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***Traffic Service Position System No. 1:***

# Automated Coin Toll Service: Overall Description and Operational Characteristics

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*Automated Coin Toll Service (ACTS) has recently been developed for use on Traffic Service Position System No. 1. ACTS automates the handling of most calls paid for at coin stations, gives time and charge quotations, and provides customer notifications. To accomplish this, a new microprocessor-controlled subsystem is added to TSPS. This subsystem generates announcements and monitors coin deposits. Since ACTS reduces the operator involvement on coin toll calls, it achieves significant savings for the operating companies. ACTS was developed together with several other associated features. This entire package was first put into service in November 1977, in Phoenix, Arizona. This paper gives a functional description of the new subsystem and details the customer interface with ACTS and the other features.*

## I. INTRODUCTION

To reduce the operating expenses associated with handling coin toll calls at a Traffic Service Position System (TSPS) No. 1,[1] Automated Coin Toll Service (ACTS) has been developed. ACTS permits automated processing of (*i*) the initial contact on most station calls paid for at coin stations (station-paid coin calls), (*ii*) notification at the end of the initial period on all coin-paid calls, (*iii*) overtime charge-due seizure on most coin calls, (*iv*) the customer-requested notification on a call that is not coin-paid, and (*v*) the quotation on time and charge calls. This is accomplished by giving machine-constructed announcements

to the customer and by providing machine recognition of coin deposit signals. Thus, ACTS reduces the operator work time on coin toll, noncoin notification, and time and charge calls, and thereby achieves significant savings for the Bell System.

The technology and concepts of Automated Coin Toll Service evolved over several years. First, the technical feasibility of ACTS was demonstrated in 1973 by building an exploratory model. System engineering studies were conducted in conjunction with American Telephone and Telegraph Company (AT&T) and the operating telephone companies that showed the reduction of operating expenses would offset introductory costs. Three parallel and interrelated development activities emerged. First, a new subsystem was added to TSPS. This subsystem, the Station Signaling and Announcement Subsystem (SSAS), uses a microprocessor called the Programmable Controller (PROCON) and semiconductor memory. The memory is loaded with speech segments that have been digitally encoded. The SSAS retrieves and concatenates these speech segments into sentences. By converting the bit stream to analog signals, SSAS can "speak" to customers. In addition, SSAS monitors coin deposits by the customer to determine when a coin deposit request is satisfied. Second, software and firmware were developed for the TSPS controller which is the Stored Program Control (SPC) unit[1] and the PROCON, respectively. This software allows the TSPS to interface with the subsystem and the subsystem to perform the desired tasks. Third, because of the complexities of the new machine-customer interface, a human factors study was conducted in Chicago, Illinois. In this study, a sampling of coin customers was exposed to the proposed ACTS service, which was simulated from existing positions. This human factors simulation established wording and timing parameters used in the ACTS design.

Part of the technical challenge was to introduce ACTS into live TSPS sites without interrupting the normal call-handling process. Not only was this challenge met, but additional features were introduced at the same time. These features include:

(i) Expanded direct distance dialing to Mexico.
(*ii*) Improved queuing strategy for calls transferred to TSPS for calling number identification for billing purposes (Centralized Automatic Message Accounting, or CAMA, traffic).
(*iii*) Special automated procedures to better control overload conditions.
(*iv*) The ability to more efficiently redistribute (rehome) TSPS trunks to different toll or local offices.
(*v*) Increased coin station test capabilities.
(*vi*) Other miscellaneous features.

These features and ACTS were packaged as a version of TSPS called Generic 8. Following initial service in Phoenix, Arizona on November

26, 1977, this generic was made generally available to the Bell System in mid-1978.

This paper gives an overview of ACTS and some of the other features associated with TSPS Generic 8. It highlights the hardware and software associated with each feature. Additional details of the three development activities that culminated in ACTS are specified in later papers in this special issue.[3-5]

## II. COIN TOLL SERVICE PRIOR TO ACTS

TSPS provides a vast improvement in efficiency over cordboards in handling coin toll calls. Not only is the operator's interaction with a customer more efficient and accurate but, in addition, TSPS allows coin customers to dial their own calls, thereby providing faster service.

In a typical TSPS, between 10 and 15 percent of the calls handled by operators are toll calls made from coin stations and paid for with coins deposited at the station by the customer. On these calls in a non-ACTS TSPS, an operator is required (*i*) to quote to the customer the initial period length and charges, and to monitor the amount deposited, (*ii*) to notify the customer at the end of the initial period, and (*iii*) to quote and collect charges due for overtime at the end of the call or after 10 overtime intervals. To assist the operator in processing coin-paid calls, TSPS generally calculates the rates, automatically displays the charges at the operator position, and times the call.

