TÉCNICO LISBOA

Mestrado em

Engenharia Electrotécnica e de Computadores

Redes Móveis e Sem Fios

Exame de Recurso – 2ª parte

30 de Junho 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. Consider an ad-hoc network formed by 4 nodes A, B, C and D in a linear topology. Node A generates data packets whose destination is D. The routing protocol supported in this network is DSR.
   a) DSR is a reactive routing protocol. Explain the advantages and disadvantages of reactive routing protocols in comparison with proactive routing protocols. (2,0 val)
   b) Draw the message diagram of route establishment between A and D, identifying unicast and broadcast transmissions and the main message fields. (2,0 val)
   c) Explain which mechanisms can be implemented in DSR in order to reduce the route establishment delay. (1,0 val)

2. Consider the TCP transport protocol used in IP networks, in its Tahoe version.
   a) Assuming that there are no bitrate limitations imposed by the Physical layer, calculate the time required to transmit 75 kbytes of data over TCP in a wireless network, with RTT=150 ms, MSS=700 bytes and considering that three duplicate acknowledgements are received asking for segment number 8. Assume that the starting slow-start threshold is set to 32 segments. (2,5 val)
   b) Calculate the minimum, average and maximum throughput of the connection. (1,5 val)
   c) Explain why TCP usually has efficient problems when operating in wireless networks, even without mobility. (1,0 val)

3) Consider a MEO satellite system operating in the 2 GHz frequency. The period of the orbit is 06:06:36 (hh:mm:ss). The satellite dish has an area of 2 m^2 and an efficiency of 80%. The ground station is similar to the satellite's antenna.
   a) Calculate the distance between the satellite and the surface of the Earth. Note: $\boldsymbol{r = \sqrt[3]{\frac{g \cdot R^2}{(2 \cdot \pi \cdot f)^2}}}$ with the following constants: $\boldsymbol{g = 9.81 m/s^2}$ (gravitational acceleration), $\boldsymbol{R = 6370\ km}$ (radius of the Earth). (1,0 val)
   b) Calculate the diameter of the footprint of the satellite, assuming that the attenuation due to the atmosphere is 10 dB, the transmit power is 30 W and the received power is -85.1 dBm. The area of a circle of radius $\boldsymbol{r}$ is $\boldsymbol{A = \pi \cdot r^2}$. (2, 0 val)
   c) How many satellites would you need to form a continuous coverage belt around the Earth? (2,0 val)

4) Consider a Digital Audio Broadcast (DAB) system, which is transmitting frames that comprise the following data blocks: AABCAABD.

a) Explain why the broadcast technologies can achieve a wider coverage more easily than e.g., GSM or UMTS. (1,0 val)

b) Considering that each block instance has a probability $\boldsymbol{p = 0.6}$ of being received correctly, calculate the probability of receiving a block of type B correctly in one frame. (2,0 val)

c) Calculate the expected number of frames required for the successful reception of a block of type B. Note: $\sum_{k=1}^{+\infty} \boldsymbol{k \cdot r^k} = \frac{r}{(1-r)^2}$ for $\boldsymbol{r < 1}$ (2,0 val)

Satellite Systems	
$\boldsymbol{F_g = m \cdot g \cdot (R/r)^2}$	$\boldsymbol{F_c = m \cdot r \cdot \omega^2}$
$\boldsymbol{L = \left(\frac{4 \cdot \pi \cdot r \cdot f}{c}\right)^2}$	$\boldsymbol{Footprint\ Diameter = \theta_{div} \times d}$
$\boldsymbol{G_{t\_plane} = 10 \cdot log_{10}(2\pi/\theta_{div})}$	$\boldsymbol{A_{eff} = \eta \cdot A_{phy} = \frac{\lambda^2}{4\pi} G_r}$
$\boldsymbol{P_r(dB) = P_t(dB) - 10 \cdot log_{10}\left(\frac{4 \cdot Footprint}{\pi^2 \cdot A_{eff}}\right) - At}$	