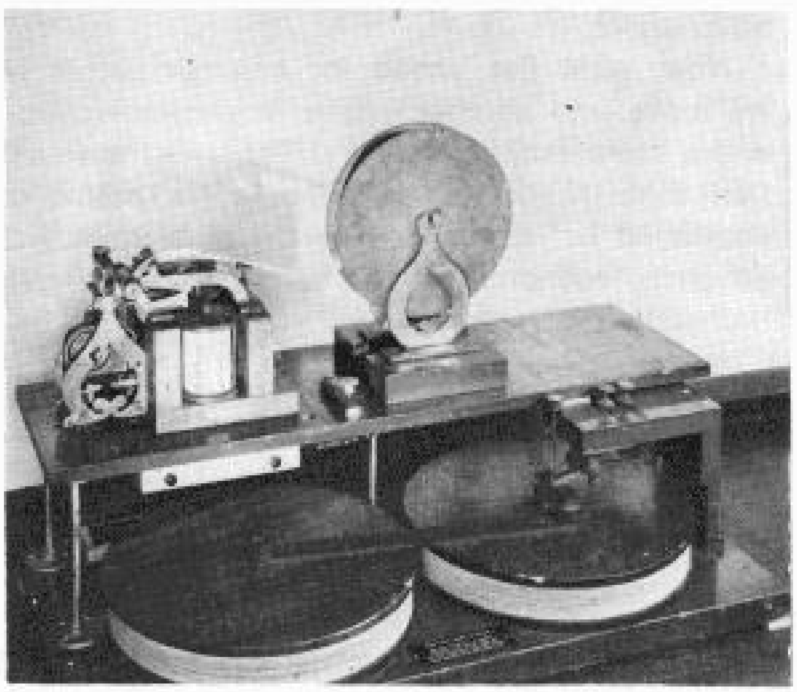


Figure 5—Morse Key and Sounder—1844 Instrument

Communications Changing

Communications have changed, and we are now using new terms and new meanings. Communication, as we know it today, includes both language and non-language, or data, which is simply the transmission of coded impulses between machines. Much of today's communication is now in data form and it is expected, within a decade, that half of all communication will be in non-language form.

For a century, telegrams were almost exclusively the company's business and all messages traveled over Western Union's public message network. But, then came a succession of new ways to send messages, innovations and new developments in the telegraph art which increased speed and efficiency.

The communications of tomorrow will be concerned increasingly with the transmission of energy pulses rather than messages. And the energy pulse—which is really a minute form of information—can be anything from the vibration of a pair of human vocal cords to the discharge from a tiny magnetic core inside a giant computer.

Western Union Developments

Leased private wire systems, many of them now controlled by computers, were designed and installed by Western Union for increasing numbers of business and government users with volume communications to many points. Messages, which formerly traveled over the public network, now are transmitted over private systems.

Telex, a teleprinter exchange service, was inaugurated by Western Union in the United States in 1958. As Telex users found out they could obtain dial-direct connections with other subscribers in just a few seconds, for the immediate, two-way exchange of messages and data, this service boomed in popularity and there are now more than 26,000 users. Again, millions of messages formerly sent over the public message network are now carried via Telex.

In 1964, Western Union placed in service a new coast-to-coast microwave system to provide more reliable, high-speed communications channels capable of handling every known type of communication including telegraph, voice, data facsimile and television; it is capable of handling a million data signals in a single second. The early telegraph poles are being replaced by tall microwave towers, spaced 20 to 30 miles apart.

The new microwave system has been put to use in providing a nationwide Broadband Exchange service that offers broadband channels at charges based only on usage. It permits the high-speed transmission of messages or data, facsimile, or other record communications in combination with voice.

Microwave has made possible the introduction of a private, point-to-point voice communication service called Hot/Line. It features automatic connections with no dialing and no minimum time charge and now serves more than 4,000 subscriber stations.

Communicating computers, linked with broadband channels, are spearheading a new cycle of technology and growth in communications. Examples of this progress are Western Union's twin SICOM and INFO-COM services. SICOM is a shared-computer system for the securities industry and INFO-COM is a similar shared network for business firms. The advantages of both systems are that users enjoy all the advantages of a private, computer-controlled network without a major investment in equipment, space, programming, training or maintenance.

The Telegram is Not Dead

Record communications are being sent in greater volume than ever. More than 60 billion words are now transmitted annually over all Western Union systems, a six-fold increase in 10 years. The telegram is not dead—it's very much alive, and healthy, but speeding the message in many new and different ways.

Today, only one out of every six record messages sent over Western Union's entire system is a yellow blank telegram. And since business is the biggest user of telegrams, sending more than 80 percent of them, and as more private wire systems and Telex machines are installed, the record message will continue to be a dominant form of communication in the future.

New advances in communications systems and techniques, including computers and communication satellites, are unleashing a succession of new ways to communicate unheard of just a short time ago.

To meet the constantly expanding communicatoins needs of the nation, Western Union is now engaged in building a technically advanced, computer-controlled, integrated record communication system to serve all types of customers, from those who send an occasional telegram to those with a constant requirement for high-speed transmission of data between computers.

The combination of the Bell System's teletypewriter with Western Union's Telex exchange network, called TWX, will substantially further the development of many new, shared-use, computer-controlled services. The potential for creative application of this new resource is enormous and it will be the foundation of Western Union's future.

In recent years we have witnessed one dramatic development after another in communications, and some of the achievements now being made in the conquest of time and space border on the incredible.

Within the past century man has climbed down from horseback and reached into space with communications. He has advanced from earth to the cosmos. And such things as earth-spanning communication satellites and instant communication by voice, record and video with moon-encircling astronauts are accepted with a minimum of amazement.

Now, what lies ahead for communicators, as we move into another phase of communications and a more exciting century? There is little question that it holds vast promise for mankind's continued betterment—a period of technological advance, economic growth and social progress unmatched in history.

* * *

Editorial Note: In the first issue of the Western Union TECHNICAL REVIEW, in July 1947, an article entitled "Applications of Electronics in a Telegraph System" by J. R. Hyneman, the first paragraph reads: The invention of the telegraph culminated in the first great electrical industry.

Bill Watts *decides to say "30" and leaves a Heritage to our new Employees*

Bill Watts, more formally known as William H. Watts, Director of Public Relations for Western Union, has been responsible for publicity and involved in public relations at Western Union since 1951.

He came to Western Union in 1925 to serve our El Paso, Texas, office, as a delivery clerk. After two years he became a branch office manager in Miami, Florida and later manager of several branch offices in New York City. While Superintendent of New York's Third District in 1946, Mr. Watts was appointed by the State Department as Western Union's representative on telegraph affairs to the United Nations Security Council and later became Division Sales Manager in New York's Metropolitan Division.

Mr. Watts studied at El Paso Junior College, City College of New York and Fordham University.

Over the years, Mr. Watts has researched a mass of literature, and written much about Morse, the early telegraph and the Company. He has also written about Western Union's accomplishments for many magazines.

Because of his interest in Western Union and his wide knowledge of telegraph history and its development, Mr. Watts was asked to contribute an article to the TECHNICAL REVIEW on Samuel F. B. Morse and his invention of the telegraph as we mark the 125th Anniversary of our first public telegram.

He has represented the Public Relations aspect of Western Unions policies especially in his membership on the Committee of Technical Publication for the past 5 years.

It is with real regret, his decision was accepted to retire from Western Union in May 1969. He leaves a "heritage of information" to our new employees, when he wrote this article for the 125th Anniversary of the Sending of the First Telegram. ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■

MINI-T and MAXI-T

—New PCM Terminals

by R. G. DeWitt and D. E. Jones

Background for the New Terminals

In long-haul operation, trade-offs involving terminal efficiency costs as opposed to line efficiency costs become significant. This often suggests the possible need for a terminal which uses the line bits very efficiently.

An efficient terminal has been designed in order to be prepared for all eventualities. Current cost studies may verify whether efficient terminals are, in fact, more attractive for long haul use than low cost inefficient terminals.

In the case of short-haul operation, line costs are usually less significant. Consequently the terminal costs dominate in the total system cost. Therefore, to reduce the total system cost the terminal cost must be minimized. A low-cost terminal for 0 to 200 bits per second short-haul teleprinter channels has been designed. The MINI-T channel is one example of the more general class of Derived Direct Digital Data (D^4) channels.

MINI-T Terminal

MINI-T is a new Pulse Code Modulation terminal designed to provide minimum cost teleprinter channels on T1 type PCM lines for short-haul network branches.

Western Union has developed a prototype system to prove the feasibility of the MINI-T design. This system has been operating successfully in "live service" between New York City and Newark, N. J. for six months.

On the basis of cost studies made over the past year, it is anticipated that the MINI-T will reduce local route transmission costs by as much as 35 percent when compared to the alternative of physical pairs. The cost reduction is even greater, when the alternative to MINI-T is FDM-Data. In this case, the advantage is in trade-offs involving terminal equipment rather than in the transmission path. The New York City to Newark, N.J. route which is about eleven miles long is a typical short-haul line.

MAXI-T

Another PCM-D4 channel, called MAXI-T, has been designed for cost effective long-haul operation. MAXI-T (maximum efficiency in the use of T1 type line bits) derives 55 teleprinter channels per voice slot. Each of these channels has a capacity of 0 to 200 bits per second.

MAXI-T is being considered at Western Union for use on satellite and terrestrial microwave systems for providing long-haul teleprinter channels. However, because of the urgent need to reduce costs in the short-haul plant more priority is being placed on MINI-T at this time.

by converting from the former to the latter. First, the cost of the Modem (or FDM Terminal) is eliminated, the voice channel unit is eliminated and the cost of the analog signal processing equipment is eliminated. These three units are replaced by one functional unit, whose cost is significantly lower. Secondly, higher efficiency in the use of digital transmission line bits can be achieved.

These two advantages may be traded off one against the other as a function of the design objective. For example in MINI-T, for short-haul operation the line efficiency was sacrificed in favor of low terminal cost. As a matter of fact

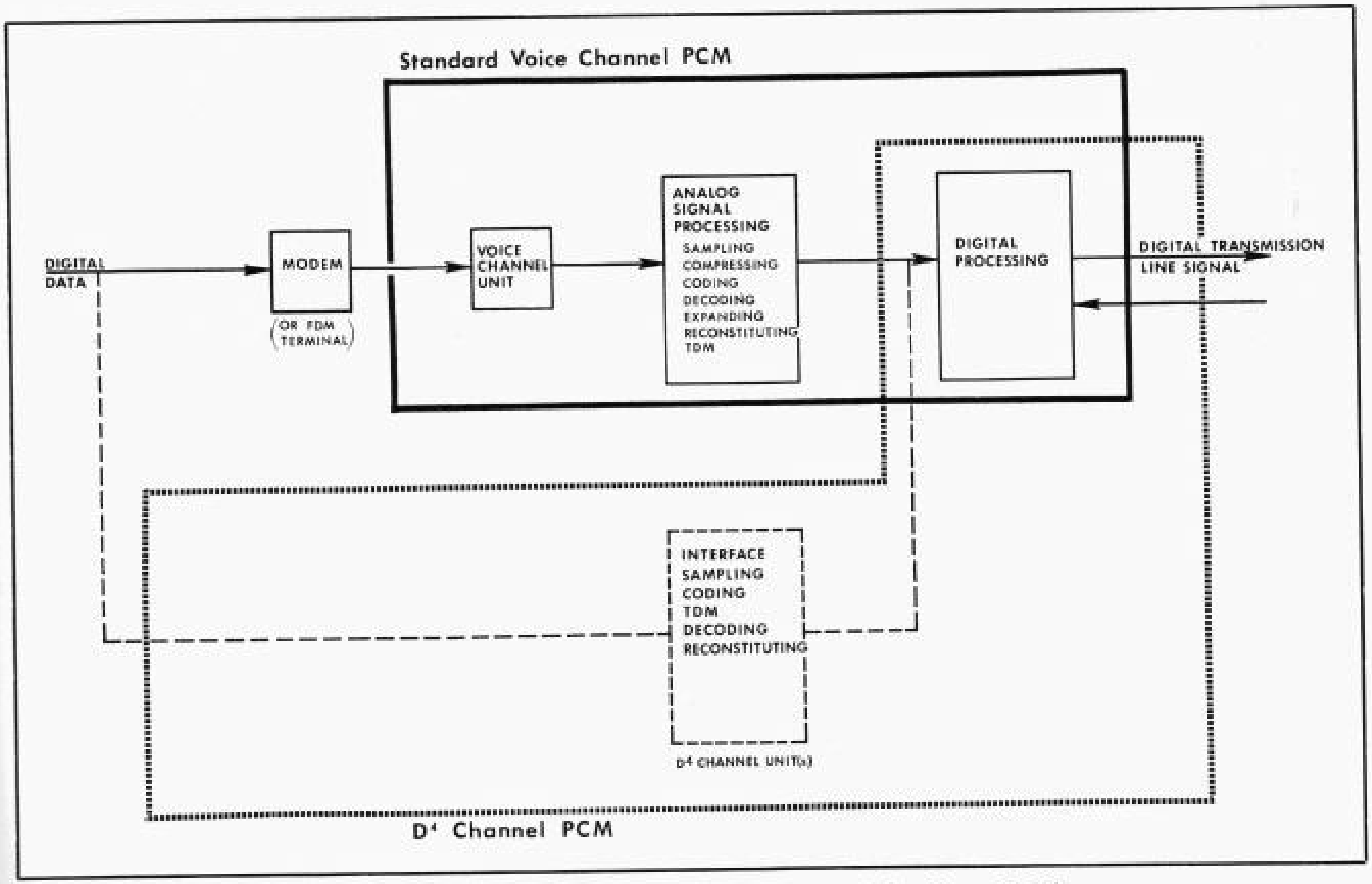


Figure 1—D4 Channel PCM compared with Standard Voice Channel PCM

D4 Channel PCM vs. Standard Voice Channel PCM for Data Services

Figure 1 shows the functional difference between Standard Voice Channel PCM and D4 Channel PCM. Two significant advantages can accrue

the efficiency was reduced below that of the standard voice channel PCM, to obtain a very favorable reduction in terminal cost.

On the other hand in MAXI-T the objective is long-haul application and therefore in the trade-off the terminal cost is increased in order to increase the line efficiency.

Western Union Traffic

Since the bulk of Western Union service is teleprinter traffic and low-speed data signals, systems such as MINI-T and MAXI-T are very desirable since they can provide plentiful low-cost 0 to 200 baud channels. For MINI-T the low-cost objective has been successfully achieved by reaching a cost low enough to not only prove-in against FDM telegraph carrier systems under certain conditions but also to displace the traditional assignment of teleprinter services on physical pairs by proving in against copper pairs down to distances as short as 5 miles. Figure 2 illustrates these two alternatives for MINI-T. We expect that for a typical candidate route, 8 to 10 miles long, costs will be reduced more than 35 percent using MINI-T, as compared to using physical pairs.

While teleprinter traffic is predominant in our nationwide network, Western Union has a variety of other types of traffic such as data at 1200 bits per second, 2400 bits per second, 4800 bits per second, 50,000 bits per second, voice, and facsimile. Furthermore most of our local routes are light in traffic, in addition to having great variety. Because of the variety of traffic plus the low density it becomes necessary to accommodate all types of traffic in one PCM terminal. Thus, we need a terminal which provides both standard voice channels and D^4 channels with the capability to use the voice slots in the basic time frame for standard voice channels, MINI-T D^4 channels, MAXI-T D^4 channels, 2400 bit per second D^4 channels, and 50,000 bit per second D^4 channels, in any ratio.

