LESSON 15:
APPLICATION SOFTWARE AND ENHANCED SERVICES

Objective

The objective here is to learn application software and enhanced services.

Introduction

APPLICATION SOFTWARE

We can divide application software of an electronic switching system into three main classes:

1. Call Processing software.
2. Administrative software.
3. Maintenance software.

A soft ware package is described by the following:

(i) Its organisation.

(ii) The data structures it uses.

(iii) The processing functions it performs.

Application software packages of an electronic switching system use a modular organisation. The software packages are divided into program modules. Each module of the software deals with H specific task. The size of the module change depending on the task. In general the modules are not self contained. They exchange data with other modules, either directly through interfaces or indirectly through data tables.

Functional units corresponding to independent functions can be constituted by grouping of various modules together. A module may be a part of more than one function unit. Usually, a functional unit runs as a separate process in the system. The modules of a process are strung together through special programs or chaining tables. Fig, 15.1 illustrates modu1e chaining through tables, each module is associated with a pointer to a set of entries in the chaining table pertaining to that module. Each entry in the chaining table consists of a key and a module number. Whenever a module completes execution, its corresponding entries in the chaining table are scanned. Therefore, the keys are compared to a function states key. If there is a complete matching, then the corresponding module in the chaining entry is executed next. This approach provides flexibility for adding new modules to a function or deleting old modules, it is done by simply modifying the chaining data.

Application software acquires about 80% of the total volume of the software in electronic switching system. Administration and maintenance software programs together constitute about 65% of the total volume. The total software of the switching system comprises between 400000 and 500000 machine instructions. The entire software need not be core resident. In real time constraint consideration the system software and call processing application software are usually core resident. The administration and maintenance software modules reside on a back up storage and are brought into the main memory as and when required. The operating system may use overlay or virtual memory

technique for this purpose. It depends on the architectural support available from the switching processor.

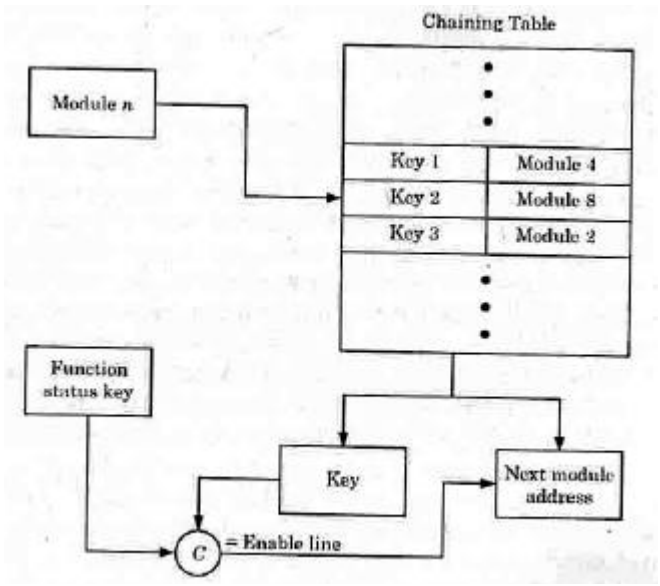

Fig. 15.1 Illustration of Module chaining through table.

A parameterised design is almost always used by switching system software. This enables the same package to he used over a wide range of telephone exchanges by adopting the package to specific exchange characteristics. The parameters used are of two types:

1. System Parameters.
2. Office Parameters.

The system parameters offered flexibility at the overall system level.

But the office parameters define program execution limits at specific exchange. The system parameters are the same at all exchanges of a given type. For example signalling time delays fault thresholds etc.

Examples of office parameters are the number of subscribers, the number of instantaneous calls, etc.

Usually, more than 100 office parameters define the characteristics of an exchange.

Parametric data are stored in the form of tables or files in the system. Parametric data is of two types: either semi-permanent or temporary.

Semi-permanent data:

This data consists of parameters that describe the hardware characteristics of the exchange and its environment. These data are updated rat-her infrequently, say when there is an expansion of the exchange.

Temporary data

These data have a lifetime equal to that of the process they pertain to. They define the state of the system resources and temporary links resources. These data include all the information specific to the process.