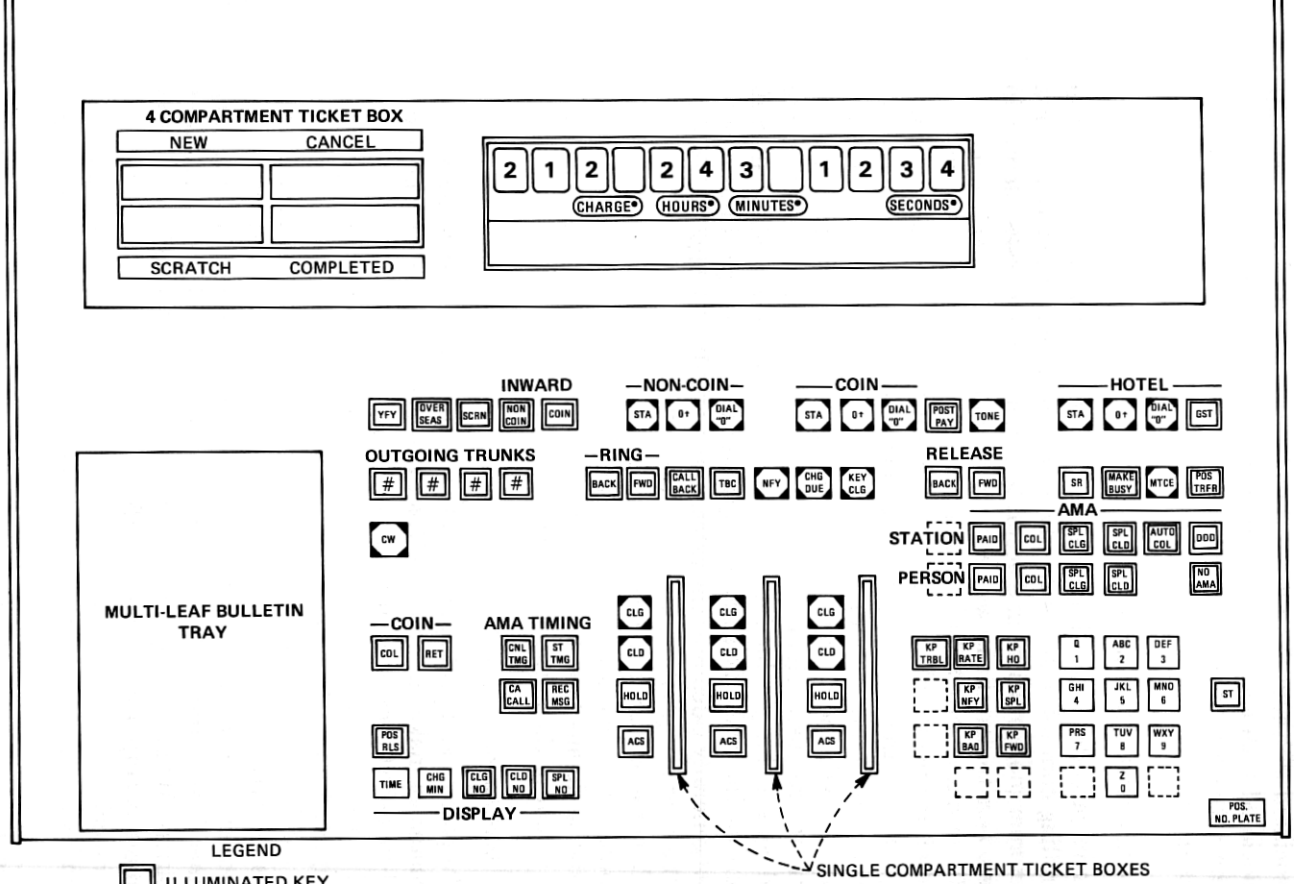
To better understand how the various functions described above are handled by an operator at a TSPS prior to the introduction of ACTS, the following details how TSPS processes a coin-paid call. Figure 1 shows the layout of the keys and lamps on the operator position.

### *2.1 Initial period contact*

To place a station-to-station call at a coin phone served by a TSPS, a customer makes an initial deposit and listens for a dial tone. (In a dial-tone-first area, the initial deposit is not required.) As soon as the dial tone is obtained, the customer dials the digit one* plus the complete 7- or 10-digit called number. The local office determines that this call is a toll call and routes it over a trunk to its associated TSPS. TSPS receives the called and calling number from the local office and determines the charges on the call. The TSPS establishes the necessary connections through its network to bring the call to an operator position. While the operator is responding to the call, the called number is outpulsed to the toll office.

The call arrives at the position with appropriate keys and lamps lit to indicate that this is a coin call. The station initial period charges

* Some areas do not require the digit one to be dialed, depending on local number plan arrangements.


