

## **Transaction Network, Telephones, and Terminals:**

# **The Switched Network Transaction Telephone System**

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*In June of 1972, an AT&T/BTL project team was formed to determine the evolving communication needs of the financial and retail industries as they moved to implement electronic funds transfer systems. The Bell System response occurred in three phases. The first phase introduced the Transaction I telephone, 407B data sets, and the Transaction Telephone Test Line Station in order to provide a simple means of evolving from the widespread manual-entry/audio-response systems into automatic-entry/audio-response systems. The second phase expanded our system offering to include Transaction II telephone, 407C data sets, and an upgraded Transaction Telephone Test Line Station. The third phase introduced the Transaction printer, which provided a simple means of generating receipts at the terminal location under control of the data center computer. This paper describes the resulting Switched Network Transaction Telephone System and the individual products of which it is built.*

### **I. INTRODUCTION**

During the past few years, the Bell System has been actively engaged in developing new offerings to satisfy the unique communication needs of financial and retail establishments. Clerks and tellers who deal directly with customers need access to information in remote data bases to authorize credit, cash checks, or handle account transactions. As our society moves toward the implementation of electronic funds transfer systems, many new communication offerings are required. In June of 1972, an

AT&T/BTL project team was formed to determine these growing needs. After visiting a large number of financial customers throughout the country and conducting an extensive market survey, the project team developed a proposal for a Transaction telephone system which used the public switched telecommunications network and which could evolve simultaneously with the increasing communication needs of the financial and retail industries.

A technical trial of the first stage in the project team's proposal was conducted with the regional data center for Master Charge transactions in Cleveland, Ohio, from October 1973 to February 1974. During this trial, 33 Transaction telephones were installed in 13 retail outlets in the Cleveland-Akron area, eight modified 407A data sets were interfaced to the regional Master Charge computer, and a custom-designed automatic call distributor (ACD) referral system was interfaced to the existing Master Charge ACD facility. Retail clerks were able to automatically dial the computer center and enter transaction data directly into the computer. The computer in turn generated a voice response to the clerk indicating approval or disapproval of the transaction.

This trial of Transaction telephones for credit authorization was a success from both technical and operational standpoints. However, the trial indicated the need for several design changes in the terminals, system configuration, and maintenance procedures. Some of these modifications were strictly technical, such as the replacement of discrete digital logic by a microprocessor and the change to a calculator type of keyboard. Others made the system more robust, such as the generation and testing of check characters and provision for customer testing of the Transaction I telephone. The redesign of the data set as the 407B added new capabilities, such as the ability of a clerk at a Transaction telephone to automatically refer the call to an attendant. A pilot installation of the modified first-phase system was conducted with a commercial bank in Cincinnati, Ohio, in early October 1974 to confirm the effectiveness of these design changes before gearing up for manufacture. This pilot installation started with Transaction telephones used as lobby inquiry terminals which were used by bank customers to obtain current account balances. It was later expanded to include check authorization/guarantee.

The Western Electric Company delivered the first production Transaction I telephones, 407B data sets, and Transaction Telephone Test Line Stations before mid-1975 to facilitate implementation of the first phase of the AT&T/BTL project team proposal. This system allowed automatic entry of data with computer-activated voice response. The Transaction II telephones, 407C data stations, and an upgraded Transaction Telephone Test Line Station were introduced about one year later to facilitate implementation of the second phase. The inclusion of an alphanumeric display on the Transaction telephone allowed the

computer to send a data response and permitted the clerk to operate in a hands-free mode. A third phase, which incorporated adjunct Transaction printers and an upgraded Transaction Telephone Line Test Station, was implemented during 1977. Receipts and authorizations were printed directly, further simplifying the clerk's task and reducing inconvenience to the customer. These various developmental phases were specified to mesh with the increasing communication needs of financial and retail establishments. Each of these three phases is described in detail in the following sections.

