OLLSCOIL NA GAILLIMHE
UNIVERSITY OF GALWAY

Autumn Examinations 2022-2023

Course Instance Code(s)	3BCT
Exam(s)	BSc in Computer Science & Information Technology
Module Code(s)	CT3531
Module(s)	Networks and Data Communications 2
Paper No.	1
External Examiner(s)	Dr. R. Trestian
Internal Examiner(s)	Prof. M. Madden *Dr. D. Chambers

Instructions: Answer any 4 questions.
All questions carry equal marks.

Duration	2 hours
No. of Pages	6
Department(s)	School of Computer Science
Course Co-ordinator(s)	Dr Colm O'Riordan

Requirements:

Release in Exam Venue	Yes	X	No	
MCQ Answersheet	Yes		No	X
Handout	None			
Statistical/ Log Tables	None			
Cambridge Tables	None			
Graph Paper	None			
Log Graph Paper	None			
Other Materials	None			
Graphic material in colour	Yes	X	No	

Question 1

a) Assume that you are working for a large corporation that wants to use the private IP address range starting at 172.16.0.0 for its internal network. The company management wants to be able to provision up to 16 separate sites in Ireland with a subnet for each site, with at least 4000 host IP addresses available per subnet. Ireland has been allocated the first /16 range available i.e. 172.16.0.0/16. You are requested to design the network layout. Answer the following questions and fully explain the logic behind each answer:

(i) What subnet mask will need to be used for the individual subnets in Ireland? Fully explain the logic behind your answer. 4 MARKS

(ii) What are the valid host addresses and the broadcast addresses for the first and second subnets in Ireland? 4 MARKS

(iii) The company has operations in 15 other European countries and each country has been allocated a /16 address range. These individual /16 address ranges are contiguous and Ireland has been allocated the first of these ranges. What route summary or supernet could be used to define a single routing entry for all of the European address ranges? 3 MARKS

b) Write a short essay, approximately 300 words, on one of the following topics. The essay should include a full description of the topic and also discuss its advantages, disadvantages, competitor technologies (if applicable) and its likely evolution:

(i) Virtual LANs
(ii) Packet Filtering and Firewalls
(iii) Dynamic Routing Protocols 14 MARKS

Question 2

A company has an office building that has been fitted out with the Local Area Network topology shown in Figure 1 below:

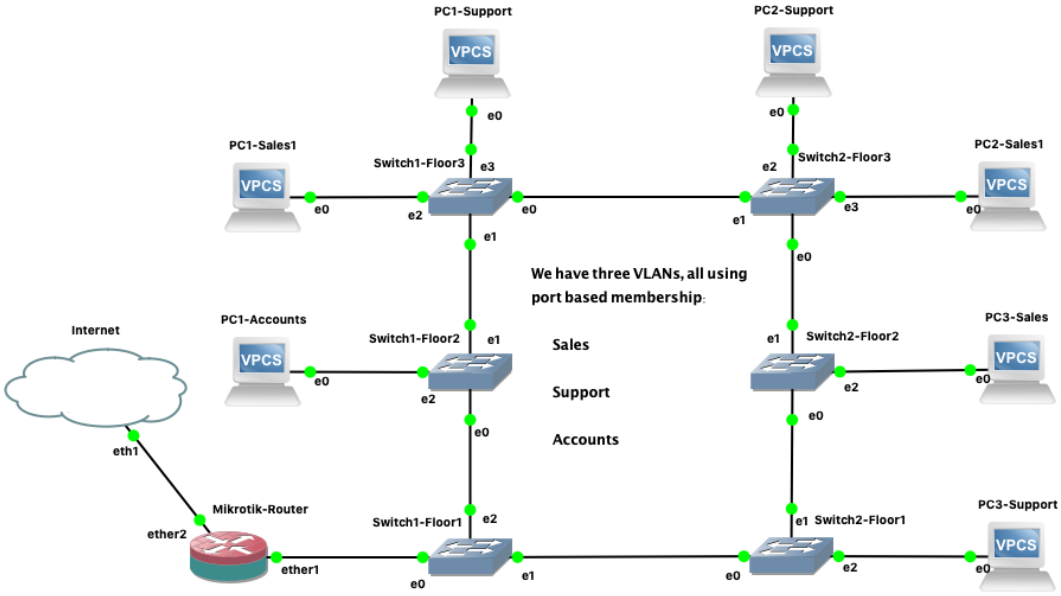

Figure 1 - Local Area Network Topology

The office building has three floors and each floor has two network switches that are used to interconnect with other switches and to connect end user devices e.g. PCs. The company is organised into three departments i.e. Sales, Support and Accounts, each department has its own VLAN. There is also a Mikrotik router connected to one of the switches on the ground floor, this router also provides internet access via an ethernet connection provided by an ISP. Answer the following questions in relation to the design and configuration of this network.

a) What are the advantages of using a VLAN for each Department? Suggest a suitable VLAN id and IP subnet for each VLAN. 5 MARKS

b) What port configuration would be required for Switch2-Floor1? In this context explain the purpose of the 802.1q protocol. 5 MARKS

c) Assume that the router gets a public IP address via DHCP from the ISP connected via ether2. What RouterOS commands are required on the router to ensure that NAT is used for outgoing internet traffic? 5 MARKS

d) What steps and additional configuration would be needed, on the router and the switches, to add another new VLAN to the existing setup? 5 MARKS

e) What mechanism is used to ensure that a broadcast storm does not occur due to the fact that the switches are interconnected in a loop type topology? Explain the basic operation of this mechanism. 5 MARKS

