The Application of a Large-Scale Electronic Computer to the Assignment of Telephone Facilities

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THE APPLICATION of telephone facilities based on customer requests for service is today performed on a manual basis throughout the telephone industry. The General Telephone Company of California will be the first operating telephone company which will install a large electronic computer, the International Business Machine Corporation's (IBM) 705, to process such service requests. At the present time there are 930,000 telephones installed in the General Telephone Company of California system and the company's growth in the past has been at an accelerated rate. This rapid growth and future potential has embarked the company on a large scale EDPM (Electric Data Processing Machine) program to handle assignment of telephone facilities. The machine is scheduled for delivery in late 1958.

First, some terms and concepts that will be used will be defined.

Central Office

A central office is a complex housing of the necessary equipment to serve a geographical area. At the present there are 66 such offices in Southern California. The cables serving these areas originate in the central office, together with such telephone equipment as X-blocks, line finders, and power and switching equipment. This paper is mainly concerned with the cables, and will just state that the other terms used are also necessary in supplying telephone service. In addition, telephone numbers are reserved and held in the central office for present customers and future assignment. A call originating in a subscriber's home is routed through its respective central office to its ultimate destination.

Terminal and Pairs

A terminal, or terminal box, contains the ends of the wires enclosed in the cable emanating from the central office. There are essentially two wires necessary for every telephone connection and this pair of wires is called, briefly, a pair. There are usually 2,121 pairs per cable, and terminal boxes come usually in 11-, 16-, or 26-pair complements. Larger terminal boxes are available for such buildings as apartment houses, office buildings, etc.

A pair is connected to the lugs in a terminal box and when service is desired by a subscriber, it is connected to the subscriber's phone, thus making a complete circuit from central office to terminal to subscriber's home and back again. A terminal will usually serve several houses.

In order to give a wider distribution to pairs in a cable, they are spliced so that the same pair, each of which has a number assigned to it as do the terminals, may appear in several terminals, which in turn can appear in different locations. Therefore, a single pair is available to be assigned in a larger area than it would be if it terminated in only one terminal. Since one pair is used for a multiple party line, only the ringing frequency being different for each party, multiple subscribers living in scattered areas may share the same pair. There is another very important reason for such splicing of pairs and it will be discussed later. Those terminals having pairs in common are called associated terminals.

Machine translation will probably be unable to compete with human translation on either a time or economic basis until a high-speed electronic reader has been developed that is satisfactory in a translation application.

From Fig. 3 it can be seen that this group is from the West Los Angeles central office, referring to cable number 1234, and containing pairs 1 to 51 of that cable. Terminal 238, or briefly T-238, is a 16-pair terminal located at 2800 Butler Avenue. The assignment of pair 1 with a telephone number of...
4-3701 has been shown, the prefix being understood from the central office in which it occurs. It is a 2-party residential service, the "2" and the "R" under their respective headings denoting this, and the terms "X-block" and "line finder" indicate the columns which will contain the numbers of these facilities once they are assigned. It can be seen from the pair number column that T-238 contains pairs 1 to 16, T-1945 contains pairs 11 to 26, and T-1634 contains pairs 21 to 36. In addition the assignment has been shown of pairs 12 and 21 to T-1945 and T-1634 respectively, assuming the remaining pairs to be assigned in one way or another. Such a group as in Fig 3 is used by the company in assigning terminals and pairs on a manual basis, by visually determining those which are available and hence can be assigned.

Having defined the basic concepts involved, the EDPM processing of a customer's request for service will be discussed.

This request for service, called a service order, is taken at any one of the 20 commercial offices scattered throughout Southern California. This service order, one of approximately 4,000 per day, is transmitted via telephone lines to the central EDPM section in Santa Monica, California where the IBM 705 will be situated. In addition to service orders arising in the field, information as to new facilities which have been established and emergency assignments will also be sent to the EDPM section to update the master files. The entire physical facilities available to the company are stored on magnetic tapes, and the customers' requests are processed against these files to find the facilities peculiar to the service desired. This service requested may take the form of a 1-, 2-, or 4-party business or residence phone; a change from one type of service to another; the removal of a phone; a color telephone or an extension cord; or a host of other possibilities.

At the EDPM section the service orders are transcribed to punched cards, several cards per service order, and these cards are transcribed onto two magnetic tapes as follows:

1. The service order file, containing only that information necessary to find the proper physical facilities. This information consists basically of street name, house number, and type of service desired.
2. The "other information" file, containing information extraneous to the assignment of facilities, such as subscriber's name, color telephone and extension cord if desired, etc.

The service order file is the one processed through the system to assign the facilities. The service order file is now matched against a magnetic tape file called the address file. This file contains the address of every house in the area served by the company which has physical plant facilities assigned to it. The first step is to find the terminal number of the terminal box serving the subscriber's house, extract this terminal number, together with other pertinent information, and write out a new service order magnetic tape.