## II. THE FIRST PHASE

The first phase in the AT&T/BTL project team plan was intended to provide a simple means of progressing from the manual-entry/audio-response systems which are in use by numerous financial and retail establishments into automatic-entry/audio-response systems. In the typical manual-entry system, either the clerk specifies the inquiry data by voice to an attendant who manually enters the data into a computer system, or the clerk manually enters the data directly into a computer system via a direct data link. The computer system may then either respond via a CRT terminal to the attendant who relays the response to the clerk by voice, or the computer may directly respond to the clerk with computerized audio. In all such cases, the inquiry data are manually entered into the computer and an audible response is given to the clerk.

The overall system requirements for our first offering were that it:

- (i) Be compatible with the subscriber's existing telephone service needs.
- (ii) Automate the manual data entry procedures.
- (iii) Be easily maintainable.
- (iv) Be compatible with existing computerized voice systems.
- (v) Allow expandable system features to meet the changing communication needs of our customers.

The system that resulted is shown in Fig. 1. Transaction I telephones call the computer center over the public switched network. An optional Automatic Call Distributor (ACD) routes incoming calls to 407B data sets, which are connected to customer-provided equipment. In the typical configuration shown, an Audio Response Unit (ARU) serves as a telecommunications front end for the host computer. CRT terminals are provided for referral clerks, who handle exceptional transactions. The Transaction Telephone Test Line Station is provided to exercise and test the Transaction telephone from the field.

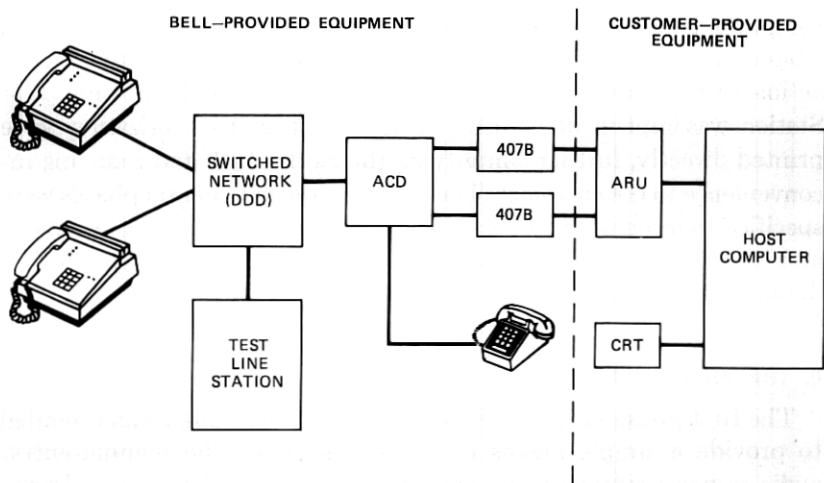


Fig. 1—Switched Network Transaction Telephone System, first phase.

## 2.1 Transaction I telephone

The Transaction I telephone<sup>1</sup> includes the following features:

- (i) Automatic dialing of the telephone number of the computer center.
- (ii) Fully buffering input data.
- (iii) Reading input data from magnetic stripe cards.
- (iv) Providing sequenced instruction lamps to aid the user in data entry.
- (v) Providing a manual entry key pad for entry of additional numeric data.
- (vi) Transmitting information and responding to answer tones.

The Transaction I telephone can dial into *TOUCH-TONE\** or rotary offices and can dial from behind PBXs or key systems. Thus it is capable of being used virtually wherever a conventional telephone can be installed. In addition, it can dial automatically from information contained on the magnetic stripe of specially encoded plastic dialing cards. To automate the data entry, the Transaction I telephone has instruction lamps to guide the clerk through the data entry procedure, a buffer for temporarily storing data until they are needed, and a magnetic stripe card reader. The buffer allows data to be entered before or after connection with the computer center is made and then to be transmitted when the computer center is ready. The card reader accepts data encoded on magnetic cards formatted according to the financial industry standard American Banking Association Track 2.

