Electronic Switching

Unit -1

Evolution of Switching systems

Content Overview

- Evolution of Switching systems
- Message Switching
- Circuits switching
- Functions of a switching system
- Crossbar switch
- General Trunking system
- Electronic switching
- Reed electronic system
- Digital switching systems.

Evolution of Switching systems

The switching system is a collection of switching elements arranged and controlled in such a way as to setup a communication path between any two distant points.

- **By the early 1800's scientists had developed ways to generate and transmit electricity.**
- **1819, oersted discovered the relation between magnetism and electricity.**
- **Ampere, Faraday and others continued this work in 1820. In 1834, Gauss and Weber wired over the roofs of Gottingen to make a telegraph system.**
- **Samuel F.B. Morse's developed the first significant work in telecommunication. F.B.**

- Morse developed code telegraphy in 1837. In 1844, a 40 mile telegraph line was setup between Baltimore and Washington by F.B. Morse. In 1845, Morse formed a telegraph company based on his technology.

- In 1849, the first slow telegraph printer link was setup. In 1874, Ban dot Introduction to Switching Systems 3 invented a "Multiplexes" system which enables up to six signal from telegraph machines to be transmitted together over the same line.

- The early stages of the development of telecommunication were due to A.G. Bell, G. Marconi and C.E. Shannon. In 1876, Bell invented a telephone system.

- In 1897 Marconi patented a wireless telephone system.

Switching Networks

- Long distance transmission is typically done over a network of switched nodes.
- Nodes not concerned with content of data.
- End devices are stations Computer, terminal, phone, etc.
- A collection of nodes and connections is a communications network Data routed by being switched from node to node.

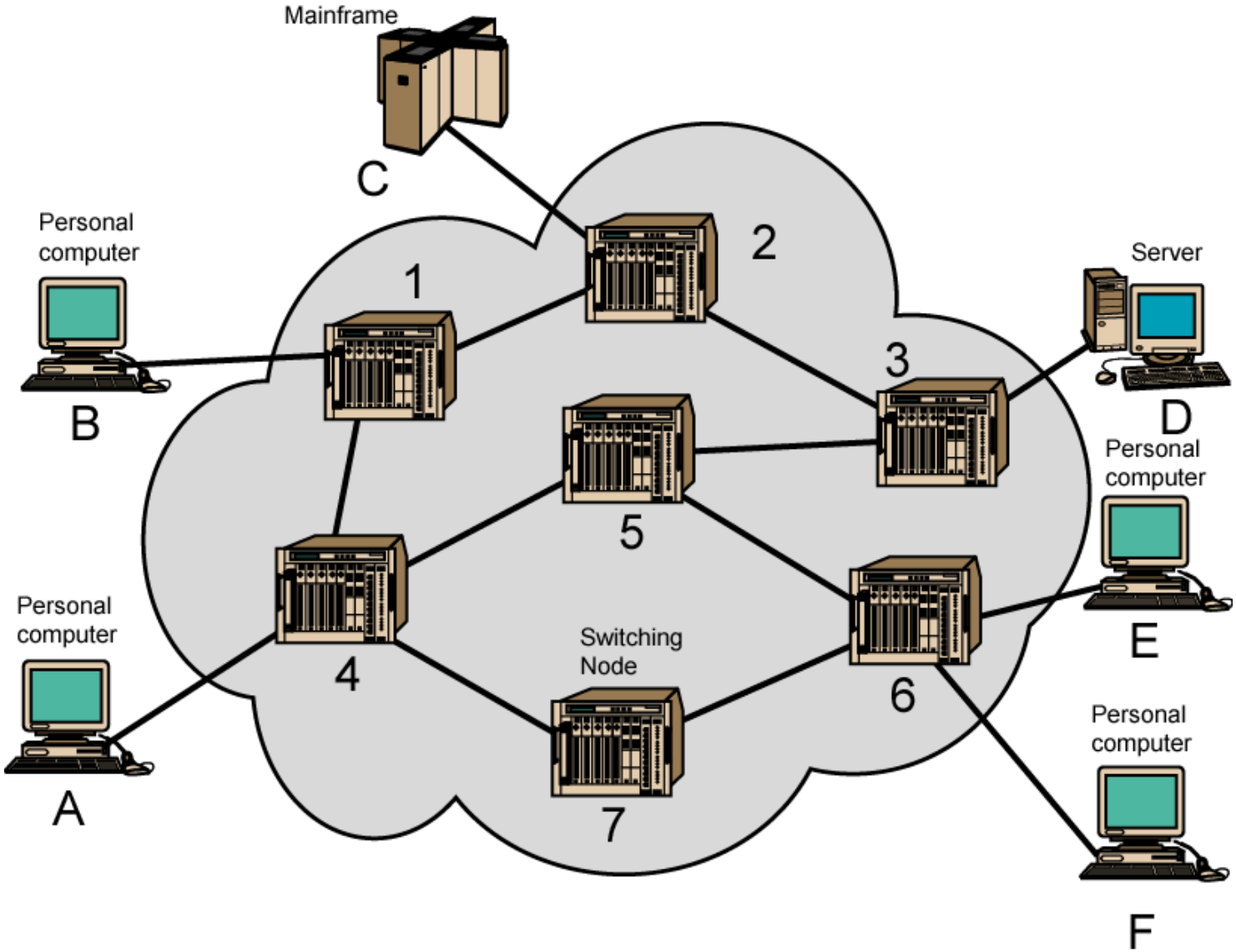
Nodes

- Nodes may connect to other nodes only, or to stations and other nodes
- Node to node links usually multiplexed
- Network is usually partially connected
- Some redundant connections are desirable for reliability
- Two different switching technologies

