

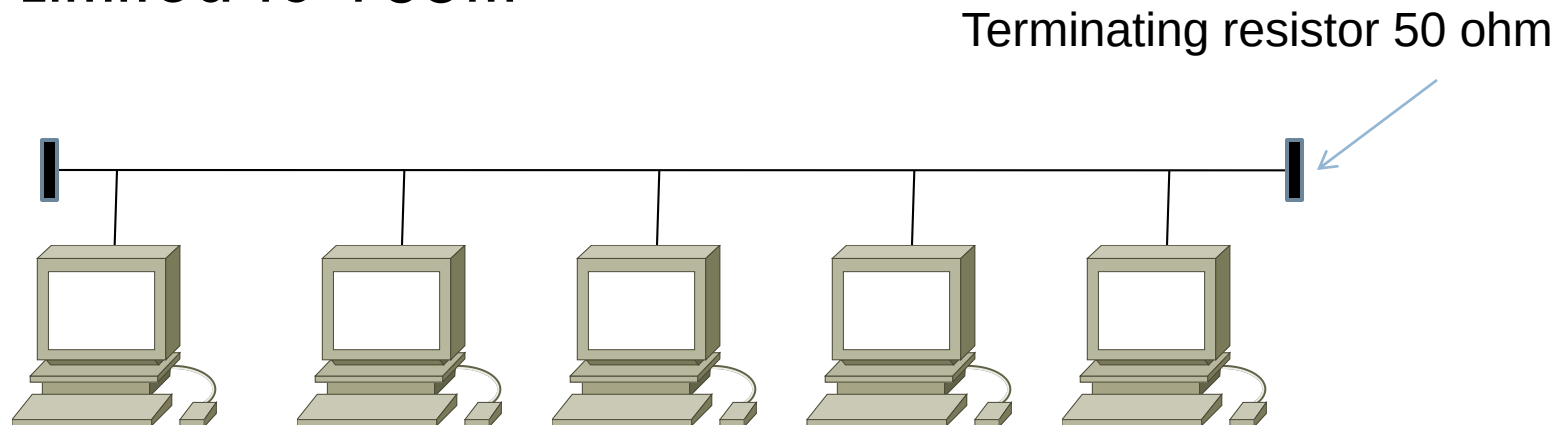
NETWORK TOPOLOGIES, CSMA/CD, CSMA/CA

Mohammad S. Hasan

Bus Topology

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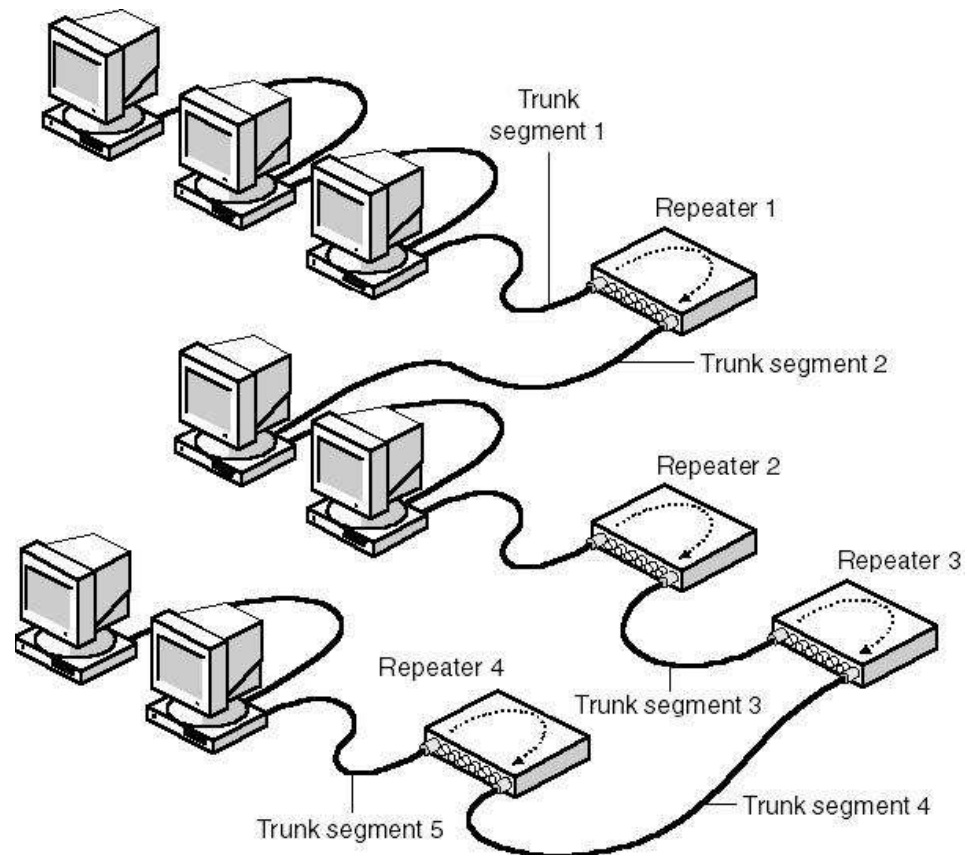
- ❑ The original linear topology
- ❑ Based on 10base2 coaxial cable
- ❑ Limited to 185m



5-4-3 rule

3

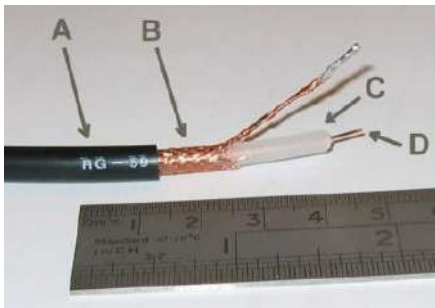
- 5
 - ▣ At most 5 segments
- 4
 - ▣ At most 4 repeaters
- 3
 - ▣ At most 3 segments with active senders



Connectors & Cable

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- Coaxial cable and BNC connector
 - ▣ Bayonet Neill-Concelman



