Automatic Call Recording and Accounting in the SATT System

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Introduction

Automatic Switching

When the first automatic telephone office was placed in public service at La Porte, Ind., in 1892, automatic switching and subscriber dialing became established facts. During the years following this notable event in the history of telephone communication, Automatic Electric Company through constant research and development of switching equipment and operating methods expanded the field of automatic switching from local exchange areas to suburban and toll networks. By 1910 operator toll dialing was introduced whereby originating toll operators were enabled to complete calls to automatic stations in distant towns by toll dialing.[1] Operator toll dialing was then expanded to provide switching of toll circuits through tandem and switching centers. During the period from 1920 to 1940, several regional automatic toll switching networks were established in various parts of the United States and Canada.

Although during that period operator toll dialing became an accepted method of toll switching, subscriber dialing of toll calls was not as yet available for several basic reasons, some of which were:

1. The numbering plans used by operators were not universal and therefore not suitable for public use.
2. If a universal numbering plan for toll switching had been available, common control switching equipment would have been required to make use of it.
3. All toll calls had to be recorded (ticketed) for billing purposes. This is one of the functions performed by toll operators.

The Director

With the introduction of the Director[2] in 1923 for the London, England, metropolitan area network universal numbering and common control operation became available for Strowger (step-by-step) automatic switching in local exchange networks. The Director also made available a number of other controls, and thus it became possible to design equipment suitable for subscriber dialing of short-haul and long-distance toll calls with automatic call recording.

Subscriber Dialed Automatic Toll Switching

In 1937, Régie des Télégraphes et des Téléphones (Belgian Telecommunication Authority) (R.T.T.) requested Automatique Electrique, S.A. (Belgian affiliate of the Automatic Electric Company) to present plans for subscriber national toll dialing with automatic recording (ticketing) of each dialed toll call. As a basic part of this undertaking, the R.T.T. had established a nation-wide area code numbering plan; see Figure 1.

The various common control facilities available in the Director provided the solution for all phases of this request, in-

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cluding automatic call recording (ticketing) with cost computation for each call; see Figure 2. The first installation of this system was made at Mons, Belgium, where it proved entirely satisfactory. A similar installation was placed in service at La Louviere in 1950.[3]

Further Developments

After the completion of the Belgian automatic toll ticketing plan in 1938, research was continued further to expand the automatic toll switching and call recording facilities contained therein. This resulted in a design which contained the following added facilities and methods of operation:

1. Detector (identifier) operation was arranged to provide subscriber dialing for party line subscribers up to five stations per line.

2. Central office toll call recording was arranged to permit the introduction of punched card accounting techniques, thereby making available complete automatic bill processing and accounting of toll messages.

Tee system resulting from the foregoing development is now referred to as the SATT (Strowger Automatic Toll Ticketing) system. When used with punched card accounting, this system is completely automatic from the dialing of toll calls by a subscriber to the printing of the bill for such calls.

A small trial unit containing most of the facilities in this system was installed in an office in the Los Angeles metropolitan network in 1944. Since that time

