Networking Basics

Course Title: Computer Networks

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Lecture Outline

1. Overview of TCP/IP Protocol Suite
2. Connecting Devices
3. Collision domain and Broadcast domain
4. Ethernet Standards
5. WLAN Standards

Overview of TCP/IP protocol suite

❖ Application Layer

- Only layer which interacts with users' applications.
- Takes data from users in sending end and provide the data to user in the receiving end.
- Protocols include HTTP, DNS, FTP, SMTP.
- Implemented in source and destination devices only.

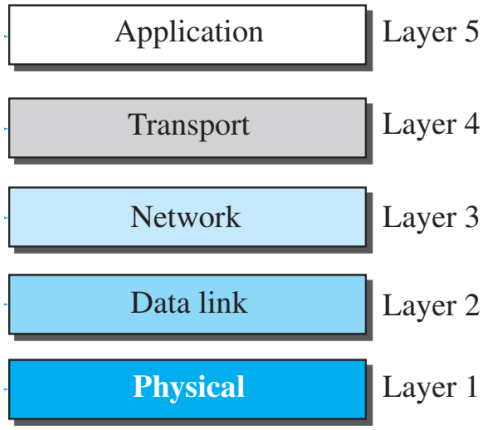


Fig. 1Layers of TCP/IP protocol suites

Overview of TCP/IP protocol suite

❖ Transport Layer

- Gets the message from the application layer, encapsulates it in a segment and sends it to Network layer.
- Message delivery can be reliable but slow (TCP) or unreliable but fast (UDP).
- Provide port addressing to application layer programs.
- Perform error control, flow control and congestion control.

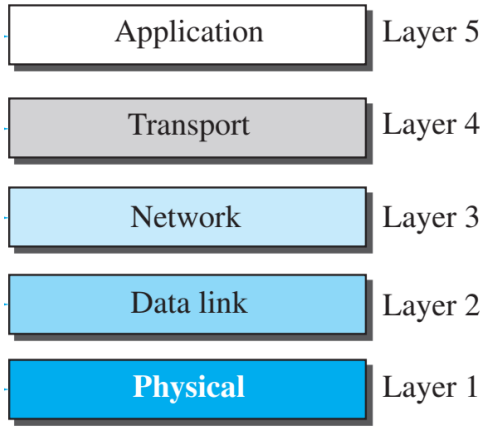


Fig. 1Layers of TCP/IP protocol suites

Overview of TCP/IP protocol suite

❖ Network Layer

- Required for communication between multiple networks.
- Introduces IP address, perform routing and congestion control.
- Encapsulate segment into a packet (called IP datagram).
- Used in end devices and network layer devices (Router, PC, Layer 3 switch, etc.).
- Protocols include IP, ICMP, RIP, EIGRP, OSPF, etc.

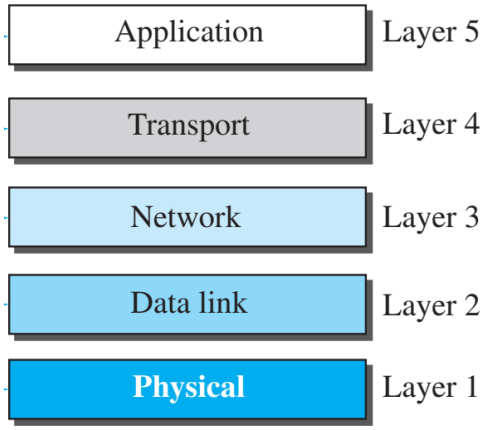


Fig. 1Layers of TCP/IP protocol suites

Overview of TCP/IP protocol suite

❖ Data-link Layer

- Required for communication inside a network.
- Introduces MAC address, perform error control, and flow control.
- Encapsulating packet into frame.
- Used in all devices (PC, Router, Switch, Bridge) except Hub & Repeater.
- Protocols include ALOHA, CSMA, CSMA/CD, CSMA/CA.

