Name . . . . ID . . . . Section . . . . . . Seat No . . . . . .

Sirindhorn International Institute of Technology
Thammasat University

Midterm Exam Answers: Semester 2, 2012

Course Title: ITS413 Internet Technologies and Applications

Instructor: Steven Gordon

Date/Time: Thursday 20 December 2012; 13:30–16:30

Instructions:

- This examination paper has 12 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.

- Students are not allowed to have communication devices (e.g. mobile phone) in their possession.

- Write your name, student ID, section, and seat number clearly on the front page of the exam, and on any separate sheets (if they exist).

Question 1 [12 marks]

Consider a network with the following components:

- Two IEEE 802.11g wireless LAN basic service sets; each BSS containing two clients. Refer to the clients as `Laptop1`, `Laptop2`, `Laptop3` and `Laptop4`.

- The BSS's are connected via a 100Mb/s Fast Ethernet switched LAN. The Fast Ethernet switch (`Switch1`) is also connected to a 1Gb/s Ethernet switch (`Switch3`).

- Three PC's (`PC1`, `PC2`, `PC3`) attached to a 100Mb/s Fast Ethernet switch (`Switch2`). The switch is also connected to the 1Gb/s Ethernet switch `Switch3`.

- `Switch3` is connected to a router (`R1`) which has two additional interfaces: an 8Mb/s PDH E2 link to an ISP's router (`R2`); and a 34Mb/s WiMax link to a router at another campus (`R3`).

- Both routers `R2` and `R3` are part of separate core networks that connect to the Internet.

(a) Draw the network topology, naming all network devices (using the names mentioned above and/or other meaningful names, such as `AP1`) and naming all links (based on the link technology, e.g. `WiMax`). [4 marks]

In answering the following questions about addresses, use the following notation for your answers:

- MAC (or hardware) address of device: *MAC(devicename)* e.g. `MAC(Laptop1)`

- IP address of device: *IP(devicename)* e.g. `IP(Laptop1)`

(b) If `Laptop1` is downloading a file from `PC1` using TCP, what addresses are inside the header of a IEEE 802.11 data frame received by `Laptop1`? [2 marks]

   Answer. *MAC(Laptop1), MAC(PC1), MAC(AP1)*

(c) If `Laptop2` in one BSS is sending data to `Laptop3` in the other BSS, what addresses are inside the header of the IEEE 802.11 data frame sent by `Laptop2`? [2 marks]

   Answer. *MAC(Laptop2), MAC(Laptop3), MAC(AP1)*

Draw the protocol stack of the following devices from the above network, 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):

