INDUSTRIAL DATA PROCESSING APPLICATIONS REPORT

Applications	Car Movement Information System
Type of Industry	Railroad
Name of User	New York Central Railroad New York, N. Y.

Equipment Used	Collins 8400 Communications Computer
	Univac 418 Computer System
	IBM 1401 Computer System (Two)
	IBM 7074 Computer System
	IBM 7010 Computer System
	Teletype Model RO 28, ASR 28, and ROTR 28 Terminals
	Navigation Computer Co. Intercouplers
	IBM 026 Card Punch-Readers
	Data Display DD-10 Units

Synopsis

Keeping track of car movements is one of the major problems facing railroads. At the New York Central, a Collins 8400 Communications Computer is at the center of a communications network that supplies information on 50,000 cars every day.

The car movement information system is made up of four computer centers -- two in New York City, one in Detroit and one in Buffalo, N. Y. Data Central, in New York, controls the receipt and retransmission of some 14 million characters of information daily. The Transportation Computer Center, also in New York, uses an IBM 7010 Computer System to provide to customers accurate information on the 110,000 freight cars that may be on-line at any one time. In Detroit, a Univac 418 Computer System takes care of waybill handling and information processing. Two IBM 1401 Computer Systems, along with an IBM 7074 Computer System in Buffalo, perform accounting and sales operations.

The New York Central is presently operating an integrated information system based on the use of a variety of computing equipment. In New York City a Collins C-8401 switching computer is the heart of a communications center known as Data Central. The communications center is tied in to the Transportation Computer Center, also in New York City, which uses an IBM 7010 computer. Also included in the system is a Univac 418 computer in Detroit. In Buffalo, N.Y., the Central has two IBM 1401 computers and an IBM 7074. Information prepared on magnetic tape at the New York City installation is sent to Buffalo by mail for processing.

An integral part of the New York Central information system is a direct distance dial telephone network, called Tele Central, that covers 10,352 telephones in 406 cities connected to 47 telephone switchboards.

Since 1962 the New York Central has spent $6 million on research, development, installation and operation of its communications and computers systems.

This integrated information system allows the New York Central to have maximum control over the movement of approximately 800 freight trains a day involving about 50,000 cars. This amounts to more than a quarter of a million trains and 18 million cars a year. At any given time there are more than 110,000 freight cars on the System.

Data Central, the communications center, acts as a classification and distribution point for all messages and data transmitted through the railroad's 10,000 mile system. There are 259 message sending and receiving points tied together through 57,764 miles of circuits under the control of Data Central. Each day this communications center handles 14 million characters of information.

Car movement information is received by Data Central and is then transferred to the Transportation Computer Center which provides the railroad's customer car tracing center with instantaneous, accurate information on the 110,000 freight cars that might be on-line.

