Two hours

UNIVERSITY OF MANCHESTER
SCHOOL OF COMPUTER SCIENCE

Digital Wireless Communication and Networks

Date: Thursday 14th May 2015
Time: 09:45 - 11:45

Please answer any THREE Questions from the FOUR Questions provided

This is a CLOSED book examination

The use of electronic calculators is permitted provided they are not programmable and do not store text
The original IEEE 802.11 used the 10110111000 Barker code to represent the digital value 1.

i) Why did it do this? Why is this method only used at one or two data rates and not elsewhere?

ii) Using the example of a DSSS system that receives a value of 10010110000, explain how the receiver decides whether this represents a 0 or a 1.

(4 marks)

b) Using Shannon’s equation show that with an SNR of zero nothing can be received.

(2 marks)

c) What SNR is required in theory to support a 2Mbps data rate in a system using a bandwidth of 20MHz?

(3 marks)

d) In an urban street scene such as the one shown below where the roads including pavements are 30 meters across and each junction is 300 meters from adjacent junctions.

i) Assuming all mobile phones are carried at 1 meter above the ground, giving reasons for your chosen value, estimate the delay spread experienced by pedestrian users of mobile phones when receiving wireless messages from a mobile station mounted just above roof height on a nearby building.

ii) What implications does this have for the maximum number of symbols that can be sent per second whilst avoiding almost all Inter Symbol Interference over a single mobile phone wireless channel?

iii) How does your result affect the data rate that high speed wireless networks can provide?

(8 marks)

e) How do wireless protocols such as IEEE 802.11ac manage to reach 1Gbps and beyond for its data rates? In what circumstances are users likely to reach these very high data rates?

(3 marks)
2. a) Briefly explain how an Indian who arrives in Manchester with a mobile telephone is able to make calls that are charged to the Indian's phone account back in India. (4 marks)

b) Mobile phones use slotted Aloha when initiating contact with a base station. Why do you think the designers of IEEE 802.11 reject slotted Aloha for use by ad hoc networks whereas mobile phones still use slotted Aloha? (5 marks)

c) IEEE 802.11 systems have a virtual carrier detect countdown timer called the Network Allocation Vector (NAV). Why? (2 marks)

d) Why is IEEE 802.11 not used by all the wireless sensor network motes used for data collection applications around the world? When would it be a good choice for a sensor network? (5 marks)

e) How could modern IEEE 802.11 systems be adapted to facilitate streaming of voice and video data? (4 marks)

3. a) Which mobile phone system generation is associated with:
   i) GSM? (3 marks)
   ii) UMTS? (3 marks)
   iii) LTE? (3 marks)

b) What is the difference between FDD and TDD? What are the advantages and disadvantages of these in LTE? (5 marks)

c) What wireless channel and system load parameters should be used to aid in making handover decisions? (3 marks)

d) Using pseudo-code, outline an algorithm for handling horizontal handover for an LTE UE between two adjacent e-UTRA e-Node-Bs. (6 marks)

e) What extra metrics or parameters would be needed to incorporate vertical handover, for example between e-UTRA and GSM into your algorithm from part "d" above? (3 marks)
4. A large wild animal game park wishes to monitor the location, activity and other measurable data from its animals using battery powered wireless sensor motes as these will allow the animals complete freedom to roam with data collected over many months or years before the devices fail. It will be necessary to transfer the sensor network data to the Internet so it can be either processed locally or forwarded to external data analysis providers.

Mobile phone coverage of the park is patchy and only the visitor centre has a satellite Internet connection and a few wired and wireless computers.

a) Suggest an architecture identifying the major components and the functionality that would provide a communications system for the new sensor data collection system. Provide a draft architecture diagram showing the main components, interfaces and information flows in your system. Briefly explain why each component, interface and flow is required in the form you have specified.

(9 marks)

b) Explain why commonly available computer or mobile phone networking technologies are or are not suitable for this task? Name each technology you discuss.

(4 marks)

c) What are the advantages and disadvantages of using IP technologies for transporting and routing the sensor network data everywhere within the system architecture?

(4 marks)

d) Briefly outline an alternative, possibly novel (invented during the exam) transport or routing protocol for the sensor network data and explain why your suggestions will work better than the ubiquitous IP technologies.

(3 marks)