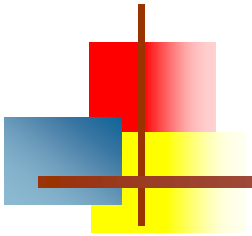
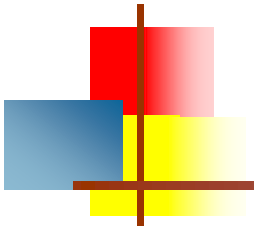


Introduction to Networks & Distributed Computing
CECS 327



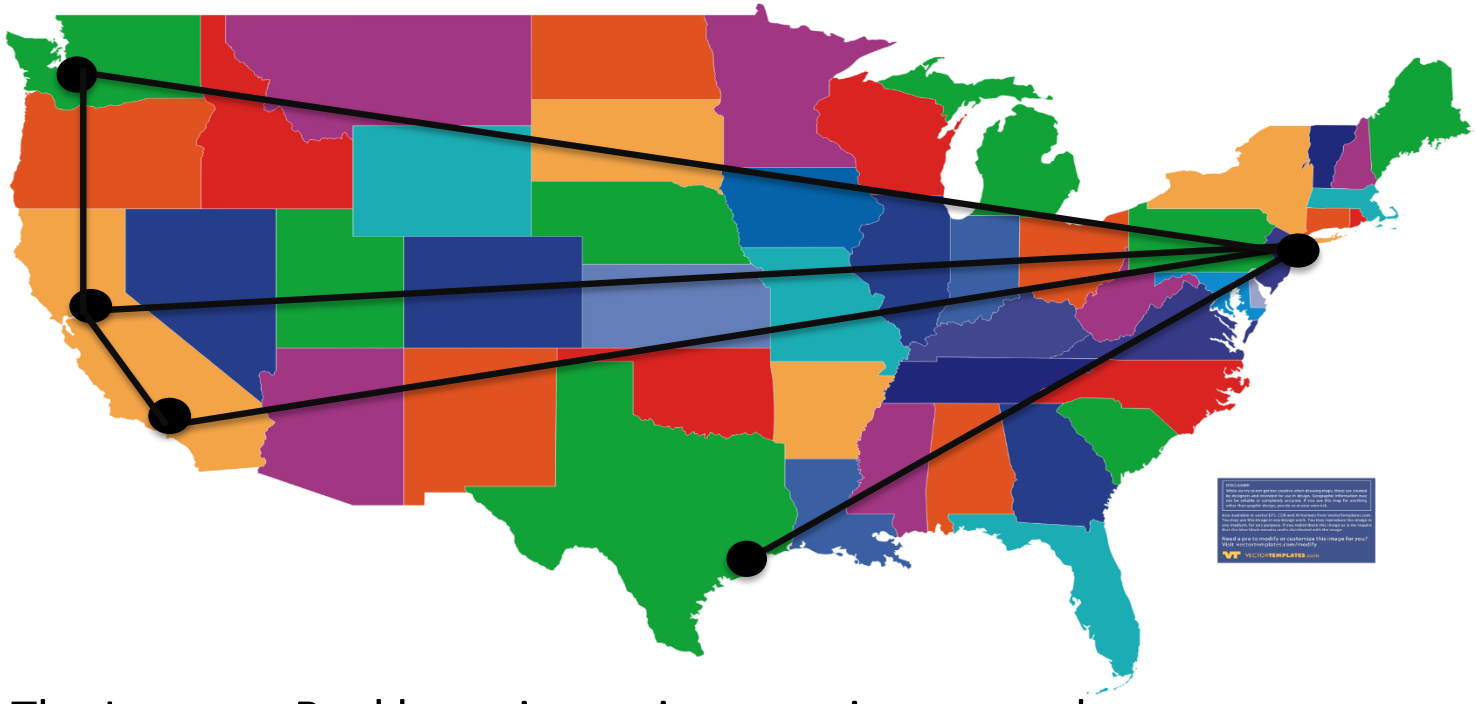
Connectivity

- A network must provide connectivity among a set of computers.
- **Defn**: A **link** is a communication channel that connects two or more devices. The link may be physical or logical that uses one or more physical links or shares a physical link with other telecommunications links. For example, coaxial cable or optical fiber.
- **Defn**: The computers connected by the physical medium are called **nodes**.
  - Note: sometimes these nodes are specialized pieces of hardware sometimes general purpose.
- **Defn**: A **host** is a node running a user application program. Host machines are interconnected by links to form computer networks.

