Information

- The duration of the exam is 4 hours (10.00-14.00).
- Answers should be well structured and readable, remember that quality is better than quantity.
- Write your name and personal-id/date-of-birth on each page.
- No help material is allowed.
- Answers will be posted on the course web within 2 weeks after the exam.
- Results will be published in Daisy no later than February 8, 2008. Graded exams can be collected from the student expedition on floor 4 in Forum by February 11, 2008. Complaints about the grading should be handed in (in writing), addressed to “Markus Hidell, KTH/ICT/ECS/TSLAB, Forum Floor 8”, no later than February 25, 2008. You can use the TSLab mail box on floor 8, elevator C, in the Forum building.
- The exam consists of 2 parts; Part A and Part B. Part A is a set of questions with short answers. Answers longer than the word limit will be truncated, meaning that we will disregard from the part of your answer that exceeds the word limit during the exam marking. Part B is a smaller set of questions that require more elaborative answers. To pass the exam you need to attain a certain number of points (preliminary 75%) on Part A. Higher grades (A-C or 4-5) will be based on the total score (Part A + Part B). **Part B will not be graded for those who do not pass Part A.**
- Preliminary grading is as follows:

Points	**Grade (A-F)**
23-30 points on Part A and 45-50 points in total	A
23-30 points on Part A and 40-44 points in total	B
23-30 points on Part A and 35-39 points in total	C
23-30 points on Part A and 23-34 points in total	D
21-22 points on Part A and passed complementary assignment	E
21-22 points on Part A (complementary assignment offered)	Fx
0-20 points on Part A	F (Fail)

Points	**Grade(U-5)**
23-30 points on Part A and 42-50 points in total	5
23-30 points on Part A and 37-41 points in total	4
23-30 points on Part A and 23-36 points in total	3
21-22 points on Part A (complementary assignment offered)	U
0-20 points on Part A	U (Fail)

Good Luck!

Exam Part A (30p) (Note the word limits)

1) Various true/false statements (10p)

Mark the following statements as true or false. Don't write "t" or "f", since it may be hard to differ between the two if the hand-writing is indistinct.

Note:

- you will get 1p for each correct answer
- you will get -1p for each wrong answer
- you will get 0p for each "no answer"
- you will **not** get less than 0p in total on this question

A. TCP uses sliding windows for flow control. (1p)
B. UDP offers an optional checksum covering header and data.(1p)
C. Both TCP and UDP are used for stored streaming audio/video. (1p)
D. Ethernet is a point-to-point link technology.(1p)
E. STP (Spanning Tree Protocol) results in optimized routing. (1p)
F. IP address aggregation leads to larger routing tables. (1p)
G. BGP can be used for label distribution in MPLS. (1p)
H. A layer 1 VPN provides a physical connection service. (1p)
I. Multicast routing based on source based trees is based on a rendezvous point router responsible for distributing multicast traffic. (1p)
J. Using a distributed hash table in peer-to-peer applications normally leads to an excessive amount of search traffic.(1p)

Answer:

A. True
B. True
C. True
D. False (Ethernet is a broadcast link technology)
E. False (Traffic concentrates towards the root)
F. False (Aggregation leads to smaller routing tables)
G. True
H. True
I. False (Each router needs one shortest path tree for each group)
J. False

2) Various short answers (10p)

Answer the following questions with short answers.

Note:

- You will get 1p for each entirely correct answer
- Word limit per question: 30 words

A. RSVP is described as a receiver-oriented protocol. What does that mean? (1p)
B. What protocol is run between a multicast router and its connected hosts in IP multicast? (1p)
C. What transport protocol does ICMP use? (1p)
D. What two key features are provided by RTP (Real-time Transport Protocol)? (1p)
E. What kind of mapping is defined by the forwarding table in a layer 2 switch (bridge)? (1p)

F. What is the aggregated network of the following subnets: 199.1.1.0/26, 199.1.1.64/26, 199.1.1.128/26, 199.1.1.192/26? (1p)
G. OSPF (Open Shortest Path First) consists of three different protocols. Which ones? (1p)
H. What does tunneling mean in the context of VPN? (1p)
I. What does “torrent” mean in the context of BitTorrent? (1p)
J. What technique is typically used in CDNs (Content Distribution Networks) to guide browsers to the correct server? (1p)

Answer:

A. The receiver is responsible for requesting resource reservations.
B. IGMP.
C. None, ICMP is encapsulated directly in IP.
D. Sequence numbers and time stamps.
E. It maps MAC addresses to port numbers (interfaces)
F. 199.1.1.0/24
G. The Hello protocol, the Exchange protocol, and the Flooding protocol
H. It means that a customer packet is encapsulated in a new (provider) packet.
I. The collection of all peers participating in the distribution of a particular file.
J. DNS redirection.