Live Traffic on MINI-T

A pair of prototype MINI-T terminals has been developed and on September 5, 1968 live traffic was established on two channels (one 135 bit per second signal which is the N. Y. Stock Exchange signal and one 67 bit per second signal which is the Chicago Grain signal, as shown in Figure 3. Besides these two pieces of live traffic carried from New York to Newark, shown in Figure 3 a number of other channels are shown. All MINI-T channels are full duplex. The two stock ticker signals are transmitted only in the direction New York to Newark so the return halves of channels 1 and 2 are used to carry duplicate versions

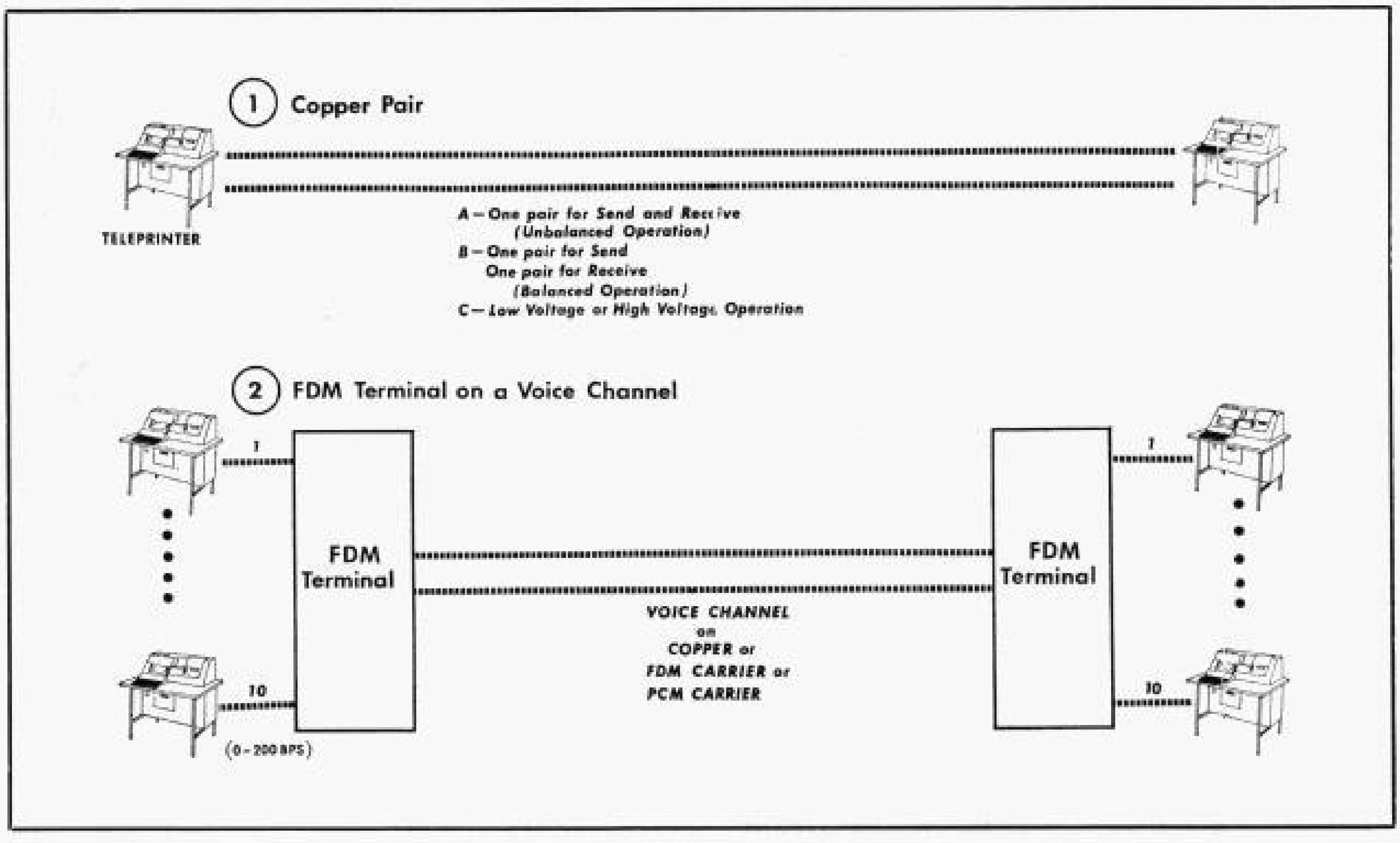


Figure 2—Two Alternatives to MINI-T

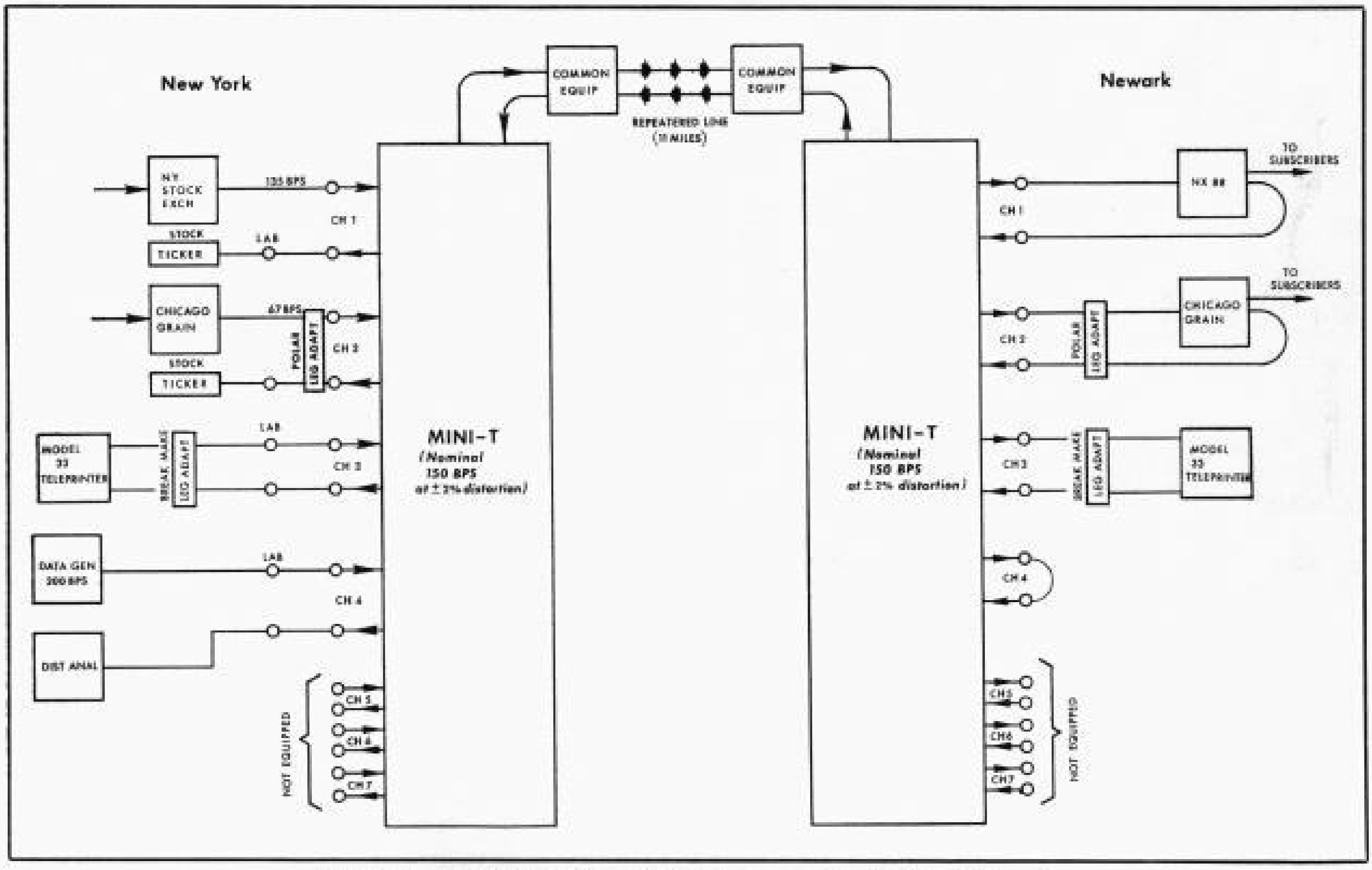


Figure 3—MINI-T Prototype System between New York and Newark

of the output back to New York where they terminate in stock ticker devices in the Western Union laboratory and can be performance monitored, as shown in Figure 4. In Figure 3, Channel 3 is used to interconnect two Model 33 teleprinters for testing and demonstration purposes, while Channel 4 carries a test data signal which is looped at Newark at the teleprinter signal interface and returned to a Distortion Analyzer in New York for testing to verify that the distortion requirement has been met. Channels 5, 6 and 7 of the seven-channel package were not equipped at this time. The repeatered line in the MINI-T system is eleven miles long; it contributes an average error rate which is less than 1 error in 10^9 bits transmitted. The performance and reliability of the whole system have been exceptionally good for the six months since cutover. Hence all the system design goals have been met.

Based on the proven feasibility of MINI-T, a contract has recently been awarded to a leading manufacturer of commercial common carrier PCM equipment for the final development and manufacture of MINI-T terminals. A Pilot Program has been developed providing for the installation of several MINI-T systems by late 1969. Metropolitan areas such as Los Angeles, New York, or Chicago present many ideal route can-

Figure 4—Engineer Arun Sobti Examines N.Y. Stock Exchange Data, Received from Newark, N.J. over the MINI-T PCM System

didates for MINI-T installations. An artist's version of the production MINI-T terminal to be used in the pilot program is shown in Figure 5.

MAXI-T has been designed, implemented, and tested also. All design goals were met. A service trial may be carried out in the near future.

Other Developments in the PCM Program

A 2400 bit per second D4 channel unit has been designed and is currently being implemented. This design will provide at least four 2400 bit per second channels per PCM voice slot of the flexible terminal. A 50,000 bit per second D4 channel unit has been designed and may be implemented in the near future. This design can provide one 50,000 bit per second channel per PCM voice slot. In addition, plans have been formulated for the possible development of long-haul PCM channels via PCM on Microwave Radio so that the low cost, high performance, high reliability, low maintenance, and flexibility of PCM may be available from coast to coast. Furthermore, when a substantial PCM network has been created PCM switching may become extremely attractive and provide additional cost savings, better performance and reliability, and lower maintenance than present-day switching equipment.

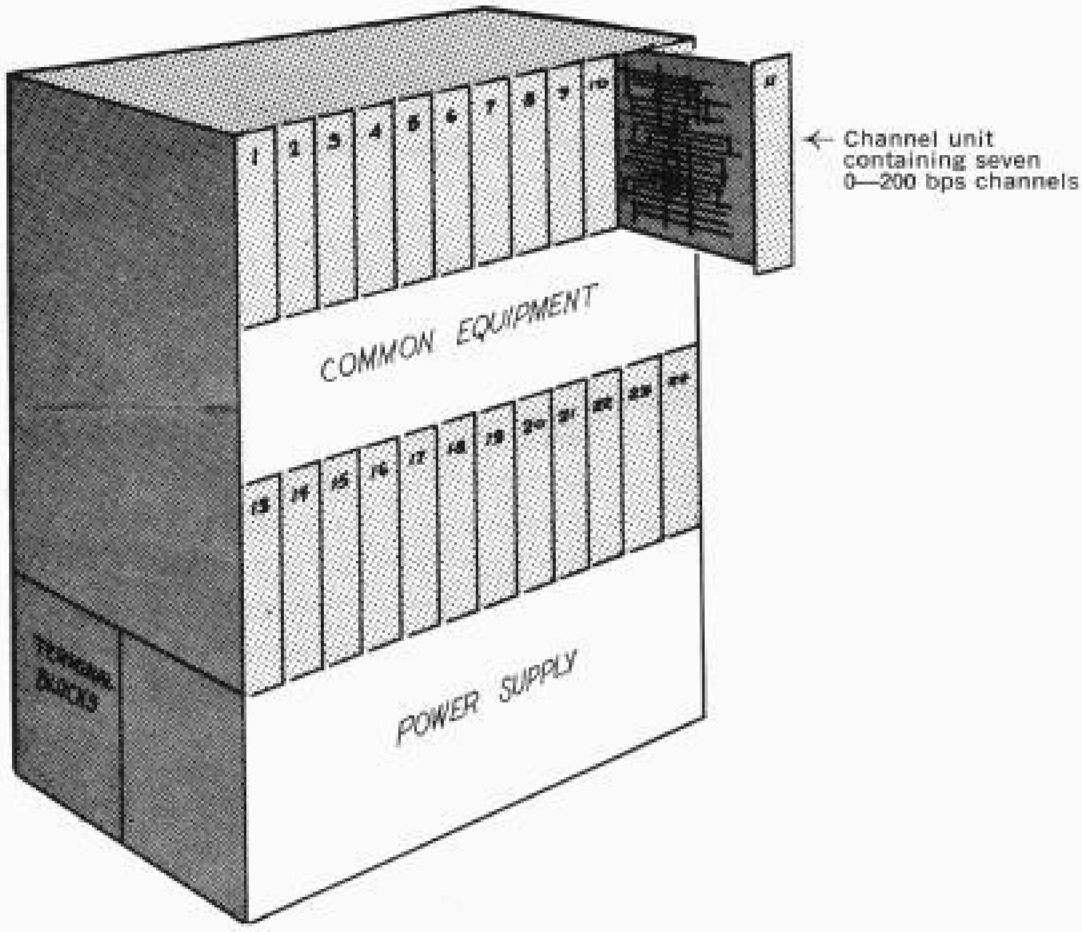


Figure 5—Artist's Rendition of a MINI-T Terminal

Description of MINI-T

The basic time frame of the MINI-T design is shown in Figure 6. There are 8000 frames per second with 193 bits per frame for a total of 1.544 megabits per second on the digital transmission line. Each frame is made up of a framing bit followed by 24 eight-bit bytes. The first seven time slots in each eight-bit byte carry individual teleprinter or digital data signals. The 8th bit in each byte is a stuffed pulse to insure that the regenerators in the line receive sufficient pulse excitation to keep their 1.544 mc clocks going.

