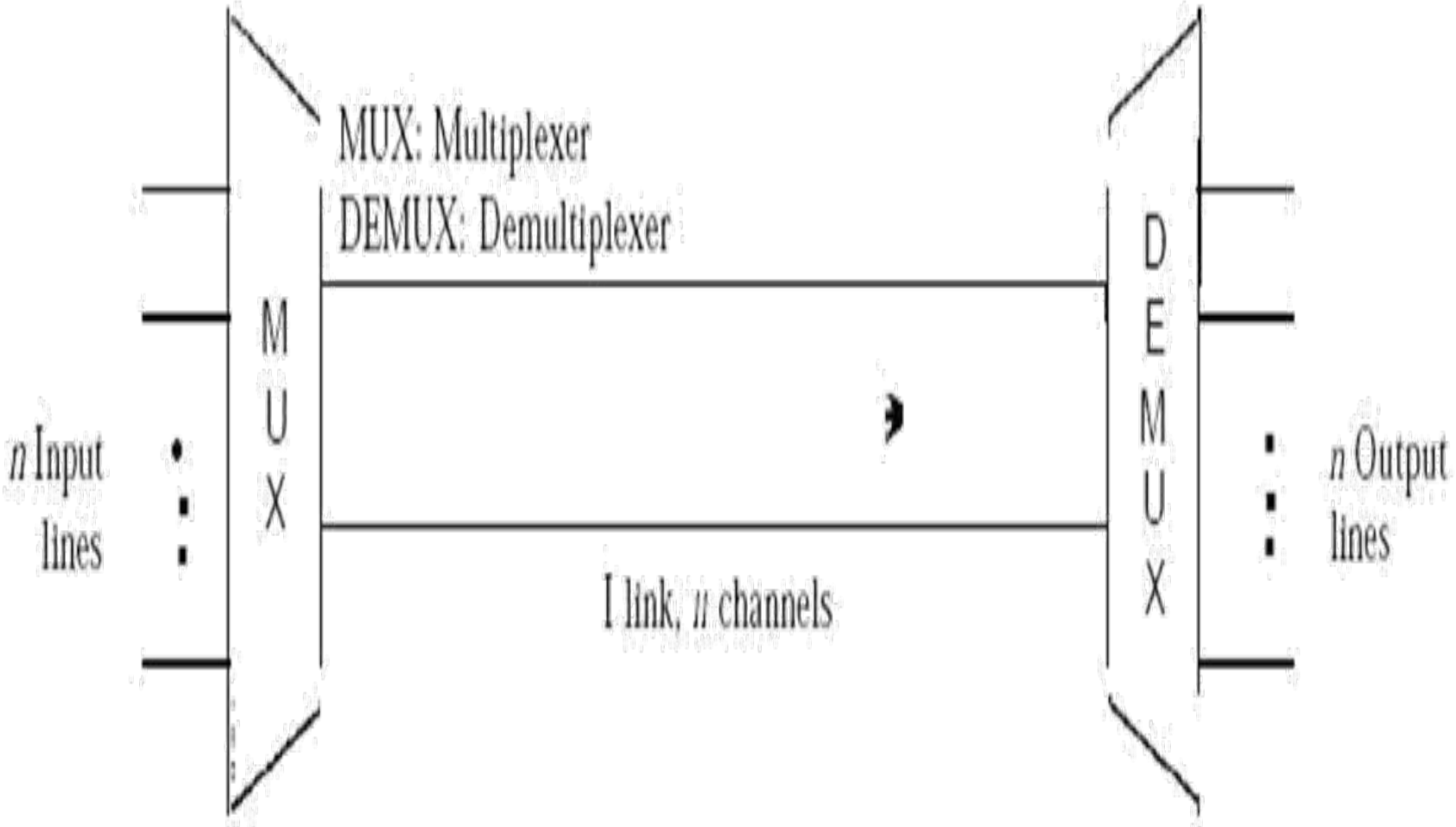
Chapter - 7

Multiplexing and circuit switches

Multiplexing

- Multiplexing is used to combine multiple communication links into a single stream.
- The aim is to share an expensive resource.

