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

Sirindhorn International Institute of Technology
Thammasat University

Midterm Examination: Semester 2/2009

Course Title : ITS413 Internet Technologies and Applications

Instructor : Dr Steven Gordon

Date/Time : Wednesday 23 December 2009, 13:30-16:30

Instructions:

- This examination paper has 16 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.

Short Questions [20 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 question is worth 1 mark.

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

1. _____ is a protocol that enables host mobility in the Internet.
2. _____ is a technology designed to support long-distance point-to-point fixed wireless communications.
3. _____ is used to provide Internet access via copper telephone lines.
4. _____ is a wireless technology that uses an unlicensed portion of spectrum to provide communications over distances of 10's to 100's of metres.
5. _____ is used to exchange routing information between autonomous systems.
6. _____ is a protocol that could allow a single device on board a train to manage mobility on behalf of all passengers on the train.
7. _____ is an example virtual circuit packet switching technology used in core networks.
8. _____ uses optical fibre to connect cities and countries at data rates greater than 1Gb/s.
9. _____ will allow mobile phone systems to provide data rates similar to or greater than current copper telephone based Internet access technologies.
10. _____ are networks normally operated by a single ISP, however sometimes large companies such as Google and Microsoft have their own.
11. _____ is the set of procedures/functions that are mandatory for IEEE 802.11 medium access control.
12. _____ is a network with multiple wireless hops, dynamic topology and no existing infrastructure.

Explain briefly (1-2 sentences) the important difference between the following concepts (e.g. A vs B). Each question is worth 2 marks. (Note that you need to give a brief definition of the differences, NOT the advantages/disadvantages).

13. Transit vs Peering agreements between ISPs

14. Access vs Core networks

15. Host vs Network mobility

16. Routers vs Hosts in the Internet

General Questions [80 marks]

Question 1 [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]

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

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

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

Question 2 [19 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: 7, 10, 23, ...
  - Client B: 3, 20, 41, ...
  - AP: 8, 19, 33, ...

Parameter	Value
Data Rate	54 Mb/s
DATA Header	27 Bytes
ACK transmission time	20 µs
RTS transmission time	20 µs
CTS transmission time	20 µs
DIFS	28 µs
SIFS	10 µs
Slot Time	9 µs
CWmin	15
CWmax	1023

Table 1: WLAN Parameters

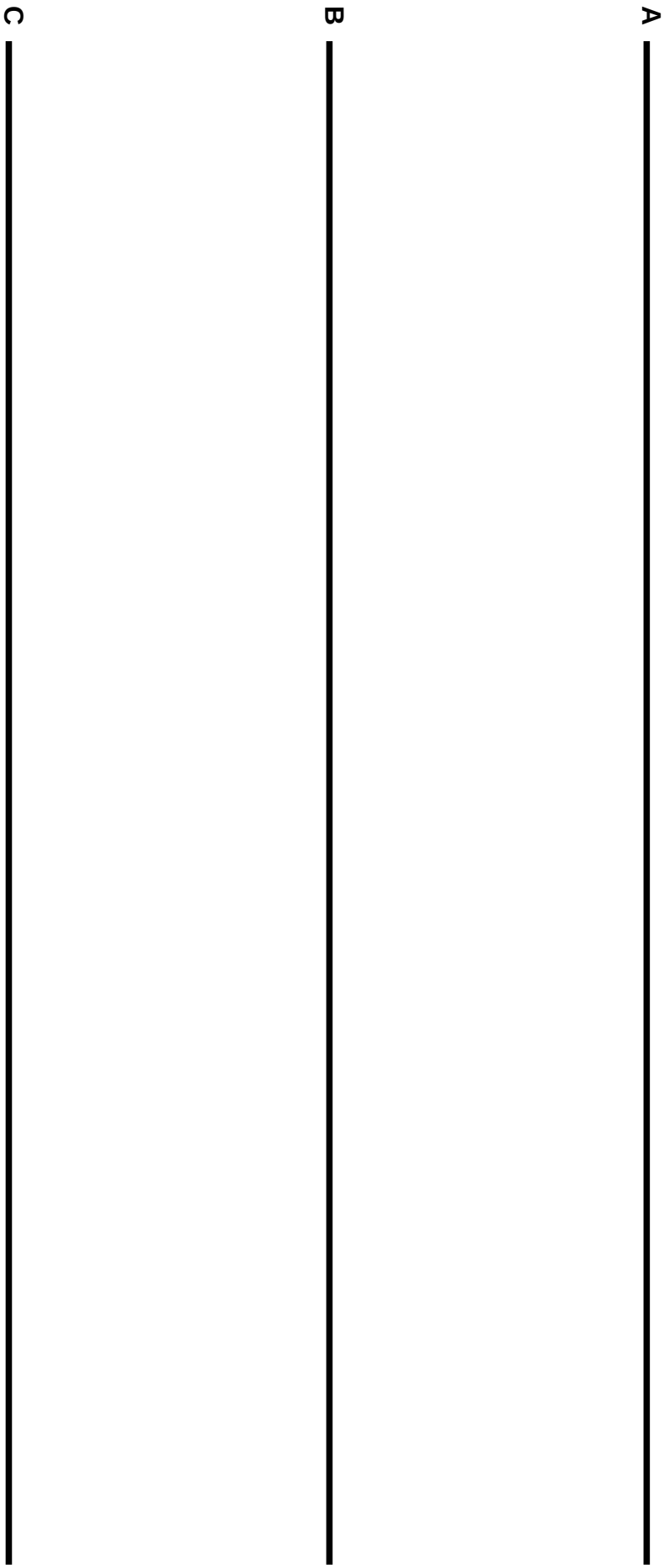
Assume client A has data with payload of 1080 Bytes ready to transmit to the AP at time 0µs, and client B has data with payload of 1080 Bytes ready to transmit to the AP at time 160µs.