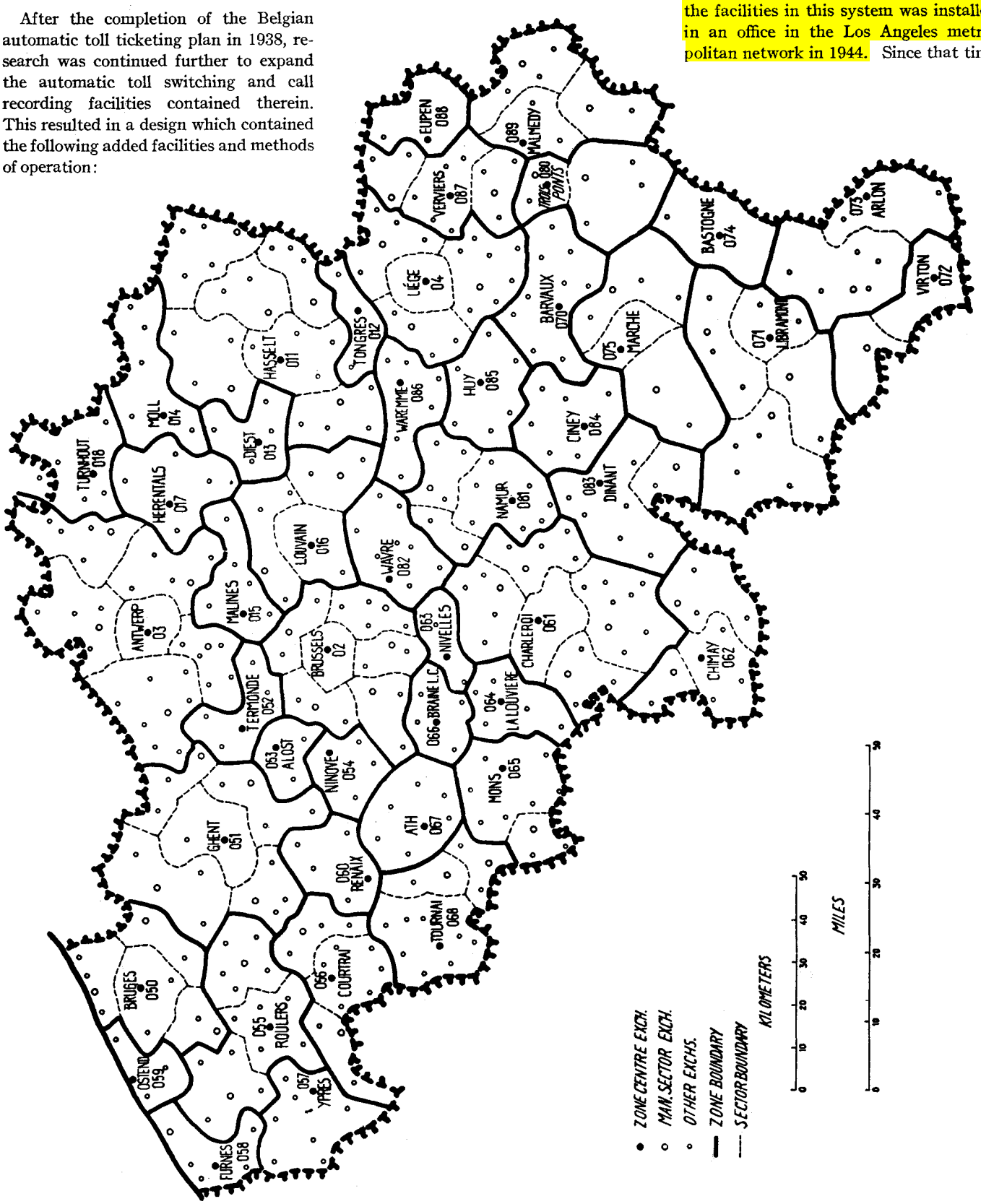

Figure 1. Map of Belgium showing national numbering plan areas with codes

Demandeur	Demandé	Date	
23745	02446070	15/3	0909
Heure	Tarif	Durée	Prix Total
12.1	6.00	15	3000

Figure 2 (left). Automatic toll ticket

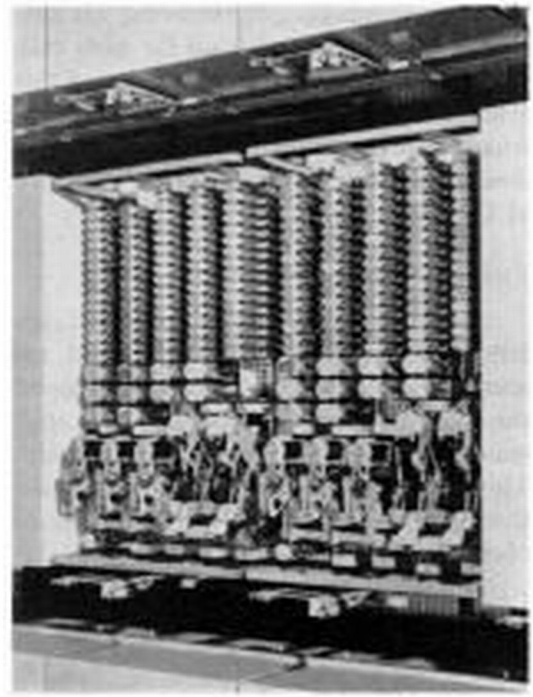

Figure 4 (right). Two ticketer units

SATT system facilities have been incorporated in several automatic central offices in the Chicago and Los Angeles metropolitan areas, thus providing subscriber dialing of short-haul toll calls.[4]

The subscriber dialing range will eventually cover the entire nation when the facilities of the gigantic Bell System project now in progress, generally referred to as nation-wide automatic switching,[5] become available to local and regional automatic networks. When this time arrives, offices having SATT facilities will find themselves prepared to take full and complete advantage of subscriber national toll dialing.

