Control of Switching Systems
Unit 4
Lecture 1

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Introduction

- Earlier electronic switching system was based on the stores program control (SPC) system in which temporary memory was used for storing different information.
- Digital systems employ multiprocessor subsystem for the best control. So software are necessary to implement the processing system for all of control structure.
- In digital switching systems, call processing functions are performed by using interface controllers.
- Different software system used for switching control are also explained along with the stored program control concept. Microprocessor is mostly used for controlling in the digital switching system to reduce the cost of call processing.

Call Processing Functions

- It is similar to common control cross bar system except that the most of the functions are performed by software or by using interface controllers.
- Some of basic functions of call processing system are:
  - Call identification
  - Call routing
  - Path setup between subscribers
  - Call status
  - billing
  - Digital translation
- Generally call processing takes place independent of switching network.

Sequence of operations:

1. **Idle state:** In this first sequence the exchange is ready to accept any call request from the subscriber.
2. **Call request identification:** At the 'off hook' condition or when the subscriber lift the handset, there is a current (About 25 mamp) in the line which is called seized signal, indicate the exchange that there is a call request from the subscriber.
3. **Providing dial tone:** After receiving the seized signal, the exchange sends the dial tone to the calling subscriber to dial the number.
4. **Address analysis:** The exchange remove the dial tone after receiving the first digit and collect the whole number. Then address analysis is done like validity of the number, whether local, STD or ISD etc. for invalid number a recorded message is sent to the subscriber.
5. **Called line identification:** From the dialled number the exchange identify the called line or termination line.

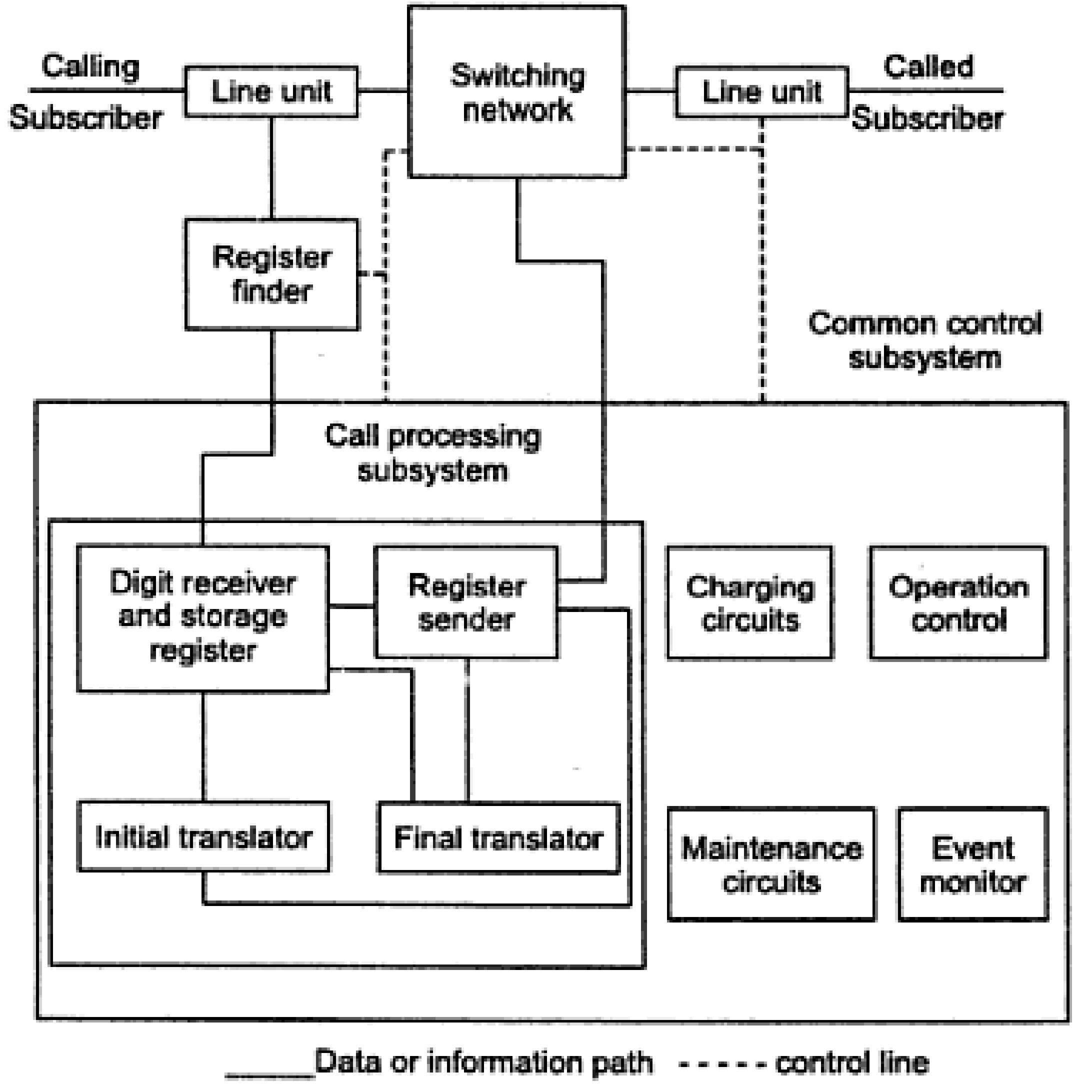
Sequence of operations (Cont.)