a) For the following two cases, 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. Use the following pages for the diagrams. Your diagrams do not have to be to scale, however showing the timing of events will help with answering subsequent parts of this question.

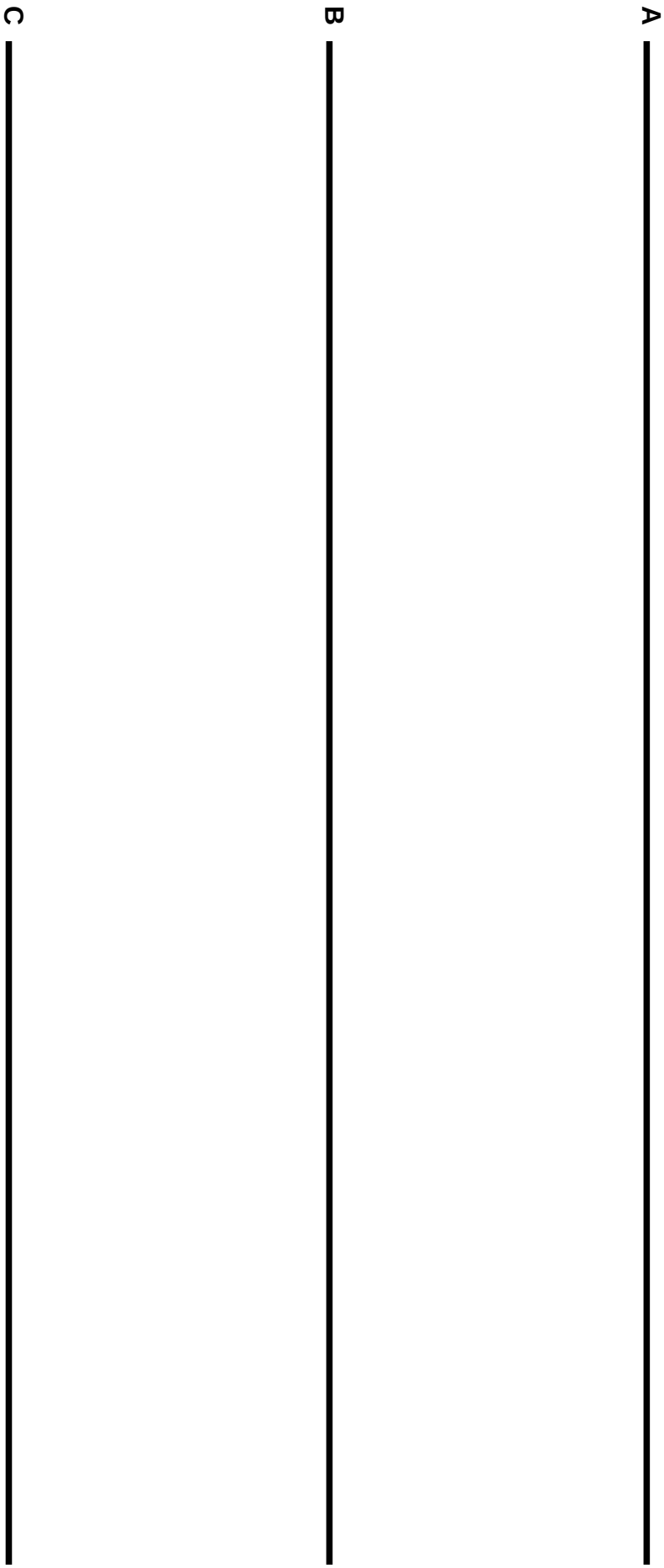
   i. RTS threshold is 1500 Bytes [5 marks]

   ii. RTS threshold is 500 Bytes [5 marks]

Part (i)



