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

Sirindhorn International Institute of Technology
Thammasat University

Midterm Exam: Semester 2, 2010

Course Title: ITS413 Internet Technologies and Applications

Instructor: Steven Gordon

Date/Time: Wednesday 29 December 2010; 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.
- 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).
- The space on the back of each page can be used if necessary.

Question 1 [18 marks]

For each question fill in the blank space with an appropriate word, acronym, name or phrase. To assist you some acronyms and technologies covered during the lectures are listed below. For each blank space you must give only one answer. However, there may be more than one correct answer. Each answer is worth 1.5 marks.

Acronyms and technologies: 3G, 802.3, 802.11, 802.15, 802.16, AS, ADSL, ATM, BGP, Bluetooth, CDMA, DCF, DSL, EDGE, FTTH, GPRS, GSM, HSPA, IANA, IEEE, IGP, IP, ISDN, ISP, IXP, LAN, LTE, MAN, MANET, Mobile IP, NEMO, PDH, POTS, PSTN, RTS/CTS, SDH, TCP, UMTS, WAN, WLAN, WiMax, X.25, ZigBee

(a) _____ is an advancement of 3G/UMTS mobile technologies that offers higher speeds, but requires significant hardware upgrades to the network base stations.

(b) Both _____ and _____ can be used for point-to-point wireless links over several kilometres.

(c) _____ is a standards organisation that has developed protocols such as IP, Mobile IP and NEMO.

(d) _____ uses optical fibre to connect cities and countries at data rates greater than 1Gb/s.

(e) An _____ is a facility where multiple ISPs connect via for peering with each other.

(f) _____ technologies can provide Internet access over copper telephone lines at identical upload/download speeds.

(g) _____ and _____ are considered 2G or 2.5G mobile technologies for data access.

(h) _____ is designed to offer low data rate wireless networking while consuming very little power.

(i) _____ is an example of a virtual circuit packet switching technology.

(j) One motivation for the design of _____ is that an application may perform poorly if an IP address on a host running that application changes during the application use.

Question 2 [6 marks]

NEMO supports network mobility as opposed to host mobility supported by Mobile IP. However, Mobile IP could be used to provide the same service as NEMO.

(a) Explain how Mobile IP could be used to support network mobility. [2 marks]

(b) Explain two advantages of using NEMO (as opposed to Mobile IP) for network mobility. [4 marks]

Question 3 [6 marks]

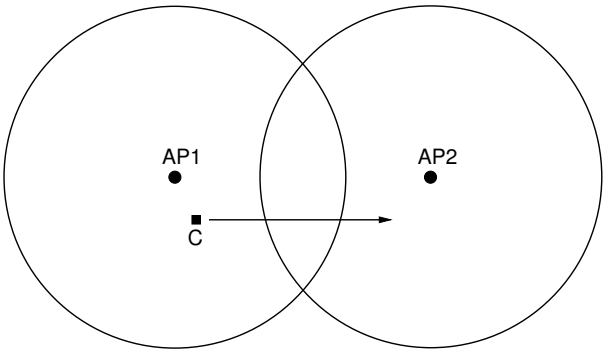
Two key characteristics of Mobile Ad Hoc Networks are infrastructure-less and dynamic topology. Explain what each means, and for each characteristic describe an advantage and disadvantage. (For example, the advantage should indicate why this characteristic is beneficial in MANETs, and the disadvantage should indicate how this characteristic makes tasks difficult in MANETs).

(a) Infrastructure-less [3 marks]

(b) Dynamic topology [3 marks]

Question 4 [20 marks]

Consider two wireless LAN access points, $AP1$ and $AP2$, that have overlapping coverage, and a client C moving between the coverage areas as shown in the figure below.



(a) If the client is initially powered off and within the coverage area of $AP1$ (but not $AP2$), explain two methods that the client, when powered on, can use to discover $AP1$. Refer to the specific types of frames. [3 marks]

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Now assume the client is associated with $AP1$. Assume the client can only receive on one frequency at a time (and cannot change frequencies while associated with an AP).