Semi-permanent data are used by all the three application areas, viz, call processing, exchange administration and line maintenance. Semi-permanent data contain information about:

1. Junctors.
2. Switching network matrices Markers
3. Scanners and
4. Distributors

These devices arc permanently interconnected. For example, a scanner receives signals from a specified set of junctors or lenses.

A marker is used to set up a specific circuit through the switching network.

Telephone exchange hardware description files kept information on such aspects usually; we maintain two different semi-permanent files for above purpose:

i. Terminal Circuit Connection file
ii. Switching network configuration file

Terminal circuit connection file has 4 fields in each record:

i. Associated Distributor address
ii. Associated Scanner address
iii. Switching Network address
iv. Physical Location address

The first three fields are self explanatory. Physical location address field identifies the rack in which the terminal circuit is housed. This entry is used for maintenance and test purposes. Every terminal circuit need not have an entry in the file. Usually, only one scanner or distributor serves groups of 16 or 32 terminal circuits.

Groups of 16 or 32 terminal circuits are housed in the same rack.

They arc usually connected to a set of switching network points which may also be identified as a group. In such a case, only one entry per group of terminal circuits is required in the file. This reduces the file size.

A Telephone switching network is made up of a single stage or multistage blocks. These blocks are connected through intermediary distribution frames. The connections within the block are prefixed and inter block connection differ from exchange to exchange. The switching network configuration file contains information about the inter block connections.

The description of exchange environment is responsible for the maintenance of the following information:

1. Connected subscriber lines.
2. Trunks towards other exchanges.
3. Rules of digit translation and routing.

We can extensively characterise the subscriber lines in SPC systems compared to electromechanical switching systems. Here following information is maintain:

1. Correspondence between line equipment number and directory line.
2. In-Service Status or out-of-service status.
3. Type of Telephone instrument
   # Rotary Dial Telephone,
   # Decadic push button Telephone or
   # DTMF pushbutton type Telephone
4. Nominal transmission parameters.
5. Call Restrictions
6. Subscriber's entitlement.
7. Subscriber Instructions.

Subscriber line information is quite voluminous. Therefore, the files containing this information are to be carefully structured for easy access and easy modification. Subscriber line files require two-access path:

- Equipment number based access
- directory number based access.

Equipment number based access:

When a call is originating, the only information known about the line is the equipment number. The calling subscriber's directory number is not known.

Hence, access at this stage is possible only through equipment number.

Directory number based access:

When a call is terminating, only the directory number of the called subscriber is known, Hence, access the line data at this stage is possible only through directory number.

An immediate consequence of the introduction of SPC is the availability of new and enhanced services to the subscribers. Many of the new services are offered on the optional basis. This calls for accepting instructions from subscribers and modifying the data in the files. It is logical to separate the files containing fixed information applicable to all subscribers and files that are optionally setup for some subscribers. Fig. 15.2 shows typical table entry structures for calling line data. This figure also illustrates the access mechanism for abbreviated dialling. Line data tables may be loaded anywhere in the processors memory, depending upon the space availability and allocation.

Hence, they are accessed using a base address and an offset. The base address is used to point to the beginning of the table. Offset when added to the base address points to the actual entry location.

At the first level in Fig. 15.2, the equipment number when multiplied by 2 provides the offset value. This table will have two words per entry.

Hence the need to double the equipment number. The first worked contains two parts.

1. The first part of the first word is the directory number of the calling subscriber. This directory number is needed for transmitting the calling party identification to downstream telephone exchanges or to the called party and for billing purposes.
2. The second part of the first word contains a pointer to the optional services table if the subscriber has availed any of the optional services otherwise, it has a null value.

The second word contains class of service information. The class of service information includes the type of instrument, type of line (individual telephone or public coin box), etc.

At the second level, each entry takes as many words as the number of optional services offered by the system. Here, we are assuming that each word in this entry stores information regarding one optional service. The value at the first level is suitably adjusted taking this into account. When the pointer value is added to the base address 2, the starting address of the entry corresponding to the calling subscriber is obtained. The user request for a service is converted to an offset. This offset is added to the starting address of the entry to obtain the word corresponding with that service.