Connectivity

- Two Types of Network Links:

1. Point-to-Point (or store-and-forward) links connect only two nodes

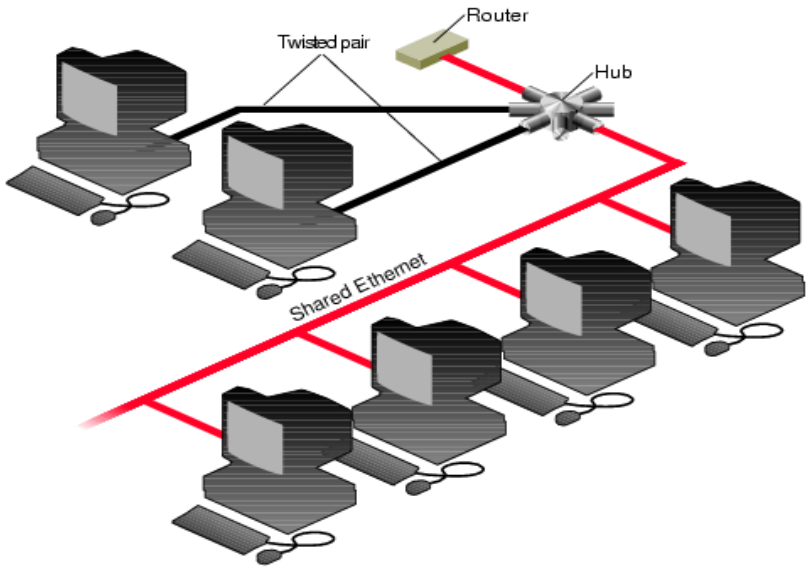


The Internet Backbone is a point-to-point network.

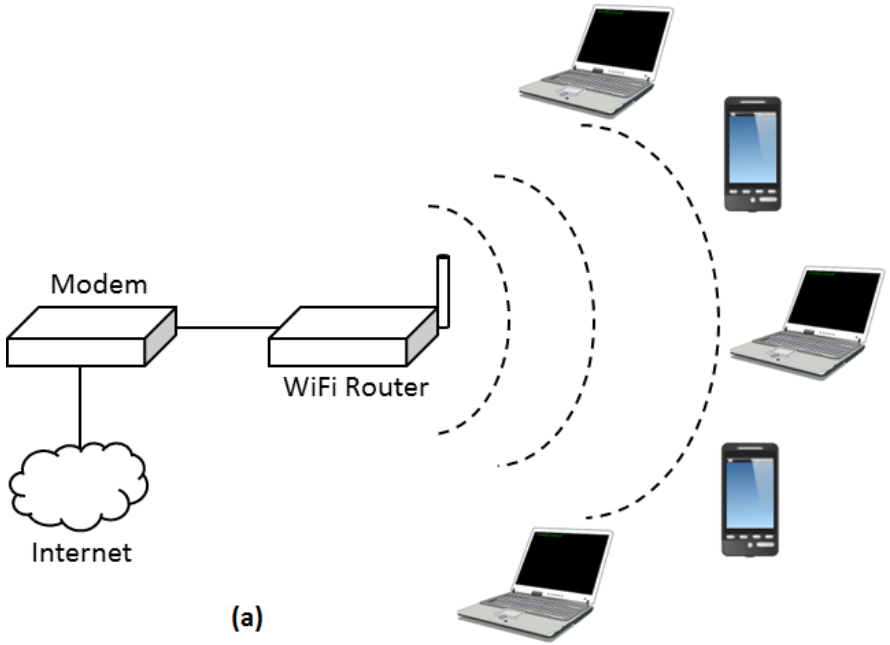
Connectivity

1. **Multiple Access** (or broadcast or shared) links allow more than two nodes to share a single physical medium.

Example 1: Ethernet Busses & Hubs (Generation I & II)



Example 2: WiFi



NOTE: In a shared link, collisions are possible if the protocol/device does not prevent them.