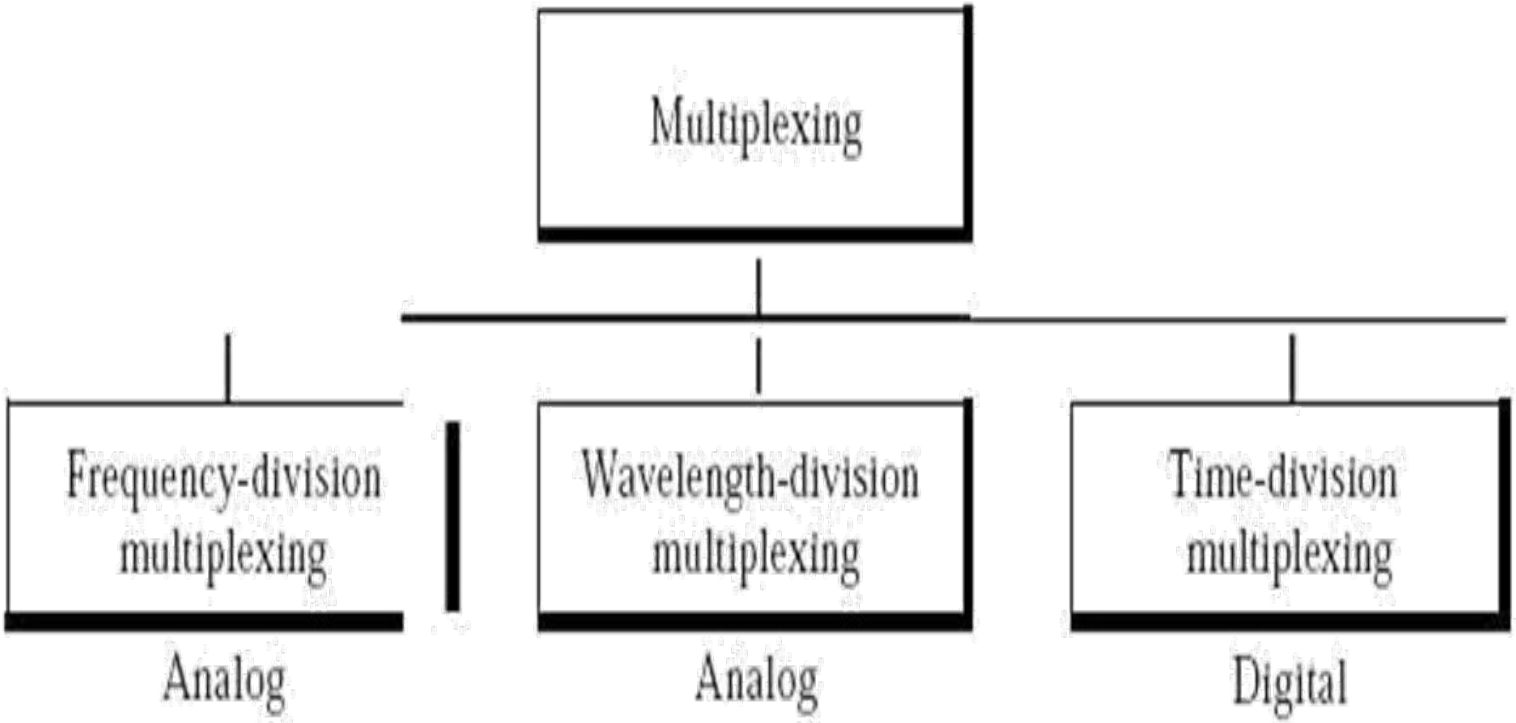
  For example several phone calls may be transferred using one wire.
- A device that performs multiplexing is called multiplexer.


