Lecture – 4 (Dt. 7^{th} April 2020)

Electronic Switching (EC- 8^{th} Sem)

Computer Controlled Switching System

References :

1) S. Agrawal : Lecture Notes (VSSUT)

2) Telecommunication Switching Systems & Networks, Thiagrajan

3) Telecommunication System Engineering, R.L. Freeman

4) Telecommunication Switching and Networks, By, P. Gnanasivam

5) Internet sources

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Module-II: COMPUTER CONTROLLED SWITCHING SYSTEMS

Introduction, Call processing, signal exchange diagram, state transition diagram, hardware configuration, switching system software organization, software classification and interfacing, Maintenance software, call processing software, Administration software, Electronic Exchanges in India.

INTRODUCTION

Most digital switching systems have a quasi-distributed hardware architecture, since they maintain control of the switching functions through an intermediate processors. All digital switching systems employ multiprocessor subsystem for the best understanding of communication and control process. The architecture of a working digital switching system is very complex with many subsystems. All present day digital switching system includes minimum software which are necessary for implementation of call processing for all the levels of control structure. In modern digital switching systems, many call processing functions are performed by using interface controllers. Some of the call processing are call identification, call routing, path setup between subscribers, digital translation, call status, billing etc.

CALL PROCESSING

In this section, the basic steps involved in processing a call is discussed. Most digital system follow a similar scheme. For any switching system design, the range of signals that has to be interchanged between a terminal and system is considered. These signals described in signal exchange diagram. The sequence of operation between subscribers and system are shown in state transition diagram (s.t.d.).

Basic Steps to Process a Call

The sequence of processing between subscribers are described below:

1. **Idle state.** At this state, the subscriber handset is in ‘on-hook’ condition. The exchange is ready to detect the call request from the subscriber.

2. **Call request identification.** The exchange identifies a line requiring for a service. When the handset is lifted, current flows in the line called seize signal indicates the call request.

3. **Providing dial tone.** Once the seize signal is received, an exchange sends a dial tone to the calling subscriber to dial the numbers.

4. **Address analysis.** Once the first digit received, the exchange removes the dial tone and collect all numbers. Then the address is analysed for the validity of the number, local, STD or ISD etc. If the number is invalid, a recorded message may be sent to the calling subscriber and terminates call request.

5. **Called line identification.** The exchange determines the required outgoing line termination from the address that it has received.

6. **Status of called subscriber.** The called line may be busy or free or unavailable or even out of service. In the case of PBX, where the customer have a group of lines, the exchange tests each termination until either it finds a free one or all one found busy. For busy, number unobtainable or the handset off hook, a status signal or call progress signal is sent to the calling subscribers for line termination. Now the exchange resumes idle state.

7. **Ringing.** Once, the exchange finds the called subscriber is free, power ringing is provided to the called subscriber and audible ringing to the calling subscriber.

8. **Path setup.** When the called subscriber lifts his handset, the line is looped and ringing is removed. Once the conversation started, the exchange completes the connections between the subscribers.

9. **Supervision.** The exchange supervises the connection to detect the end of the call for charging.

10. **Clear signal.** Once the need for connection is over, either customer may replace his handset. It causes the line current seize and provides a clear signal to exchange. If the calling subscriber replaces his phone set, the clear signal sent to the exchange is called clear forward signal. If called subscriber do first, the clear signal is called clear backward signal.

Signal Exchange Diagram

There are two types of diagrams used to represent the sequence of events between the subscriber and exchanges. They are signal exchange diagram and state transition diagram. Both diagrams