Part (ii)



b) For each case, at what time does each client know that the data has been successfully delivered:

i. RTS threshold 1500, Client A? [1.5 mark] Answer: _____

ii. RTS threshold 1500, Client B? [1.5 mark] Answer: _____

iii. RTS threshold 500, Client A? [1.5 mark] Answer: _____

iv. RTS threshold 500, Client B? [1.5 mark] Answer: _____

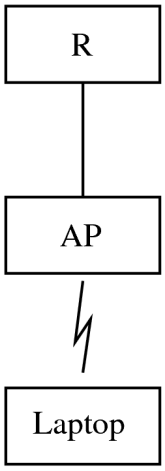
c) Which value of RTS threshold (1500 or 500) leads to better performance for this scenario? Explain why it leads to better performance. [3 marks]

Question 3 [25 marks]

a) A Home Agent (HA) in Mobile IP maintains a Mobility Binding Table. What is the purpose of this table and what is the important information in the table? [2 marks]

b) A Foreign Agent (FA) in Mobile IP maintains a Visitors List. What is the purpose of this list and what is the important information in the list? [2 marks]

Consider an IEEE802.11 based laptop running Mobile IP that has just turned on in a foreign network (see figure below). The Foreign Agent is router R. (In parts (c) to (f) you may give a written description or use a diagram showing the message exchange. In either case, make sure you clearly state the type of messages being sent, and the source/destination.)



c) Describe two methods for the laptop to discover the access point using IEEE 802.11. [4 marks]

d) Once the AP is discovered, describe the procedure for the laptop to join the wireless LAN. [2 marks]

e) Describe two methods for the laptop to discover the Mobile IP Foreign Agent. [4 marks]

f) Once the FA is discovered, describe the procedure that the laptop takes to join the foreign network and inform its HA of the new location. [2 marks]

Considering your answers from parts (c) to (f), assume the delay for sending a single message (WLAN frame or Mobile IP packet) from laptop to AP is 2ms, from AP to FA is 1ms, and from FA to HA is 10ms. The same delays occur in the opposite direction.

g) Ignoring all other delays (processing, queuing, collisions, etc.) what is the minimum delay from when the laptop turns on, until when the laptop can send data in the foreign network? State which discovery methods you assume, and state any assumptions about the rate at which messages are sent. [4 marks]

Once the laptop has successfully joined the foreign network, consider the IP datagrams being sent/forwarded along the path between between the laptop and a correspondent node. Assume the following IP addresses (with subnet mask 255.255.255.0 in all networks):

- Mobile Node Home IP: 63.14.23.94
- CoA: 103.3.22.46
- Home Agent: 63.14.23.13
- Foreign Agent: 103.3.22.1
- Correspondent Node: 102.16.100.4

h) For the data being sent from correspondent node to laptop, indicate the source and destination addresses in the IP header:

i. IP datagram sent by correspondent node [1 mark]

Source: _____ Dest.: _____

ii. IP datagram sent/forwarded by Home Agent [1 mark]

Source: _____ Dest.: _____

iii. IP datagram sent/forwarded by Foreign Agent [1 mark]

Source: _____ Dest.: _____

i) For the data being sent from laptop to correspondent node, indicate the source and destination addresses in the IP header:

i. IP datagram sent by laptop [1 mark]

Source: _____ Dest.: _____

ii. IP datagram sent/forwarded by Foreign Agent [1 mark]

Source: _____ Dest.: _____

Question 5 [17 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). [5 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]

c) If Laptop1 is downloading a file from PC1 using TCP, what addresses are inside the header of the IP datagram received by Laptop1? [2 marks]

d) 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]

e) 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. Laptop1 [2 marks]