MUX: Multiplexer
DEMUX: Demultiplexer
n Input lines
MUX
DEMUX
n Output lines
1 link, n channels

Demultiplexing

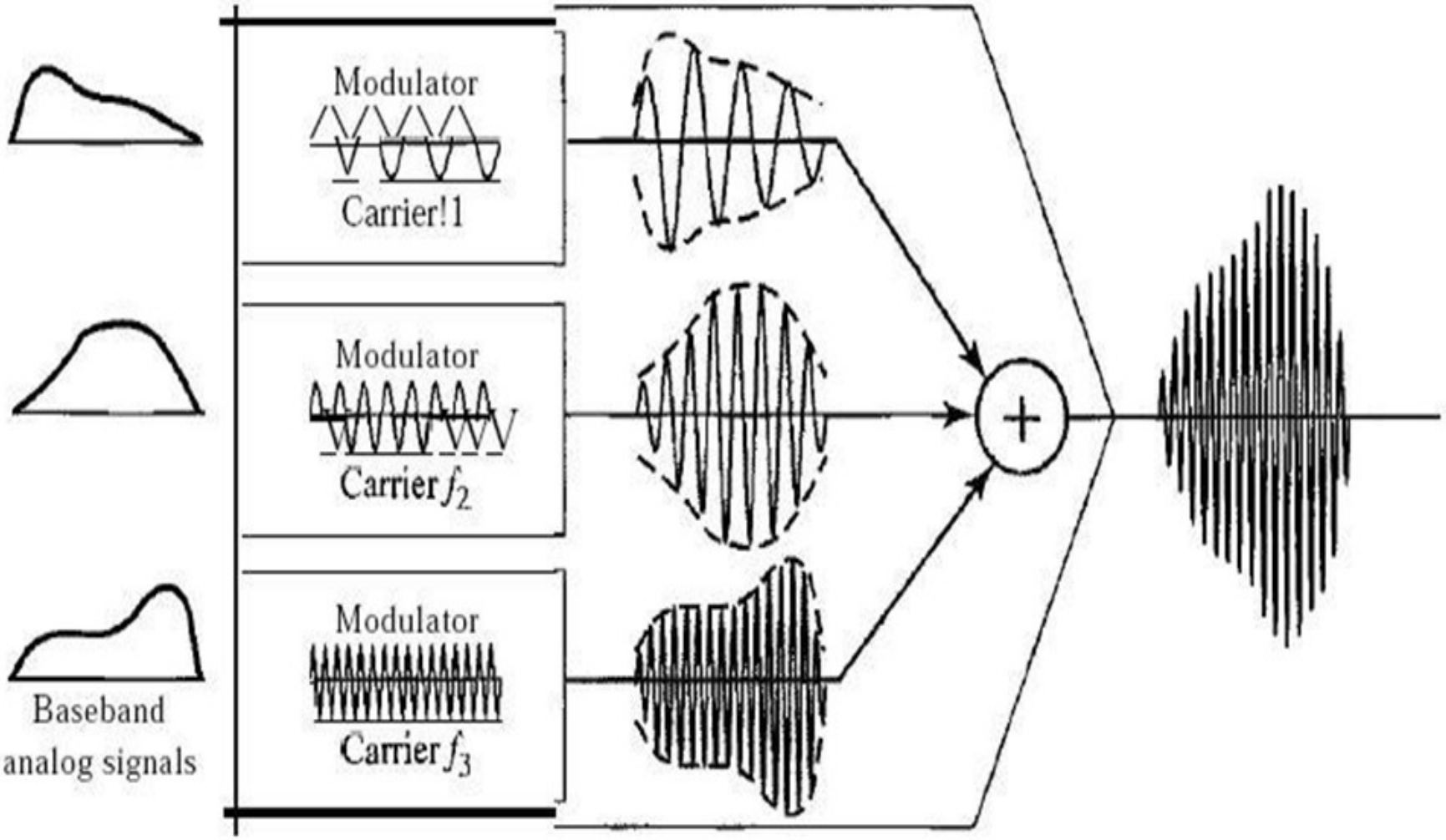
- A device that performs demultiplexing is called demultiplexer.
- At receiving end, demultiplexer separate the single stream back into its component transmissions and direct to their intended receiving devices.

