LUND
UNIVERSITY
Electrical and Information Technology

Home Exam in Internet–Techniques and Applications, EITF25

January, 2015

Name: _____

Id Number: _____

Programme: _____

Nbr of sheets: _____

Mark with a cross the problems you solved.				
1	2	3	4	5

Signature: _____

Control protocol					
1	2	3	4	5	$\sum$

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- Write your name on each paper.
- Start a new solution on a new sheet of paper. Use only one side of the paper.
- Solutions should clearly show the line of reasoning.
- The exam should be solved and handed in individually.

Good luck!

Problem 1

In Figure 1.1 the beginning of an IP datagram is shown. What can you say about

(a) Layer 3 and layer 4

- Protocol
- Payload
- Addressing

(b) End user application?

(c) Is the IP header received correct? Show all relevant derivations.

```
4500 04CC 9CBB 4000  0511 4BA0 C0A8
054E 82EB 3FE4 1AE1 1AE5 04B8 B152
```

Figure 1.1: Beginning of a datagram

(3+2+5=10p)

Problem 2

In Figure 2.1 a network is shown. In the figure the links are labelled with a cost metric. In this network the cost is equal in both directions for the link.

(a) Use Dijkstra's algorithm to get a spanning tree from node A to all other nodes. Show for example by numbering of the nodes how the algorithm works. Give the routing table for node A.

(b) In the Bellman-Ford algorithm distance vectors are exchanged between nodes. What is the initial distance vector of node C? If node C receives the initial distance vector from node F, what is the updated distance vector at node C?

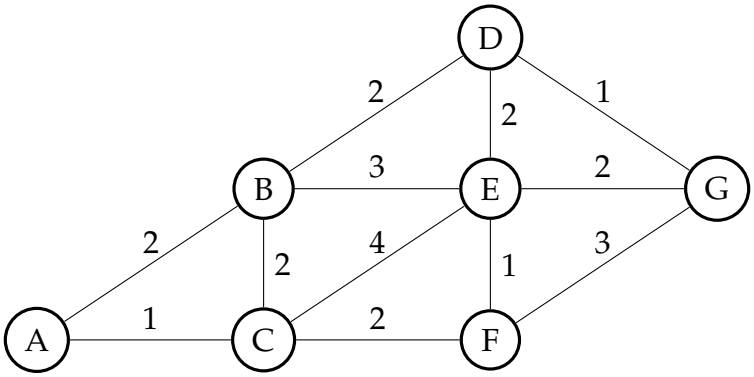

Figure 2.1: A network with nodes and links. The cost for using a link is independent of the direction.

(6+4=10p)

Problem 3

Consider a Stop-and-wait ARQ system. The expected transmission time for the fame is T_{t1} and the expected transmission time for the acknowledge frame is T_{t2}. The expected one directional propagation time is T_p, and it is equal in both directions, see Figure 3.1.

(a) What is the expected time delivering a frame and receiving the acknowledgement if there are no errors during the trasmission? What is the utilisation of the channel?

(b) Denote by p_1 and p_2 the probability of packet loss from A to B and from B to A, respectively. Let q be the total probability that a packet, and its acknowledge, is received error free. Show that the expected number of retransmissions is

$$E[\text{Number retransmission}] = \frac{1-q}{q}$$

(c) At the start of a transmission at node A, a timer is set to T_o. When there is a packet loss the frame will be transmitted again after time out. Give an expression for the expected time to deliver a packet and receiving the acknowledge. Evaluate the expression for the normalised times $T_{t1} = T_{t2} = 1$, $T_p = 0.1$, $p_1 = p_2 = 0.1$ and $T_o = 5$.

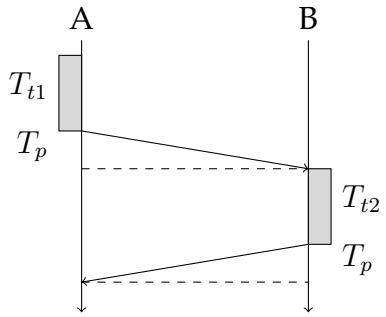

Figure 3.1: Timing in the Stop-and-wait ARQ system.

(2+3+5=10p)

Problem 4

In Figure 4.1 a network architecture is shown. The following questions are related to this network. In the picture R1, R2, R3 and R4 are routers, while S1 andS2 are switches. The MAC and IP addresses for the network interfaces of routers are given in the tables in the figure. The server Serv1 is a DNS server and Serv2 and Serv3 are web servers. Comp1, Comp2 and Print1 are connected in a typical home environment.

(a) Determine the number of IP networks and state their network addresses.

(b) Assume that the computer Comp2 is just connected to the network for the first time ever. Describe how it connects to the network and choose a suitable IP address. All packets should be described and the addressing should be on layer 2 and layer 3.

