INSTITUTO SUPERIOR TÉCNICO

Mestrado em

Engenharia Electrotécnica e de Computadores

Redes Móveis e Sem Fios

1º Teste – 1ª parte

10 de Abril de 2015

Duração 1h15

In order to avoid grading mistakes, please answer each question <u>on a different page</u> and keeping the order as much as possible.

1) In a mobile network using CDMA with 8-symbol chip sequences, there are two mobile stations trying to transmit to a base station with keys S1= -1, -1, +1, +1, +1, +1, -1, -1 and S2= -1, -1, -1, -1, +1, +1, +1, +1. The signal from S1 arrives at the base station with twice the pulse amplitude of the signal from S2: the chip pulse amplitude received from S1 is +2 and the chip pulse amplitude received from S2 is +1. The time of one bit corresponds to 8 chips. Assume that the logical value "0" is represented by -1 and logic value "1" is represented by +1. The sequence that was received at the base station was the following: -1, 0, +3, +3, +1, +1, -3, -5. The decoding thresholds are -2 and +2, respectively for logical "0" and logical "1".

   a) Which data bits coming from S1 and S2 were decoded by the base station? (2,0 val)

   b) Was the received signal affected by noise? In that case, quantify the noise. (2,0 val)

   c) Which would be the sequence received at the base station, had the signal from S1 been received with the same chip pulse amplitude as that of S2? (2,0 val)

2) Consider the communication between a radio sender and receiver located in an area of flat terrain, being 1.5 km from each other. The RF channel is 200 kHz wide and the center frequency is 450 MHz. The employed modulation is QPSK, the transmit power is 20 mW. The noise spectral density is -170 dBm/Hz. Assume that the sender and receiver antennas are isotropic. The height of the antenna's mast is 2 meter for both sender and receiver.

   a) Which propagation model fits best to the given scenario: the Friis model or the Two-Ray model? Justify. Suggestion: Calculate the fraction of the 1st Fresnel Zone that is obstructed. (2,0 val)

   b) Calculate the channel capacity limit, assuming that the received power is -85 dBm (1,0 val)

   c) Calculate the received power using the propagation model selected in a). (1,0 val)

   d) Based on the result obtained from c), what is the FER of 100 byte frames, assuming a BSC channel with constant BER? (2,0 val)

3) Consider the IPv4 network represented in the picture below, as well as the routing tables of each router and host.

   a) What is the path followed by a packet transmitted by H1 towards H2? Justify. (2,0 val)

   b) How is the translation between IP and MAC addresses performed at each link? (2,0 val)

4) Consider a MIPv6 system without optimizations or extensions, where the hop distances between the different entities are the following: CN→HA=30; HA→CN=33; HA→FA=70; FA→HA=80; FA→MN=7; MN→FA=7; MN→CN=90; CN→MN=80. The CN wishes to establish a Skype session with the MN. Assume that the TTL field of the IP headers is always initialized with 100.

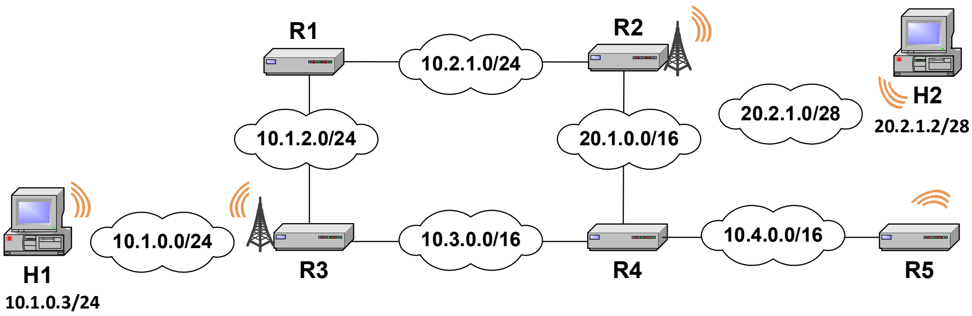
   a) Is it possible to setup a Skype session between the CN and the MN? Justify. (2,0 val)

   b) In a simple MIP setting (no reverse tunneling), consider that the relevant entities have the following IPv4 addresses: MN (193.154.3.10), HA (193.154.3.1), FA/CoA (195.137.10.2), CN (146.64.4.6). What are the source and destination IP addresses in IPv4 headers of packets exchanged between those entities, considering both inner and outer headers (when applicable)? Justify. (2,0 val)

Destination	Next Hop
10.1.0.0/24	R3
10.1.2.0/24	direct
10.2.1.0/24	direct
10.3.1.0/24	R3
20.2.0.0/16	R2
30.1.1.0/28	R2

Destination	Next Hop
10.1.0.0/24	R1
10.1.2.0/24	R1
10.2.1.0/24	direct
10.3.1.0/24	R4
20.1.0.0/16	direct
20.2.1.0/28	direct
20.2.0.0/16	R4