- Tee connector

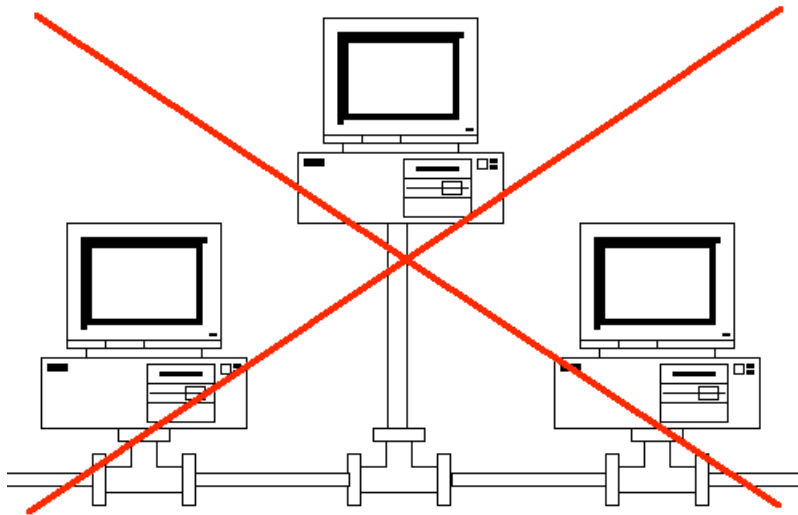
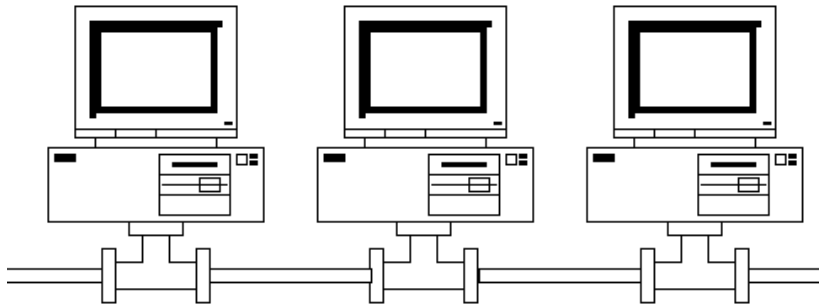