The Transaction I telephone's design incorporates several features which facilitate use with existing computerized voice systems and which allow expansion of the product line to meet evolving communication

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needs. To ease the integration of Transaction I telephones into existing voice response systems, the Transaction I telephone transmits the inquiry data as *TOUCH-TONE* signals. It uses a magnetic-stripe character-to-*TOUCH-TONE*-signal conversion table which was selected for compatibility with all commercially available voice response systems. The *TOUCH-TONE* inquiry also includes error check and status characters in anticipation of increased needs to automatically detect transmission errors and limit certain types of potential fraud exposure. The automatic generation of check characters and the use of all 16 *TOUCH-TONE* signals make it impossible for a conventional telephone to be used to place a fraudulent Transaction telephone call. To facilitate the expansion of system capabilities, all data inquiries begin with a unique sequence of terminal identification characters which identify the calling set as a Transaction I telephone. Other sequences of characters identify different members of the Transaction telephone family. The Transaction I telephone is designed to receive simple tone responses from nonaudio systems as well as to receive the usual voice response from systems with computerized audio capability. Tone responses of specified durations will activate the green or yellow response lamps, which can be used to signal such action as the approval or disapproval of a transaction.

During the introduction of the first phase offerings, the need for remote entry of a secret Personal Identification Number (PIN) by the customer was evidenced. This provided a greater measure of security for the customer and gave the customer a greater sense of control over a transaction. In response to this need, an optional auxiliary manual entry pad, called a PIN pad, was added to the first phase offerings. PIN entries are used to minimize unauthorized use of customer cards, since only the customer is supposed to know the PIN.

## **2.2 407B data set**

The 407B data set has all the features of the 407A data set<sup>2</sup> plus several features that enable it to satisfy the special needs for transaction processing in the financial and retail industries. Like the 407A data set, it was designed to interface Bell System terminals and the network with existing computerized voice response systems. It receives and decodes incoming *TOUCH-TONE* signals, presenting them in a 2-out-of-8 parallel format to the computer system. In addition, it provides a means for sending back voice signals generated by the computer or for sending answer tones to the Transaction telephone. The 407B data set includes extensive self and remote test capabilities to facilitate system maintenance.

The 407B data set can initiate referrals to an attendant at the request of either the computer system or the clerk using the Transaction tele-

phone. The 407B detects a special sequence of *TOUCH-TONE* signals from the Transaction telephone which the clerk can initiate. This referral capability can be implemented with adjunct *CALL DIRECTOR*\* telephones or through certain ACD arrangements. This clerk is connected directly to the referral attendant and can receive verbal assistance in handling the transaction. The 407B data set can also detect a "computer down" condition and proceed in a limited fashion to handle inquiries from Transaction telephones. This eliminates "ring-no answer" or busy signals during computer outages and allows transactions to be consummated. The 407B sends a special answer tone to the Transaction telephone, indicating the "computer down" condition. If the dollar amount of the transaction is below a "floor limit" encoded on the dialing card, the "Follow Special Instructions" lamp is lighted. If the floor limit is exceeded, a different response lamp lights, and an automatic referral is initiated by the Transaction telephone.

One feature could only be implemented in the second phase, when the Transaction II telephone became available. This feature, an automatic disconnect, shortens computer port holding time and improves efficiency. The Transaction II telephone can send a special *TOUCH-TONE* sequence just before it disconnects from the line. This sequence is interpreted by the 407B, which then drops its end of the line.

### **2.3 Transaction Telephone Test Line Station**

The 1973 to 1974 Master Charge technical trial indicated the need for improved terminal maintenance procedures. As a result, the 1A Transaction Telephone Test Line Station was developed and deployed. The Test Line Station is located on telephone company premises, typically in a Data Test Center. One unit can serve a large number (up to 1200) of Transaction telephones. The Test Line Station is comprised of a 407A data set and an 806E data auxiliary set. The data set answers test calls, sends back answer tones, and receives and converts *TOUCH-TONE* signals. The 806E DAS is a microprocessor-controlled unit which verifies that the Transaction telephone is transmitting the proper data and generates control signals to the Transaction telephone at appropriate times during a test.