  Circuit switching

  Packet switching

Simple Switched Network



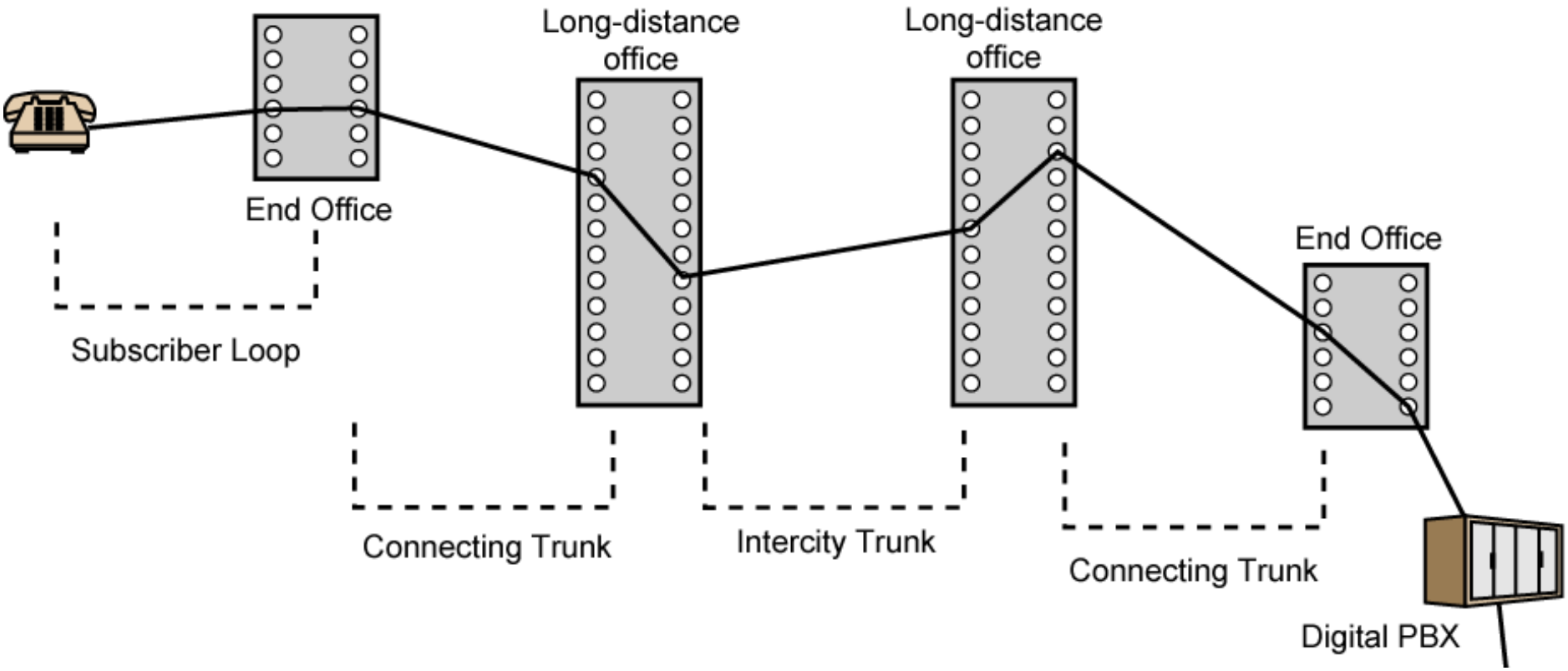
Circuit Switching

- Dedicated communication path between two stations
- Three phases
  - Establish
  - Transfer
  - Disconnect
- Must have switching capacity and channel capacity to establish connection
- Must have intelligence to work out routing

Circuit Switching - Applications

- Inefficient
- Channel capacity dedicated for duration of connection
- If no data, capacity wasted
- Set up (connection) takes time
- Once connected, transfer is transparent
- Developed for voice traffic (phone)