(d) A wireless LAN AP [2 marks]
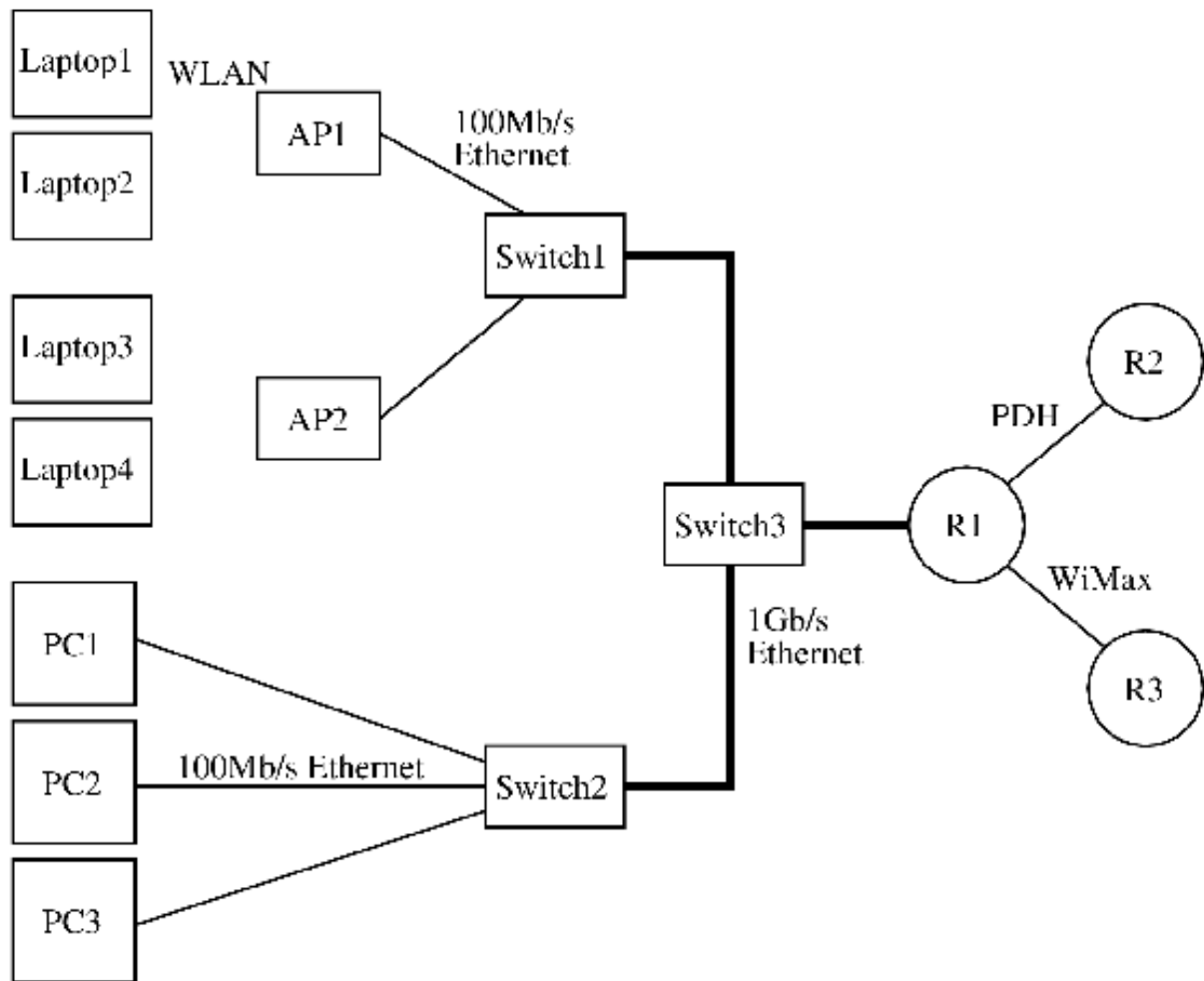
IEEE 802.2 Bridging	
IEEE 802.11 MAC	IEEE 802.3 MAC
IEEE 802.11 PHY	IEEE 802.3 PHY

(e) Router `R1` [2 marks]

IP		
IEEE 802.3 MAC	IEEE 802.16 MAC	PPP
IEEE 802.3 PHY	IEEE 802.16 PHY	PDH

Question 2   [9 marks]

(a) List the following in ascending order of size (from smallest to biggest): MAN, BAN, WAN, LAN. [1 mark]

    Answer. *BAN, LAN, MAN, WAN*

(b) List two advantages of wireless networks compared to wired networks. [1 mark]

    Answer. *Mobility, convenience.*

(c) List two disadvantages of wireless networks compared to wired networks. [1 mark]

    Answer. *Lower data rates, interference, high error rates.*

(d) Explain the difference between an access network and a core network. [1 mark]

    Answer. *Access networks are used by end-users; Core networks normally carry only the traffic of other access/core networks (end-users do not use core networks directly).*

(e) Explain an advantage of using ADSL for home internet access compared to coaxial cable. [1 mark]

    Answer. *ADSL provides a dedicated line; uses existing copper telephone line.*

(f) Which technology typically provides the lowest data rate: WiFi, WiMax, HSPA, Bluetooth, ZigBee? [1 mark]

    Answer. *ZigBee*

(g) Which technology typically provides the highest download data rate: GPRS, LTE, HSPA, EDGE, CSD? [1 mark]

    Answer. *LTE*

(h) Explain two reasons why, when selecting a wireless technology, considering the frequency/bandwidth the technology uses is important. [2 marks]

    Answer. *Some frequencies require a license and hence a high cost involved. Interference between users using the same frequency may lead to poor performance. Frequency impacts on transmission range.*

Question 3 [8 marks]

(a) Draw a diagram that shows the exchange of frames for the client to actively discover a wireless LAN access point and join that AP's network. Label each frame with its name. [3 marks]

    Answer. *Probe Request from Client to AP2*

    Probe Response from AP2 to Client

    Authentication Request from Client to AP2

    Authentication Response from AP2 to Client

    Association Request from Client to AP2

    Association Response from AP2 to Client

(b) Explain how passive discovery works in wireless LANs, including the frame types used. [1 mark]

