T01: Introduction To Networking

Q1: Fill in the table to indicate the layers that handle each of the following functions:

Function	OSI Model Layer ?	TCP/IP Model Layer ?
Dividing the transmitted bit stream into frames		
Determining which route to use through the subnet (LAN)		
Determining which route to use through the internet		
Determining which application to communicate with in a remote host		

Q2: Consider the following case studies:

a. The French and Chinese Prime Ministers need to come to an agreement by telephone, but neither speaks the other language. Further, neither has on hand a translator that can translate to the language of the other. However, both prime ministers have English translators on their staffs. Draw a diagram (similar to a protocol stack) to depict the situation and describe the interaction at each level.

b. Now suppose that the Chinese Prime Minister's translator can translate only into Japanese and the French Prime Minister has a German translator available. A translator between German and Japanese is available in Germany. Draw a new diagram that reflects this arrangement and describe the hypothetical phone conversation.

Q3: A man gets onto a Qantas flight to Sydney with 100 CDs full of data, each CD can store 650MBytes of data each. The plane travels to Sydney in 4.5 hours. Calculate the bandwidth (in bits per second) this communication medium can offer.

Q4: Given the following parameters for a switching network:

N = number of hops between two given end systems

L = message length in bits

B = Data rate in bits per sec (bps) on all links

P = fixed packet size

H = overhead (header) in bits pet packet

S = call setup time (circuit switching or virtual circuit) in seconds

D = propagation delay per hop in seconds

Compute the end-to-end delay for

(i) **Circuit Switching**,

(ii) **Packet Switching** and

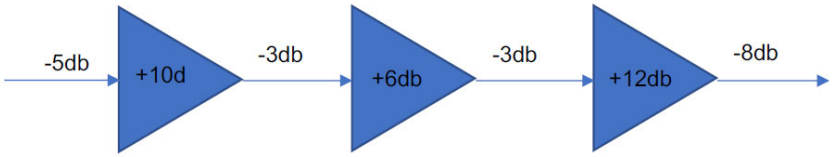
(iii) Virtual Circuit Packet Switching.

Assume that there are no acknowledgements and ignore processing delay at the nodes.

Q5: Compare and contrast Circuit Switching, Packet Switching and Virtual Circuit Packet Switching networks while providing example for each of the networks?

T02: Physical Layer

Q1: Given the diagram below with 3 segments, what is the final output if the **input power is 1 watt**?



Q2: Sketch the differential Manchester and MLT-3 encoding for the bit stream: 1001111100010001, assuming the line is **initially in the low state**?

Q3: What is bandwidth? how is it different from speed, latency, and throughput?

Q4: Name a few last mile technologies? What is the key significance of NBN?

Q5: What is the significance of using millimeter waves in 5G compared to the frequency band used in 4G? what is the disadvantage of using millimeter waves?

T03: Data Link Layer I

Q1: Consider the case of transmitting 1250 Bytes frame over on a link with a delay of 200ms (millisecond) when the length of the link is 200km. Assume that acknowledgment packets are of negligible size, processing time at a node is negligible, and the link is error-free.

Calculate the transmission efficiency of following ARQ methods if the bandwidths and the lengths of the link are 1Kbps, 1Mbps, 1Gbps and 20Km, 200Km, 2000Km, 20000Km respectively.

a. Stop-and-wait ARQ?

b. Go-Back-N ARQ where W is large enough to keep the channel fully busy?

c. Selective-Repeat ARQ where W is 7?

Q2: Consider a sliding window protocol (Go-Back-N ARQ) used for flow control on a given data link where the data rate is 8,000 bits/second, the propagation delay is 0.25 second, and the frame size is 1600 bits. Assume that acknowledgment packets are of negligible size, processing time at a node is negligible, and the link is error-free. What is the minimum window size which will allow full utilization (efficiency) of the link?

Q3: Assume data in 8-bit words as shown below:

10011001 11100010 00100100 10000100

a. Calculate the checksum at the sender's end and the receiver's end

b. State an example of an error that checksum fails to detect?

