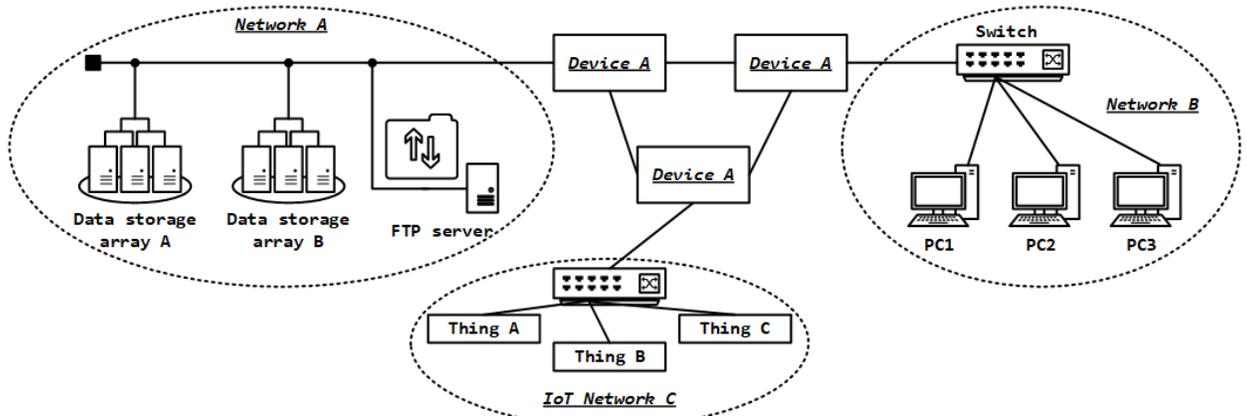


CME451 Exam Questions

1. What is the main advantage of asynchronous TDM over synchronous TDM? Briefly explain your answer. [2 marks]
2. List at least three fiber optical transmission impairments. [3 marks]
3. Suppose you are the network engineer working on a long-haul link between Saskatoon and Toronto (assume the total distance of 2300 Km). You are given the following components (rated for 5 Gb/s):
 - (a) Laser source: output power of 1mW and spectral width of 0.75nm.
 - (b) APD receiver with input sensitivity of 1uW.
 - (c) Optical fiber 1550-nm wavelength with attenuation of 0.35dB/Km.
 - (d) SMF dispersion of 1.5ps/(nm Km).
 - (e) O-E-O regenerator that can cover at most 40% of the data eye.
 - (1) If the required system capacity is at least 30 Gb/s, how can you achieve this capacity number? [2 marks]
 - (2) How many regenerators do you need? What is the distance between two neighbouring regenerators? [5 marks]

4. Comprehensive Question for IoT and Networking.

Networking is the practice of transporting and exchanging data between computers or devices over a shared medium. The diagram below shows an example architecture which consists of three different networks.



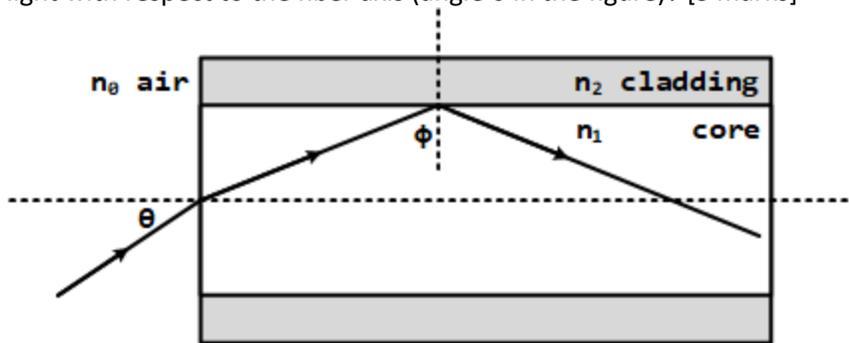
- (1) The architecture contains a small IoT network. In addition to device (things) and Internet, what are the other two essential elements in IoT? [2 marks]
- (2) List some challenges in IoT system development. [2 marks]
- (3) What is the type of network A in the above diagram? [1 mark]
- (4) What is the topology of network B? What are the characteristics of that topology? [2 marks]
- (5) Which type of transmission media is usually used in network B? [1 mark]
- (6) The communication between Thing A and PC1 can be realized with packet switching. What are the advantages of packet switching over circuit switching? [2 marks]

- (7) Device A is used to interconnect three different networks. Which network device can be used for device A? Which OSI layer it belongs to? [2 marks]
- (8) Assume the IP address of PC1 is 192.168.10.20/20. What is the network address of network B? [1 mark]

5. Comprehensive Question for Optical Fiber.

Optical fiber is usually used in a long-haul transmission.