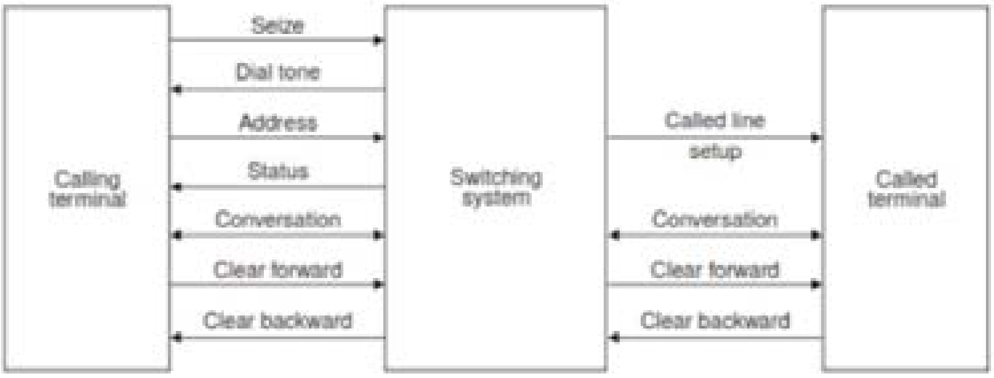


Fig. Signal exchange diagram

can be used to specify the behaviour of different control units in switching centre. For the local call, the steps involved in processing a call is shown in Fig. 6.1.Normally, once the conversation is over, the exchange will be at idle state. But in general, there are two types difficulties arises.

1. **Called subscriber held (CSH).** This condition arises when the called subscriber replaces the hand set but the caller does not. In this case, the caller does not originate a call or receiver a call.

2. **Permanent loop condition (PL).** This condition occurs when the caller replaces the phone but the called subscriber does not. Now, a loop present between called and exchange and it results in busy tone to another call to the same called subscriber. In strowger system, this condition is called permanent glow condition. In electromechanical system, the above conditions are removed by manual disconnection. In modern ESS systems, a time out process is used. If the call setup between two subscribers are made through many exchanges and trunks, the originating exchange where calling subscriber is connected sends the seize and then address to the terminating exchange where the called subscriber is connected. Remaining signalling are similar to the local call, but through the originating and terminating exchanges. In electromechanical system, the signalling between exchanges are sent through same interexchange circuits referred as channel associated signalling. In SPC controlled exchanges, interexchange signals are generated at originating exchange, but processed at terminating exchange. The signals are transferred over high speed data like instead of speech connections are referred as common channel signalling.

State Transition Diagram

The state transition diagram (s.t.d.) specifies the response of a control unit to any sequence of events. s.t.d. is a powerful design tool. It helps the designer to consider all possibilities of occurrence of events. Fig. shows the basic symbols used in a state transition diagram.

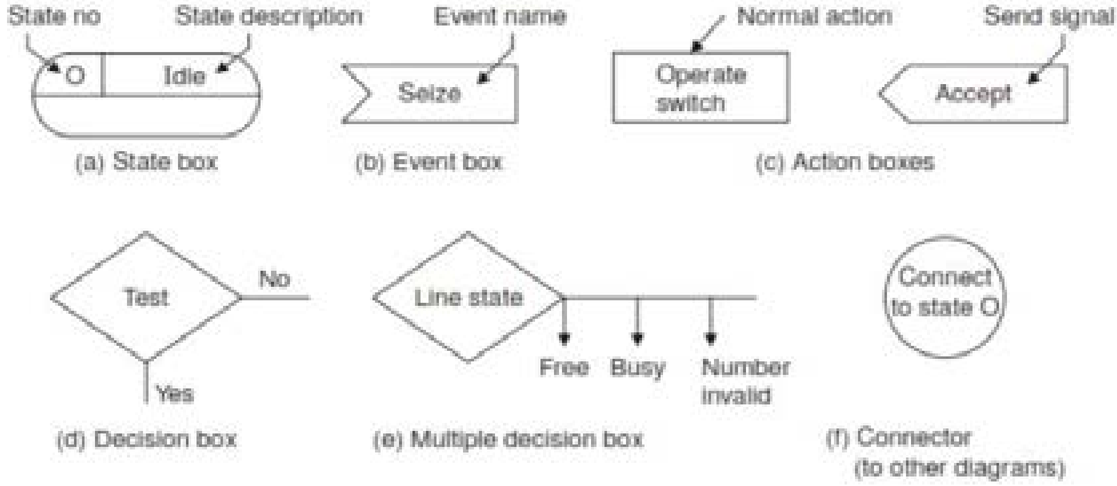


Fig. basic symbols of s.t.d.

