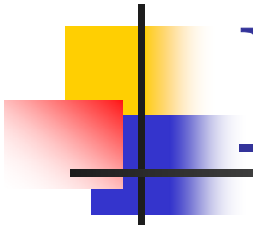
NETWORKING ESSENTIALS

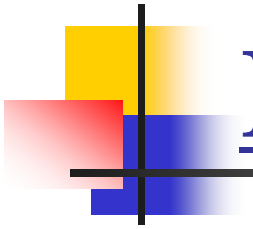


What is a network?

- A network is a group of computers that are wired together in some fashion which enables sharing of information and services

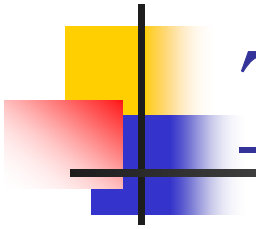
Required network elements ?

- At least two individuals who have some thing to share : - (Network Services)
- A method or pathway for connecting each other : - (Transmission Media)
- Rules so that two or more individuals can communicate : - (Protocols)



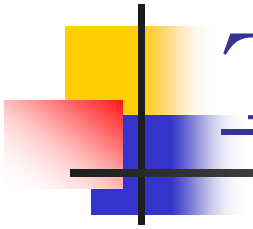
Network Services

- The capabilities that networked computers share. These are provided by numerous combinations of computer hardware and software



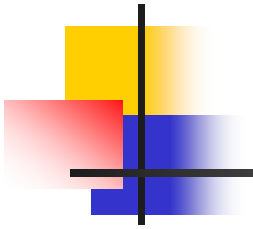
Two types of networks

- Peer – to – peer ：– Allow any entity to both request and provide network services
- Server – centric ：– Places restrictions upon which entity may make requests or service them



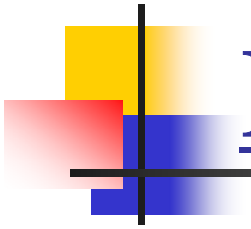
Transmission Media

- The pathway networked entities use to contact each other
- Includes cable and wireless technologies



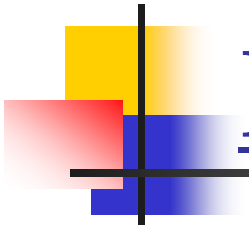
Protocols

- Rules required to help entities communicate or understand each other
- When both entities formally agrees to use a common language , there established a successful communication protocol



NETWORK SERVICES

- File Services
- Print Services
- Message Services
- Application Services
- Database Services



File Services

- Includes network apps designed to efficiently store, retrieve or move data files.Its main functions are
  - File transfer
  - File storage and data migration
  - File update synchronization
  - File archiving

Print services

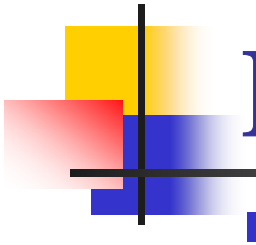
- Are network apps that control and manage access to printers and fax equipment.Its functions are,
  - Provide multiple access from limited interfaces
  - Eliminate distance constraints
  - Handle simultaneous requests and queue those requests
  - Share specialized equipment

Message services

- Include storing, accessing and delivering text,binary,graphic,digitized video and audio data.Its functions are,
  - Electronic mail
  - Integrated electronic mail and voice mail
  - Object-oriented applications
  - Workgroup applications

Application services

- Are network services that run software for network clients.Its functions are,
  - Specialization of servers
  - Scalability and growth



Database Services

- Provides server-based database storage & retrieval that allow network clients to control data manipulation and presentation.They provide
  - Data security
  - Co-ordination of distributed data
  - Replication

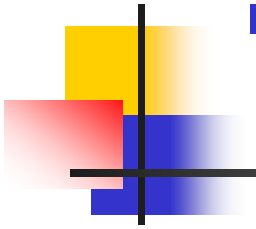
- Cable Media : - using wires or fibers that conduct electricity or light
  - Twisted pair cable
  - Co-axial cable
  - Fiber-optic cable
- Wireless media : -typically uses higher electromagnetic frequencies

Twisted Pair Cable

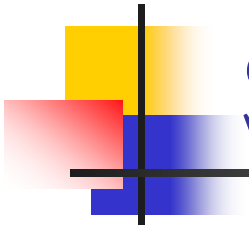
- Uses twisted copper wires of 22-26 gauge
- Two types : -
  - Unshielded Twisted Pair
  - Shielded Twisted Pair