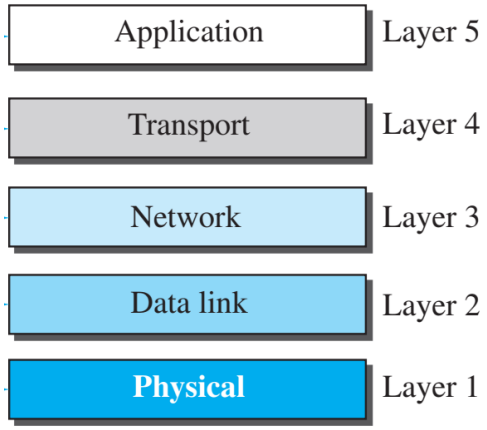


Fig. 1Layers of TCP/IP protocol suites

Overview of TCP/IP protocol suite

❖ Physical Layer

- Accepts a complete frame from the Data Link layer and encodes it as a series of signals that are transmitted onto the local media.
- Specifies transmission media.
- Network physical topology [1].

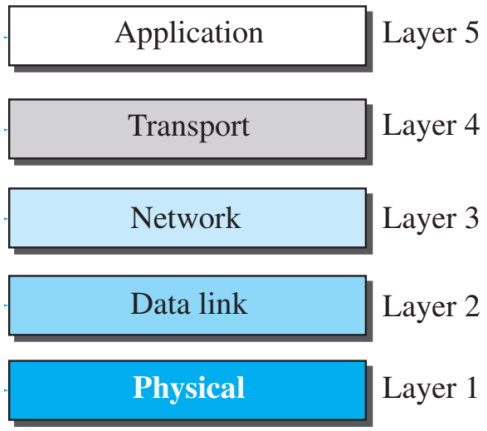


Fig. 1Layers of TCP/IP protocol suites

Overview of TCP/IP protocol suite

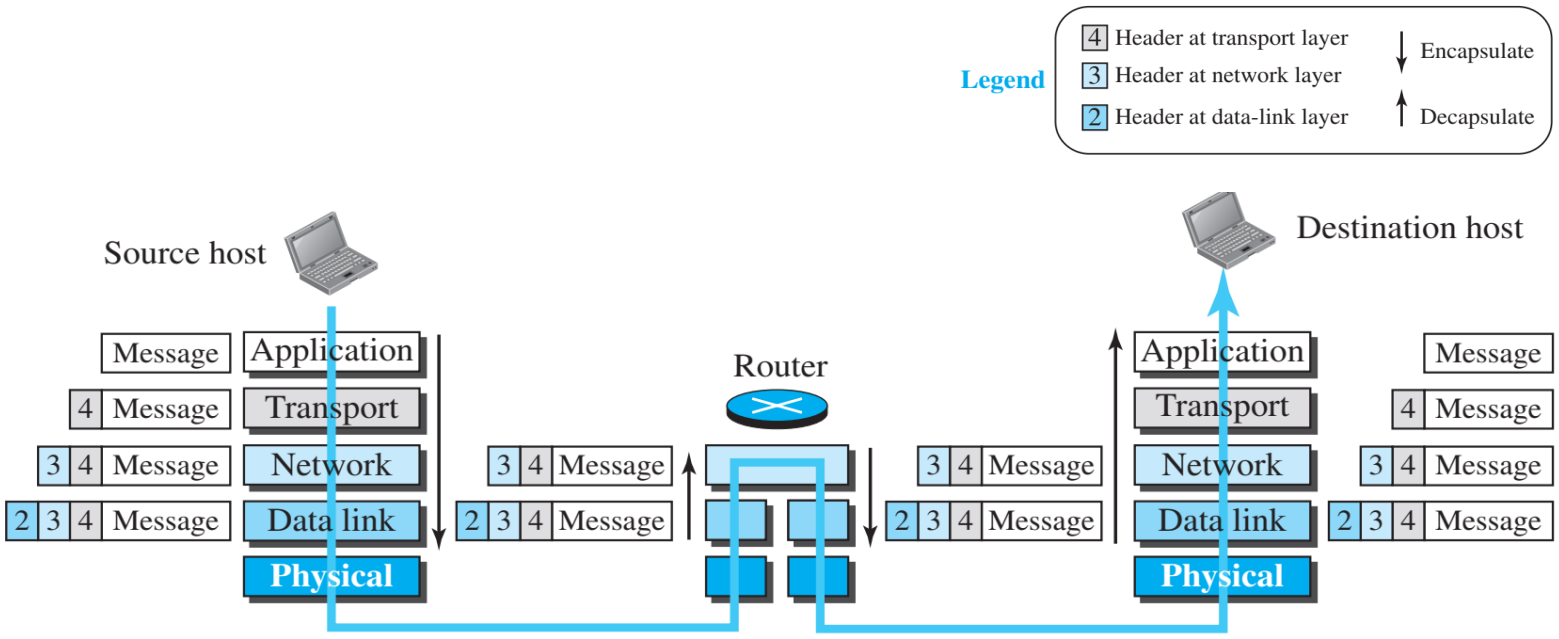


Fig. 2 Encapsulation/Decapsulation

Connecting Devices

Repeater

❖ Repeater

- Layer 1 device that takes voltage from the line, amplifies the voltage, and sends it down the line [3].
- Used to extend a network beyond the maximum length of the cable segment [2].
