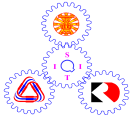# Sirindhorn International Institute of Technology
Thammasat University

Midterm Examination: Semester 2/2008

Course Title   : ITS413 Internet Technologies and Applications

Instructor   : Dr Steven Gordon

Date/Time   : Wednesday 7 January 2009, 13:30-16:30

Instructions:

- This examination paper has 17 pages (including this page).

- Conditions of Examination
    Closed book
    No dictionary
    Non-programmable calculator is allowed

- Students are not allowed to be out of the exam room during examination. Going to the restroom may result in score deduction.

- Turn off all communication devices (mobile phone etc.) and leave them under your seat.

- Write your name, student ID, section, and seat number clearly on the answer sheet.

- The space on the back of each page can be used if necessary.

Multiple Choice Questions [15 marks]

Select the most appropriate answer. Clearly circle (or indicate) your final answer. You must select only one answer. Each question is worth 1.5 marks.

1. Which of the following statements is *false*?

   a) A wireless host is the same as a mobile host.

   b) A point-to-multipoint wireless technology may use omni-directional antennas.

   c) Wireless technologies generally offer lower data rates than similar cost wired technologies.

   d) Transmission range of wireless technologies depends on the transmit power at the source.

   e) The transmission range of wireless devices differs depending on the environment.

   f) Wireless devices can be used in a point-to-point topology.

2. Which network technology is most suited for point-to-point fixed wireless communications?

   a) IEEE 802.15.4 (ZigBee)

   b) IEEE 802.16 (WiMax)

   c) Bluetooth

   d) SDH

   e) GPRS

   f) Long Term Evolution (LTE)

3. Which mobile telephony based wireless technology provides the highest download data rate?

   a) GPRS

   b) EDGE

   c) HSDPA

   d) GSM

   e) WLAN

   f) PSTN

4. Which protocol/system does not use packet switching?

   a) X.25

   b) IP

   c) ATM

   d) PSTN

   e) Frame Relay

5. An 34Mb/s E3 line is an example of which technology?
   a) PDH
   b) IP
   c) ATM
   d) ZigBee
   e) OC (Optical Carrier)
   f) DSL
   g) PAN

6. The typical transmission power of wireless LAN clients ranges from:
   a) 0.01mW to 0.1mW
   b) 0.1mW to 1mW
   c) 1mW to 100mW
   d) 1mW to 1000mW
   e) 1W to 10W
   f) 1W to 100W

7. Which of the following is *false* about most typical IEEE 802.11g wireless LANs deployments?
   a) Half-duplex communications
   b) Point-to-multipoint topology
   c) Licensed spectrum
   d) Multiple channels are available
   e) Transmission range may vary in different locations
   f) Collisions may occur

8. A mobile ad hoc network (MANET) has the following characteristics that differentiate it from an infrastructure-based wireless network:
   a) Multiple wireless hops; fixed access points; and no security
   b) No security; multiple wireless hops; and pre-existing servers
   c) Fixed access points; dynamic routes; and multiple wireless hops
   d) Multiple wireless hops; dynamic routes and node mobility
   e) Node mobility; fixed access points and dynamic routes
   f) Fixed routes; multiple wireless hops and no security.

9. Which of the following is *false* about Digital Subscriber Line technologies?

   a) There are DSL technologies that offer asymmetrical as well as symmetrical data rates.

   b) DSL often makes use of the existing copper telephone network

   c) DSL can provide data rates greater than 20Mb/s

   d) ADSL is most often considered an access network technology.

   e) The data rate achievable with DSL reduces as the distance of the line increases.

   f) DSL uses the same frequencies for data transmission as telephone calls (POTS)

10. What change would you make for a WLAN station if you wanted to reduce the impact of hidden terminals:

    a) Decrease the RTS Threshold

    b) Increase the RTS Threshold

    c) Decrease the data rate

    d) Increase the data rate

    e) Decrease CWmin

    f) Increase CWmin

Short Questions [20 marks]

For each question fill in the blank space with an appropriate word, acronym, name or phrase. For each blank space you must give only one answer. However, there may be more than one correct answer. Each question is worth 2 marks.