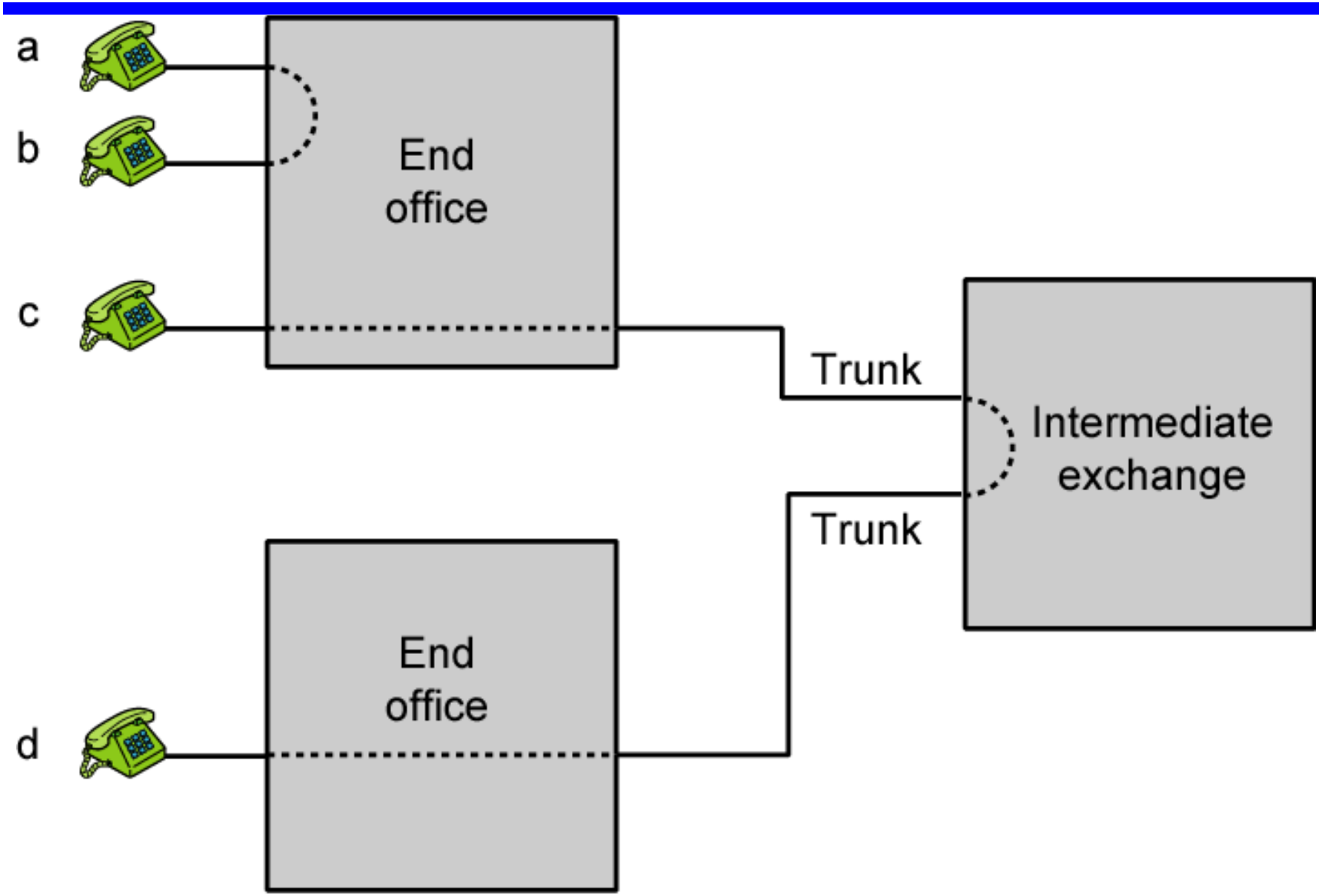
Public Circuit Switched Network



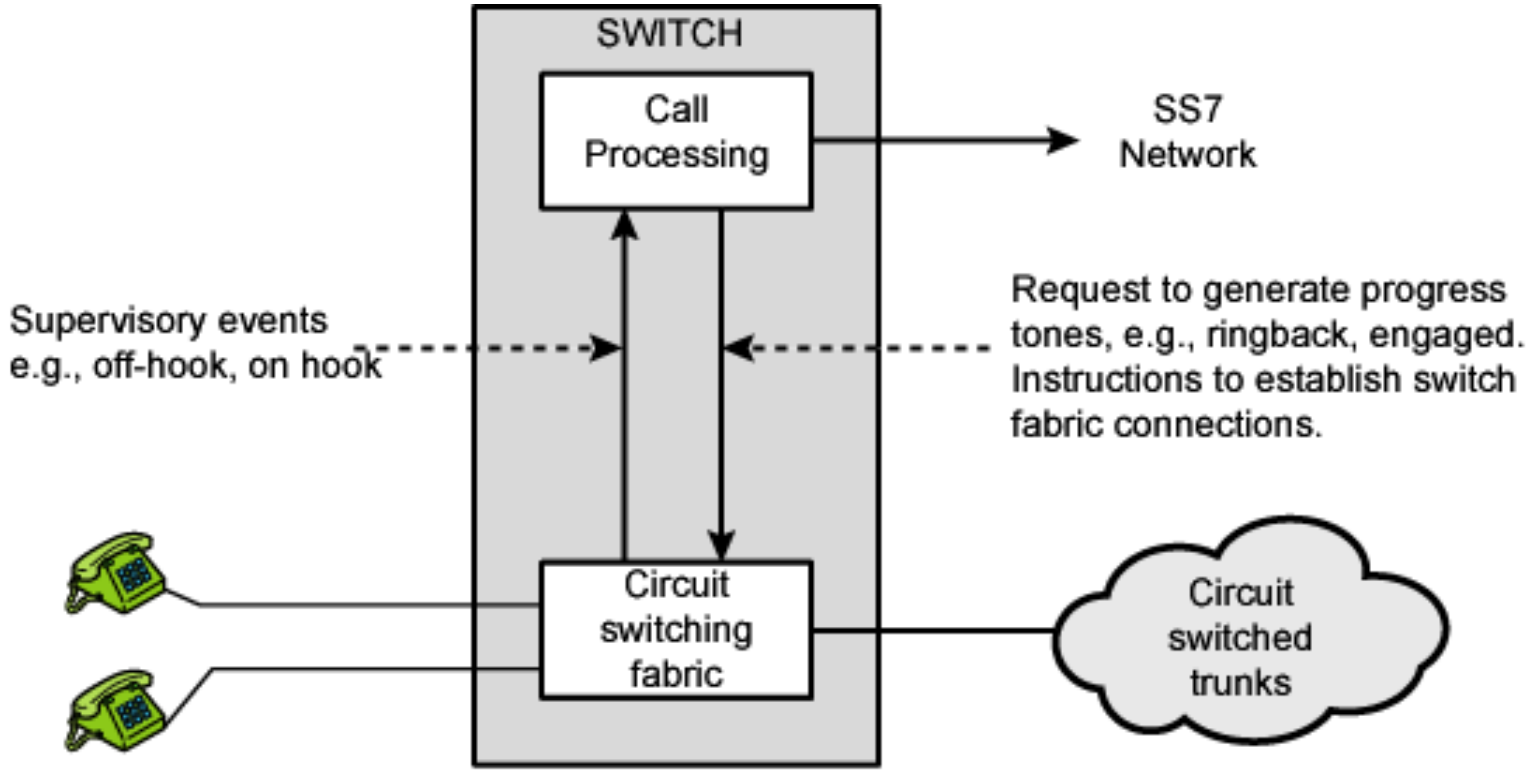
Telecomms Components

- Subscriber
  - Devices attached to network
- Subscriber line
  - Local Loop
  - Subscriber loop
  - Connection to network
  - Few km up to few tens of km
- Exchange
  - Switching centers
  - End office - supports subscribers
- Trunks
  - Branches between exchanges
  - Multiplexed

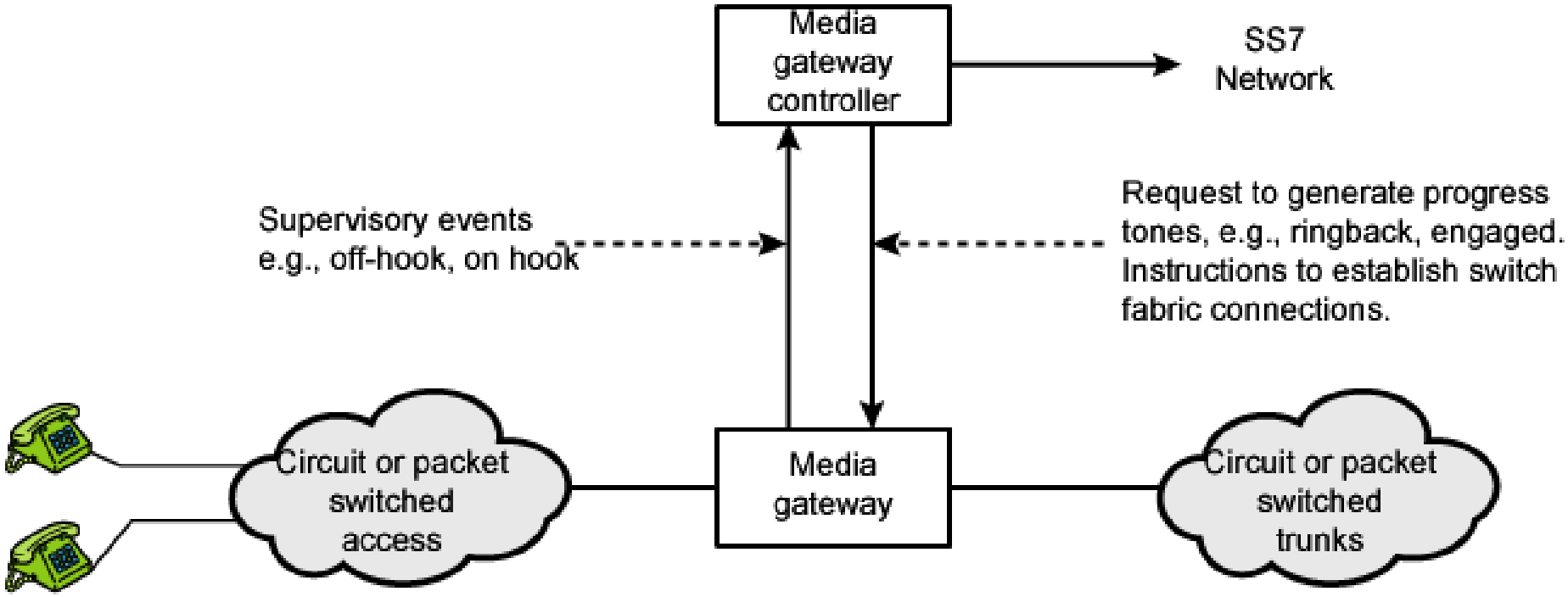
Circuit Establishment



Traditional Circuit Switching



Soft switch


Media gateway controller
SS7 Network
Supervisory events e.g., off-hook, on hook
Request to generate progress tones, e.g., ringback, engaged. Instructions to establish switch fabric connections.
Circuit or packet switched access
Media gateway
Circuit or packet switched trunks

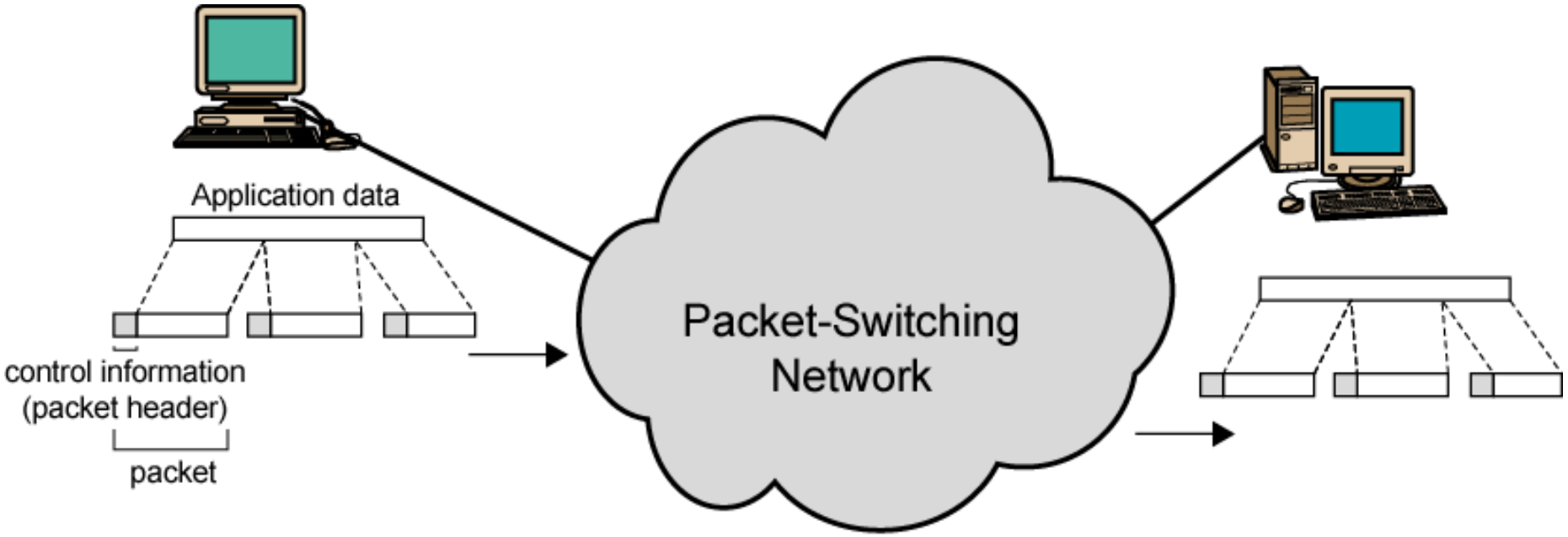
Packet Switching Principles

- Circuit switching designed for voice
- Resources dedicated to a particular call
- Much of the time a data connection is idle
- Data rate is fixed
- Both ends must operate at the same rate

