UNIVERSITY OF DUBLIN

TRINITY COLLEGE

FACULTY OF ENGINEERING, MATHEMATICS & SCIENCE

SCHOOL OF ENGINEERING

Electronic & Electrical Engineering

Senior Sophister
Engineering
Annual Examinations

Trinity Term, 2014

WIRELESS COMMUNICATIONS (4C4)

Date: 7th May 2014   **Venue: AB, RM 5025**   **Time: 14.00 – 16.00**

Prof. Luiz DaSilva
Prof. Linda Doyle

Answer ALL FOUR questions.

All questions carry equal marks.

Permitted Materials:

Graph paper
Calculator
Any book
Any personal notes (on paper)
Laptop (all network connectivity must be disabled)

Q.1

This question asks you to discuss specific points raised in some of the reading assignments for this course.

(a) The journal paper "Net neutrality: a progress report," by J. Krämer, L. Wiewiorra, and C. Weinhardt, mentions that Internet Service Providers (ISPs) sometimes perform deep packet inspection.
   (i) Explain what deep packet inspection is and what layers of the protocol stack it involves.
   (ii) Explain the motivation for ISPs to perform deep packet inspection, in the context of net neutrality.

[6 marks]

(b) The paper cited in part (a) also discusses content distribution networks (CDNs).
   (i) What are CDNs?
   (ii) How do CDNs affect the Quality of Experience of network subscribers, even when the ISP practices net neutrality?

[6 marks]

(c) The technical report "The mistaken axioms of wireless network research," by D. Kotz, C. Newport, and C. Elliott, asserts that signal strength in a wireless link between two nodes is generally asymmetric. Discuss how this can affect the performance of an IEEE 802.11 system.

[5 marks]

(d) Millimetre wave communication is likely to play a role in future wireless communication systems.
   (i) What is the main advantage of millimetre wave communications, as compared to wireless systems that are widely deployed today?
   (ii) What is the main challenge to be overcome in the employment of millimetre wave communications in commercial systems?

[4 marks]

(e) In the conference paper "Augmenting mobile 3G using WiFi," by A. Balasubramanian, R. Mahajan, and A. Venkataramani, the authors report consistently higher throughput when connected to a 3G network than when connected to a WiFi network. Is this a general result, or a consequence of the characteristics of the particular environment in which the tests were conducted? Explain.

[4 marks]

Q.2

The plot below was reported by Prof. Giuseppe Bianchi in his early work on the performance analysis of IEEE 802.11 networks [IEEE Communications Letters, vol. 2, no. 12, 1998]. The x-axis shows the number of stations in the network and the y-axis shows the maximum normalized throughput obtainable. The curves labelled "basic" correspond to cases where transmissions are not preceded by an exchange of RTS and CTS frames, while curves labelled "rts-cts" denote cases where an RTS/CTS exchange is employed. The variable W denotes the size of the contention window; for the purposes of this question, it is safe to ignore the effects of the variable m, which denotes the backoff stage.
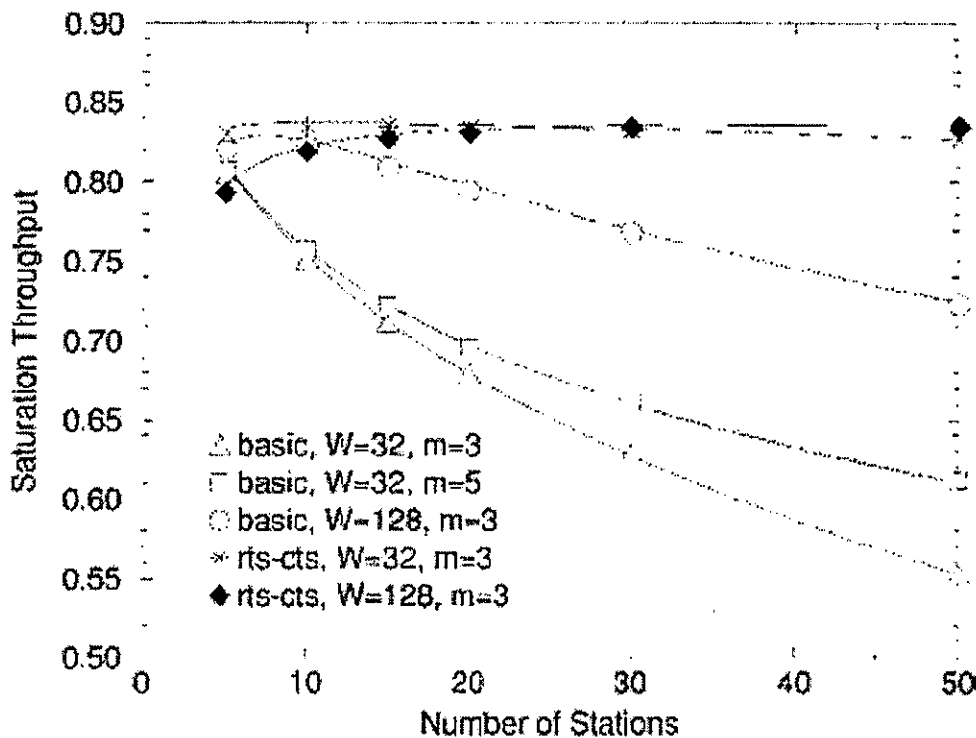
Saturation Throughput

△ basic, W=32, m=3
Γ basic, W=32, m=5
○ basic, W=128, m=3
✳ rts-cts, W=32, m=3
◆ rts-cts, W=128, m=3

Number of Stations

Fig. Q.2

(a) The curves labelled "rts-cts" seem to be monotonically increasing, while the curves labelled "basic" seem to decrease after some point. Provide an intuitive explanation for this.

[7 marks]

(b) The curves labelled "rts-cts, W=128, m=3" and "basic, W=128, m=3" cross. Provide an intuitive explanation for this.

[7 marks]

(c) Provide an intuitive explanation for the role of W on throughput.

[7 marks]

(d) In commercially available IEEE 802.11 systems, are all data frames preceded by an exchange of RTS and CTS? Explain.

[4 marks]

Q.3

(a) What factors are taken into account when selecting a propagation model?

[2 Marks]

(b) The paper, 'A Practical Path Loss Model For Indoor WiFi Positioning Enhancement' by Atreyi Bose and Chuan Heng Foh is on the reading list for the class. Summarise the key findings in the paper in bullet point form. Confine your answer to five major bullet points.

[5 Marks]

(c) Do you think the selection of the Hata-Okumara propagation model by the authors is appropriate? Explain your answer.

[4 Marks]

(d) If you were using the approach suggested in the paper to determine the location of a mobile phone device that was not WiFi enabled but instead used the receive signal strength of the mobile phone frequency, what if anything would you change about the approach? Explain your answer. If you feel nothing needs to change, explain why.

[4 Marks]

(e) Do you think the method suggested for position determination in the paper and their implementation of the method is a good? Explain your answer.

[10 Marks]

Q4.

(a) What are TV White Spaces and how will the use of the TVWS frequencies be implemented?

[5 Marks]

(b) Compare and contrast the FCC and Ofcom approach to the TVWS database from a technical and any other perspective you deem appropriate?

[12 Marks]

(c) Define the different types of spectrum sharing approaches that are advocated in the PCAST report. How is this different to what is considered for TVWS? How does the PCAST report compare to the License Shared Access /Authorized Shared Access approaches? Which of all of these more dynamic approaches to spectrum management do you believe will be most successful and why?

[8 Marks]