- Terminating resistor



Connection issues

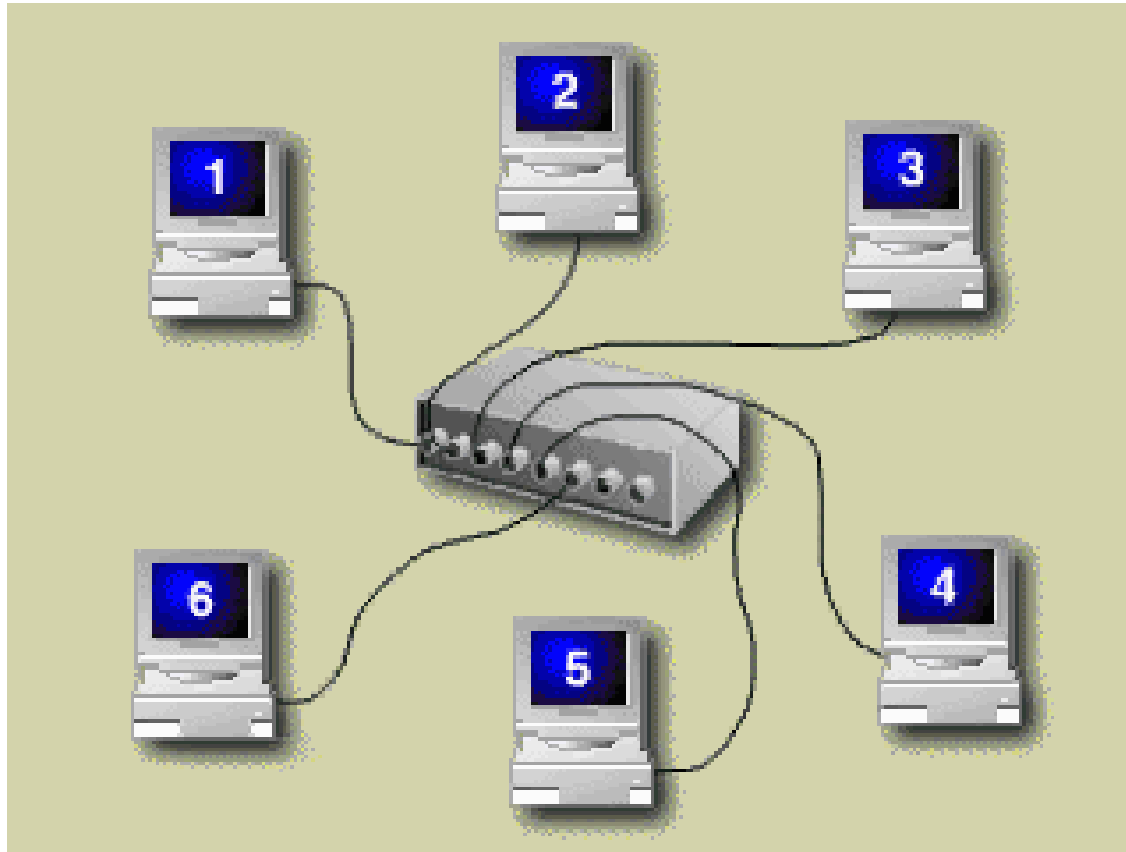
5



The dropper cable
produces
circulating currents

Star Network

6

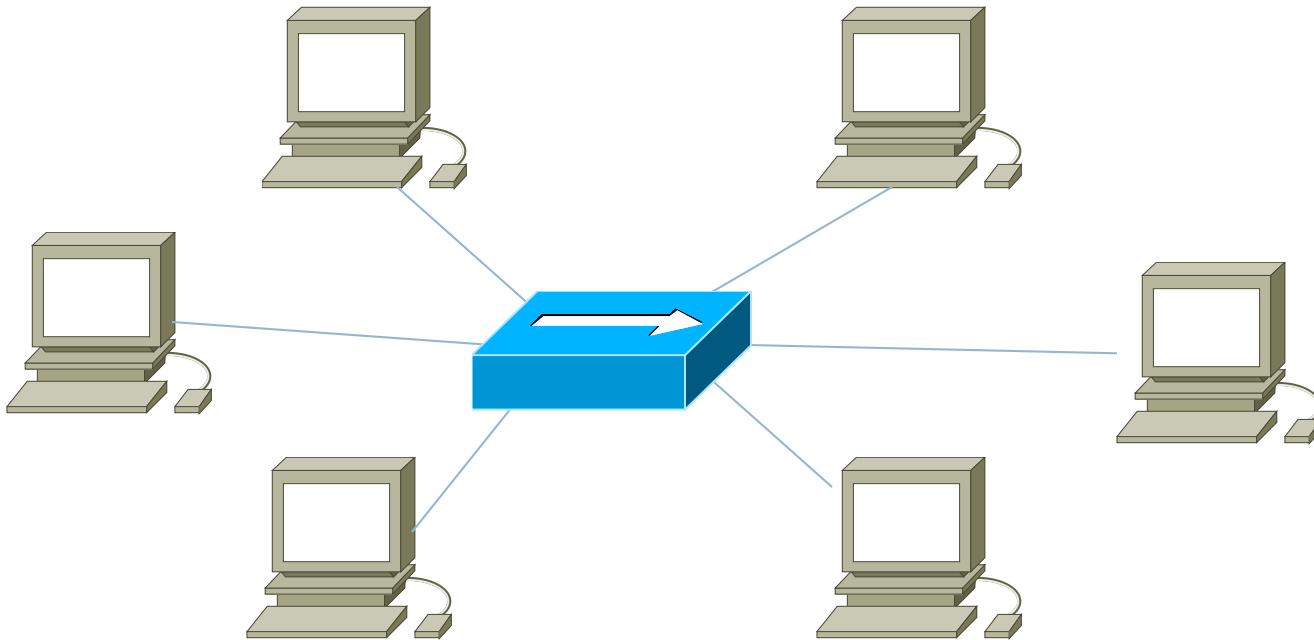


Network Topologies, CSMA/CD, CSMA/CA

Star Network based on Hub

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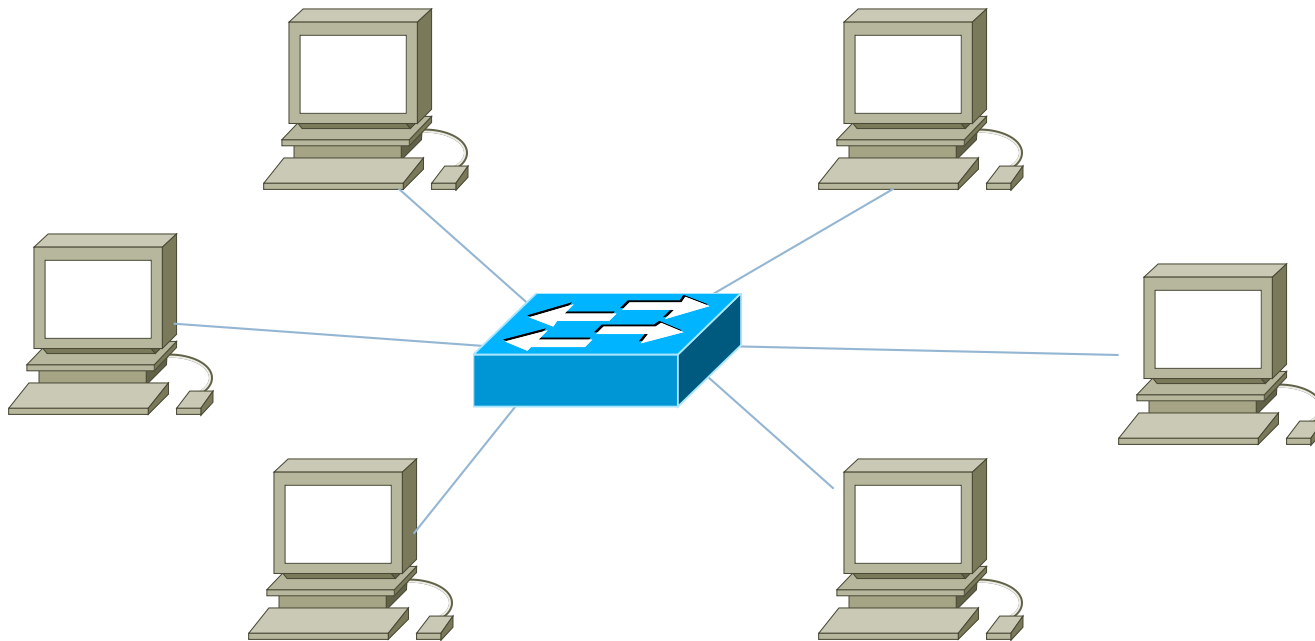
- All nodes are connected to a central point
- Original was via a hub



Star Network based on Switch

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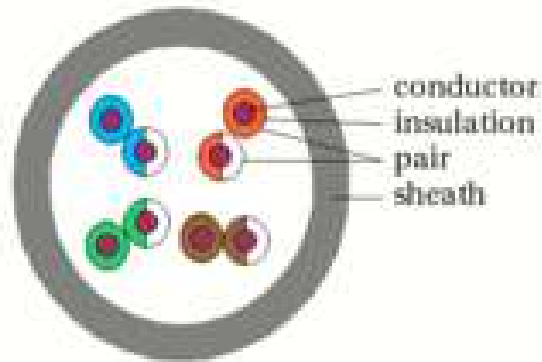
- A better more efficient and faster solution is via a switch



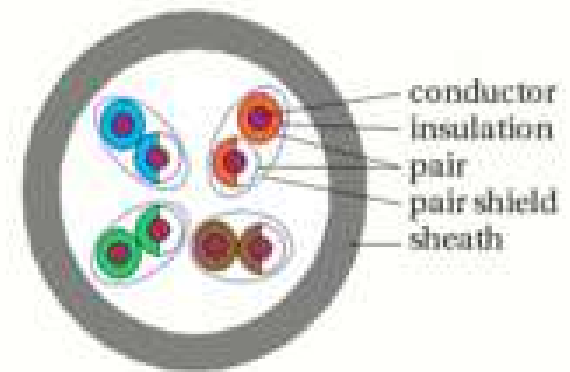
UTP/STP

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UTP

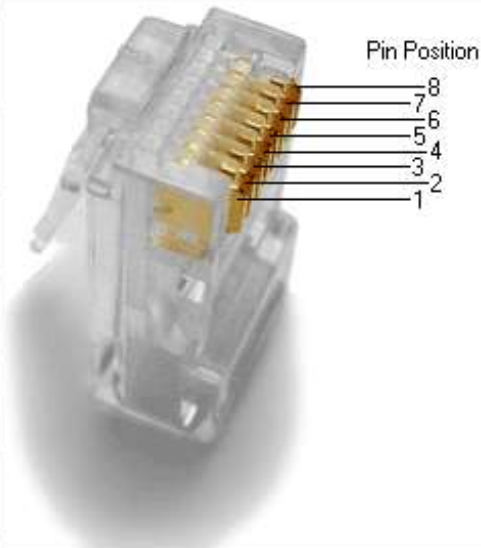


STP



Straight through Ethernet cable

10

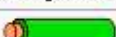
Pin	T568A Pair	T568B Pair	1000BASE-T Signal ID	Wire	T568A Color	T568B Color	Pins on plug face (socket is reversed)
1	3	2	DA+	tip	 white/green stripe	 white/orange stripe	
2	3	2	DA-	ring	 green solid	 orange solid	
3	2	3	DB+	tip	 white/orange stripe	 white/green stripe	
4	1	1	DC+	ring	 blue solid	 blue solid	
5	1	1	DC-	tip	 white/blue stripe	 white/blue stripe	
6	2	3	DB-	ring	 orange solid	 green solid	
7	4	4	DD+	tip	 white/brown stripe	 white/brown stripe	
8	4	4	DD-	ring	 brown solid	 brown solid	

Crossover cable

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Two pairs crossed, two pairs uncrossed