For each channel shown in Figure 6 the following functions are performed. The first function, the Interface, listed in Figure 1, is described fully in Figure 7. Figure 7 (a) Transmit Interface, the data source is a polar signal on a single conductor with reference to ground. The polar signal waveform, shown in Figure 7 (b) indicates a "mark" is minus 12 volts open circuit and a "space" is plus 12 volts open circuit while the source impedance is 600 ohms. Since the load is nominally 600 ohms, the current is nominally 10 milliamperes. The rate of the input may have any value from 0 to 200 bits per second and can vary widely in any manner or the input can be a random telegraph signal whose minimum spacing between transitions is never less than 5 milliseconds. The latter statement also means that the channels can be used for slow-speed binary digital facsimile transmission in addition to data. The receive interface is shown in Figure 7 (c). Here the MINI-T appears to the load as a data generator whose open circuit voltage is plus or minus 12 volts on a single conductor to ground and whose source impedance is 600 ohms. The MINI-T expects to "see" a load of 600 ohms nominally and a nominal current of 10 milliamperes flows through this load. Thus only two conductors cross the interface—one for the transmit signal and one for the receive signal. The mark and space voltages are required to be within 5 per cent of each other. Now the time slot on the digital transmission line devoted to a given channel occurs regularly 8000 times per second and each time slot can carry one bit of information in the form of a pulse or no pulse. Thus we merely have to sample the incoming polar (two levels) signal regularly 8000 times a second and if at a given sampling instant the input signal is a mark (minus 6 volts) we put a pulse in that time slot on the line. If the input signal is in the space state then we put no

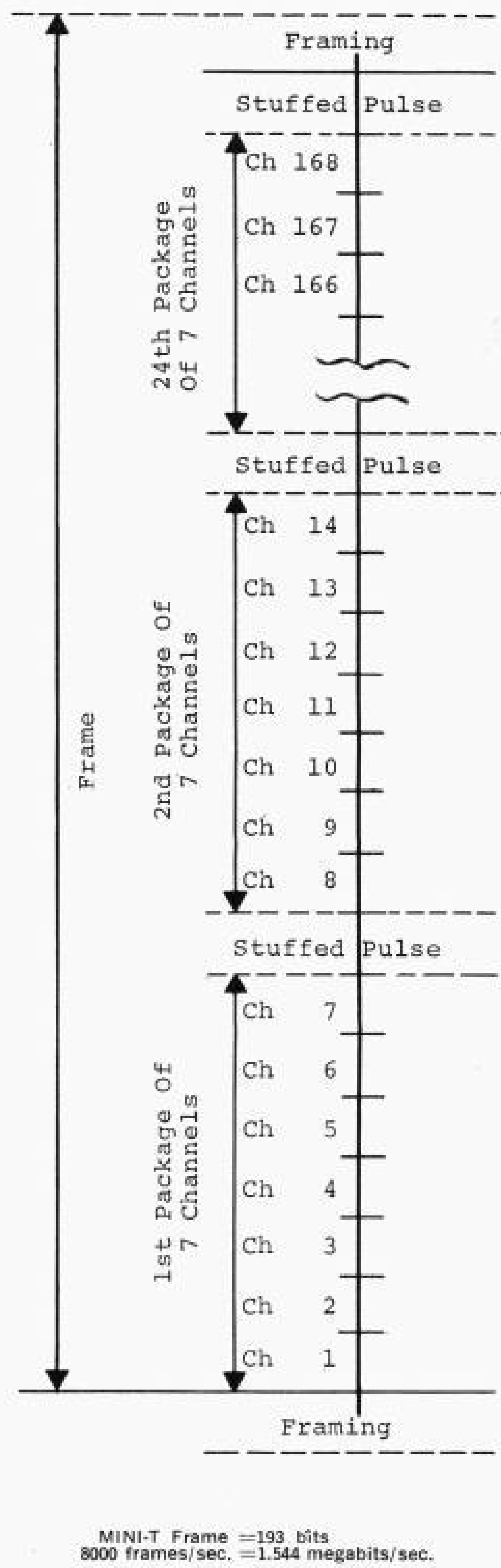


Figure 6—MINI-T Frame Format

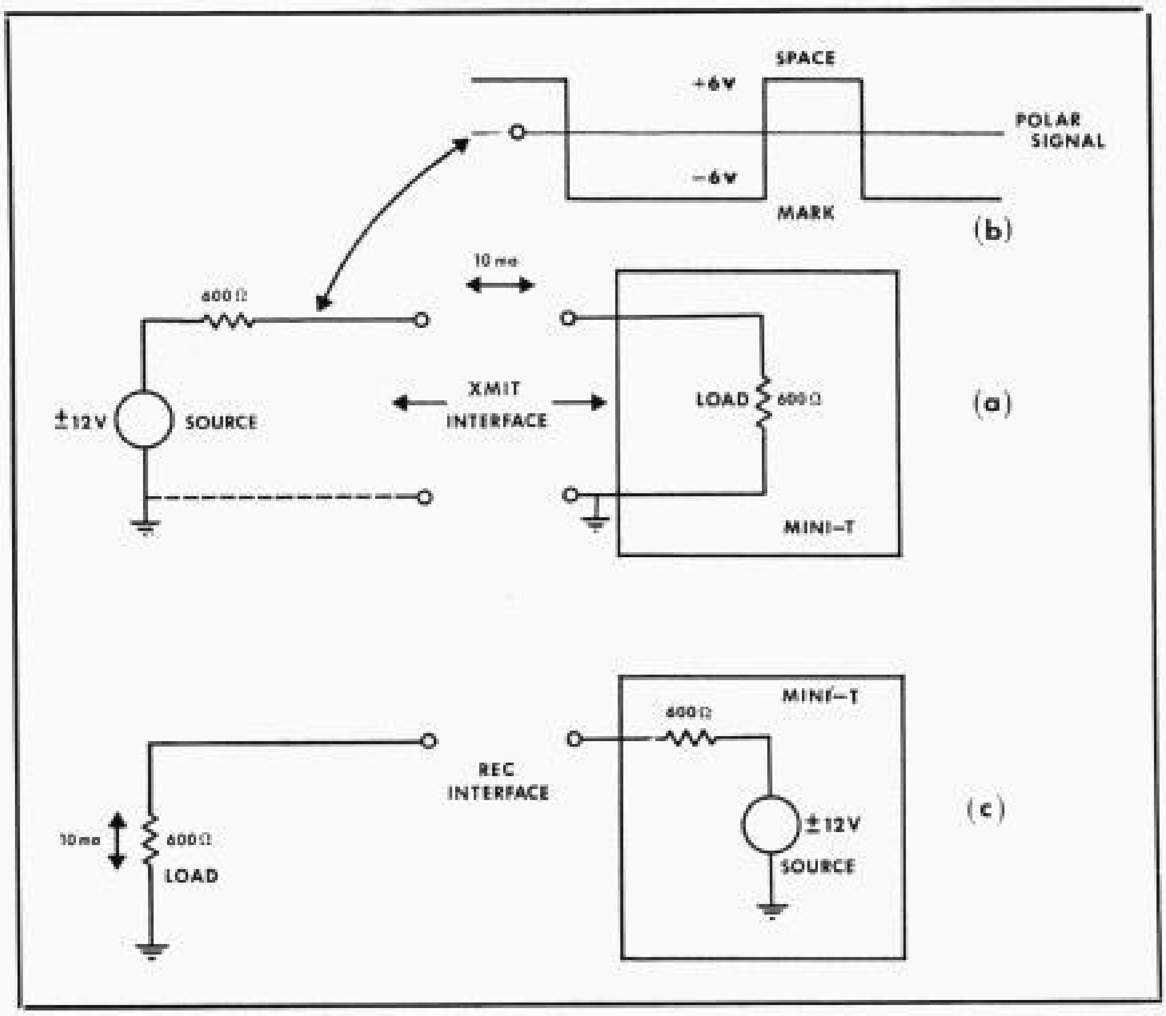


Figure 7—Subscriber Interface Characteristics

pulse in the time slot on the line. Hence, we sample the incoming signal at an 8 kc rate and the coding step of Figure 1 in this case is a one-bit encoding.

The receiver must be synchronized with the transmitter so that it can correctly distribute the channels. It does this by searching for a distinctive framing signal. In this case the framing time slot shown in Figure 6 carries a pulse in every odd frame and no pulse in every even frame. Having searched for, found, and locked onto this distinctive pattern the receiver then delivers the sequence of pulses or no pulses for the given teleprinter channel to the per channel equipment for that channel. There the sequence of pulses and no pulses from the line is decoded and reconstituted back to the polar signal which crosses the receive interface.

When a binary digital signal such as we have here is sampled by a sampler which is not synchronized with the input signal, a type of distortion called "jitter" is produced. In other words the transitions of the signal crossing the receive interface are slightly displaced from where they were relative to each other at the transmit interface. However, this distortion is held to suitable low levels by design. For MINI-T the design objective was to consider a "worst case" peak distortion (defined as the ratio in percentage of the maximum difference between the spacing of two most closely spaced consecutive transitions in the signal at the transmit interface and the spacing of the same two transitions at the receive interface to the spacing of the input) of plus or minus 2.5 per cent for an input rate of 200 bits per second. There is a linear relationship so that the channel can be used at higher speeds if the increased distortion can be tolerated. Doubling the rate doubles the peak distortion. For an input rate of 400 bits per second the worst case peak distortion is 5 per cent while at 800 bits per second it is 10 per cent. Therefore while our main interest is in signals in the range of 0 to 200 bits per second, there are some higher speed signals in our traffic inventory which can tolerate 10 per cent or more of distortion for one-link point-to-point applications. We have conducted studies of the accumulation of distortion of this type for a number of links in tandem and we have found that the accumulation is negligible after several independent links in tandem have been traversed. The exact phenomenon is that the accumulation continues but the time between the occurrences increases rapidly therefore making it have negligible effect.

Referring back to Figure 1, the sampling function is not always required. For example, in MAXI-T transition encoding is used to achieve higher line efficiency; therefore instead of the sampling function transition detection follows the interface which is followed by coding. In MINI-T the sampling and coding functions are extremely simple and inexpensive in keeping with the objective. One logic "and" gate performs both functions. The prototype MINI-T was implemented using integrated circuits throughout. The Transistor-Transistor Logic (TTL) variety of IC was used because its high speed minimizes signal delay problems. Also the low output impedance in both high and low output states provided by TTL is a distinct advantage. Furthermore, it was recognized that the cost of TTL has been dropping due to its wide use and that further cost reductions might be a distinct possibility. If the cost of TTL were to drop significantly or the use of MSI and/or LSI provided the same result then the prove-in distance for MINI-T might be reduced to less than 5 miles.

Since the distribution of routes as a function of length is steep in this distance range, each mile that the prove-in distance is reduced leads to a substantial increase in applications.

Medium scale integration (MSI) is the natural follow-on for single or discrete integrated circuits. MSI is an emerging technology based upon the discrete IC technology, but containing the equivalent of many discrete ICs on a single chip. Hence, many ICs are replaced by a single MSI unit a little larger than one IC. The physical space requirements are thus reduced and external wiring is eliminated. Reliability is enhanced and cost per logic function is decreased. These factors can all be translated into system cost reduction.

Large scale integration (LSI), also an emerging technology, is an extension of MSI, although not as developed. It contains more functions on one chip, with 100 gate complexity usually chosen as the boundary between MSI and LSI.

Future logic systems, including data transmission systems like PCM will usually be combinations of MSI and single ICs. LSI will follow shortly thereafter, initially in the area of repetitive logic. Pricing of these IC/MSI/LSI systems will be lower than the all-discrete IC versions.

The distortion figure for MINI-T is derived by noting that the period of the 8 kc sampler is one eighth of a millisecond and that the uncertainty in the transition location at the receiver interface is a maximum of plus or minus that amount. For the maximum rate of 200 bits per second the period is 5 milliseconds. The peak distortion in per cent is the ratio of the former to the latter times one hundred which gives plus or minus 2.5 per cent.

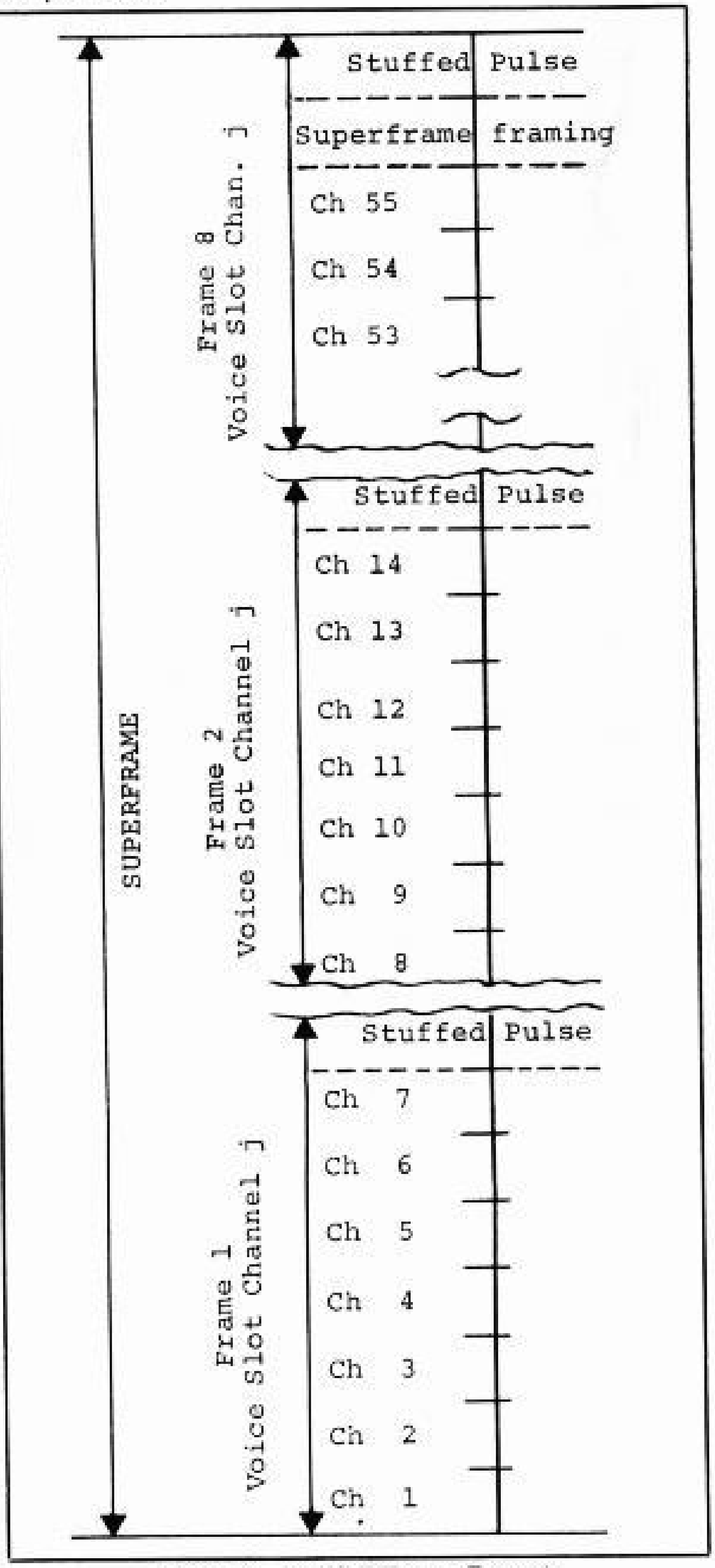
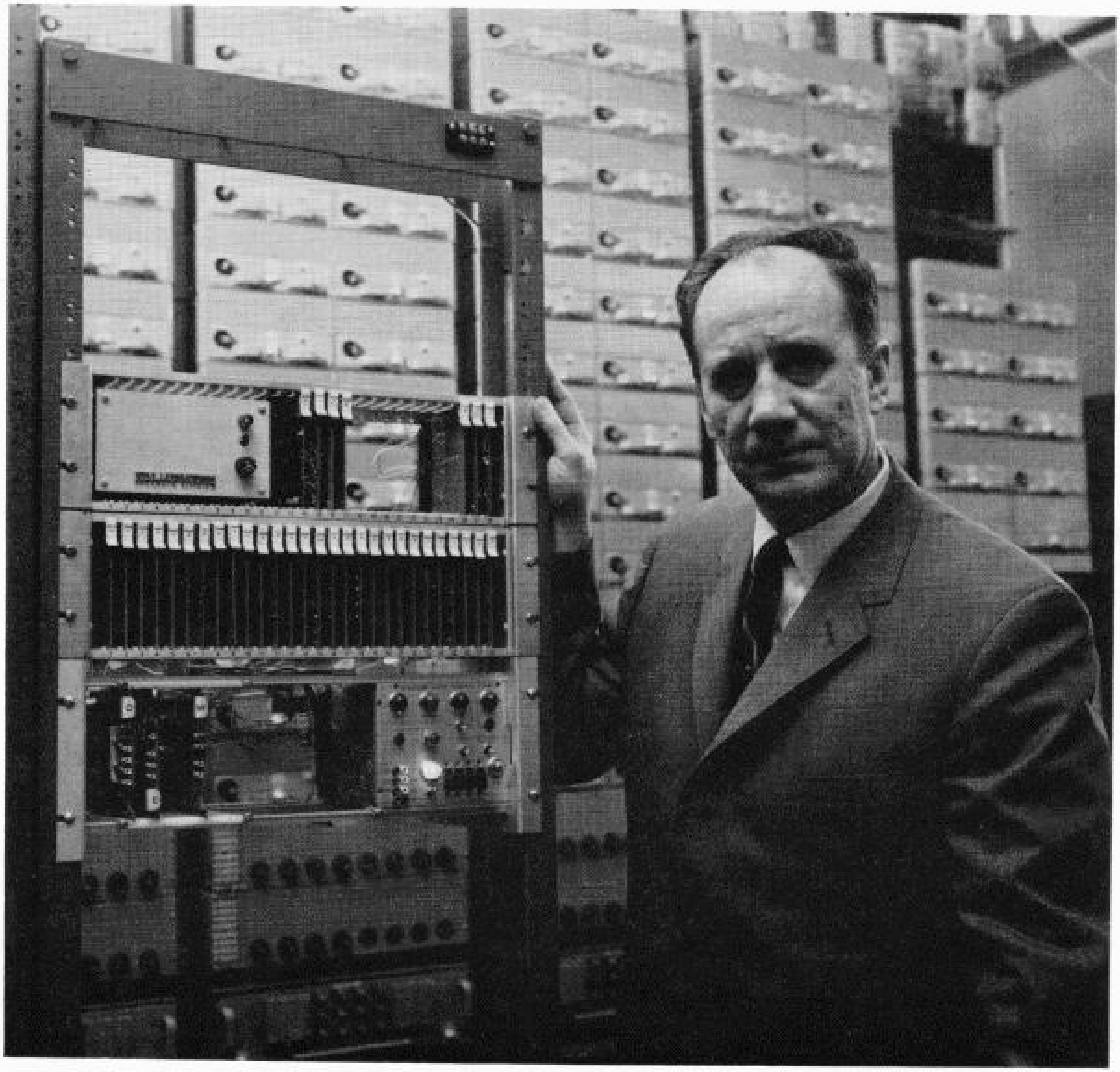