6. **Status of called subscriber:** The called line may be busy or free or unavailable or out of service. In case of busy, number unobtainable or busy tone is sent to the calling subscriber. For other cases, recorded messages are sent to the calling subscriber.
7. **Ringing:** Whenever the exchange find the called subscriber free, power ringing is sent to the called subscriber and audible ringing to the calling subscriber.
8. **Path setup:** Once the called subscriber lifts handset, the ringing is removed and the exchange make the complete connection between the two subscribers.
9. **Supervision:** The exchange works as a supervisor during conversation to detect the end of the call for charging.
10. **Clear Signal:** Once the conversation is over, either subscriber may replace his/her handset. If the calling subscriber replaces his/her handset then a clear signal is sent to the exchange known as clear forward signal and for called subscriber the clear signal, known as clear backward signal sent to the exchange.

Common control

- In this method there is no connection made until entire number is received. The number is stored in a memory and the information conveyed by the number is translated by the logic circuitry into instruction to switch contact mechanisms which then contact the appropriate connections.
- After establishing the connection, the logic circuitry is free to service other calls. So, subscriber handling capacity is much more.
  - In step by step switching system there were disadvantages like for the entire call duration the whole set of switches including contacts and relay mechanisms are busy and are not available for servicing other calls.
  - For a particular number, the subscriber location is fixed
  - Slow switching system.
  - Responds only one subscriber at a time, so limited facility.

Common control switching system Diagram



Common Control Switching System

Reliability availability and security

- In case of common control system the exchange depend on a small number of equipments. So that they must be designed for high **reliability** to obtain long mean time between failures (MTBF). In stored program control (SPC) system, the software must be very reliable.
- Without **security** the existence of a system comes under doubt. therefore, security should be provided in the switching system. Measured should provide security i.e. to ensure correct operation even when faults are present in the system. The security measures that are used are as follows:
  - Line circuits : none
  - Switching network : none (or partial duplication)
  - Common controls :1 in n sparing
  - Central processors: Replication