Question 3

a) Explain how traceroute works and what it shows using an appropriate example. 5 MARKS

b) State and differentiate the three main means of interconnecting an Autonomous System with another Autonomous System. 3 MARKS

c) Describe briefly each of the following: Border Gateway Protocol, Internet Exchange Point, Asymmetric Route. 6 MARKS

d) Describe in your own words what a Route Server is, what function it performs and why it is necessary. 5 MARKS

e) The result of running the command /ip route print on a Mikrotik router is shown below. The router is running OSPF with other routers in the same Autonomous System:

```
[admin@10.10.10.1] > ip route print
Flags: X - disabled, A - active, D - dynamic,
C - connect, S - static, r - rip, b - bgp, o - ospf, m - mme,
B - blackhole, U - unreachable, P - prohibit
 #      DST-ADDRESS        PREF-SRC        GATEWAY            DISTANCE
 0 ADo  0.0.0.0/0                          10.1.1.2                110
 1 ADC  10.1.1.0/24        10.1.1.1        ether1                    0
 2 ADo  10.1.4.0/24                        10.1.1.2                110
 3 ADC  10.10.10.1/32      10.10.10.1      loopback                  0
 4 ADo  10.10.10.2/32                      10.1.1.2                110
 5 ADo  10.10.10.4/32                      10.1.1.2                110
 6 ADC  172.21.1.0/30      172.21.1.2      ether2                    0
 7 ADC  192.168.10.0/24    192.168.10.1    ether3                    0
 8 ADo  192.168.11.0/24                    10.1.1.2                110
 9 ADo  192.168.12.0/24                    10.1.1.2                110
10 ADo  192.168.81.0/24                    10.1.1.2                110
11 ADC  192.168.182.0/24   192.168.182.138 ether4                    0
```

Answer the following questions in relation to this routing table.

i. What does the route entry for destination 0.0.0.0/0 mean and why is this route entry particularly important? 2 MARKS

ii. Is the destination IP range 192.168.10.0/24 on the same router or a different router? How can you tell? 2 MARKS

iii. What is the meaning of the GATEWAY value shown and how might this affect a routing decision? 2 MARKS

Question 4

Assume that an Internet Service Provider has built a routed network in Co Galway as shown in Figure 2 below:

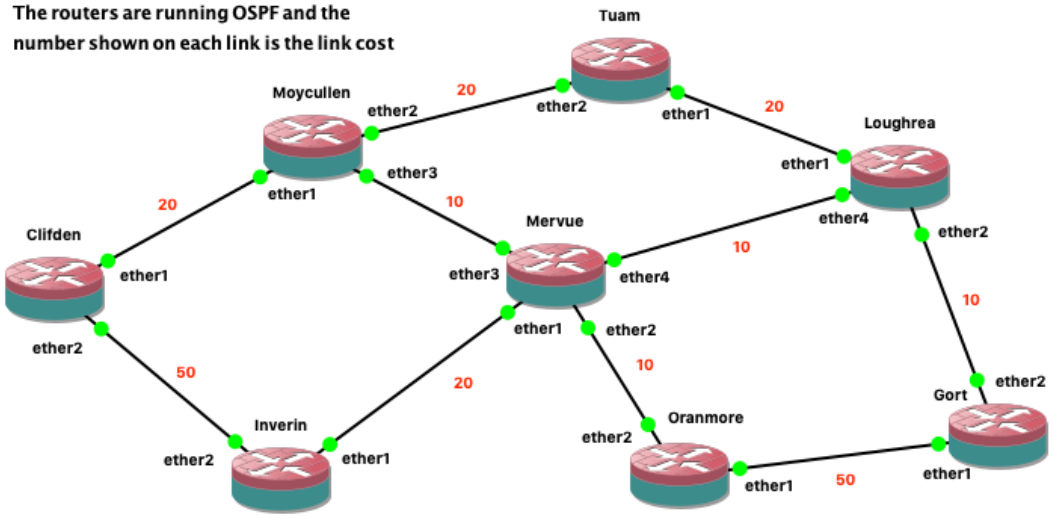

Figure 2 - ISP Regional Network

The routers are all Mikrotik routers running the RouterOS operating system. Answer the following questions in relation to the operation and configuration of this network. Please note that you do not need to build the network shown in the GNS3 simulator to answer these questions.

a) Describe the operation and purpose of the OSPF protocol in the network shown. How is Dijkstra's Algorithm used by OSPF in this context and what would the sink tree look like from the Loughrea router? 5 MARKS

b) Describe the format of an OSPF Link State Announcement. Explain how a Link State Announcement from the Loughrea router would be disseminated throughout the network and how can this be done reliably. 5 MARKS

c) Suggest suitable IP subnets for the links connected to the Loughrea router. What RouterOS commands are required to assign appropriate IP addresses and to also fully enable OSPF on the Loughrea router? 5 MARKS

d) What route would a PC attached to the Inverin router normally take to get to the Gort router? What exactly would happen with OSPF if the link between Inverin and Mervue became unavailable for some reason? 5 MARKS

e) Assume that the Clifden router needs to have an additional local area network, attached to ether3, for some end user devices e.g. PCs. Suggest a suitable IP subnet for this new local area network. What RouterOS commands would be required on the Clifden router to assign an appropriate IP address for this additional local area network and to ensure that the new IP range is reachable from the other routers in the network? 5 MARKS

Question 5

a) What types of Sockets are supported in the Java networking package and which type of Socket would you recommend for a VOIP type application and a File Transfer type application? 5 MARKS

b) Write a network Server program in Java where the Server waits for incoming client connections using stream type sockets. Once a Client connects it sends a String object to the server with a simple query – the server then responds with a text based response. The connection is then terminated. The server should use a separate thread of execution for each new client connection and all interaction between the Server and the Client should be done within this thread. The answer only needs to include source code for the server side application. 10 MARKS

c) Write another Java application with the same functionality as outlined in part b of this question, but this time using Datagram type sockets. Hint: you can use ByteArrayOutputStream and ByteArrayInputStream to populate and read the array associated with the DatagramPacket object. This application does not need to implement a reliable data transfer protocol or use multiple threads at the server for each new client. The answer only needs to include source code for the server side application. 10 MARKS

Autumn Examinations 2021-2022

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Graph Paper	None			
Log Graph Paper	None			
Other Materials	None			
Graphic material in colour	Yes	X	No	

Question 1

a) Assume that you are working for a large corporation that wants to use the private IP address range starting at 172.16.0.0 for its internal network. The company management wants to be able to provision up to 32 separate sites in Ireland with a subnet for each site, with at most 2000 host IP addresses available per subnet. Ireland has been allocated the first /16 range available i.e. 172.16.0.0/16. You are requested to design the network layout. Answer the following questions and fully explain the logic behind each answer:

(i) What subnet mask will need to be used for the individual subnets in Ireland? Fully explain the logic behind your answer. 4 MARKS

(ii) What are the valid host addresses and the broadcast addresses for the first and second subnets in Ireland? 4 MARKS