In Fig. 15.2, the calling subscriber requests abbreviated dialling (AD) facility which is given by the service request number 01. The word 1 of the entry corresponding to the AD service. This service contains a pointer, ADD-PTR, to a third level table. The third level table is the AD directory for the subscribers.

An access mechanism (similar to as used in second level) gives out the directory number of the called subscriber corresponding to the AD number two.

As far as the called subscriber line data is concerned, the main purpose here is to identify the equipment number corresponding to the directory line number and class of service information with regard to reception. Now, we are assuming a 4-digit directory line, number (Telephone Exchange code excluded) a 10,000-entry table would enable one level translation. But in telephone exchanges where r. the actual number of connected subscribers is small (say 2000-5000), t many of the thousandth position digits in the directory number are not used.

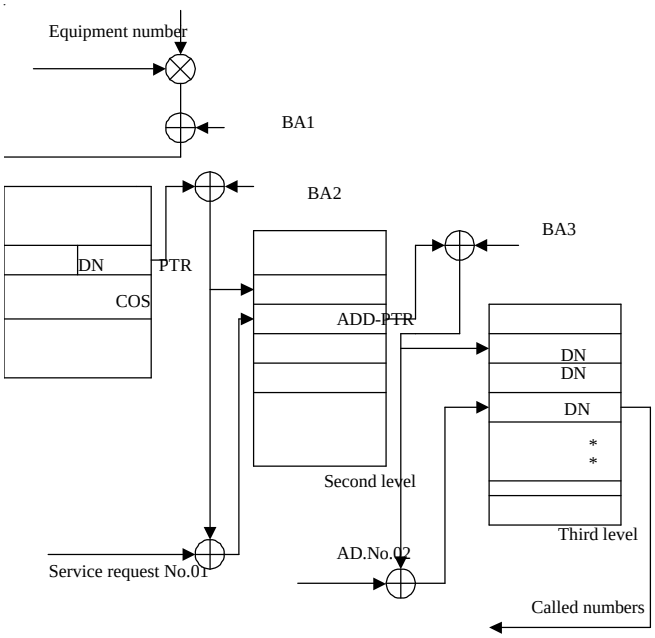

Fig. 15.2 Illustration of access to calling line data.

In these cases, a two-level translation would result in saving storage space.

Semi permanent data associated with the trunks gives the assignment of trunk groups to different telephone exchanges and the signalling method to be used for each group. If the trunk circuits in sequence are grouped together, then organisation of trunk circuit's data becomes simple. There is one entry per trunk group in the table. The centre is accessed using the group address as offset.

When a signal arrives on an incoming trunk, the trunk group is easily identified by discarding the lower order bits of the binary address of the trunk circuits. If there are 8 circuits per group, the lower three bits are discarded. The table is then accessed using higher order bits which represent the group address.

For outgoing trunks, the trunk group is determined on the basis of translation of dialled digits corresponding to the office code. In, of transit calls, the office code address recovered on the trunk. Office code address is translated to determine the trunk group.

Office code address translation can be organised by using either or pyramidal structure for the data tales. Linear structure if the number of digits to be translated is fixed. Example: Telephone environment, the number of address digits to be C -is rarely fixed. Telephone exchange codes are either 2 or 3 digits.

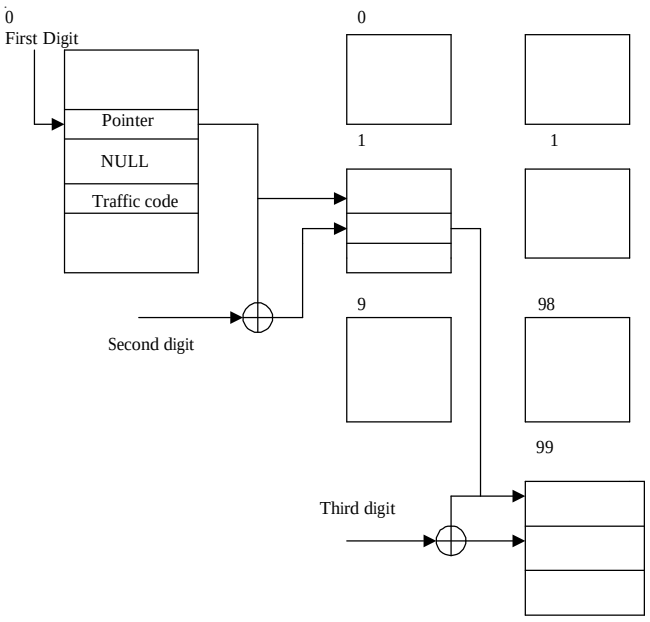

Fig. 15.3 Pyramidal structure for office code translation.