Q4: Given the data word (1011011), or data polynomial $D(x) = x^6 + x^4 + x^3 + x^1 + 1$ and given the generator polynomial $G(x) = x + 1$?

a. Find the codeword C(x)

b. Assume the received message H (x) is

H(x) = C(x) + E(x), where E(x) is the error polynomial

i. When H(x) contains no errors show that H(x) is divisible by G(x)

ii. Determine whether the error is detectable when:

- $E(x) = 1$
- $E(x) = x + 1$
- $E(x) = x^3 + x$

Q5: Show **byte-stuffing & destuffing** steps for the following data bits if **PPP frame** is used?

0100000101111101010000100111111001010000011100000100011O

Q6 (Optional): In some networks the data link layer requests all damaged frames to be retransmitted. Assume that the acknowledgement frame is never lost. If the probability of a frame being damaged on a particular link is *p*, what is the normalized throughput of the link if stop-and-wait ARG is used?

[Hint: $\sum_{i=1}^{\infty}(i \times x^{i-1}) = \frac{1}{(1-x)^2} \quad for(-1 < x < 1)$]

T04: Data Link Layer II

Q1: Show **byte-stuffing & destuffing** steps for the following data bits if **PPP frame** is used.

01000001011111010100001001111110010100000111000001000110

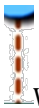
Q2: Describe the MAC protocol used in IEEE 802.3 Ethernet. Explain the purpose of exponential backoff delay.

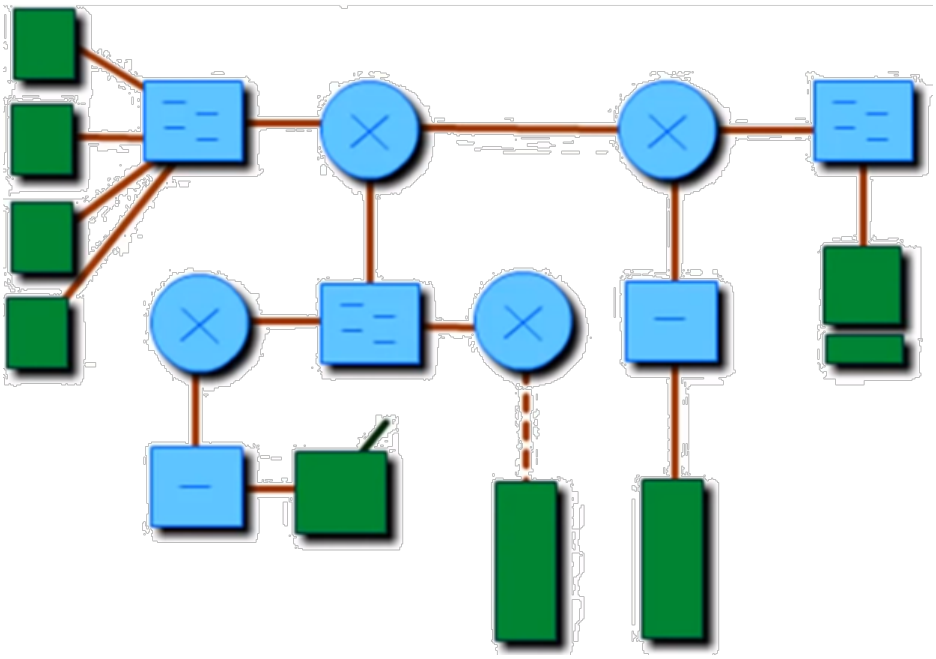
Q3: How many broadcast domains and collisions domains are in the following network?


Swtich


Router


Hub


Wireless Communication



Q4: Why is CSMA/CD infeasible for wireless communication? Name and explain a solution in detail for sharing the wireless medium.

Q5: Why is it not safe to connect to a public WiFi access point or hotspot?