(c) After some time the user at Comp2 decides to start a web browser and types in the URL `http://www.web.com:8080/file/index.html`. In the web server file system on Serv2 the file `file/index.html` is the following:

```
<!DOCTYPE HTML>
<html>
<head>
  <title>My Page</title>
</head>
<body>
<h1>My Page</h1>
Bla bla bla bla bla bla bla bla bla bla
bla bla bla bla bla bla bla bla bla bla
bla bla bla bla.
<br>
<img src="http://www.imgstore.net/image/star.jpg"
  style="width:142px">
</body>
</html>
```

Describe the communication to show the page in the web browser. Describe all packets sent in the network and describe the addressing on layer 2, 3 and 4. Assume that the DNS table on Comp2 is empty at start. but all ARP and routing tables in the network are complete. Write the packets in a table, for example using the table header below.

Addressing						
L2		L3		L4		
Source	Dest	Source	Dest	Source	Dest	Description

(2+3+5=10p)

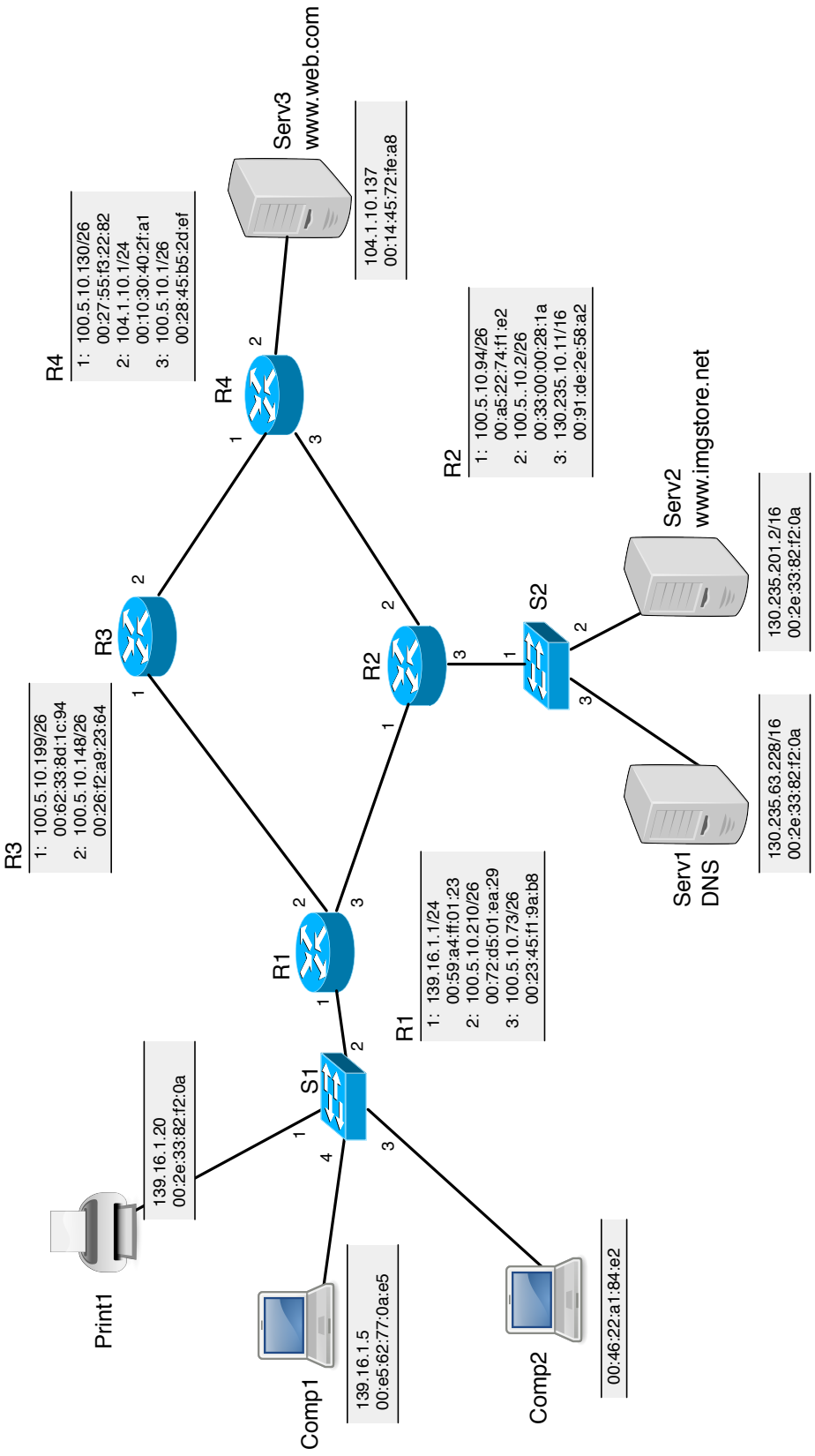

Figure 4.1: A network architecture. the network picture can also be found on a separate file on the course web page, next to the exam file.