An address which starts with digit zero implies an intercity or international call requiring translation action immediately after the first digit is received. Pyramidal table structures are preferred in electronic exchanges for the purpose of this variable number of digits. Here, the digits are decoded one by one as they arrive. At each decoding level, the received digit indexes a table. The entry in the table determines the next step. Illustration of the scheme is shown in Fig. 15.3. All tables in this scheme have 10 entries each.

First Level possesses one table, Second Level possesses a maximum of 10 tables, and Third Level possesses 100 tables.

If certain digits are not used, the corresponding tables in the next level do not exist. An entry in the table may contain a traffic code, or a pointer at the beginning of block in the next level or a null value. If the particular digit combination is not used then it possesses null value. The traffic code supplies the outgoing trunk group number and the associated signalling characteristics.

There is also an alternate arrangement that an alternate trunk group number can be used in case of overflow in the primary trunk group.

Temporary data are created and modified during call processing. They define the dynamic state of resources and links. They contain the call related data that are stored in the working area of process.

Following main state description tables are used:

1. Subscriber Line State Table
2. Terminal Circuit State Table
3. Switching Network Link State Table
4. Working area of a process.

The working area of a process holds following information:

1. Call Progress Information
2. Dialled Digits
3. Translation data read from the routing tables
4. Class of service information for both calling and called subscriber etc.

Until now we have studied the organisation of the application: software and data structures used by it. Now we discuss about process functions of each of three application areas.

Call processing in electronic telephone exchanges is somewhat; similar to the one in a common control crossbar system except that most of the functions are performed by software. In actual, call processing is usually handled by a number of different software processes. These processes are created and terminated for every call by the main system control process. In addition, there are other system processes that run periodically. Therefore, these processes are used to perform certain functions related to call processing. A system process from the periodically scheduled processes scans all the subscriber lines every few hundred milliseconds looking for off- hook conditions. When an off-hook condition is detected, the matter is reported to main control process. Therefore, main control process activates another process to handle all functions associated with the calling line.

The functions include looking up the subscriber line data table to find whether the subscriber has a rotary dial, decadic pushbutton or DTMF push button telephone, allocate an appropriate digit receiver and monitor the receipt of dialled digits. The collected digits are passed on to another process. This process performs digit translation and routing. Another process obtains the routing information and set-up switching network1inks.mthe meantime a process is created to perform all the functions related to the called line.

In addition to the usual administrative functions, administrative programs in
electronic telephone exchange performs the following functions:

1. Generate traffic reports
2. Monitor traffic flow
3. Uncover traffic sensitive network or terminal problems
4. Gather information for billing.

If the traffic load exceeds the capacity of the system, an overload control process is initiated. This process reschedules priorities and frequencies of activities to ensure that the system continues to process as many calls as practicable. One method of overload control is to restrict the number of call originations per unit time. Number of call originations per unit time is restricted by delaying the sending of dial tone for a few seconds to a subscriber who goes off-hook. Maintenance programs are run for performing either diagnostic function or preventive maintenance.

During normal traffic periods, there are preventive maintenance programs. These preventive

maintenance programs take the advantage of unused real time to run test programs of hardware and to audit system memory contents for correctness and consistency.

In high traffic periods, these programs are deferred. If a fault occurs .in the system, the operating system activates unsched-

uled maintenance programs to recover the system from the fault with minimal mutilation of calls in progress. Sections of the exchange hardware may be isolated. Thus, diagnostic program run to enable maintenance personnel to fix faults.