Each Transaction telephone is shipped with a universal magnetic stripe test card which the installer uses to test proper operation. The installer calls the Test Line Station with the handset on the Transaction telephone and uses the test card to enter both dialing and customer data. The installer presses each button in the prescribed sequence and observes the proper operation of the response lamps on the Transaction telephone. Every functional element of the Transaction telephone is exercised and verified during the test. Unique tone responses on the handset indicate success or failure of the test. The test card and Test Line

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Station telephone number are left at the installation site so that the subscriber can also verify proper operation of the telephone. Subscribers are encouraged to test any Transaction telephone that seems to be functioning improperly. This helps to isolate problems either to the telephone or to some other element of the entire Transaction telephone system.

### **III. THE SECOND PHASE**

The second phase of the AT&T/BTL project team plan was intended to satisfy the needs of the financial and retail establishments that did not find it efficacious to support computerized voice response systems. At the same time, it was desired not to exclude the use of the new Phase II equipment by concerns which did support computerized audio systems. This second phase provides a simple means of evolving from the labor-intensive, manual-entry/attendant-response systems which are in wide use in the financial and retail industries into automatic-entry/visual-response systems.

The overall system requirements for the second offering include all those of the first phase system. In addition, it was required that it:

- (i) Be compatible with computer front-end telecommunications controllers.
- (ii) Be capable of supporting Transaction I telephones in a limited fashion.

The full second-phase system is shown in Fig. 2. Both Transaction I and II telephones can call the computer center over the public switched network. Calls are routed to 407B data sets, which are connected to customer-provided Audio Response Units, or to 407C data sets, which are connected to digital front-end telecommunications controllers. A new Test Line Station is provided to test both Transaction I and II telephones.

#### **3.1 Transaction II telephone**

The Transaction II telephone<sup>1</sup> is similar to the Transaction I telephone with the addition of an eight-character visual display, a data receiver, a monitoring loudspeaker, and ON/OFF buttons. The Transaction II telephone includes all the dialing capabilities of the Transaction I telephone plus a visual display of the dialed number for manually entered telephone numbers. It provides two data entry features beyond those of the Transaction I telephone:

- (i) Hands-free operation, so that the clerk does not need to raise the handset.
- (ii) Visual display for verifying all manually entered data and for displaying the data center responses.

Transaction II telephones can be supported by existing computerized

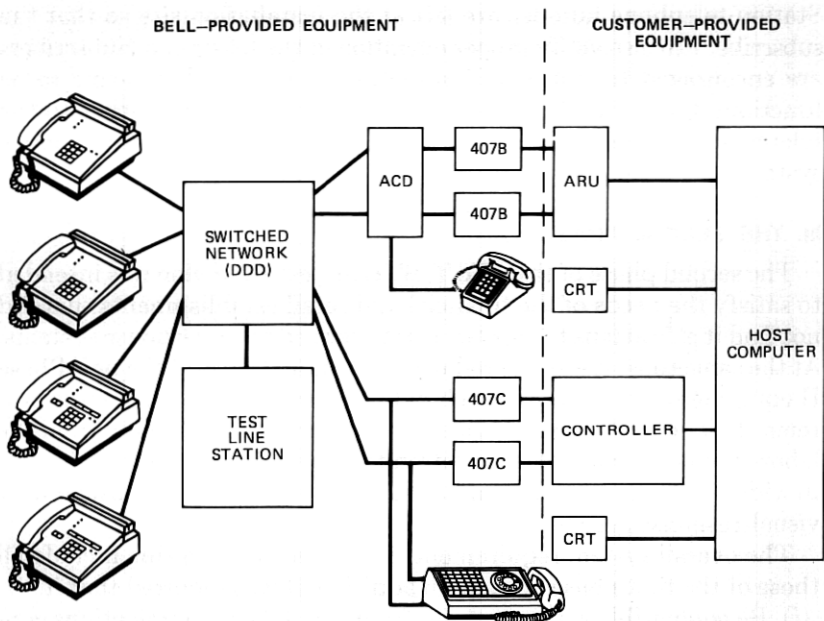


Fig. 2—Switched Network Transaction Telephone System, second phase.