- If there is any "noise" caused by electromagnetic interference on the wire, it will also amplify the noise and send it [3].
- The use of three repeater in a row results in an unusable signal transmission because of extreme noise [3].
- These devices are not in common use anymore; they have been replaced by hubs, bridges, and switches.

Connecting Devices

Repeater

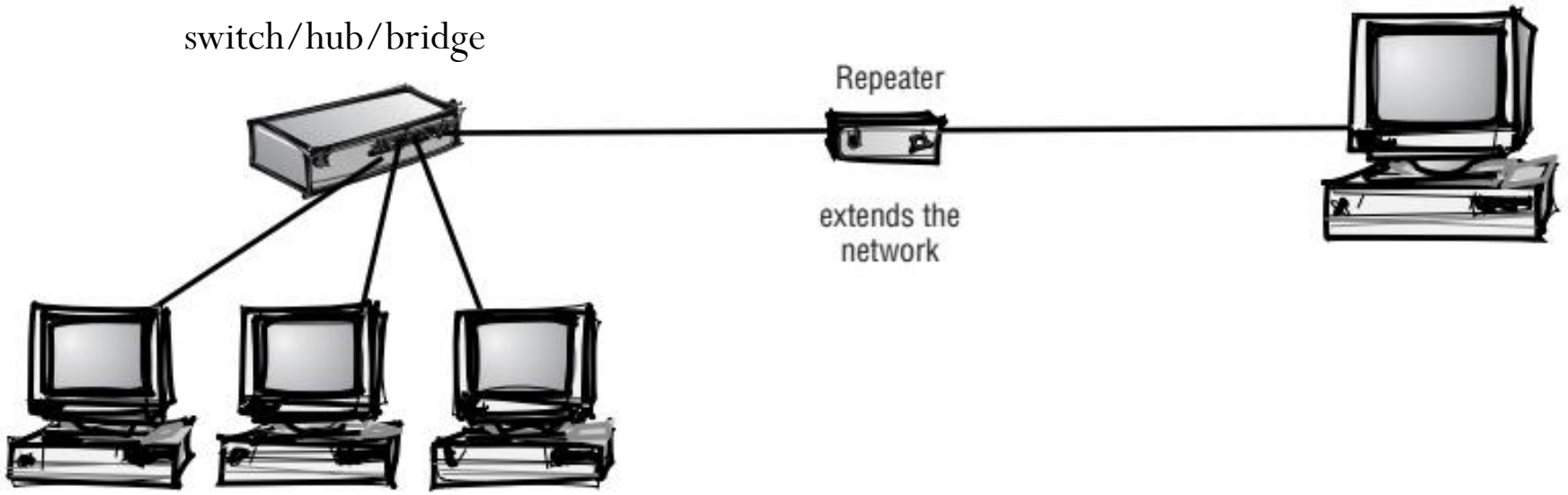


Fig. 3 Use of repeaters and switch/hub/bridge [2]

Connecting Devices

Hub

Hub

- A repeater with more than one output port.
- Electrical signal comes through one port of the hub and gets amplified and sent out through all ports of the hub.
- if you have a 10-Mbps hub and three devices are transmitting at the same time, each device gets one third of the bandwidth [5].