3) Spanning tree protocol (2p) (Word limit: 50+50)

Suppose a bridge B has ID 94, and on its 6 interfaces it hears the following Hellos, with fields (Root ID, cost to Root, my ID). Each interface has a configured cost, as included below:

interface a (with cost 3): (37, 72, 126)
interface b (with cost 7): (49, 15, 92)
interface c (with cost 5): (37, 70, 99)
interface d (with cost 4): (37, 71, 127)
interface e (with cost 3): (37, 75, 51)
interface f (with cost 4): (37, 76, 87)

A. What will B’s Hello message look like and on which interfaces will B become Designated Bridge? (1p)
B. Which interfaces will B put into forwarding state? (1p)

Answer:

A. (37, 75, 94) will be its Hello, which is better than on b and f, so it will be Designated Bridge on b and f.
B. It will choose interface c as its path to the Root (because of the tie-breaker of neighbor ID). So the ports in forwarding state will be b, c, and f.

4) IP Routing (2p) (Word limit: 70)

Describe the difference between static and dynamic routing.

Answer:

Static routing is configured by the network administrator and is not capable of adjusting to changes in the network without network administrator intervention. Dynamic routing adjusts to changing network

circumstances by analyzing incoming routing update messages without administrator intervention.

5) Quality of service in IP networks (2p) (Word limit: 40)

Integrated services (int-serv) and differentiated services (diff-serv) are two different IETF approaches for quality-of-service in IP networks. How do these two approaches differ when it comes to allocation of resources?
You only need to mention the overall principle.

Answer:

Integrated services: resources are allocated on a per-application basis.
Differentiated services: resources are allocated on a per-class basis.

6) TCP/IP networking (2p)

Place the following protocols in the correct TCP/IP protocol layer: STP (Spanning Tree Protocol), ICMP, RTSP (Real-Time Streaming Protocol), FTP, PPP (Point-to-Point Protocol), TCP.

Answer:

Application	RTSP, FTP
Transport	TCP
Network	ICMP
Link	STP, PPP

7) Multimedia networking (2p) (Word limit: 60)

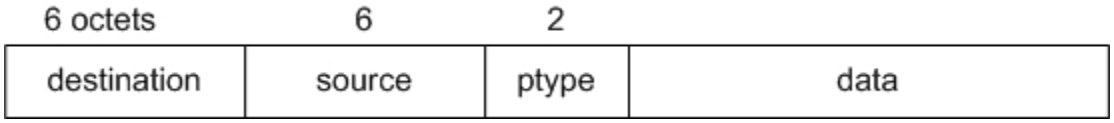
What is the difference between end-to-end delay and delay jitter? What could be the cause of delay jitter?

Answer:

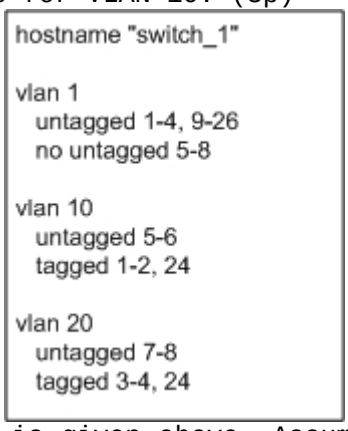
End-to-end delay is the time it takes a packet to travel across the network from source to destination. Delay jitter is the fluctuation of end-to-end delay from packet to the next packet. Causes of delay jitter: buffering in routers, packets may take different paths through the Internet, congestion.

Exam Part B (20p)

8) Virtual LAN (5p)



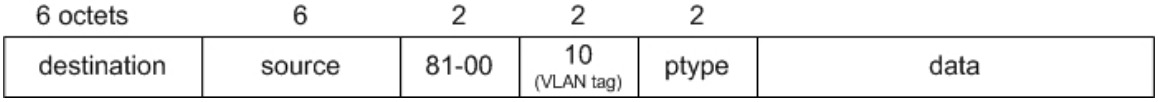
A. Given the Ethernet frame above, what are the additional fields that must be added to the frame when VLAN tagging is used? Draw an Ethernet frame with correct values of the additional fields assuming the frame is for VLAN 10. (3p)



B. A VLAN configuration is given above. Assume further that there is no station cache on switch_1 and that a packet is coming in on port 5 of switch_1. To which ports will switch_1 forward this packet? (2p)

Answer:

A. Two additional fields must be added: 2-byte tag header containing tag protocol ID (0x8100) and 2-byte tag control information containing VLAN ID. An Ethernet frame with correct VLAN additional fields with their values is depicted below:



B. Port 1-2, 6, 24

9) Multicast routing (5p)

A. Explain how the RPF mechanism works in IP multicast. What happens when the RPF check passes and when the RPF check fails? (3p)
B. What is the purpose of using MSDP (Multicast Source Discovery Protocol)? (1p)
C. What are the drawbacks of MSDP? (1p)

Answer:

A. When a multicast packet enters a router's interface it will lookup the list of networks that are reachable via that input interface i.e., it checks the reverse path of the packet. If the router finds a matching routing entry for the source IP of the multicast packet, the RPF check passes and the packet is forwarded to all other interfaces that are participating in

multicast for this multicast group. If the RPF check fails the packet will be dropped. As a result the forwarding of the packet is decided based upon the reverse path of the packet rather than the forward path.