Types of multiplexing



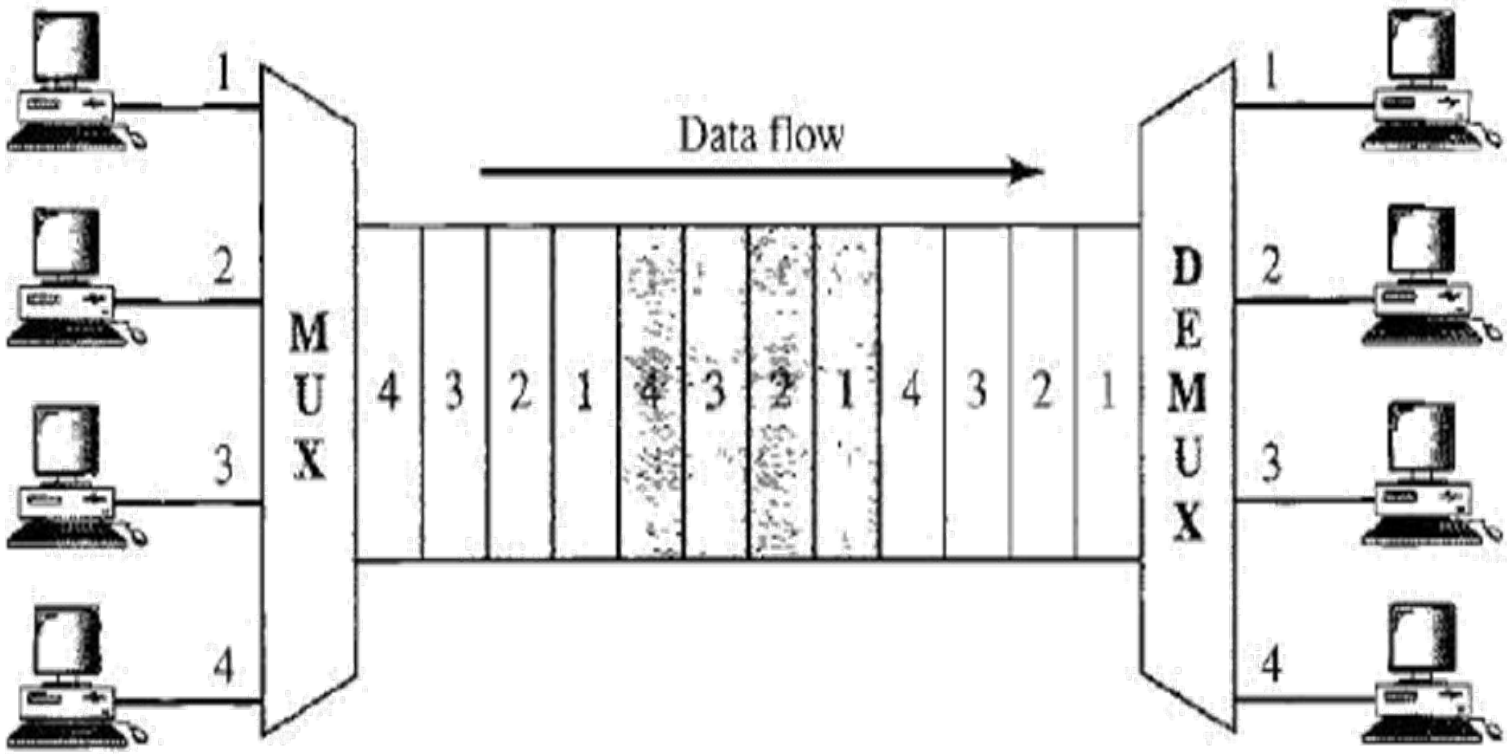
Frequency Division Multiplexing

- In analog transmission, signals are commonly multiplexed using Frequency Division Multiplexing.
- In FDM, signals generated by each sending device modulate different carrier frequencies. These modulated signals are then combined into a single composite signal that can be transported by the link.