Destination	Next Hop
10.1.0.0/24	R2
10.1.2.0/24	R2
10.2.1.0/24	R2
10.3.1.0/24	R2
20.1.0.0/16	R2
20.2.1.0/28	direct
10.4.0.0/16	R5



Destination	Next Hop
10.1.0.0/24	direct
10.1.2.0/24	R3
10.2.1.0/24	R3
10.3.1.0/24	R3
20.1.0.0/16	R3
20.2.1.0/28	R3
10.4.0.0/16	R3

Destination	Next Hop
10.1.0.0/24	direct
10.1.2.0/24	direct
10.2.1.0/24	R4
10.3.1.0/24	direct
10.4.0.0/16	R4
20.2.0.0/22	R4
20.2.0.0/23	R1

Destination	Next Hop
10.1.0.0/24	R3
10.1.2.0/24	R3
10.2.1.0/24	R2
10.3.1.0/24	direct
20.1.0.0/16	direct
20.2.1.0/28	R5
10.4.0.0/16	direct

Destination	Next Hop
10.1.0.0/24	R4
10.1.2.0/24	R4
10.2.1.0/24	R2
10.3.0.0/16	R4
10.4.0.0/16	direct
20.2.1.0/28	direct

Propagation Models		Channel Capacity	
Fresnel Zone Radius	$r(F_n) = \sqrt{\frac{n \cdot \lambda \cdot d_1 \cdot d_2}{d_1 + d_2}}$	**Shannon-Heartley Theorem**	$C = B \cdot \log_2\left(1 + \frac{S}{N}\right)$
Friis Model	$P_r = P_t \cdot \frac{G_t \cdot G_r \cdot \lambda^2}{(4 \cdot \pi \cdot d)^2 \cdot L}$	**Bit Error Rate (DQPSK)**	$BER_{DBPSK} = 0.5 \cdot e^{-\frac{E_b}{N_0}}$
Two-Ray Model	$P_r = P_t \cdot \frac{G_t \cdot G_r \cdot (h_t \cdot h_r)^2}{d^4}$	**Bit Error Rate (BPSK)**	$BER_{BPSK} = Q\left(\sqrt{\frac{2 \cdot E_b}{N_0}}\right)$
Log-Distance Model w/ Lognormal Shadowing	$PL = PL_0 + 10 \cdot \gamma \cdot log_{10}\left(\frac{d}{d_0}\right) + X_g$	**Bit Error Rate (QPSK)**	$BER_{QPSK} = Q\left(\sqrt{\frac{2 \cdot E_b}{N_0}}\right)$
		Q function	$Q(k) = P(X > \mu + k\sigma) = \frac{1}{\sqrt{2\pi}} \int_k^{+\infty} e^{-\lambda^2/2} d\lambda$

TABLE OF THE Q FUNCTION

0	5.000000e–01	2.4	8.197534e–03	4.8	7.933274e–07
0.1	4.601722e–01	2.5	6.209665e–03	4.9	4.791830e–07
0.2	4.207403e–01	2.6	4.661189e–03	5.0	2.866516e–07
0.3	3.820886e–01	2.7	3.466973e–03	5.1	1.698268e–07
0.4	3.445783e–01	2.8	2.555131e–03	5.2	9.964437e–06
0.5	3.085375e–01	2.9	1.865812e–03	5.3	5.790128e–08
0.6	2.742531e–01	3.0	1.349898e–03	5.4	3.332043e–08
0.7	2.419637e–01	3.1	9.676035e–04	5.5	1.898956e–08
0.8	2.118554e–01	3.2	6.871378e–04	5.6	1.071760e–08
0.9	1.840601e–01	3.3	4.834242e–04	5.7	5.990378e–09
1.0	1.586553e–01	3.4	3.369291e–04	5.8	3.315742e–09
1.1	1.356661e–01	3.5	2.326291e–04	5.9	1.817507e–09
1.2	1.150697e–01	3.6	1.591086e–04	6.0	9.865876e–10
1.3	9.680049e–02	3.7	1.077997e–04	6.1	5.303426e–10
1.4	8.075666e–02	3.8	7.234806e–05	6.2	2.823161e–10
1.5	6.680720e–02	3.9	4.809633e–05	6.3	1.488226e–10
1.6	5.479929e–02	4.0	3.167124e–05	6.4	7.768843e–11
1.7	4.456546e–02	4.1	2.065752e–05	6.5	4.016001e–11
1.8	3.593032e–02	4.2	1.334576e–05	6.6	2.055790e–11
1.9	2.871656e–02	4.3	8.539898e–06	6.7	1.042099e–11
2.0	2.275013e–02	4.4	5.412542e–06	6.8	5.230951e–12
2.1	1.786442e–02	4.5	3.397673e–06	6.9	2.600125e–12
2.2	1.390345e–02	4.6	2.112456e–06	7.0	1.279813e–12
2.3	1.072411e–02	4.7	1.300809e–06		