IT304 Computer Networks Final Examination 2020
Solutions Outline

PART – I [0/1/2]

1. Flow control, error detection and correct delivery of packets may be implemented in both the Link layer and the Transport layer. Give reasons for this duplication.
   *Not all link protocols have the reliability implemented. [1]
   *End to end reliability (as provided in TL) is not possible to replicate just by doing multiple link layer reliability. E.g. router may drop a packet and the link layer controls will not be able to detect it. [1]

2. What is the role of *Cookies* in the HTTP protocol performance? Explain its operation.
   Cookies provide sessions. Sessions are being stored in cookies and information which needs to be shared, can be available in sessions and shared via it.
   It provides better scalability. As most frequently used information is available via cookies which is stored on the client side, it reduce the load on the server. Typical Operations are: Set cookies, Modify cookies, Delete cookies

3. Briefly explain the iterative and recursive mode of query processing in DNS. Which mode is used by the root node and why?
   Iterative: Client queries are partially resolved at each DNS server level and client makes multiple requests to servers at different levels to get the final answer.
   Recursive: Client makes a request which is resolved recursively by the server which responds with the final answer. [1]

   Root server never works in the recursive mode as it has to handle very large number of requests and it must resolve each query as quickly as it can. Recursive query will slow down the root server quite a bit.[1]

4. Construct an example to show that a selective repeat protocol with 3 bit sequence number and a window of size 8 can fail to perform correctly.
   A simple example where the protocol fails would be the following: A full window of packets (seq-0 to seq-7, packets 1 to 8) is sent. They are received correctly and acknowledgements are sent. All acks are delayed (timed out). Hence, all packets (seq-0 to seq-7, packets 1 to 8) are retransmitted. After the retransmissions, the ACKs are received and sender is satisfied that packets 1-8 are successfully sent. However, the receiver treats the retransmitted packets (seq-0 to seq-7) as the next set of packets (packets 9 to 16) and accepts these. Hence the protocol performs incorrectly.

5. Describe the functioning of a switched hub in a LAN and its impact on the system goodput.

   A switched hub maintains a table with [MAC address(es), port number] mapping. This table is generated by examining the source MAC addresses of the incoming packets on a port. Whenever a packet arrives on a port, the table is looked up to find the output port corresponding to the destination MAC address and the packet is switched to the given output port.

   Since the switched hub is able to simultaneously switch packets between each pair of ports, there is effectively no collision and the system is able to operate at maximum efficiency. [0/1/2]

6. Explain the VLAN functioning in a port-based L3 switch.

   L3 switch combines routing along with MAC switching functions.

   A subset of ports in a switch can be configured to belong to a single **broadcast** domain (VLAN). Hence VLAN provide flexibility in assigning a node/port to a particular VLAN. Further, ports across the switches may also be part of a single VLAN.

   Routing module within the L3 switch is able to route packets from one VLAN to other VLAN based on the configured routing table. [0/1/2]

7. Briefly describe the Token-ring protocol and qualitatively explain its performance under high load condition.

   Token ring functions as a logical ring with all nodes having a successor and a predecessor node. A token circulates in the ring. Nodes wait for the token. Once received, nodes hold the token, transmit a packet, and then release the token. Intermediate nodes forward the packet till it is extracted by the sender.

   Under high load condition, the protocol performs like round-robin with a small token overhead and efficiency approaches one. [0/1/2] (however, if the operations part is FULLY explained, give 2 marks)

8. Briefly describe the functioning of CSMA/CD protocol and qualitatively explain its performance under high load condition.

   Carrier Sensing – send only if channel is idle. Collision detection – compare the Tx and Rx signal. If mismatch, implies collision. Abort.

   Under high load, collisions keep increasing leading to more retransmissions. And the throughput saturates and then starts decreasing. [0/1/2]

9. Explain the need of exponential back-off mechanism in 1-presistent CSMA/CD.

   In Binary Exponential Backoff (BEB) , after successive collision, sending nodes wait for a random time unit chosen from $[0 – (2^k-1)]$ where k is the collision count. Nodes do not have information about the number of nodes which have data to send. If there are N active nodes, for best performance nodes should transmit with probability 1/N. However, since N is unknown, BEB takes an average of log(N) attempts by the nodes before success, which is the best result under these conditions. [0/1/2]

10. Briefly describe the operation of slotted ALOHA. Derive its efficiency, showing only the main steps.

    In slotted ALOHA, nodes are synchronized and transmit at the beginning of a slot. All packets are assumed to be of same size. If a node has data to send, it transmits with a probability p and defers transmission with probability (1-p). [1]

    Transmission in a given slot is successful if only one node transmits and other nodes defer transmission. Probability of successful transmission $P = N*p*(1-p)^{(N-1)}$. P is maximum when p=1/N. For large N, P tends to 1/e which is about 0.36. Hence efficiency is about 36%. [1]

PART-II

11. What is the purpose of the flow ID field in IPv6 header?

    Flow ID allows all the packets of a common connection (flow) to have a common identity. Part of NL and a single field is able to identify the flow which makes the identification faster.