T05: Network Layer I

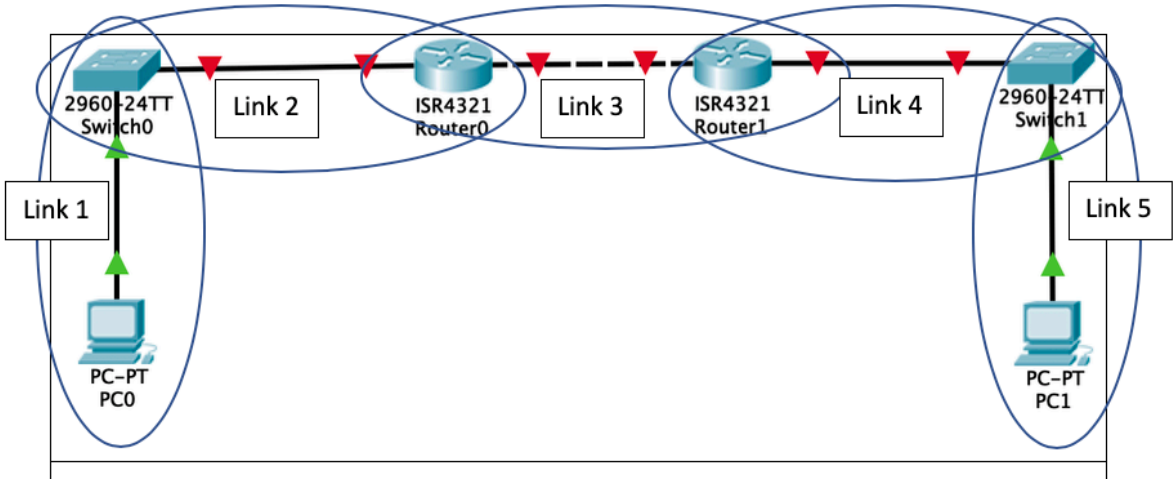
Q1: A router has the following (CIDR) entries in its routing table?

Address/mask	**Next hop**
129.47.104.0/21	Interface 0
129.47.112.0/21	Interface 1
190.34.116.0/22	Interface 2
129.47.192.0/19	Router 1
default Router	Router 2

For each of the following IP addresses, what does the router do if a packet with the following destination address arrives?

a. 129.47.85.10
b. 129.47.110.14
c. 129.47.221.2
d. 190.34.119.7
e. 190.34.106.7

Q2: Consider the network diagram below consisting of 5 links and 3 subnets. If PC0 sends an IP packet to PC1, what are the source and destination MAC and IP addresses on each link?



	MAC	**IP**
PC0	AA:AA:AA:AA:AA:AA	10.1.1.1
Switch 0 (PC side)	BB:BB:BB:BB:BB:BB	110.1.1.2
Router0 (Switch side)	CC:CC:CC:CC:CC:CC	10.1.1.3
Router0 (WAN side)	DD:DD:DD:DD:DD:DD	10.1.2.1
Router1 (WAN side)	EE:EE:EE:EE:EE:EE	10.1.2.2
Router1 (Switch side)	11:11:11:11:11:11	10.1.3.1
Switch 1 (PC side)	22:22:22:22:22:22	10.1.3.2
PC1	33:33:33:33:33:33	10.1.3.3

Complete the table below:

	Source MAC Address	Dest. Mac Address	Source IP Address	Dest. IP Address
Link 1	AA:AA:AA:AA:AA:AA		10.1.1.1	
Link 2				
Link 3		EE:EE:EE:EE:EE:EE		
Link 4				
Link 5		33:33:33:33:33:33		10.1.3.3

Q3: What is the special significance of the following addresses?