voice response systems in two modes. First, the Transaction II telephone can perform in the same way as a Transaction I telephone, where the new capabilities are not used. The user is instructed to raise the handset and listen for the usual computerized voice response. Second, the data vocabulary can be recorded in the computerized voice response system in its audio version, using the frequency-shift keying (FSK) equivalent for each ASCII character. These audio FSK signals can be sent through the 407B data set's voice channel to activate the Transaction II telephones' visual display. In fact, a special 14-character subset of the full 128 ASCII character code can be used to activate most of the Transaction II telephone features. This special subset was specified because of the limited storage vocabulary capability of most existing computerized voice systems.

The Transaction II telephone incorporates features which facilitate working into digital front-end controllers and at the same time retain a compatibility which permits simultaneous limited support of Transaction I telephones. The Transaction II telephone transmits the inquiry data as *TOUCH-TONE* characters using the same transmission format as the Transaction I telephone except for the leading terminal-type identification characters. All data inquiries begin with terminal identification characters that specify the Transaction II telephone's mode of operation. If the Transaction II telephone is being used in a voice response mode, that is, like a Transaction I telephone, the terminal-type identification characters are the same as for a Transaction I telephone.



If, on the other hand, the Transaction II telephone is being used in its usual data response mode, the terminal-type identification characters specify that a data response is expected. Each data center specifies the modes of operation it will support by encoding certain characters on the dialing cards which it provides to the subscriber. The Transaction II telephone's internal data receiver can be set for either 110 or 150 b/s FSK-modulated responses. The data responses can contain up to 120 characters, which are buffered by the telephone until they are needed. After verifying the validity of the data response by checking parity and error control characters, the Transaction II telephone divides the response into three fields of data.

The first field, the action field, is executed to control the switchhook, response lamps, and other terminal control features. The second field is the display field. After executing the action field, the first eight characters of the display field are presented. The clerk may page through the display, eight characters at a time, by pressing the ERASE button. The third field, the print field, is reserved for use in the third-phase offering.

### **3.2 407C data set**

The 407C data set is a completely new unit whose design is based on microprocessor technology. It offers all the features of the 407B data set plus an array of significant expanded capabilities. In addition to receiving and decoding *TOUCH-TONE* signals and presenting them to the customer's equipment in a parallel 2-out-of-8 format, the 407C can translate them into the parallel binary-coded matrix form used by certain commercial voice response units. Not only does the 407C interface Transaction telephones to computer systems with voice response systems, it also presents an interface to digital front-end telecommunications controllers. The data processing system need support only low-speed serial interfaces of the kind used by Teletype-like terminals, and the 407C will make the connection to the Transaction telephone system.

In its serial mode of operation, the 407C translates the incoming *TOUCH-TONE* inquiry into a serial ASCII data stream. Each *TOUCH-TONE* signal is converted into an 8-bit ASCII character. The 407C also verifies the validity of the inquiry by checking the error control characters which are generated in the Transaction I and II telephones.

The data set performs a number of specialized interfacing functions for various digital front-end controller configurations. The 407C provides 18 options which are selectable by the customer. Data transmission can occur at rates of 110, 150, or 300 b/s. Automatic disconnect and "computer down" features can be enabled, as can initiation of referrals from the terminal.

End-of-message sequences can be selected to match a particular computer system. Other options allow buffering messages, inserting the punctuation characters expected by the Transaction II telephone, and implementing the error control protocol of the Transaction II telephone. The expanded error control and specialized interfacing functions of the 407C data set simplify interfacing to existing data base facilities. Thus, through the customer's selection of the options provided by the 407C, the interface format and protocol can be tailored to suit the customer's telecommunications hardware and software installation.