Enhanced Services

One of the immediate benefits of SPC is that a host of new or improved services can be made available to the subscribers. Over a hundred new services have been introduced by different agencies l like CCITT. The list of services is growing day by day. Although, 170 there are large number of services available. But, these services are grouped under four broad categories.

Category 1: Services associated with the calling subscriber. These services are designed to

reduce the time spent on dialling and the number of dialling errors.

Category 2: Services associated with called subscriber. These Services are designed to increase the call completion rate.

Category 3: Service involving more than two parties.

Category 4: Miscellaneous Services.

These new services are called supplementary services. Some of the prominent supplementary services are categorized as in Table. 15.1

Table. 15.1 Supplementary Services

Category 1 Services:

1. Abbreviated Dialling (AD)
2. Recorded Number calls or No Dialling calls
3. Call back when free

Category 2 Services:

1. Call Forwarding
2. Operator Answer

Category 3 Services:

1. Calling Number Record
2. Call Waiting
3. Consultation Hold
4. Conference Calls

Category 4 Services:

1. Automatic Alarm
2. STD Barring
3. Malicious Call Tracing

Before discussing above important services, we describe the general procedure used for communicating subscriber commands to the exchange for obtaining these services.

A subscriber issues commands to an exchange to activate or deactivate a service, record or clear data in the subscriber line data area or solicit an acknowledgement from the telephone exchange. For example, a user may enable or disable STD facility on his line by using a command. A command mayor may not have data associated, with it. The number of digits in the data, when present, may vary.

The number of digits in the data depends upon the command. Consequently, subscriber commands are designed to be of variable length necessitating the use of an end-of-commands symbol. Fig. 15.4 shows the General Command Syntax

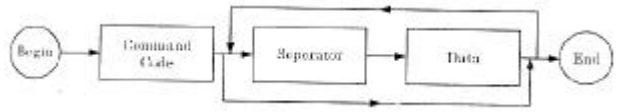

Fig. 15.4 Illustration of general command syntax.

The command code is usually a 2-digit number. In general, enhanced services are available only to subscribers with DTMF push button telephone. The two push buttons (with symbols * and #) are used extensively for communicating subscriber commands to the exchange. For easy handling of the commands at the telephone exchange end, the commands are placed under 4 groups. These are given on Table. 15.2. It also gives the most popularly used command formats with and without data for each group. The symbol * is used as a separator f. and the symbol # as the end-of-command symbol. The beginning symbols of a command depends on the group of the command. For f making abbreviated dialling (AD) a simple as possible, neither a t symbol is used to Indicate the beginning of the command nor IS f. there any command code used in this case.

Table 15.2 Various Formats for User Command

Command Group	Format
1. Service Activation and Data Recording	* CC # * CC * NNN #
2. Service Deactivation and Data Clearing	# C # # CC * NNN #
3. Interrogation	* # CC # * # CC * NNN #
4. Special Abbreviated Dialling	AN #
Where, CC = Command Code AN = Abbreviated Number NNN = Data associated with the command.	

Abbreviated Dialling:

It is denoted as AD. AD facility allows an entitled subscriber to call any of a predefined list of other subscribers by dialling just one or two digits. AD may be implemented through 'Repertory Diallers' or similar equipment attached to the telephone

Here, we are concerned with the service provided by the telephone exchange with the subscribers using simple DTMF instruments. We know that memory area is also called abbreviated Dial Directory. It is reserved for each user availing AD facility. This directory contains the abbreviated number (AN) and the corresponding full number (FN) of the subscriber to be called. Call processing program translated the AN to FN by consulting this AD directory. The data in the AD directory may

be entered and modified by an operator or the subscriber himself. If the data in the AD is entered or modified by subscriber himself then the subscriber will execute the following commands:

To record a number: * CC *AN *, FN #

To cancel a number: # CC *' AN #

To dial a number: AN #.

The use of some single digit and two-digit values as ANs may be prohibited. For example, in some countries, no AN may start with zero and no 2-digit AN may start with a one. Thus, AN range is restricted to 1 to 9 and 20 to 99 providing a maximum of 89 ANs. If any user has taken AD facility then it implies reservation of memory space in the SPC processor. Hence, the charges for the service may be directly proportional to the number of ANs a subscriber wishes to have.