1. A directional antenna is used in a _____ wireless network topology, while an omni-directional antenna is used in a _____ wireless network topology.

2. In wired core networks, _____ was developed to overcome the limitations, and increase the data rate of _____.

3. Regarding the physical connections between Autonomous System peers, _____ peering involves connecting via a point-to-point connection, whereas _____ peering involves connecting via a shared network or Internet Exchange Point.

4. A _____ forwards IP datagrams, whereas a _____ does not forward IP datagrams.

5. Autonomous Systems use the _____ Protocol to exchange information with each other about their networks and routes.

6. In IEEE 802.11 DCF Basic Access, if station A is counting down its backoff interval and another station (within transmission range) starts to transmit DATA frame, then station A will _____ until the medium becomes _____.

7. _____ is a protocol for supporting host mobility, whereas _____ is a protocol for supporting network mobility.

8. Regarding agreements between Autonomous System peers, with a _____ agreement two peers exchange traffic freely, whereas with a _____ agreement one peer pays the other peer for carrying their traffic.

9. A problem with mobility in the Internet (before Mobile IP was available) is that if an IP address is changed then some _____ will not work, but if an IP address is not changed then _____ will not work.

10. Two key factors of interest to IT professionals when considering wireless technologies include: _____ and _____.

General Questions [65 marks]

Question 1 [13 marks]

a) Explain an advantage of using IEEE 802.11g (compared to IEEE 802.11a). [2 marks]

b) Explain a disadvantage of using IEEE 802.11g (compared to IEEE 802.11a). [2 marks]

c) Although most wireless LAN standards allow at least 11 channels, the number of non-overlapping channels is much less (e.g. 3 non-overlapping). Use an example of multiple APs and many clients to explain the importance of non-overlapping channels with respect to maximising throughput delivered to individual users. [3 marks]

d) Explain what is meant by a *collision* in a wireless network. Give the conditions when a collision may occur. [2 marks]

e) Explain why collisions should be avoided (that is, why are they bad for performance). [2 marks]

f) For IEEE 802.11 MAC protocol, describe one case (set of conditions) where a collision may still occur. [2 marks]

Question 2 [11 marks]

When a WLAN client loses connectivity with its current AP (e.g. moves out of range), it will attempt to discover new APs and then join one of the selected APs. The time from when connectivity is lost with the old AP until the time when the client has successful joined with a new AP, is called the *handover time*.

Consider the scenario with the client (C) moving from AP1 towards AP2 in Figure 1. The large circles show the transmission ranges of the APs. Assume at the current position, the client has just lost connectivity with AP1.
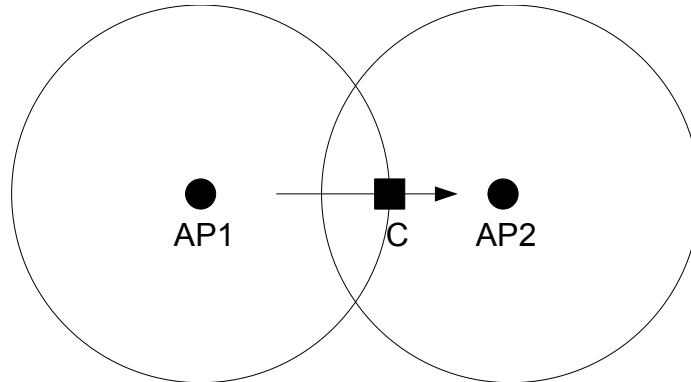

Figure 1: WLAN Handover

a) Draw a diagram that shows the exchange of frames for the client to *actively* discover AP2 *and* join AP2's network. Label each frame with its name. [3 marks]

Assume the transmission (and propagation) of a single frame in part (a) takes 100µs. All frames take the same time. Processing and queuing delay is 0.

b) Calculate the handover time for part (a). [2 marks]

c) If only *passive* discovery of APs is used, and beacons are sent at a rate of 10 per second, calculate the:

  i. Minimum handover time [2 marks]

  ii. Maximum handover time [2 marks]

d) Explain a way to reduce the handover time for WLANs when only passive discovery is used. [2 marks]

Question 3 [12 marks]

a) Consider three WLAN stations, all within transmission range of each other. IEEE 802.11 DCF is used. Draw a diagram that illustrates the DCF operation under the following conditions:

   ○ All times are given in microseconds (μs).