Unshielded Twisted Pair (UTP)

- Composed of a set of twisted pairs with a simple plastic encasement.
- Uses RJ 45 connector
- Follows EIA's cable category standards i.e. CAT 1- CAT5



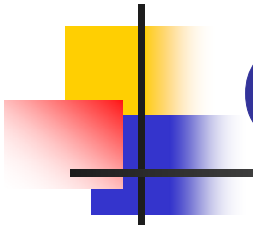
- Features : -
  - Cost : - extremely low
  - Ease of installation and reconfiguration
  - Capacity – 1-100MBps
  - Attenuation – affects if the length is more than a 100 meters
  - EMI – the copper cable used is prone to EMI



Shielded Twisted Pair

- Insulated cable which includes bundled pairs wrapped in a foil shielding
- Extensively used by Apple and IBM in proprietary networks
- Features : –
  - Cost – moderately expensive
  - Installation – difficult

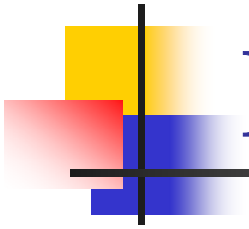
- More bandwidth efficient and can use higher frequencies
- Up to 500MBps at 100m (common is 16MBps)
- Attenuation – similar to UTP
- EMI – very less due to shielding



Co-axial cable

- Is made of two conductors that share a common axis
- 4 types : -
  - 50 Ohm RG-8 7 RG-11 (used in thick Ethernet)
  - 50 Ohm RG-58 (Used in thin Ethernet)
  - 75 Ohm RG-59 (Used for cable TV)
  - 93 Ohm RG-63 (Used for ARC net)

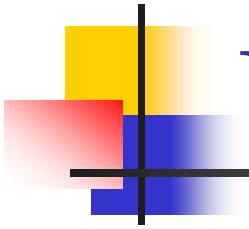
- Features : -
  - Cost – approx: same as UTP
  - Installation – simple
  - Bandwidth – only used in networks with 10MBps or less
  - EMI – resists better than TP cables



Fiber Optic Cable

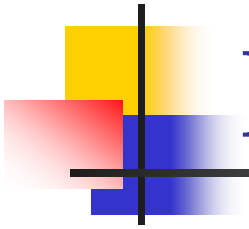
- Made of a light conducting glass or plastic core surrounded by cladding and a tough outer sheath
- Single mode : - allows only one light path
- Multi mode : - allows various paths

- Common types : -
  - 8.3micron core/125micron cladding (single)
  - 62.5microncore/125 micron cladding (multi)
  - 50micron core/125 micron cladding (multi)
  - 100micron core/140micron cladding (multi)
- Features : -
  - Cost – relatively expensive
  - Installation – difficult
  - Bandwidth–very high 100MBps to >2GBps
  - Attenuation – very low
  - Interference – more immune



Wireless media

- Transmits and receives signals without an electrical or optical conductor
- Common 3 types
  - Radio wave
  - Microwave
  - Infrared light



Radio Frequency

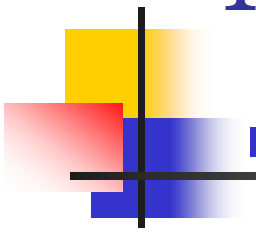
- Resides between 10KHz to 1 GHz
- Can be broadcast omni directionally , or fine tuned for directional emissions from a variety of transmitting antennas
- Low attenuation
- Stations can be mobile or stationary

Microwave

Exists in two forms

- Terrestrial systems (earth based) – uses directional parabolic antennas.Operates in 4-6 or 21-23 GHz range, expensive, high bandwidth etc
- Satellite systems –Uses directional parabolic antennas located on earth and geosynchronous orbiting satellites .11-14 GHz, expensive, prone to atmospheric interference.