The basic symbols are defined as follows:

State boxes. The state boxes are labelled with state number and state description. If necessary, additional information can also be included. The combination of the present state and a new event defines a task and performing this results in next state. Sometimes more than one state occurs, the choice depending on external information.

Event boxes. The intended arrow of the symbol indicate whether the event corresponds to the receipt of forward or backward signal. The forward signal and backward signal refers to the flow of signal from calling to called and called to calling subscriber through exchange respectively.

Action boxes. The rectangular box represents the action taken on the event. The protruding arrow indicates whether the signal is sent forward or backward.

Decision boxes. The diamond shaped box is used for the cases where two divisions are possible. For multiple decisions, another symbol shown in Fig. (*e*) is used.

Connectors. This symbols are used to connect one flow chart to another diagram.

Fig. shows the s.t.d. diagram for a typical local call. Let the calling subscriber is A and the called subscriber is B.

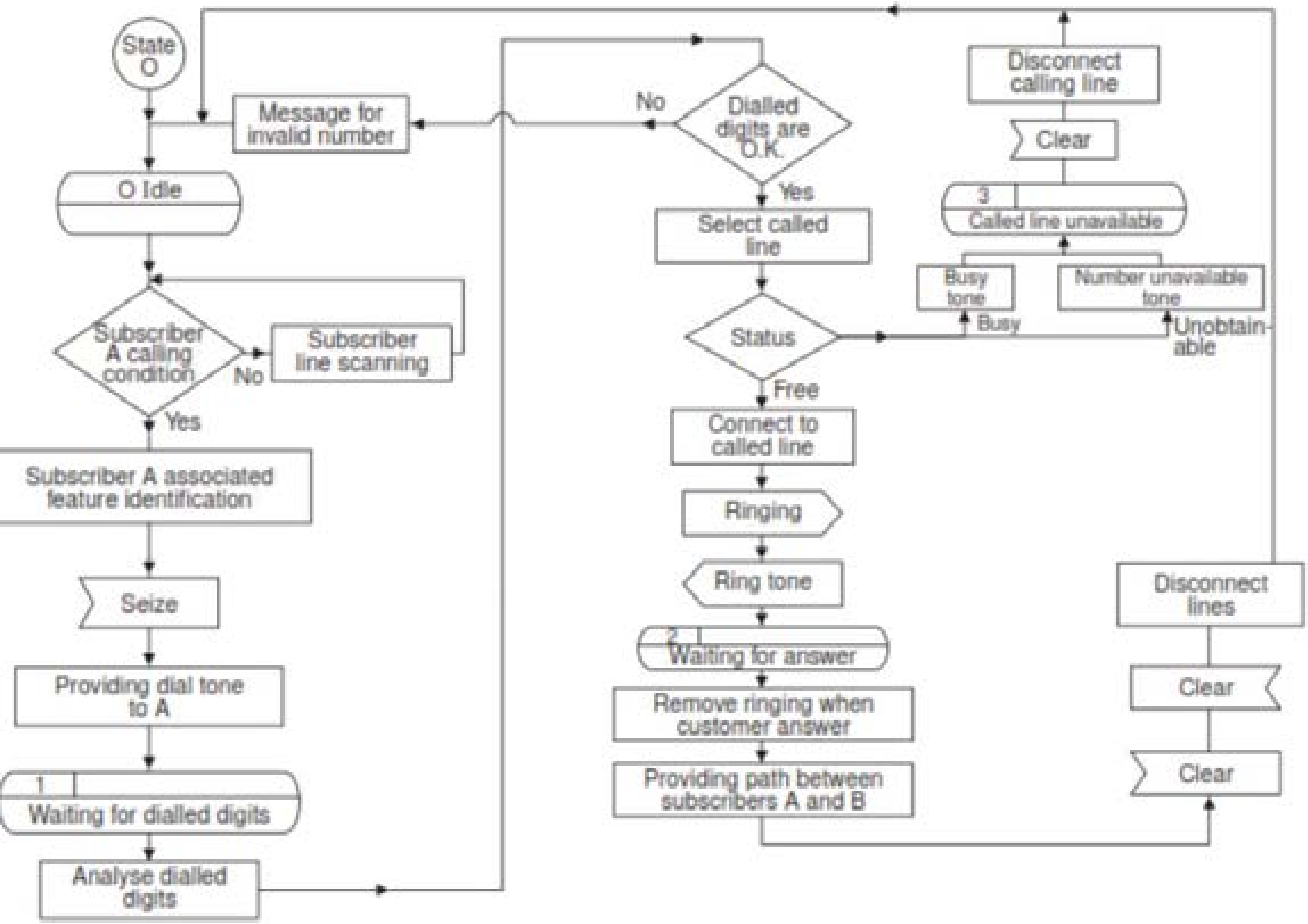


Fig. State transition diagram.

The computer controlled switching is in general referred as electronic switching system (ESS). ESS offers the greatest potential for both voice and data communications. An ESS consists of