   ○ Station A has data with payload 500 Bytes ready to transmit to station B at time 0

   ○ Station C has data with payload 1000 Bytes ready to transmit to station B at time 100

   ○ When choosing random numbers, the stations choose the following values in order:

      ▪ Station A: 14, 6, 7, ...

      ▪ Station B: 5, 10 ,3, ...

      ▪ Station C: 3, 12, 1, ...

   ○ The WLAN parameters as in Table 1 are used.

Parameter	Value
Data Rate	20 Mb/s
DATA Header	50 Bytes
ACK transmission	10 μs
RTS transmission	10 μs
CTS transmission	10 μs
RTS Threshold	1500 Bytes
Fragmentation Threshold	1500 Bytes
DIFS	35 μs
SIFS	10 μs
Slot Time	10 μs
CWmin	15
CWmax	1023

Table 1: WLAN Parameters

You must clearly label all events/frames in the operation. Start at time 0, and finish when the last DATA frame is acknowledged. Use the following page for the diagram. Your diagram does not have to be to scale, however showing the timing of events will help with answering subsequent parts of this question. [4 marks]

C

B

A

b) At what time does station A know its data has been successfully transferred? [1.5 mark]

c) At what time does station C know its data has been successfully transferred? [1.5 mark]

d) What is the throughput experienced by station A? [1 mark]

e) What is the throughput experienced by station C? [1 mark]

f) What change in parameter value or condition would lead to a retransmission by one of the stations? Give a detailed explanation of the change and the reason a retransmission would occur. [3 marks]

Question 4 [18 marks]

Figure 2 shows an IP network with a set of routers (R) and hosts (H). The lines show the IP connectivity between the devices. The lower case letters (a, b and c) are labels for the router interfaces. For example, router R5 has three network interfaces: a, b and c (or R5a, R5b and R5c). Each host only has a single network interface. Hosts H1 and H2 are in the same IP subnet as R1a (called subnet W). Router interfaces R1b and R5a are in the same IP subnet as each other (but different from subnet W). Assume any layer 2 network technology (wired or wireless) may be used to provide the IP connectivity between interfaces. The figure does not indicate physical proximity of devices: that is, although hosts H2 and H3 are near each other in the figure, they may not be near each other in the real network.
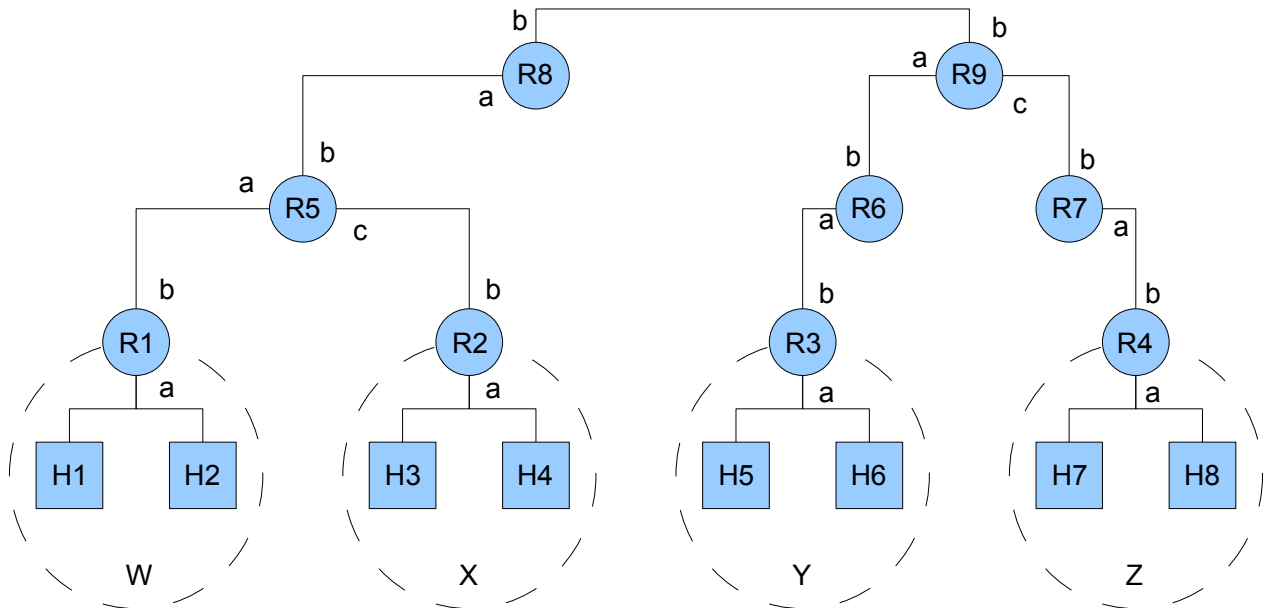