In the serial mode, the 407C converts the ASCII response from the computer to a Transaction II telephone into the FSK form that can be transmitted through the network. At the same time, the 407C permits simultaneous limited support of Transaction I telephones by sending answer tones to light response lamps. The 407C data set includes extensive self and remote test capabilities to facilitate system maintenance.

### **3.3 Transaction Telephone Test Line Station**

To facilitate Transaction II telephone maintenance, a modified Transaction Telephone Test Line Station was introduced to support it. This new test line station was designed to test all the new features of the Transaction II telephone as well as perform the Phase I tests on the Transaction I telephones. Due to the microprocessor-based design of the 806E data auxiliary set, no hardware modification was needed to provide the new testing capabilities. Instead, additional programming was done to accomplish the changes. The programming was done in a modular fashion so that all the initial program was retained intact and a new program was added. Since the program is stored in integrated circuits, it was possible to update existing units to become an 806E2 DAS in the field.

All Transaction II telephones are shipped with a magnetic striped test card which the installer and subscriber can use to verify proper operation of the Transaction II telephones in a manner similar to that for Transaction I telephones. The magnetic stripes on the Transaction I and II test cards are the same, but the testing instructions on the cards are different. Thus, a knowledgeable installer needs to have only one test card. The detailed test procedures for Transaction II telephones are quite different, however, in that they exercise the data receiver, the display, and the hands-free mode of operation.

## **IV. THE THIRD PHASE**

The third phase of the AT&T/BTL project team plan was intended to augment the Phase II offering by providing a simple means of generating receipts at the terminal location under control of the data center

computer. Starting in 1977, the production of Transaction II telephones included a jack for connection to the Transaction printer. These Transaction II telephones and a preproduction printer design were given a technical evaluation from late 1976 through early 1977. Western Electric Company is now delivering standard production Transaction printers.

The Transaction printer provides the means for printing on forms or slips of paper. ASCII-coded, FSK-modulated, response messages contain transaction data transmitted to the local Transaction II telephone from a remotely located data center. The content and format of the printer message is under full control of the data center. The third (print) field of the FSK response message to the Transaction II telephone is executed after the clerk has finished paging through the display field and has inserted paper in the Transaction printer. The print field contains the text to be printed and control characters to activate special printer features.

The top of the printer is designed to support the Transaction II telephone so that the units can be stacked to conserve counter space. When top mounting is undesirable, the Transaction II telephone may be located on the same surface as the printer (on either side) with a connecting cord which is provided. A detailed description of the Transaction printer is contained in a companion paper<sup>3</sup> in this issue.

To facilitate maintenance of the Transaction II telephone with printer, a third version of the Transaction Telephone Test Line Station was introduced. This new test line station was designed to test Transaction II telephones with printers, as well as to perform the Phase I and II tests. Kits of parts were distributed to upgrade test line stations to this third version.

## **V. SUMMARY**

As the financial and retail establishments of our society move toward the implementation of electronic funds transfer systems, the Bell System has been actively developing and offering an expanding variety of terminals and systems to coincide with their ever-increasing communication needs. In the process of responding to these needs, three phases of new offerings have been trialed and subsequently introduced. The first phase introduced the Transaction I telephones, 407B data sets, and the Transaction Telephone Test Line Station to provide a simple means of evolving from manual-entry/audio-response systems into automatic-entry/audio-response systems. The second phase expanded our system offering to include Transaction II telephones, 407C data sets, and an upgraded Transaction Telephone Test Line Station to satisfy the communication needs of establishments that did not choose to support computerized audio systems. The third phase provided a simple means of generating receipts at the terminal location under control of the data center computer.

## REFERENCES

1. W. E. Baker, R. M. Dudonis, and J. H. Kee, "Transaction Network, Telephones, and Terminals: Transaction Stations," B.S.T.J., this issue, pp. 3487-3502.
2. "Data Set 407 Interface Specification," Bell System Technical Reference PUB 41408, Preliminary, June 1975.
3. H. G. Mattes and B. A. Wright, "Transaction Network, Telephones, and Terminals: Transaction Printer," B.S.T.J., this issue, pp. 3517-3529.