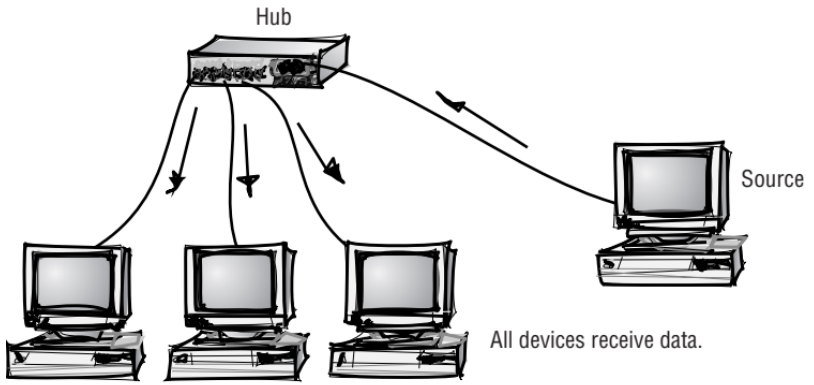


Fig. 4 Broadcasting of a Hub [2]

- For a successful transmission, only one station can send data at a time.
- More active ports cause more collision among signal, thereby resulting in lower data rate.
- A layer 1 device [2] and is Used to connect devices of a single network.

Connecting Devices

Bridge

❖ Bridge

- A layer 2 device.
- Used to connect devices of a single network.
- It sends the received frame only to the intended destination based on the destination MAC address of the frame.
- Better bandwidth usage [3].
- Unlike hub, it has error detection capability.
- Limited ports (2-4, usually 2 ports).

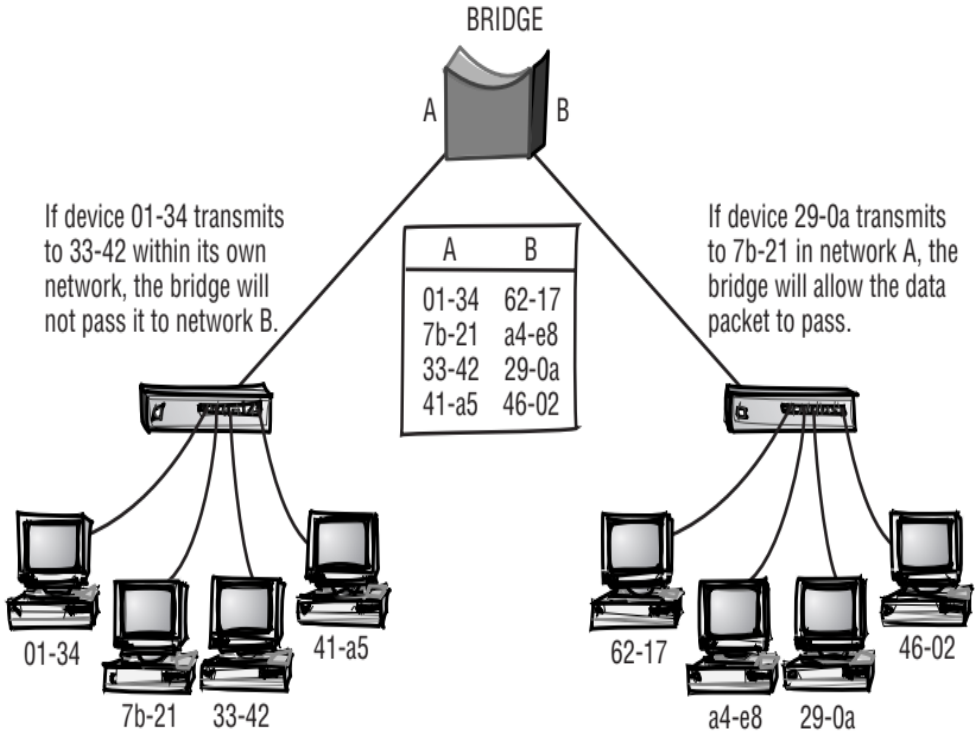


Fig. 5 Filtering of a Bridge [2]