a. 0.0.0.0
b. 0.0.0.18
c. 255.255.255.255
d. 161.115.255.255

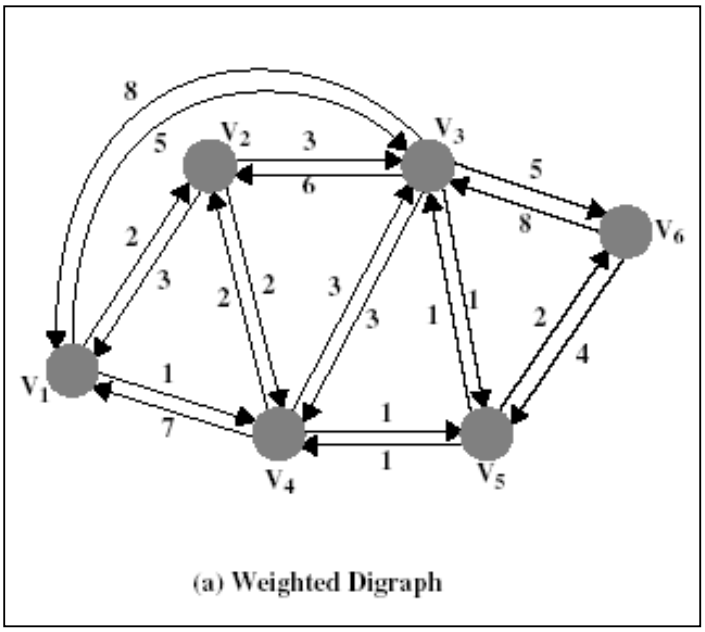
Q4: Suppose that a network with address 123.132.23.0/24 is to be split into 16 subnets. How many hosts can there be on each subnet?

Q5: Which of the following are valid IPv6 addresses. (Choose all those apply)?

a) ::192:168:0:1
b) 2002:c0a8:101::42
c) 2003:dead:beef:4dad:23:46:bb:101
d) ::
e) 2002::d01c:102::2

T06: Network Layer II

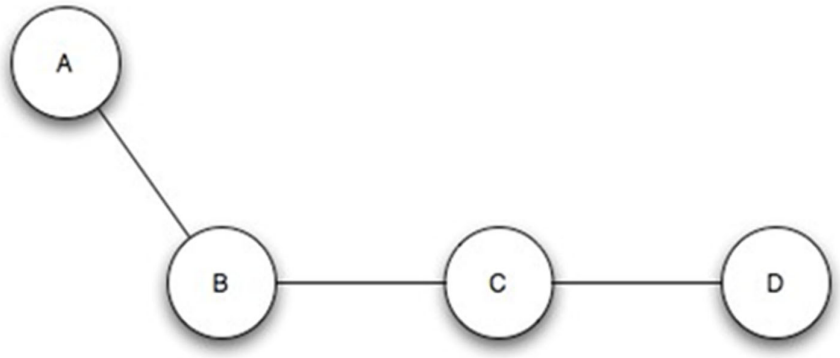
Q1: Using Dijkstra's algorithm, generate a least-cost route to all other nodes for Node V2 in the Figure below.



(a) Weighted Digraph

Q2: Repeat the last question with Bellman Ford algorithm?

Q3: Refer to the diagram below. The link from router A to router B fails, explain how this may cause the "count to infinity" problem in a distance vector routing protocol. Illustrate your answer with the routing tables in the effected routers?



Q4: What is the purpose of Hold-down timer in RIP?

Q5: Between RIP and OSPF, which is more suitable for a large network? Explain in detail.

T07: Transport Layer I

Q1: Explain the difference between end-to-end communication and node-node communication with a diagram. What does transport layer facilitate (end-to-end communication or node-node communication)?

Q2: What are the similarities and dissimilarities in transport and data link layer protocols? Is flow control & buffering in transport layer different from data link layer? Briefly explain.

Q3: Both UDP and TCP use port number to identify the destination entity when delivering a message. Give two reasons for why these protocols invented a new abstract ID (port number), instead of using process IDs, which already existed when these protocols were designed?

Q4: Why does the maximum packet lifetime, T, have to be large enough to ensure that not only the packet but also its acknowledgements have vanished?

Q5: Why does the symmetric connection release is not completely foolproof? Explain with a diagram.

Q6: How does transport layer recover from a router or network crash? Explain your answer with respect to unreliable datagram service (packet switching), connection-oriented network service (virtual-circuit packet switching).