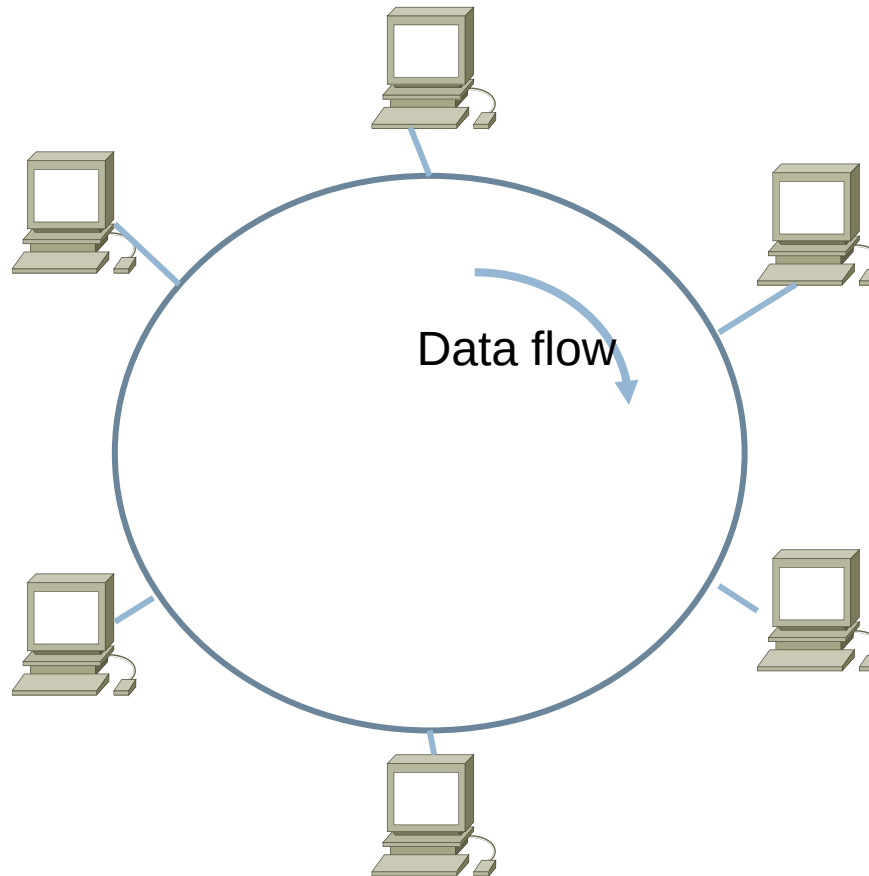
T1 crossover

Pin	Connection 1: T568A		Connection 2: T568B		Pins on plug face
	pair	color	pair	color	
1	2	 white/orange stripe	1	 blue solid	
2	2	 orange solid	1	 white/blue stripe	
3	3	 white/green stripe	3	 white/green stripe	
4	1	 blue solid	2	 white/orange stripe	
5	1	 white/blue stripe	2	 orange solid	
6	3	 green solid	3	 green solid	
7	4	 white/brown stripe	4	 white/brown stripe	
8	4	 brown solid	4	 brown solid	

Network Topologies, CSMA/CD, CSMA/CA

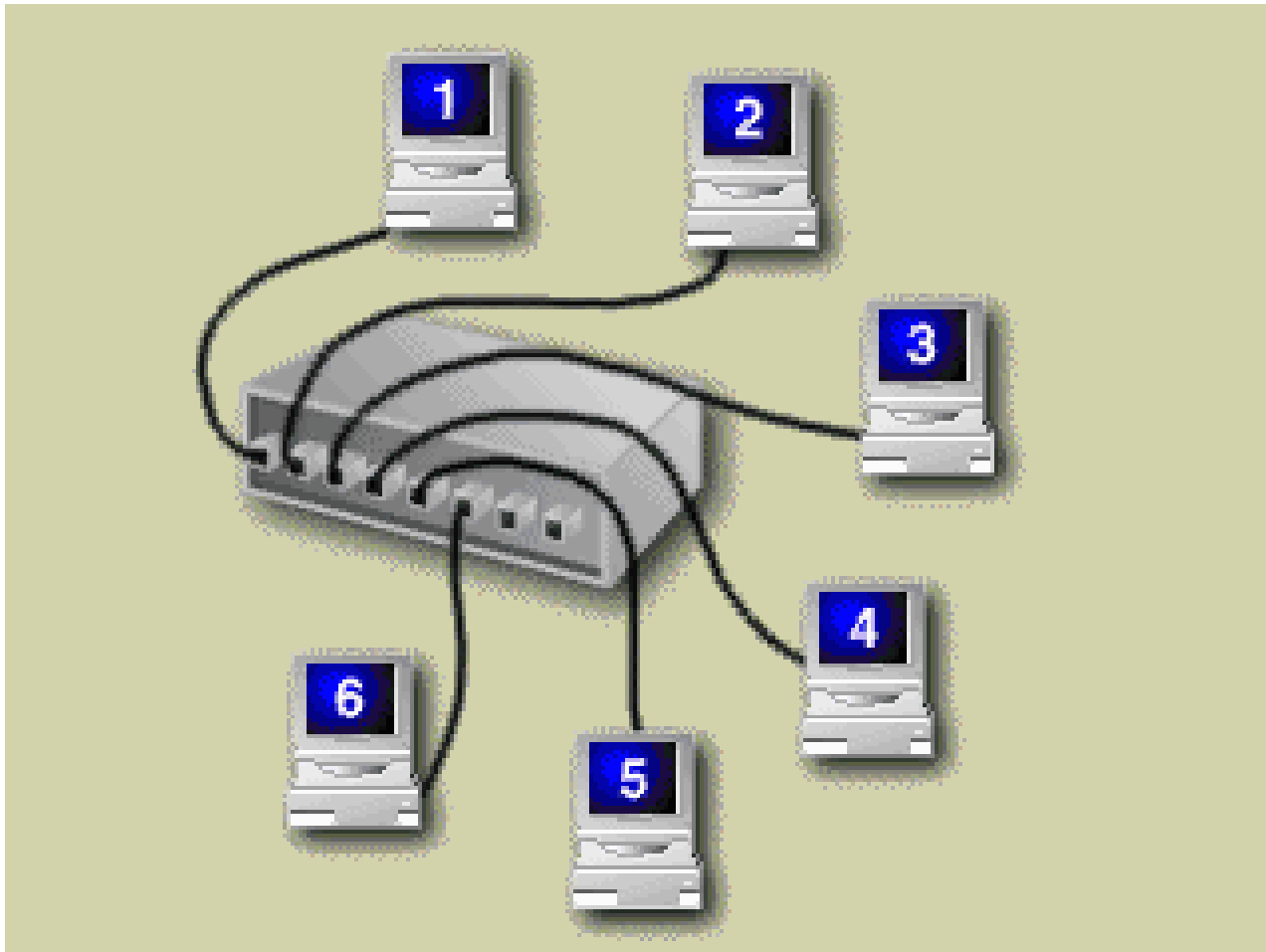
Token Ring Network (IEEE 802.5)

