PhD

Florida Institute of Technology

Comprehensive Examination

Spring 2015

Computer Networks

Read Carefully: Resolve each of the following problems without any reference material (closed books and closed notes). **Calculators are allowed.** Please **fully explain** your response, and make sure to specifically address the questions asked. If additional space is needed please attach a blank page and add your student ID to it. There are 6 questions on this exam, please budget your time accordingly.

Student ID: ____________________

Date: ____________________

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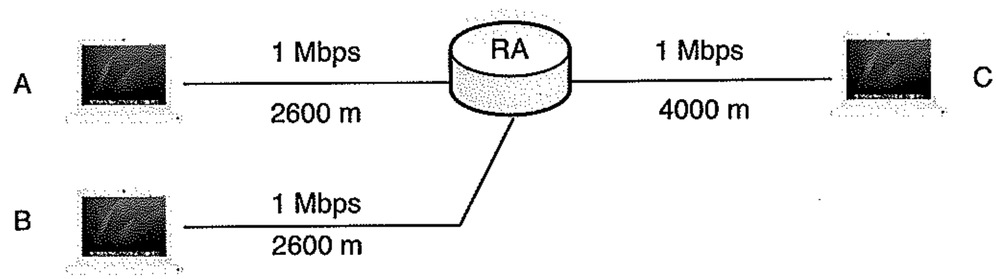
1. **Question 01 (20 points)** In the scenario below, the propagation speed in all links is $2 \cdot 10^8$ m/s. Assuming a store-and-forward model for router RA, and that each of its interfaces is connected to a separate 1 Mbps link to each of the hosts, answer the following questions:



   a. If hosts A and B simultaneously start transmitting 25 frames each to node C, how long would it take for node C to fully receive all frames? Consider that each frame is 5000 Bytes long.

b. Would the total delay estimated in question (1.a) change if the link between B and RA was 2 Mbps, instead of 1 Mbps? If so, what would be the new delay for the full transmission? (Assume that links A-RA, and RA-C are all kept at 1 Mbps, as illustrated in the figure).

Question 02 (10 points):

The IP header is described by a 20-byte section structured as follows:

Version	Header Length	Service Type	Total Length	
Identification			Flags	Frame Offset
TTL		Protocol	Header Checksum	
Source IP Address				
Destination IP Address				

The Header Checksum in the segment is calculated using the **16-bit Internet Checksum**. The calculation is done before each packet is transmitted, and used by the receiver to verify the integrity of the header.

4	5	0	64	
0			0110	0
6		6	0	
10.10.110.10				
10.10.110.25				

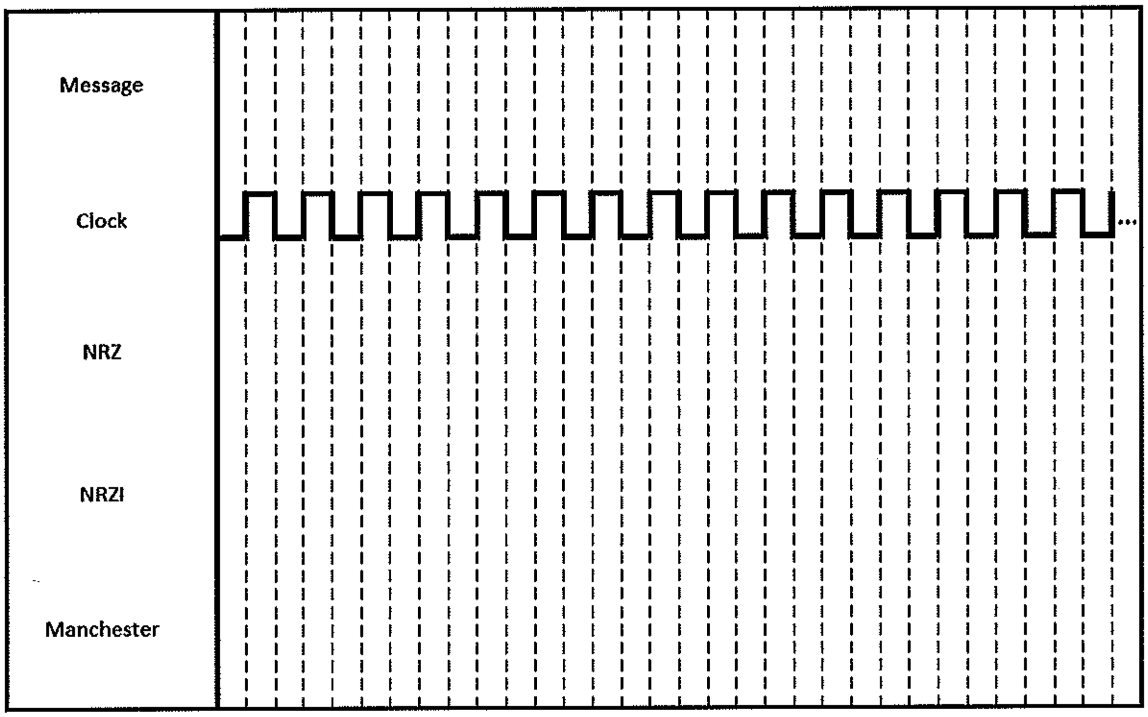
Using the example above, calculate the Internet Checksum of the header, and construct the final packet (in binary) that will be transmitted by the sender. To facilitate the process, the decimal numbers above have been already converted to binary in the image below. Show your calculations of the Internet checksum and fill out the final header with that information (recall that in order to calculate the checksum, we first assume all bits in the checksum field to be zeros).