Basic Operation

- Data transmitted in small packets
  - Typically 1000 octets
  - Longer messages split into series of packets
  - Each packet contains a portion of user data plus some control info
- Control info
  - Routing (addressing) info
- Packets are received, stored briefly (buffered) and past on to the next node
  - Store and forward

Use of Packets



Advantages

- Line efficiency
  - Single node to node link can be shared by many packets over time
  - Packets queued and transmitted as fast as possible
- Data rate conversion
  - Each station connects to the local node at its own speed
  - Nodes buffer data if required to equalize rates
- Packets are accepted even when network is busy
  - Delivery may slow down
- Priorities can be used

Switching Technique

- Station breaks long message into packets
- Packets sent one at a time to the network

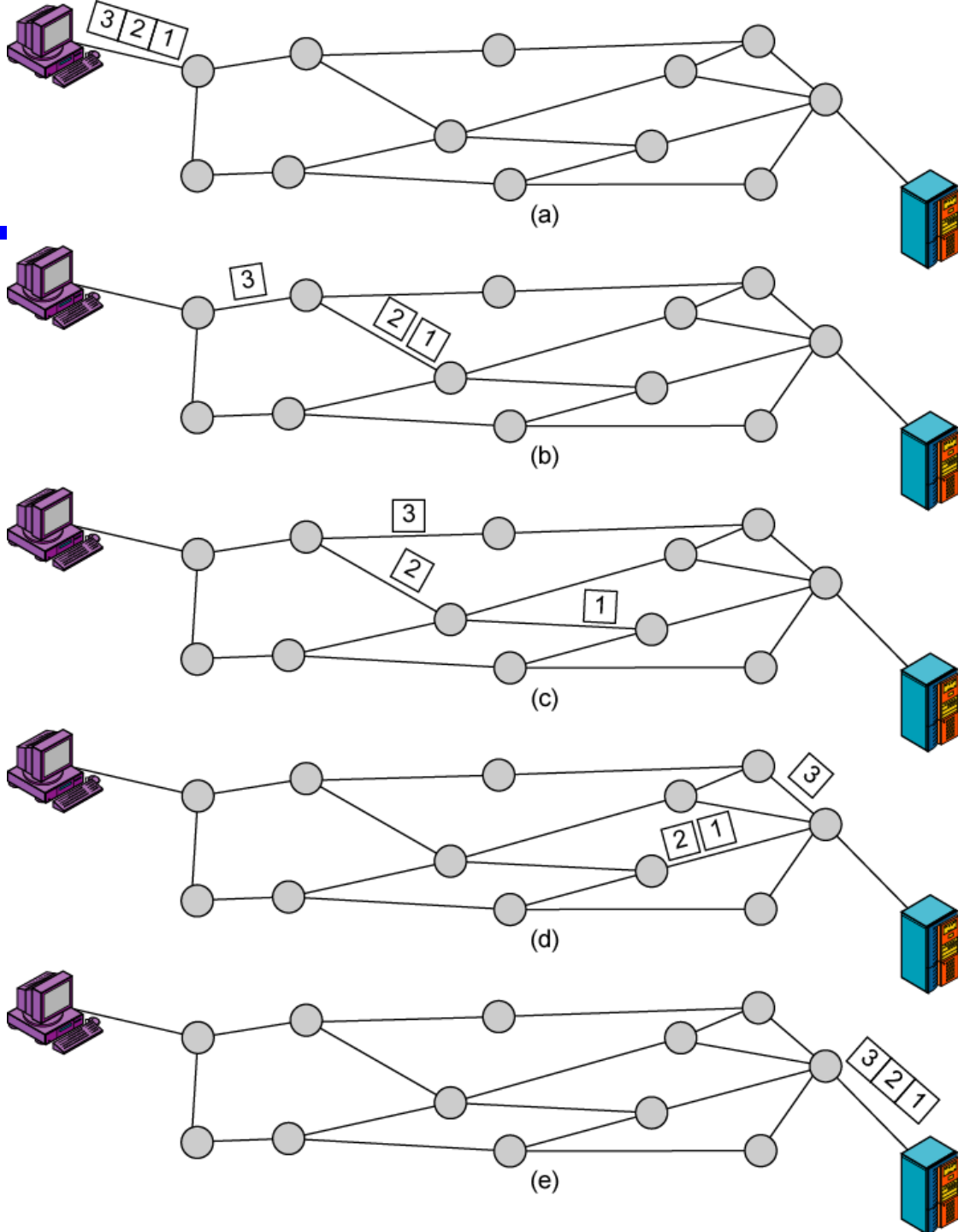
- Packets handled in two ways

  - Datagram
  - Virtual circuit

Datagram

- Each packet treated independently
- Packets can take any practical route
- Packets may arrive out of order
- Packets may go missing
- Up to receiver to re-order packets and recover from missing packets

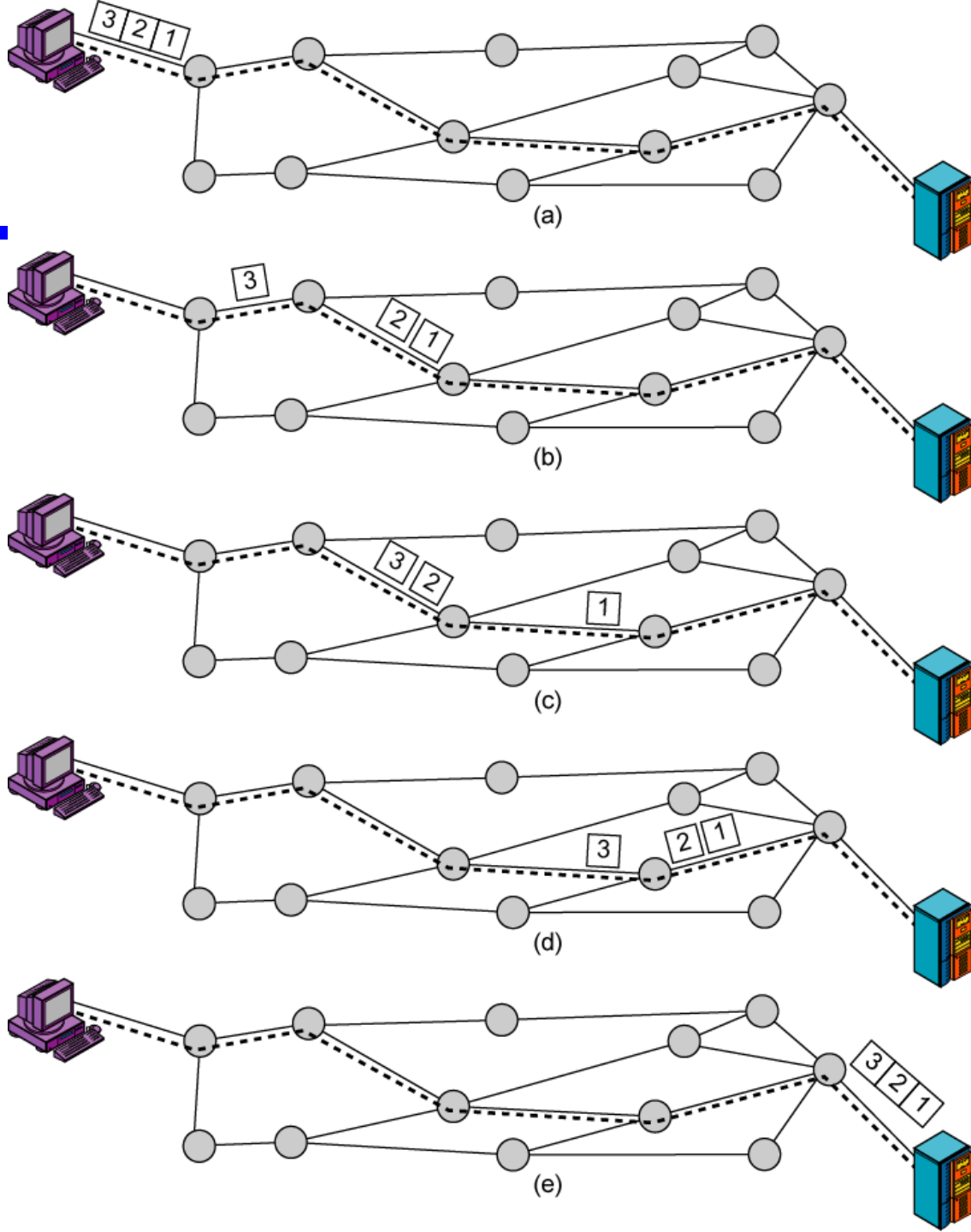
Datagram Diagram



Virtual Circuit

- Preplanned route established before any packets sent
- Call request and call accept packets establish connection (handshake)
- Each packet contains a virtual circuit identifier instead of destination address
- No routing decisions required for each packet
- Clear request to drop circuit
- Not a dedicated path

