

Two hours

**UNIVERSITY OF MANCHESTER  
SCHOOL OF COMPUTER SCIENCE**

Digital Wireless Communication and Networks

Date: Tuesday 6th June 2017

Time: 09:45 - 11:45

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**Please answer any THREE Questions from the FOUR Questions provided**

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This is a CLOSED book examination

The use of electronic calculators is permitted provided they  
are not programmable and do not store text

**[PTO]**

If needed, you should assume the speed of light is  $3 \times 10^8 \text{ m s}^{-1}$  or  $3 \times 10^5 \text{ km s}^{-1}$ .

1.

1. Using an example explain why moving a microwave frequency device by a small amount affects the signal strength much more than moving a device operating at a much lower frequency? [4 marks]
2. What does the unit “dBi” mean when referring to a wireless antenna? What does the “i” stand for? [2 marks]
3. Three lossless wireless antennas have gains of:
  - i. A standard half-wave dipole has a gain of 2.15dBi.
  - ii. A shortened dipole antenna has a reduced gain of 1.76dBi and
  - iii. The third antenna has a gain given as 3.05dBd.

What is the (non decibel) power ratio for each antenna compared to an isotropic antenna? [3 marks]

4. What is DSSS as a modulation scheme? How was it used in early IEEE802.11 systems? [3 marks]
5. What is OFDM as a modulation scheme? How is it used in IEEE802.11g (pre-MIMO) systems? [8 marks]

2.

- a. Many of the core systems for 4G mobile telephony systems are moved to the so called “cloud”. Stating reasons why they are suitable, give 2 examples in each case of core systems for 4G systems that are:
  - i. Sensible to move to a cloud computing platform.
  - ii. Not sensible to move to a cloud computing platform.

[8 marks]
- b. A mobile phone company proposes to mount a mobile telephone mast on top of a primary school which is adjacent to a maternity hospital and a secondary school.

Outline the scientific case for and against this proposal. Giving your reasons and sensible assumptions that you have made, state whether you would support or oppose the plans. [12 marks]

- 3.
- a. Other than the simplistic “too much traffic” answer, list and explain causes that contribute to congestion in ad-hoc and mesh wireless networks. [12 marks]
  - b. What is a Piconet? [3 marks]
  - c. Two Piconets carrying large but constant amounts of data traffic overlap in space. What happens? Are there variations in the outcome? If so, explain. [5 marks]

[PTO]

4.

Assuming the earth has a circumference of 40,000km via any great circle route and that geostationary satellites are always positioned 35,786km above the earth's surface at the equator. The velocity factor for light in most fibre optic cables is roughly 0.80. A ping from London to Sydney Australia (a distance of close to 17,000km) on average takes 300ms.

1. TCP is a great protocol for reliably moving large amounts of data around the world. Suggest a sensible value giving an approximate justification for the maximum latency between sending a datagram and expecting it to be acknowledged for terrestrial end-to-end connections. How does TCP react when this latency threshold is exceeded? [4 marks]
2. Briefly outline an approach to routing that will work for interplanetary communications as well as efficient on-planet communications routing between static and mobile sensors and other Internet of Things (IoT) devices. [4 marks]
3. The Earth at its closest is 4.3 billion km ( $4.3 \times 10^9$ km) from the planet Neptune and when they are at their furthest apart the distance is 4.7 billion km. A typical Earth to Neptune Internet route would take several hops to get to a terrestrial base station and be transmitted. At the Neptune end a similar assumption can be made.
  - i. Approximately how long (in hours will do) does a "ping" to Neptune take from Earth?

Outline the design of a protocol suitable for providing reliable Earth to Neptune or other deep space destinations communications. Describe:

- ii. How a reliable deep space connection is created.
- iii. Suggest a suitable message exchange and appropriate control and data fields for the frames used for this purpose. Use diagrams to aid in explaining the structure of each frame used to establish the connection.
- iv. Explain how devices manage to make reliable and lower reliability very large data exchanges again outlining the structure of the frames exchanged and explaining the purpose and usage of each field in each frame.

[12 marks]

**END OF EXAMINATION**