- As the termination unit of the subscribers line contain very few components, so that it suffer less fault than the line itself. No additional measures are required to obtain the availability. If each incoming trunk has access to a sufficient no. trunks on each route to give the required GOS is known as limited availability. The availability is defined as:

$$A = \frac{MTBF}{MTBF + MTTR}$$

MTBF = Mean time before failure

MTTR = Mean time to repair

Stored Program Control

- Stored program control (SPC) is a broad term designating switches where common control is carried out entirely by computer. In some exchanges, this involves a large, powerful computer. In others, two or more minicomputers may carryout the SPC function.
- With other switches, the basic switch functions are controlled by distributed microprocessors. Software may be hard-wired on one hand or programmable on the other.
- In most cases these also work in the binary digital domain. The crossbar markers and registers are typical examples. The conventional crossbar marker requires about half a second to service a call. Up to 40 expensive markers are required on a large exchange.
- Strapping points on the marker are available to laboriously reconfigure the exchange for subscriber change, new subscribers, changes in traffic patterns, reconfiguration of existing trunks or their interface, and so on.
- A simple input sequence on the keyboard of the computer workstation replaces strapping procedures. System faults are displayed as they occur, and circuit status may be indicated on the screen periodically. Due to the high speed of the computer, post dial delay is reduced. SPC exchanges permit numerous new service offerings, such as conference calls, abbreviated dialing, “camp-on-busy,” call forwarding, voice mail, and call waiting.

Basic SPC Functions

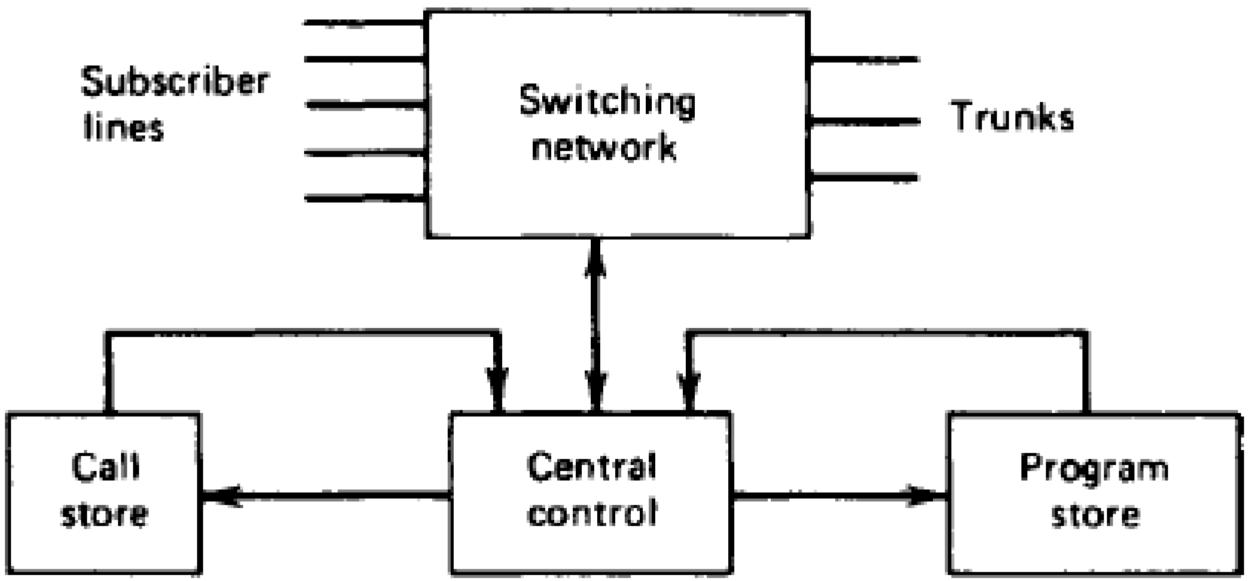
There are four basic functional elements of an SPC switching system:

1. Switching matrix
2. Call store (memory)
3. Program store (memory)
4. Central processor (computer)

The earlier switching matrices consisted of electromechanical cross-points, such as a crossbar matrix, reed, correed, or ferreed cross-points. Later switching matrices employed solid-state cross-points.

The call store is often referred to as the “scratch-pad” memory. This is temporary storage of incoming call information ready for use, on command from the central processor. It also contains availability and status information of lines, trunks, and service circuits under internal switch-circuit conditions. Circuit status information is brought to the memory by a method of scanning. All speech circuits are scanned for a busy/idle condition. The program store provides basic instructions to the controller (central processor). In many installations, translation information is held in this store (memory), such as DN to EN translation and trunk signaling information.