Figure 2: IP Network

Consider the case when any of the hosts may be mobile and Mobile IP is used. Assume hosts may only attach to router R1, R2, R3 and R4 (that is, the other routers do not support hosts visiting their IP subnet). In your answers you may refer to a device or interface by its name (e.g. H1; R5 or R5a). Instead of giving a real IP address, indicate the interface (e.g. H1; R5a).

a) List the Home Agent(s) with respect to H1. [1 mark]

b) List the Foreign Agent(s) with respect to H1. [1 mark]

Host H1 is corresponding with host H8 (that is, H8 is the correspondent node). Assume that during the communication host H1 moves such that it leaves subnet W and enters subnet Y. Mobile IP is used to maintain the connection during movement.

    c) Explain two ways in which H1 can detect it has entered a new subnet. [4 marks]

After detecting a new subnet, H1 must perform a Mobile IP registration.

    d) Draw a diagram that illustrates the Mobile IP registration procedure. You should show the types of messages sent and the devices involved. [2 marks]

    e) Assuming the FA assigns its own IP address as the COA of visiting mobile nodes, show the four entries in the Mobility Binding Table and Visitors List after the registration is complete. [2 marks]

Mobile Host	COA

Table 2: Mobility Binding Table

Home IP	HA	MAC Address
		(not needed in answer)

Table 3: Visitors List

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f) Now the registration is complete, indicate the path that packets take for IP packets being sent (indicate the path by listing the complete set of routers, in order, the packets pass via):

   i. From H8 to H1 [2 marks]

   ii. From H1 to H8 [2 marks]

g) Draw the packet received by router R6 for the following cases (the packet must clearly indicate all source/destination IP addresses carried in the packet header):

   i. From H8 to H1 [2 marks]

   ii. From H1 to H8 [2 marks]

Question 5 [11 marks]

Consider a network consisting of two IEEE 802.11a wireless LAN clients in a BSS, and that BSS is connected to router R1 via a switched 100Mb/s Fast Ethernet LAN. The router R1 has three interfaces in total, one of which is PDH (which connects to router R2) and another is Gigabit Ethernet (there are two servers attached, via a switch, to this interface). The router R2 has two interfaces, the 2nd interface uses ATM to connect to router R3. The router R3 has an in-built Bluetooth access point. There is a single mobile phone connected to that Bluetooth access point.

   a) Draw the network topology, naming all network devices and naming all links. [3 marks]

   b) How many IP subnets are in the network? [1 mark]

c) Draw the protocol stack of the following devices, clearly labelling the protocols/technologies used at each layer (assume hosts run a 5 layer Internet stack; if the question does not indicate a specific protocol, then give the layer name or example protocol):

    i.   One of the wireless LAN clients [2 marks]

    ii. The wireless LAN AP [2 marks]

    iii. Router R1 [3 marks]