This paper describes in outline the equipment and the automatic call recording (ticketing) and accounting (bill processing) methods used in the SATT system.

SATT Components and Functions

SATT (type *A*) facilities are provided when the following basic components are added to Director-controlled local exchange equipment: 1. call recorder; 2. detector; 3. ticketer; 4. tabulator and tape perforator; and 5. dater-clock. The method of arranging these units in a Director office is shown in functional block diagram form in Figure 5.

The Components

The call recorder is composed of relays and rotary switches and is added to each Director. Its function is to assemble and transmit to the ticketer the following data for each toll call:

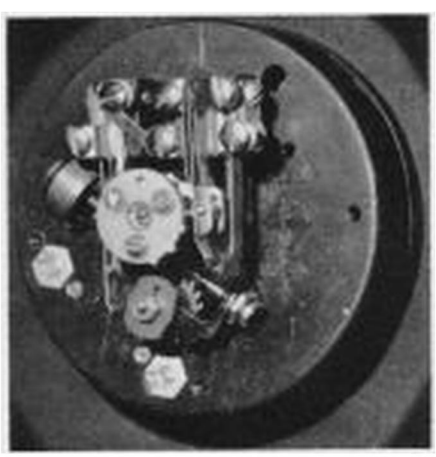

Figure 3. Identity dial

1. Calling station terminal number.
2. Class of service.
3. Called station directory number.
4. Rate index.
5. Director identity number.

These items are transmitted to a ticketer in codel code pulses when a toll connection is established.

The detector is composed of relays, rotary switches, and neon lamps. Its function is to detect, under the control of the call recorder, the terminal (connector) number of a station making a toll call. This unit is common to each exchange. The operating time for each detector cycle is about 100 milliseconds.

The ticketer is composed of relays and rotary switches; see Figure 4. The function of a ticketer is to store ticket data transmitted to it from a Director and to record conversation time when a called station answers. This call timing facility consists of a self-contained unit, which always starts from a zero position, thereby eliminating fractional errors resulting from fixed time pulses. A definite timing delay is also provided to permit a calling station to check if the correct called station has been obtained. This delay can be adjusted in 1-second steps from 3 to 10 seconds as desired by the operating company. Storage of conversation time is provided up to 5 hours. If a toll connection is kept established beyond this period, a supervisory trunk automatically extends the call to an operator for observation and action.

Each tabulator is a unit composed of relays and rotary switches. The function of a tabulator is to tabulate call data received from a ticketer, to add thereto the calling office code, tabulator identity number, date and clock time, and finally to produce a perforated tape record of each completed toll call. Permanently associated with each tabulator is a tape perforator similar to those used in telegraph services. Standard perforator tape is used. Each tabulator contains strapping facilities into which the code of the office unit in which it is located and the identity number of the tabulator are strapped.

The dater-clock is common to all tabulators in a central office and provides the date and clock time for each completed toll call. Clock time is expressed in Navy figures—the 24 hours of each day being numbered continuously instead of in two 12-hour cycles. It operates on a 4-year cycle so that the extra day in leap year is automatically provided for.

By a similar facility, ticket items can be transmitted to the tape in any sequence desired by the operating company when manual accounting by tickets is used. Regardless of the item sequence, tape perforation occurs in reverse order. After all items are recorded, the tabulator adds a start symbol. This arrangement permits the use of the tape from the outside of a storage reel when final accounting records are made, thus avoiding rewinding. As indicated in the next section, the initial record data of incompleted toll calls are always wiped out when the calling station hangs up. Therefore, the only recordings in the tape will be those of completed calls. Each call recording requires about 3 inches of tape.

Station Identity Dial

A basic facility of SATT service to party-line stations is provided by a station identity dial; see Figure 3. This is a standard dial to which has been added a pulsing arrangement which identifies up to five stations on a party line. This facility does not alter the normal mechanical structure or function of the dial.