Functional Diagram of an SPC exchange



A simplified functional diagram of an SPC exchange.

Availability:

Single Processor :

$$\text{Availability (A)} = \frac{MTBF}{MTBF + MTTR}$$

where MTBF = Mean time between failures

MTTR = Mean time to repair

$$\therefore \quad \text{Unavailability (U)} = 1 - A = 1 - \frac{MTBF}{MTBF + MTTR}$$

$$\Rightarrow \quad U = \frac{MTTR}{MTBF + MTTR}$$

If MTBF >> MTTR, then

$$U = \frac{MTTR}{MTBF}$$

Dual Processor :

The MTBF of a dual processor is given by,

$$(MTBF)_D = \frac{(MTBF)^2}{2\,MTTR}$$

where $(MTBF)_D$ = MTBF of dual processor.

A dual processor system is said to have failed only when both the processors fail and the total system is unavailable.

$$\text{Availability } (A_D) = \frac{(MTBF)_D}{MTTR + (MTBF)_D}$$

$$= \frac{\dfrac{(MTBF)^2}{2\,MTTR}}{MTTR + \dfrac{(MTBF)^2}{2\,MTTR}}$$

$$= \frac{(MTBF)^2}{(MTBF)^2 + 2\,(MTTR)^2}$$

$$\text{Unavailability } (U_D) = 1 - A_D$$

$$= 1 - \frac{(MTBF)^2}{(MTBF)^2 + 2\,(MTTR)^2}$$

$$= \frac{2\,(MTTR)^2}{(MTBF)^2 + 2\,(MTTR)^2}$$

If MTBF >> MTTR

$$\therefore \quad U_D = \frac{2\,(MTTR)^2}{(MTBF)^2}$$

Question Sample

Calculate the unavailability for a single and dual processor systems for 5 years and 10 years if MTBF = 2000 hrs and MTTR = 4 hrs.

Solution.

Given, MTBF = 2000 hrs.

MTTR = 4 hrs.

Unavailability of single processor,

$$U = \frac{MTTR}{MTBF} = \frac{4}{2000} = 2 \times 10^{-3}$$

for 5 years, $U = 24 \text{ yrs} \times 365 \text{ days} \times 5 \text{ years} \times 2 \times 10^{-3}$

for 10 years, $U = 24 \text{ hrs} \times 365 \text{ days} \times 10 \text{ years} \times 2 \times 10^{-3}$

$= 175.2$ hrs.

Unavailability of dual processor,

$$U = \frac{2\,(MTTR)^2}{(MTBF)^2} = \frac{2 \times 4^2}{(2000)^2} = 8 \times 10^{-6}$$

for 5 years, $U_D = 24 \times 365 \times 5 \times 8 \times 10^{-6}$

$= 0.35$ min

for 10 years, $U_D = 24 \times 365 \times 10 \times 8 \times 10^{-6}$

$= 0.7008$ hrs.

$= 4.2$ min

COMPARISON OF THREE MODES OF CENTRALISED SPC

Stand by mode	*Synchronous duplex mode*	*Load sharing mode*
(*i*) One processor is active and another one is stand by.	(*i*) Two processors are active and execute the same function.	(*i*) Two processors are active and execute the different function *i.e.*, share the load.
(*ii*) Common secondary storage is used.	(*ii*) Separate secondary storage is used.	(*ii*) Separate secondary storage is used.
(*iii*) In case of overload, performance is not good.	(*iii*) Performance is good in the overload traffic.	(*iii*) Much better performance in case of handling the overload traffic.
(*iv*) This mode has no capacity to handle large exchange.	(*iv*) Has good capacity to handle large exchange.	(*iv*) Increases the effective traffic capacity by 30 percent compared to synchronous duplex mode.
(*v*) Purely centralised stored program control.	(*v*) Centralised stored program control system.	(*v*) One step forward to the distributed stored program control.