ECE 3700

- 2007 Midterm (solved)
- ~~2006 Midterm (unsolved)~~

ECE 3700 Telecomm

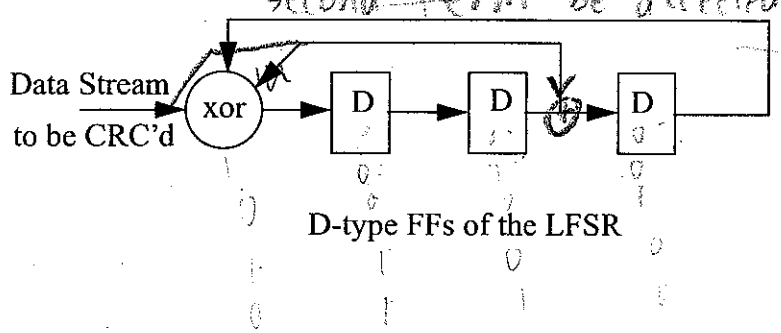
Midterm 24:3700 Name (print): Travis "The Yellow Dart" Friesen

March 1, 2007 Student Number: 6796047

Part 1: CRC (6 marks)

Given you have a CRC that uses x^3+x+1 as the characteristic polynomial for checking a data stream. This is a maximal length primitive polynomial (good CRC properties).

Your LFSR is no good - should the 1st second term be affected by xor, not vice-versa?



Shit, the CRC is the state of the FFs not the content

When you apply a data stream to be checked it is run through the LFSR representing the CRC polynomial. The CRC is also called a signature or fingerprint of the data stream.

Hope there's time to fix

Assume the LFSR starts in the all zero state.

1. Assume a data stream of 0 0 0 0 0 0 0 0 is presented to the CRC register. Right most bit first. What is the CRC of the data stream?

   ~~00000000~~ 000

2. Assume a data stream of 0 1 0 1 0 1 0 1 is presented to the CRC register. Right most bit first. What is the CRC of the data stream?

   L-R 00010011 001

3. Assume that a bit was flipped due to noise within the last data stream, such that 1 1 0 1 0 1 0 1 was received (right most first). What is the CRC of the corrupted date stream?

   00101011 101

4. Did the CRC detect the error?

   No Yes

5. If this were the CRC used on a ethernet frame, what does the NIC card, (the ethernet mac layer) do if a CRC detects the frame in error.

   discard ~~packet~~ frame

6. Can a one bit error cause aliasing (correct signature for erroneous input) of a CRC signature?

   ~~In this case, yes. If the error occurs in the last 3 bits, they are~~ No

6 8 5 5 5 10 3

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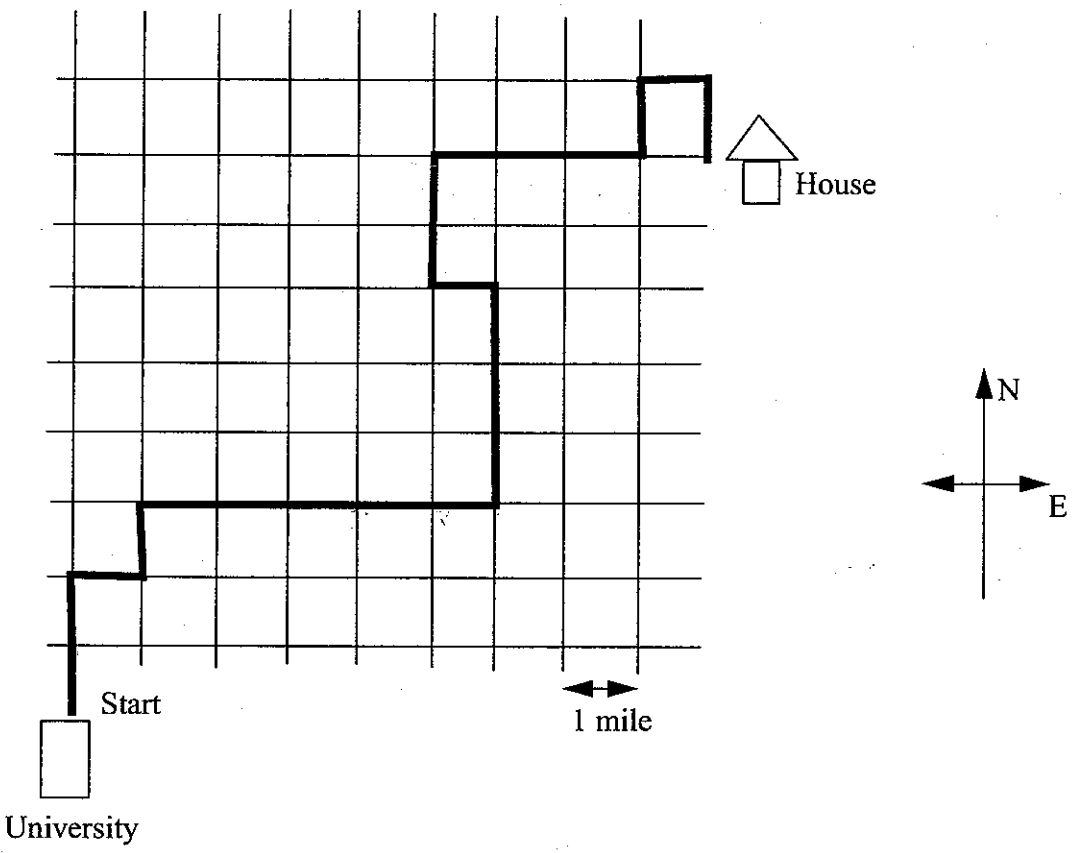
Part 2: QPSK and DQPSK (10 marks: weighted as 1,1,2,2,4)