0100 0101	0000 0000	0000 0000	0100 0000
0000 0000	0000 0000	0110 0000	0000 0000
0000 0110	0000 0110		
0000 1010	0000 1010	0110 1110	0000 1010
0000 1010	0000 1010	0110 1110	0001 1001

Question 03 (20 points): Consider the following message (as a sequence of bits).

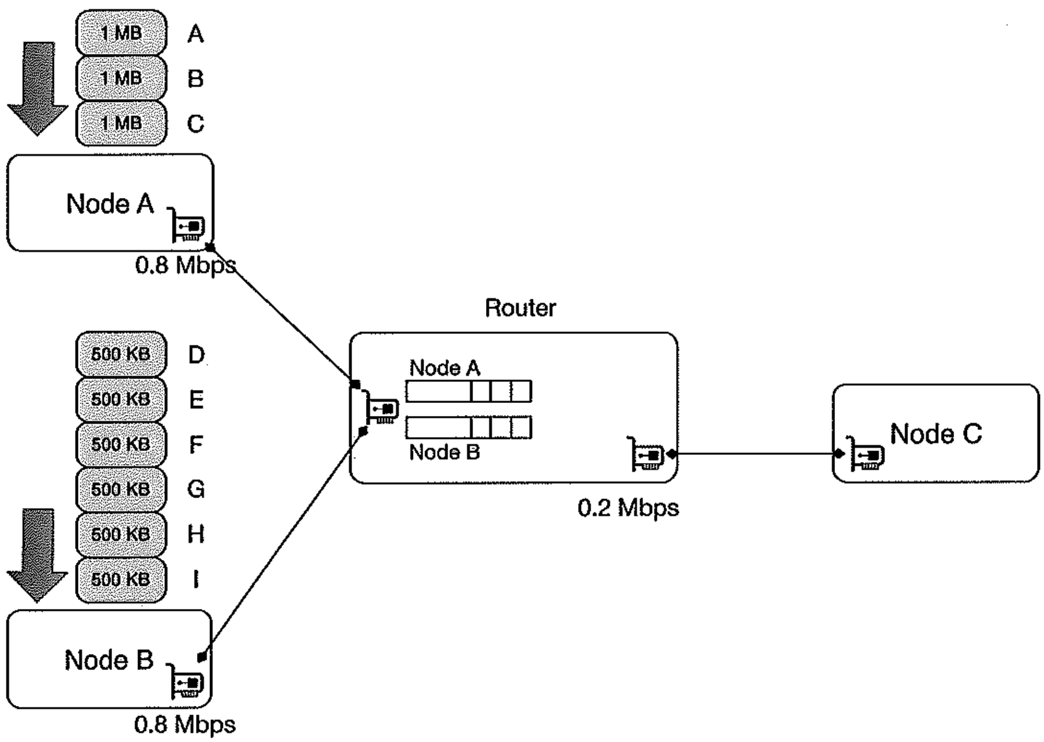
Message: `1011011010101`

a) The figure below shows the clock of the system, please draw the message, and each of the corresponding encodings listed in the figure.



b) NRZ (Non-Return to Zero) is a simple type of encoding used at the physical layer. The encoding is illustrated in the figure below. There are two main problems with this type of encoding, which has led to the development of several alternative schemes. In a few sentences, please identify and explain each of these problems.

Question 04 (20 points): In the scenario below, each of the transmitting nodes (A and B) is sending a short sequence of data segments to node C. The router in the center of the network uses a priority queuing algorithm and maintains a separate queue for each of the connections. The propagation delay on all links is negligible and can be ignored. Assume that the receive bandwidth of all interfaces is unlimited – that is, nodes can receive data as fast as it is delivered to the receive interface. Note that each frame is labeled (A through I).



a) Please describe the **letter sequence** (i.e. A, B, C, …) in which frames will be received at node C, assuming that the router uses a **fair queuing scheduling** algorithm for packet delivery.

b) Please describe the **letter sequence** (i.e. A, B, C, …) in which frames will be received at node C, assuming that the router uses a **round-robin scheduling** algorithm for packet delivery.