The Transportation Computer Center provides a readily accessible picture of freight operations. It provides information on the daily location of specially assigned and specially equipped cars. It also establishes daily inventories by type and location of all cars on the Central's property and gives daily summaries of all trains operated, cars loaded and cars interchanged with other roads.
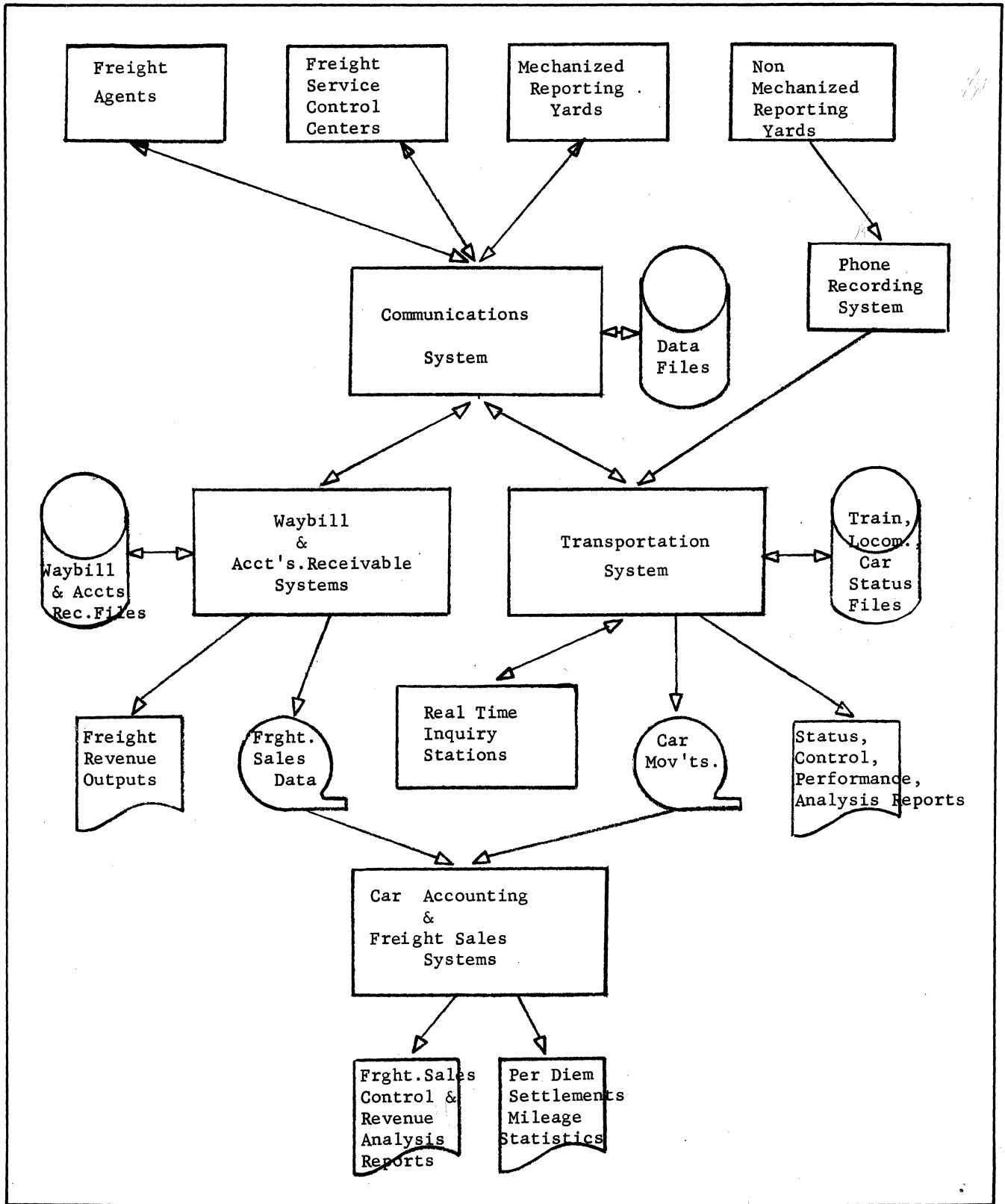
EDP at New York Central

In 1956 the New York Central installed its first mechanized car reporting system consisting of a yard-to-yard teletype network and punched card equipment. A card was punched for each card in the yard. As cars left the yard the corresponding punched card data was transmitted to the next yard. A copy of this was also transmitted to a central service bureau.

This system enabled advance yards to carry out their operations more efficiently. It also established four centrally located service bureaus that had on file complete information on car movements.

Each bureau prepared a complete record of all car movements reported during the previous 24-hour period. These reports were then distributed to the yards and to freight sales offices to serve as a permanent record of movement and to aid in handling inquiries.

The service bureaus would then take tapes -- a copy of transmitted data -- and convert them into punched cards. When a customer inquired about car status a clerk would search through a card file manually to find the needed information. This operation was successful but a time lag of four to eight hours existed between the time a consist (train message) was transmitted and the time information was available in the card file.