Figure 8—MAXI-T Frame Format



Mr. D. E. Jones, one of the authors, compares a new PCM terminal, at his hand, with the FM Carrier equipment shown in the background. A MINI-T terminal shown above can replace 8 or more racks of FM Carrier equipment. The advantage of the savings in space is obvious, since one MINI-T terminal takes only the space of ⅓ of a rack.

Description of MAXI-T

A superframe of eight regular frames is generated by dividing the regular framing time slot occurrence rate by eight. In each frame of the superframe shown in Figure 8, a given channel say the jth devotes its first seven time slots to individual teleprinter channels and the 8th bit is a stuffed pulse to insure sufficient excitation to keep the clocks running in the regenerators of the digital transmission line. The 7th bit of the eighth frame is used for superframe framing. Hence, as shown in Figure 8, the number of teleprinter channels available is 55 per voice slot or 1320 for a 1.544 megabit per second line since there are twenty-four voice slots. There is no sampling in this case. The interface, which is the same as for MINI-T, is followed by a transition encoder which produces a four-bit code for each transition. Since each time slot in a frame occurs 8000 times per second but only every eighth frame carries the codes of a given teleprinter channel 1000 time slots per second are available to carry each teleprinter's information. With a four-bit encoding it can be seen that there is an absolute upper bound on the channel capacity of 250 transitions per second. Since the input is a non return to zero polar signal the maximum data rate is also 250 bits per second. The code for each transition consists of a start bit followed by two position bits and a polarity bit. The polarity bit indicates whether the transition was mark to space or space to mark. The two position bits form a binary code which indicates in which quarter of the superframe the transition occurred. Since the superframe is one millisecond long the uncertainty in transition location at the receive interface produced is plus or minus one eighth of a millisecond. For the nominal upper limit rate at which the channel is to be used of 200 bits per second the transitions are five milliseconds apart. Hence, the peak distortion is 5.0 per cent.

Future Plans

Some other aspects of PCM networks are also presently being developed and studied. The development of PCM on microwave radio may be actively pursued so that the high performance, and operational advantages of PCM may be available in our network from coast to coast. If PCM is gradually introduced into long-haul plant where there is already a substantial investment in FDM, compatibility between the two must be established in such a way that the expected useful economic life of the FDM will still be realized.

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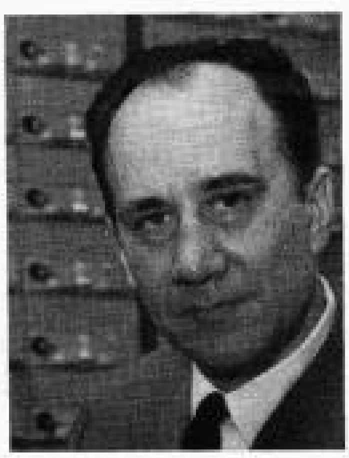
He is a senior member of the IEEE and a member of Tau Beta Pi. He has one patent and several patents pending. He has presented many technical papers and written articles for many technical journals.



MR. D. E. JONES, Plant Facility Engineer in the NSO Department, is responsible for the planning, expansion, and effective utilization of all Facility Systems in Western Union National Service Organization Service.

His twenty years service with Western Union was interrupted with two years military service in the Navy CEC, as Lieutenant J.G. in the Public Works Department, stationed in Japan. His experience in some of Western Union's basic systems, such as Plan 21, Plan 51, Letter Fax, etc., covers training personnel, production standards, budgets and management development programs.

He received a B.S.E.E. Degree, University of Oklahoma in 1948. He is a member of Tau Beta Pi and Etta Kappa Nu, Honorary Engineering fraternities.

WESTERN UNION

Requires Continuous Quality Monitoring of Telegraph and Data Circuits

J. W. Thomas

The need for more efficient maintenance and quality control procedures has become increasingly apparent with the introduction of highly complex, miniaturized hardware that permits centralized technical control of large numbers of communications circuits. To implement these procedures, Western Union investigated the availability of hardware that would extract data from its operating circuits and display that data so that system status would be recorded automatically and particular attention would be drawn to trouble spots. The hardware, to be selected, had to be capable of interfacing with existing equipments and easily adaptable to future equipments. It had to sample the actual traffic from live circuits and yet perform this function passively, so as not to run the risk of adversely affecting operating circuits.

Western Union was successful in obtaining a device capable of automatically measuring the quality of transmission on a large number of its telegraph and data circuits and recording the resulting data, via a peripheral teleprinter or punch, for manual corrective action. Eleven of these devices, called ACCESS—Automatic Communication Circuit Evaluation and Sensory System—were installed, during 1967, in large Western Union offices throughout the United States as part of its Modernization Program. The overall impact of these devices on system service is being evaluated by Western Union. ACCESS has been found so successful in monitoring circuitry in Western Union's own plant that the Company is now offering the device to private customers on a leased tariff basis and has already placed several ACCESS systems into service for the Federal Government.

ACCESS

ACCESS—Automatic Communication Circuit Evaluation and Sensory System, shown in Figure 1, is an automated multichannel system designed to take a statistical sampling, while monitoring large blocks of communications circuits, to obtain qualitative data related to specific parameters of the traffic on each channel. ACCESS, designed by Digitech, Inc., of Ridgefield, Connecticut, samples, measures, and displays distortion of up to 800 circuits so that operators may quickly recognize those circuits which have exceeded preestablished quality levels. The major "mission" of ACCESS is to perform a routine first-level monitoring function continuously, and free the technical control station operators so that they may concentrate on only those circuits most liable to trouble.

System Characteristics

Ambient Operating Temperature
—0° to 50° C or
32° to 120° F

Main Power Input—100 to 130 v ac,
60 Hz, single phase

Data/Telegraph Speed—30 to 9600 bauds

Output Loop Voltage Source—Supplies externally

Size —19" W, 31½" H, (min.)

Weight—75 lbs. (min.) excluding cabinet

Figure 2 is a functional Block Diagram of ACCESS system. ACCESS contains analyzers for measuring transition displacement distortion of dc telegraph and data signals. Baud rate, distortion alarm threshold, and open line/no transition functions may be set independently for each circuit by the operator. A Circuit Scanner allows the analyzers to measure a multiple number of circuits on a time-shared basis. A Control Panel, shown in Figure 3, allows the operator to scan all circuits or a restricted block of circuits. The results of each circuit analysis are printed out in an ACCESS Printout, a report showing circuit address, time, and date information, described in detail later in this article. An external teleprinter records the formatted information. Printout control can be selected for an "all-channel" or by exception "alarm-only" printout.