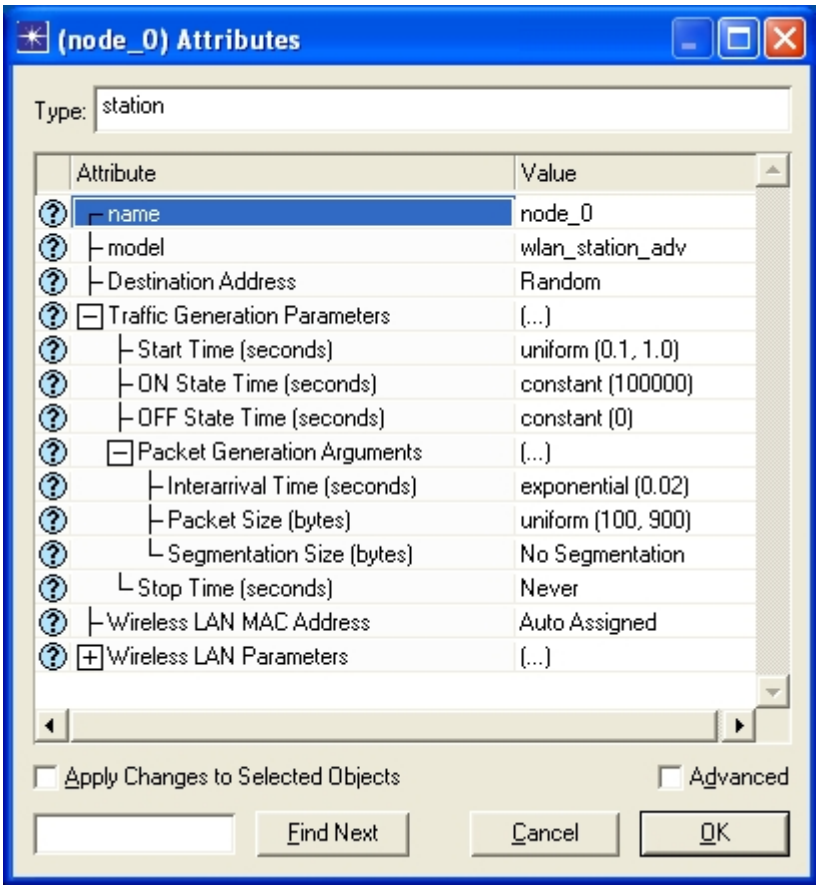
ii. A wireless LAN AP [2 marks]

iii. Router R1 [2 marks]

Question 6 [8 marks]

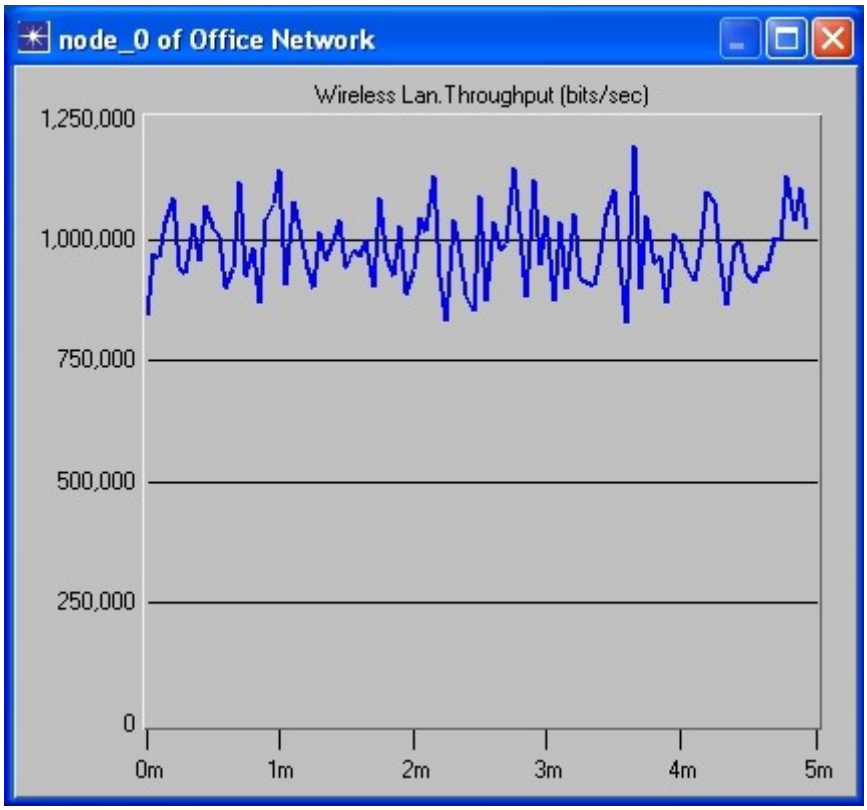
OPNET IT Guru allows you to simulate networks and applications to predict their performance before they are deployed. The steps involved in setting up a simulation include: defining the network topology; selecting values for node/protocol parameters; defining the traffic to be generated by applications/users in the network; and selecting statistics to measure.

Consider the Traffic Generation Parameters for a node in a network. The following screenshot shows selected parameter values from a node in OPNET.



a) If there were 3 nodes in the network with the same attributes as above, then what is the average rate at which traffic is generated in the entire network? In other words, what is the *load* on the network due to the 3 nodes? [3 marks]

Consider the statistics obtained from a simulation. The following screenshot shows a result from an OPNET simulation. It is the throughput measured for a single node in a network. Assume the result was obtained when nodes in the network had the same traffic generation parameter values as shown above (except the interarrival time was changed from 0.02 to another value).



b) If you exclude wireless LAN specific factors (such as backoff and collisions), explain why the measured throughput varies over time. [3 marks]

c) The simulation above was run for a duration of 5 minutes. If instead the simulation was run for a duration of 5 seconds, do you think the results would be an accurate reflection of the network performance? Explain your answer. [2 marks]