Modulator
Carrier!1
Modulator
Carrier f_2
Modulator
Carrier f_3
Baseband
analog signals

Time Division Multiplexing (TDM)

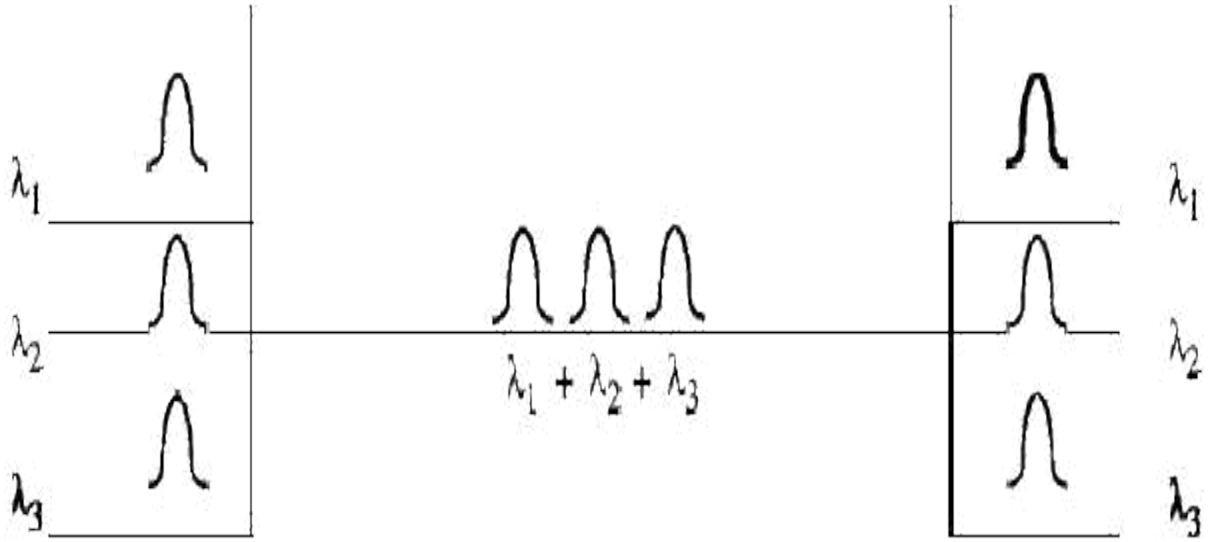
- TDM is another popular method of utilizing the capacity of a physical channel effectively, in which multiple signals are carried over the same channel in alternating time slots.
- In TDM, User can send the message sequentially on after another. Each user can utilize the full bandwidth of channel during his time slot.


1
2
3
4
MUX
Data flow
4 3 2 1 4 3 2 1 4 3 2 1
DEMUX
1
2
3
4

Wave length Division Multiplexing

- Wavelength-division multiplexing (WDM) is designed to use the high-data-rate capability of fiber-optic cable.
- WDM is similar to FDM but here several light signals of different frequencies are combined into single light at the multiplexer.

Wavelength Division Multiplexing



CIRCUIT SWITCHES

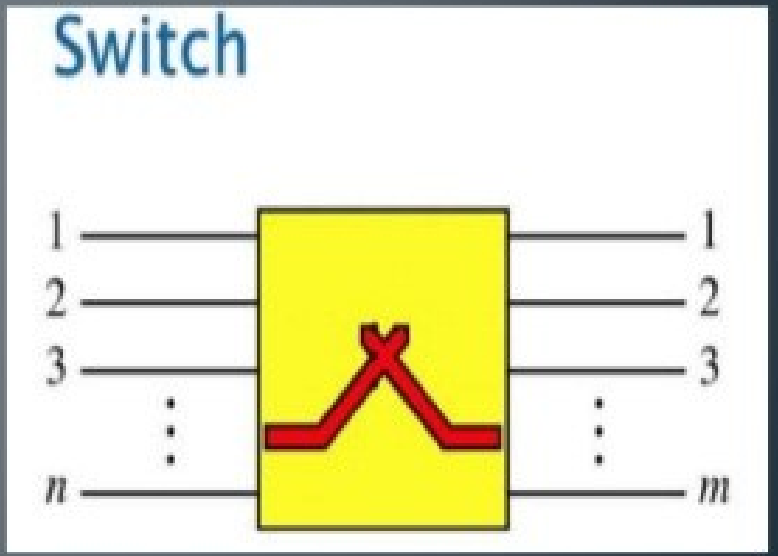
- . Switches are devices capable of creating temporary connections between two or more devices.
- There are two types of switches

  circuit switches

  Packet switches

SWITCH

Switching network consists of series of interlinked nodes called switches



Structure of Circuit switches

- The function of circuit switch is to transfer the signal that arrives at a given input to an appropriate output.
- Circuit switches establishes a dedicated path between the source and destination.
- Circuit switch can use either of two technologies