Problem 5

In LTE (the 4G mobile system) a frame represents a transmission time of 10 ms. As described in the Figure 5.1 a frame consists of ten sub-frames, and each sub-frame consists of two slots. A slot is built from a sequence of seven OFDM frames, where the name comes from the modulation scheme OFDM used in LTE. An OFDM frame consists of a complex sample vector of length *FFTsize* appended with a cyclic prefix, *CP*. The CP of the first OFDM symbol is of length CP_a and for the six remaining the length is CP_b.

An LTE link can be set up with six different bandwidths $W \in \{1.4, 3, 5, 10, 15, 20\}$ MHz. In the table below the bandwidths and their corresponding FFTsizes and CP lengths, CP_a and CP_b, are listed. The lengths are given in number of samples. Since it is a radio signal the samples are complex valued.

Internally in the base station, when passing the radio signal from the baseband unit to the radio unit, a protocol called CPRI is often used. Each real sample is then quantised and represented by 15 bits.

For each of the bandwidths:

(a) Determine the symbol time T_S and symbol rate R_S for frames, sub-frames, slots and OFDM frames. (Since the OFDM frames are not equal length, give an average value).

(b) Find the sample frequency F_s, bit time T_b and the bit rate R_b required between the baseband unit and the radio unit.

(c) The OFDM modulation is based on FFT (Fast Fourier Transform) where a vector of N samples in the frequency domain is transformed to N samples in the time domain. The size of the vectors is the value FFTsize in the description. Each sample before the transform (in frquency domain) represents at most six bits of data (neglecting some synchronisation and management data). There is also a guard band in the frame not used for transmission, meaning only a part of the samples is used for data. In the table the value Data Samples is the number of samples per FFT frame used to store data. Derive the expansion of bit rate, i.e. the ratio between the efficient bit rate for data and the bit rate for the samples between the baseband unit and the radio unit.

W [MHz]	1.4	3	5	10	15	20
FFTsize	128	256	512	1024	1536	2048
CP_a	10	20	40	80	120	160
CP_b	9	18	36	72	108	144
Data Samples	72	180	300	600	900	1200

(3+4+3=10p)

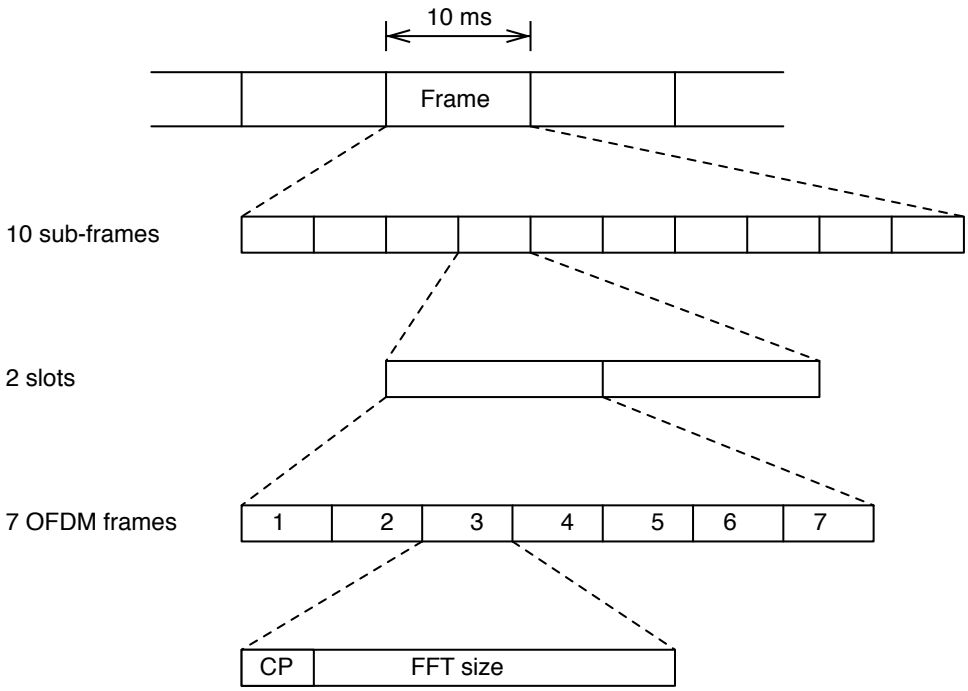

Figure 5.1: Frame structure in the LTE mobile system.