1.computer

2. Memory or storage

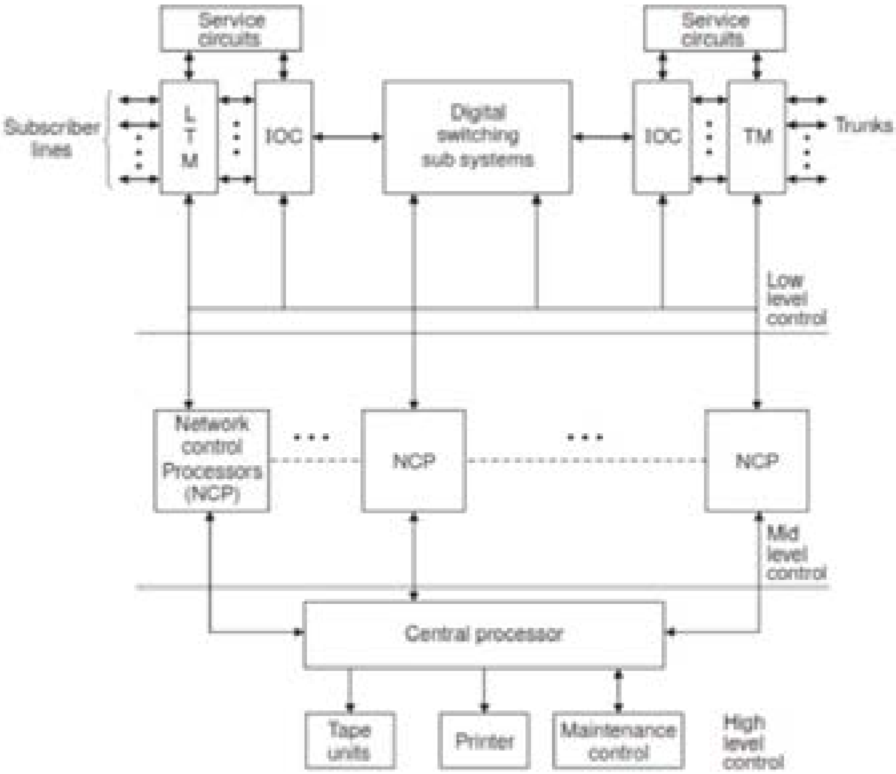
3. Programming capability

4. An extremely rapid switching component.

A computer based common control switching equipment implies two distinct type of units. They are 1. Control unit 2. Switching network. The common control receives, stores and interprets dial pulses and then selects an available path through the switching hardware to complete connection. Efficient high speed common control equipment can complete many calling connections during the time of an average phone call. Thus it saves a lot of time and money. The switching network can be used to connect many lines by one common group of control devices referred as control unit. Thus the control unit is the brain of a switching system, a control unit completes its function in a small fraction of a second for a single call. The hardware of digital switching system are broadly divided by their functions into many subsystems. The functions performed by the subsystem includes line and trunk access, line scanning, message interpretation, switching communications, path setup between subscribers, line supervision, line termination, billing providing advanced features and system maintenance. These subsystems are classified into various levels of control. Each level of control and its subsystems are tabulated in table.