Q7: When hosts/servers crash, recovery becomes an issue. There are always situations where the protocol fails to recover properly.

For the strategies (sending host and receiving host) shown in the table below, indicate whether it's **OK**, **DUP** (packet duplicate), **LOST** (packet loss) appropriately.

Assume each client (sender) can be in one of the two states (S0, S1) when the Sever (receiver) announces that it had just rebooted and request that its clients (senders) to inform the status of all open connections.

- No TPDUs outstanding, S0
- One TPDU outstanding, S1

Hint: first one is done for your reference

Strategy used by Client	**Strategy used by Server**					
	First ACK, then write			**First write, then ACK**		
	AC(W)	AWC	C(AW)	C(WA)	WAC	WC(A)
Always retransmit the last TPDU	OK	DUP	OK	OK	DUP	DUP
Never retransmit the last TPDU						

Retransmit only in state S0 (No TPDU outstanding)						
Retransmit only in state S1 (TPDU outstanding)						

T08: Transport Layer II

Q1: Are the objectives of flow control and congestion control the same? Why or why not?

Q2: What is the advantage in using typical choke packet over hop-by-hop choke packet method as a solution to network congestion?

Q3: Describe two (2) major differences between the bit warning method and the RED method.

Q4: Why was it difficult to detect congestion in old days?

Q5: Consider the effect of using slow start on a line with a 10-msec round-trip time and no congestion. The receive window is 24KB and the maximum segment size is 2KB. How long does it take before the first full window can be sent?

Q6: Why is TCP called a byte-stream protocol? How does UDP differ from TCP in this regard? Which layer is responsible to segment the data if UDP is used in Transport layer? (Is it Transport layer itself or Application layer)? What protocol would you use to multicast or broadcast a message?

Q7: DNS uses UDP instead of TCP. What is the main difference between UDP and TCP? If a DNS packet is lost, will there be automatic recovery? Will that cause a problem? Why or why not?

T09: Application Layer I

Q1: Name the two paradigms (architectures) in applications layers?

Q2: What are the important aspects/services that one may consider in transport layer in developing applications?

Q3: What is the purpose of SSL (Secure Socket Library)? Explain your answer.

Q4: How does HTTP maintain the "state" of the user?

Q5: What is the difference between GET method and Conditional GET?

Q6: Describe an elegant solution for an enterprise to minimize the delay of response for web requests?

Q7: What are web sockets and how it is different from typical HTTP communication and TCP sockets?

Q8: Is WWW another term to refer to "internet"? Explain.

Q9: Compare and Contrast POP3 and IMAP. Explain how IMAP maintain the user state across sessions with an example.

T10: Application Layer II

Q1: In DHCP, why is the client required to renew the lease on IP address in use?

Q2: Can a machine with a single DNS name have multiple IP address? How could this occur?

Q3: What is the use of "hosts" file? What are the advantages of having a DNS server over "host" file?

Q4: Consider the following case study.

Alice in Curitn University (alice@cs.curtin.edu.au) wants to send an email to Bob in Yale university (bob@cs.ai.yale.edu). Write down all the steps involved in the process of sending an email including the name resolution process via the DNS Servers.

You may assume that the DNS servers exist for curtin, edu (TLD), Yale and Yale Computing Faculty (cs)

Q5: Why is Napster not considered a pure p2p protocol? Why is Gnutella considered to be a pure p2p protocol?

Q6: Explain the process of joining a torrent in BitTorrent protocol. What does the term **tit-for-tat** mean in BitTorrent protocol?

Q7: In P2P web, explain how the users visiting a website can contribute to the bandwidth.

T12: Emerging Network Technology

Q1: What are the "things" in IoT? Give a couple of examples on the applications of IoT.

Answer

The things in ioT are physical objects that are embedded with sensors, software and other technologies for the purpose of connecting and exchanging data with other devices and systems over the internet. These devices range from ordinary household objects to sophisticated and complex industrial systems.

Examples includes household appliances, wearable monitoring equipment, smart manufacturing devices, etc.