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Ring Network

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Network Topologies, CSMA/CD, CSMA/CA

Ring Network

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- Data flows theoretically in one direction
- Each station can only transmit when it has the TOKEN
- A further enhancement is FDDI (Fibre Distributed Data Interface)
 - ▣ IEEE802.4 token bus based
 - ▣ Up to 124 miles (200 km)
 - ▣ Normally optical fibre but can be copper
 - ▣ 2 counter rotating rings

Carrier Sense Multiple Access (CSMA) Protocol

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- A station wishing to transmit has to first listen to the channel for a predetermined amount of time to check for any activity.
 - ▣ If the channel is sensed "idle" then the station is permitted to transmit.
 - ▣ If the channel is sensed as "busy" the station has to defer its transmission.
- This is the essence of both CSMA/CA and CSMA/CD.

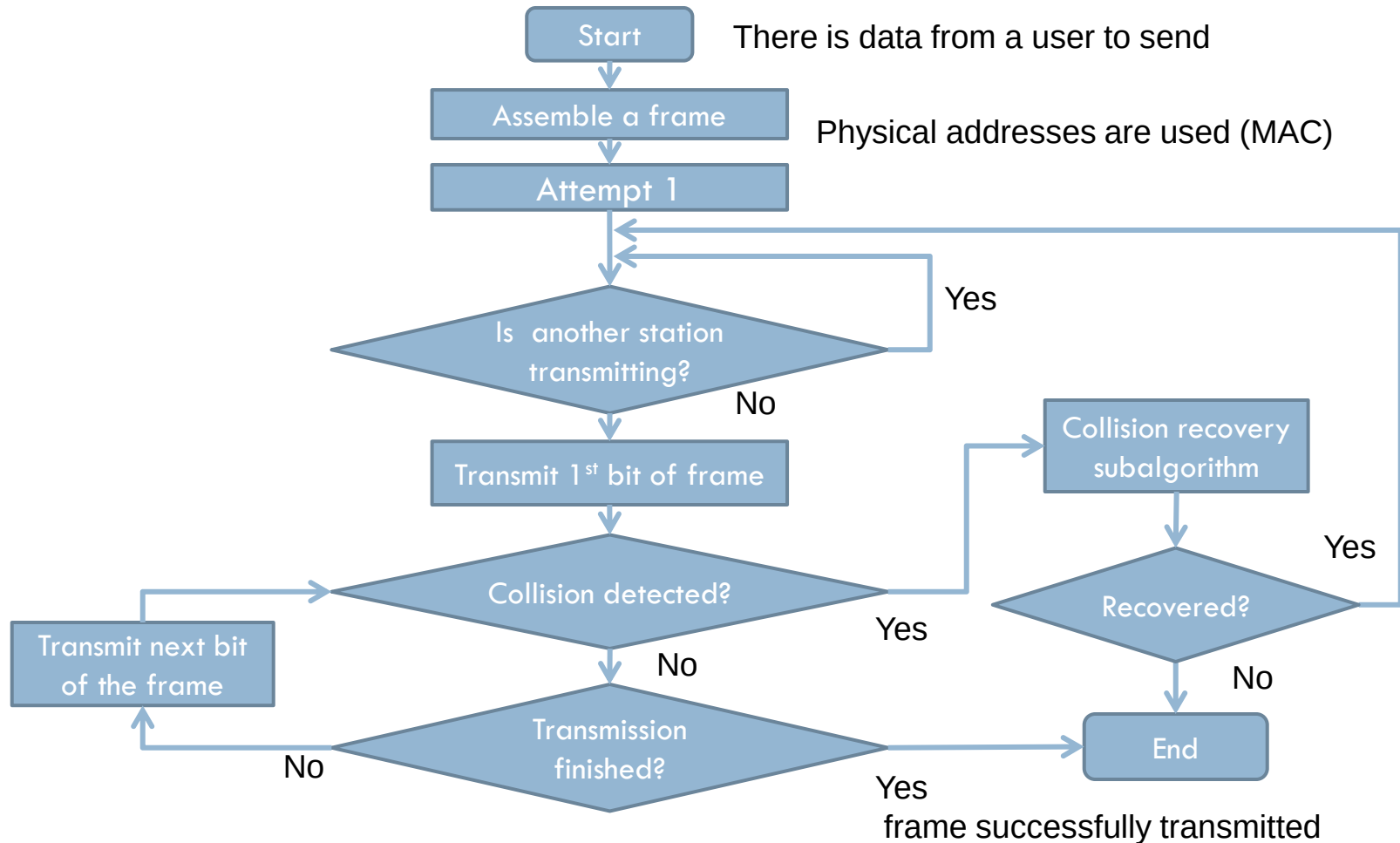
Carrier Sense Multiple Access / Collision Detection (CSMA/CD)

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- Typically Ethernet LANs
 - ▣ A carrier sensing scheme is used
- If a transmitting station detects another signal while transmitting a frame
 - ▣ stops transmitting that frame,
 - ▣ transmits a jam signal,
 - ▣ then waits for a random time interval “backoff delay” before trying again
 - The backoff delay is determined using the truncated binary exponential backoff algorithm

CSMA/CD and Wired Networks

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Truncated binary exponential backoff

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- After i collisions, a random number of slot times between 0 and $2^i - 1$ is chosen.
 - ▣ For the first collision, each sender might wait 0 or 1 slot times.
 - ▣ After the second collision, the senders might wait 0, 1, 2, or 3 slot times, and so forth.
- As the number of retransmission attempts increases, the number of possibilities for delay increases.

Truncated binary exponential backoff (cont.)