4 COMPARTMENT TICKET BOX
NEW
CANCEL
SCRATCH
COMPLETED
2 1 2 2 4 3 1 2 3 4
CHARGE•
HOURS•
MINUTES•
SECONDS•
INWARD
YFV
OVER SEAS
SCRN
NON COIN
COIN
—NON-COIN—
STA
0+
DIAL "0"
—COIN—
POST PAY
TONE
—HOTEL—
GST
OUTGOING TRUNKS
#
—RING—
BACK
FWD
CALL BACK
TBC
NFY
CHG DUE
KEY CLG
RELEASE
SR
MAKE BUSY
MTCE
POS TRFR
CW
AMA
STATION
PERSON
PAID
COL
SPL CLG
SPL CLD
AUTO COL
DDD
NO AMA
MULTI-LEAF BULLETIN TRAY
—COIN—
RET
AMA TIMING
CNL TMG
ST TMG
CA CALL
REC MSG
CLG
CLD
HOLD
ACS
KP TRBL
KP RATE
KP HO
KP NFY
KP SPL
KP BAD
KP FWD
Q 1
ABC 2
DEF 3
GHI 4
JKL 5
MNO 6
ST
PRS 7
TUV 8
WXY 9
Z 0
POS RLS
TIME
CHG MIN
CLG NO
CLD NO
SPL NO
—DISPLAY—
POS. NO. PLATE
SINGLE COMPARTMENT TICKET BOXES
LEGEND
ILLUMINATED KEY
NON-ILLUMINATED KEY
LAMP
# TRUNKS TO RATE AND ROUTE, INTERCEPT, INFORMATION CARD SWITCHBOARD, ETC. AS REQUIRED
• THESE DESIGNATIONS ARE NOT VISIBLE UNLESS SIGNIFICANT

and minutes are displayed to the operator, as depicted in Fig. 2. The operator then requests the initial deposit from the customer and depresses the station-paid class-of-charge key to indicate to the system that a station-paid call is being handled. The customer then deposits the coins, and the operator monitors coin signals to determine if the proper deposit has been made. Meanwhile, the call is forwarded through the Direct Distance Dialing (DDD) network.

When the customer deposits the correct amount, the operator acknowledges receipt of the deposit. Then, upon hearing the audible ring of the calling station, the operator prepares the system for automatic timing of the call after called party answer. This is done by depressing

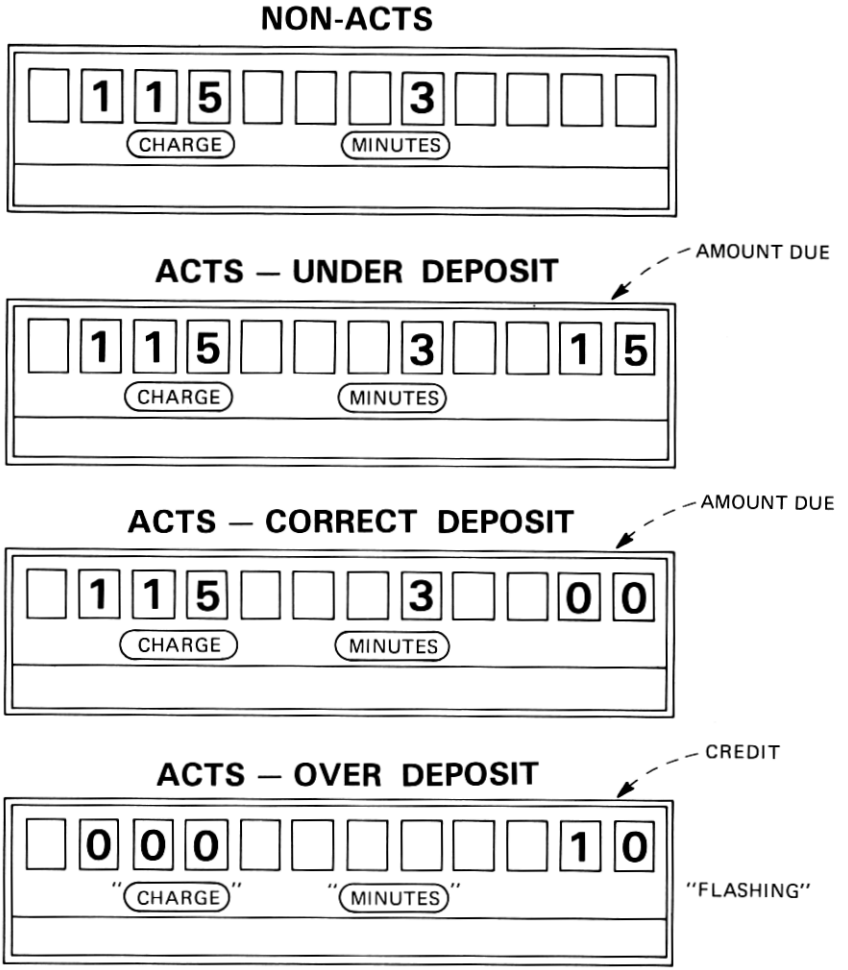



Fig. 2—TSPS No. 1 console numeric display.

the start timing key. The operator then releases the position, concluding the initial contact phase of the calls.