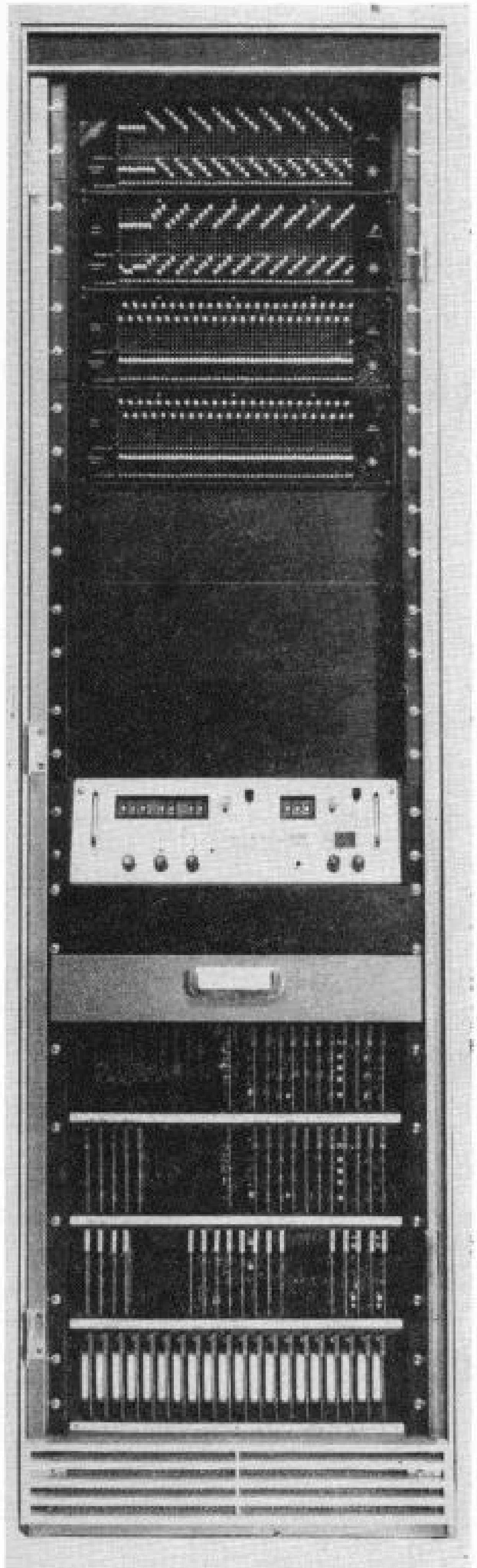


Figure 1—ACCESS—100D

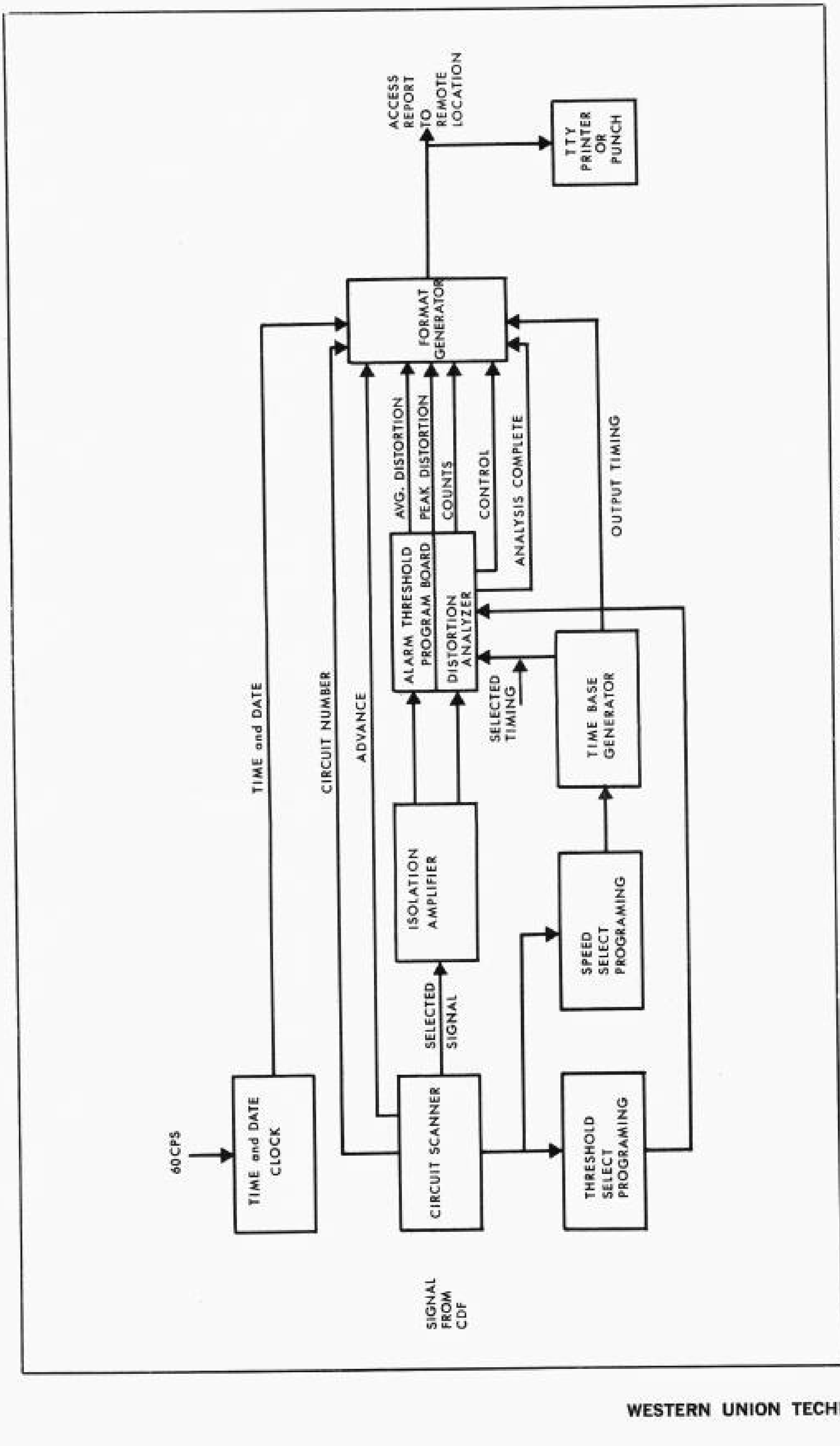


Figure 2—Functional Block Diagram of ACCESS

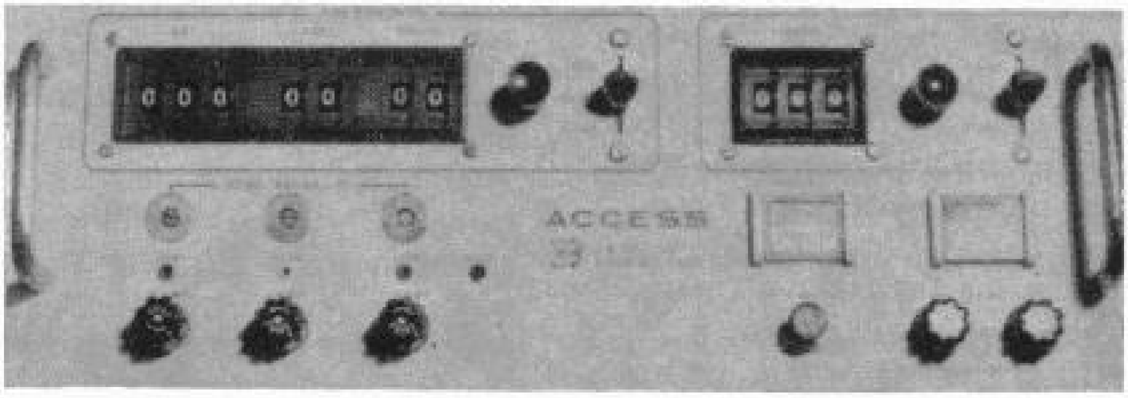


Figure 3—ACCESS Control Panel

SINGLE or DUPLEX OPERATION

The system is designed for 50-400 single or duplex operation. Up to ten different operating speeds, in the 30 to 9600 baud range, may be preprogrammed into the Time Base Generator shown in Figure 2. This Generator provides the basic timing signals, both selected timing and output. Four pairs of distortion thresholds within the levels ranging from 1 to 49 percent are preselected through internal strapping. The known operating speed of each individual circuit is programmed, by the operator, by insertion of a diode pin into the corresponding jack of the Speed Sections of the Program Board, shown in Figure 4. The desired "alarm threshold" level for each individual circuit is programmed, by the operator, by insertion of a diode pin into the corresponding jack of the Threshold Select Section of the Program Board. When a selected threshold is exceeded, the measured data is applied to the Format Generator. When a threshold program pin for a given signal channel is removed, that channel is muted and is so indicated in the output report of the Format Generator, the Printout. A "no transition" condition or an "open line" is detected for each individual circuit by manual insertion of a programming pin into the corresponding NT/OL jack of the Program Board. The in/out placement of the pin determines either "no-transition" alarm or "open line" detection, respectively.

POLAR and NEUTRAL LINES

Both polar and neutral lines are scanned individually and automatically by the use of dry reed relays. Polar lines are monitored on a bridging basis for all voltages from $\pm$ 6 to $\pm$ 150 volts. Neutral lines are monitored on a current-sensing basis for the standard 20 and 60 ma lines. A series drop of nine volts is required for neutral operation. As each circuit is locked in by the scanner, signal input data is relayed to the distortion analyzers for sampling and analysis. Circuit isolation is provided to prevent accidental interruption of traffic in the event of scanner malfunction. ACCESS completes more than twelve scans per hour, for each circuit connected (in the "alarm-only" mode, with a 100 wpm printer—when alarm conditions exist for less than five percent of all channels).

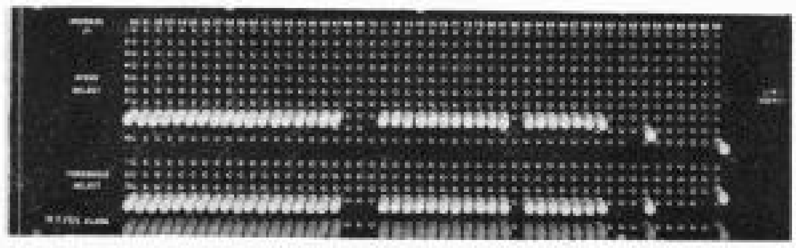


Figure 4—ACCESS Address Program Board

DISTORTION

The distortion analyzers measure both total peak and average distortion. The sampling interval can be preprogrammed for a setting of 8, 16, or 32 individual measurements. Once made, this setting applies to all circuits. If fewer than the preprogrammed number of transitions are detected during a sampling interval, no measurement can be taken. In this case, the scanner pauses for a predetermined length of time, which may be adjustable from 0.5 to 10 seconds—and then proceeds to the next circuit. Total "peak" distortion is the maximum value of distortion measured in each sampling interval. "Average" distortion is the mean absolute value of the 8, 16, or 32 measurements. In most cases this average will correspond to circuit bias. By the proper setting of the average threshold, ACCESS calls attention to increased bias conditions before they reach critical values.

ACCESS PRINTOUT

The Format Generator sequentially selects circuit number, date/time groups and Distortion Analyzers' output in parallel form. Time and date information is provided from the Clock. Output from ACCESS may be in serial form on a punched tape and/or on a page printer readout. A typical page printer readout is illustrated in Figure 5 showing the information that is available at the time of readout as Figure 5a and the Line Status Report or printout as Figure 5b.

In Figure 5a the address number is followed by the Julian day which is followed by the "time of day," to the minute, on a 24-hour basis. The information which follows is the "status indicator." This may be either a ?, —, /, or a bell (normally upper case "S"). The ? indicates no traffic, i.e. no transitions during the sample period. The — indicates there was traffic but neither of the established thresholds was exceeded. The / indicates a muted line. A bell character (non-shift function on teleprinter) indicates at least one of the thresholds was exceeded. Because the bell is a non-shift function, those addresses that require attention are automatically indented one space in the all-address readout as shown in Figure 5b. After the "Status Indication," the three final bits of information, peak count, peak distortion and average distortion are indicated.

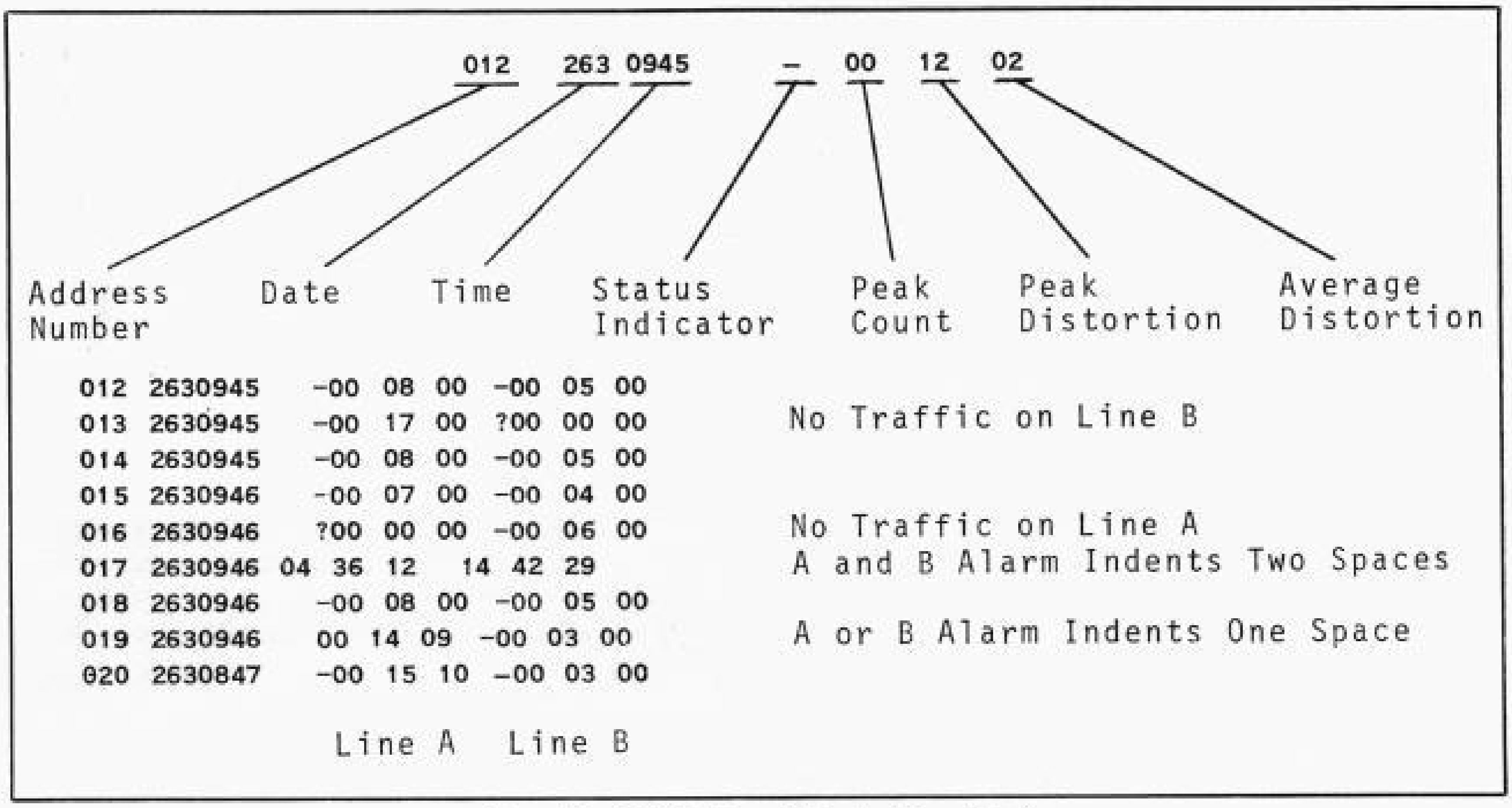


Figure 5—ACCESS Report (Duplex Operations)

ALL-ADDRESS READOUT

Figure 5b illustrates the all-address readout, which may be effected automatically by the time clock or manually switched by means of a switch on the Control Panel, for the purposes of maintenance shift changes, circuit studies or equipment operational check. In a duplex system, two Distortion Analyzers are used, consequently the Status Indicator, peak count, peak distortion and average distortion are repeated for the second line, B, as shown in Figure 5b.

ALARM CONDITION

Double sampling is provided when an alarm condition exists. Whenever average or peak thresholds have been exceeded on a given address, or on a given circuit, the analyzer will verify the alarm conditions before providing the Format Generator with average distortion, peak distortion, and peak count. If the alarm condition does exist, the "all-address readout" appears indented from the right, as shown in Figure 5b. (If no alarm exists, readout would be normal.) In the ALARM ONLY readout position, a readout would be presented only if an alarm exists. NT/OL, no transition or open line, will also cause a printout.

Upon receipt of an alarm from ACCESS a further investigation of the alarming circuit can be made manually by use of an external distortion analyzer and oscilloscope to determine in more detail the nature and cause of the alarm condition. ACCESS is particularly useful in detecting long-term signal degradation.

MEASUREMENT TECHNIQUE

The specific analyzing technique used is the measurement of the time duration from a mark-to-space transition to the next space-to-mark transition. Time is measured as a percentage of the programmed bit length (for multiple as well as single bits) rather than in seconds. This type of analysis is known as transition displacement analysis. The measurement of time makes it necessary to define when the mark-to-space and space-to-mark transitions occur (trigger point). When the signal waveform is rectangular, as shown in Figure 6a there is no problem. However, when shaped or otherwise disturbed waveforms such as those illustrated in Figure 6b are measured, typical in most operating circuits, it is necessary to establish a threshold and define all inputs below this point as "spacing" and all inputs above as "marking."

THRESHOLD

The proper threshold is half-amplitude for neutral signals and zero for polar signals. This threshold will show only a time delay when the mark-to-space and space-to-mark transitions are symmetrically shaped. When shaping is not symmetrical as illustrated in Figure 7, distortion results. Figure 7 shows what happens when the signal waveform has discontinuities. It becomes impossible to define accurately the time of occurrence of the mark-to-space and space-to-mark transitions and hence the percentage of distortion.

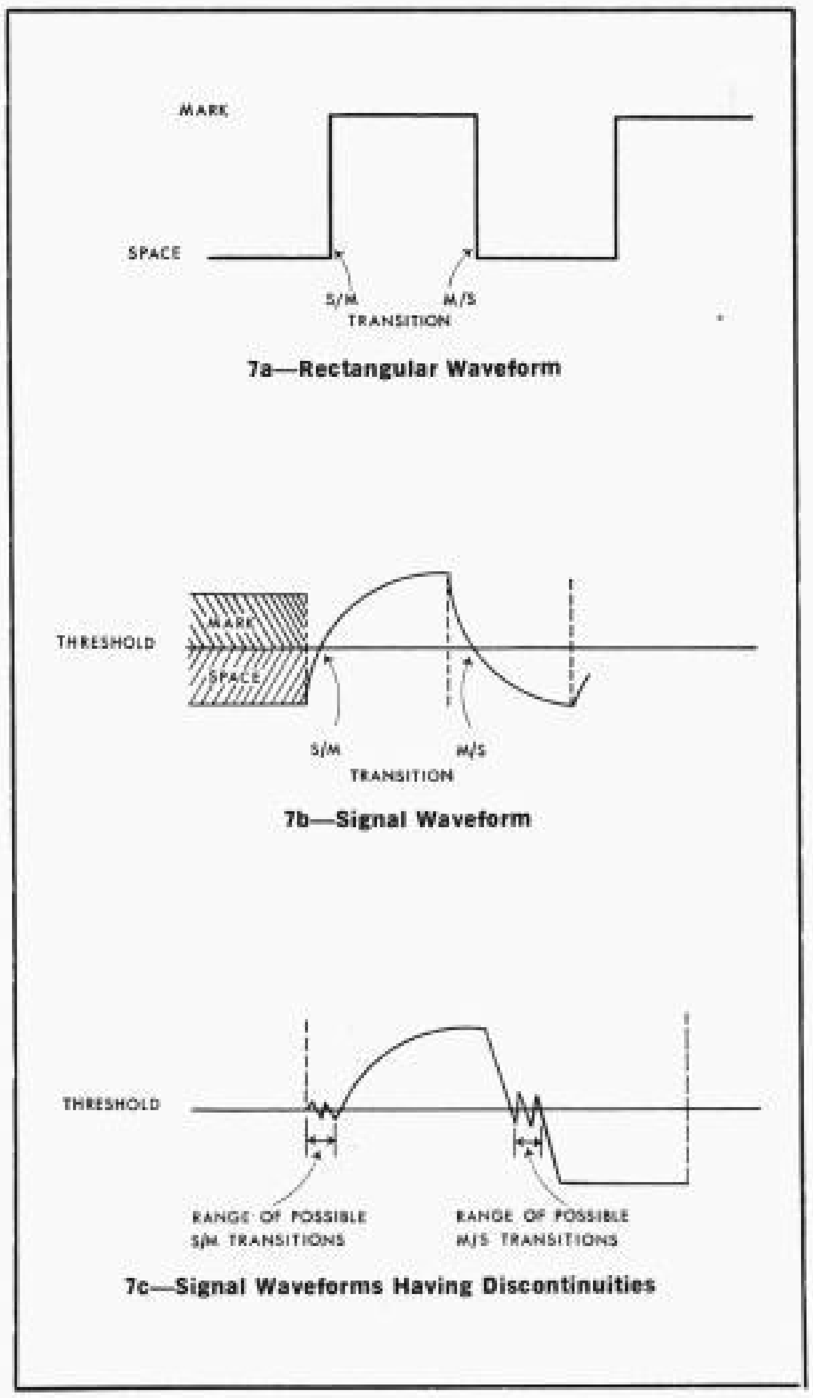


Figure 7—Three Typical Signal Waveforms

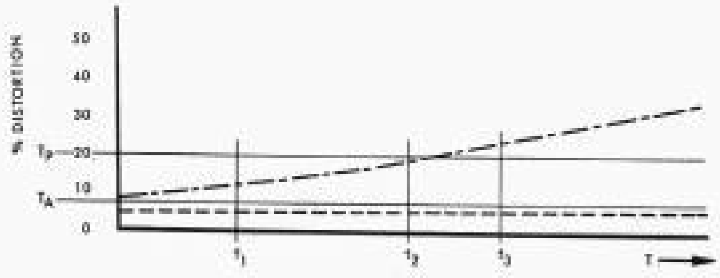


Figure 7a—Circuit Failure Caused by Increasing Fortuitous Distortion With No Change in Bias