Freight
Agents

Freight
Service
Control
Centers

Mechanized
Reporting .
Yards

Non
Mechanized
Reporting
Yards

Communications
System

Data
Files

Phone
Recording
System

Waybill
&
Acct's.Receivable
Systems

Waybill
& Accts
Rec.Files

Transportation
System

Train,
Locom.
Car
Status
Files

Freight
Revenue
Outputs

Frght.
Sales
Data

Real Time
Inquiry
Stations

Car
Mov'ts.

Status,
Control,
Performance,
Analysis Reports

Car   Accounting
&
Freight Sales
Systems

Frght.Sales
Control &
Revenue
Analysis
Reports

Per Diem
Settlements
Mileage
Statistics

CAR MOVEMENT INFORMATION SYSTEM

In 1960 the Central installed an IBM 305 RAMAC (Random Method Access) computer to help speed up the process. This reduced the time lag mentioned above to about one and a half hours. It also enabled an operator to receive typeouts of car movement information within seconds instead of searching manually through a card file.

As the need for more comprehensive reporting grew, the Central installed an IBM 1410 computer system. The 1410 was eventually replaced by the present system.

Data Central

The heart of the New York Central's data communication network is a Collins C-8401 switching computer manufactured by the Collins Radio Co. Connected to the communications center are over 57,000 miles of circuits that tie in 259 transmitting and receiving stations. The longest circuit is approximately 1,500 miles in length.

Remote station equipment consists of teletypewriter and/or punched card transmitting and receiving equipment. The teletypewriters are model 28s and the card equipment consists of Navigation Computer Co. intercouplers with IBM 026 card punch-readers. The use of paper tape is restricted to the administrative portion of the network. Direct card-to-card transmission is utilized in the car reporting network. This is implemented by a New York Central developed translator called an intercoupler that enables card readers and card punches to be connected directly to the teletype lines. The intercoupler not only converts codes but makes format and character conversions. Conventional teletypewriters are coupled to the lines to provide page copy of incoming and outgoing card transmissions.

The switching center consists of input/output registers, a dual level memory, disc files, magnetic tape stands, a high speed printer, a console and a high speed tape input and output. All of the main components of the system are duplicated and connected to form a fully backed up on-line system. Teletype inputs are connected directly to the input/output registers of the C-8401 switching computer without the need of buffers or conversion equipment.

The basic input in the car movement system begins with the movement of cars in trains outbound from one of the "mechanized car reporting yards." As cars are switched into train sequence, yard clerks key punch appropriate car movement data into IBM cards. Source documents used by the yard clerks are waybills (the railroad's routing slip). These waybills are forwarded with the cars as they leave as part of the outbound train for destination. The cards are used to construct "consists" which are transmitted to the next yard. This advance notice alerts the next yard of the train's physical make-up, facilitating the handling of the train upon its arrival.

These consists are passed through Data Central where they are automatically re-directed to the proper yards. Information contained in the consists is recorded on magnetic tape and forwarded to the Transportation Computer Center for edit processing and posting to random access disc files. As cars move in and out of yards, current data is recorded in files. As the cars move off line to other roads, record areas are updated and closed out.

The input lines are scanned to detect a valid start bit of the first character in a message and the remaining bits are synchronized for reception. Each incoming character is received in the same manner, thus overcoming any distortion in the transmission.

The dual level memory consists of a high speed unit of 1,024 thirty-six bit words containing the logics of the system and a main memory that contains all tables and special instructions.

