**TDTS06 Computer Networks, January 15, 2008**

Sketched answers to the written examination, provided by Juha Takkinen, IDA, juhta@ida.liu.se. ("Sketched" means that you, in addition to the below answers, need to show your calculations, assumptions and justifications.)

Question 1.

a)

i) protocol stack = a list of specific protocols that implements a network architecture

ii) multiplexing = the technique of combining distinct channels at one level (layer) into a single lower-level channel

b)
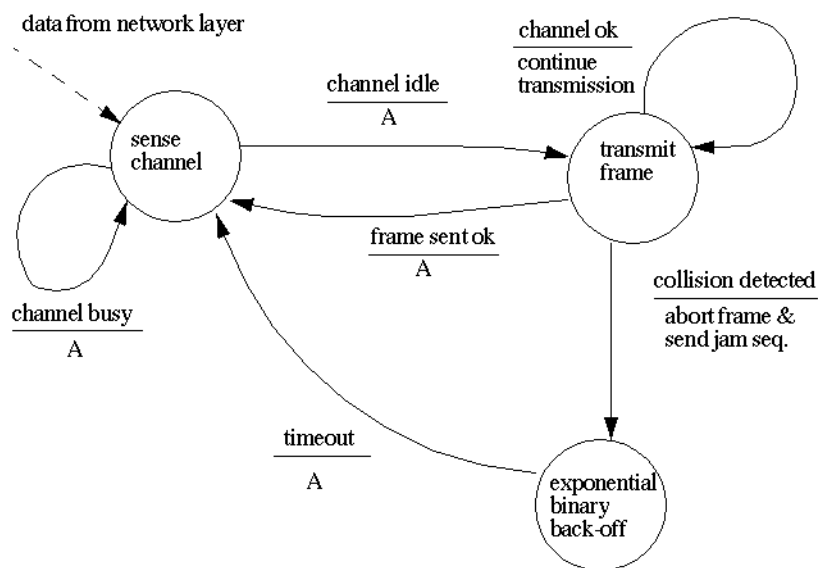
Question 2.

a)

1. transmission delay, when inserting a packet into a link

2. propagation delay, when transporting a packet along a link

3. queueing delay, in a node's (switch, router) output queue, when waiting for transmission

4. processing delay, in a node, when processing protocol header.

Assuming a 1-KB packet and a 10-MB link, the transmission delay is 1 KB / 10 MB, which is approximately 0.1 microsecs.

The propagation delay is related to the speed of light in the medium, and in the example approximately 110 ms [traceroute to www.nytimes.com 2008-01-17].

The queuing delay is generally more difficult to predict and is related to the current network load and node hardware; the queueing delay can vary from microsecs to several seconds.

The processing delay is generally very short, measured in microsecs.

b) False, because the network can delay a message so we will need a method to distinguish between a new and an old message.

c) The maximum number of bits that one can send is measured by the "pipe", which is the bandwidth-delay product.

The bandwidth is 100×10^6 bits. The delay is $(3 \times 10^8 \text{ m/s}) / (385,000 \text{ m}) = 779,2$ s. This gives us a bw product of 77920 Mbits.

Question 3.

a) A web application uses the http protocol for communication between the client and the server. Addressing is based on the url and the well-known port number 80, which is reserved for the http protocol. The combination of these two gives information about what host to connect to (the domain name part of the url) and what process to connect to (the port no.).

b) False, because each root server is in reality replicated to several local servers, which gives the dns system robustness by backup. Furthermore, the root servers are protected by packet filters. Also, the addresses of top-level domain servers are typically cached by local name servers, which makes many queries to bypass the root servers.

c)

T
F
F
T

Question 4.

a) Flow control is a mechanism that paces that packets sent between sender and receiver based on the amount of available buffers at the receiver, while congestion control is a mechanism that paces the packets sent by the sender based on information about the current network load (no information about the receiver).

Flow control makes use of the information in the Window-size field in the TCP header.

Congestion control makes use of the sequence and acknowledgement numbers as well as the timestamp of each TCP segment.

b) leaky (token) bucket and admission control, for example.

Question 5.

a)

i) best effort = the service model of the current Internet architecture; delivery of a message is attempted but not guaranteed

ii) tunneling = the technique of encapsulating a packet using a protocol that operates at the same layer as the packet, for example used during the transition from IPv4 to IPv6.

b) Fragmentation is a method for transmission of messages larger than the network's MTU; messages are fragmented into small pieces by the sender and reassembled by the receiver.

In IPv4, router's are also allowed to fragment a message, but this functionality has been removed in IPv6 in order to lighten the workload of the router.

c) The network address is 25.34.0.0 and the netmask is 255.255.0.0.

Question 6.

a) Assuming only the PCs do broadcasts, then the number of broadcasts domains in the network is 4; one for each collection of 5 PCs.

However, the routers also break the broadcast domain, so there can be 4 more broadcast domains (between each switch and router) in the network, giving a total of 8 broadcast domains.

b)

T
T
F
F

c) False, because the standard defines an association phase that requires that the station only can be associated with one access point at one time. The association is implemented by using association frames in conjunction with beacon frames.

Question 7.

a)

S	N'	D(s), p(s)	D(t), p(t)	D(u), p(u)	D(v), p(v)	D(x), p(x)	D(y), p(y)	D(z), p(z)
0	w	∞	∞	3, w	1, w	1, ~~x~~ w	∞	∞
1	wv	∞	10, v	2, v	done	1, ~~x~~ w	2, v	∞
2	wvx	∞	10, v	2, v		done	2, v	∞
3	wvxu	6, u	4, u	2, v			2, v	∞
4	wvxuy	6, u	4, u				done	16, y
5	wvxuyt	5, t	done					6, t
6	wvxuyts	done						6, t

b) Assuming 1-hop link costs are all 1:

Dest.	Cost	NextHop
W	3	C
X	2	C
Y	1	F
Z	5	G

c) RIP is simpler than OSPF but older and with a limit of 15 hops for the network size because of the count-to-infinity problem. OSPF is a modern routing protocol designed for handling several subnetworks, called autonomous systems, but more complex.

If I had a small network I would choose RIP.

d) The purpose of BGP is to function as an interdomain routing protocol by which autonomous systems exchange reachability information.

Question 8.

a) False, because SSL is an application-layer security protocol and as such not visible to routers, which work in the three lower protocol layers. Authentication is, in other words, performed betwen the end systems.

b) PGP uses the combination of an encrypted secret key with a message digests (MD5) to authenticate e-mail messages.

c) AH and ESP.