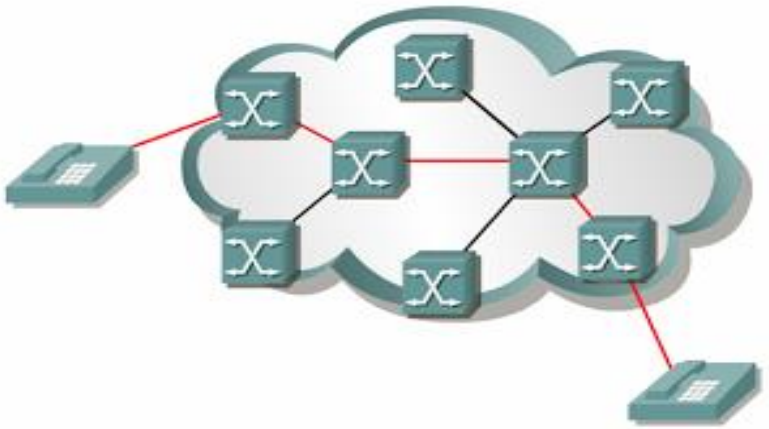
Switched Networks

Two types of switched networks:

1. **Over point-to-point links**, **Circuit-switched** network provide service by setting up a total path of connected links from the origin to the destination host.

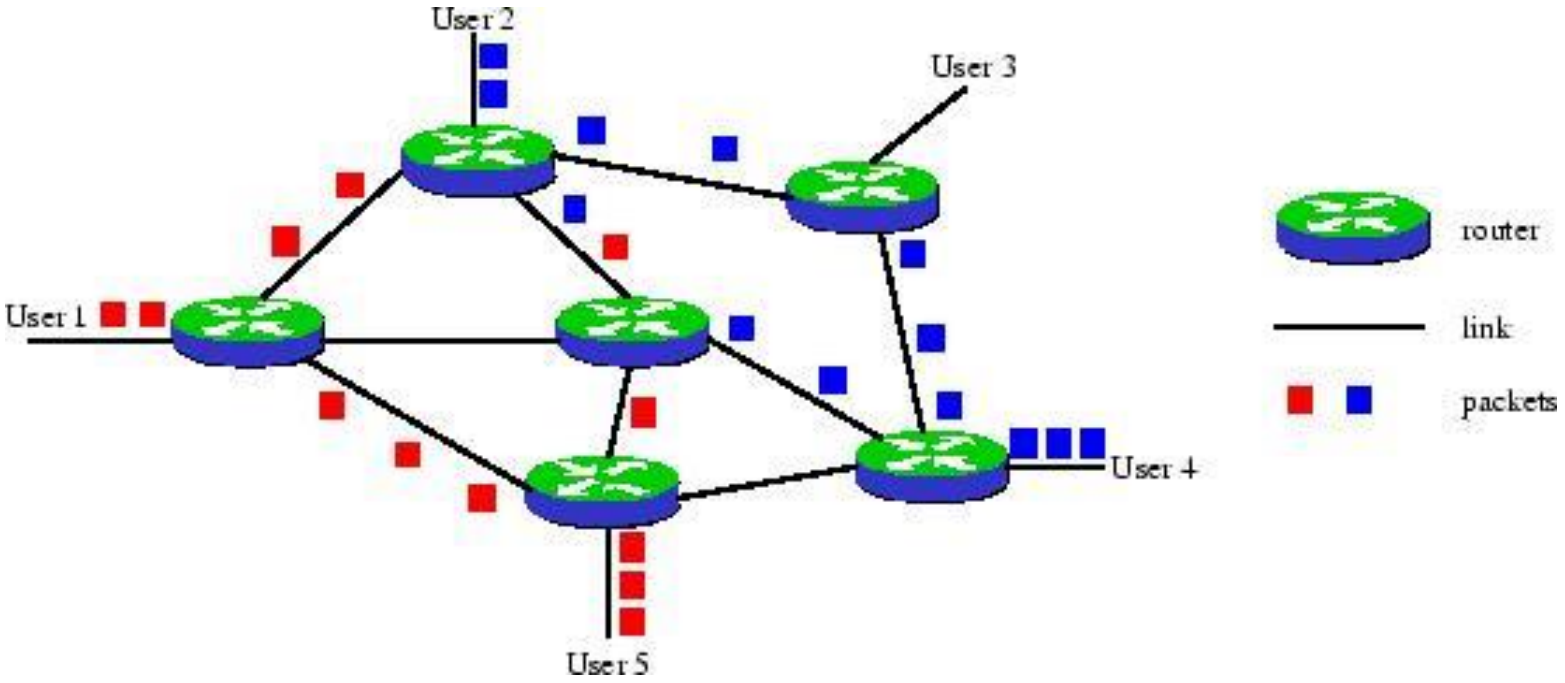
   - A control message is first sent to setup a path from the origin to the destination. (A return signal informs the origin that data transmission may proceed.)
   - Once data transmission starts, all channels in the path are used simultaneously, and the entire path remains allocated to the transmission (whether or not it is in use).