Infrared



- Most useful in small or open indoor environments
- Not capable of penetrating walls or other opaque objects
- Operates in 100GHz to 1,000 THz
- Two categories
  - Point-to-point – directed at specific targets
  - Broadcast – relaxes the focus to a wide area

Network Connectivity Hardware

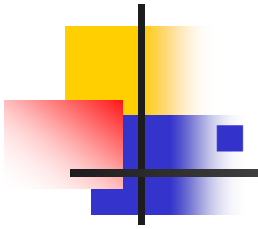
- Repeaters
- Hubs
- Bridges
- Multiplexers

Repeater

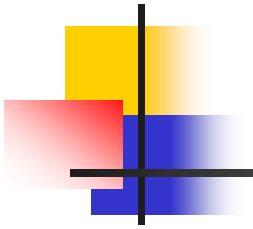
- Is an amplification device used to increase the medium's max: effective distance
- Two types
  - Amplifier : - amplifies all incoming signals including undesirable noise (simple,fast)
  - Signal regenerating repeater : - strips data out of the signal, reconstructs and retransmits the signal (complex,time consuming)

Hubs

- Provides a central point of connection between media segments are called hubs, multiport repeaters or concentrators
- Three types
  - Passive
  - Active
  - intelligent

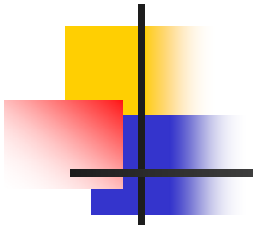


- Passive Hub : - Connects medium segments together , no signal regeneration is performed
- Active Hub : - Like passive one but it regenerates or amplifies signals
- Intelligent Hubs : -In addition to signal regeneration and network management, it provides intelligent path selection, and can choose different paths for delivery



Bridge

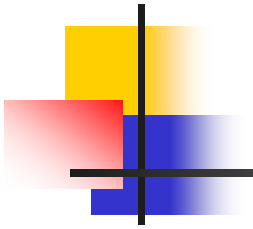
- Extends the max: distance by connecting separate segments together.
- Selectively pass signals from one medium segment to another
- Used to minimize network traffic



Multiplexers

- Are used to combine two or more separate signals on single transmission media segment to make full use of the transmission media

Internetwork Connectivity Hardware

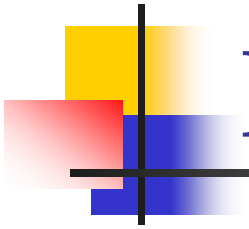


- Used to connect 2 individual networks without losing their separate identities
  - Routers
  - Brouters
  - CSU/DSU

- Routers : - Connect two or more logically separate networks (or sub networks)
- Brouters : - are routers which performs also as bridges
- Channel Service Unit/Digital Service Unit : - are devices that prepare electric pulse signals for transmission on WAN transmission media; protects from electrical noise and unsafe electric voltages