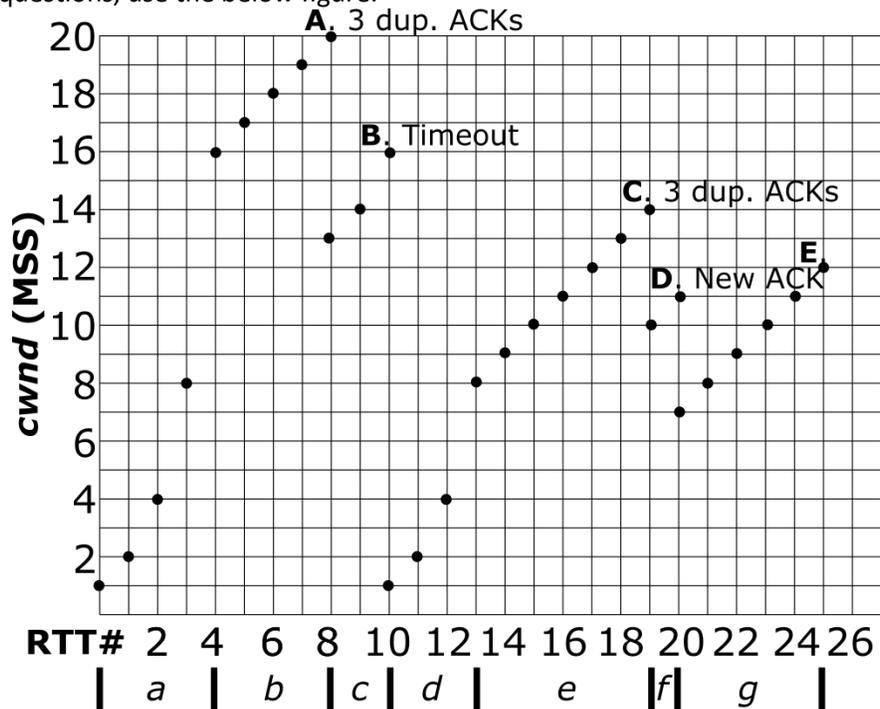
- (1) There are two types of fibers, SMF and MMF, usually used in optical communication. What is the difference between these two kinds of fibers? [1 mark]
- (2) Assume the air has a refractive index of $n_0 = 1$, the fiber core has a refractive index of $n_1 = 1.5$, and the cladding has a refractive index of $n_2 = 1.3$, as shown in the figure below. In order to make the light can be transmitted through the fiber, what is the maximum angle of incident light with respect to the fiber axis (angle θ in the figure)? [3 marks]



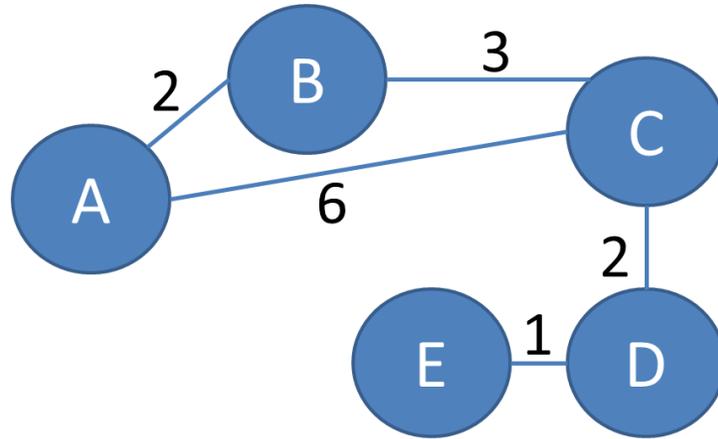
- (3) Multi-mode dispersion happens in MMF which significantly affects the bandwidth and transmission distance of the optical fiber. Provides two solutions to reduce multi-mode dispersion. [2 marks]
 - (4) Besides multi-mode dispersion, what other impairments could happen during optical fiber transmission? [2 marks]
- 6. What is the theoretical transfer rate when 100 Mbps Ethernet is ran in full-duplex mode? [1 mark]
 - 7. List 2 advantages and 2 disadvantages of a centralized (over a distributed) scheme as discussed in Layer 2 protocols. [4 marks]
 - 8. What is the main difference between CSMA- and ALOHA-based protocols? What is the main difference between CSMA and CSMA/CD? [4 marks]
 - 9. Describe the hidden terminal problem as discussed in class. Use a diagram. [2 marks]
 - 10. A stream of data is being carried by STS-1 frames. If the *user data rate* of the stream is 49.527 Mbps, how many STS-1 frames per second must leave one empty byte after the H3 byte? (5 marks)
 - 11. If using an oscillator clock with an accuracy of $\pm 10 \times 10^{-6}$ s ($\pm 10 \mu$ s), what is the minimum and maximum data rate of an STS-1 frame? (4 marks)
- 11. List three protocols in the IPv4 network layer that are combined into a single protocol in IPv6. [3 marks]
 - 12. What is the purpose of including the IP header and the first 8 bytes of datagram in the error reporting ICMP messages? [2 marks]
 - 13. In which transition strategy do we need to encapsulate IPv6 packets in the IPv4 packets? [1 mark]
 - 14. The ____ layer is responsible for process-to-process delivery. [1 mark]