(b) Assuming the APs use different frequencies, explain how the client may decide to initiate a handover to a new AP (e.g. $AP2$). [1.5 marks]

(c) Assuming the APs use the same frequency, explain a better method than above for the client to decide to initiate a handover to $AP2$. [1.5 marks]

(d) Explain why the 2nd approach (part(c)) is better than the 1st (part (b)). [2 marks]

Now consider that the client has decided to handover to $AP2$.

(e) Draw a diagram that shows the exchange of frames for the client to join AP2's network. Label each frame with its name. [2 marks]

Assume now that the client has associated with $AP2$. This AP is on a different IP subnet than the previous AP. Assume the client implements Mobile IP, and HAs/FAs exist in the relevant networks.

(f) Explain two methods that the client can use to discover a FA on the new IP subnet. Refer to the specific types of packets. [3 marks]

Now consider the client has discovered the FA.

(g) Draw a diagram showing the exchange of packets for the Mobile IP registration procedure. Indicate the types of packets, the ordering of packets (e.g. which one is sent 1st) and the nodes involved. [3 marks]

(h) Which node in the network stores the Visitors List? [1 mark]

(i) After the registration procedure is complete, what values are stored in the Visitors List? [1 mark]

(j) Which node in the network stores the Mobility Binding Table? [1 mark]

(k) After the registration procedure is complete, what values are stored in the Mobility Binding Table? [1 mark]

Question 5 [11 marks]

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

(b) The hidden terminal problem is one reason that collisions may occur in IEEE 802.11 wireless LANs. Explain what the hidden terminal problem is. [2 marks]

(c) What IEEE 802.11 technique can be used to reduce the impact of the hidden terminal problem? [1 mark]

(d) For a IEEE 802.11 wireless LAN that does not contain hidden terminals, describe the set of conditions that may still result in a collision. [2 marks]

The DCF Contention Window (CW) is approximately doubled for each retransmission in IEEE802.11 DCF.

(e) What is an advantage of using a larger CW for retransmitted frames? Explain why it is an advantage. [2 marks]

(f) What is a disadvantage of using a larger CW for retransmitted frames? Explain why it is a disadvantage. [2 marks]

Question 6 [8 marks]

(a) Consider the following four IP networks: Steve's home network (consisting of several PCs, laptops and routers); TOT's network; SIIT's network (including Bangkadi and Rangsit); Google's network. Select zero, one or multiple networks which are most likely considered *Autonomous Systems*. [1 mark]

(b) Explain the difference between transit and peering agreements between ISPs. [3 marks]

(c) Explain the difference between an Interior Gateway Protocol and Exterior Gateway Protocol. [3 marks]

(d) Give the name (or acronym) of an Exterior Gateway Protocol. [1 mark]

Question 7 [18 marks]

Consider a wireless LAN with one AP and two clients (A and B) under the following conditions:

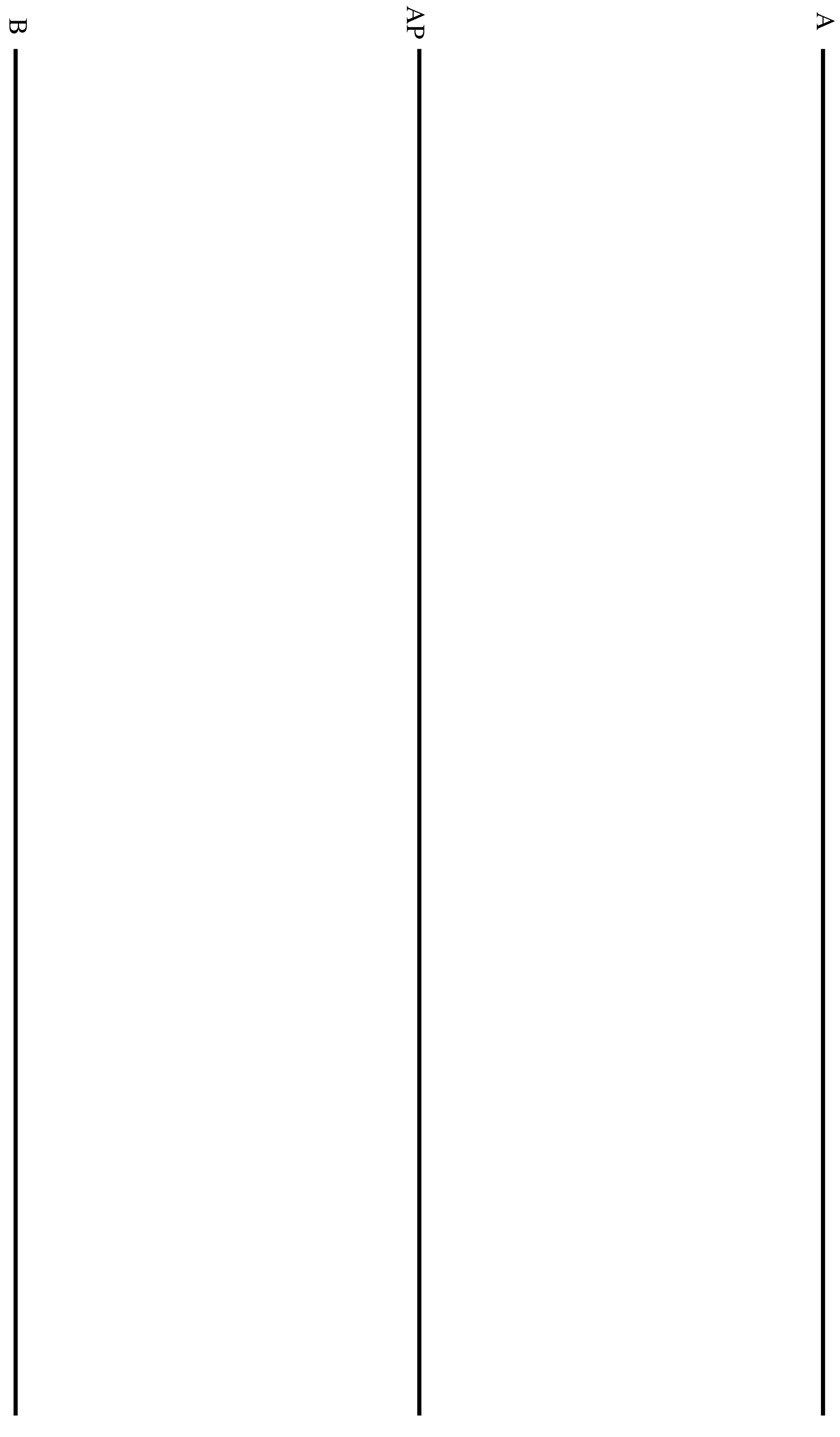
- Both clients are within range of the AP, however the clients are outside of range of each other (e.g. A cannot hear B).
- Fragmentation is not used.
- When choosing random numbers, the stations choose the following values in order:
  - Client A: 6, 19, 7
  - Client B: 20, 5, 23
  - AP: 1, 12, 3
- Stations have data with payload 875 Bytes ready to transmit at the following times:
  - Client A: time 0μs to AP
  - AP: time 10μs to B
  - Client B: time 150μs to AP