Low level control	Mid level control	High level control
1. Line Terminating module 2. Trunk module 3. Input/output controller 4. Service circuits	1. Network control Processors	1. Central processors 2. Tape units 3. Printers 4. Maintenance control

A general hardware configuration is shown in Fig. However, various switching system may have different kind of arrangements of the subsystems. Most digital switching systems have a quasi-distributed hardware architecture, as the control of the switching functions are made through an intermediate processors. All digital switching systems employ multiprocessor subsystems as shown in Fig. A similar architecture is used by most of the digital telephone exchange systems. Some popular systems are AXE – 10 systems (Sweden), DMS – 10 (Canada),E – 10 system (France), No. 5 ESS system (USA) EWS D system (Germany) and the NEAX system (Japan). Fig. illustrates the hardware architecture of the digital switching system.



LTM : Line terminating modules, TM : Trunk modules,
IOC : Input/Output controller, NCP : Network control processors.

Low level control. This level associated with subscriber lines, trunks, selective circuits, Input/output controller and digital subsystems. The line terminating module and trunk modules are microprocessor based and communicate with subsystems through the input/output controllers. The input/output controllers interpret the incoming messages and takes necessary actions and communicate to the network control processors. All subscriber lines connected to digital switching system through the main distributing frame (MDF) are continuously scanned to detect the state of the subscriber.

When the customer lifts his handset, the line scanning program detects this state and reports to the input/output controller. The IOC is the primary peripheral controller and it controls all peripherals associated with call or trunk processing. At this level, all the requests of incoming and outgoing trunks are handled. Any advanced features to be incorporated in a digital switching system also handled at this level using IOC.

Mid-level control. This level is associated with network control processors and associated circuits. The IOC is controlled by the network control processors (NCP). Many NCP's are used depends on the size of the digital switching system. A dedicated bus system is usually required for the processors to communicate with one another. Specific messaging protocols are used to communicate between processors. For messaging between the peripherals and external systems, many digital switching systems utilize standard protocols such as signalling system 7(SS7); X.25 and X.75. Thus this is the most important level of control any digital switching system. Distributed processing are performed at this level.

High level control. This level associated with central processor which organizes the entire network control sub processors. In includes many subsystems like call accounting subsystems (CAS), call processing subsystems (CPS). Digital switching subsystems (DSS).Digital subscriber's switching subsystem (DSSS), Local administration (LA), maintenance control subsystems (MCS); management statistics subsystems (MSS), message transmission subsystems (MTS), signal interworking subsystems etc. This central processor is normally a main frame type computers. Thus all basic controls of a digital switching system are incorporated at this level. In real time operation, the processor determines the state of a call by reading data from memory. The store areas (not shown) include,

Line store. In this memory, the status of the line is stored. The status may be busy, free or disconnected.

Call record. All the call processing data's such as origin of a call, path of a call, and duration of a call and clearing of a call are stored.

Translation tables. Most switching system require a look-up table in order to decode routing digits into suitable routings. For electromechanical system, such tables are realized by distribution frame. Hundreds of translation tables are built for a switching system which stores data for equipment number (EN) to directory number (DN) and for DN–to–EN translation. Also it consists of, features related to a particular subscriber, data to route the call based on the first 3 digits dialled, area code translation, international call translators etc.

Map of the switching network. There are two techniques for selection junctors.

1. **Map-in-memory.** In this technique, the memory contain a bit for each link. If it is set to 1 the link is free and if this bit is set to zero, the line is busy.

2. **Map-in-network.** In this technique, the junctor itself contains a one bit memory element, which is read by the path setup program to check whether it is free. The map-in-network consumes more time, but more advantages when several processors controlling the system.