Assume that in QPSK the symbols transmitted are N E W S. The following is a map from the University to my house.

At each grid point a new direction (symbol) is given. You are the passenger in the car giving your buddy (the driver) directions.



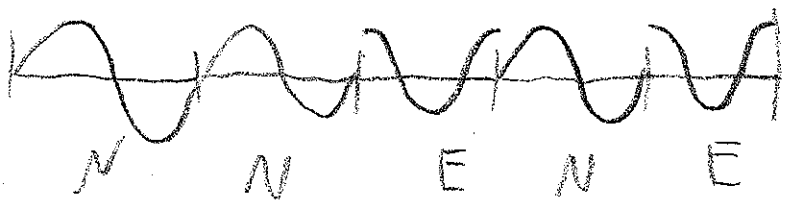
1. What are the directions to get from the University to my house, using the QPSK symbols?

~~NWSWWWSSESSSWWWWWSWSS~~
@N ENEEEEENNNWNNEEENES
University seems to start an extra point S

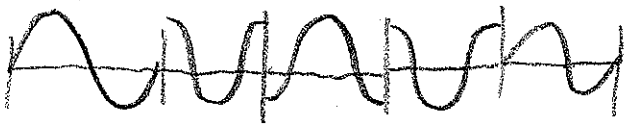
2. DQPSK encodes for a **change** in direction. What is a reasonable coding to scheme to use that differentially encodes for direction changes that also provides directions to my house.

left, right, straight, (turn around)

3. For QPSK assume that N is encoded as sin(wt), E is encoded as sin(wt+pi/2), W is encoded as sin(wt+pi), and S is encoded as sin(wt+3pi/2). What does the QPSK waveform look like for the first 5 symbols? Assume one cycle per symbol.



4. For DQPSK assume that a change in direction of 0 degrees encodes as sin(wt), a right turn is encoded as sin(wt+pi/2), a change in direction of 180 degrees is encoded as sin(wt+pi), and left turn is encoded as sin(wt+3pi/2). What does the DQPSK waveform look like for the first 5 symbols? Assume one cycle per symbol.



5. Assuming a channel bandwidth of 10 cycles/second (i.e. 10 Hz) and a Signal to Noise ratio of 1, your buddy is listening to you and the radio at the same time. What is the channel capacity between you and your buddy? What is the maximum speed that your buddy can drive and get to my house? What is that speed in miles per hour? $C=W\log_2(1+P/N)$

$C = 10\log_2(2) = 10$

10 miles/sec = 36000 mph (at least, were he only bound by how quickly he could receive directions)

Part 3: Wireless 802.11 (5 marks)

1. In wireless 802.11 the how does a sender know that the data was received correctly by the recipient? recipient generates an ACK for each frame