Virtual Circuit Diagram



Virtual Circuits v Datagram

- Virtual circuits
  - Network can provide sequencing and error control
  - Packets are forwarded more quickly
    - No routing decisions to make
  - Less reliable
    - Loss of a node looses all circuits through that node
- Datagram
  - No call setup phase
    - Better if few packets
  - More flexible
    - Routing can be used to avoid congested parts of the network

Circuit v Packet Switching

- **Performance**
  - **Propagation delay**
  - **Transmission time**
  - **Node delay**

Comparison between Message and Circuit switching

Message switching	Cirtuit switching
The source and destination do not interact in real time	The source and destination are connected temporarily during data transfer.
Message delivery is on delayed basis if destination node is busy or otherwise unable to accept traffic.	Before path setup delay, may be there due to busy destination node. Once the connection is made, the data transfer takes place with negligible propagation time.
Destination node status is not required before sending message.	Destination node status is necessary before setting up a path for data transfer.
Message switching network normally accepts all traffic but provides longer delivery time because of increased queue length.	A circuit switching network rejects excess traffic, if all the lines are busy.
In message switching network, the transmission links are never idle.	In circuit switching, after path setup, if the users denied service, the line will be idle. Thus, the transmission capacity will be less, if the lines are idle.

Circuit Switching	Datagram Packet Switching	Virtual Circuit Packet Switching
Dedicated transmission path	No dedicated path	No dedicated path
Continuous transmission of data	Transmission of packets	Transmission of packets
Fast enough for interactive	Fast enough for interactive	Fast enough for interactive
Messages are not stored	Packets may be stored until delivered	Packets stored until delivered
The path is established for entire conversation	Route established for each packet	Route established for entire conversation
Call setup delay; negligible transmission delay	Packet transmission delay	Call setup delay; packet transmission delay
Busy signal if called party busy	Sender may be notified if packet not delivered	Sender notified of connection denial
Overload may block call setup; no delay for established calls	Overload increases packet delay	Overload may block call setup; increases packet delay
Electromechanical or computerized switching nodes	Small switching nodes	Small switching nodes
User responsible for message loss protection	Network may be responsible for individual packets	Network may be responsible for packet sequences
Usually no speed or code conversion	Speed and code conversion	Speed and code conversion
Fixed bandwidth	Dynamic use of bandwidth	Dynamic use of bandwidth
No overhead bits after call setup	Overhead bits in each packet	Overhead bits in each packet

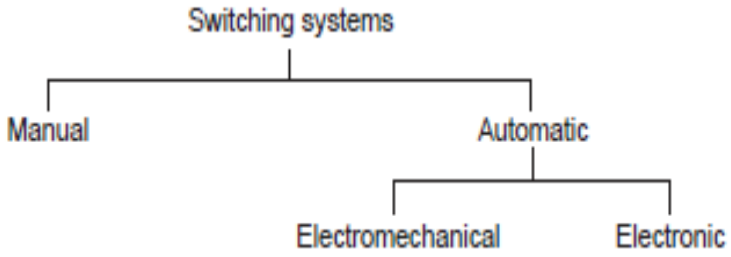
Switching system

- In early days, the human exchange provided switching facilities.
- In manual exchanges, a human operator and the elements like switches, plugs and sacks were used to connect two subscribers.
- Around 1890's many electromechanical switching devices were introduced.
- Till 1940, different electromechanical switching system were invented, of which strowger switching system and cross bar switching system were still popular.

Classification of Switching System

Switching systems Classification

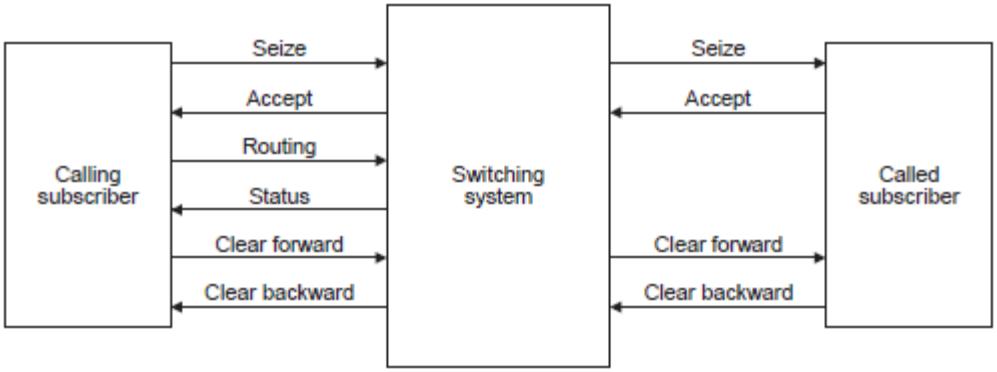
- **Manual**
- **Automatic**
  - **Electromechanical**
  - **Electronic**



Functions of Switching System

The switching office performs the following basic functions irrespective of the system whether it is a manual or electromechanical or electronic switching system.

- **Identity: The local switching center must react to a calling signal from calling subscriber and must be able to receive information to identify the required destination terminal seize.**
- **Addressing : The switching system must be able to identify the called subscriber from the input information (train of pulses or multiple frequency depends on the dialing facility).The address may be in same local centre or some other exchange. If the terminal or trunk group is busy, a suitable signal must be returned to the calling subscriber. If more than one free circuit, particular one will be selected.**



Simple signal exchange diagram.

- **Busy testing : If number dialled by the calling subscriber is wrong or the called subscriber is busy (not attending the phone) or the terminal may be free (lifting the phone) but no response (not willing to talk or children handling), a switching system has to pass a corresponding voice message or busy tone after waiting for some time (status).**

- **Finding and path setup : Once the calling subscriber destination is identified and the called subscriber is available, an accept signal is passed to the switching system and calling subscriber. Based on the availability, suitable path will be selected.**
- **Supervision. Once the path is setup between calling and called subscriber, it should be supervised in order to detect answer and clear down conditions and recording billing information.**

- **Clear down : When the established call is completed, the path setup should be disconnected. If the calling subscriber keeps the phone down first, the signal called clear forward is passed to the switching system. If the called subscriber keeps the phone down first, a signal called clear backward signal is passed to the switching system. By clear signal, the switching system must disconnect the path setup between calling and called subscriber.**

- **Billing : A switching system should have a mechanism to meter to count the number of units made during the conversation. The cumulative number of units made for a particular duration by the calling subscriber is calculated. This information and if any should be sent to the called subscriber.**

Manual Switching System

- In the manual exchange (until 1892), the control was provided by a human operator and the elements of the switch assemblies are plugs and jacks.
- Limitations of manual exchanges :
- Language dependent. The operation of a human exchange is language dependent as the subscriber needs to communicate with the operator. In multilingual areas (big towns, cities and tourist spots). This language dependency poses severe problems.
- Lack of privacy. As a human operator is involving in connecting two subscribers, he or she may be willing to hear the conversation of two VIP's or record the message. So in human exchanges, privacy is not possible.