Recorded Number Calls

This facility is also termed as No-dialling calls facility. This facility permits a subscriber to call a predetermined number by simply lifting the hand set without dialling any digit whatsoever. In a hot line facility, a dedicated line between the calling and called subscriber exists and no other calls are permitted using this line and instrument. Unlike a hot line facility, the recorded number call service is a programmable one. Here, the subscriber may use his telephone in the normal way and at the same time have recorded number call facility. If the subscriber goes off-hook and does not dial any digit for a few seconds then the telephone exchange automatically starts setting up the call to the previously recorded number. Such type of delay time in dialling a digit is called predetermined delay. If a subscriber dials a digit within the predetermined delay then a normal call is assumed. The subscriber may record or cancel a number to be dialled automatically by using the appropriate subscriber commands.

Automatic Redialling or Report Dialling

Whenever a call does not materialise, a subscriber would want to attempt the call again. In such a case, the subscriber can request for an automatic redialling or repeat dialling. In automatic redialling or repeat dialling, the most recently dialled number is automatically redialled by the telephone exchange. Continuous Repeat Dialling increases the call, non-completion rate. Therefore, the automatic repeat dialling is usually limited to a few trials.

Call back when Free

This feature of facility permits the calling subscriber to instruct the telephone exchange, when the called party is busy, to monitor the called line and ring him back when it becomes free. Its implementation is fairly easy within a local exchange. Monitoring distant calls requires extensive signalling between telephone exchanges.

Call Forwarding

This facility enables a subscriber to instruct the telephone exchange to forward all his calls to another number. It is relatively straightforward to implement this facility in a PABX or a local telephone exchange. If call forwarding is to be done a cross telephone exchanges, a number of difficulties arise:

1. Concern Routing
2. Charging
3. Trunk Utilization

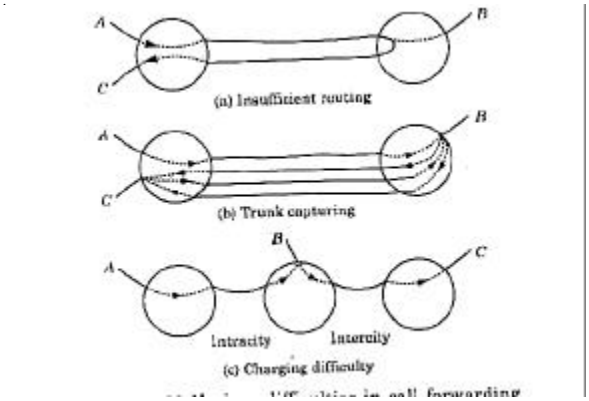

Fig. 15.5 Various difficulties in call forwarding across telephone exchanges.

Now we consider the situation shown in Fig.15.5 (a) where subscriber A calls subscriber B. Subscriber B has given instructions to forward is call to subscriber C. The subscriber C is in the originating exchange. An interchange call is now set – up instead of a local call. Now we consider another situation shown in Fig. 15.5 (b). Here subscriber A calls subscriber B who has given instructions to forward this calls to subscriber C who in turn has given instructions to forward his calls to B.

There is a ping-pong effect between subscriber Band C and soon all the trunks are used up or captured in attempting to establish the call.

Now we have another situation. It is shown in Fig.15.5 (c). Here subscriber A calls subscriber B who is in the same city.

Subscriber B has given instructions to forward his calls to subscriber C who is in another city. If subscriber A's call is forwarded to subscriber C. Now one question arises that who (A or B) should bear the cost of the intercity call. If A has to pay, he must know that his local call is being changed to an intercity call so that he has the option not to go ahead with the call.

Operator Answer Service

This service diverts all the calls of subscriber to an operator, who answers the calls, takes down messages which are communicated to the subscriber whenever he calls the operator.

With the availability of efficient and relatively cheap telephone answer machines, the usefulness of operator answer service has been diminished.

Calling Number Record Service

This service keeps a record of the numbers calling the subscriber when he is unable to attend the calls for same reason or the other. The number of calling phone numbers are recorded. These numbers are limited to a few. For example: say upto 5 most recently dialled numbers. On return, the user may request the telephone exchange to dial these telephone numbers and return the calls.