Connecting Devices

Switch

❖ Switch

- A layer 2 device.
- Used to connect devices of a single network.
- Like a Bridge, it sends the received frame only to the intended destination based on the destination MAC address of the frame.
- Unlike hub, it has error detection capability.
- Hundreds of ports(2 to more than 100).
- Frame forwarding decision is taken based hardware, hence it is faster than bridge [4].
- If you have a 10-Mpbs switch with three devices connected to it, all three devices can use 10- Mbps of bandwidth. [5].

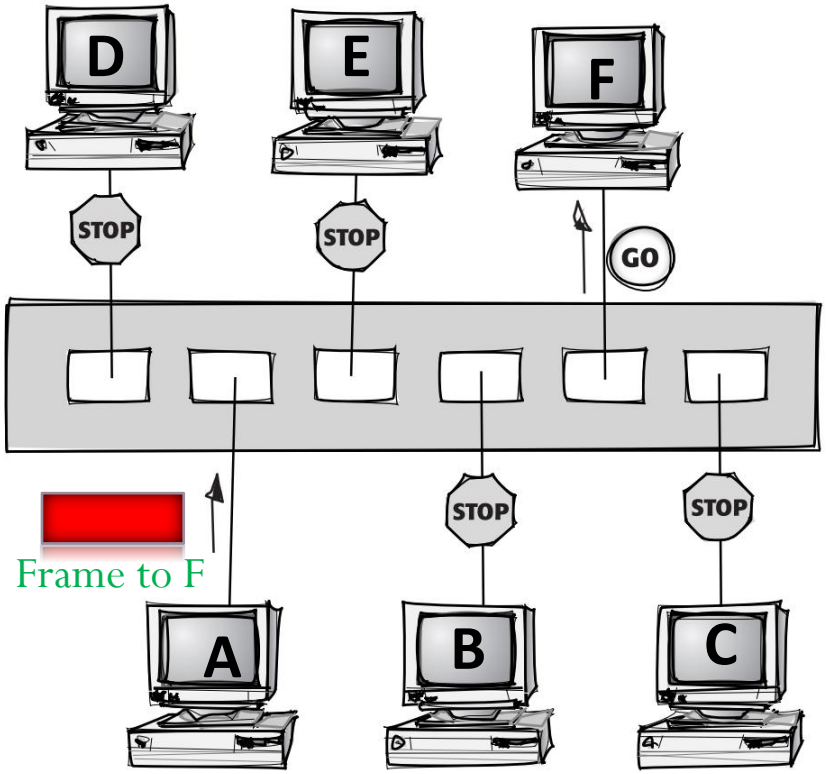


Fig. 6 Filtering of a Switch [2]

Connecting Devices

Router

❖ Router

- A layer 3 device.
- Used to connect multiple networks.
- Connected networks can have different protocols and speed.
- Forward packets based on destination IP address.
- Most intelligent connecting device.
- Can also be used to forward packet within network.
- Slower than switch because of its routing protocol implementation.