Example: Plain Old Telephone SERVICE (POTS)



Switched Networks

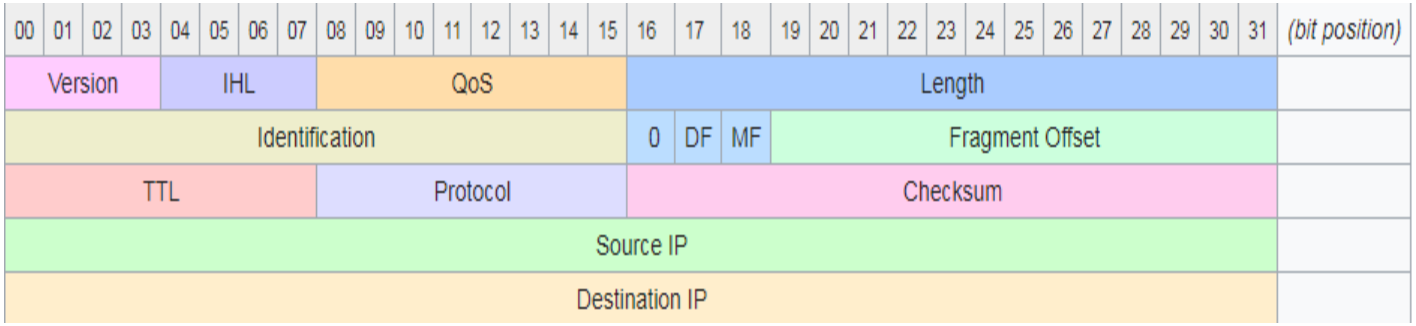
2. **Over point-to-point and multiple access links, <u>Packet-switched</u>** networks decompose messages into small pieces called packets. These packets are each numbered and make their way through the net in a *store-and-forward fashion*. Links are considered busy only when they are currently transmitting packets.

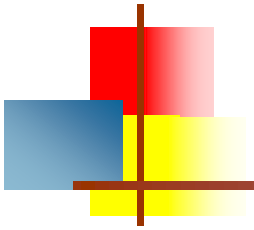


Switched Networks

Network Packet:

- A network packet is a formatted unit of data carried by a packet-switched network.
- A packet consists of control information and user data which is also known as the payload.
- Control information provides data for delivering the payload, for example: source and destination network addresses, error detection codes, and sequencing information.
- Typically, control information is found in packet headers and trailers.



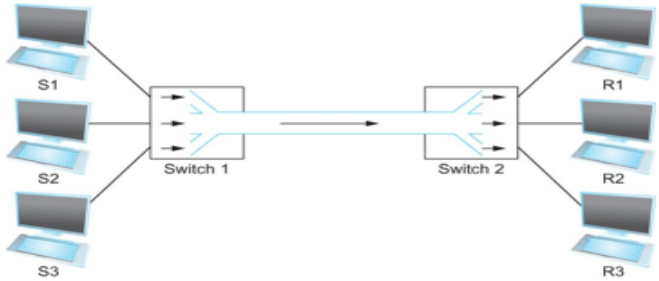


Cost-Effective Resource Sharing

- Under the simplest conditions, a medium can carry only one signal at any moment in time
- If we try to pass multiple signals through a common medium, they will possibly interfere with each other
- When two or more signals with same frequency pass at the same time though a common medium the interference phenomena occurs
- This means we have to devise a way to avoid the interference of the signals
- Which mean that multiple signals:
  - Should have different frequency
  - Must not travel at the same time
  - Must not travel through same medium
- For multiple signals to share a medium the medium must somehow be divided so that each signal receives a portion of the total bandwidth
- Bandwidth utilization is the wise use of available bandwidth to achieve specific goals