2. In the event that the 802.11 frame was not received correctly, the sender will enter an exponential back-off algorithm where it will wait and attempt a retransmission. Assume that the back-off window is 8 slots. What is the probability that the frame will be retransmitted in slot 4? currently 1/4

1/8 = 0.125

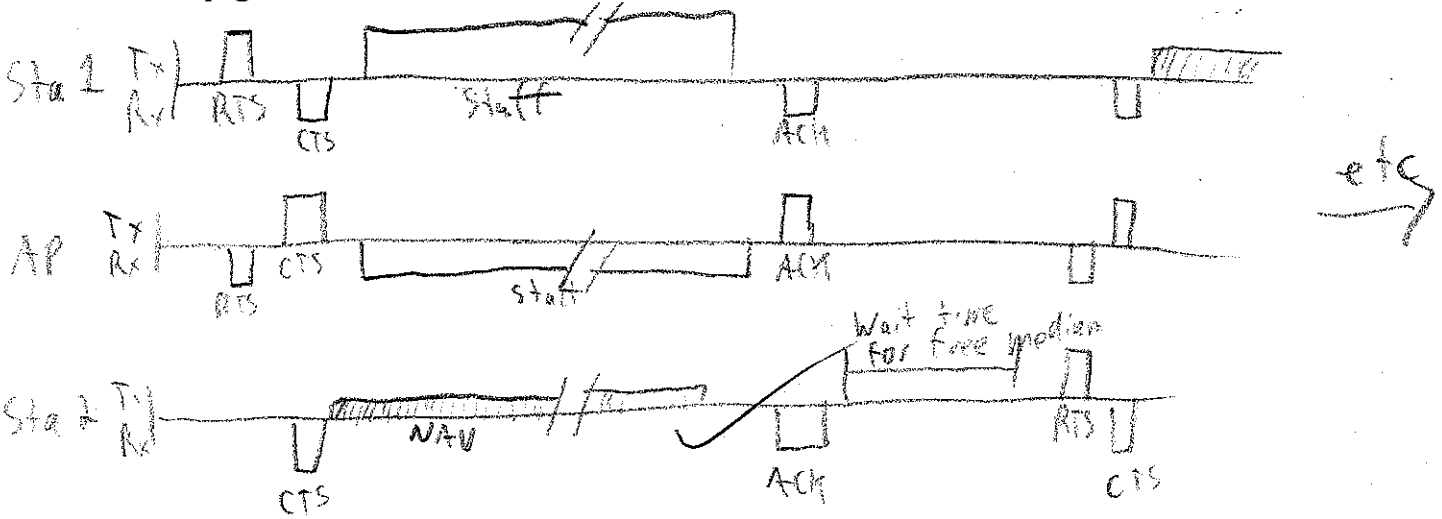
3. While in the exponential back-off mode, if the sender senses traffic or senses the medium busy, does it stop counting down and resume counting down when it senses the medium idle or count down regardless of the state of the medium? How does this differ from the exponential back-off mechanism of ethernet?

Stops count down ✓

4. Is wireless 802.11 full duplex or half duplex, explain.

half-duplex, transmission and reception occur on the same ~~medium~~ channel and cannot happen simultaneously

5. In certain scenarios with 802.11 there can be a hidden node problem where although each host can interact with the base station they may not be able to hear each other and hence would be unable to detect a carrier and infer the medium busy. Instead 802.11 can use a RTS/CTS protocol effectively allowing a host to infer traffic and thereby defer transmission that would otherwise result in a collision. Sketch the RTS/CTS protocol timing diagram and indicate how the NAV is set for a hidden node. The NAV is simply a timer that allows a station to infer the presence of traffic for a certain duration. Note a timing diagram typically goes across the page.