When the customer does not deposit enough money, the operator requests the additional amount. If the call has not yet progressed through the DDD network, the operator stops the forward action of the call by depressing the release forward key. When a full deposit is received, the operator reinitiates the network connection by depressing the start key, then he or she depresses the start timing key, and releases the position.

If a customer lacks proper change, he or she may deposit too much money. The operator acknowledges this overdeposit and instructs the customer to tell the operator that credit is due when overtime is collected.

With the operator released to handle another call, TSPS times the call for the initial period. Before the end of the initial period, TSPS sends a signal to the local office to cause the initial deposit to be collected.

### *2.2 Notification at the end of initial period*

Generally, the call is again connected to an operator at the end of the initial period. This operator is not likely to be the same person who handled the initial contact. The call arrives at the position with the appropriate keys and lamps lit to indicate that this is a notify seizure. The operator notifies the customer that the initial period has ended and requests that the customer signal (by flashing the switchhook) when the call is completed. The operator releases the position and TSPS starts overtime timing.

### *2.3 Quotation and collection of charges due for overtime*

If a call goes into overtime and reaches an elapsed time of 10 overtime intervals (usually 10 minutes), an operator is reconnected to the customer's line to request an intermediate deposit. This deposit is intended to limit coin overtime losses that result when a customer walks away at the completion of the call without paying the charges due. The operator counts the deposits and, when the request is satisfied, releases the position. Additional intermediate deposits are requested at appropriate intervals until the call terminates. Calls in overtime are not interrupted more frequently because of the operator work time penalty.

When the call is concluded, as indicated to TSPS by the calling customer signaling (flashing the switchhook) or either customer hanging up, the call is brought to a position for overtime collection. If the calling customer's phone is on hook, the operator rings the station by operating the ringback key. When the calling party is on the line, the operator requests the charges due and counts the coin deposits. When

the deposit request is satisfied, the operator thanks the customer, depresses a key which signals that coins are to be collected, and releases the position. If the calling customer does not answer the ringback or the operator is unable to obtain full payment for the call, a "walkaway" is recorded on a mark-sense ticket and the operator releases the position.

## III. THE ACTS HARDWARE

A new hardware subsystem is added to the TSPS for ACTS, called the Station Signaling and Announcement Subsystem (SSAS). It is composed of a control unit containing a programmable controller called PROCON, an announcement store, and service circuits called Coin Detection and Announcement circuits (CDAS) (see Fig. 3). The control unit and announcement store are duplicated for reliability. One controller is active and the other is standby. The units are not run synchronously, but the temporary memory of each unit is updated on an ongoing basis.

The SSAS control unit contains the PROCON with a read-only program memory and a random access memory for temporary data storage. The SSAS control unit provides an interface with the Stored Program Control (SPC) unit,[1] its mate controller, the announcement memory,

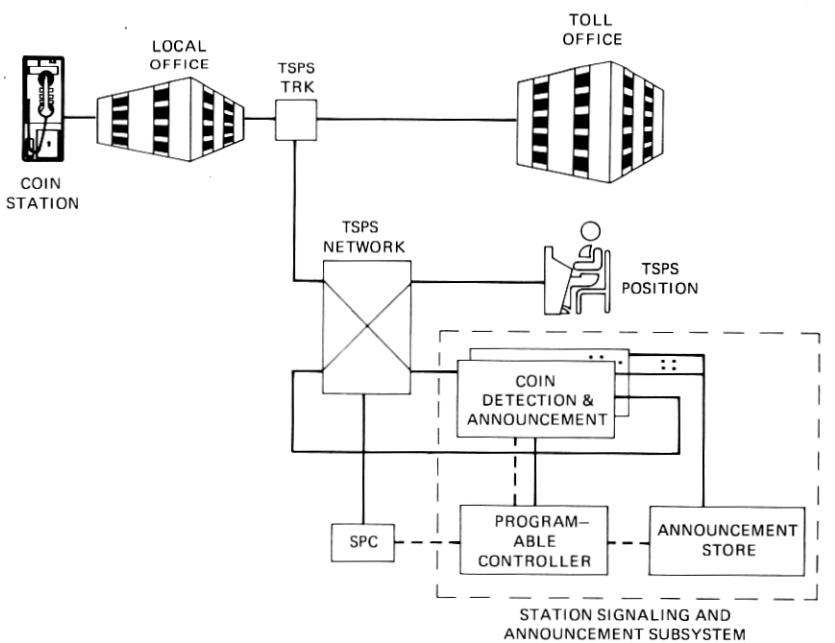



Fig. 3—ACTS block diagram.

and the CDA service circuits. The SPC communicates every 25 ms with the SSAS via software buffers as it does with other peripheral units.