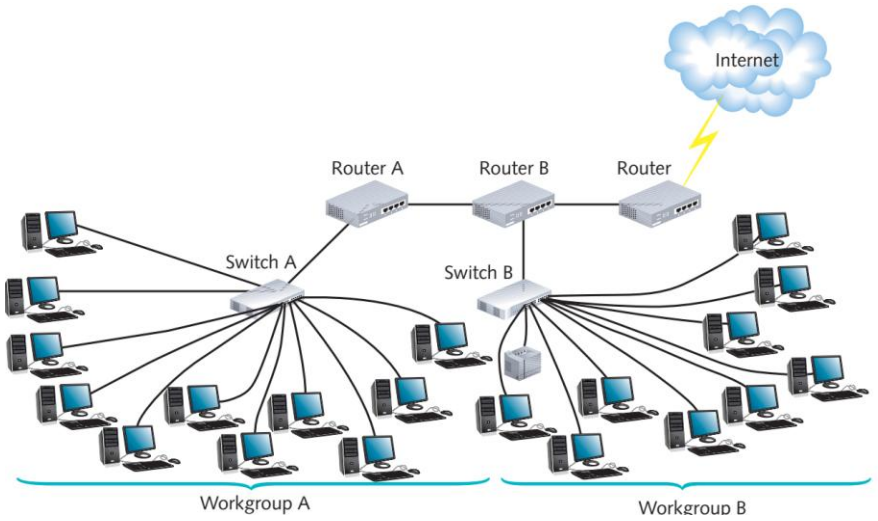
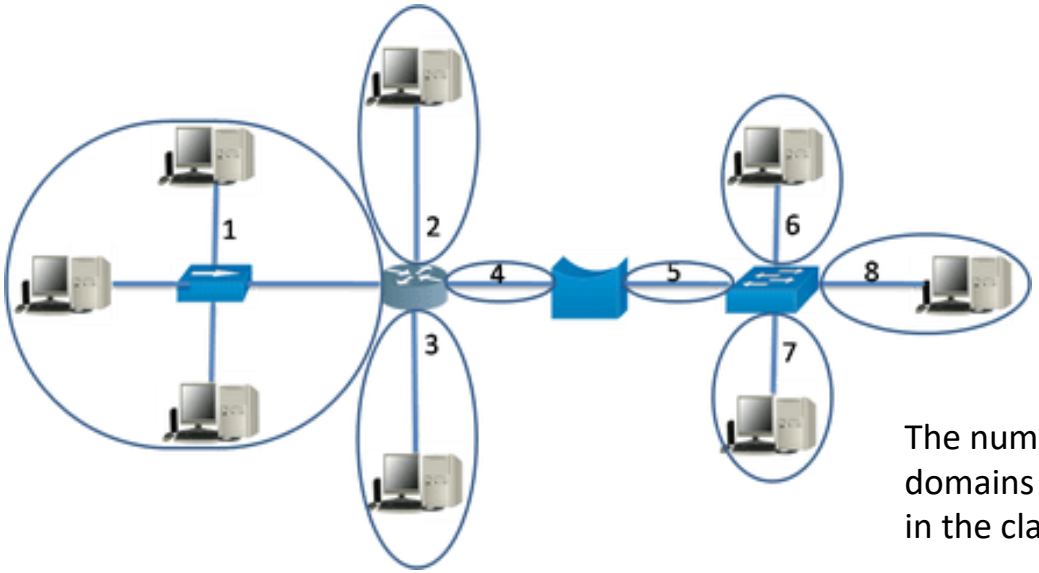


Fig. 7 Router connecting multiple networks [6]

Collision Domain

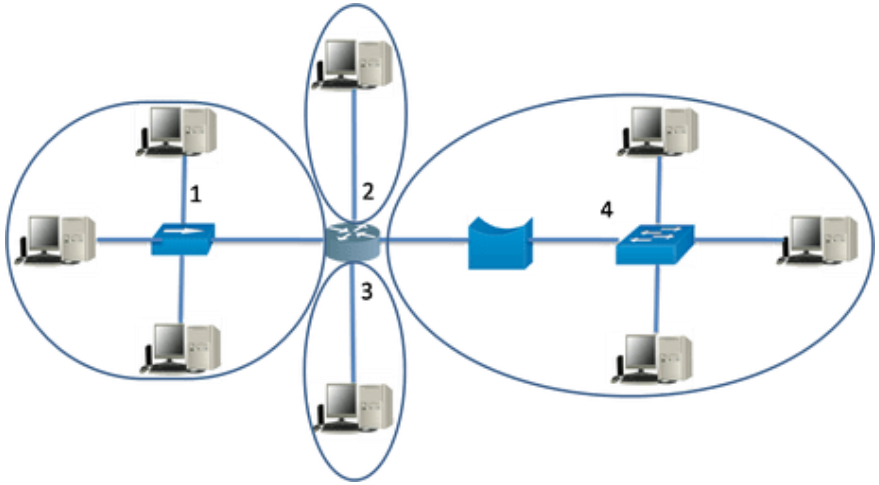
- The “collision domain” describes a network where packet collisions can occur when two devices on a shared network medium send packets simultaneously.
- Hub: All ports belong to the same collision domain.
- Bridge, Switch, Router: Each port belongs to a separate collision domain.