In operation, this dial transmits station identity pulses during each pull, but these pulses are inserted between the regular dial pulses and do not in any way interfere with them. The Director contains a facility which records this station identity code. If the call is local, this recording is not used, but if the call is toll, it is transferred to the call recorder, Figure 5.

Therefore, when a call recorder tests for a calling station terminal number, it already knows what service a calling station has, that is, individual line or party line. If party line, it knows which station of a maximum of five on the line has dialed the call. It will, therefore, make the terminal number detection (identification) test accordingly.

SATT System Code

All call data transmitted and recorded in the SATT system consist of numerals in a code pattern referred to as the codel code. Each digit is represented by combinations of four elements for transmission pulses, storage relays, or tape perforations as shown in Table I.

When data from the call recorder are pulsed out to the ticketer (see the next section), each digit is composed of four high and low pulses. When digits are stored on relays, a codel relay group is used with the relays marked *W*, *X*, *Y*, and *Z*, which are operated for each digit as indicated in the table. The tape code is a 4-channel type with perforations in the same relative positions as the high pulses in each code digit, Figure 8. When a tape is processed, the start symbol is used to start transfer of tape data into either a ticket printer (manual accounting) or into a card punch (automatic accounting). The blank symbol is used to fill in the third office code digit space when combined 2-4 and 2-5 numbering is used in an exchange area.

SATT System Operation

This section deals with the automatic call recording (ticketing) facilities in the SATT (type *A*) system. The methods of establishing subscriber dialed speech connections and other functions are not described except as required to explain call recording operations. The outline of SATT components in the preceding section describes most functions of each component in more detail.

Call Recording from Party-Line Stations

The initial versions of the SATT system provided subscriber dialed toll service for individual line subscribers only. As relatively large portions of subscribers in telephone exchanges in the United States use party-line service, it became apparent that in order to make full use of the service and economic advantages of subscriber dialing which are available in the SATT system, service had to be provided for party-line as well as individual line stations.

Surveys of the independent operating field indicate that in most cases where party-line service is provided, it is of the 4-party type, although in a comparatively few cases 5-party service is also provided. The SATT equipment is therefore arranged for completely automatic individual and 5-party terminal per station automatic call recording.

Table I. Functional Chart of Codel Code Pulsing, Storage, and Tape Recording

	Pulse Position				Relays Operated				Tape Channel			
Digit	1	2	3	4	W.	X.	Y.	Z.	1	2	3	4
1	H	H	L	L	*	*			.	.		
2	H	L	H	L	*		*		.		.	
3	H	L	L	H	*			*	.			.
4	L	H	H	L		*	*			.	.	
5	L	H	L	H		*		*		.		.
6	L	L	H	H			*	*			.	.
7	H	L	L	L	*				.			
8	L	H	L	L		*				.		
9	L	L	H	L			*				.	
0	L	L	L	H				*				.
Start									.	.	.	.
Blank											.	.

Automatic Recording of Call Data

When a call is initiated in an automatic exchange containing SATT system facilities, it is extended to a Director which is composed of several common control units, Figure 5. After receiving dial tone, the calling subscriber dials the directory number of the called station. This is stored in the call register. If the office code portion of this number indicates that the terminating office is a toll point, the resulting directive (translation) obtained from the common translator will always establish a trunking path to the called office via a ticketer. This directive will also alert the call recorder. This unit of the Director assembles the major portion of the toll call data.

The call recorder upon being alerted first of all receives from the call register an indication as to whether the calling station is on an individual or party line, and if on a party line, which particular station on that line has initiated the call. The call recorder now calls for the common detector (identifier). As soon as the detector responds, the call recorder informs the detector in which particular group of station terminals it should search for the calling station. In the case of an office