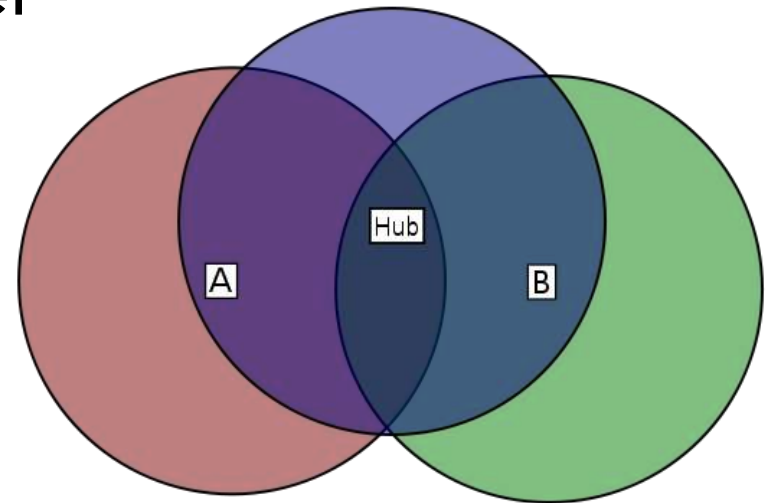
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- The 'truncated'
 - ▣ after a certain number of increases, the exponentiation stops i.e. the retransmission timeout reaches a ceiling, and thereafter does not increase any further.
 - For example, if the ceiling is set at $i=10$, then the maximum delay is 1023 slot times.
- Because these delays cause other stations who are sending to collide as well, there is a possibility that, on a busy network, hundreds of people may be caught in a single collision set. Because of this possibility, after 16 attempts at transmission, the process is aborted.

Wireless Network - Hidden Node Problem

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- A and B can communicate with the hub
- A and B can NOT communicate with each other directly
 - ▣ hidden from each other
- Typical wireless problem
 - ▣ Simultaneous transmission from A and B



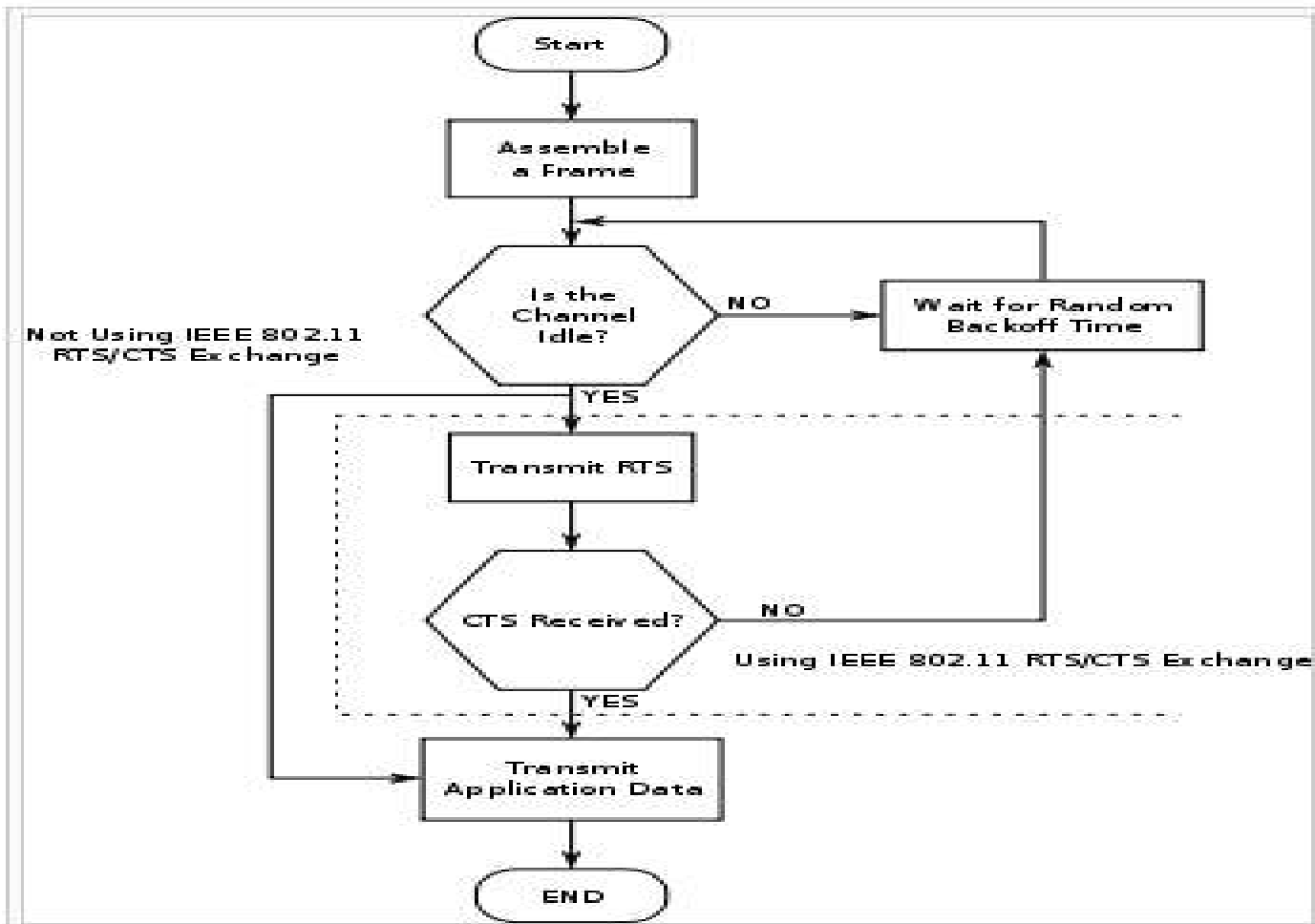
Carrier Sense Multiple Access / Collision Avoidance (CSMA/CA)

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- Typical application is on Wireless networks
 - ▣ Collision detection is NOT possible
- Collision Avoidance (CA) protocol
 - ▣ The sender sends Request To Send (RTS) to the receiver
 - ▣ The Receiver replies back with a Clear To Send (CTS) to the Sender
 - ▣ The Sender starts data transmission
 - ▣ The RTS or the CTS tell other nodes NOT to send data for a given amount of time.

CSMA/CA

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LAN limitations

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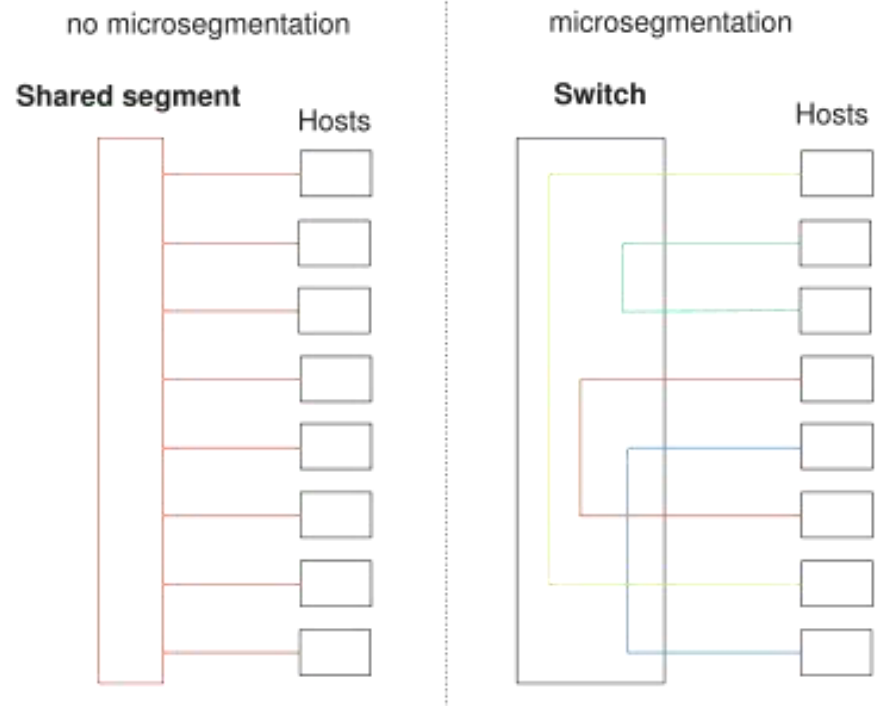
- The choice of connection equipment is extremely important
 - ▣ For example, do you connect via a hub or switch
- In a previous lecture
 - ▣ hubs share bandwidth
 - ▣ so available bandwidth