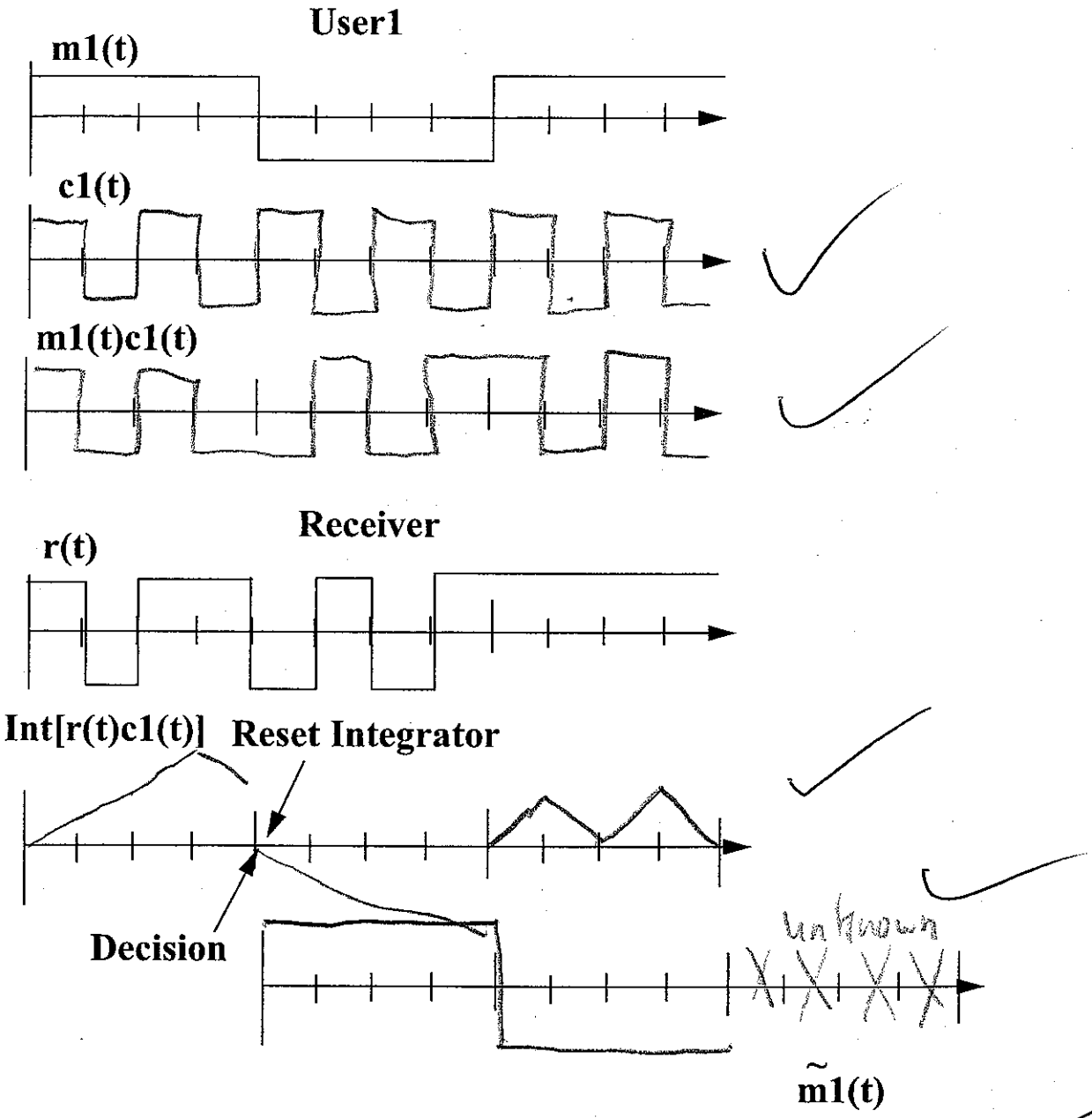
This save is 'sketchy' - a number of details missing like DIFS, etc. And that wait time is probably longer. Meh.

Part 4: Spread Spectrum (value 5 - 1 marks each)

Table 1:

User	PN Code
m1	1 -1 1 -1

Sketch missing waveforms. Note: **The PN code modulates each data bit.**



1. What is the spreading gain of this system and what is spread?

4

Part 5: Acronyms: (5 marks)

What do the following terms or acronyms stand for and mean?

e.g. Question and answer: WDM: WDM stands for wavelength division multiplexing. WDM associates a channel with a given wavelength.