- **Switching delay. Before setting a path between two subscriber, the operator has to monitor various signalling and if the operator is not active, the delay in switching will be high normally it takes minutes to setup a call or release a call.**
- **Limited service. An exchange can provide service only to minimum number of subscriber. If the subscriber rate increases, overload and thus congestion are not unexpected.**
- **To avoid congestion, more hardware should be duplicated and more human operator is necessary. These all will results in large overhead for the exchange.**

- **Several electromechanical switching system were developed around 1880–1890 to eliminate the limitations of manual exchanges and to establish automatic exchanges to improve the speed and carry more leads (subscribers). Among those electromechanical automatic switches, strowger's step by step switching system was the most pupular.**

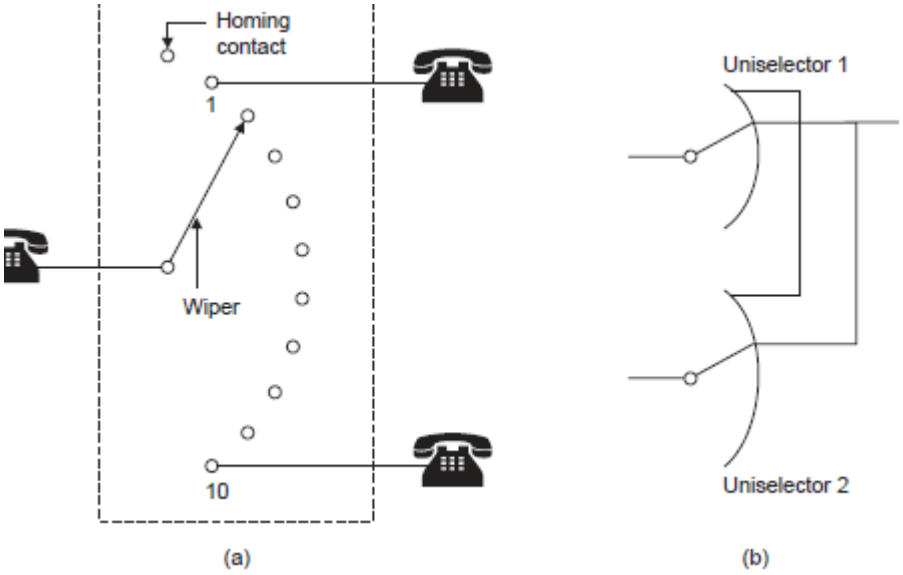
Basic Elements of Strowger Switching System

There are two types of basic elements which performs most of the functions of the strowger switching system.

(a) Uniselectors and

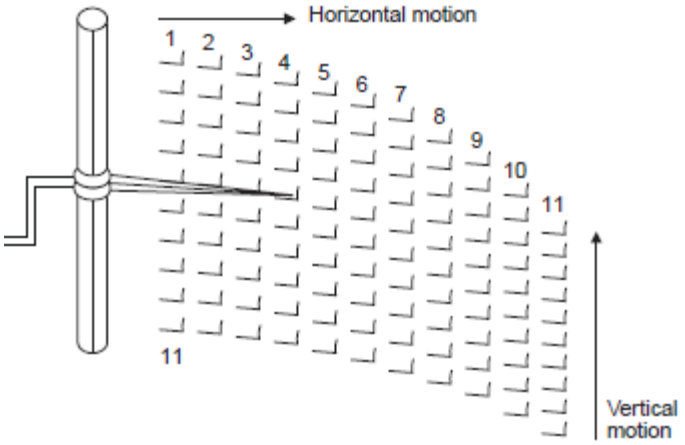
(b) Two motion selectors.

Strowger Swtiching System



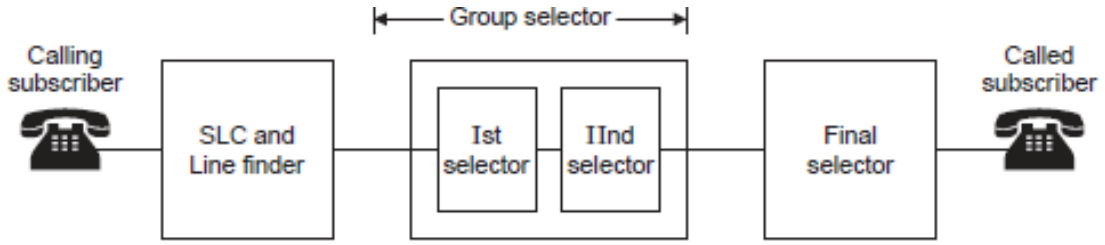
(*a*) 10 contact uniselector, (*b*) graded uniselectors.

Two motion switches

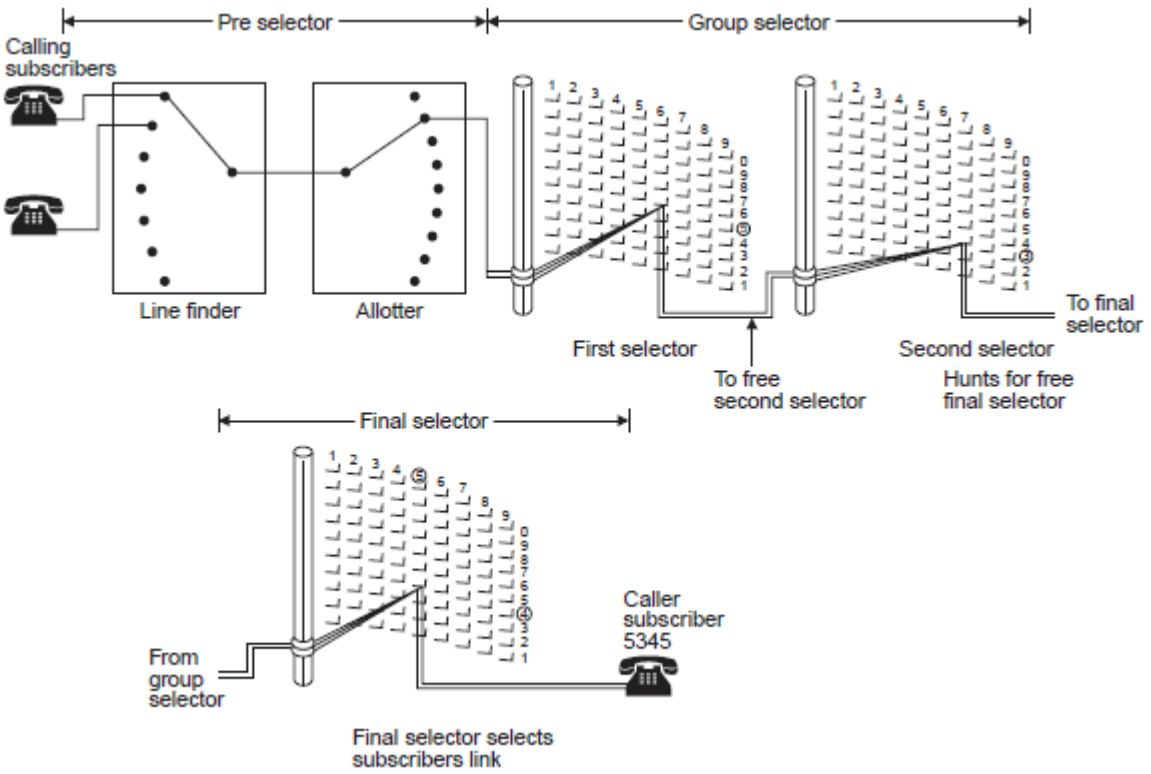


Block Diagram of switching System

In general, the strowger switching system consists of subscriber's line circuit, line finder & alloter circuit, Group selector and final selector.