    Answer. *APs periodically broadcast Beacon frames. If a client receives a Beacon, it has discovered an AP.*

(c) What is the name (or acronym) for the network identifier that is common across all wireless LAN APs in the same network? [1 mark]

    Answer. *Extended Service Set ID*

(d) What is the most common frequency used by wireless LANs? [1 mark]

    Answer. *2.4 GHz*

(e) What is the name of the firmware running on the wireless routers for your assignment? [1 mark]

    Answer. *OpenWRT*

(f) What is the maximum wireless LAN data rate supported by the wireless routers for your assignment? [1 mark]

    Answer. *54 Mb/s*

Question 4   [12 marks]

(a) Explain the difference between a transit agreement and a peering agreement between ISPs. [2 marks]

     Answer. *A transit agreement involves one ISP paying another ISP for their traffic to traverse their network. A peering agreement involves two ISPs agreeing to allow their traffic to traverse each others network for free.*

(b) With respect to the transit and peering agreements made between ISPs, explain the difference between a Tier 1 ISP and a Tier 2 ISP. [2 marks]

     Answer. *A Tier 1 ISPs does not have to pay for transit of other networks—it has connectivity across the worlds via peering agreements with other Tier 1 ISPs. A Tier 2 ISP must pay for some transit via Tier 1 ISPs.*

(c) Explain the difference between public peering and private peering. [2 marks]

     Answer. *Public peering involves physical connections between multiple ISPs in a public Internet exchange. Private peering involves a physical connection direct between two ISPs.*

(d) Explain the difference between an interior and exterior gateway (or routing) protocol. [2 marks]

   **Answer.** *An IGP is used for routing within an AS, while a EGP is used for routing between AS's.*

(e) Which of the following organisations/networks are most likely to have an AS Number? Thammasat University's network, SIIT School of ICT's network, Steve's home network, TOT's network, Google's network (List the organisations; there may be multiple) [1 mark]

     Answer. *Thammasat University's network; TOT's network; Google's network.*

(f) Draw a diagram of an internet that shows the following:

- 3 autonomous systems connected via 2 routers; each of these routers have two interfaces
- Each AS has 2 subnets
- Routers should be drawn as circles
- Networks should be drawn as clouds (or ellipses)
- Label each AS and subnet with a name, e.g. "AS1", "SN2"

There may be multiple ways to draw the network. [3 marks]
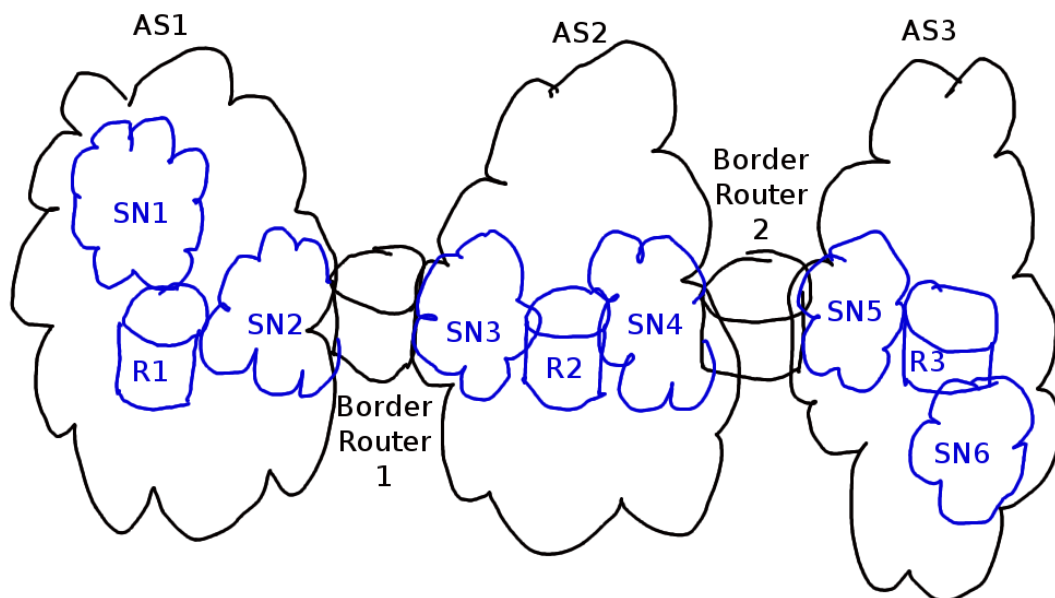
Question 5 [19 marks]

Some of the following questions require you to draw a timing diagram to illustrate the steps of the IEEE 802.11 DCF protocol. You must label the frames and different time periods with appropriate names (e.g. SIFS, Backoff, Defer, ACK). The exact times and scale are not important, just the ordering of the steps. Unless otherwise stated, assume all stations are within transmission range of each other.