(iii) The company has operations in 15 other European countries and each country has been allocated a /16 address range. These individual /16 address ranges are contiguous and Ireland has been allocated the first of these ranges. What route summary or supernet could be used to define a single routing entry for all of the European address ranges? 3 MARKS

b) Write a short essay, approximately 300 words, on one of the following topics. The essay should include a full description of the topic and also discuss its advantages, disadvantages, competitor technologies (if applicable) and its likely evolution:

(i) Virtual LANs
(ii) Network Security and Firewalls
(iii) Dynamic Routing Protocols 14 MARKS

Question 2

A company has an office building that has been fitted out with the Local Area Network topology shown in Figure 1 below:

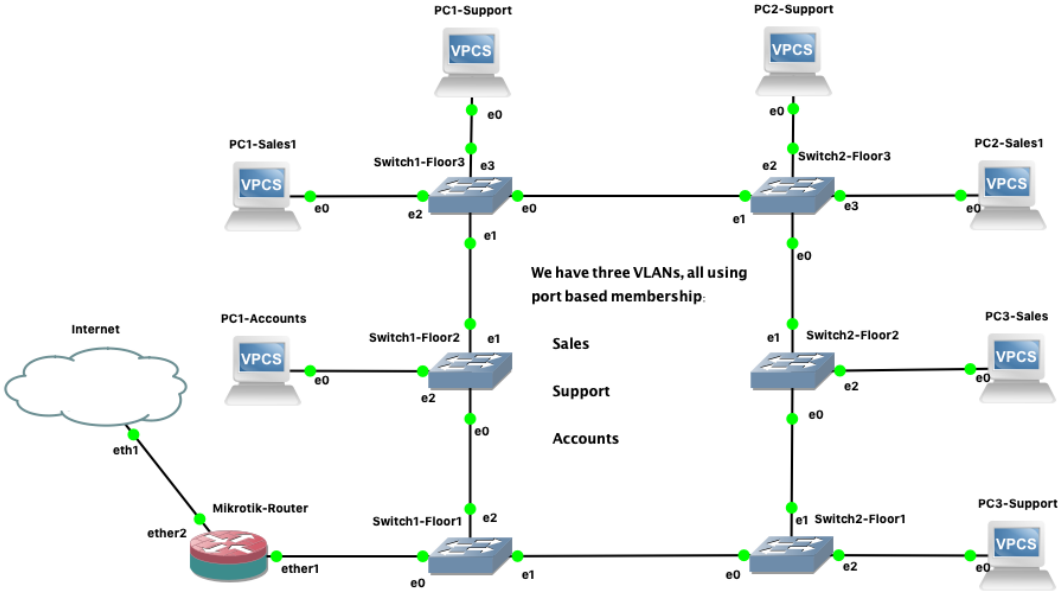

Figure 1 - Local Area Network Topology

The office building has three floors and each floor has two network switches that are used to interconnect with other switches and to connect end user devices e.g. PCs. The company is organised into three departments i.e. Sales, Support and Accounts, each department has its own VLAN. There is also a Mikrotik router connected to one of the switches on the ground floor, this router also provides internet access via an ethernet connection provided by an ISP. Answer the following questions in relation to the design and configuration of this network.

a) What are the advantages of using a VLAN for each Department? Suggest a suitable VLAN id and IP subnet for each VLAN. 5 MARKS

b) What port configuration would be required for Switch2-Floor3? In this context explain the purpose of the 802.1q protocol. 5 MARKS

c) Assume that the router gets a public IP address via DHCP from the ISP connected via ether2. What RouterOS commands are required on the router to ensure that NAT is used for outgoing internet traffic? 5 MARKS

d) What steps and additional configuration would be needed, on the router and the switches, to add another new VLAN to the existing setup? 5 MARKS

e) What mechanism is used to ensure that a broadcast storm does not occur due to the fact that the switches are interconnected in a loop type topology? Explain the basic operation of this mechanism. 5 MARKS

Question 3

a) Explain how traceroute works and what it shows using an appropriate example. 5 MARKS

b) State and differentiate the three main means of interconnecting an Autonomous System with another Autonomous System. 3 MARKS

c) Describe briefly each of the following: Border Gateway Protocol, Internet Exchange Point, Asymmetric Route 6 MARKS

d) Describe in your own words what a Route Server is, what function it performs and why it is necessary. 5 MARKS

e) The result of running the command /ip route print on a Mikrotik router is shown below. The router is running OSPF with other routers in the same Autonomous System:

```
[admin@10.10.10.1] > ip route print
Flags: X - disabled, A - active, D - dynamic,
C - connect, S - static, r - rip, b - bgp, o - ospf, m - mme,
B - blackhole, U - unreachable, P - prohibit
 #      DST-ADDRESS        PREF-SRC        GATEWAY            DISTANCE
 0 ADo  0.0.0.0/0                          10.1.1.2                110
 1 ADC  10.1.1.0/24        10.1.1.1        ether1                    0
 2 ADo  10.1.4.0/24                        10.1.1.2                110
 3 ADC  10.10.10.1/32      10.10.10.1      loopback                  0
 4 ADo  10.10.10.2/32                      10.1.1.2                110
 5 ADo  10.10.10.4/32                      10.1.1.2                110
 6 ADC  172.21.1.0/30      172.21.1.2      ether2                    0
 7 ADC  192.168.10.0/24    192.168.10.1    ether3                    0
 8 ADo  192.168.11.0/24                    10.1.1.2                110
 9 ADo  192.168.12.0/24                    10.1.1.2                110
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11 ADC  192.168.182.0/24   192.168.182.138 ether4                    0
```

Answer the following questions in relation to this routing table.

i. What does the route entry for destination 0.0.0.0/0 mean and why is this route entry particularly important? 2 MARKS

ii. Is the destination IP range 192.168.11.0/24 on the same router or a different router? How can you tell? 2 MARKS

iii. What is the meaning of the GATEWAY value shown and how might this affect a routing decision? 2 MARKS

Question 4

Assume that an Internet Service Provider has built a routed network in Co Galway as shown in Figure 2 below:

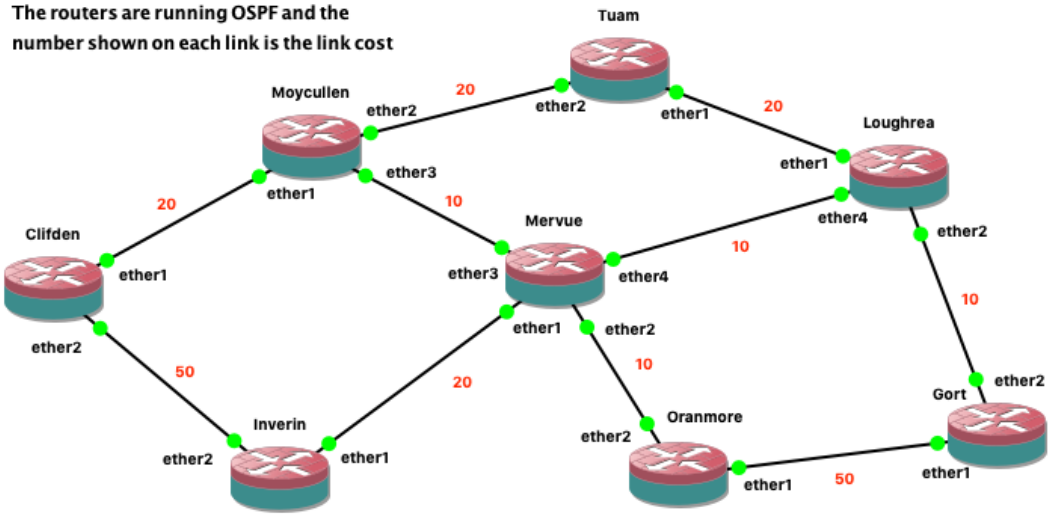

Figure 2 - ISP Regional Network

The routers are all Mikrotik routers running the RouterOS operating system. Answer the following questions in relation to the operation and configuration of this network. Please note that you do not need to build the network shown in the GNS3 simulator to answer these questions.

a) Describe the operation and purpose of the OSPF protocol in the network shown. How is Dijkstra's Algorithm used by OSPF in this context and what would the sink tree look like from the Clifden router? 5 MARKS

b) Describe the format of an OSPF Link State Announcement. Explain how a Link State Announcement from the Loughrea router would be disseminated throughout the network and how can this be done reliably. 5 MARKS

c) Suggest suitable IP subnets for the links connected to the Loughrea router. What RouterOS commands are required to assign appropriate IP addresses and to also fully enable OSPF on the Loughrea router? 5 MARKS

d) What route would a PC attached to the Clifden router normally take to get to the Gort router? What exactly would happen with OSPF if the link between Mervue and Loughrea became unavailable for some reason? 5 MARKS

e) Assume that the Clifden router needs to have an additional local area network, attached to ether3, for some end user devices e.g. PCs. Suggest a suitable IP subnet for this new local area network. What RouterOS commands would be required on the Clifden router to assign an appropriate IP address for this additional local area network and to ensure that the new IP range is reachable from the other routers in the network? 5 MARKS

Question 5

a: What types of Sockets are supported in the Java networking package and which type of Socket would you recommend for a VOIP type application and a File Transfer type application? 5 MARKS

b: Write a network Server program in Java where the Server waits for incoming client connections using stream type sockets. Once a Client connects it sends a String object to the server with a simple query – the server then responds with a text based response. The connection is then terminated. The server should use a separate thread of execution for each new client connection and all interaction between the Server and the Client should be done within this thread. The answer only needs to include source code for the server side application. 10 MARKS

c: Write another Java application with the same functionality as outlined in part b of this question, but this time using Datagram type sockets. Hint: you can use ByteArrayOutputStream and ByteArrayInputStream to populate and read the array associated with the DatagramPacket object. This application does not need to implement a reliable data transfer protocol or use multiple threads at the server for each new client. The answer only needs to include source code for the server side application. 10 MARKS

NUI Galway
OÉ Gaillimh

Semester 1 Examinations 2021-2022

Exam Code(s)	3BCT
Exam(s)	BSc in Computer Science & Information Technology
Module Code(s)	CT3531
Module(s)	Networks and Data Communications 2
Paper No.	1
External Examiner(s)	Dr. R. Trestian
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Instructions: Answer any 4 questions.
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Duration	2 hours
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Department(s)	School of Computer Science

Requirements:

Release in Exam Venue	Yes	X	No	
MCQ Answersheet	Yes		No	X
Handout	None			
Statistical/ Log Tables	None			
Cambridge Tables	None			
Graph Paper	None			
Log Graph Paper	None			
Other Materials	None			
Graphic material in colour	Yes	X	No	

Question 1

a) Assume that you are working for a large corporation that wants to use the private IP address range starting at 172.16.0.0 for its internal network. The company management wants to be able to provision up to 8 separate sites in Ireland with a subnet for each site, with at least 8000 host IP addresses available per subnet. Ireland has been allocated the first /16 range available i.e. 172.16.0.0/16. You are requested to design the network layout. Answer the following questions and fully explain the logic behind each answer:

(i) What subnet mask will need to be used for the individual subnets in Ireland? Fully explain the logic behind your answer. 5 MARKS

(ii) What are the valid host addresses and the broadcast addresses for the first and second subnets in Ireland? 5 MARKS

(iii) The company has operations in 15 other European countries and each country has been allocated a /16 address range. These individual /16 address ranges are contiguous and Ireland has been allocated the first of these ranges. What route summary or supernet could be used to define a single routing entry for all of the European address ranges? 3 MARKS

b) Write a short essay, approximately 300 words, on one of the following topics. The essay should include a full description of the topic and also discuss its advantages, disadvantages, competitor technologies (if applicable) and its likely evolution:

(i) The Domain Name System (DNS)
(ii) Packet Filtering and Firewalls
(iii) Internet Exchange Points 12 MARKS

Question 2

A company has an office building that has been fitted out with the Local Area Network topology shown in Figure 1 below:

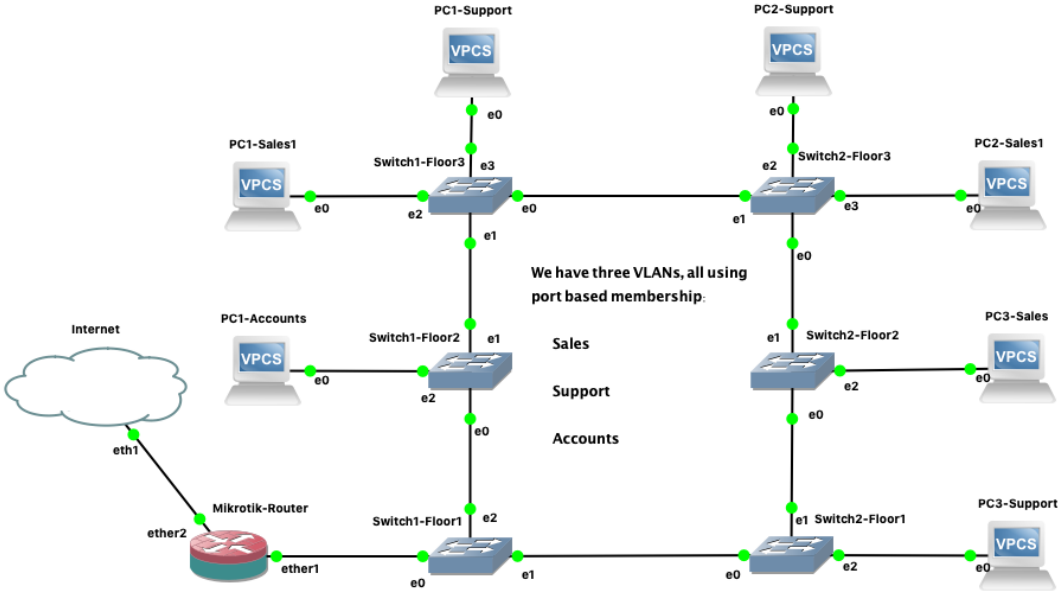

Figure 1 - Local Area Network Topology

The office building has three floors and each floor has two network switches that are used to interconnect with other switches and to connect end user devices e.g. PCs. The company is organised into three departments i.e. Sales, Support and Accounts, each department has its own VLAN. There is also a Mikrotik router connected to one of the switches on the ground floor, this router also provides internet access via an ethernet connection provided by an ISP. Answer the following questions in relation to the design and configuration of this network.

a) What are the advantages of using a VLAN for each Department? Suggest a suitable VLAN id and IP subnet for each VLAN. 5 MARKS

b) What port configuration would be required for Switch2-Floor3? In this context explain the purpose of the 802.1q protocol. 5 MARKS

c) Assume that the router gets a public IP address via DHCP from the ISP connected via ether2. What RouterOS commands are required on the router to ensure that NAT is used for outgoing internet traffic? 5 MARKS

d) What steps and additional configuration would be needed, on the router and the switches, to add another new VLAN to the existing setup? 5 MARKS

e) What mechanism is used to ensure that a broadcast storm does not occur due to the fact that the switches are interconnected in a loop type topology? Explain the basic operation of this mechanism. 5 MARKS

Question 3

a) Explain how traceroute works and what it shows. 5 MARKS

b) State and differentiate the three main means of interconnecting an Autonomous System with another Autonomous System. 3 MARKS

c) Describe briefly each of the following: Border Gateway Protocol, Internet Exchange Point, Asymmetric Route 6 MARKS

d) Describe in your own words what a Route Server is, what function it performs and why it is necessary. 5 MARKS

e) The result of running 'show bgp ipv4 unicast 140.203.0.0/16' on an internet facing BGP router of an ISP in Ireland is shown below. What is the best path from that ISP to the NUI Galway network (140.203.0.0/16)? Explain fully in your answer how the best path is chosen in this case. 6 MARKS

```
rtr01#show bgp ipv4 unicast 140.203.0.0/16

BGP routing table entry for 140.203.0.0/16

Paths: (3 available, best #x)
  174 3356 1213 1213
    154.50.192.49 from 154.50.192.49 (154.26.32.227)
      Localpref 100, valid, external
  1213
    194.88.240.15 from 194.88.240.8 (194.88.240.8)
      Localpref 400, valid, external
  1213
    83.220.203.172 from 83.220.203.172 (83.220.203.170)
      Localpref 300, valid, internal
```

Question 4 Consider the example network shown in Figure 2 below:

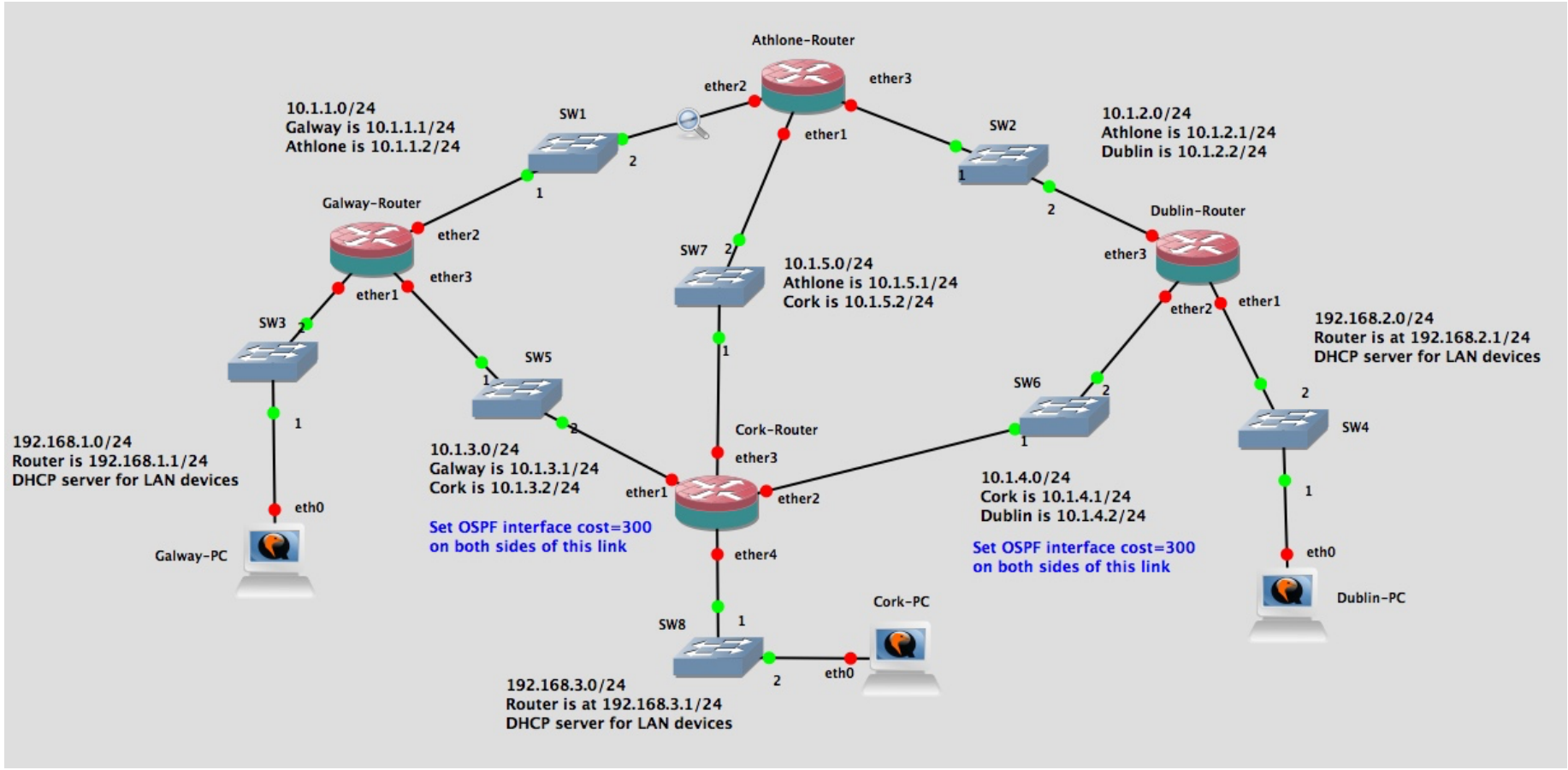

Figure 2 - Example Network

Answer the following questions in relation to this network:

a) Describe the operation and purpose of the OSPF protocol in the network shown. What is the Link State Database and how is Dijkstra's Algorithm used by OSPF in this context? 5 MARKS

b) Describe the format of an OSPF Link State Announcement. Explain how a Link State Announcement from the Galway router would be disseminated throughout the network? 6 MARKS

c) What route will a PC attached to the Cork router normally take to get to the Galway router? What would happen with OSPF if the link between the Galway and Athlone became unavailable for some reason? 5 MARKS

d) Suppose a company was using the RIP dynamic routing protocol on its routers, what reasons would you give to persuade them to change to OSPF instead? In this context explain the difference between Distance Vector and Link State routing. 5 MARKS

e) What is special about the entry **0.0.0.0/0** in an IPv4 routing table? What option needs to be enabled in OSPF to make sure this route is available on other routers within an OSPF network? 4 MARKS

5.a: What types of Sockets are supported in the Java networking package and which type of Socket would you recommend for a VOIP type application and a File Transfer type application? 5 MARKS

b: Write a network Server program in Java where the Server waits for incoming client connections using stream type sockets. Once a Client connects it sends a String object to the server with a simple query – the server then responds with a text based response. The connection is then terminated. The server should use a separate thread of execution for each new client connection and all interaction between the Server and the Client should be done within this thread. The answer only needs to include source code for the server side application. 10 MARKS

c: Write another Java application with the same functionality as outlined above, in part b of this question, but this time using Datagram type sockets. Hint: you can use ByteArrayOutputStream and ByteArrayInputStream to populate and read the array associated with the DatagramPacket object. This application does not need to implement a reliable data transfer protocol or use multiple threads at the server for each new client. The answer only needs to include source code for the server side application. 10 MARKS

Semester 1 Examinations 2019/2020

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External Examiner(s)	Dr. J. Howe
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Graph Paper	None			
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PTO

Question 1

a) In the context of Local Area Networks (LANs) explain briefly what is meant by the term "broadcast traffic" and provide an example of when this type of traffic will occur. 5 MARKS

b) Describe the basic function and advantages of using Virtual LANs (VLANs). How is the traffic between different VLANs handled? 5 MARKS

c) How is VLAN membership decided in relation to determining and controlling which VLAN a packet gets assigned to? 5 MARKS

d) How do network switches demultiplex traffic from different VLANS in a situation where VLANs span multiple switches? 5 MARKS

e) Explain briefly the purpose and operation of the Spanning Tree Protocol. 5 MARKS

Question 2

Assume that you are working for a large corporation that wants to use the private IP address range starting at 10.0.0.0/8 for its internal network. The company management wants to be able to have up to 256 separate sites globally with a routed subnet for each site. You are requested to design the network layout. Answer the following questions and fully explain the logic behind each answer:

a) What subnet mask will need to be used for the individual routed subnets? 5 MARKS

b) How many host IP addresses are available in each of the 256 sites? 4 MARKS

c) What are the valid host addresses and the broadcast addresses for the first and second subnets? 5 MARKS

d) Would it be possible for each of the 256 sites to further subnet the IP range allocated to them? Explain your answer with an example. 5 MARKS

e) What is the purpose of using a Network Address Translation (NAT) router? Does using a NAT router enhance or decrease security for an internal network? Explain the logic behind your answer. 6 MARKS

Question 3

a) Explain the purpose of the ***mtr*** utility and what it typically shows. 4 MARKS

b) Who is responsible for allocating public IP addresses in Europe? Explain briefly the purpose and implementation of the so-called "Last /8 Policy". 3 MARKS

c) Describe briefly each of the following: Private Network Interconnect, IP Transit Provider, Default Free Zone 6 MARKS

d) What are the key parameters that are required for a Border Gateway Protocol (BGP) peering session? Give an example of how a BGP peering session might be configured on a Mikrotik Router. 6 MARKS

e) Explain the use of the Local Preference Multi-Exit Discriminator attributes in BGP. How would you scale the peering requirements of a large BGP deployment in an Internet Exchange Point (IXP)? 6 MARKS

Question 4

a) Describe briefly the purpose of a Virtual Private Network and give some examples of the protocols that can be used to implement a VPN. 5 MARKS

b) In the context of network security what does the term "stateful firewall" mean and how is it typically used to protect a network? 5 MARKS

c) Give an example of an Intrusion Detection System (IDS) and list the kind of features that it implements. Are there any disadvantages to using an IDS? 5 MARKS

d) Outline briefly the three main functions provided by a Packet Filter in Linux. Which firewall chain is used in IPTABLES for packets that are destined for a local process running on the device itself? 5 MARKS

e) What type of firewall features are included in Mikrotik RouterOS? 5 MARKS

Question 5 Consider the example network shown in Figure 1 below:

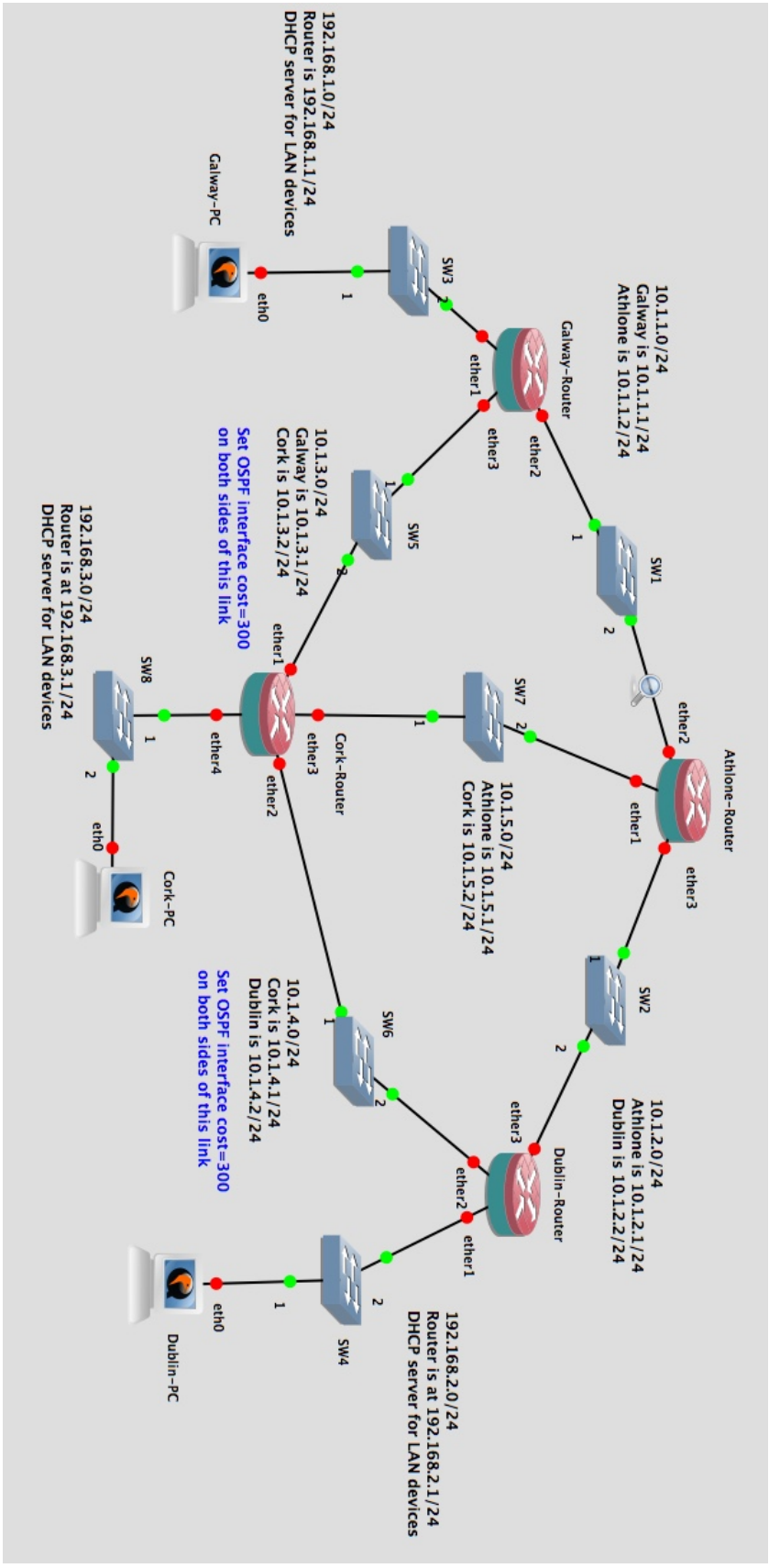

Figure 1 - Example Network

Answer the following questions in relation to this network:

a) Describe the operation and purpose of the OSPF protocol in the network shown. What is the Link State Database and how is Dijkstra's Algorithm used by OSPF in this context? 5 MARKS

b) Describe the format of an OSPF Link State Announcement. Explain how a Link State Announcement from the Galway router would be disseminated throughout the network? 6 MARKS

c) What route will a PC attached to the Dublin router normally take to get to the Galway router? What would happen with OSPF if the link between the Galway and Athlone became unavailable for some reason? 5 MARKS

d) Suppose a company was using the RIP dynamic routing protocol on its routers, what reasons would you give to persuade them to change to OSPF instead? In this context explain the difference between Distance Vector and Link State routing. 5 MARKS

e) Assume that the routers are running Mikrotik RouterOS. The Galway, Cork and Dublin routers need to be setup as DHCP Servers for the local network with the host device. What configuration commands are required to enable this feature on a Mikrotik router? 4 MARKS

NUI Galway
OÉ Gaillimh

Autumn Examinations 2019

Exam Code(s)	3BCT
Exam(s)	Third Year Computer Science & Information Technology
Module Code(s)	CT3531
Module(s)	Networks and Data Communications 2
Paper No.	1
External Examiner(s)	Dr. J. Howe
Internal Examiner(s)	Prof. M. Madden *Dr. D. Chambers

Instructions: Answer any 4 questions.
All questions carry equal marks.

Duration	2 hrs
No. of Pages	6
Discipline(s)	Information Technology
Course Co-Ordinator	Dr. D. Chambers
Requirements	None

Question 1

a) What are the main phases of network design as per the top-down network design approach? 5 MARKS

b) What are some typical technical goals for organizations today when undertaking network design? 5 MARKS

c) How is Availability typically measured or expressed? How might it be possible to achieve "Five Nines" in this context? 5 MARKS

d) When considering protocol behavior, what is the difference between relative network utilization and absolute network utilization? 5 MARKS

e) What architectural and environmental factors should you consider for a new wireless installation? 5 MARKS

Question 2

Assume that you are working for a large corporation that wants to use the private IP address range starting at 10.0.0.0/8 for its internal network. The company management wants to be able to have up to 256 separate sites globally with a routed subnet for each site. You are requested to design the network layout. Answer the following questions and fully explain the logic behind each answer:

a) What subnet mask will need to be used for the individual routed subnets? 6 MARKS

b) How many host IP addresses are available in each routed subnet? 4 MARKS

c) What are the valid host addresses and the broadcast addresses for the first and last subnets? 5 MARKS

d) What other private IP ranges could the company use if needed? 4 MARKS

e) What is the purpose of using a Network Address Translation (NAT) router? Does using a NAT router enhance or decrease security for an internal network? Explain the logic behind your answer. 6 MARKS