Q2: What is software defined networks? List 4 major differences between SDNs and traditional networks.

Answer

Software defined network (SDN) is an approach to network management that enables dynamic, programmatically efficient network configuration. SDN attempts to centralize network intelligence in one network component by disassociating the forwarding process of network packets (data plane) from the routing process (control plane). The control plane consists of one or more controllers, which are considered the brain of the SDN network where the whole intelligence is incorporated.

SDNs vs. traditional networks:

centralized control vs. distributed control.
data plane and control plane are decoupled by software vs. data plane and control plane are mounted on same plane
automatic configuration so it takes less time vs. static/manual configuration so it takes more time
structural complexity is low vs. high
easy to troubleshoot and report as it is centralized controlled vs. difficult to troubleshoot and report as it is distributed controlled
maintenance cost of SDN is lower than traditional network

Q3: How does Blockchain handle block tampering? Explain with details.

Answer

Creation of blocks is not easy and cannot be done instantly. Blockchain follows a mechanism to slow down the creation of new blocks (PoW – Proof Of Work). Tampering a block requires recalculating the hash values of all the blocks ahead of the tampered block which will require a considerable amount of time. Furthermore, blockchain being distributed let everyone (nodes) keep a copy of the ledger (blockchain) and makes it impossible for one to alter the content of a block (Distributed Consensus).

Q4: In a Bitcoin Ledger, why is it important to have a unique ID and the digital signature for each transaction recorded?

Answer

Digital Signature helps to verify the transaction by the money sender. UniqueID prevents duplicating the ledge entries including the digital signatures.

Q5: What are the key features of Bitcoin protocol?

Answer

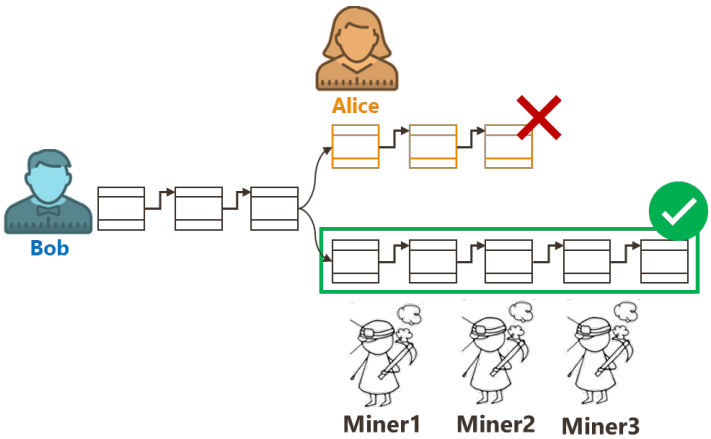
- Broadcast Transactions
- Only Accept Signed Transactions
- No Overspending
- Distributed Consensuses
- Mechanism to Prove Work (PoW, PoS)

Q6: Why is it extremely difficult for someone to fool someone else with fraudulent blocks of transactions in Bitcoin?

Answer

Let's say an intruder (Alice) managed to win the lottery in PoW for a few times against all the other miners competing, and send a fraud block to a node (Bob). But to be the longest chain (ledger that has the most work put on) the intruder (Alice) must have at least >50% of the computing resources among all miners **(which is impossible)** so that she can always win the lottery in PoW with high probability.

Note that the node (Bob) will eventually reject the intruder's (Alice's) chain in favor of the longer chain if the intruder fails to be the longest chain.



Q7: How does "**Proof of Work**" differ from "**Proof of Stake**"?

Answer

Proof of stake holds a stake (security deposit) from a validator to ensure the integrity of the minting /forging (similar mining in PoW). This can help to mitigate the biggest problem of PoW which is the high energy usage for mining.

Q8: What are smart contracts?

Answer

Digital Contracts, tiny computer program stored in Blockchain (immutable, distributed)

- Once smart contract is created, can never be changed.
- Output of the contract is validated by everyone in the network.
- A single person cannot force the contract to release the funds!