The numbering (counting) of the domains is inaccurate as I explained in the class.

Broadcast Domain

- All the devices in the broadcast domain can be reached via broadcast at the data link layer.
- A Broadcast Domain can receive any broadcast packet originating from any device within the network segment.
- All ports of hub and switch belong to same broadcast domain, but all ports of the router belong to different broadcast domain [9].



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Problem

Problem 1: From Fig 1, find out the number of Broadcast and Collision Domains along with highlighting all the broadcast domains and collision domains using circle/ellipse (10 pts).

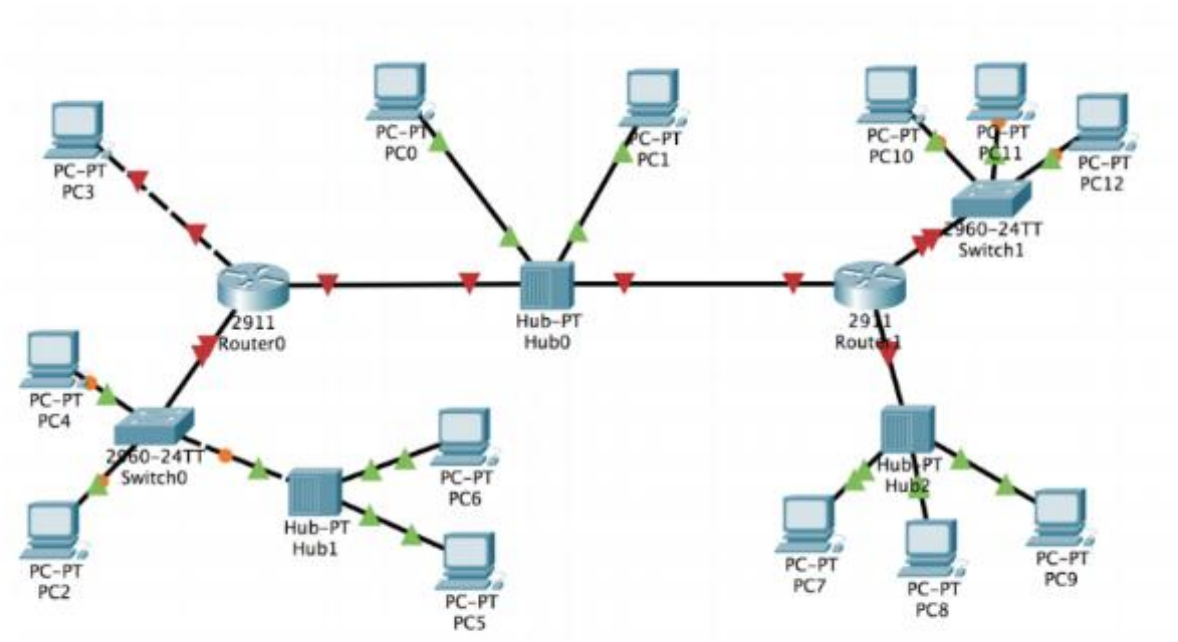

Fig1: Sample Topology

Ethernet Standards

TABLE I Ethernet Standard [7]