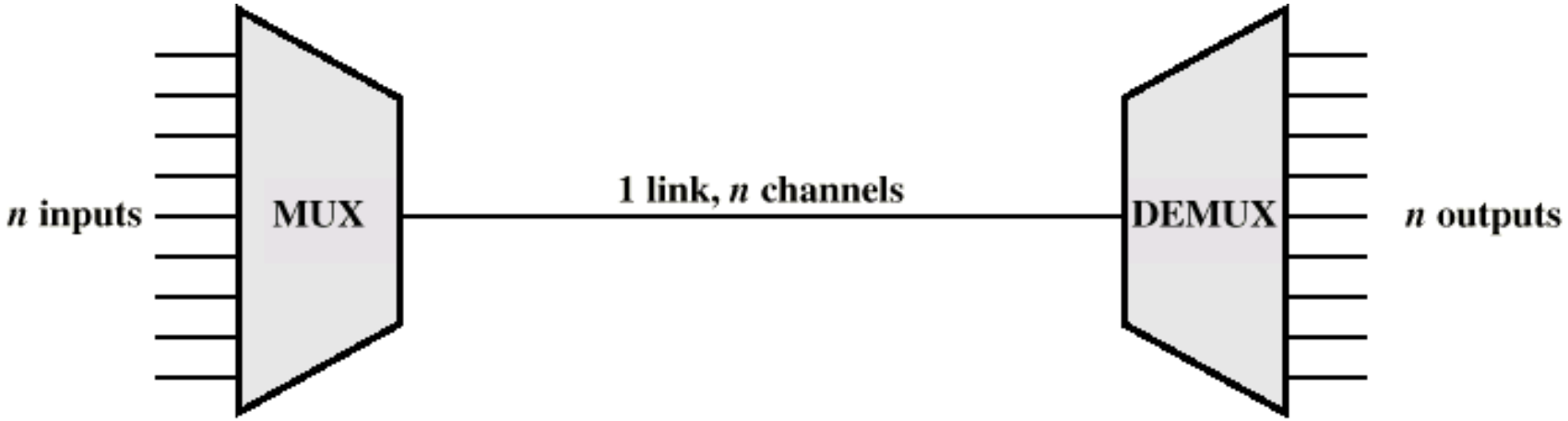
Cost-Effective Resource Sharing

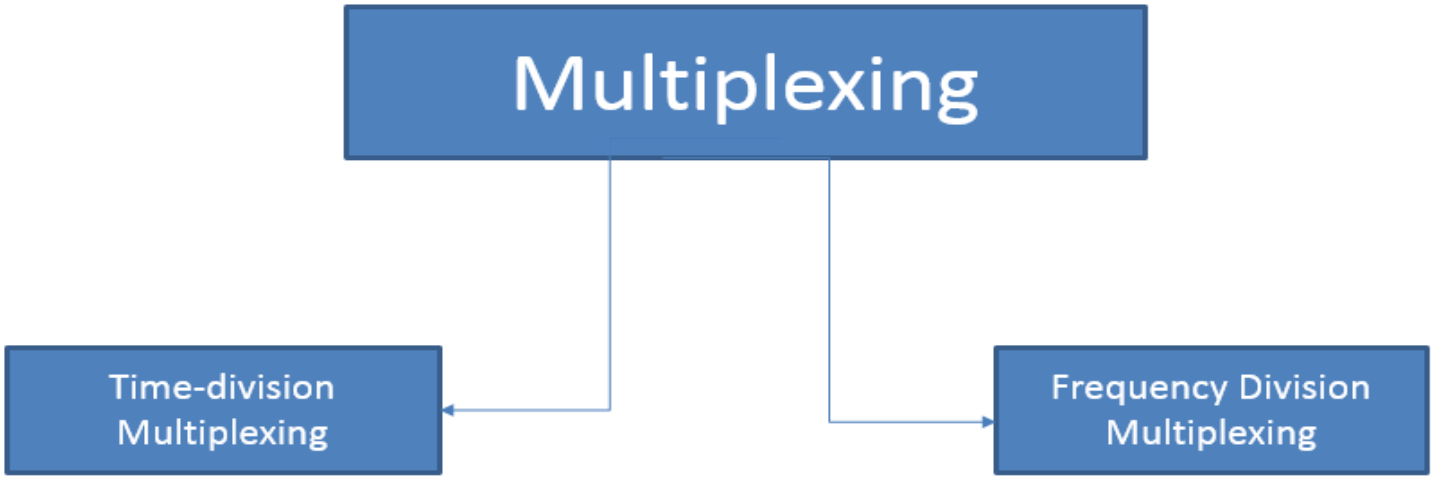
- Transmission services are very expensive (leased lines, packet switched networks)
- Multiplexing and compression techniques save the business money
- As the data capacity of line increases, it will become more cost effective for a company
- Most data services require modest data rate support