The first part of a message (the header) is interpreted and passed on through the system. If outgoing lines are busy, the message is stored in a disc file until the lines become available, at which
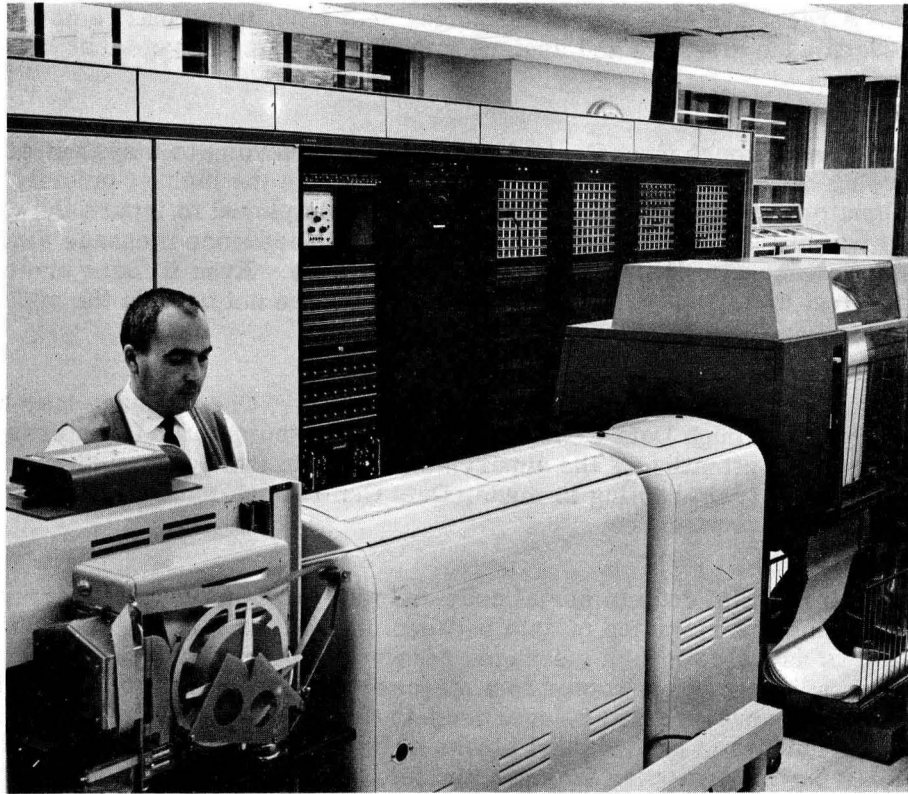
COLLINS 8400 COMMUNICATIONS COMPUTER AND ASSOCIATED
EQUIPMENT IN DATA CENTRAL.

time it is immediately sent out. A single message may have a number of addresses but it is stored in the disc files only once. Short messages are completely received before being sent out to their destination. Longer messages are started on their retransmission as soon as a sufficient number of characters has been received at Data Central and an output line is available. This allows maximum use of outgoing circuits.

Tape units associated with Data Central serve several purposes. As each message is received, information from the header of the message which consists of the origin station identification, the destinations' stations addresses, the length of the message, time in, time out, message number and Data Central index number are stored on a logging tape. This tape controls operations within the center and is also used for future studies. A tape unit also handles overflow requirements. For example, if a group of remote stations is out of service, traffic can be routed to the overflow tape for future transmissions. Historical tape files also provide for long term message storage.

The disc file contains sufficient space for storage of approximately 20 million characters -- the estimated traffic for 30 hours. Messages received within the previous 30-hour period can be retrieved from the disc files.

Data Central also uses a printer capable of printing 600 lines a minute. It provides hard copy print out of messages originally written on magnetic tape, and it is used extensively for diagnostic procedures.

Automatic message accounting is carried out by the Collins C-8401 processor. A number is assigned to each message received at Data Central and to each message transmitted from the com-

munications center. A record is also kept of messages sent from individual remote stations. The processor acknowledges each message and assigns a number to the message that is used for message retrieval.

Messages switched through Data Central are handled according to a system of priorities. All service messages going out of Data Centra automatically become the highest priority without the need for any special designator on the message. Priority is also employed to insure the arrival of messages before the arrival of trains at a particular station. A precedence message arriving on an output line automatically advances to the head of the outgoing queue. Even if there are other messages waiting it will be the first to be sent out. Priority interrupts are not used in the communications system.