The PROCON handles the internal control, data manipulation, and data transfer required for processing the call through the successive steps from customer contact through deposit acknowledgment. Within each control unit, the PROCON provides a self-checking mechanism for immediate detection of faults.

Prerecorded words and phases are digitally encoded and stored in the announcement store. The announcement store can be expanded in increments of eighty 512-ms speech segments. It is organized to be tolerant to single-bit faults and is diagnosed via the SPC. PROCON forms announcements by directing speech segments from the announcement store to the CDA in the appropriate sequence.

The CDA circuits have appearances on the TSPS switching network and perform the functions of making announcements to customers and of detecting coin deposits. The CDA circuits also are used to monitor for coin deposits when an operator is handling the call. CDAs are traffic-engineered with a typical TSPS requiring from 30 to 40 of these service circuits for ACTS. These service circuits convert the digital bit stream to an analog announcement.

## IV. COIN SERVICE WITH ACTS

ACTS uses SSAS to automate the handling of (*i*) initial period coin collections, (*ii*) notifications of the end of the initial period, (*iii*) charge due coin collections, (*iv*) time and charge quotations, and (*v*) notifications on nonpaid calls. This section details the procedures used to automate these call seizures.

### *4.1 Initial period coin collection*

With ACTS, a coin customer initiates a station-to-station call as in the past by dialing one* plus the called number. Since no local office trunk modifications are needed, the local office goes through normal routing of the call to TSPS. After TSPS receives the called and the calling numbers, it determines the rate and computes the initial period charges. However, instead of connecting an operator, TSPS makes network connections that bring the call to a CDA circuit and passes the initial period and charge information to the SSAS. The call is not outpulsed forward until the SSAS completes the initial contact with the customer. In the following sections, the procedures and announcements for the initial collection are described.

* Some areas do not require the one to be dialed.

#### 4.1.1 Initial deposit request

The SSAS constructs the following announcement:

$$\text{“}\left\{\begin{array}{l}\text{X dollar(s)}\\ \text{X dollar(s) and Y cents}\\ \text{Y cents}\end{array}\right\}\text{please.” (2-second pause)}$$

$$\text{“Please deposit }\left\{\begin{array}{l}\text{X dollar(s)}\\ \text{X dollar(s) and Y cents}\\ \text{Y cents}\end{array}\right\}\text{ for the first Z minute(s).”}$$

#### 4.1.2 Initial coin prompt

In studies of customers making coin-paid toll calls, it was observed that many customers ask the operator to repeat the amount before they begin depositing. This even occurred on calls in which the amount was stated twice in the initial request. In view of this, if no deposit is detected within an allotted time after the initial announcement, the SSAS prompts the customer with, for example:

“Please deposit 1 dollar and 50 cents.”

Although a 5.5-second initial coin timing interval is used for the beginning of the call, all timing intervals are designed so that they can be changed in case significant differences in customer behavior are encountered as a result of growing customer familiarity with the service or as a result of demographic differences.

#### 4.1.3 Intercoin prompt

Some customers begin depositing, but stop before the request is satisfied. For example, the customer may lose count of the coins deposited. To accommodate these customers, an intercoin prompt is given. If the time between coin deposits exceeds an allotted time and the deposit is not satisfied, the SSAS prompts the customer by announcing the additional deposit needed in a manner similar to the initial coin prompt.

#### 4.1.4 Acknowledgment of a correct deposit

Data show that over 80 percent of the customers satisfy the deposit request within the allotted time intervals. When the customer deposits the correct amount, the SSAS takes three actions. First, it informs the TSPS to outpulse the call. Second, while the call is being outpulsed, the SSAS acknowledges the deposit to the customer by

“Thank you.”

Third, when the announcement is completed, the SSAS reports the

amount detected to TSPS. Following this report, the TSPS disconnects the CDA circuit and proceeds to time the call.

#### 4.1.5 Acknowledgment of an overdeposit

Some customers lack the proper change and deposit too much money. With ACTS, an overdeposit is acknowledged and credit toward overtime charges is automatically obtained. This eliminates the need for a customer to indicate a credit is due. When the overdeposit is recognized, the SSAS informs TSPS to outpulse the call and to record the amount of the overdeposit. The SSAS acknowledges the overdeposit with the following phase:

"Thank you. You have W cents
credit toward overtime."

If the customer does not use the overdeposit credit and wants a refund, the customer must reach an operator and request a refund.