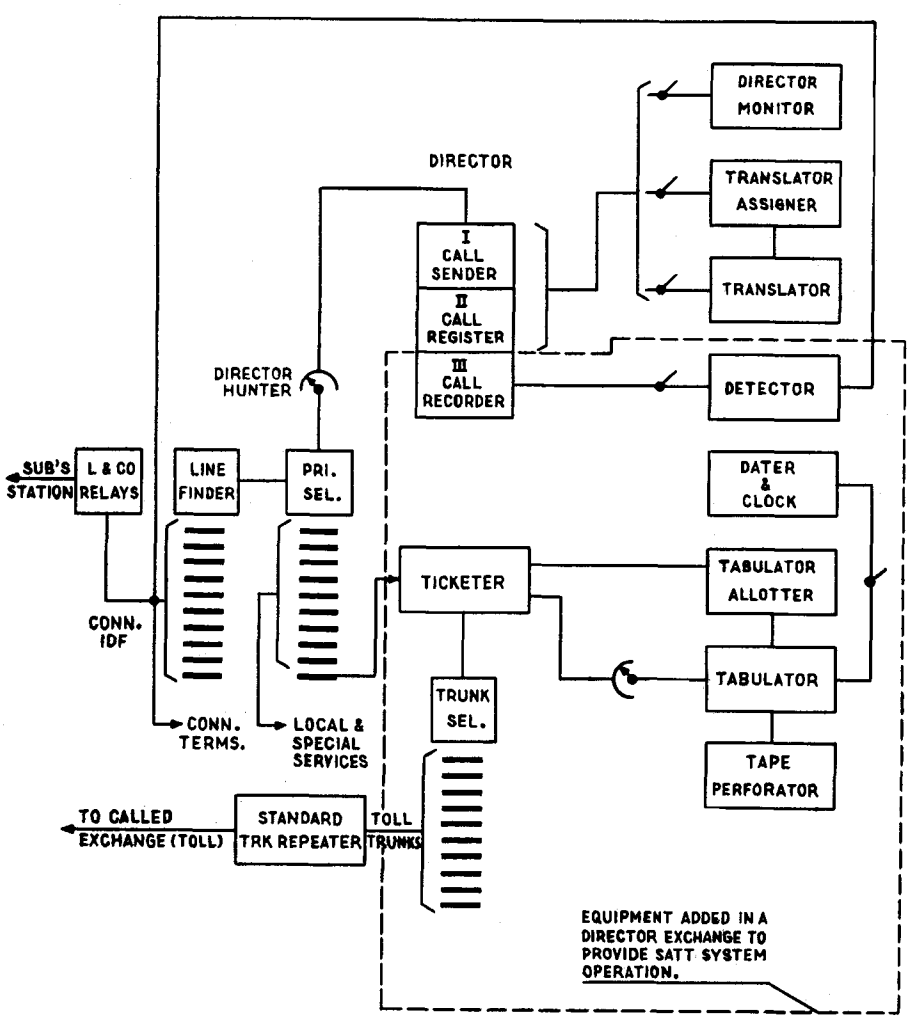

Figure 5. Central office SATT system functional block diagram

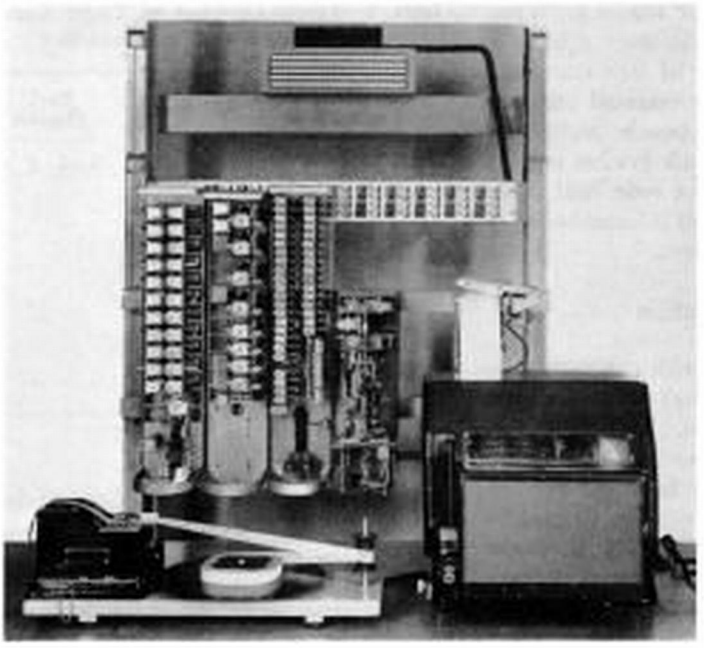

Figure 6 (left). Tape reader and ticket printer

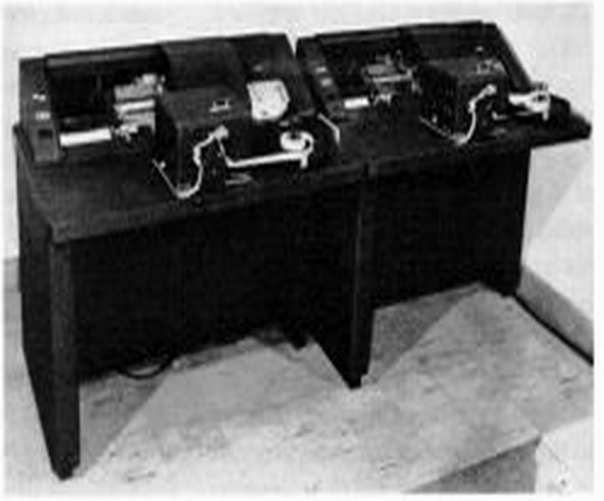

Figure 7 (above). Card punch with tape-to-card control unit

providing individual and 5-party service, this means one of six different number groups. The detector then tests in the indicated group for the terminal number of the calling station, and transmits this number to the call recorder where it is stored. The detector then releases.

The call sender unit of the Director will be establishing the desired connection while the foregoing cycle in the call recorder takes place. As soon as the call recorder has dismissed the detector, it will start sending the ticket data now available in the Director to the ticketer where it is stored. This transmission, which is in codel code, takes place simultaneously with the establishing of the trunk (speech path) connection to the called office.

The call data transmitted to the ticketer from the call recorder consists of the following:

1. Calling station terminal number.
2. Called station directory number.
3. Rate index.
4. Class of service.

In addition to these call items, the call recorder also transmits the identity number of the Director handling the call.

After a connection has been established to the called central office terminal, the Director releases. The calling station is now connected to the called station connector terminal via a ticketer in the originating office, and the call (ticket) particulars accumulated up to this point are written up (recorded) in the ticketer. At this stage, the call may result in a busy signal or no answer. Should this occur, the calling subscriber replaces the handset, whereupon all equipment involved in the connection is released, and the accumulated call data are wiped out.

Timing of Conversation

When a call is answered by a called station, timing of conversation begins after a fixed delay to permit the calling subscriber to ascertain that the correct called station has been obtained. The conversation time is recorded in minutes.

Tabulation of Call Data

When a conversation is completed, the calling subscriber replaces the handset. This results in the following operations:

1. All switching equipment and trunks held by the call are released except the ticketer which locks up and makes itself busy to other calls.
2. The ticketer calls for a tabulator via the tabulator assigner. The assigned tabulator connects itself to the calling ticketer.

The ticketer now transmits the following items to the tabulator where they are stored:

1. Calling station terminal number.
2. Called station directory number.
3. Rate index.
4. Class of service.
5. Conversation time.
6. Director identity number.
7. Ticketer identity number.

At the end of this transmission the ticketer is released, thereby removing its busy condition.

Final Call Data Recording

As soon as a tabulator has received the call data from a ticketer, its associated tape perforator starts to perforate the data into its tape. Such data may be, for instance, in the following sequence:

1. Ticketer identity number.
2. Director identity number.
3. Date.
4. Clock time.
5. Called station directory number.
6. Conversation time.
7. Rate index.
8. Class of service.
9. Calling station directory number.
10. Tabulator identity number.

To this series of items is always added a start symbol. This is followed by the restoration to normal of all tabulator components thus making the tabulator available for another call. The punched tape is automatically wound up on a storage reel from which it is removed periodically and forwarded to an accounting center for processing.

SATT Accounting (Bill Processing) Methods

General

A basic requirement in connection with the provision of short- and long-haul toll services to telephone subscribers is that of obtaining a ticket or call record for each completed call in order to enable the telephone company to bill the subscriber for this service. Therefore, in automatic networks without automatic toll call recording facilities, subscribers desiring toll connections are required to dial an operator so that the telephone company may obtain the data required to bill subscribers for such calls. Otherwise these connections could in many cases be subscriber dialed the same as local calls.

A manual toll ticket, as prepared by an operator, generally contains:

1. Date and clock time.
2. Calling station directory number.
3. Called station directory number.
4. Conversation time.

Items 1, 2, and 3 are recorded when the call is initiated and item 4 when the call is completed.