Three alphabetic characters designate station addresses. One message may have several addresses and will be routed through Data Central to the stations indicated. If a message has an invalid address, it is brought to the attention of the supervisor. A train symbol may also be used as an address. Thus, if a change in train routing is made, Data Central can make the change without affecting remote station operating procedures.

Conversion from parallel code to serial code and vice versa is done concurrently with message switching, permitting transmission of data between unlike terminal devices. In the car reporting operation this works as follows: car messages received by Data Central are recognized by a special code in their headings and are routed to a magnetic tape which is used as the input to the car reporting computer. A conversion from 5-level code to 7-level BCD is made, and the teletypewriter messages are formed into records and blocks of the correct length for computer input. Conversely, information from the computer is converted into teletype code and sent to stations on the line.

Inputs to Data Central consist of teletypewriters, punched card devices and magnetic tape units. Data Central is not used merely to link one piece of equipment with another. The system merges the five basic categories of equipment, data processing, data originating, data transmission, conversion equipment and output devices into a single system.

Transportation Computer Center
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The Transportation Computer Center provides the railroad's customer car tracing center with instantaneous accurate information on the 110,000 freight cars that may be on-line at any one time. An IBM 7010 computer records about 100,000 car movements a day. High speed disc files are used to record data relating to car movements and provide a current record of almost all freight cars, both loaded and empty. The disc file record enables the New York Central to keep track of what traffic needs to be moved, what trains are moving, and where empty cars are.

Most of the input data to the Transportation Computer Center is transmitted from mechanized yards through Data Central. This data consists of waybills, train consists, interchange reports and car delay reports and is received on magnetic tape from Data Central.

All data received is edited for validity and completeness and any invalid record is rejected by the computer. When a record is rejected, it is punched onto a card and printed exactly as received. It is then examined, corrected and fed back into the IBM 7010 computer. If an invalid record cannot be corrected, the yard that originated the message is contacted to attain the proper information.

Car movement messages that pass the edit phase are posted to the active car file stored on IBM 2302 disc files. Magnetic tapes are used to record each transaction received. Using this information, reports are printed and a special tape is prepared for the Auditor of Car Accounts.

Another report produced shows the flow of selected cars at interchange points and records the number of loaded cars received and empty cars delivered to a connecting point.

The Transportation Computer Center also enables customer queries to be answered by the use of a data display device, Model DD-10, manufactured by Data Display, Inc. An operator keys in an identifying number and information pertaining to car movements is immediately displayed on the screen.

The car files also represent a current inventory and are used to produce a daily analysis of movements of specially equipped cars. This report is also used to prepare car allocations and to determine car assignments. In addition, each day an inventory report is prepared that shows a complete count of cars on line and those cars that are in for repairs.