    This is to be used primarily for providing Quality of Services (QoS) and [also for traffic engineering (SDN)] E.g. A table with Fl-id as index for monitoring CBS traffic. [0/1/2]

12. Explain the Fragment and reassembly feature in IPv4? How is it handled in IPv6 and why?

    Fragment ID, Offset fields are there in the IP header. If a router needs to fragment the packet, it creates mulliple fragment packets with common ID and appropriate OFFset values. Flags are turned on for these fragement packets. Given these fields, it is possible to combine all these fragments at the receiver.

    IPv6 **doesn't** support fragmentation at the routers. This is to allow the routers to process the packets faster. (lowers the processing overhead) . Routers simply send an ICMP packet back to the source and source creates smaller packets. [0/1/2]

13. Qualitatively explain the impact of RTT and noise on TCP performance.

    TCP uses slow start algorithm. Throughput is proportional to the window size. IF RTT is large, the increase in window size happens more slowly and hence the average throughput remains low.
    If noise is high, packet loss happens more frequently. Every loss (timeout) leads to reduction of the window size to a minimum. Hence increase of noise leads to lower throughput. [0/1/2]

14. Explain how tunneling is used to allow incremental deployment of IPv6 and co-existence of IPv4 and IPv6?

    Tunneling is a mechanism where a whole packet is encapsulated as a payload inside another packet (with its own header). This allows an encapsulated packet to traverse a link/rigion that doesn't support the original protocol. At the other end, the encapsulated packet is to be extracted.

    This allows IPv6/IPv4 boundary routers to tunnel IPv6 packets encapsulated inside IPv4 headers. At the other IPv6 entry point, extraction is done.These packets can be routed through the IPv4 legacy components. [0/1/2]

15. Using an example, show the functioning of NAT protocol. Why do we use this protocol?

    Nat server keeps a table with [src ip, src port, mapped port]. Src ip is replaced with NAT ip, and src port with mapped port. When the response comes, table is looked up for the mapped port as key and reverse replacement is done. [1]

    This allows for local addresses to be used for accessing internet. Useful when only a few global addresses are available. Sometimes useful for security reasons as well. [1]

16. Using an example, show how multiple class-C address blocks can be combined using CIDR. How does it help in routing performance?

    Ex. Multiple class C blocks with a common prefix (mergeable) can be combined to create a single entry in the routing table. 200.200. [0-7].xx /21 [1]

    This allows the number of entries in the table to be small and thus search time is reduced. [1]

17. What is the effect of congestion on the TCP and UDP flows passing through the same router?

    Congestion leads to packet drop that affects equally both UDP and TCP flows. However, TCP flow slows down (slow-start algo) while UDP flow continues at the same rate. Hence after such congestion drop event, share of TCP flow decreases and UDP captures more of the bandwidth. [0,1,2]

18. How do you compute CRC value for a data block? Can CRC based detection techniques detect all types of errors? Explain.

    CRC generator [polynomial]. Polynomial division and the remainder (or complement) that is added to data. [data block] concatenated with Remainder. [1]

    Same remainder (e.g. 32 bit) is possible for multiple data blocks. E.g. we can always add multiple of the generator to the data and have the same remainder. Hence not all errors can be detected. [1]

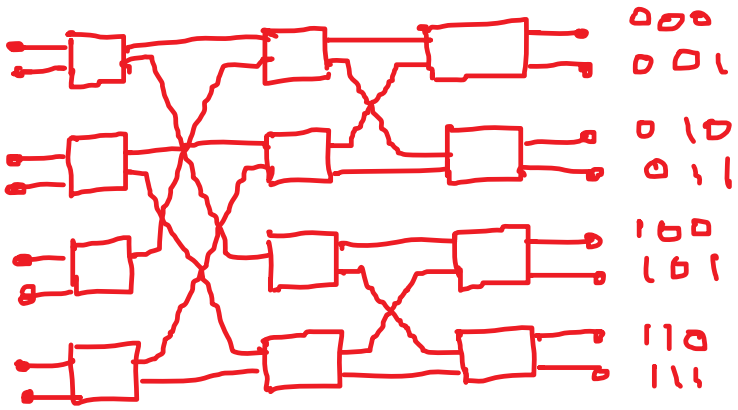
19. Briefly describe the OpenFlow protocol. How does it compare to LSP based routing protocol?

    OpenFlow defines a messaging protocol using TCP between the SDN controller (server) and client switches. This allows the controller to query and configure the switch features. The protocol also allows the controller to program the flow table entries by adding, deleting, and modifying entries. This allows the packet forwarding behaviour to be controlled by the openflow controller.

    LSP based routing protocol generates the routing table using a distributed network discovery and shortest path algorithm. In contrast, OpenFlow allows a controller to centrally program the bahaviour of the routers within its domain. [0/1/2]

20. Draw the schematic of an 8x8 Banyan switch. Can this design still lead to blocking?

    3 stage. 4 sets of 2x2 initially followed by 2 sets of 4x4 [0/1/2]



    Yes. If multiple input wants to go to same 4x4 block, then there may be a blocking. [1]