$$\frac{\textit{Total_bandwidth}}{\textit{Number_of_users}}$$

LAN limitations

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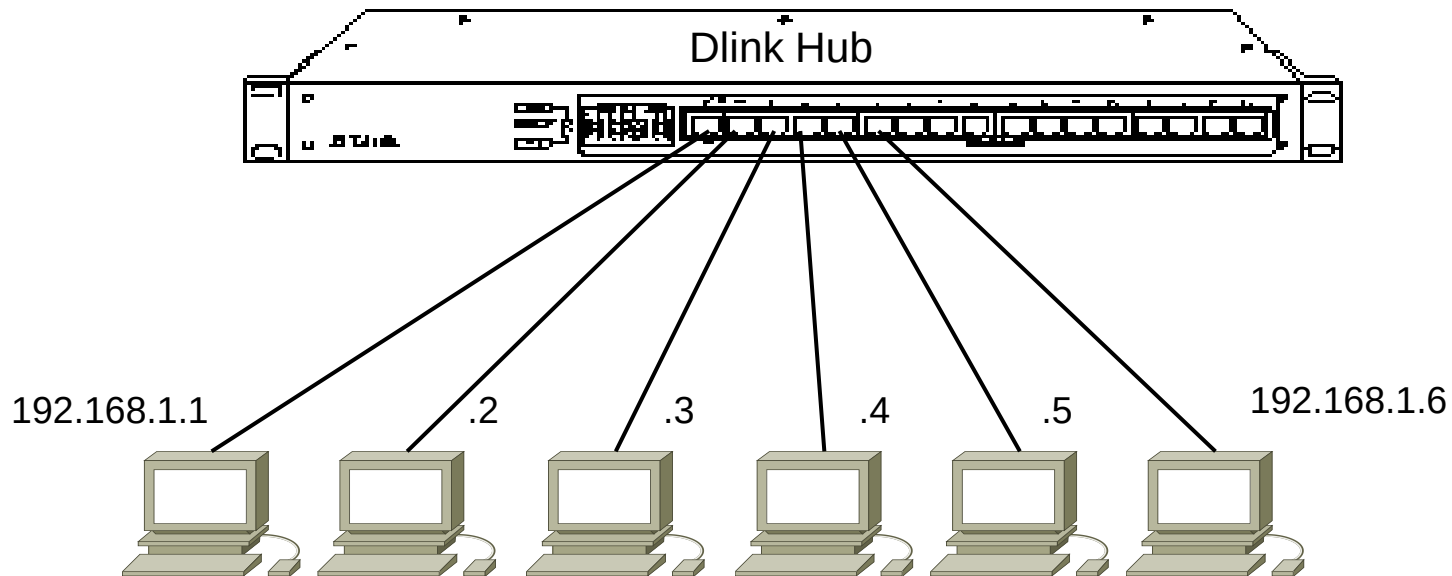
- A switch however uses a process called microsegmentation to create dedicated full bandwidth links between the ports



Proof of Hub limitations – Ping command

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- Type in command prompt (where x is the address of another machine)
 - ▣ C:\>ping 192.168.1.x -l 65500 -n 65500



Ping with hub - 3 PC's, 1 cmd prompt only

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```
C:\WINDOWS\system32\cmd.exe
^C
C:\Documents and Settings\cisco.FCET_K104-1>ping 192.168.10.3 -l 65500 -n 65500

Pinging 192.168.10.3 with 65500 bytes of data:

Reply from 192.168.10.3: bytes=65500 time=110ms TTL=128
Reply from 192.168.10.3: bytes=65500 time=110ms TTL=128
Reply from 192.168.10.3: bytes=65500 time=110ms TTL=128
Reply from 192.168.10.3: bytes=65500 time=110ms TTL=128
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Reply from 192.168.10.3: bytes=65500 time=109ms TTL=128
Reply from 192.168.10.3: bytes=65500 time=110ms TTL=128
Reply from 192.168.10.3: bytes=65500 time=109ms TTL=128
Reply from 192.168.10.3: bytes=65500 time=110ms TTL=128
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Reply from 192.168.10.3: bytes=65500 time=109ms TTL=128
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Reply from 192.168.10.3: bytes=65500 time=110ms TTL=128
Reply from 192.168.10.3: bytes=65500 time=110ms TTL=128
Reply from 192.168.10.3: bytes=65500 time=110ms TTL=128