The SSAS does not time for overdeposits greater than breakage, but as long as the CDA circuit is attached, subsequent deposits are credited towards overtime. Breakage occurs when the denomination of the last coin brings the amount deposited over the amount due (i.e., \$0.05, \$0.10, \$0.15, or \$0.20). As soon as the amount deposited equals or exceeds the amount due, the SSAS informs TSPS to outpulse. To time for additional overdeposits (i.e., prepayment of overtime), the SSAS would have to delay all calls. If the customer overdeposits inadvertently and wishes to redeposit the correct amount, the customer must hang up to have the coins returned. This can be done any time before the called party answers.

#### 4.1.6 Deposits during announcements

The CDA circuits monitor coin deposits during deposit requests. If a coin is detected during a request, the request is truncated immediately. If this coin does not bring the amount deposited up to the amount due, intercoin timing begins. If the amount due is met, the appropriate acknowledgment is transmitted. This allows customers who know the charges for a call to deposit the required amount without listening to the entire deposit request.

#### 4.1.7 Operator assistance

Coin customers may not properly respond to fully-automated service and may need operator assistance. For example, customers who lack the correct change may request that the charges be billed to a credit card, to a third party, or to the called party. To deal with such occurrences, an operator is needed. Thus, if the customer fails to deposit within the allotted time following a prompt, the call times out and receives operator assistance. In addition, if a customer flashes the

switchhook during the coin deposit announcements, the call is also brought to an operator.

When the operator is attached, a new pattern of keys and lamps as well as a new numeric display (see Fig. 2) are lit on the operator console. This informs the operator of an ACTS call and provides the operator with the additional information concerning the amount still to be deposited. The CDA circuit remains connected between the customer and the operator. The circuit continues to monitor coin deposits but makes no announcements. The operator assists the customer in making a full deposit.

When the CDA circuit detects the full deposit, the SSAS reports "deposit satisfied" to the TSPS. The TSPS updates the operator's numeric display and outpulses the call. If the coin deposit tones are not being accepted by the CDA circuit and the operator suspects an equipment malfunction, the operator can override the SSAS and allow the call to progress.

### *4.2 Notification at the end of the initial period*

The SSAS can provide the notification of the end of the initial period on all coin-paid calls whether the initial contact was handled by the SSAS or by an operator. When the initial period timing ends, the call is connected to a CDA circuit instead of an operator. TSPS informs the SSAS of the length of the initial period and the CDA circuit being used. The SSAS then announces to the customer:

"Z minute(s) has ended. Please
signal when through"

where Z ranges between 1 and 6.

When the announcement is complete, the SSAS informs the TSPS that the CDA circuit is idle. The TSPS disconnects the CDA circuit and starts overtime timing.

### *4.3 Charge due seizures*

The ACTS procedures for fully automating overtime charge due seizures on coin-paid calls are presented in this section. The same sequence of deposit requests, coin deposit timing, prompting, and acknowledging described for the initial period deposit request are used for the overtime deposit request. However, the announcement wording is appropriately changed to indicate that money is due for the preceding connection time.

#### *4.3.1 Charge due deposit request*

In the same way as before ACTS, if a call lasts a certain number of overtime intervals, an intermediate deposit is requested from the customer. With Generic 8, the number of overtime intervals can be

varied in accordance with the amount of overtime charges (previously it was fixed at 10). Additional intermediate deposits are requested until the call terminates. The SSAS automates the collection at both intermediate and end-of-call overtime charge due seizures on ACTS-handled calls. The collection sequences for end-of-call deposits and intermediate deposits are essentially the same.* Furthermore, these collection sequences are very similar to those used for the initial contact on station (1+) calls.

Without interrupting the conversation path, TSPS connects an idle CDA circuit to the call. TSPS informs the SSAS of the amount due, the number of minutes talked, the CDA circuit being used, and the fact that it is a charge-due seizure. The SSAS generates an announcement similar to that used for initial coin deposit requests.

If the customer overdeposited during the previous collection sequence, the credit is automatically given. The overdeposit is subtracted from the calculated charges due. If no money is due, no actions are taken. If money is due, the TSPS connects an idle CDA circuit to the call. TSPS informs the SSAS of the amount due, the amount of credit, the number of chargeable minutes, the CDA circuit being used, and that it is a charge-due seizure with credit.

To assure the customer that credit is being given, an announcement is used, such as

> "2 dollars and 10 cents please." (2-second pause) "You have 20 cents credit. Please deposit 2 dollars and 10 cents more for the past 10 minutes."

After the charge-due deposit request is made, the deposit timing and, if needed, the prompting announcements described for the initial contact are used. If the deposit request is satisfied, the "Thank You" acknowledgment is given. When the SSAS informs TSPS that the acknowledgment is completed, the CDA circuit is disconnected from the call.

As with initial contact, operator assistance is given if no coin is deposited within a time interval, presently set at 5.5 seconds, or if the customer flashes during the deposit sequence. An operator is also connected if the customer goes on-hook during the announcement sequence.