(i) Space-division switch

(ii) time-division switch

Space-Division Switch

- In space-division switching, the paths in the circuit are separated from one another spatially.
- This technology was originally designed for use in analog networks but is used currently in both analog and digital networks.

Time-Division Switch

- Time-division switching uses time-division multiplexing (TDM) inside a switch. The most popular technology is called the

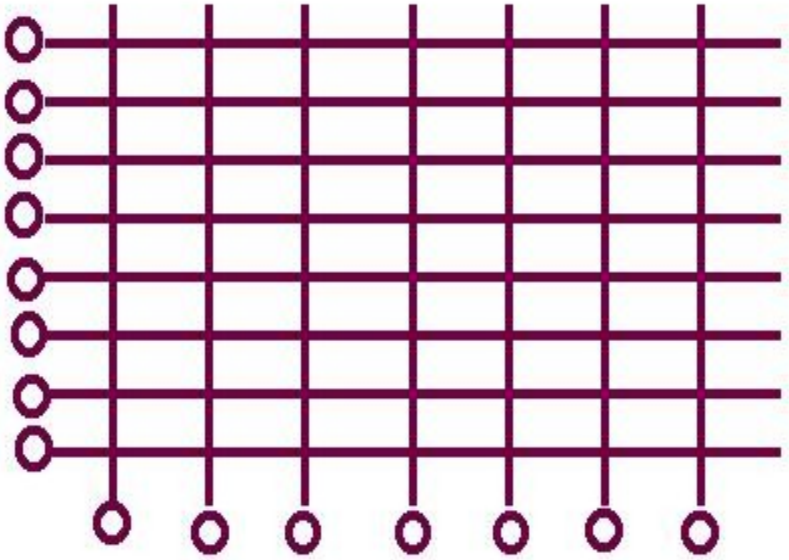
- Space division switches are of two types
  - Crossbar switches
  - Multistage switches

Crossbar switches

- A crossbar switch connects n inputs to m outputs in a grid, using electronic microswitches (transistors) at each crosspoint.
- The major limitation of this design is the number of crosspoints required.
- To connect n inputs to m outputs using a crossbar switch requires n x m crosspoints.