Ping statistics for 192.168.10.3:
    Packets: Sent = 27, Received = 27, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 109ms, Maximum = 110ms, Average = 109ms
Control-C
^C
C:\Documents and Settings\cisco.FCET_K104-1>
```

Note round trip time

Ping with hub - 3 PC's, 4 cmd prompts per PC

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```
C:\WINDOWS\system32\cmd.exe - ping 192.168.10.3 -l 65500 -n 65500
Reply from 192.168.10.3: bytes=65500 time=110ms TTL=128
Reply from 192.168.10.3: bytes=65500 time=110ms TTL=128
Request timed out.
Reply from 192.168.10.3: bytes=65500 time=460ms TTL=128
Reply from 192.168.10.3: bytes=65500 time=110ms TTL=128
Reply from 192.168.10.3: bytes=65500 time=110ms TTL=128
Reply from 192.168.10.3: bytes=65500 time=110ms TTL=128
Reply from 192.168.10.3: bytes=65500 time=110ms TTL=128
Reply from 192.168.10.3: bytes=65500 time=110ms TTL=128
Reply from 192.168.10.3: bytes=65500 time=110ms TTL=128
Reply from 192.168.10.3: bytes=65500 time=110ms TTL=128
Reply from 192.168.10.3: bytes=65500 time=110ms TTL=128
Reply from 192.168.10.3: bytes=65500 time=110ms TTL=128
Reply from 192.168.10.3: bytes=65500 time=110ms TTL=128
Reply from 192.168.10.3: bytes=65500 time=537ms TTL=128
Reply from 192.168.10.3: bytes=65500 time=167ms TTL=128
Reply from 192.168.10.3: bytes=65500 time=165ms TTL=128
Reply from 192.168.10.3: bytes=65500 time=164ms TTL=128
Reply from 192.168.10.3: bytes=65500 time=167ms TTL=128
Reply from 192.168.10.3: bytes=65500 time=165ms TTL=128
Reply from 192.168.10.3: bytes=65500 time=307ms TTL=128
Reply from 192.168.10.3: bytes=65500 time=221ms TTL=128
Reply from 192.168.10.3: bytes=65500 time=219ms TTL=128
Reply from 192.168.10.3: bytes=65500 time=164ms TTL=128
Reply from 192.168.10.3: bytes=65500 time=175ms TTL=128
Request timed out.
Request timed out.
Reply from 192.168.10.3: bytes=65500 time=664ms TTL=128
Request timed out.
Reply from 192.168.10.3: bytes=65500 time=221ms TTL=128
Reply from 192.168.10.3: bytes=65500 time=174ms TTL=128
Reply from 192.168.10.3: bytes=65500 time=110ms TTL=128
Reply from 192.168.10.3: bytes=65500 time=119ms TTL=128
Reply from 192.168.10.3: bytes=65500 time=130ms TTL=128
Reply from 192.168.10.3: bytes=65500 time=251ms TTL=128
Reply from 192.168.10.3: bytes=65500 time=249ms TTL=128
Reply from 192.168.10.3: bytes=65500 time=237ms TTL=128
```

Note increased round trip time

```
C:\WINDOWS\system32\cmd.exe - ping 192.168.10.2 -l 65500 -n 65500
Reply from 192.168.10.2: bytes=65500 time=110ms TTL=128
Request timed out.
Request timed out.
Request timed out.
Request timed out.
Request timed out.
Request timed out.
Request timed out.
Request timed out.
Reply from 192.168.10.2: bytes=65500 time=352ms TTL=128
Reply from 192.168.10.2: bytes=65500 time=173ms TTL=128
Reply from 192.168.10.2: bytes=65500 time=155ms TTL=128
Reply from 192.168.10.2: bytes=65500 time=141ms TTL=128
Reply from 192.168.10.2: bytes=65500 time=149ms TTL=128
Request timed out.
Request timed out.
Reply from 192.168.10.2: bytes=65500 time=110ms TTL=128
Reply from 192.168.10.2: bytes=65500 time=163ms TTL=128
Reply from 192.168.10.2: bytes=65500 time=110ms TTL=128
Reply from 192.168.10.2: bytes=65500 time=110ms TTL=128
Reply from 192.168.10.2: bytes=65500 time=110ms TTL=128
Reply from 192.168.10.2: bytes=65500 time=110ms TTL=128
Ping statistics for 192.168.10.2:
    Packets: Sent = 45, Received = 34, Lost = 11 (24% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 110ms, Maximum = 372ms, Average = 144ms
Control-C
C:\Documents and Settings\ci\co.FCET_K104-1>ping 192.168.10.2 -l 65500

Pinging 192.168.10.2 with 65500 bytes of data:

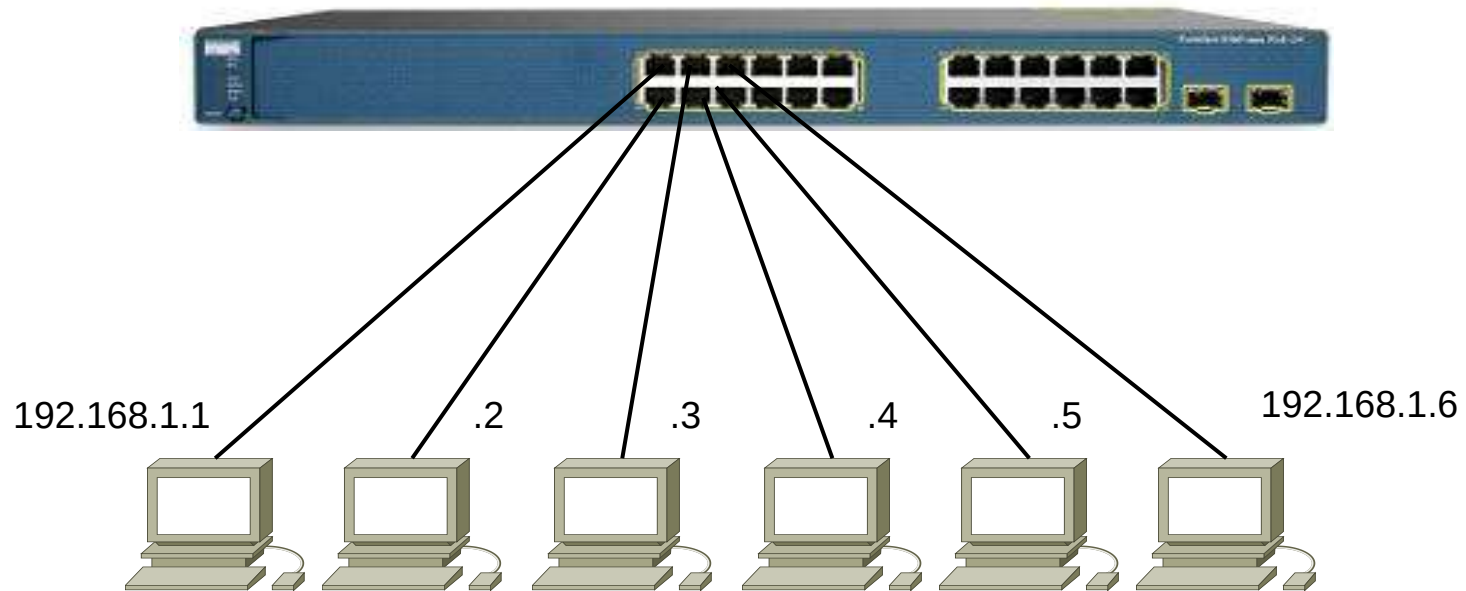
Reply from 192.168.10.2: bytes=65500 time=110ms TTL=128
Reply from 192.168.10.2: bytes=65500 time=110ms TTL=128
Request timed out.
```

Network stalled due to too many collisions

Proof of Switch Performance – Ping Command

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- Type in the command prompt (where x is the address of another machine:
 - ▣ C:\>ping 192.168.1.x -l 65500 -n 65500



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Noticed the reduced round trip time

Network Topologies, CSMA/CD, CSMA/CA