#### *4.3.2 Walkaways*

If the calling customer goes on-hook at the end of a coin-paid call and charges are due, TSPS automatically generates a ringback signal to

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* With intermediate deposits, the called party is off-hook. A special coin detection arrangement is used to monitor the calling and called stations.

cause the calling phone to ring. If the calling party answers, an ACTS overtime charge due announcement is made. The start of the announcement is delayed 2 seconds from the time the customer goes off-hook. This allows time for the customer to get the handset to the ear.

However, if the calling party does not answer, TSPS assumes a walkaway. Since the customer did not respond to an automatic ringback, the customer probably will not respond to an operator ringback. Hence, an operator is not connected. Instead, a traffic counter is pegged and a walkaway record is made on the Automatic Message Accounting (AMA) tape. These walkaway records can be processed later to determine patterns so that action can be taken to reduce fraudulent use of coin phones.

### *4.4 Time and charge quotations*

When a customer requests a time and charge (T&C) quotation on a call, the operator instructs the customer to flash and remain off-hook at the end of the call. If the customer follows the operator's instructions and the called party goes on-hook for two or more seconds, the forward connection is released and the call is connected to an idle CDA circuit. TSPS informs the SSAS of the charges, the length of conversation, the CDA being used, and that it is a time and charge quotation. The SSAS generates an announcement, such as

"The charges are 3 dollars and 94 cents plus tax for 12 minutes."

If the calling customer remains off-hook, the quote is repeated 3 seconds later. The SSAS informs TSPS when the second quote is completed, and the call is terminated. If the calling customer goes on-hook during this sequence, TSPS informs the SSAS to suspend the announcement sequence, and the CDA circuit is idled.

The fully automated quotation is given only to calling customers who remain off-hook at the end of the call. If the calling customer goes on-hook at the end of the call, TSPS connects an operator to contact the calling customer and give the T&C quotation. An operator is required because a system ringback may not be answered by the calling customer. For example, a ringback could be answered by a PBX attendant who knows nothing about the call.

When the SSAS gives the T&C quotation, the AMA record specifies that an SSAS quotation was given and the charges the customer was quoted.

### *4.5 Customer requested notification*

On a call that is not coin-paid, a customer can ask to be notified at the end of 1 to 10 minutes. During the initial contact, the operator enters the customer's request into TSPS memory. If such an entry is

made, TSPS connects the idle CDA circuit to the call at the appropriate time. TSPS informs the SSAS of the CDA circuit being used, the number of elapsed minutes, and that it is a notification seizure. The SSAS generates the prescribed tone and announces, for example,

"5 minutes has ended."

When the SSAS informs the TSPS that the announcement is finished, TSPS disconnects the CDA circuit and continues to time the call.

## V. ADDITIONAL TSPS FEATURES ON GENERIC 8

In parallel with the ACTS development, other service and maintenance features were developed. Those features are released with ACTS in a software package known as a generic. Since the generic containing ACTS is the eighth for TSPS No. 1, it is called Generic 8. This section briefly describes some of the additional features in Generic 8.

### *5.1 Expanded dialing to Mexico*

This feature expands customer dialing capability on calls to Mexico. The Generic 8 dialing plan for Mexico is eight digits, except that the Northwest border area has a 903 area code followed by seven digits. Presently, calls to the 903 and 905 (Mexico City) area codes are customer dialable. (In the case of Mexico City, the digit "5" is both the third digit of the area code and the first of the eight digits in the dialing plan for Mexico.) Other calls to Mexico are only dialable by an operator, and many areas can only be reached by an inward operator.

The expanded Generic 8 capability allows customers to dial directly, using the international format, calls that currently are only dialable by an operator. Specifically, a customer dials 011 or 01 plus a country code of 52 plus the 8-digit Mexican number. TSPS software recognized the 52 country code and bypasses the 2-stage outpulsing normally done on international calls. TSPS then outpulses 180 plus the 8-digit number for routine handling (6-digit translation) in the domestic toll network. A toll office with trunks to Mexico eventually is reached and outpulses the 8-digit number. In Generic 8, TSPS also continues to handle calls dialed using the 903 and 905 formats.

Besides expanding direct dialing, this feature also simplifies inward calls to Mexico. The TSPS operator keys 52x-121, where x = 5 for Mexico City, 8 for Monterrey, 1 for Chihuahua, or 6 for Hermosillo. TSPS uses the "x" digit to index into a translation table. This table contains the codes to be outpulsed to reach the appropriate Terminating Toll Center.

This feature improves service by allowing the customer to dial calls directly. It also is expected to yield significant economic savings by automating a class of traffic that is experiencing substantial annual growth.