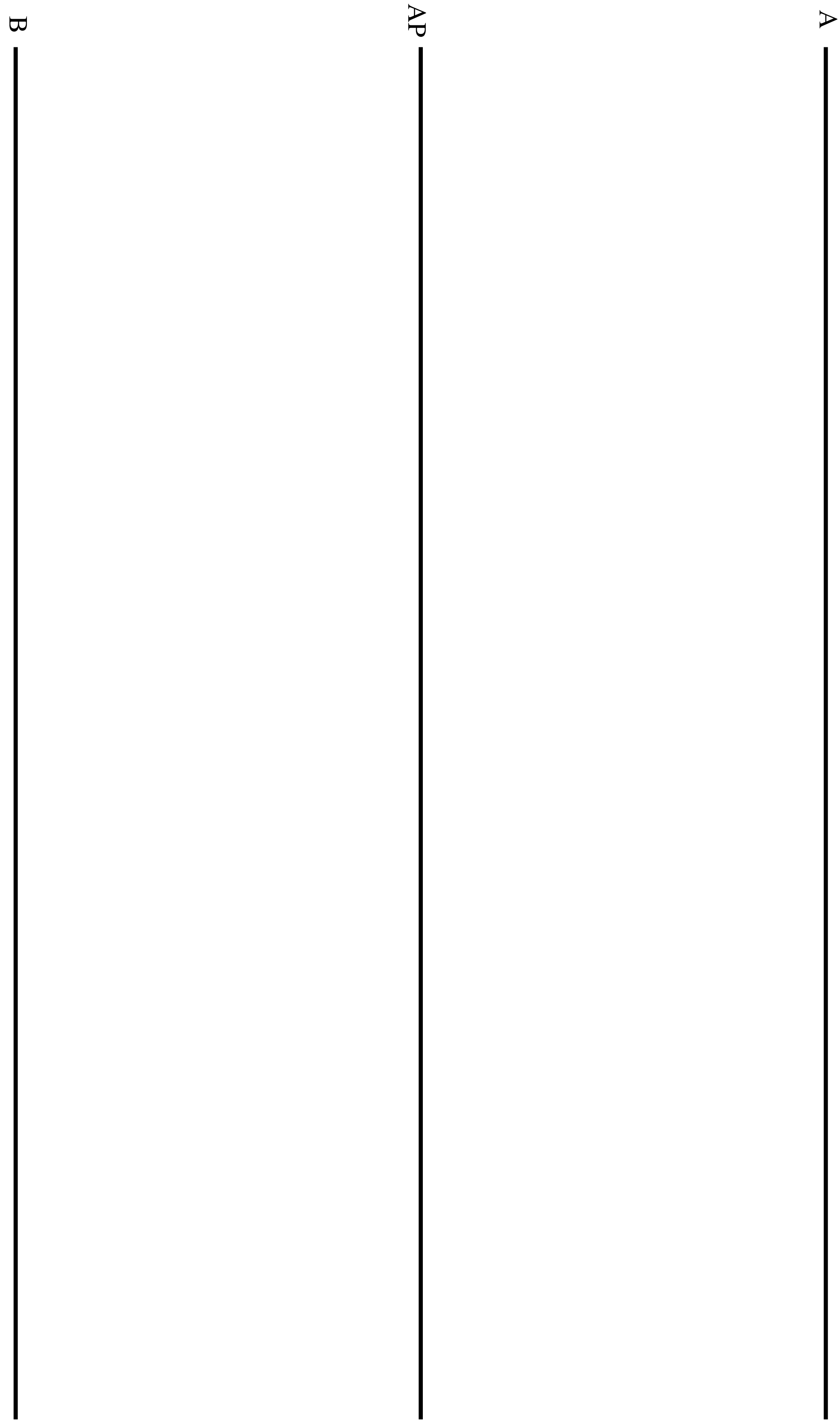
Parameter	Value
Data Rate	48 Mb/s
DATA Header	25 Bytes
ACK transmission time	20 μs
RTS transmission time	20 μs
CTS transmission time	20 μs
DIFS	30 μs
SIFS	10 μs
Slot Time	10 μs
CWmin	31
CWmax	1023
ACKTimeout	30 μs

On the following pages, draw a diagram that illustrates the DCF operation. You must clearly label all events/frames in the operation. Start at time 0, and finish when the last DATA frame is acknowledged. Your diagrams do not have to be to scale, however showing the timing of events will help with answering subsequent parts of this question.

(a) Basic access is used [6 marks]

(b) RTS/CTS is used [6 marks]


A
AP
B


B
AP
A

(c) For the following cases, at what time does each station know the data has been successfully delivered to the destination? [6 marks]

i. Basic Access, Client A:

ii. Basic Access, Client B:

iii. Basic Access, AP:

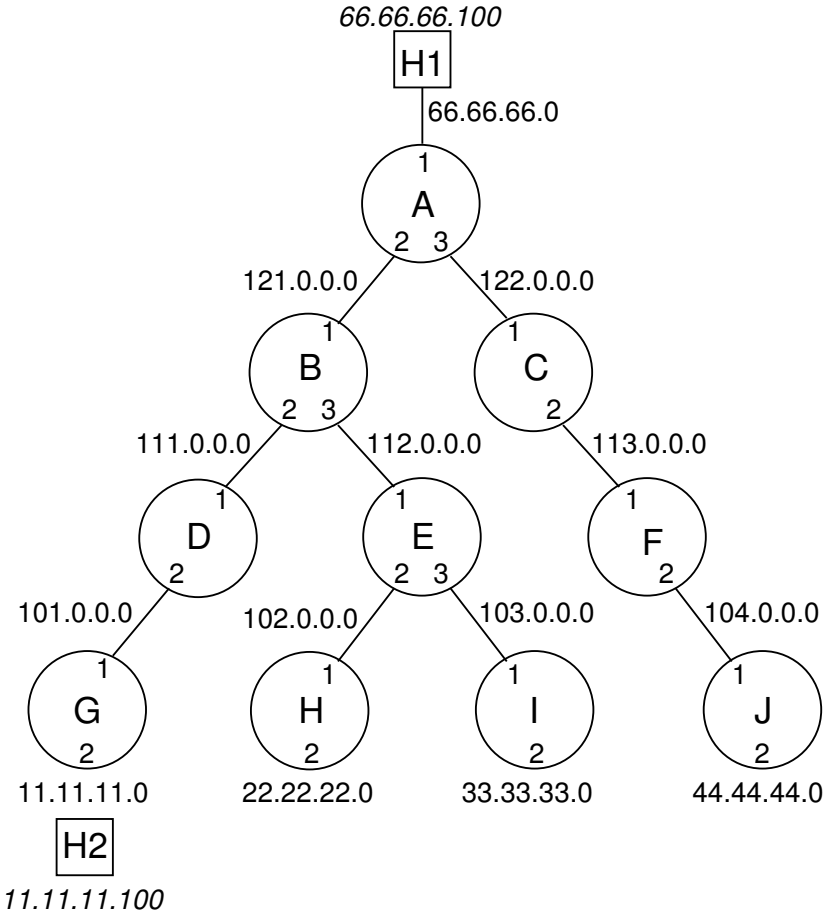
iv. RTS/CTS, Client A:

v. RTS/CTS, Client B:

vi. RTS/CTS, AP:

Question 8 [13 marks]

Consider the network shown in the figure below. There are routers (circles) and hosts (squares). Routers are named with letters, and each interface is given a label (e.g. 1, 2 or 3). Network addresses are given. Router IP addresses are constructed from the network address and the interface number. For example, router A has three IP address: `66.66.66.1`, `121.0.0.2` and `122.0.0.3`. The home IP addresses of hosts H1 and H2 are given (`66.66.66.100` and `11.11.11.100`, respectively). The IP subnets `11.11.11.0`, `22.22.22.0`, `33.33.33.0` and `44.44.44.0` support host mobility (e.g. `11.11.11.2` is a FA/HA).



Assume hosts H1 and H2 are communicating (e.g. sending packets to each other in a video conference). Routing protocols have already been run such that shortest paths (in number of hops) will always be used. For example, the path from H1 to H2 is A-B-D-G.

Assume H2 is running Mobile IP and moves into subnet `22.22.22.0`. Answer the following questions, assuming Mobile IP registration has successfully completed.

(a) What is the path taken for the packets sent from H1 to H2? [2 marks]

(b) For the packets in this direction (H1 to H2), when the FA receives a packet, what

is the source IP address in the packet header? [1.5 marks]

(c) For the packets in this direction (H1 to H2), when the FA receives a packet, what is the destination IP address in the packet header? [1.5 marks]

(d) For the packets in this direction (H1 to H2), when H2 receives a packet, what is the destination IP address in the packet header? [1.5 marks]

(e) What is the path taken for the packets sent from H2 to H1? [2 marks]

(f) For the packets in this direction (H2 to H1), when the FA sends a packet, what is the source IP address in the packet header? [1.5 marks]

(g) For the packets in this direction (H2 to H1), when the FA sends a packet, what is the destination IP address in the packet header? [1.5 marks]

Now assume H2 has moved into subnet `44.44.44.0` and the Mobile IP registration has successfully completed.

(h) Considering this case, state a problem with using Mobile IP and explain how that may impact on application performance. [1.5 marks]