Routing of Call in Step by step switching system

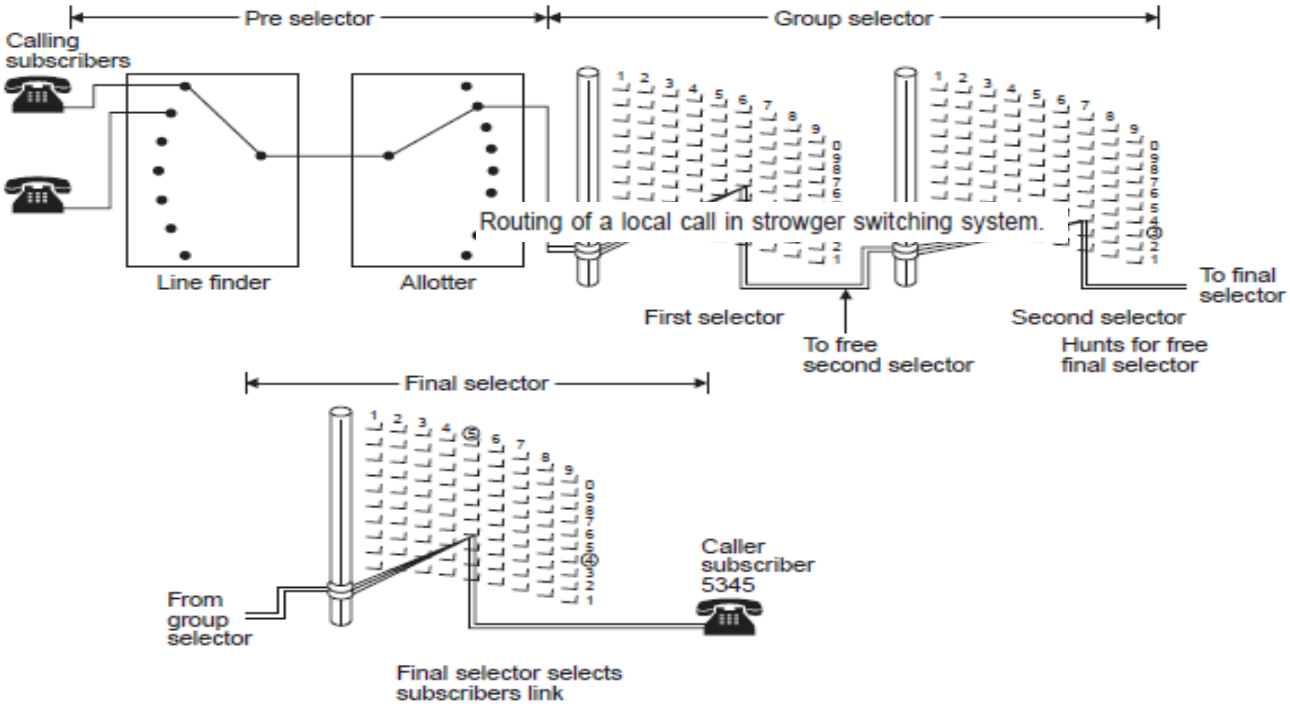


Routing of Call in Step by step switching system

- **Subscriber line circuit (SLC): Every subscriber is connected to his local exchange by one pair of wires. This single pair carries the voice in both directions and the ring current to ring the bell when a call is received. At the exchange, every subscriber line terminates into its own subscriber line circuit (SLC). This consists of a pair of relays dedicated to that subscriber. If there are 1000 subscriber on that exchange, then there are 1000 SLCs.**

- **Line Finder & Alloter: As there are many subscribers, but only a few selectors, there has to be a method for finding a free selector and to connect the calling subscriber to that free.**

- **Group Selector :Depends on the subscriber number, the group selector may comprise one or two selectros, generally referred as first and second selectors. For 3 digit number, only one selector is required. For a 4 digit number, two selectors are required.**


Pre selector
Group selector
Calling subscribers
Line finder
Allotter
First selector
To free second selector
Second selector
Hunts for free final selector
To final selector
Routing of a local call in strowger switching system.
Final selector
From group selector
Caller subscriber 5345
Final selector selects subscribers link

Crossbar switch

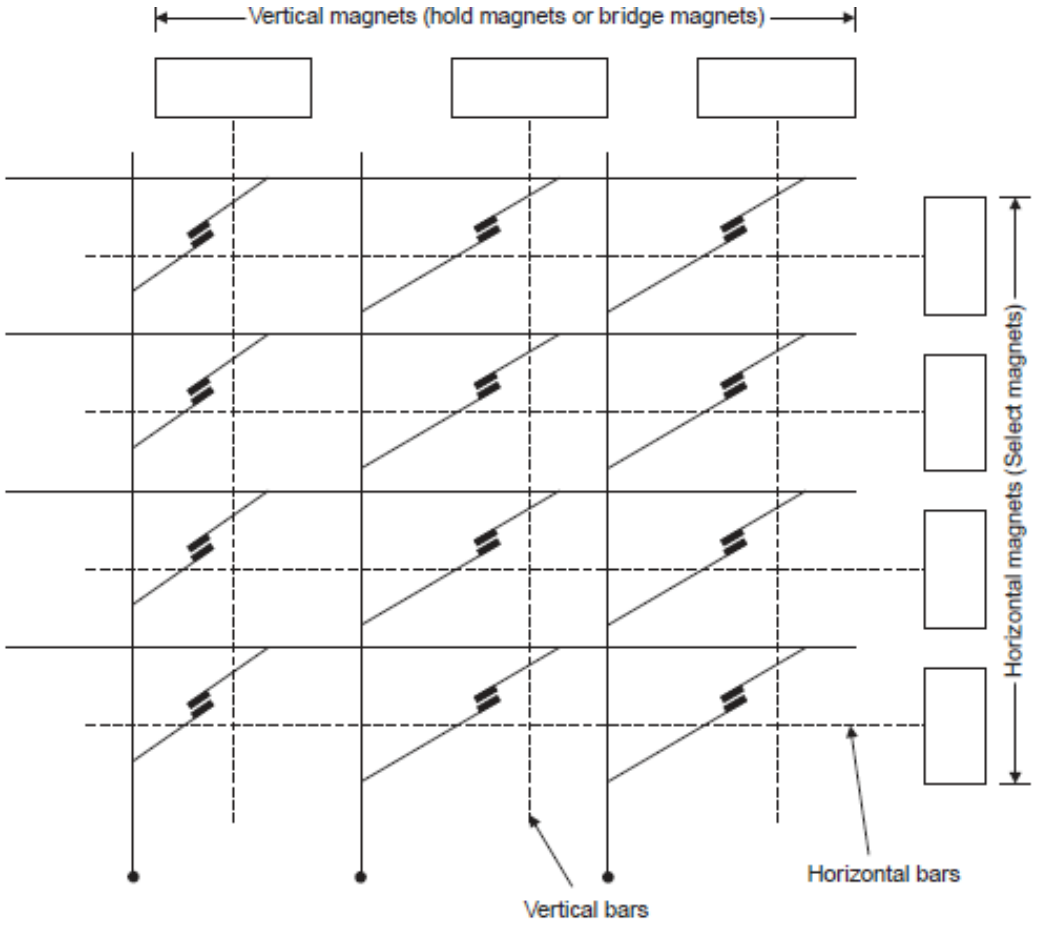
The unique features of the crossbar switches are

(i) Common control allows the customer and the switch to share the common equipments used to process the call.

(ii) Wire logic computer allows specific routine functions of call processing to be hardwired into the switch.

(iii) Flexible concentration ratios allows the system designer to select the appropriate ratio for a specific switch based on customer mix in a specific location.