### 5.2 Transfer CAMA queuing improvement

In some cases, TSPS operators provide Operator Number Identification (ONI) to a CAMA office which will record the billing information. For instance, many TSPSs handle transfer CAMA traffic at night, when CAMA boards are closed and traffic is normally light. If traffic fluctuations produce a relatively heavy load, incoming calls can experience delays before reaching an operator position. Generic 8 has an improved strategy, called delay ratio control queuing, for handling traffic in TSPS offices which perform a transfer CAMA function.

This new queuing strategy tends to maintain a preselected balance between the delays experienced by transfer CAMA and other TSPS customers. A separate queue is established for transfer CAMA calls waiting for a position. Other TSPS customers queue as they do now. The serving rate for transfer CAMA versus other TSPS customers is dynamically modulated by the ratio of the respective queue lengths. This approach has been verified by analytical simulation and field studies to provide better service to CAMA customers while maintaining good service to other TSPS customers.

### 5.3 Dynamic queuing strategy

The dynamic queuing feature provides measurements and controls of the delays experienced by calls which require an operator position. The delay measurements are used to determine when to light a "calls waiting" lamp indicating to the operators that a moderate number of customers are awaiting assistance. Operators can then expedite call handling. If the delays increase further, the dynamic queuing measurements trigger the application of delay announcements.* These announcements turn away some of the new calls that would otherwise enter the queues.

Previously, the number of TSPS positions staffed was used to index into tables giving critical queue lengths for activating delay announcements and the call waiting lamp. These tables were originally constructed on the assumption of a fixed (60-second) Average Work Time (AWT) per call. Tables based on fixed AWT are insensitive to variations in service rate.

The dynamic queuing feature measures the actual delay encountered by incoming calls. Call abandonments are also directly taken into account, since they affect the measured delay. This accurate delay estimate improves service to TSPS customers. The dynamic queuing feature interacts constructively with the transfer CAMA queuing feature, since separate data can be obtained on the delays seen in the transfer CAMA queue. An integrated approach to lighting the call

* Position disconnect is supplied on transfer CAMA trunks so that reorder can be given at the toll office. The delay announcement is given to other TSPS traffic.

waiting lamp and turning on the delay announcement (or supplying position disconnect) is based on accurate assessments of all the queuing delays in the system.

### 5.4 Redistributing (rehome) TSPS trunks

The ability to redistribute (rehome) TSPS trunks to a different toll or local offices allows an operating company to react to changing traffic trends. This ability allows TSPS capacity to be efficiently used in adapting to the evolving traffic patterns. Rehoming can be used to relieve congestion at a toll office or when an existing office is being replaced by a more modern electronic office. As an example, perhaps a No. 4A Crossbar office is being replaced by a No. 4 ESS.

Office data parameters for the trunks can be changed en masse. The software limitation of a single office parameter per trunk group is deleted for rehome. The software accommodates a difference (for instance, wink versus delay dial signaling) between the offices.

### 5.5 Improved coin station tests capabilities

TSPS Generic 8 provides a new coin station test capability. With this capability, a craftsperson can make end-to-end, coin signaling tests between coin stations and TSPS. This new procedure directs the craftsperson at the coin station through a series of tests. The SSAS is utilized to provide appropriate feedback to the craftsperson concerning the denomination of the detected coins. Marginal/stress testing is an integral part of the test. With the test information, the craftsperson is able to determine whether the station is functioning correctly and, if not, what functional area of the station is defective. In addition, certain types of coin-deposit signaling errors detected by the SSAS are recorded with other call billing details. This failure information can be summarized by a telephone company using the new Coin Operational and Information Network (COIN) package.* This information can be used to direct the craftsperson to potentially defective coin stations. Together, the per-call failure information and the quick, simple, and flexible coin station procedures provide the telephone companies with improved detection and resolution of coin system problems.

## VI. ACTS DEPLOYMENT AND ECONOMICS

Today, over 75 percent of the coin stations and 80 percent of the average business-day, coin-paid calls in the Bell System are handled on TSPS, and this coverage is increasing each year. The incorporation of ACTS into TSPS eliminates or reduces operator handling of most of

* COIN is an off-line computer package which performs collection, scheduling, and revenue analysis functions for public telephones.

these coin-paid calls, thereby achieving significant operating expense savings for the Bell System.

To achieve these savings, the previously described hardware and software are added to TSPS. In preparation for the introduction of ACTS in the Bell System, new coin stations and coin chassis produced by Western Electric since 1975 have been (and will continue to be) equipped for ACTS coin detection.

On November 26, 1977, the first new TSPS equipped with the ACTS feature was introduced into service in Phoenix, Arizona. In March, 1978, an existing TSPS was first retrofitted with the Generic 8 features in Oakbrook, Illinois.

ACTS was made available on a standard basis to the Bell System operating companies in the middle of 1978.

## VII. ACKNOWLEDGMENTS

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