Call Waiting Facility

This feature provides an indication to a busy subscriber that another party is trying to reach him. Such type of indication is sent through a short audible tone. It lasts typically about 3 seconds.

The subscriber can do following after listening such type of tone:

1. He can ignore the incoming call and continue with the present tone.
2.. He can place the incoming call on hold and continue with the first call.
3. He can place the first call on hold and answer the new call y
4. He can release the first call and accept the new one.

Call waiting facility requires two switching paths to be set up simultaneously. Both the switching paths must use the same signaling scheme.

Consultation Hold Facility

This facility enables a subscriber in conversation to place the other subscriber on hold and contact a third subscriber for consultation. The consultation hold is equivalent to the telephone extension service used in offices where a secretary may consult the executive while holding an incoming call except that any subscriber number can be dialled for consultation. It is also possible for a subscriber to switch forth between the original parts and the consulting party performed by alternatively placing one of them on hold.

Call Facility

Is an extension of consultation hold facility. After third introduced, a conference connection is set up among all the parties then receives the speech signals. Therefore, each one can proceed with the conversation mode. Establishment of a three-party conference calls for special equipment at the telephone exchange the speech signals of two parties and provides the same on line of third party.

The arrangement of 3-party conference is shown in Fig. 15.6. For Involving N persons, total number of N separate must be performed. One summation for each person all signals required.

Method of conferencing involves monitoring the activity of persons and switching the signals of the loudest talker to all others.

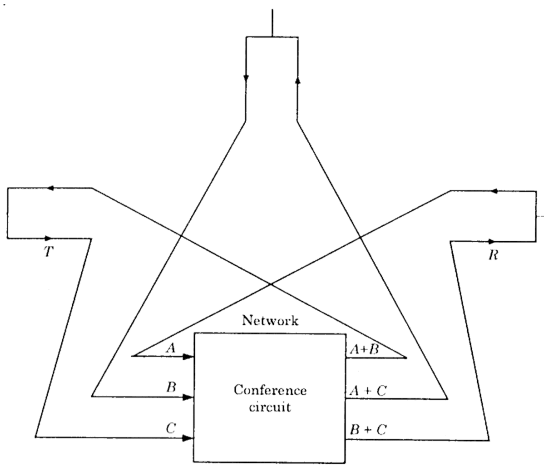

Fig.15.6 The arrangement of 3-party conference connection.

Automatic alarm call Facility

This facility allows a user to record time at which the alarm call is to be given. The SPC processor rings back the subscriber at the appropriate time back and forth between the original parts and the consulting party. Performed by alternatively placing one of them on hold.

Usually, a separate synchronous process scans a table that holds the alarm times and the corresponding subscriber numbers. A synchronous process runs periodically, say every 5 minutes. When the alarm time matches the time of the day, a ringing tone is sent to the subscriber's instrument. The ringing tone rings usually for one minute or until he answers, whichever is earlier. When the subscriber answers, a recorded greeting message is played to inform him that it is a wake-up call.

Many a time, telephones with STD/ISD facility are misused. For preventing such type misuse of telephone, we use a manual lock. This lock restricts STD/ISD calls as well as local calls.

With SPC systems, a user can activate and deactivate STD/ISD facility by signaling suitable commands to the processor.

The subscriber in this case is given a secret number that is called password. STD/ISD barring or enabling is done by the appropriate command along with password. When STD/ISD is barred, the instrument can be used freely to make local calls.

Malicious Call Tracing Facility

Malicious call tracing is easily done in an electronic telephone exchange. The exchange is usually activated by the network operator on request from the subscriber. When malicious call tracing is on, the subscriber can not avail the other supplementary services or extended services as a single button operation by the subscriber is used to obtain the complete information about the call in progress. The information includes the time of the day and the calling line directory number if it is local call; otherwise it includes the incoming trunk identification called party can have control on release of call. The circuit is not released until the call party goes on-hook. Thus the transmission path would be traced to the calling line to provide unquestionable identification of the calling line.