The messages received at the Transportation Computer Center are outbound messages, arrival notices, interchange receipts and deliveries, and car status reports.
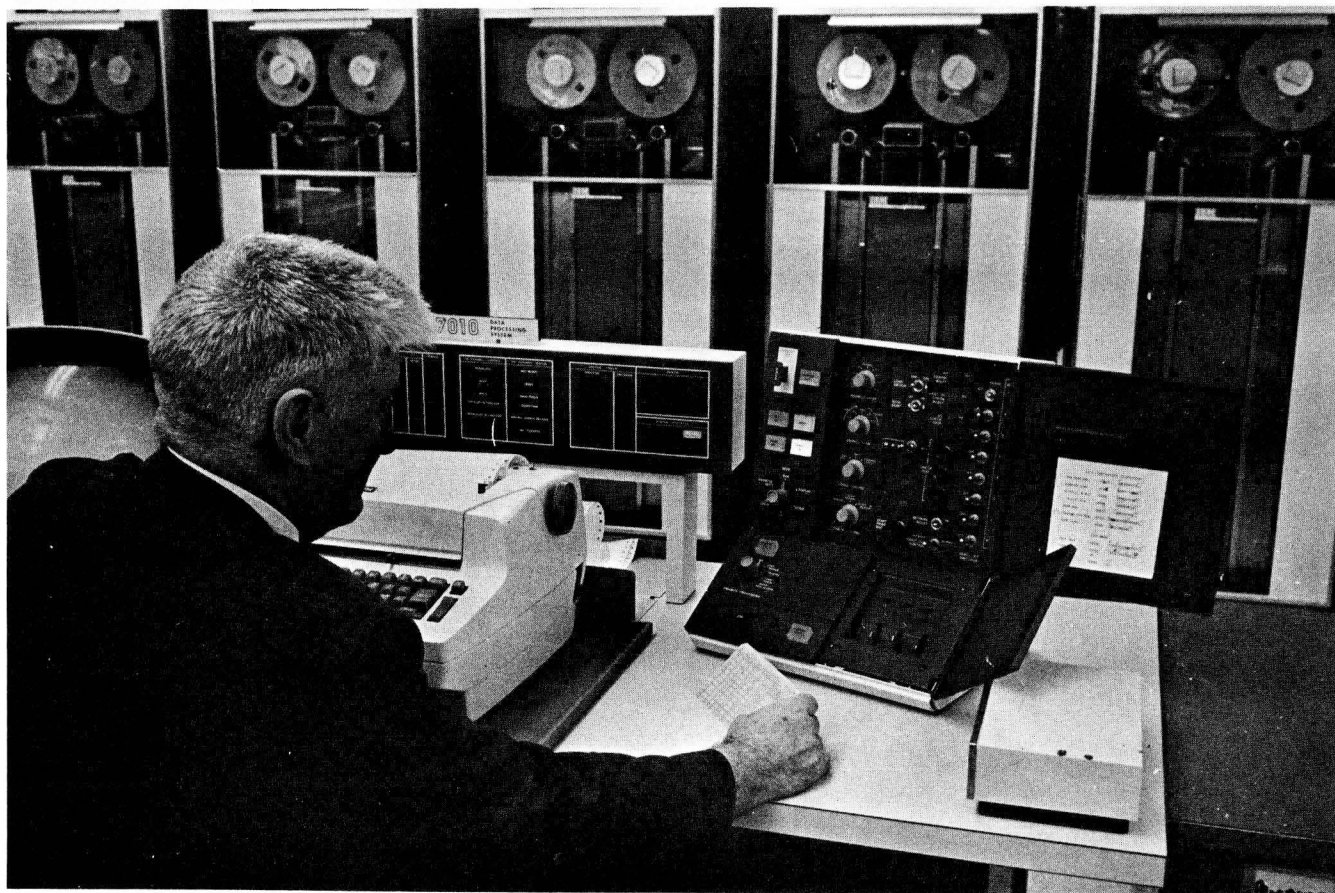

IBM 7010 DATA PROCESSING SYSTEM IN THE TRANSPORTATION COMPUTER CENTER

Waybill Handling and Information Processing (WHIP)

Over 125 waybilling points equipped with Model 28 teletype equipment furnish the initial input to the system. Data is transmitted over the communications network through Data Central to and from the Computer Center in Detroit. In Detroit, a Univac 418 computer performs appropriate edits and posts waybill data on a magnetic drum for subsequent retrieval and processing. Output is generated for eight central locations strategically located along the Central's lines.