2. CDMA: Code division multiple access - method of multiplexing multiple signals onto a single channel by assigning each signal a unique orthogonal code

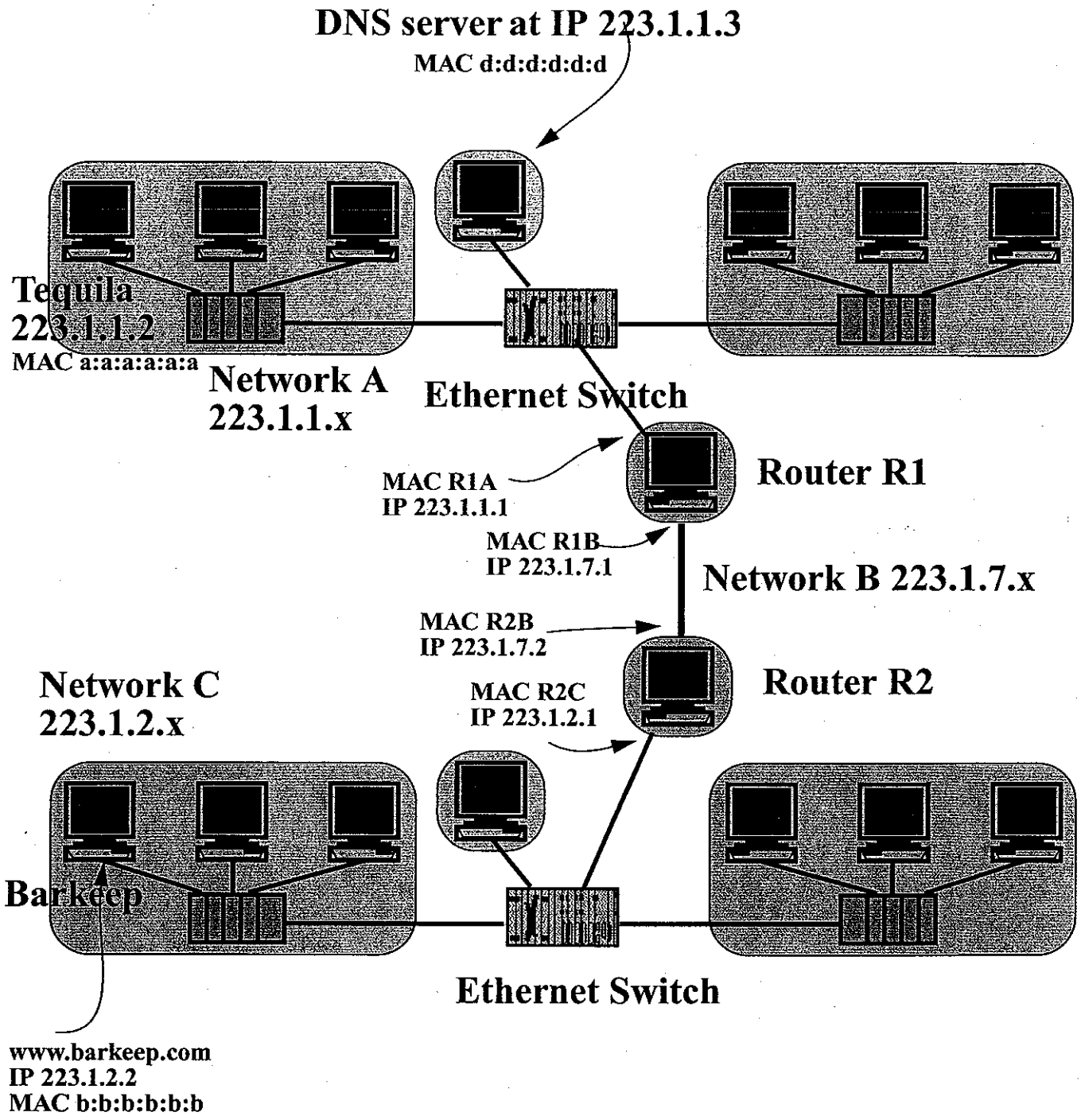
3. CSMA/CD: Carrier Sense multiple access/ Collision detection method of determining if a collision has occurred on a shared medium

4. ARP: Address Resolution protocol
- Protocol used to associate MAC addresses w/ IP addresses

5. MAC: Media Access Control
- Layer 2 specification
- each physical device has a unique MAC address (in theory)

6. DHCP: Dynamic Host Configuration Protocol
- method of dynamically ~~binging~~ binding IP addresses to specific hosts

This illustration is to be used with the questions in Part 6.
This page may be ripped out of the test, and does not need to be returned.