Multiplexing is the set of techniques that allows the simultaneous transmission of multiple signals across a single data link. As data and telecommunications use increases, so does traffic.

Cost-Effective Resource Sharing





Cost-Effective Resource Sharing

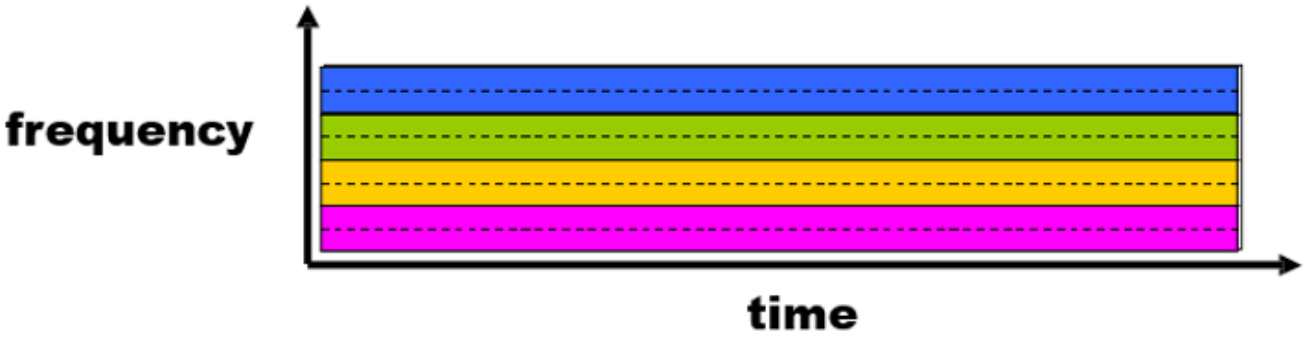
Frequency Division Multiplexing (FDM):

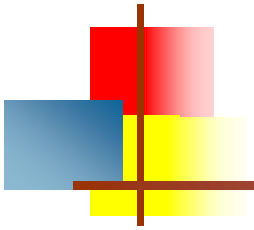
- Useful bandwidth of medium exceeds required bandwidth of channel
- Each signal is modulated to a different carrier frequency
- Carrier frequencies separated so signals do not overlap (guard bands)
- e.g. broadcast radio
- Channel allocated even if no data

Example:

FDM

4 pair of users





Cost-Effective Resource Sharing

Disadvantages of FDM

- The problem with FDM is that it cannot utilize the full capacity of the system
- We need to ensure that the adjacent bands do not overlap each other , otherwise the signal in one band may interfere the signal in other band
- Although system has the capacity still in some cases the channel cannot pass the actual signal

Cost-Effective Resource Sharing

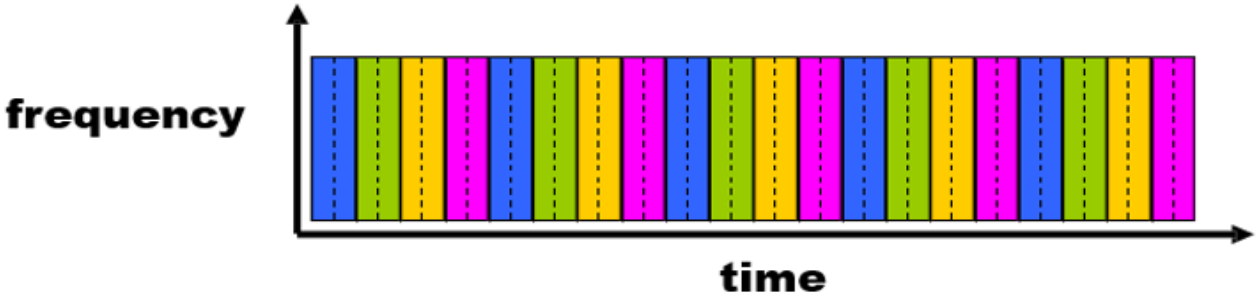
Time Division Multiplexing:

- Data rate of medium exceeds data rate of digital signal to be transmitted
- Multiple digital signals interleaved in time
- May be at bit level of blocks
- Time slots preassigned to sources and fixed
- Time slots allocated even if no data
- Time slots do not have to be evenly distributed amongst sources

Example:

4 pair of users

TDM

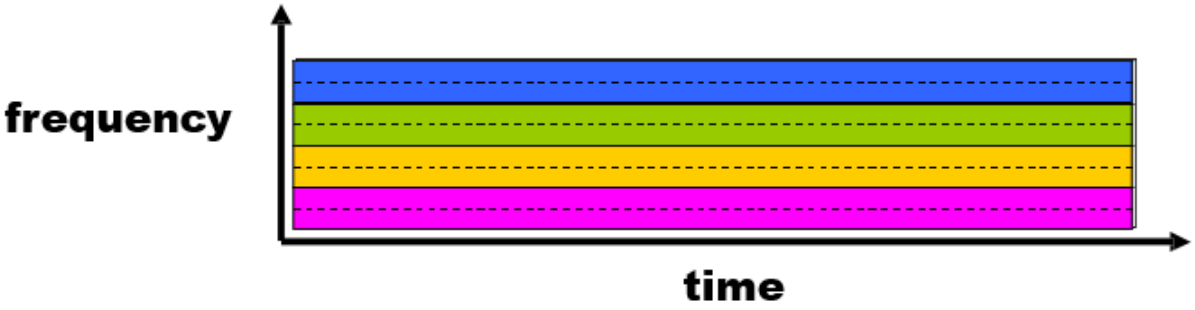


Cost-Effective Resource Sharing

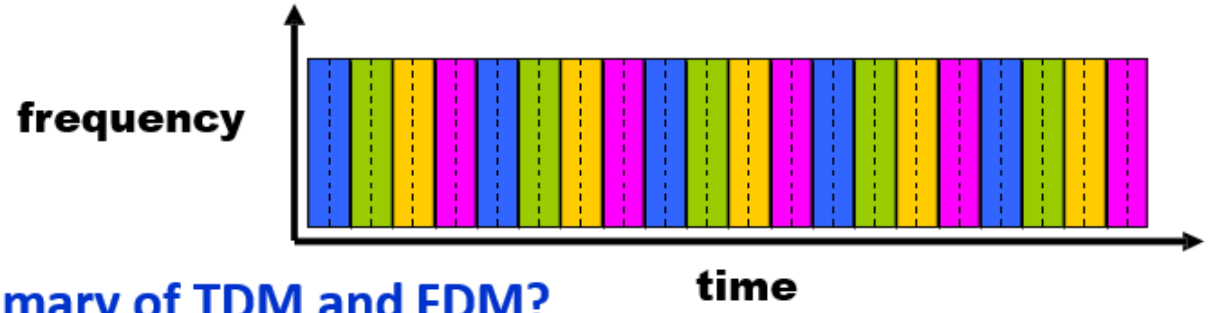
Example:

FDM

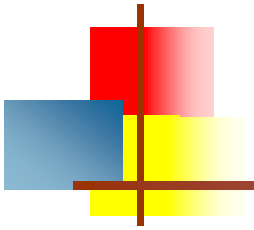
4 pair of users



TDM



Summary of TDM and FDM?



References

- Distributed Systems: Concepts and Design. George Coulouris, Jean Dollimore, Tim Kindberg and Gordon Blair. Fifth Edition, Pearson, 2012.
- Computer Networks, Fifth Edition: A Systems Approach (The Morgan Kaufmann Series in Networking).
- Computer Networks and Internets (5th Edition)
- Some slides by Dr. Tracy Bradley Maples