When a shipping order is received by one of the railroad's agencies, the billing clerk prepares a hard copy waybill on a Model 28 teletype producing, along with the hard copy waybill, a 5-channel paper tape with machine-language representation of each keystroke appearing on the waybill itself. The original hard copy waybill moves with the railroad car it represents to destination. A copy is kept in the agency and, when an appropriate batch is accumulated, is forwarded to one of eight accounting control points where the waybills are filed by months for reference purposes. When a batch of waybills, perhaps 15 to 20, has been prepared, data on paper tape is transmitted from the agency billing point to the central computer in Detroit. This transmission occurs on a real-time basis and, as messages are received in the Univac 418 computer, the data is edited and processed for the generation of output data to the eight central locations.
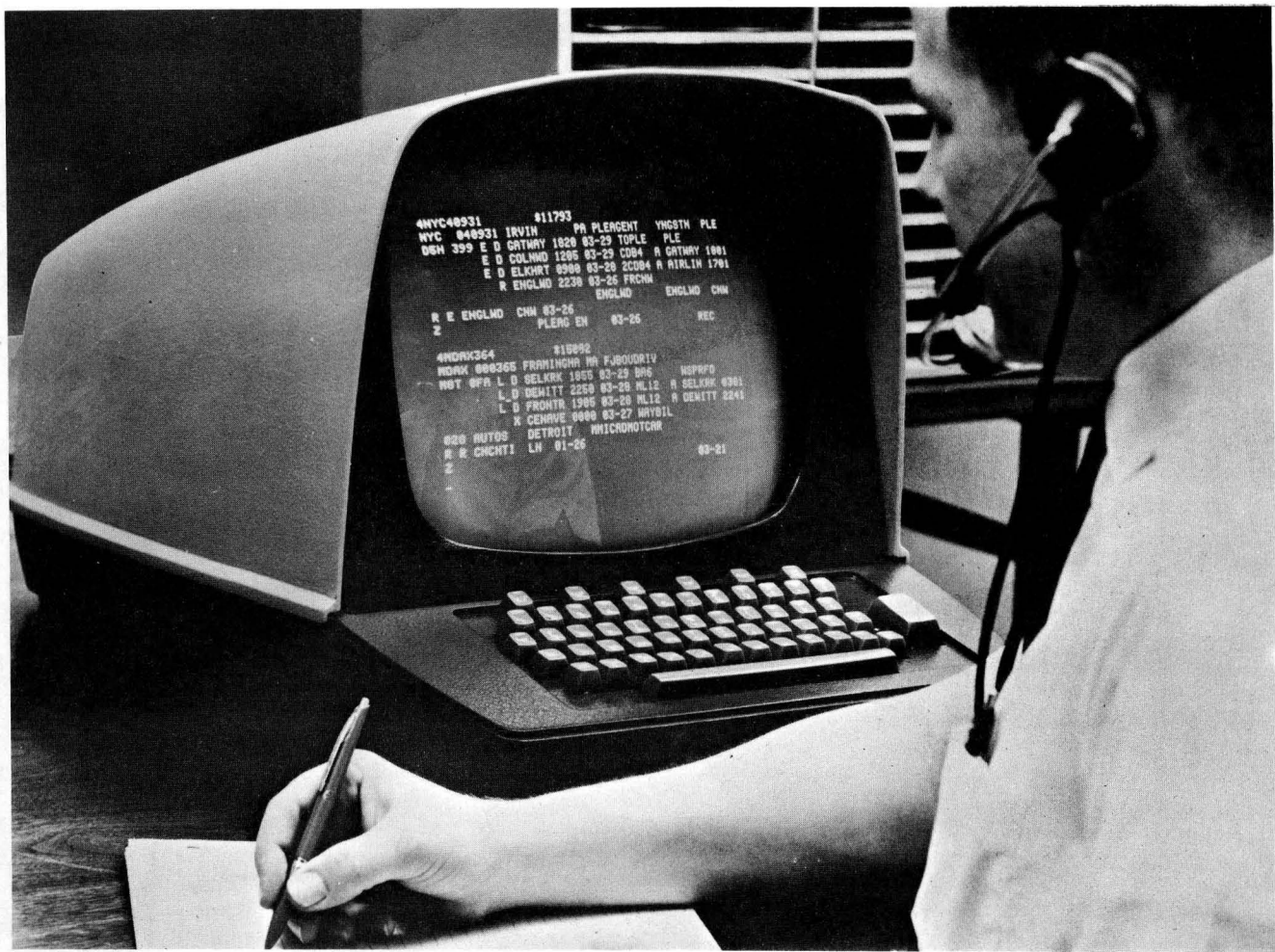
DATA DISPLAY DEVICE IN CAR TRACING CENTER PROVIDES FREIGHT CAR INFORMATION

After editing has been accomplished, processing proceeds in the following manner:

1. A car movement record is transmitted to the appropriate mechanized car reporting yard for use in the yard-to-yard consist transmission. A duplicate record is transmitted to the Transportation Computer Center in New York for use in controlling the yard-to-yard activity and preparing transportation reports for system transportation management.