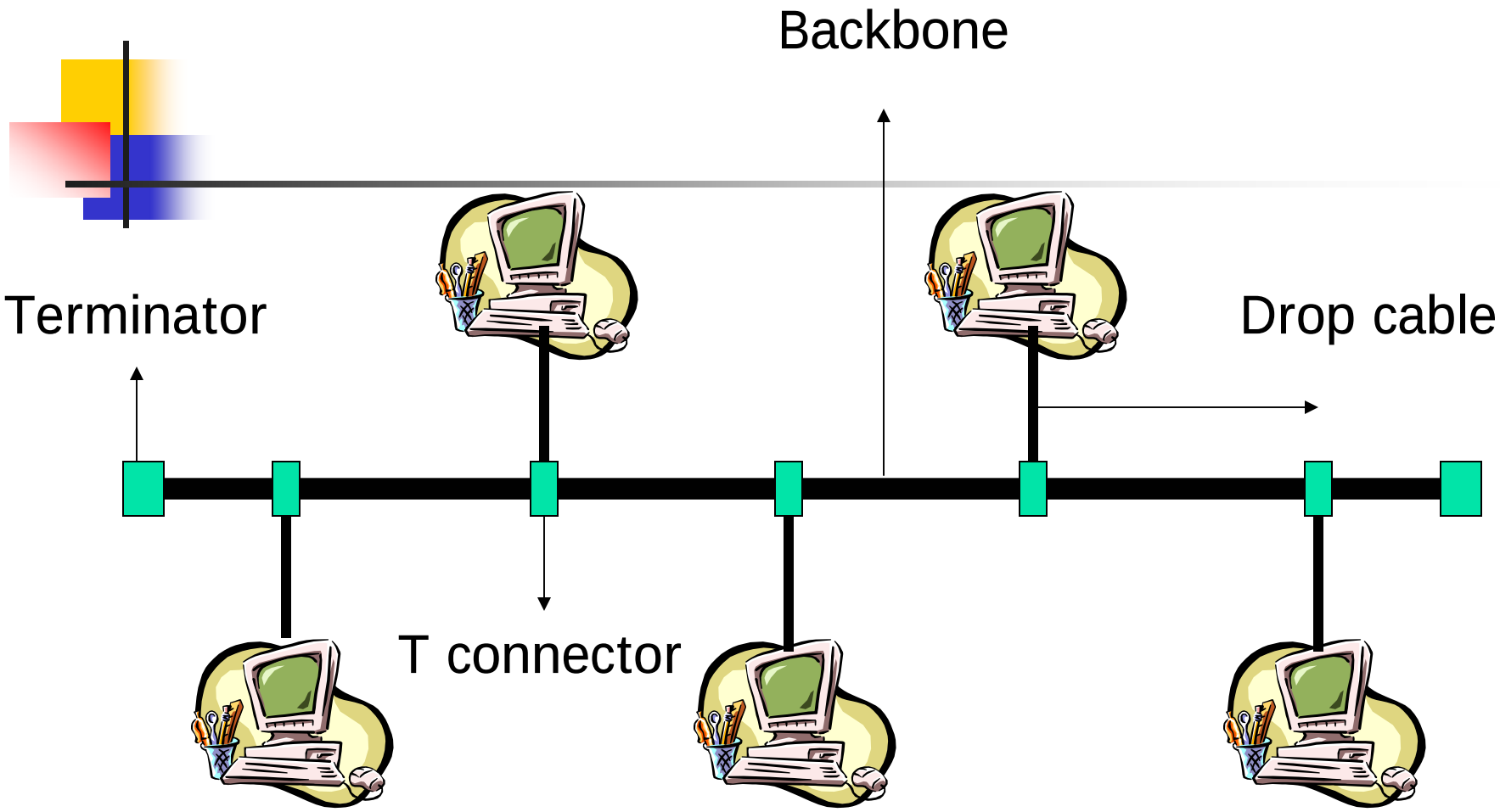
Physical layer addresses the following : -

- Connection types : -Point to Point or multipoint
- Physical topology : -Bus, Star,Ring, Mesh, Cellular
- Signaling : - Digital, Analog
- Bit Synchronization : - Sync, Asynchronous
- Bandwidth usage: - Broadband, Base band
- Multiplexing: -TDM, FDM, Stat TDM



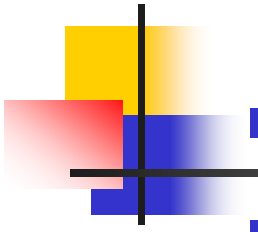
Physical Topology

- Is the complete physical structure of the transmission media
- Things to be taken care during choosing a topology
  - Ease of installation
  - Ease of reconfiguration
  - Ease of troubleshooting
  - Number of units affected by media failure