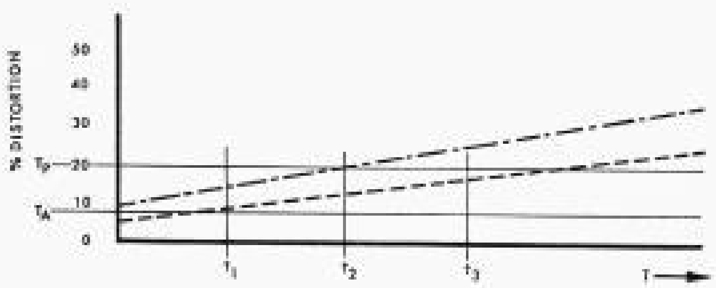


Figure 7b—Circuit Failure Caused by Increasing Bias Distortion with No Change in Jitter

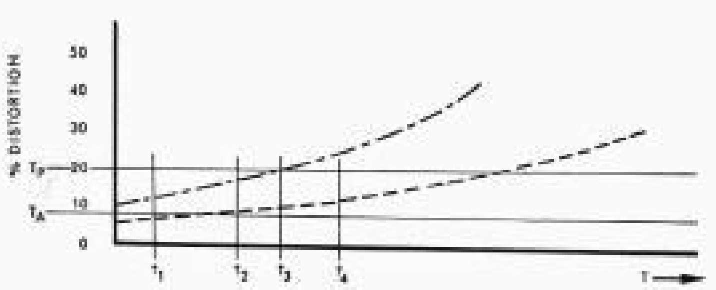


Figure 7c—Circuit Failure Caused by Increasing Bias Distortion in a Narrow Bandwidth Channel

— — — — Average Distortion
- — - — - — Total Distortion (Peak)
T_P = Peak Threshold
T_A = Average Threshold

Figure 7—Responses to Degradation Failure Modes

In those cases where it is not possible to eliminate the waveform discontinuities by circuit engineering or filtering, ACCESS can monitor the circuit for distortion changes, provided the operator chooses an appropriate distortion threshold level. ACCESS contains an input circuit filter which removes normal circuit disturbances, such as relay bounce on low speeds, and prevents their measurement. However, when those disturbances exceed approximately one to two milliseconds in duration, or when they appear an excessive number of times, ACCESS will call attention to this condition by "alarming" and then displaying illogical combinations of peak and average distortion values.

Figures 7a, 7b, and 7c show the response of ACCESS to gradual degradation failure modes. Available data, to date, indicates that the time cycle required for distortion to increase until it reaches unacceptable levels, ranges from one to six months.

Advantages of ACCESS

1) Early Prediction of Failures—
   A study of this available data shows that ACCESS can predict these failure modes sufficiently far in advance of the circuit reaching unacceptable distortion levels.
2) No Inconvenience to Customer in Maintenance—
   By means of this device scheduled maintenance may correct the failure with no inconvenience to the customer and hopefully without the customer's becoming aware of the problem.
3) "Sudden Death" Failure Eliminated—
   Thus ACCESS can prevent gradual degradation failure modes from becoming seemingly sudden death failures. It has been proven that full-period peak monitoring can never do this.
4) Gradual Degradation Failures Detected Early—
   It may be concluded that a large percentage of what are now classified as "sudden death" failures are actually gradual degradation failures for which no automatic means of early detection was available until ACCESS was designed.

APPLICATIONS FOR MONITORING INSTRUMENTATION

The ACCESS design concept appears to have many applications. One good application is its use as a data sensor wherever some type of signals standardization exists.

It is difficult to predict the future of communication instrumentation at this time because of the rapid changes in terminal and switching hardware. However, following the general maintenance system concept mentioned earlier, Western Union can foresee the need for additional instrumentation similar to the design of ACCESS, which is capable of measuring and monitoring additional system parameters such as voice frequency telegraph system (VFTG) signals.

While many components of a communications system do not have common interfaces, where the ACCESS concept can be applied, status and performance data are required as an input to the overall maintenance system. One solution to this problem would be to require all new terminal and switching hardware to be self-monitoring. Then, with a common interface and language, all parts of the communication system could send status and performance data to a centralized data processor. This data would then be used to generate specialized displays to aid and coordinate manual corrective actions.

Another application which, even now, is receiving serious attention, is the possibility of setting up automatic corrective actions, thus providing a closed-loop maintenance function which will assure Western Union's customers of self-correcting communication systems in the future.

* * * *

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Acknowledgment

The author acknowledges the cooperation of Messrs. R. E. Reid and R. E. Nolan of the Technical Facilities Department in their confirmation of some of the material published in this article.

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Our Customer Says:

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Why We Need a Computerized Switching System

Weyerhaeuser has a lot going for it right now. We are rich in assets, production capacity, skilled men and women—we feel we are a mighty corporation, On the Move and still growing.

We are an integrated company, and that means we do a lot of things well. For example, we are a major logging firm—we are the nation's first tree farmer and still one of the largest. We make industrial chemicals, wood pulp, paper, packages and containers, manufactured panels and building products. We supply raw materials to other industries and finished products to the homeowners.

Our scope is international. We serve in 17 countries. We operate more than 100 production facilities and 100 distribution centers throughout the United States and around the world. We not only make products we also move them. We operate our own railroads to get logs to our mills, charter ocean-going vessels to move our products to far-away markets, operate port facilities, airplanes and truck fleets. We do anything to get our customers the right products at those places where the action is.

We manufacture a surprising variety of items, more than 5,000 products in all. And we are still looking for more. With our strong financial and resource base, Weyerhaeuser—like its new High Yield Forests*—is producing in a surging, vigorous growth cycle.

We are over 37,000 strong, including 4,000 who nce

Entry System

State Selector

by William R. MacDonald

work with us in the 16 other countries where Weyerhaeuser has offices, production facilities and land.

We have a young, enthusiastic, well-informed management. The average age of our decision-making team is 48 years. The background of each member of this team ranges from forestry to marketing, to engineering, to chemistry, to finance data processing, law and business administration. In all, we employ men and women in 700 different job classifications, and they must have digital data transmitted to them quickly and by means of the most sophisticated techniques in the communication industry.

*High Yield Forestry is a service mark of Weyerhaeuser Company.

William R. MacDonald, Manager of Weyerhaeuser's Computing and Telecommunications Operations Department, is responsible for the operation of the corporate private line and voice network and national data network. The computer complex serves the business and scientific users of the Corporation. He has been associated with the development of major "on line" applications systems.

Weyerhaeuser's Selection of Hardware

A few years ago Weyerhaeuser Company decided to build a central computing facility at our corporate headquarters in Tacoma, Washington. It was part of our plan that this central computing facility would ultimately serve all divisions of the corporation and would collect and process information "as it happens" rather than just process and produce statements and reports "after the fact."

Because all the potential users of this computing facility were located in production, distribution, sales plants and offices throughout the United States, the Weyerhaeuser Company quickly directed its attention to the need for a common corporate communications network. This communication network would have to serve not only to transmit administrative traffic, but also serve multiple order entry, production control and inventory control systems handling the input of raw data within demanding turnaround time parameters in a message switching environment.

We carefully studied and researched our company's requirements for a total system. After discussing our system requirements with computer manufacturers and communication carriers, the decision was made—based on the vendors' ability to provide what we wanted. We selected GENERAL ELECTRIC to provide the processing and message switching computers and WESTERN UNION to provide the remote low-speed communication lines and terminals.

Components of the Total System

a) *Computers*

The total system consists of four General Electric DN-30 computers which are used for system control and as store and forward message switching centers. There are two DN-30 computers at Tacoma, as shown in Figure 1 one at Chicago and one at Philadelphia.

There are approximately 125 outstations serving three Weyerhaeuser Divisions,

The Wood Products, the Packaging and the Paper Divisions

The DN-30 computer at Philadelphia terminates the circuits and stations located east of Cleveland.

The DN-30 computer at Chicago terminates the circuits and stations located west of Cleveland and east of Denver.

The two DN-30 computers at Tacoma, Washington terminate the circuits and stations located west of Denver.

The two DN-30 computers at Tacoma, Washington are connected to the DN-30 computer at Chicago with one full-duplex, 2400 baud, high-speed line.

The DN-30 computer at Chicago is connected with the DN-30 computer at Philadelphia with one full-duplex, 2400 baud, high-speed line.

These 2400 baud high-speed lines (originally supplied by Western Union) and associated 201-B Modems are supplied by the Telephone Company utilizing circuits within the base capacity of Telpak channels.

At Tacoma, the two DN-30 computers are directly linked to one General Electric 235 computer and a complex of four General Electric 635 computers. These computers are used for our total on-line, batch processing and test and development requirements of the company.

The DN-30 computers poll the outstations for message or order traffic under control of a line service routine program. Messages and orders are routed through the DN-30 computers for transmission either to the order processing computers at Tacoma or to other stations in the system.

b) *Outstation Equipment*

The outstation equipment consists of the following basic units in various configurations depending upon the local needs:

Model 35 ASR sets

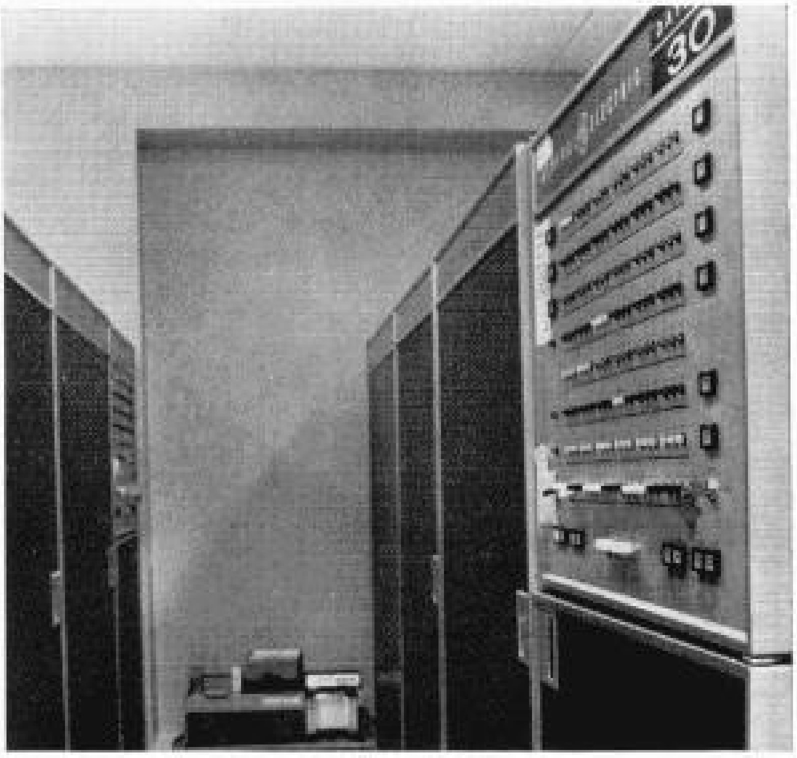

Figure 1—Face-to-Face Datanet 30s. Two of the Four Computers which Control and Switch Messages Among Our Main Processors and Our Low and High-Speed Communication Facilities

Model 35 RO printers

Model 35 LXD tape transmitters

Model 35 LPR typing reperforators

Type 11708 Western Union Solid State Selectors

McGraw Edison AMU units (customer owned).

What Function Does Each Component Perform?

Model 35 ASR sets are used to prepare sales orders and/or administrative messages off-line in perforated tape form. The McGraw Edison AMU units are programmed with product items, billing and ship-to addresses and are used in conjunction with order preparation. They are used in much the same manner as edge punched cards where used in older systems.

The Model 35 RO printers are used to receive copies of invoices and administrative messages.

The Model 35 LXD tape transmitters are used at stations where several off-line Model 35 ASR sets are required for order preparation and the LXD is connected to the communication line for transmission.

Model 35 LPR typing reperforators are used at some locations where printed perforated tape is required for relay or local processing.

The Western Union Type 11708 solid state selector is used for system control.

c) Transmission Lines

Low-speed, full-duplex circuits (simultaneous send and receive) servicing the network stations are terminated in the General Electric Datanet-30 communications controllers. The Datanet-30 controllers are interconnected by high-speed circuits which provide access to the computers serving the system's processing functions.

Messages to other network stations are routed to the proper destination by means of a unique call directing code (mneumonic address) assigned to each station. In addition, each station has an answerback code and a circuit identifying call letter. The call directing code and answerback are validated by the Datanet-30 prior to accepting or delivering a message. Messages are prepared in perforated tape and transmitted into the system via the station's transmitter. After a "request to send" has been initiated by use of the AUTO SEND REQUEST switch, the Datanet-30 generates an "invitation to send" when ready to accept the message. Figure 2 is a photo of a Western Union Communication Line Terminal which provides convenient access to low-speed line terminations in our Network Control areas for monitoring, patching and testing purposes.