2. A sales record is generated and transmitted to the railroad's Sales Computer at Buffalo for use in the preparation of marketing and freight sales control and analytical reports.

3. If the waybill is a prepaid bill, a freight bill message and patron card message will be transmitted to one of the eight centralized control points where a hard copy freight bill will be prepared on a teletype machine for mailing to the customer.

4. Posting is made to an outstanding account receivable file on the magnetic storage drum for controlling cash receivables from customers for freight services. If the waybill is not prepaid, the account receivable processing is not done as above; a record is posted to a car enroute file, providing control over waybills in transit. This also permits re-capture of waybill data upon arrival of the car in order to prepare the necessary freight bill and account receivable records.

5. In addition to the above, the waybill data is recorded on magnetic tape in a format required by the Central's Auditor of Freight Revenues. The data is used in station accounting control and for preparing interline settlement bills between railroads.

When waybills fail to pass the initial edit, the computer generates a re-bill message and transmits this message back to the billing point, indicating to the biller the particular waybill which is in error and the type of error creating the need for preparing a corrected bill.

In the case of collect (or non-prepaid) waybills, an arrival message is sent to the computer upon arrival of the car at destination. This message triggers the activity indicated above, dealing with the generation of freight bill and account receivable documents.

Buffalo Computer Center

The Buffalo Computer Center consists of two IBM 1401 computer systems and an IBM 7074 computer system. The functions performed at this center include car accounting, freight sales reporting, freight claim payments and statistics, and freight revenue analysis. To perform these operations a total of over 400 programs are used in the two computer systems.

The freight sales and marketing analysis operation uses car movements records on magnetic tape as its input. This tape is prepared in the New York computer center. Reports are produced covering such items as loaded car movements, freight traffic interchange statistics and salesman territory car movements.

The car accounting procedure also uses car movement records on magnetic tape for input as well as punched card data on such items as per diem credits, interchange and other records. Reports produced include historical car movement records, car location tallies, locomotive mileage and various billing and audit records.

The freight claim and freight revenue analysis operations provide statistics and other information used by salesmen and accounting personnel.

Tele Central

Integrated into the communication system is a direct distance dialing network, called Tele Central, that covers 406 cities.

Tele Central is a direct distance dial network with over 10,000 telephones connected to 47 switchboards. Each telephone in the network can be reached by dialing a three digit routing code plus the extension number. Equipment and circuits for Tele Central are leased by the New York Central from the Bell System.

Five current telephone directories are prepared by the communications headquarters in New York. These five directories (one for each district) cover the entire railroad. For each person listed in the directory there is a punched card with his name, title, department, office location, telephone extension number and teletype address code. A change in the directory is readied by preparing a new punched card. Thus, periodic corrections can be published without difficulty.

Tele Central enables freight sales personnel to request information on car movements from the New York Center. It also allows a shipper to find out the exact location of his shipment with a single telephone call. Coordinated with Data Central, the telephone network provides for an interchange of data among all points on the system. Locations outside the teletype network use Tele Central to report transactions directly to tape recorders at the Transportation Computer Center. Data is then punched on cards and entered into the computer.

Results and Future Plans

The present system used by the New York Central is a major step toward a total management information system. It has improved and speeded up communications and the processing of data and has established methods for preparing management reports from car movements information. Furthermore, it has decreased considerably the time lag between the time car movement reports are recorded and the time this information is available to the customer.

The four computer centers discussed above will be further integrated as new communications devices are developed. This will enable data to be transmitted between one center and the other at high speeds. Work has already begun toward this goal.