(a) Draw a timing diagram that illustrates the normal procedure (no errors, no deference, no collisions) for the IEEE 802.11 DCF Basic access protocol when station A has data to send to station B. No other stations are present. [3 marks]

   Answer. *DIFS—Backoff—DATA—SIFS—ACK*

(b) Draw a diagram as in part (a), but when RTS/CTS is used instead of Basic Access. [3 marks]

   Answer. *DIFS—Backoff—RTS—SIFS—CTS—SIFS—DATA—SIFS—ACK*

(c) Assume there are 4 stations, A, B, C and D. Station D has just completed a data transfer to C. That is, C has just responded to D with an ACK frame. Both A and B had data to send to C during the data transfer from D to C, but both A and B deferred until the ACK from C to D was completed. Assuming A chooses a smaller random integer than B, draw a timing diagram showing the data transfer from A and B to C, starting from immediately after the initial ACK from C to D. That is, you don't need to draw the data transfer from D to C, only from A to C and B to C. Basic access is used. [3 marks]
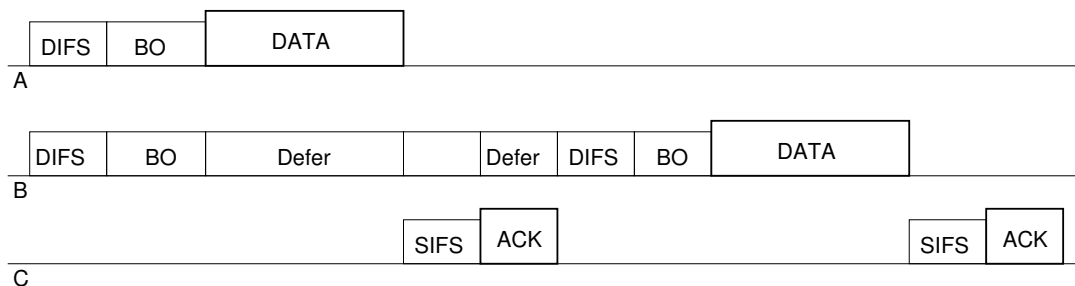
(d) What would happen if in part (c), both A and B chose the same random integer? [1 mark]

   Answer. *A collision would occur as both A and B finished backoff at the same time, and transmit at the same time.*

(e) DCF uses a Contention Window, *CW*. Its initial value is set to *CWmin*, which is defined for each IEEE 802.11 physical layer. The value of *CW* changes when a station must retransmit frames. Explain how *CW* changes for each retransmission. [1 mark]

Answer. *CW effectively doubles for each retransmission*

(f) Explain an advantage of this change of CW for a retransmission. [1 mark]

Answer. *Double CW means the chance that two stations choose the same CW leading to a collision is much lower.*

(g) Explain a disadvantage of this change of CW for a retransmission. [1 mark]

Answer. *A larger CW means the longer a station must wait for Backoff, reducing efficiency when there are no collision.*

(h) Explain the hidden terminal problem, e.g. what causes it and what happens in DCF. [2 marks]

Answer. *When two or more transmitting stations are within range of a receiver, both those transmitting stations are out of range of each other, then when they sense the medium they will not sense each other transmitting. Hence they may both send at the same time, causing a collision at the receiver.*

(i) RTS/CTS can be used to reduce the impact of the hidden terminal problem. What information is contained in the RTS (and CTS) frame that is used to reduce the impact of the hidden terminal problem? [1 mark]

Answer. *Duration of the upcoming transmission*

(j) If a station, which is not the destination of a CTS, receives a CTS frame, what does that station do? [1 mark]

Answer. *Defers for the specified duration.*

(k) Explain how a station chooses whether to use Basic Access or RTS/CTS. [2 marks]

Answer. *If the DATA frame size is less than the RTS Threshold, then Basic Access is used, otherwise RTS/CTS is used.*