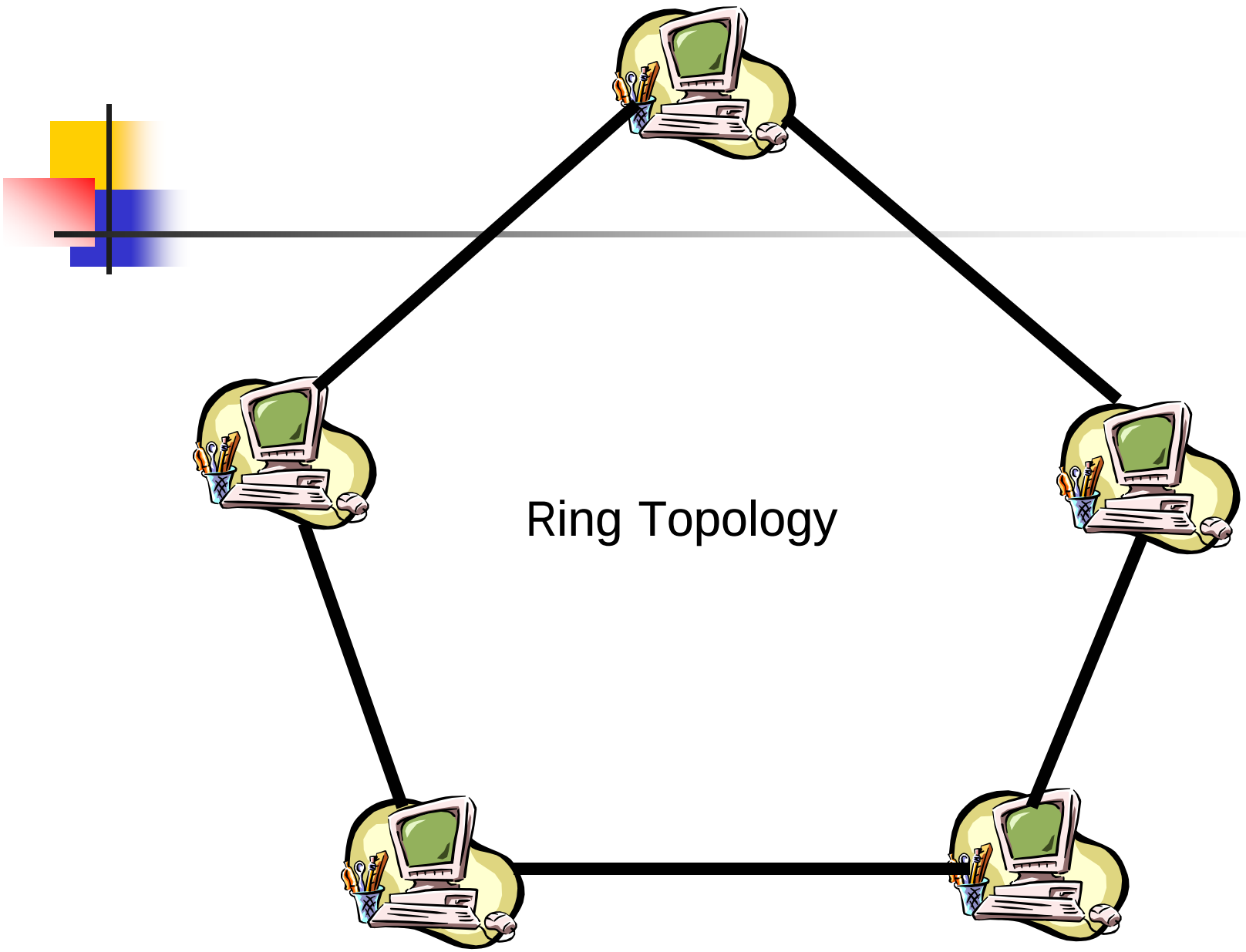


Bus Topology

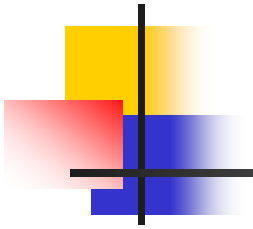
Bus Topology – features



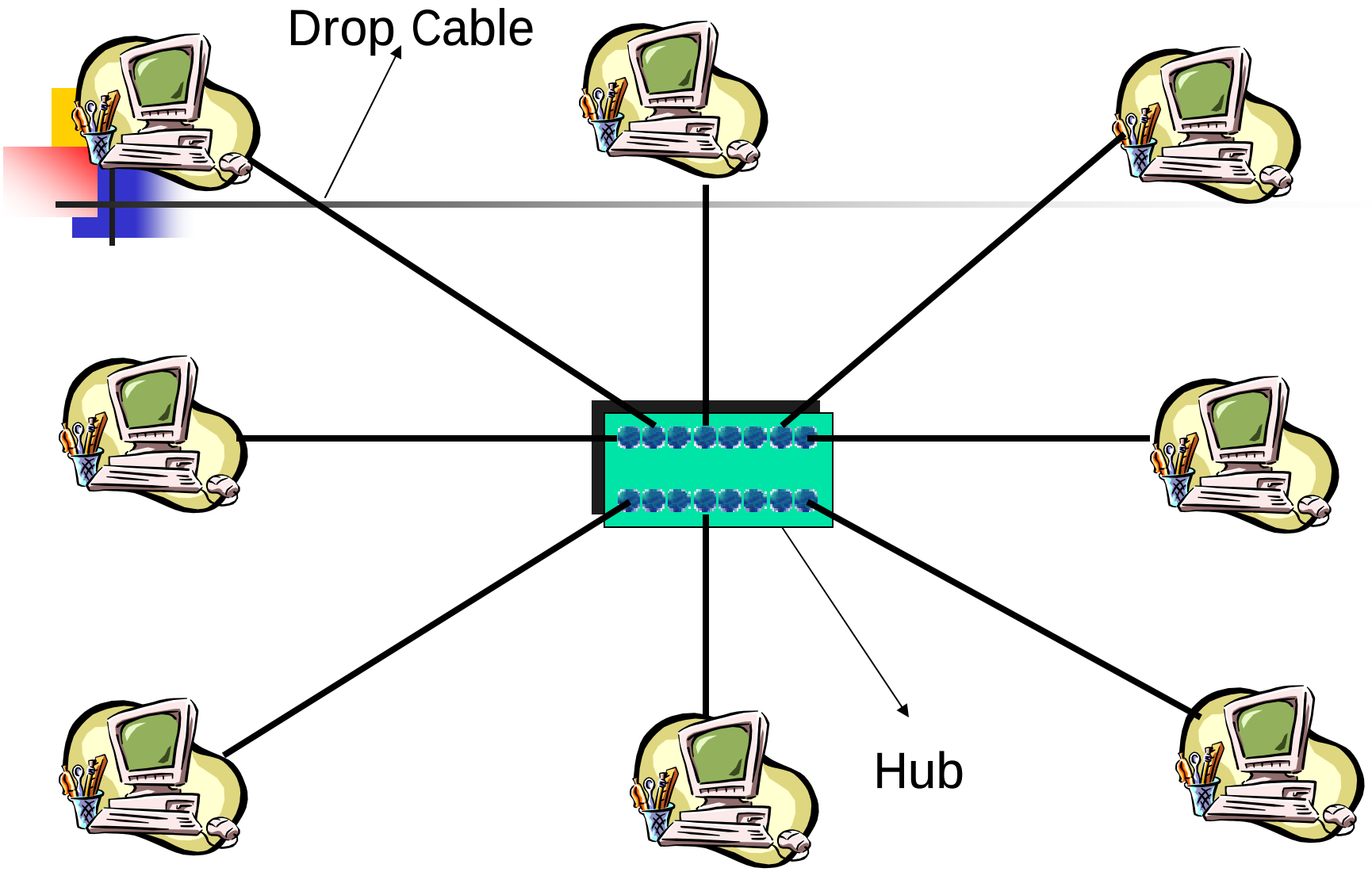
- Uses a long cable called Backbone
- Short cables called Drop cables can be attached to backbone to connect nodes
- Backbone is terminated at both ends
- Relatively easy to install
- Requires less media than others
- Difficult to troubleshoot
- All units affected by media failure
- Difficult to reconfigure


Ring Topology

Ring Topology – features

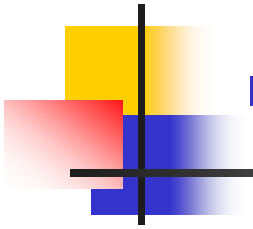


- Is a circular, closed loop topology
- Signals are regenerated at each node ; so minimal degradation
- Cable faults can easily be identified
- More difficult to install and reconfigure
- Media failure can cause complete network failure in uni-directional rings