Space Division Switching

- crossbar switch N x N



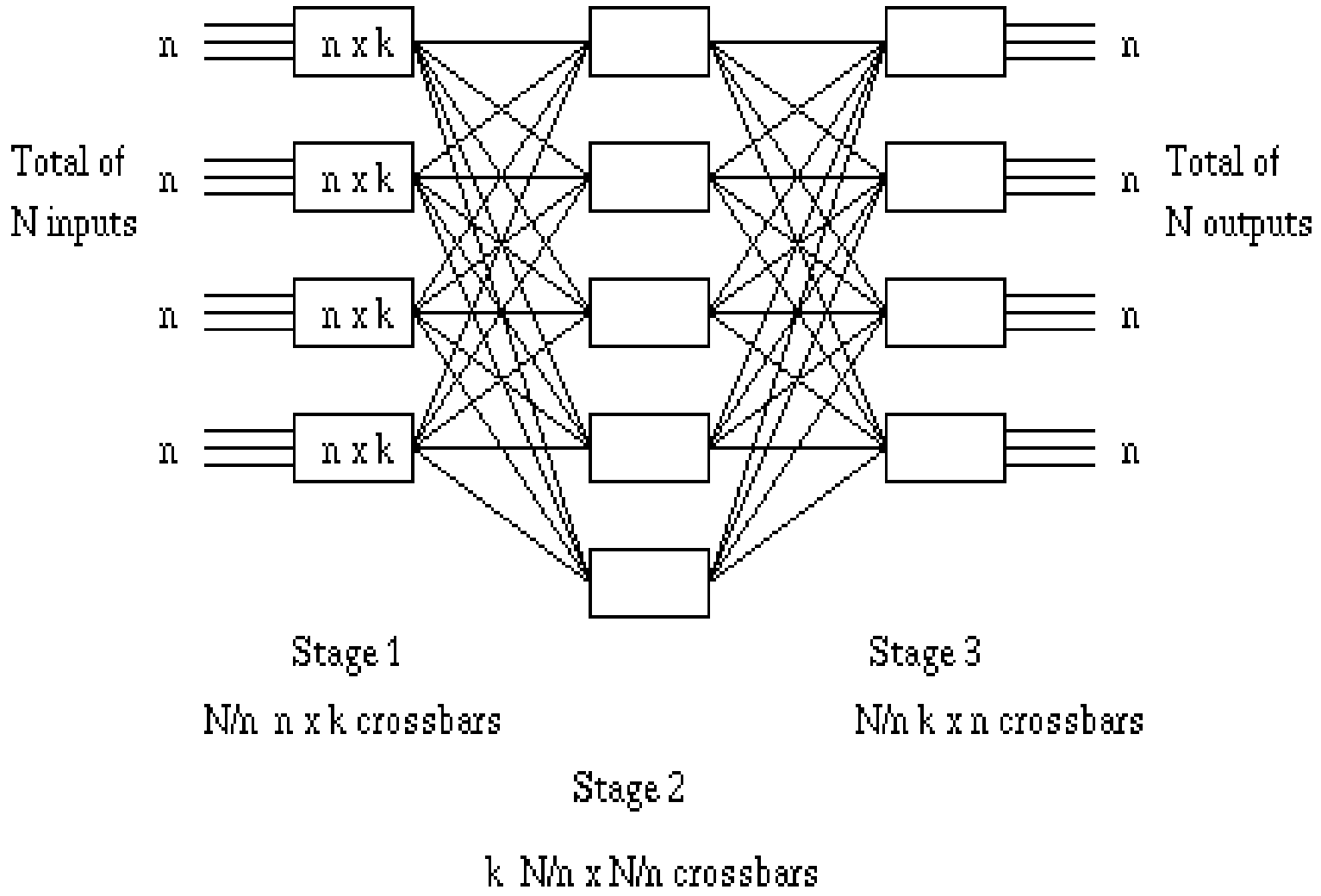
N input lines

N^2 crosspoints
at most N used

N output lines

Multistage switch

- The solution to the limitation of crossbar switch is multistage switch, which combines crossbar switches in several(normally three) stages.
- In multistage switch, it consists of three stages of smaller space division switches.


Total of
N inputs
n
n
n
n
n x k
n x k
n x k
n x k
n
n
n
n
Total of
N outputs
Stage 1
N/n n x k crossbars
Stage 2
k N/n x N/n crossbars
Stage 3
N/n k x n crossbars

TIME DIVISION SWITCHES

- In Time Division Switch, the slots are divided by time slots instead of space.
- The heart of the time division switch is the time slot interchanger (TSI) which replaces crosspoints in a crossbar switch.
- TSI receive digital pulses during one time slot, stores them for one processor cycle and next time ,it will change the time slot depending on the decision of control unit.

SONET MULTIPLEXING

- SONET stands for Synchronous Optical Network.
- SONET is a synchronous network. A single clock is used to handle the timing of transmissions.
- Synchronous optical networking (SONET) is a standardized digital communication protocol that is used to transmit a large volume of data over relatively long distances using a fiber optic medium using

Devices in SONET

- **STS Multiplexers**

It converts electronic signal to optical signals. It multiplexes the incoming signals to create STS(Synchronous Transfer Signal) signal.