Part 6: IP: (10 marks - {2,2,2, 4})

1. An IP packet is transmitted from host Tequila to host Barkeep. Fill in the following table with the IP packet's source and destination IP and encapsulating ethernet frame's MAC addresses for each network leg that the packet takes.

Network Leg		Source	Destination
First Leg	IP address	223.1.1.2	223.1.2.2
	MAC address	a:a:a:a:a:a	R1A
Second Leg	IP address	223.1.1.2	223.1.2.2
	MAC address	R1B	R2B
Third Leg	IP address	223.1.1.2	223.1.2.2
	MAC address	R2C	b:b:b:b:b:b

2. IP addresses are essentially composed of a network and a host part. What is the most likely network part of the IP address for **Network A**?

223.1.1 (class C)

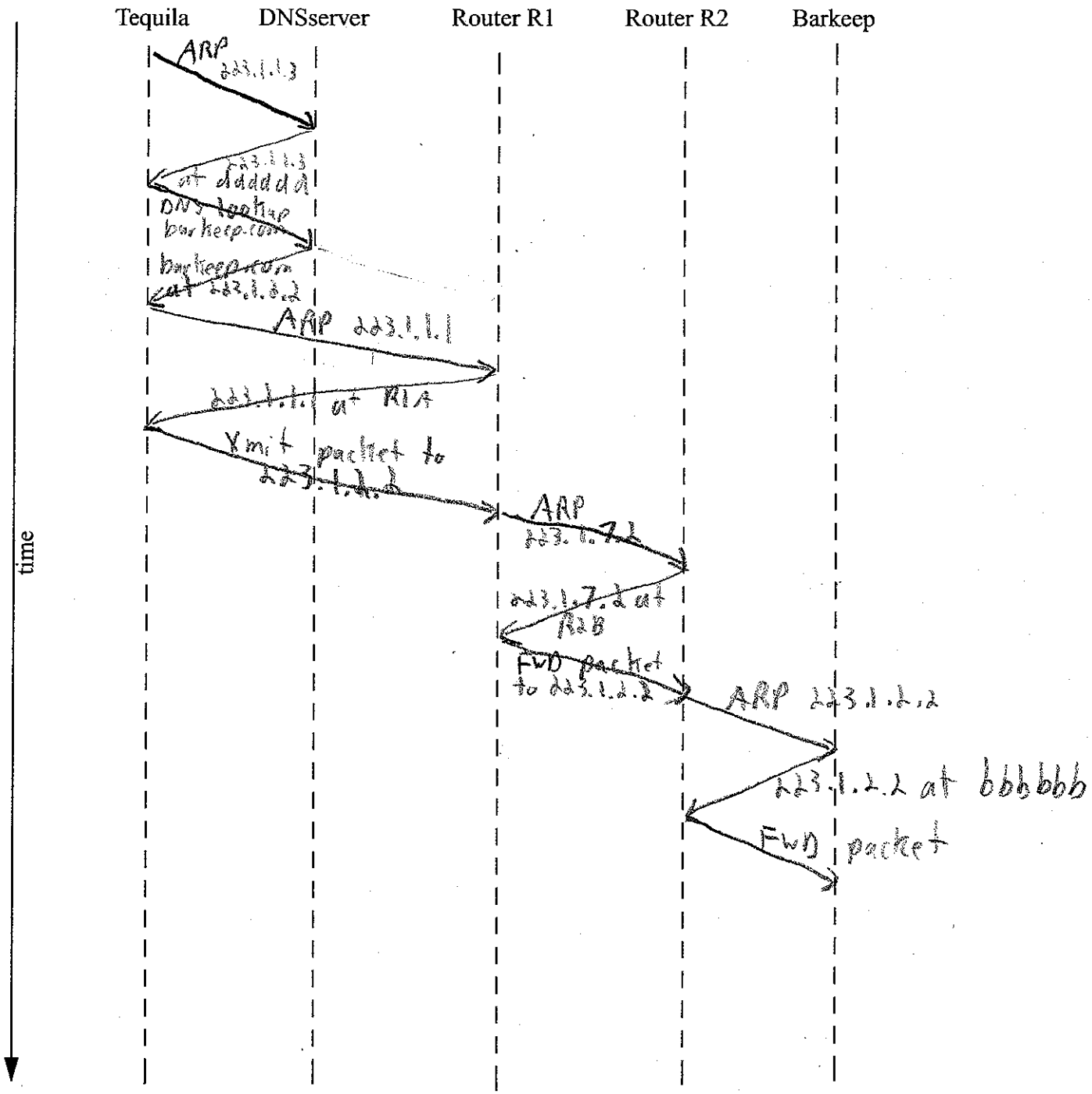
3. If **tequila** wants to send a packet to IP 223.1.2.3, how does it know it is to route it to R1.