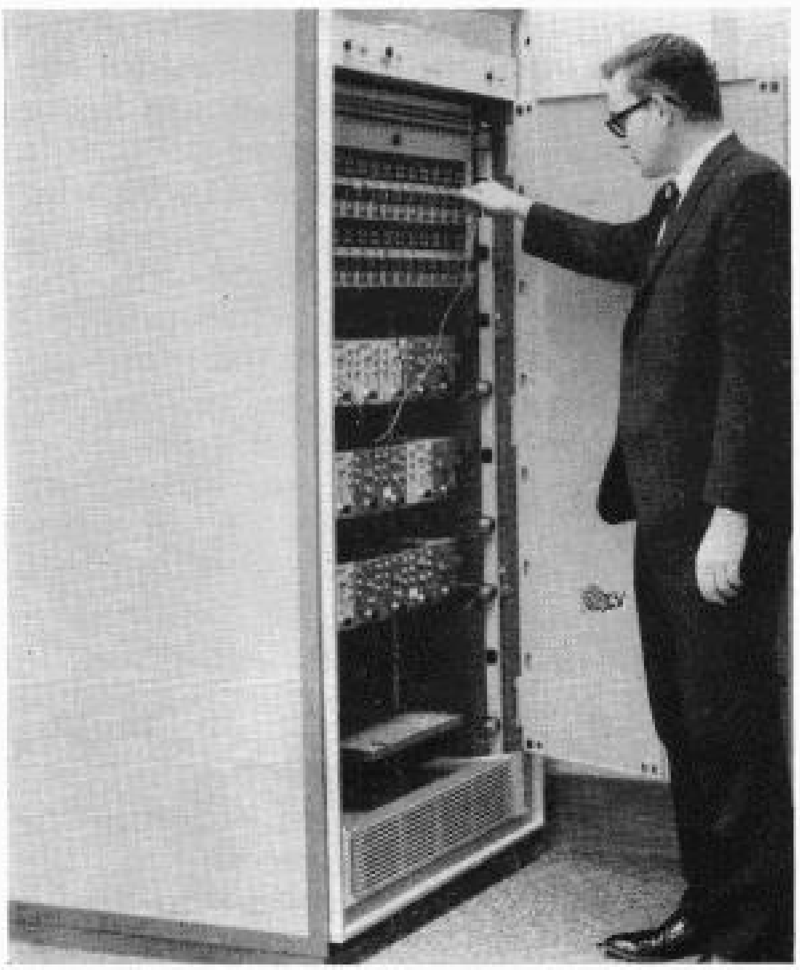

Figure 2—Western Union Communication Line Terminal

Here is "How the Total System Works":

The Datanet-30 computer polls the outstations for message traffic or order traffic, under control of a line service routine program. If the Datanet-30 is transmitting on the circuit to a station, it will pause, long enough, to invite a station "to send." The polling for an "invitation to send" is set up as follows:

1. Transmit a *S3*—(Shift, control K) (11011000). This conditions all solid state selectors on the circuit to the "transmit mode" and inhibits printing of the next character received. (i.e. the call letter)
2. Transmit the *call letter*. This is an alpha character which is unique to each station on a low-speed circuit. This will select the proper station and start its transmitter, if paper tape is properly positioned and pick up has been requested. If the station is not prepared to send, the station will automatically respond to the polling (call letter) with a *normal no traffic acknowledgement code* (00111111).
3. Transmit a *S7*—(Shift, control O) (11111001). This stops the transmitter and knocks down the S3. This does not set the alarm light, but cancels the single request. The Datanet always follows an S7 with an S3, in case there are more messages to send and the request switch is in the "auto" position. (When there is traffic to send, the S7 will not be sent until the Datanet has received an EOT).
4. Transmit a *S6*—(Shift, control N) (01111000). This stops the transmitter and sets the alarm light at the sending station following bad response to polling or bad input. It also knocks down the S3 in the selector if there is no response.

Message Format

The Datanet-30 Communication Controller checks each message for proper format. Only messages that meet the format validation are accepted by the Datanet-30, stored and forwarded to the destination(s); others are rejected. The rejection notice (error message) defines the type of error the Datanet-30 will send the errored message to the station in error, and also to Network Control.

Error Detection Capability

The Weyerhaeuser data network also has an error detection capability—a feature designed into the Western Union solid state selector shown in Figure 3. Each character in a message is parity checked by the Datanet-30 upon input. If a parity error is detected, the message is rejected and the Datanet generates the appropriate error message to the station attempting to send and to the Network Control.

If an error in parity occurs when the Datanet is transmitting to a station, the station will detect the error, but will not reject the message. The receiving station will print the character received (if it is printable) and will print in place of the next character a left-hand arrow (←) immediately following the character received in error. Then, if necessary, the receiving station may request the Datanet for a repeat of the message.

How Message is Delivered

When the Datanet-30 has a message to deliver to an outstation, the following takes place: a) the computer assumes that some station on the circuit is sending input, b) it must stop this input long enough to make connection with the station which is to receive the message. To stop this input, the Datanet-30 will:

1. Transmit an *EOT*—(Control D) (00100001). This will condition all selectors on the circuit into the "select," but "non-print" mode.
2. Transmit an *S2*—(Control Z) (01011001). This will temporarily stop any transmitter on the circuit that is transmitting.
3. Transmit an *S4*—(Shift, control L) (00111001). This will condition all selectors on the circuit to receive the following call letter.
4. Send the call letter assigned to the station which is to receive traffic.
   (If the station is ready to receive, it will respond with a *normal acknowledgement code.*) (00111111)
5. Transmit an *EOA*—(Control B) (01000001). This will condition the selector to receive traffic on the selected printer, if a *normal acknowledgement* was received.
6. Transmit a *S5*—(Shift, control M) (10111000). This will restart the transmitter, which was temporarily stopped by the *S2* code.
7. Send output traffic as desired.

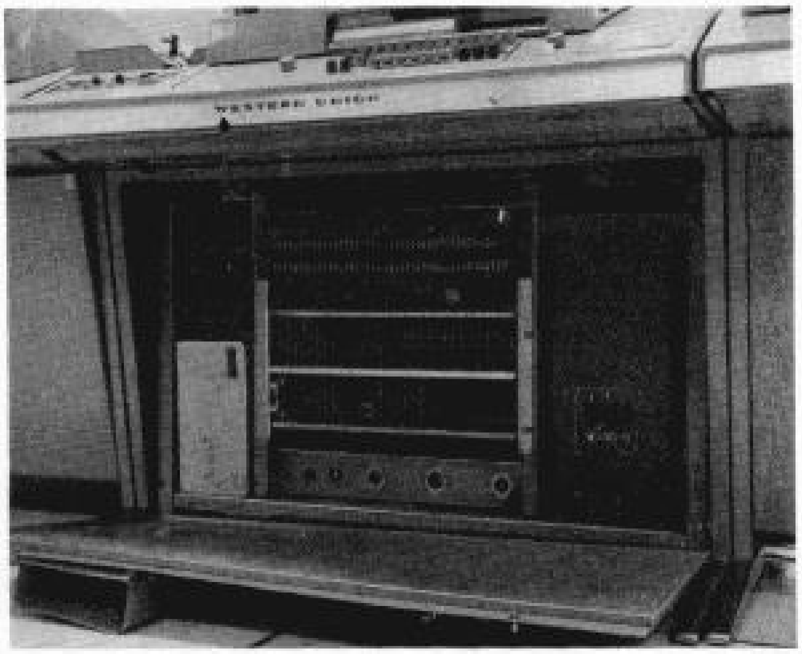

Figure 3—Western Union Solid State Selector Housed in the Lower Section of an ASR Unit

Plan 137-A Switching System

The heart of the Weyerhaeuser computerized switching system terminal is the Solid State Selector #11708, designed by Western Union for the Plan 137-A Switching System, installed in 1965. This selector reduced the noise at the outstations caused previously by the stunt boxes in the Western Union Plan 115A. While other systems were considered by us, only Western Union offered to design and install the system to meet our user requirements. The Plan 137-A Switching System is all full duplex and uses 8-level ASCII code. It was the first application of the #11708 selector to computerized switching.

The selector is used for outstation control. There are approximately 125 outstations serving all the Weyerhaeuser divisions. The selector responds to computer polling by means of a unique answerback, and identifies the station, upon selection, as the "called" station. The selector allows control selection and control of the transmitter, printer, auxilliary transmitter and other peripheral devices such as the punched card reading equipment, located at the outstation.

The selector responds to requests polled by the computer indicating any one of the following three conditions:

1) traffic is present at the outstation, for transmission to the computer,
2) no traffic is present at the outstation, or
3) the outstation is "off line" at the time of the request.

Salient Features of the Selector

- Solid State—This unit is completely solid state. Timing consideratione are held within tolerances.

- Several Answerbacks—
Several types of answerbacks are available: answerback on Polling, answerback on selection.

- Hardware Programmable—
It allows any practical assignment of control or selection functional character.

- Unique Parity Check—
In addition to polling, the selector has another unique function—it checks the parity of each received character. If a parity error is detected, a special symbol, (←), is printed in place of the character in which the parity was detected.

- Unattended Operation.

- Automatic Sequential Polling of Sending Stations.

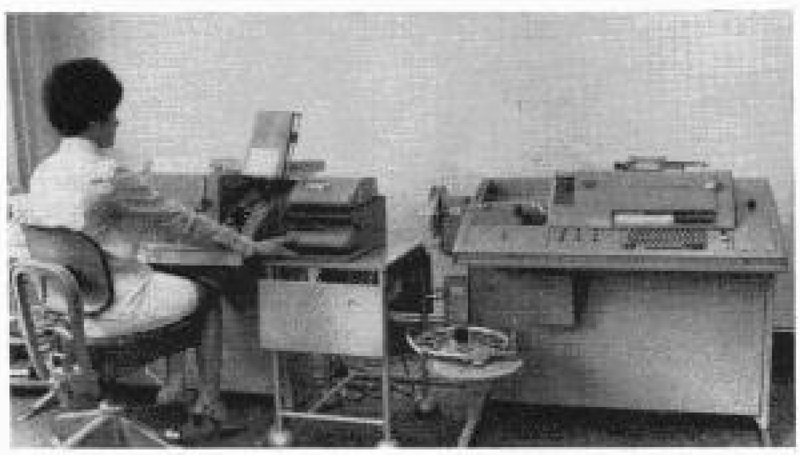

Figure 4—McGraw Edison Address Memory Units (in center) Used as Fixed Storage Devices for Preparing Hard Copy and Message Tapes for Order Entry. Special Teletype Equipment Is Provided by Western Union for Preparing Up-dated AMUs and for Playback Editing

Performance of the Weyerhaeuser Network

The overall performance of our communications network is excellent. From test data accumulated during the last six months, network performance of the computers and reliability of the system have been as follows:

1) Datanet-30 uptime—over 99.5%.
2) Western Union circuitry and terminal equipment uptime—approximately 99%.
3) Reliability of accurate data transmission—over 99.9%.
4) Weyerhaeuser customers can now be assured of faster delivery than when orders were processed manually.
5) Availability of products can be determined in a matter of minutes, by sending an inquiry to the cumputer. Thus the customer can be informed quickly of the inventory status.
6) Price changes are kept current at the sales offices—for quotation to customers.

A large part of this success is a result of a responsive team effort among General Electric, Western Union and Weyerhaeuser people. A strong contributing factor also has been the development of effective training and operating techniques among our teletype operators and at Network Control Centers located at each of the network switching sites.

Use of McGraw Edison address Memory Units

Users of our system who transmit large volumes of customer orders into the network are assisted by the use of McGraw Edison Address Memory Units (AMU). The AMU shown in Figure 4 is a small magnetic tape storage device which can be programmed with fixed information (usually customer and product identification data). Each AMU has a storage capacity of 1,000 lines of information with 80 characters per line. With the AMU, the teletypewriter operator just selects the line of information she wishes to enter on her order, presses a lever, and the information is automatically typed on the order as shown in Figure 4. Punched paper tape is produced as a by-product of this simple operation.

Western Union Interface

These AMU's are all programmed, recorded, edited and serviced at Tacoma, Washington. Western Union provided valuable assistance not only in the development of the Teletype-AMU interface, but also by providing the modified equipment necessary to produce these AMU's at our Tacoma office as shown in Figure 5.

Western Union Punched Card Transmitters and 35 ROTR's are used in converting the source information from standard 80-column cards to punched paper tape as shown in Figure 6.

A special 35 ASR teletype is used to prepare the index tape for the printed display of the AMU.

Another ASR has been modified by Western Union so that data from paper tape may be transferred into the magnetic tape storage unit of the AMU.

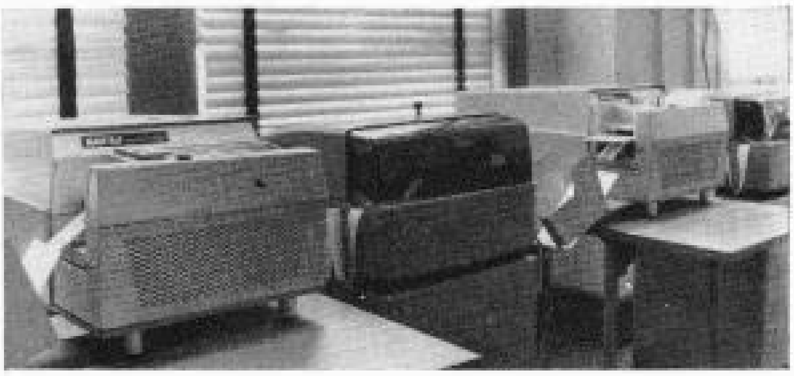

Figure 6—Western Union Punched Card Transmitters and 35 ROTRs Are Used to Convert Punched Card Data to 8-level Punched Paper Tape. This Prepares Our Input Data for Up-Dating and Recording our McGraw Edison AMUs.

Communications Center Operation

Our Communications Center in Tacoma encompasses several operating activities. The network control operation, shown in Figure 5, is a 24 hour per day, 6 days per week activity. Network Control provides monitoring, testing and control functions for the West Coast portion of the Weyerhaeuser Data Network and provides functional control for the Chicago and Philadelphia Centers.

The Communication Center includes 300 AMUs, which are updated and recorded annually, for the preparation and maintenance activity. From 200 to 400 orders are processed daily in Weyerhaeuser's Order Entry System. The output of the system is monitored and printed out at the teletype stations in the Communications Center.

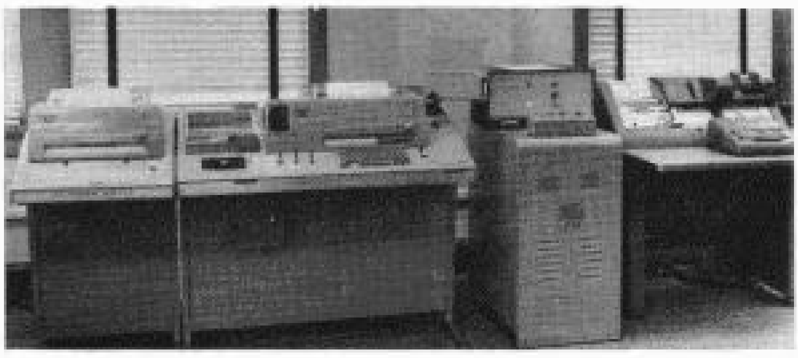

Figure 7—A Typical Full Station—Equipped with a standard Western Union Plan 137-A station, an Oneida Translator and an IBM 026 Keypunch

Figure 5—Tacoma, Washington Network Control—Teleprinter Monitoring and Control Area

Implementation of Punched Card Send and Receive Terminals

A number of our stations are now being equipped with Western Union's Punched Card Transmitters to enhance the station's capability of sending and receiving punched cards, in addition to the regular features of the Plan 137-A teletype station. A typical full station terminal, shown in Figure 7, consists of a standard Plan 137-A station with an Oneida Translator (ASCII—Hollerith) and an IBM 026 Keypunch. Again, Western Union designed the interface, shown in Figure 7, required for connection of the translator and keypunch with the teletype.