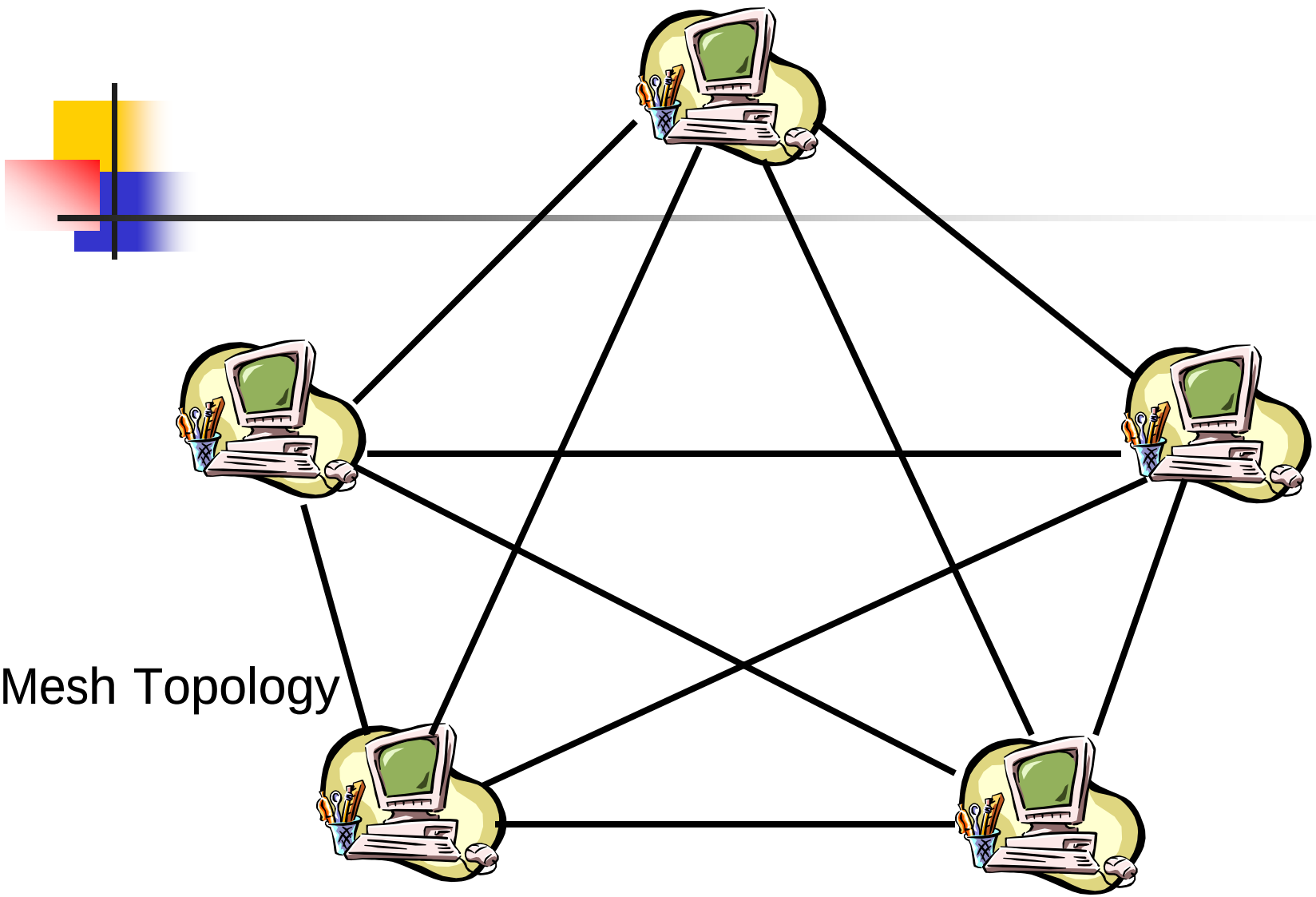


Star Topology

Star Topology

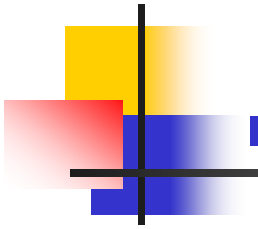


- Uses a central device with drop cables extending in all directions
- Star topologies can be nested within other stars
- Each device is connected via a point to point link to the central device
- Easy to reconfigure, troubleshoot
- Requires more cable than others
- Media faults will not affect another segment