Part of tequila's configuration consists of setting up routing tables (can be automatic or manual). Basically, ~~any~~ tequila knows anything not on 223.1.1.X must be passed through R1

4. Assuming that all ARP tables are initially empty, the routing tables are stable, and the DNS server can resolve any request, the IP address of the DNS server is known. Show the sequence of packets that will occur for **Tequila** to send a single IP packet to **www.barkeep.com.** Provide sufficiently detail comments with each transaction.

e.g. Tequila DNSserver

Tequila Arps for MAC address of the DNSserver

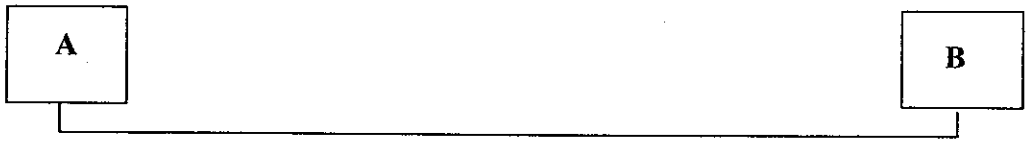


of course, any ACKs, etc have been omitted for the sake of brevity

Assume 1MB = 1 000 000 bytes

Part 7: General Packet Question :(7 marks)

Given the following network.



Sender **10 Mbps "Ethernet" point to point connection 300 Km** **Receiver**

The sender wants to send a 1.5M Byte file to the receiver. The protocol will be "stop and wait". Assume if the ack was not received when expected, the packet is lost and immediately retransmitted.

1. What is a "stop and wait" protocol?

after xmission, sender stops and waits for acknowledgement ✓

Given: The sender will break the file into 1500 Byte DATA packets. While the receiver will reply with 100 Byte ACK packets. Strong CRC codes are used to check the data and acks.

2. What is the transmission time for a DATA packet? What is the propagation time assuming the velocity of the electromagnetic signal is $c=3x10^8$ m/sec? (ignore any overhead of encapsulation)

$1500/10\,000\,000 = 15/10^5\ s = 0.00015\ s = 0.15\ ms$ X

$-$

$-\ 300\,000/300\,000\,000 = 1/1000\ s = 1\ ms$

3. What is the total time to send an entire Data Packet reliably (i.e. with acknowledgement that it was received).

$1ms + 15/10^5 s + 1/10^5 s + 1ms = 16/10^5 s + 2ms = 2.16\ ms$

X

4. What is the total time to send the file? Assume the channel is error free.

1000 packets · 2.16 = 2160 ms = 2.16 s

X

Assume now that the channel has a BER (Bit Error Rate) of $1*10^{-5}$.

5. What is the probability that the DATA packet contains an error? What is the probability that the ACK packet contains an error?

$-\ 0.015$

$-\ 0.001$

X

Assume:- No errors on retransmits
~~Timeout is exactly~~

6. With a BER (Bit Error Rate) of $1*10^{-5}$, what is the total time anticipated to transfer the 1.5MByte file? (only consider the potential of a DATA packet error, i.e. ignore ACK packets). This might be helpful, if probability of flipping a head with a coin is p, the expected number of heads in n flips is np.

$0.015 \cdot 1000 = 15$ erroneous packets

$2160 + 15 \cdot 2.16 = 2192.4\ ms = 2.1924\ s$ ✓

7. In the case of a negligible BER, what is the time to transit the entire file if the distance is reduced to 30m?

prop time = $30/300000000 = 1/10^7 = 100\ ns$

$200\ ns + 16/10^5\ s =$ ~~360 ns~~ ~~RIT~~ $160.2\ s$

~~360 1000 = 360 ms~~

$160.2 1000 = 160.1\ ms$

Time is short and my math may be bad