This new service order file is now processed against the terminal file which contains all the terminals in the system, approximately 160,000 in number, together with the pair numbers contained in each terminal and information consisting of the present status of each pair. In addition, each terminal carries with it its associated terminal numbers.

The primary objective now is to find an available pair (namely, an unassigned pair) in the terminal serving the customer's house, which will fit exactly the service requested. For example, if the request is for a one-party service, a pair must be found among the 26 pairs which is completely free. If the request is for a 2-party service, a pair must be found having only one other customer on it (the same pair is used for multiple parties, only the ringing frequency for each varies). If this fails, then an available pair must be found to be designated as a 2-party pair.

Take the example of a request for a single party service and further, say that no available pair exists in the terminal involved. Other means are now introduced to try to satisfy the customer's request. In Fig. 3 let T-238 be the terminal serving the subscriber's home. The IBM 705 searches T-238 for an available pair and suppose there is none. The search does not end here. For, the next associated terminal of T-238, namely T-1945, is searched, and this terminal associated now with T-1945, namely T-1634, is searched, and this
The procedure is repeated throughout the group until either an available pair in the group is found or the search is unsuccessful. In the latter case the service order is printed out as being unable to be served, and held for the next day's processing, when the addition of new facilities or the removal of a pair from an existing subscriber may remedy the situation.

In the example, pair 31 in T-1634 is available and the search ends here. The problem now is to reflect this opening in T-238 and here another very important reason for the overlapping of pairs in terminals is evident.

A Mr. Smith has a one-party line in T-1634 and has been assigned pair 21 which is also common to T-1945. Mr. Smith is now moved to pair 31 in T-1634, this procedure called, in telephone parlance, a “cut”. The mechanical procedure consists simply of moving pairs around in the terminal box. Mr. Smith still has his one-party service and same telephone number and couldn’t care less about the switching of pairs. Now pair 21 is free in T-1634 and what is most important in T-1945.

Now a Mr. Jones has a one-party line using pair 12 in T-1945 which is also common to T-238, the terminal in which we are interested. Another cut is now performed which moves Mr. Jones from pair 12 to pair 21, thus freeing pair 12 in T-238 and giving the subscriber the service he wants. The same impartiality of Mr. Smith toward the procedure is also evidenced by Mr. Jones; however these changes must be reflected in the records stored on magnetic tape. There will be made at most two such cuts in order to assign a line, but the programming is such that any number within a group can be encompassed. Of the 4,000 service orders daily, approximately 1,000 will involve cuts of the type just described.

The IBM 705 will perform the above complicated analysis and will be programmed to do this so that the rear-

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*Drandell—Application of a Computer to Telephone Facilities*
An Experiment in Mechanical Searching
of Research Literature with RAMAC

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A LITERATURE searching system which can store for retrieval information on 25,000 documents has been developed at the International Business Machines Corporation (IBM) Research Laboratory, San Jose, California. This was accomplished on an IBM 305 Random Access Memory Accounting Computer (RAMAC) in a research project aimed at gaining experience in information retrieval while providing functional aid to the technical library at the laboratory.

This system is an outgrowth of a study conducted by J. J. Nolan of IBM Product Planning which demonstrated the practicability of the 305 as a tool for information searching.1

When a researcher has a question that may be answered in the literature in the library, his inquiry is used to search through a dictionary of terms in the RAMAC, which then prints out a bibliography of titles with their library location numbers.

Description

The IBM 305 RAMAC shown in Fig. 1 contains a disk memory, a card reader and printer, punch, a drum for processing, a typewriter for manual input/output, necessary control panels, operator controls, and logical circuitry equipment.

The memory unit is composed of 50 magnetic disks and has a capacity of five million characters which are divided into 50,000 records of 100 characters, see Fig. 2. Any record is obtained by positioning the access arm at the desired address and reading its information onto the processing drum or into one of the output devices.

SYSTEM PHILOSOPHY

As a result of experience from working with an IBM 101 card searching system, the following principles determined the approach to the operation:

1. The system was to be evolutionary in nature. Operating experience dictates possible improvements or necessary modifications.
2. As much of the work as practicable, such as the machine coding of input words and the direct bibliography print-out, would be done by the machine.
3. Human effort on input processing would be held to a minimum on the premise that a majority of the information put into the system will never be called for, so that the work in entering such information will be essentially wasted.
4. All effort spent on output is productive; therefore, work would be concentrated on that part of the program.

INFORMATION PREPARATION

Documents are normally sent to the retrieval office from the library immediately after the routine processing there is completed. A 5-digit serial number is assigned to identify the document within the system and two types of cards are punched.

The first is a bibliography card that will be used to identify the document in response to a search. This card contains the serial number, library location number, author, title, and date. The second is an input card used to describe the document within the machine system. It contains the serial number and as many words as necessary to describe the information content of the document. Word length is limited to ten characters. Combinations such as “spectrophotometer” are divided into logical word units, e.g., spectro, photometer.

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