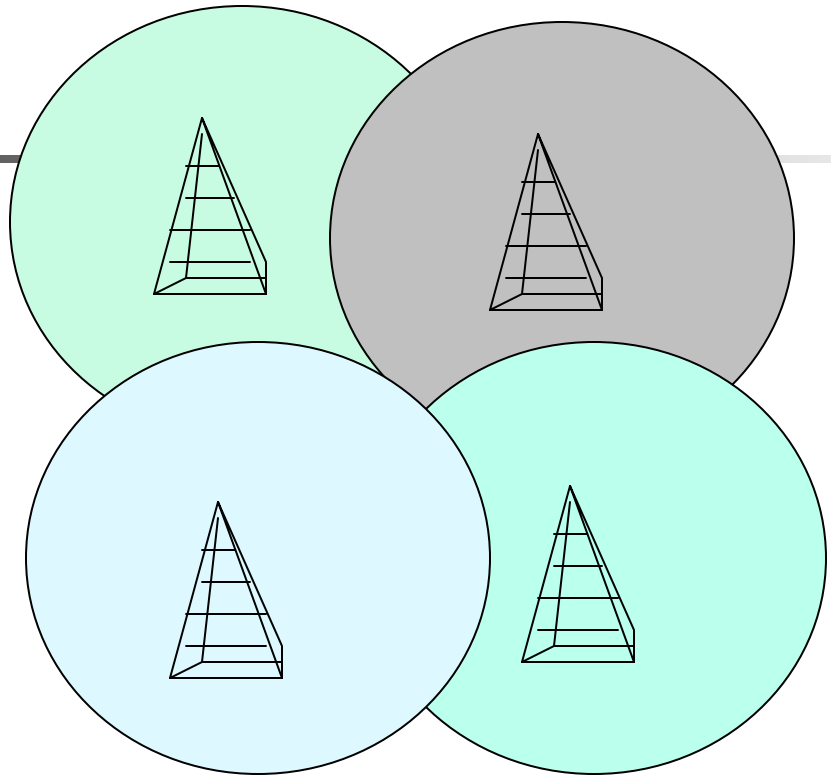


Mesh Topology

Mesh Topology – features

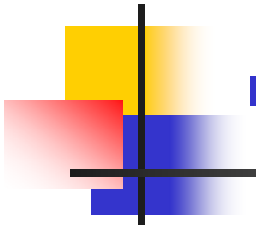


- Has point to point connection between every device in the network
- Excessive bandwidth is wasted for node to node signaling
- Easy to isolate faults, troubleshoot etc
- Extremely fault tolerant
- Difficult to install and reconfigure

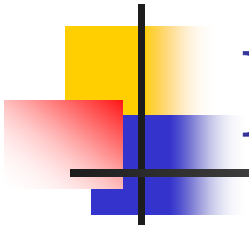


Cellular Topology

Cellular Topology



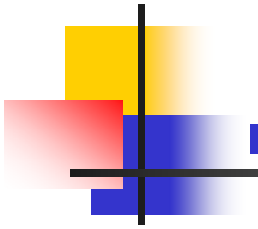
- Combines wireless point to point and multipoint strategies
- Divides a geographic area into cells
- Devices within a cell communicates with a central station or hub
- Devices can roam from cell to cell while maintaining connection
- Easy to install, troubleshoot
- No need of media reconfiguration when adding or moving users



Broadband Systems

- Uses the media's capacity for a single channel
- Multiple channels are created using a process called Frequency Division Multiplexing

Multiplexing

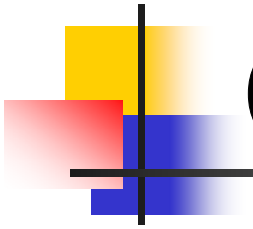


- Allows multiple devices to communicate simultaneously over s single transmission media
- Equipment used for this purpose is called Multiplexer or mux
- 3 common methods used in mux
  - Frequency Division Multiplexing (FDM)
  - Time Division Multiplexing (TDM)
  - Statistical Time Division Multiplexing (Stat TDM)

Frequency Division Multiplexing (FDM)

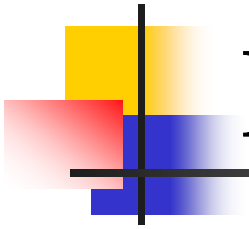
- Uses separate frequencies to establish multiple channels within a broadband medium
- Special carrier signals are created by mux and data signals are added to it during transmission and are removed at receiving end

Time Division Multiplexing (TDM)

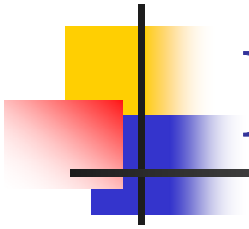


- Divides a single channel into short-time slots
- Time slots are of the same length and same order – so also called Synchronous TDM

Statistical Time Division Multiplexing (Stat TDM)



- Dynamically allocates timeslots to active devices in priority basis
- Overcomes the wastage due to unused timeslotsm



MAC Address

- These are unique hardware addresses typically assigned by hardware vendors
- The format used depends on the media access method used so it it is called MAC address
- All devices in the network, like bridges require this address to transmit packets