- **Regenerator**

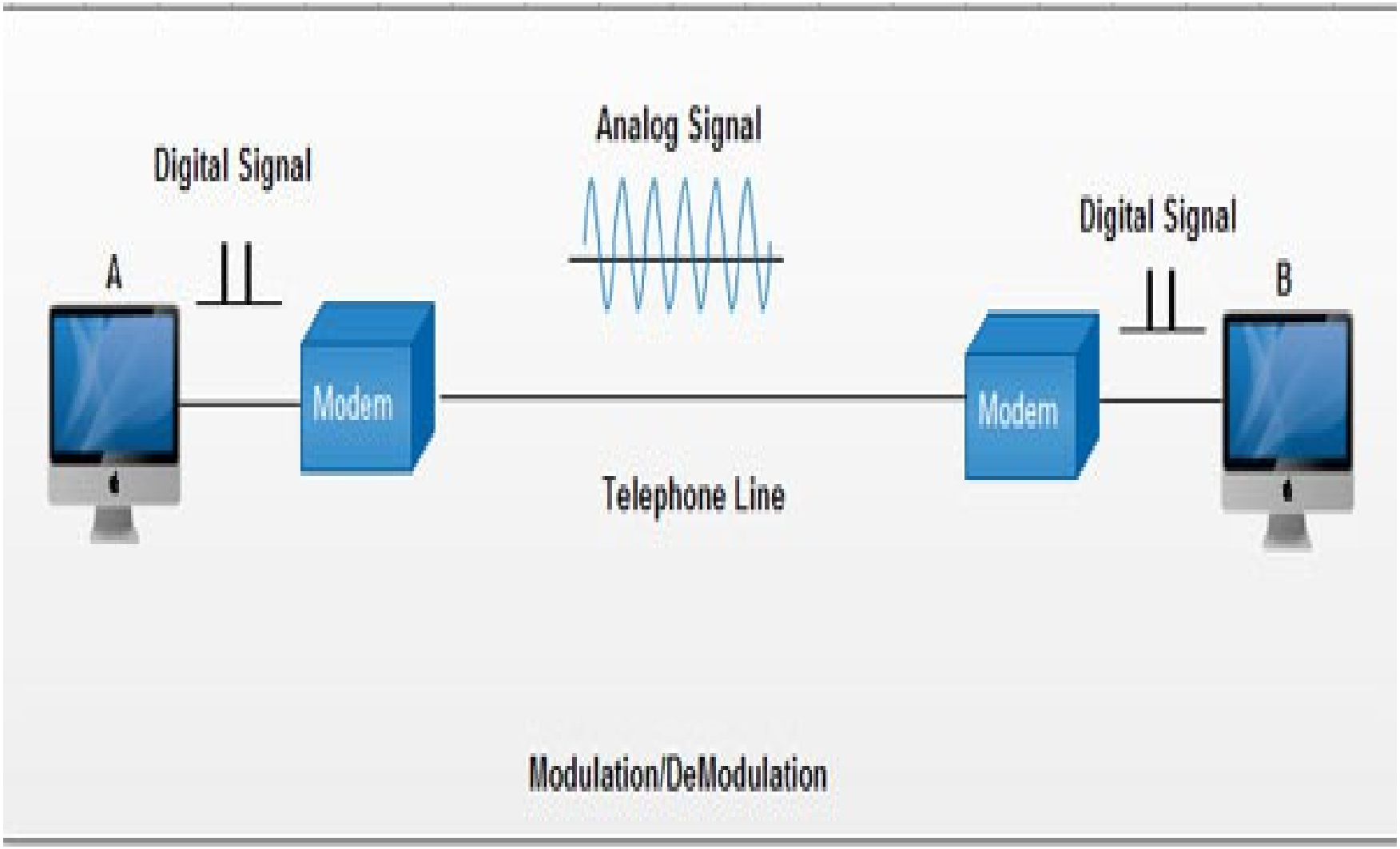
It is used to regenerate high power signals.

- **Add/Drop Multiplexer**

MODEM (Modulator Demodulator)

- **Modem is abbreviation for Modulator – Demodulator.** Modems are used for data transfer from one computer network to another computer network through telephone lines.
- **Modulator** converts information from **digital mode to analog mode** at the transmitting end and demodulator converts the same from **analog to digital at receiving end**.

MODEM


Analog Signal
Digital Signal
A
Modem
Telephone Line
Modem
Digital Signal
B
Modulation/DeModulation