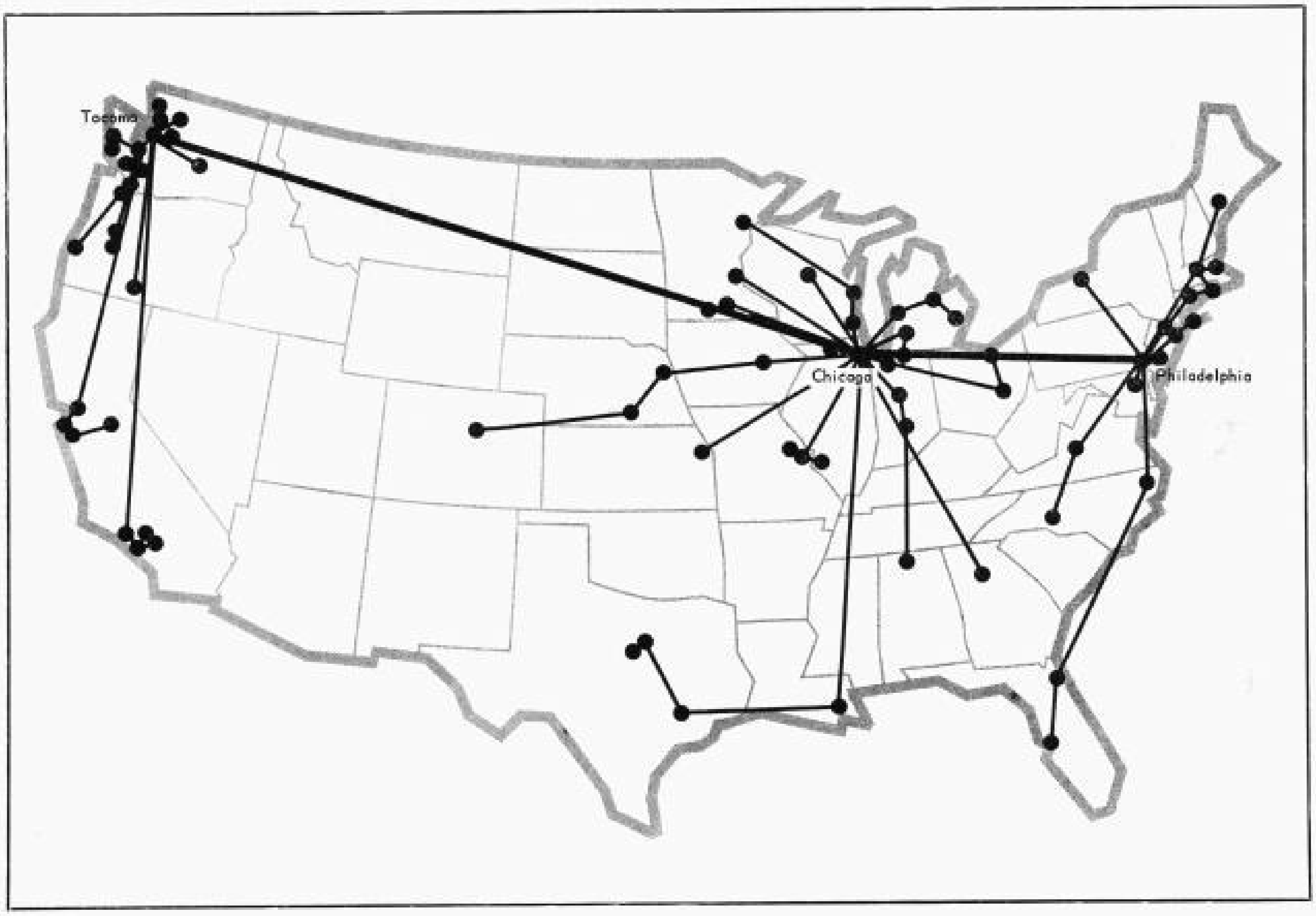

Figure 8—Weyerhaeuser Data Network

Figure 9—Computing Operators Control Area in Our Computer Facility, which contains four G.E. 635 Computers in Weyerhaeuser Headquarters at Tacoma, Washington

Summary

Our network shown in Figure 8 is dedicated to giving our managers instant access to electronic data related to any phase of their responsibility, for fast decision-making based on the most accurate, timely factual support available.

To meet this objective, our communications network must certainly continue to become "bigger and better." Presently we use about sixty 180 baud channels with anywhere from one to five stations per channel. On many of these channels our daily volume exceeds 500,000 characters sent and received. Our Computer Facility at headquarters in Tacoma, Wash. is shown in Figure 9.

We also know that in the future, the need for special "tailor-made" applications of our network will arise again and again. We share the challenge of meeting these needs with those who provide our communications network equipment and services. ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■

Upper Management Summarizes Our Accomplishments at the Annual Stockholders' Meeting

Editor's Note: The following remarks were extracted from the remarks of the President and Executive Vice Presidents at the annual stockholders' meeting at San Francisco, Calif., on April 9, 1969.

Russell W. McFall, Chairman and President:

This is a particularly important annual meeting because it comes after a most significant year—a year I consider to be the turning point in this Company's history. . . . .

. . . . . . Earl Hilburn will talk about the program to restructure our operations . . . .

Jerry Hoyt will then tell you about the integration of our planning, engineering and marketing efforts to create entirely new communication capabilities. . . . .

. . . . . . This will, I hope, give you a good idea of the new role Western Union will play as the national record communication system.

I am pleased to introduce Mr. Earl Hilburn, Executive Vice President.

Mr. Hilburn:

These are days of rapid change for all of us. . . . . Technological innovations, together with rapidly developing requirements for new services, are forcing important changes in our national communications policies and in the competitive alignment of the equipment suppliers and common carriers. . . . .

We are currently setting up what we call our single-line organization.

Time, of course, does not permit a detailed review of each Vice Presidential function. However, I should like to touch on one—the National System Operation. . . . .

. . . . . . National System Operation which we have set up to manage Western Union's basic transmission network. . . . .

. . . . . . And when one considered the comparative lengths of the messages AUTODIN actually carries about twenty times the total traffic moved through the public message system.

The triangles you see show the key centers of the Advanced Record System of the General Services Administration, another very large government system.

Western Union's ISCS computer centers, ... will form the new integrated message switching system, ...

. . . . . . The National System Operation will carry out the engineering, planning, installation and operation of all microwave and leased trunk transmission facilities. It will operate and maintain the AUTODIN and Advanced Record System computer centers, the Bomb Alarm System, and, after the initial engineering "shake down," the Western Union ISCS computer centers at New York, Chicago, San Francisco and Atlanta; and the SICOM computer center at Mahwah New Jersey.

NSO will be a service organization, supplying wholesale communications and computer center operations services to the eighteen areas.

Apart from what we are doing to restructure our management organization for more efficient total Company operation, we are automating a great many of our internal administrative activities—a job that could be done only with the aid of computers because of the volume and complexity of the data involved. Time limitations prevent my mentioning more than two of these.

EDITS, which stands for Electronic Data Information Technical Service, is now operating in 60 major cities and being expanded on a nationwide plan. It records every service malfunction of some 80,000 pieces of equipment, and provides a weekly report of outages, restoral times and preventative maintenance calls; thus permitting your management to critically assess the quality of service being provided to any particular customer or to any given geographical area.

Our Productivity Evaluation Program, called PEP, is also helping your management to maintain a closer watch on plant costs. This computer-produced report now measures the costs and effectiveness of our manpower in terms of the ratio of maintenance effort to invested capital by location, and the results are distributed monthly to both headquarters and our field forces for review and action.

By comparing the quality of service as indicated by EDITS with the cost of the maintenance effort as reported by PEP, we can properly evaluate the effectiveness of the local manager.

What we are now doing organizationally and procedurally will appreciably improve the over-all operating performance of the field operations at Western Union in 1969, and its effects will be even more evident in 1970.

Under President McFall's personal direction, a balance was achieved between these veterans and new people skilled in the application of computers to both communications and management information systems. It is a transition that has given the Company a greatly strengthened management capability. With a top-level decision-making team whose average age is now about 48 years, I think we can say, with confidence, that Western Union is once again a young Company, an action Company, that is keeping pace with the challenging tomorrows that are now upon us.

I can assure you that we are moving toward a higher level of total management effectiveness and corporate profitability.

Mr. McFall:

Thank you, Earl. Now, I'd like to introduce Mr. Jerry Hoyt, executive vice president.

Mr. Hoyt:

These new competences have been added to the nationwide sales staff which had previously been developed in the telegraph business. We have added product and service planning experts and program management specialists—men who are trained to analyze customers' needs and to respond with creative solutions made possible by technological innovation from both within the Company and outside it. . . . .

We are now proceeding to develop service offerings to satisfy our expanding opportunities in accordance with a few simple concepts.

First—customers need not one service but a mix of several kinds of service. . . . .

Our second concept, deriving from the first, is that we wish to satisfy these customer needs by putting in place a modern, electronic, communication facility which is flexible enough to handle these high volume, medium volume, and low volume requirements in any mix, and without the necessity of investing in a completely new facility for each change in the customers' needs. In other words, we are developing a common, flexible, shared plant which can adapt to new service situations without undue operating costs or the danger of early obsolescence.

Our third concept, which is really a part of the second, is that we will modernize our existing plant in such a way that the older services such as telegrams can be handled by the same new facility which handles new services so that if new services prove attractive enough to continue to divert traffic from the telegram business, we will be able to utilize the unloaded facilities.

Our fourth concept is that we will pace our expansion by proceeding with each new service offering on a building block approach. Each service will be offered first on an experimental basis so that we can continually test our understanding of the market needs and to satisfy them without making expensive mistakes.

Parenthetically, I should remind you that Western Union has always been the dominant supplier of record message services in this country, and I want to assure you that we intend to retain our fair share of this market—even allowing for the time taken by this building block approach. . . . . .

We have put in place the first phase of our basic program. We have installed electronic switching equipment in 4 major centers: New York, San Francisco, Chicago and Atlanta—and we are presently using this equipment in offering new communication services across the country. These new services are large enough to be of real present value to the public.

The first of these services we call TCCS which is a short name for Telex Computer Communications Services. This service allows a teleprinter customer, such as a Telex user, to send messages not only to other Telex users as he has in the past, but now in addition, to TWX customers, to certain computer users, and to any individual via the telegram system.

A second service which we now have demonstrated is called Info-Com and it allows a customer to have the advantages of a privately controlled electronic communication system, except that by using our facilities he shares the expense with others and does not have to devote his valuable space and manpower to maintain his own equipment.

The third service which we have demonstrated we call SICOM which is really a special form of Info-Com, only this service is for the special benefit of the securities industry.

I am happy to report that all of these services are in place, are satisfying customers, and have demonstrated operating reliability of over 99%.

. . . .

In the meantime, our Telex services by themselves have continued to grow to nearly 30,000 subscribers by year end. The addition of 40,000 TWX subscribers, coupled with the computerized exchange systems which I have mentioned, will add a new quality of service for a very large segment of the public.

Mr. McFall:

We began with a changed concept of Western Union as a corporation. The first step was to recognize that we were no longer—could no longer afford to be—simply in the telegraph business. We were in the communications business.

The second step was to look at how we were in the communications business.

From the existing multiplicity of systems, we proposed to create one broad-based system. With such a system we could take advantage of the new business opportunities we saw before us. At the same time, we could solve many of the problems of our public message business.

The point is that all services would benefit from the creation of a single system. Each would be part of a communications capability more advanced, more sophisticated, and with greater capacity than could be justified by any individual service.

What made this concept economically and technologically feasible was the development in the last few years of large-scale computers. These computers can be utilized both for the development of shared-use systems and the modernization of our public message system.

First of all, let me explain what exactly the integrated single system is to be. It will be a system in which all services—from public message to high-speed data handling—use the same transmission and switching facilities. It will be a system in which compatible and interchangeable terminal equipment is used for all servces. It will be a system with built-in flexibility in designing for the customer's own needs—the modular concept—a system that permits growth as the customer's needs grow. In other words, with an integrated system the customer can progressively upgrade—from public message to higher speed switched services and from simple switched services to more sophisticated store-and-forward systems, or to any combination of services. . . . .

. . . . . . The key difference between the services other firms can offer and those we will be able to provide is an inter-exchange capability. In other words, the Western Union customer of the 1970's could have access to almost any individual or organization in the United States. He will be able to send and receive information from his own customers, his suppliers, outside sources of information, key industries other than his own—in fact, his system, interconnected to the public message system, will even provide him access to the general public. . . . .

. . . . . . What will be new and significant in the single system will be the capability of offering exchange interconnection between any and all customers. . . . .

That is why the acquision of TWX was so important to us. The combined Telex/TWX system will be the vehicle for his expanded exchange service. It will provide the broad base for the integrated system. . . . .

. . . . . . We propose to integrate the progress that has been made in management technology, information technology, and communications technology, and offer this capability to the business community. ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■

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Anniversaries
P.M.S.
Electronic Age
Telegraph Industry

Watts, W. H.: Morse, Pioneer of the Electronic Age
—The Sending of the First Public Telegram
Launched the Telegraph Industry

Western Union TECHNICAL REVIEW, Vol. 23, No. 2 (Spring 1969)
pp. 46-53

The 125th Anniversary of the sending of the first telegram is celebrated on May 24, 1969. The author, Bill Watts, has researched the early developments of the telegraph inventor. He has included a background of Samuel F. B. Morse, the inventor, and pointed up his capability as a portrait painter too.

This article summarizes the early concept of communications and its impact on Morse, the development of the Picture Frame and the Morse Key and Sounder and compares it to communications today and Western Union's new developments in communications systems and services.

PCM
T1 Carrier
D^4 Channels

De Witt, R. G. and Jones, D. E.: MINI-T and MAXI-T
—New PCM Terminals

Western Union TECHNICAL REVIEW, Vol. 23, No. 2 (Spring 1969)
pp. 54-63

MINI-T is a new Pulse Code Modulation terminal designed to provide minimum cost teleprinter channels on T1 type PCM lines for short-haul network branches.

MAXI-T is another PCM terminal designed for cost-effective long-haul operation.

Both terminals, designed by Western Union have many advantages.

Western Union has had live traffic at the prototype terminals and has proven the feasibility of MINI-T and MAXI-T.

Data Circuits
Quality Assurance
Circuit Evaluation
Continuous Monitoring

Thomas, John: Western Union Requires Continuous Quality Monitoring of Telegraph and Data Circuits

Western Union TECHNICAL REVIEW, Vol. 23, No. 2 (Spring 1969)
pp. 64-71

Western Union has found a device called ACCESS, Automatic Communications Circuit Evaluation and Sensory System, which takes a statistical sampling, while monitoring large blocks of communications circuits to obtain qualitative data related to specific parameters of the traffic on each channel.

This system, ACCESS 100D, was designed by Digitech, Inc. of Ridgefield, Conn. contains a Circuit Scanner which allows the system analyzers to measure a multiple number of circuits on a time-shared basis. The results of each circuit analysis are printed out in an ACCESS Printout described in detail in this article.

Switching System
Solid State Selector
Plan 137-A
Punched Card Transmitter

Our Customer Says: W. R. MacDonald, Manager of Weyerhaeuser Company
"Instant Circuit Assurance of Weyerhaeuser's Order Entry System made possible with Western Union's Solid State Selector."

Western Union TECHNICAL REVIEW, Vol. 23, No. 2 (Spring 1969)
pp. 72-79

This article was written by the Manager of Telecommunications Operation at Weyerhaeuser, W. R. MacDonald. It described the need for a Computerized Switching System and points up the benefits of Western Union's Solid State Selector in circuit assurance when polling stations for their Order Entry System.

Western Union's Punched Card Transmitter and Western Union's Communication Line Terminal are described.

Publication Expansion to Meet Our Company Growth

The realignment of top management in engineering has encouraged our technical publications effort to expand productions, to meet the demands of Western Union's new objectives.

The TECHNICAL REVIEW has served this effort in a very vital way for the past 22 years. Now, in 1969, we recognize this one publication "needs to" and "can do" more things. In May 1969 a primer to the TECHNICAL REVIEW will be published, which will be used to educate the new technical employees in the basic technology related to our company objectives. This primer will be identified as the Western Union Education Bulletin. The first two issues:

Bulletin #101—Basic Concepts of Switching
" 102—Samuel F. B. Morse—Yankee Portrait Artist

will be released on May 1, 1969 for Western Union employees only. Requests for these bulletins may be sent to:

The Editor
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The TECHNICAL REVIEW is also being expanded by an additional "Special Issue" which will be published May 25, 1969. This special issue will be devoted to the Advanced Record System designed for G.S.A.—and will document new techniques developed by Western Union in the solution of fundamental record communication system problems.

Mary C. Killilea, Editor