UNIVERSITY OF EDINBURGH

COLLEGE OF SCIENCE AND ENGINEERING

SCHOOL OF INFORMATICS

INFR11049 COMPUTER NETWORKING (LEVEL 11)

Thursday 12 th May 2016

14:30 to 16:30

INSTRUCTIONS TO CANDIDATES

Answer any TWO questions.

All questions carry equal weight.

CALCULATORS MAY BE USED IN THIS EXAMINATION

Year 4 Courses

Convener: I. Stark
External Examiners: A. Burns, A. Cohn, P. Healey, T. Field, T. Norman

THIS EXAMINATION WILL BE MARKED ANONYMOUSLY

1. (a) Distinguish between basic service set (BSS) and extended service set (ESS) in infrastructure 802.11 wireless LANs. [*2 marks*]

   (b) Explain the key features of the IEEE 802.11 Multiple Access Control (MAC) protocol. [*5 marks*]

   (c) Explain the type of fairness enabled by the TXOP feature introduced in the 802.11e standard and contrast it with the default form of fairness supported by the original 802.11 standard. [*3 marks*]

   (d) Suppose you are tasked with optimizing voice over IP (VoIP) performance over WiFi (802.11) for mobile smartphone users in an enterprise while being compliant to the 802.11 standard. What aspects/parameters of the protocol would you choose to optimize and why? Assume that you can update the 802.11 related software on access points as well as user devices. [*4 marks*]

   (e) Compared to the home scenario, AP channel configuration in enterprise wireless LANs is relatively a smaller concern given that channels are carefully assigned to APs either by system administrators or dynamically by a backend controller. However, enterprise wireless LANs typically comprise many APs to serve the client devices over a wider area, which leads to the AP selection problem for clients. Discuss the similarities and differences between the AP selection and AP channel assignment problems. [*4 marks*]

   (f) With the newer 802.11n/ac wireless LAN standards providing very high physical layer data rates, throughput seen above the MAC layer can be relatively quite low if suitable measures are not taken at the MAC layer. Why? What enhancements are proposed in 802.11n/ac to address this MAC efficiency issue? Identify and elaborate on a potential disadvantage of aggressively employing these enhancements to increase the MAC efficiency. [*7 marks*]

2. (a) Give three reasons why HTTP streaming is preferred over UDP streaming for video streaming applications? [*6 marks*]

   (b) With HTTP streaming, are the TCP receive buffer and the media player clients application buffer the same thing? If so, why? If not, how do they interact? [*2 marks*]

   (c) Consider the following notation to model client-side buffering for video streaming. Let B denote the size of the client's application buffer in bits. Let $Q(< B)$ denote the number of bits that must be buffered before the client application begins playout. Let r denote the video consumption rate during playback. Finally, assume that the client receives data into the application buffer from the network at a rate x (referred to as the *fill rate*) when the client buffer is not full.

      i. When $x < r$, determine the length of each continuous playout and freezing period as a function of Q, r and x. [*6 marks*]

      ii. If $x > r$, then at what time, say t_f, does the client application buffer become full? [*3 marks*]

   (d) With the increasing popularity of video content, Internet Service Providers (ISPs) face the challenge of managing traffic spikes during peak hours.

      i. If you were an ISP, what policy would you apply to shape the traffic of high bandwidth consuming users at peak hours? How you would implement it? [*4 marks*]

      ii. Suppose that some of those users are willing to pay an extra premium to avoid such traffic shaping. How would you support your premium users? [*1 mark*]

   (e) At the time of initiating a call with the Session Initiation Protocol (SIP), a caller may not know the current network (IP) address of the callee. How does the SIP infrastructure aid the caller in getting the callee's IP address? [*3 marks*]

3. (a) Explain the cellular concept in telecommunication systems. [*2 marks*]

(b) What are the key changes in the radio access network (RAN) and core parts of cellular networks between second generation (2G GSM), third generation (3G UMTS) and fourth generation (4G LTE) systems? [*4 marks*]

(c) Distinguish between frequency division duplex (FDD) and time division duplex (TDD) modes in the context of mobile cellular networks. [*3 marks*]

(d) How does the operating frequency influence the design and performance of a wireless communication system? [*2 marks*]

(e) i. Express received power at a wireless device (in dB form) as a function of transmit power, channel path loss and antenna gains. [*2 marks*]

ii. Using a transmit power of 17 dBm, 3 dBi for transmit and receive antenna gains and assuming that the channel between transmitter and receiver experiences only distance-dependent deterministic free space based path loss, compute the received powers for the following different transmit-receiver separation distances: 1Km, 2Km and 3Km. Assume that transmissions happen over the channel with a carrier frequency of 2437MHz. Also assume that there are no feeder/cable losses. [*6 marks*]

iii. If the thresholds for minimum received power (receive sensitivity values) to support different physical layer data rates are as per the following table, for each of the distances in part (ii) indicate the rates that are supported.

Receive Sensitivity	Rate
-86 dBm	18 Mbps
-80 dBm	36 Mbps
-71 dBm	54 Mbps

[*3 marks*]

(f) Why does TCP performance degrade in the presence of wireless channel related losses? Suggest a way to overcome this problem. [*3 marks*]