Crossbar switch



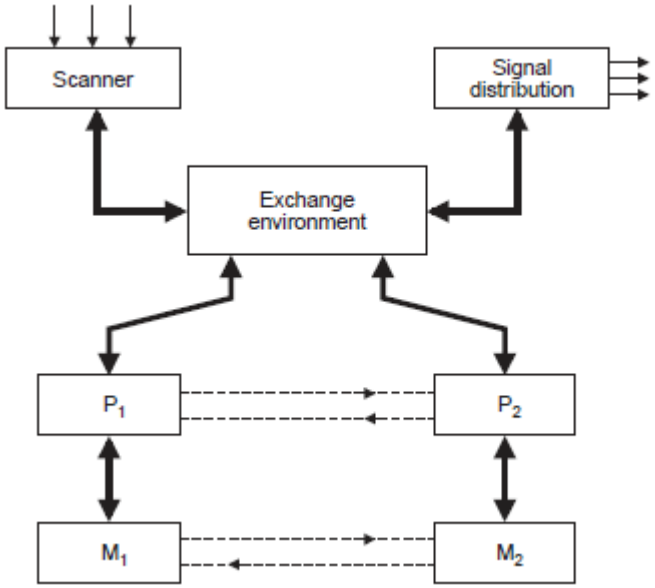
3 × 4 crossbar switch.

Basic of SPC

- In SPC, a programe or a set of instructions are stored in its memory and executed automatically one by one by the processor. Carrying out the exchange control functions through programs stored in the memory of a computer led to the name stored program control. A computer can be programmed to test the conditions of the inputs and last states and decide on new outputs and states.

- The SPC uses processors designed to meet the various requirements of the exchange.More than one processors are used for the reliability. Normally these processors are duplicated.Also the SPC system uses distributed software and hardware architectures. To carry over the maintenance functions of the switching system, a separate processor is used.

Centralized SPC



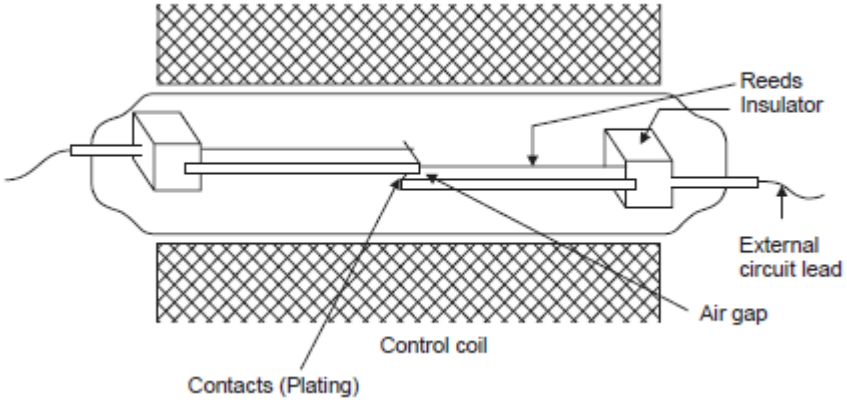
Early electronic switching systems are centralised SPC exchanges and used a single processor to perform the exchange functions. Presently centralised exchanges uses dual processor forhigh reliability. All the control equipments are replaced by the processors. A dual processor architecture may be configured to operate in

(a) stand by mode

(b) synchronous duplex mode

(c) Load sharing mode.

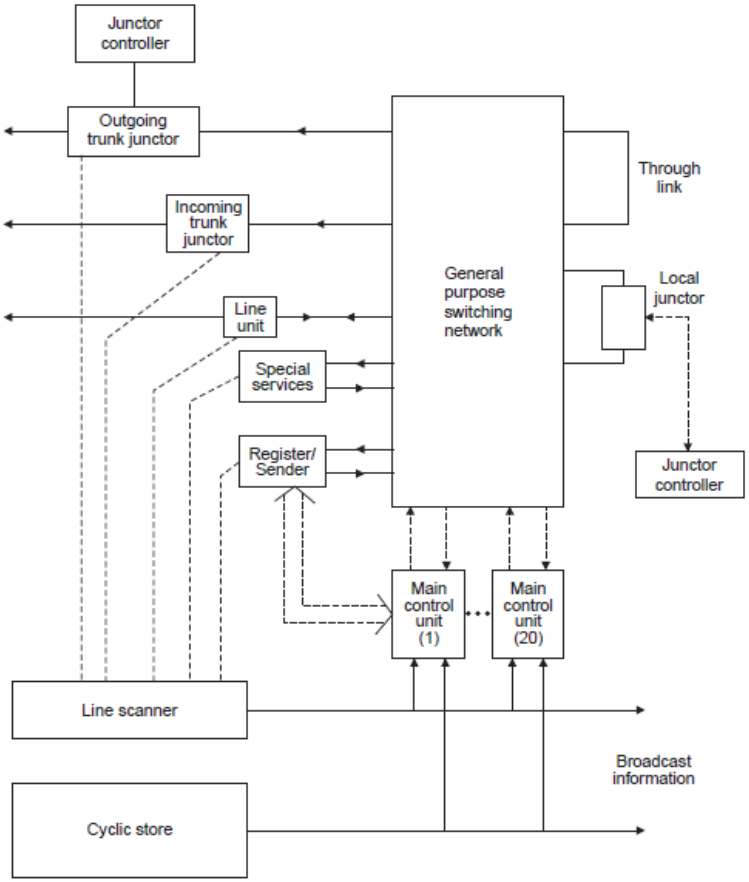
ReedRelay


Reeds
Insulator
External
circuit lead
Air gap
Control coil
Contacts (Plating)

Reed Relay

- In basic reed relay, the contacts are plated on the ends of overlapping centilevered magnetic strips or reeds which serve as contact springs.
- The reeds, contacts and air gap are enclosed in a glass envelop to obtain the benefits of a relatively corrosion free atmosphere for
- contact operation.
- The enclosed reeds are wound by the control winding for the magnetic flux.
- The reeds are magnetized by the flux and are pulled together to close the air gap at the plated contacts.
- This closes the external circuit path connected to the activated reeds. When a demagnetising current is applied to one or the other of the coils, the contacts open.

General view of TXE 4



General view of TXE 4.

Digital switching System

- A switching system is called digital when the input to and output from the switching system can directly support digital signal. Many basic elements of the digital switching system and its operation are very similar to the stored program control (SPC) switching system.

- The functions of the digital switching network is to connect pairs of channels. So that information arriving at the switching centre in a particular channel on one PCM multiplex system can be passed to some other channel on an outgoing PCM multiplex systems. To achieve this switching, two processes referred to as time switching and space switching are used.

Digital switching System

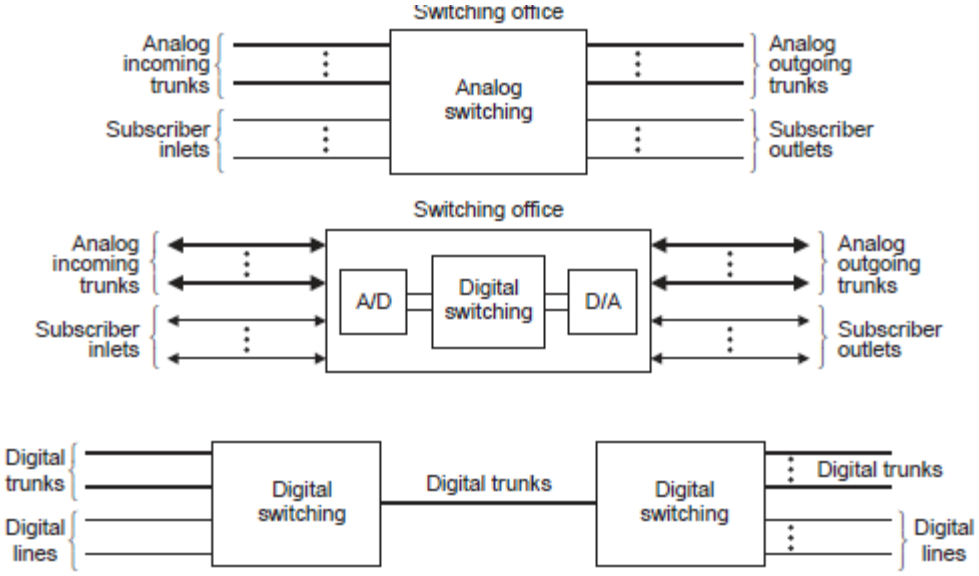


Fig. 5.1. Evaluation of digital switching.