B. MSDP is used to interconnect multiple PIM-SM domains
C. The drawbacks are
   a. Scaling problem: many (S,G) pairs can be active in the Internet. Information must be passed about all these pairs.
   b. Configuration-intensive (many tunnels needed)

10) Peer-to-peer networking (4p)

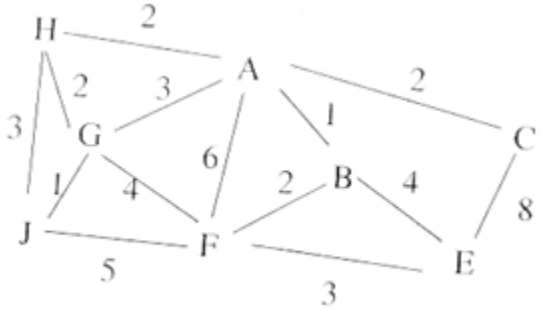
A. What is the advantage of using query flooding for locating content comparing to using a centralized directory. (1p)
B. What is the drawback of query flooding? (1p)
C. Explain the technique called “rarest first” used for requesting chunks in BitTorrent? (1p)
D. How does a BitTorrent client know which peers have the file it wants? (1p)

Answer:

A. Query flooding is fully distributed, thus no single point of failure.
B. It is not scalable since flooding introduces a significant amount of traffic into the network.
C. The technique is used to determine the chunks that are the rarest (i.e. chunks that have the fewest repeated copies among the neighbors) among the neighbors and then request those rarest chunk first.
D. A torrent client will contact the tracker for list of peers who have the file.

11) Dynamic routing (6p)

A,B,C,E,F,G,H, and J are routers interconnected as shown in the figure below. Each link represents a physical link directly between each two routers. Assume that a link state protocol is used in all routers, and that the number on each link represents the cost of each link.



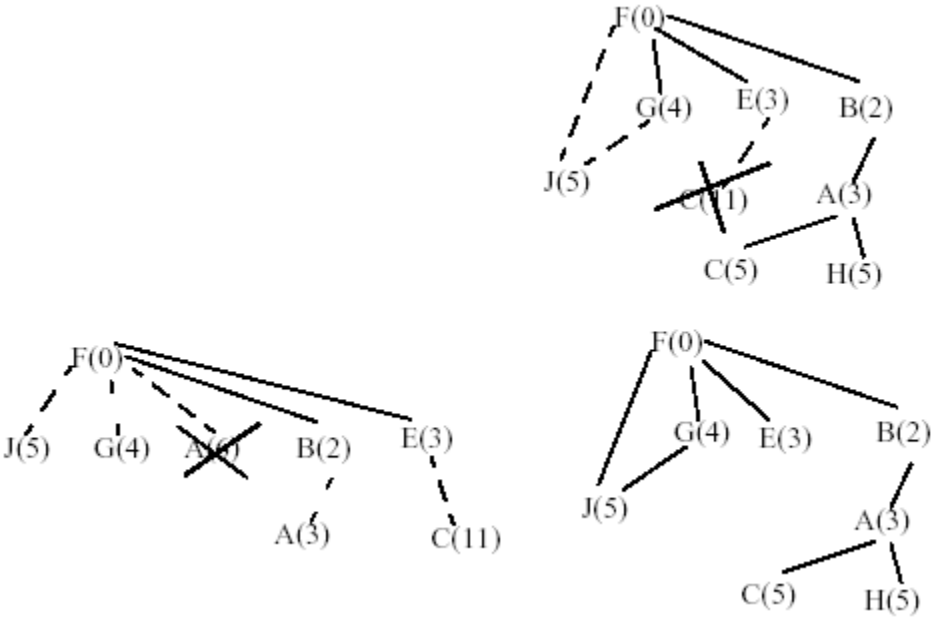
A. Calculate the Dijkstra tree from F's viewpoint. (2p)
B. Base on the result, write down F’s forwarding table (on the format dst/next_hop) for all destinations. (2p)

   Example answer: **X/Y, Z/V**, and so on, where **X** and **Z** are destinations and **Y** and **V** are next hops.

C. If RIP is used as the routing protocol instead of a link state protocol, what would F's forwarding table for all destinations be? (2p)

Answer:

A.



Note: when looking at G's neighbors, an equal path to J is found. It is acceptable to keep either or both parents of J.

B. Forwarding table: A/B, B/B, C/B, E/E, F/0, G/G, J/(J or G), H/B.

C. Forwarding table: A/A, B,B, C/(A or E), E/E, F/0, G/G, J/J, H/(A or G or J)