15. Socket address consists of _____ and _____. [2 marks]
16. Can SMTP use the services of UDP? Why? [2 marks]
17. TCP adds a header to each segment (for control purpose) and delivers the segment to the _____ for transmission. The segments are encapsulated in _____ and transmitted. [2 marks]
18. List three security issues that are particularly applicable to the IP protocol. What is the solution for these issues in IPv4? [4 marks]
19. Describe Nagle's Algorithm and Clark's Algorithm, and when it is appropriate to use them in terms of the type of silly window syndrome occurring at the sender and/or receiver. [4 marks] What is the danger of using both together? [+1 bonus]
20. What is fast retransmission? [2 marks]

For the next 5 questions, use the below figure.



- (1) For *a* through *h*, label the TCP congestion control stage. (E.g. slow start.) [0.5 marks each]
 - (2) What is the value of *ssthresh* initially and after the events at **A**, **B**, **C**, and **D**? What would be the value of *ssthresh* if **E** was a timeout? What if it was 3 duplicate ACKs? [0.5 marks each]
 - (3) What TCP version is this? [1 mark]
 - (4) Consider RTT# 13 through 25 an AIMD "sawtooth" pattern. What is the maximum throughput? Leave your answer in terms of MSS and RTT. [2 marks]
 - (5) Consider **E** as a timeout or 3 duplicate ACKs event. Over time, has the network gotten more or less congested? [1 mark] Why? [+1 bonus]
21. Name 1 motivation for CUBIC TCP over earlier TCP variants. [1 marks]
 22. Briefly describe "one shortest route, regardless of load conditions", which is one of difficulties with TCP/IP, and briefly describe how MPLS solves this difficulty. [2 marks]
 23. What is the concept of separating the control plane from the data plane, i.e. decoupling hardware and software, in routing called? [1 mark]
 24. For the next 3 questions, use the figure below.



(1) Fill in the RIP routing table for the view of routing to node A in the form (cost, next hop), as discussed in class. [0.5 marks for each correct cell]

Exchange	From B	From C	From D	From E
Initial	∞	∞	∞	∞
1 st				
2 nd				
3 rd				

- (2) Assuming no topology changes, will the values in the 3rd exchange in the previous question be the final state of the system? [1 mark] Why? [+1 bonus]
 (3) Draw the shortest path tree at node A to the other nodes. [2 marks]

25. Matching: Match the protocol to the best definition. Wordbank: RIP, OSPF, BGP. [1 mark each]

- (1) Allows each router to reconstruct the entire network topology.
- (2) Policy-based.
- (3) Routing by rumour.

26. In a step-indexed fiber, assume the core has a refractive index of $n_1 = 1.5$, the cladding has a refractive index of $n_2 = 1.3$. The refractive index of the air is $n_0 = 1.0$. If the angle of incident light with respect to the fiber axis is 30° , can this light be transmitted using this fiber? Explain your answer. [3 marks]

27. Consider an ITU-type channel spacing scheme. What should be the reference frequency if a wavelength separation of 0.8-nm is equivalent to 110-GHz channel spacing? [4 marks]

28. (5 points) We are going to do long-haul transmission between two cities A and B (approximate distance of 5400Km) for 10Gb/s bandwidth capacity. Assume the following 10Gb/s components are available:

- a. Laser source.
- b. Photodetector: PIN with optical input sensitivity of $10 \mu\text{W}$.
- c. SMF: 1550nm wavelength band with optical attenuation of 0.24dB/Km, and dispersion of 1ps/(nm•Km).
- d. O-E-O regenerator that can recover half of the data eye.

We are going to apply 60 O-E-O regenerators for the whole transmission distance. Calculate the minimum output power required for the laser source. For dispersion management, calculate the maximum output line width required for the laser source.

Protocol stacks

29. 2 of these statements about MPLS are false. Identify them. [2 marks]

- a. MPLS can provide a framework for VPN.
- b. The IP layer must be aware of MPLS for IP packets to be routed through an MPLS network
- c. A label edge router will assign an incoming packet a label, and the packet will use that label until it leaves the MPLS network.
- d. MPLS is capable of handling aggregates of flows via stacking multiple MPLS network labels.

30. Matching: Match the protocol to the best definition. Wordbank: G.709/OTN, GFP, RPR, FC. [1 mark each]

- a. Uses RS (255, 239) FEC.
- b. Has an effective multicast.
- c. Interfaces primarily to SANs.
- d. Can carry many streams in the same logical channel.