Speed	Common Name	Informal Standard Name	Formal Standard Name	Cable Type	Max. Length
10 Mbps	Ethernet	10BASE-T	802.3	Cat3	100 m
100 Mbps	Fast Ethernet	100BASE-T	802.3u	Cat5	100 m
1000 Mbps	Gigabit Ethernet	1000BASE-LX	802.3z	Single mode fiber	5000 m
				50-micron multimode fiber	550 m
				62.5-micron multimode fiber	440 m
1000 Mbps	Gigabit Ethernet	1000BASE-T	802.3ab	Cat5, Cat5e	100 m
10 Gbps	10 Gig bit Ethernet	10GBASE-T	802.3an	Cat6, Cat6a	100 m

WLAN Standards

TABLE II WLAN Standard [8]

Release date	Standard	Frequency band	Bandwidth	Transmission scheme	Max modulation	MIMO	Max data rate
1997	802.11	2.4 GHz	20 MHz	DSSS, FHSS	QPSK	N/A	2 Mbps
1999	802.11b	2.4 GHz	20 MHz	DSSS	QPSK	N/A	11 Mbps
1999	802.11a	5 GHz	20 MHz	OFDM	64 QAM	N/A	54 Mbps
2003	802.11g	2.4 GHz	20 MHz	DSSS, OFDM	64 QAM	N/A	54 Mbps
2009	802.11n	2.4 GHz 5 GHz	20 MHz 40 MHz	OFDM	64 QAM	4×4	600 Mbps
2013	802.11ac	5 GHz	20 MHz 40 MHz 80 MHz 160 MHz	OFDM	256 QAM	8×8	6.93 Gbps
2018	802.11ad	60 GHz	2160 MHz	SC-FDM, OFDM	256 QAM	Beamforming	6.93 Mbps

Acronyms

DSSS: Direct sequence spread spectrum

FHSS: Frequency hop spread spectrum

OFDM: Orthogonal Frequency Division Multiplexing

SC FDM: Single carrier frequency domain multiplexing

QPSK: Quadrature phase shift keying

QAM: Quadrature amplitude modulation

MIMO: Multiple input multiple output

Beamforming: Technique of focusing a wireless signal towards a specific receiving device

References

[1] B. A. Forouzan, *Data Communication and Networking,* 5th ed., The McGraw-Hill Companies, Inc., USA, 2013, pp. 38-42.

[2] P. Ciccarelli and C. Faulkner, *Networking Foundations*, Sybex Inc., USA, 2004, pp. 160 – 165.

[3] D. Liu, *Cisco CCNA/CCENT Exam 640-802, 640-822, 640-816 Preparation Kit*, Syngress Publishing, Inc., 2009, pp. 607-609.

[4] Difference between a switch and a bridge, https://geek-university.com/ccna/differences-between-a-switch-and-a-bridge/, [Accessed: April. 22, 2020].

[5] D. Barrett and T. King, *Computer Networking Illuminated*, Jones and Bartlett Publishers, Inc., USA, 2003, pp. 90-91.

[6] T. Dean, *Network+ Guide to Networks*, Course Technology, USA, 2013, pp. 270.

[7] W. Odom, Official Cert Guide CCNA 200-301 Volume 1, Pearson Education, Inc., 2020, USA, p. 37.

[8] Wifi Standard Evolutions, https://www.grandmetric.com/2018/05/29/wi-fi-standards-evolution/, [Accessed: April. 30, 2020].

[9] Collision and broadcast domain, https://networkustad.com/2019/07/16/collision-and-broadcast-domains/, [Accessed: April. 30, 2020].

Recommended Books

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2. **Computer Networking: A Top-Down Approach**, *J. F., Kurose, K. W. Ross*, Pearson Education, Inc., Sixth Edition, USA.
3. **Official Cert Guide CCNA 200-301 , vol. 1**, *W. Odom*, Cisco Press, First Edition, 2019, USA.
4. **CCNA Routing and Switching**, *T. Lammle*, John Wily & Sons, Second Edition, 2016, USA.
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