Completed toll tickets are forwarded to the accounting or commercial department of an operating company where they are put through a routine referred to as bill

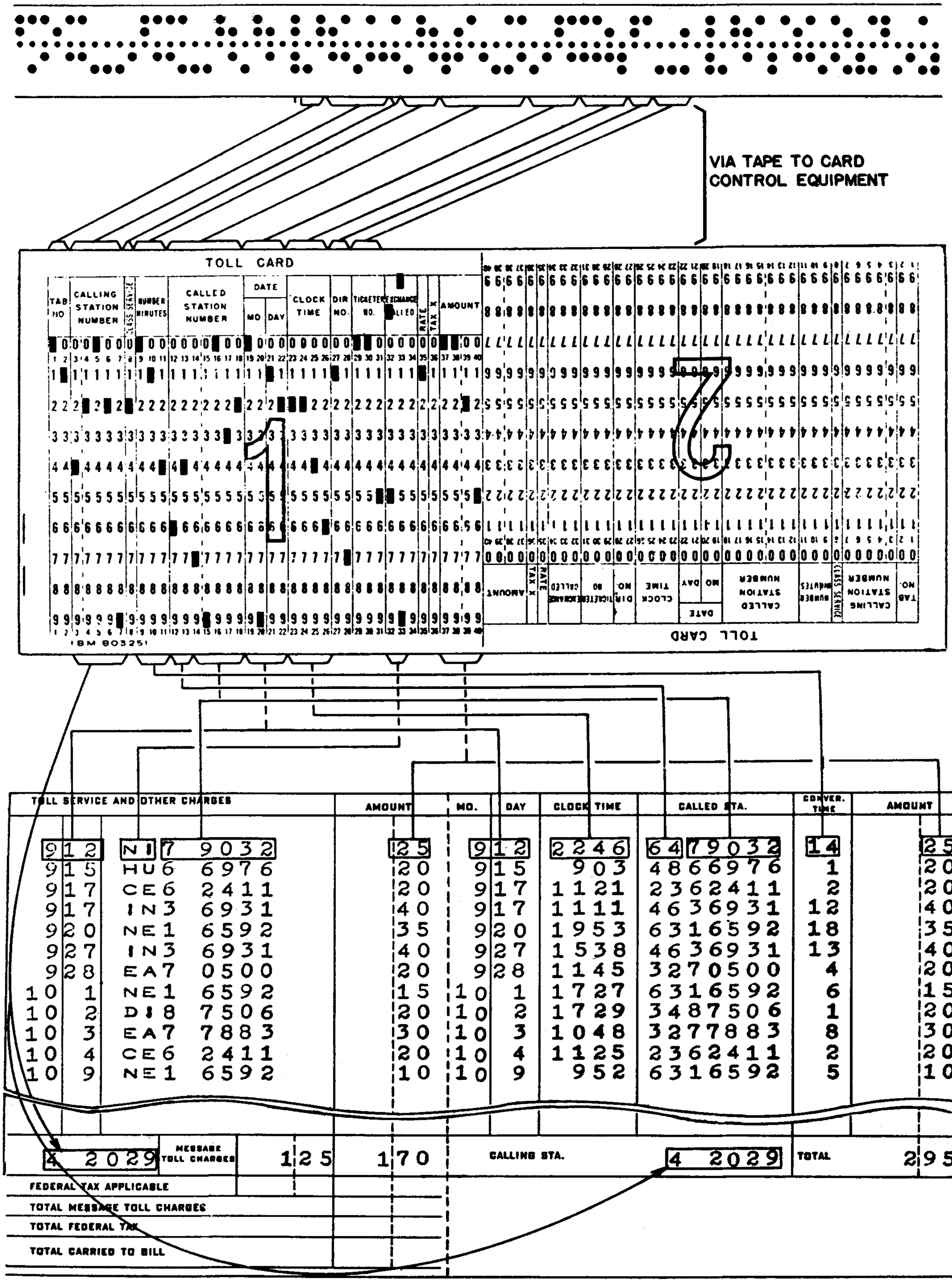

Figure 8. Block diagram of punched card tape-to-bill process

processing. This routine is to a large extent a manual procedure, consisting primarily of computing the cost of each call from the ticket data, adding federal (and sometimes local) taxes, and so forth. These calls are then transcribed to and added up on a toll service statement which is attached and added to the regular monthly bill. The amount of detail shown for each call is usually prescribed by the state or federal regulatory commissions under whose jurisdiction the telephone company operates.