Question 05 (20 points): Consider two nodes (A and B) that are directly connected. Node A would like to send a 100 KB message to node B. The message is fragmented in 1 KB frames, and an additional 80 Bytes is appended to each frame (for header and CRC). The channel between nodes A and B can reliably transmit 5000 symbols per second. Disregarding any transmission, queuing or propagation delays, please choose a modulation for the channel that would allow the transmission of 15 Kbits/second bit-rate. Please draw and explain the constellation diagram of the modulation you choose.

Question 06 (10 points): Assuming the 7-layer OSI model, describe the name and functionality of layers 2 and 3. Please be concise.

Binary	Hex	Quad Dec	2^n	CIDR	Number of addresses	
00000000000000000000000000000000	00000000	0.0.0.0	2^{32}	/0	4,294,967,296	4 G
10000000000000000000000000000000	80000000	128.0.0.0	2^{31}	/1	2,147,483,648	2 G
11000000000000000000000000000000	C0000000	192.0.0.0	2^{30}	/2	1,073,741,824	1 G
11100000000000000000000000000000	E0000000	224.0.0.0	2^{29}	/3	536,870,912	512 M
11110000000000000000000000000000	F0000000	240.0.0.0	2^{28}	/4	268,435,456	256 M
11111000000000000000000000000000	F8000000	248.0.0.0	2^{27}	/5	134,217,728	128 M
11111100000000000000000000000000	FC000000	252.0.0.0	2^{26}	/6	67,108,864	64 M
11111110000000000000000000000000	FE000000	254.0.0.0	2^{25}	/7	33,554,432	32 M
11111111000000000000000000000000	FF000000	255.0.0.0	2^{24}	/8	16,777,216	16 M
11111111100000000000000000000000	FF800000	255.128.0.0	2^{23}	/9	8,388,608	8 M
11111111110000000000000000000000	FFC00000	255.192.0.0	2^{22}	/10	4,194,304	4 M
11111111111000000000000000000000	FFE00000	255.224.0.0	2^{21}	/11	2,097,152	2 M
11111111111100000000000000000000	FFF00000	255.240.0.0	2^{20}	/12	1,048,576	1 M
11111111111110000000000000000000	FFF80000	255.248.0.0	2^{19}	/13	524,288	512 k
11111111111111000000000000000000	FFFC0000	255.252.0.0	2^{18}	/14	262,144	256 k
11111111111111100000000000000000	FFFE0000	255.254.0.0	2^{17}	/15	131,072	128 k
11111111111111110000000000000000	FFFF0000	255.255.0.0	2^{16}	/16	65,536	64 k
11111111111111111000000000000000	FFFF8000	255.255.128.0	2^{15}	/17	32,768	32 k
11111111111111111100000000000000	FFFFC000	255.255.192.0	2^{14}	/18	16,384	16 k
11111111111111111110000000000000	FFFFE000	255.255.224.0	2^{13}	/19	8,192	8 k
11111111111111111111000000000000	FFFFF000	255.255.240.0	2^{12}	/20	4,096	4 k
11111111111111111111100000000000	FFFFF800	255.255.248.0	2^{11}	/21	2,048	2 k
11111111111111111111110000000000	FFFFFC00	255.255.252.0	2^{10}	/22	1,024	1 k
11111111111111111111111000000000	FFFFFE00	255.255.254.0	2^{9}	/23	512	
11111111111111111111111100000000	FFFFFF00	255.255.255.0	2^{8}	/24	256	
11111111111111111111111110000000	FFFFFF80	255.255.255.128	2^{7}	/25	128	
11111111111111111111111111000000	FFFFFFC0	255.255.255.192	2^{6}	/26	64	
11111111111111111111111111100000	FFFFFFE0	255.255.255.224	2^{5}	/27	32	
11111111111111111111111111110000	FFFFFFF0	255.255.255.240	2^{4}	/28	16	
11111111111111111111111111111000	FFFFFFF8	255.255.255.248	2^{3}	/29	8	
11111111111111111111111111111100	FFFFFFFC	255.255.255.252	2^{2}	/30	4	
11111111111111111111111111111110	FFFFFFFE	255.255.255.254	2^{1}	/31	2	
11111111111111111111111111111111	FFFFFFFF	255.255.255.255	2^{0}	/32	1	