Some of these regulatory bodies require all toll calls to be billed in more or less detail, while some permit calls within certain metropolitan areas to be reduced to message units. All message units are then added and bulk-billed for each billing period as one item without detail. In detail billing each call may show not only the called station, the date and total cost, but may also show rate and conversation time to permit subscribers to check each call in detail for themselves.

No matter what rules govern the manual toll billing process of an operating company, it is always a function which requires considerable organization details and manual labor. The use of various labor-saving devices has assisted in making manual accounting very efficient, but complete mechanization of this process will considerably reduce billing costs to telephone companies.

As described in previous sections, each toll call completed in a SATT system central office is recorded in a perforated tape. This tape is the equivalent of the call tickets obtained in manual operation and is therefore the primary record of each call.

Completed tapes from central offices are sent to an accounting center by mail or by other means. However, when trunk facilities are available, the tape data are also suitable for transmission by wire to an accounting center. This can in many cases speed up processing operations.

To obtain subscribers' toll statements from ticket tapes, two methods are available: manual or automatic bill processing.

Manual Processing

When it is desired to obtain subscribers' bills from SATT tapes by manual methods, a tape-to-ticket assembly is provided; see Figure 6. This assembly consists of a printer controlled by a tape reader. This assembly prints a standard size toll ticket for each call contained in the tape. These tickets are then processed in the same manner as regular manual tickets.

If desired, this process can be made partly automatic. A unit termed a computer can be included with the tape reader. When this is done, the cost of each call will be automatically computed from the tape data and printed on the ticket in addition to other data.

As previously described, the tabulator can be strapped in such a manner as to record each item in the tape in the same sequence as used on tickets prepared by manual operators. This will avoid manual errors in processing tickets from two sources.

Automatic Processing

Automatic accounting (processing) of SATT system call data is accomplished by means of punched card accounting equipment. This type of equipment has proved satisfactory over many years for almost every known kind of accounting requirement.

It may be of interest at this point to relate that surveys of accounting methods by independent telephone companies have disclosed the fact that some of them are already using punched card equipments to speed up and simplify manual accounting processes. When these companies adopt SATT operation, they will therefore be able to continue using their present facilities and methods by merely adding a tape-to-card unit to each card punch.

The first and basic step in obtaining printed subscribers' bills and auditing records with punched card equipment is to produce a punched card from the call data in a ticket tape. This is done by using a tape-to-card unit with a regular card punch, Figure 7. After a punched card has been obtained, it is used to control subsequent processes from which the basic end result will be a printed subscriber's bill, Figure 8. However, in this process, various other types of records are also obtained, depending on the amount and kinds of accounting data an operating company may require.

An interesting by-product obtainable from punched cards is toll traffic data. Computation machines can be set to sort out the particular items desired such as busy hour calls, average holding times, and from what classes of subscribers calls originate.

Conclusion

When the SATT system was designed, one of the primary aims was to use as far as possible tried and proved circuitry arrangements, and only such components as had been proved satisfactory in other fields and were commercially available. Thus the system described herein contains common control (Director) circuitry which has been used for many years in metropolitan areas. The record tape is of the same type as the message tape used in telegraph services. The punched card accounting equipment is also a well-known and proved equipment used in many commercial fields.

SATT system facilities are basically of such a nature that they can also be provided for non-Director step-by-step automatic central offices of all types and sizes, but special numbering and dialing methods must then be employed for subscriber dialed toll traffic. However, the end result is the same in each office: each completed subscriber dialed toll call is recorded in a ticket tape in exactly the same manner as in a Director-controlled office.

One interesting fact is already becoming apparent. Operating companies now providing SATT system service have found that mechanical accounting is not only a very desirable method as compared with manual processing, but also more economical.[6]

As automatic telephone switching eventually became the accepted mode in providing local telephone service, subscriber dialing, automatic call recording, and automatic accounting will without a doubt be the accepted mode in providing regional and national toll telephone service in the future.

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No Discussion