Question 3

a) Explain the purpose of the ***mtr*** utility and what it typically shows.
4 MARKS

b) Who is responsible for allocating public IP addresses in Europe? Explain briefly the purpose and implementation of the so-called "Last /8 Policy".
3 MARKS

c) Describe briefly each of the following: Private Network Interconnect, IP Transit Provider, Default Free Zone 6 MARKS

d) What are the key parameters required for a Border Gateway Protocol (GBP) session? Give an example of how a BGP session might be configured on a Mikrotik Router. 6 MARKS

e) The result of a running 'show bgp ipv4 unicast 140.203.0.0/16' on an internet facing BGP router of a University in the USA is shown below. What is the best path from that University to the NUI Galway network (140.203.0.0/16)? Explain in your answer how the best path is chosen in this case. What Autonomous System number announces the prefix 140.203.0.0/16?
6 MARKS

BGP routing table entry for 140.203.0.0/16

Paths: (3 available, best #x)

3128 11537 20965 1213
143.235.40.4 from 143.235.40.4 (143.235.32.1)
Origin IGP, localpref 976, valid, external

11537 20965 1213
144.92.254.229 from 146.151.156.145 (146.151.156.145)
Origin IGP, localpref 975, valid, internal

174 1213
33.145.32.1 from 33.145.32.1 (33.145.32.1)
Origin IGP, localpref 975, valid, external

Question 4

a) Describe the 12-Step Programme for Network Security Design. What additional steps can be taken to maintain good security over time?
6 MARKS

b) What is the best practice for securing Public Servers accessible over the Internet? What is the purpose of running Virtual Private Network (VPN) software on client devices? 7 MARKS

c) Outline briefly the three main functions provided by a Packet Filter in Linux. Which firewall chain is used in IPTABLES for packets that are destined for a local process running on the device itself? Explain in detail the purpose of the following two firewall rules that are defined using IPTABLES format:

iptables -I FORWARD –p tcp –d 140.203.0.0/8 --syn –j DROP

iptables -t nat -A POSTROUTING -s 192.168.0.0/16 -j SNAT –to-source 91.203.182.14

12 MARKS

Question 5 Consider the example network shown in Figure 1 below:

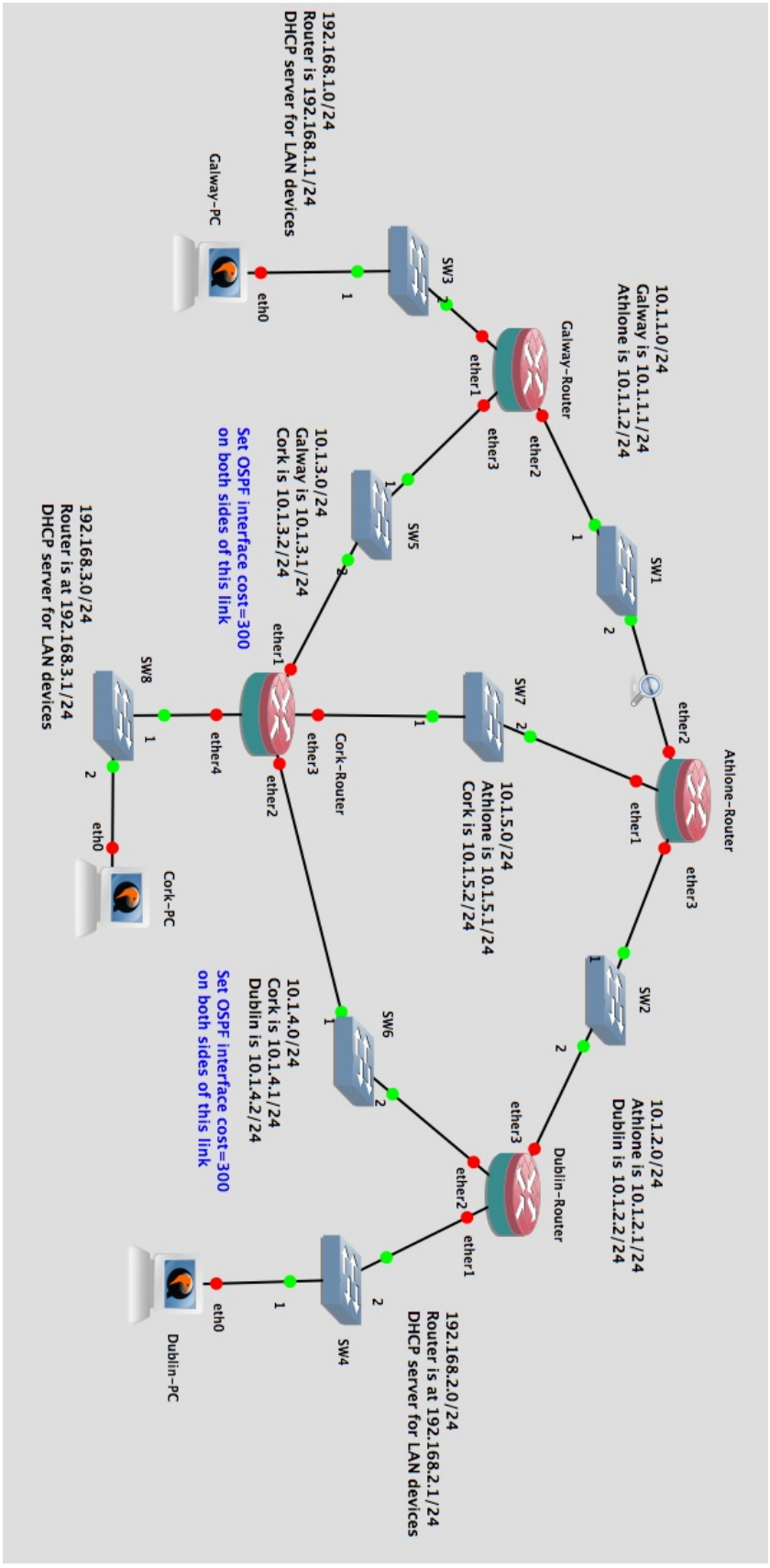

Figure 1 - Example Network

Answer the following questions in relation to this network:

a) Describe the operation and purpose of the OSPF protocol in the network shown. What is the Link State Database and how is Dijkstra's Algorithm used by OSPF in this context? 5 MARKS

b) Describe the format of an OSPF Link State Announcement. Explain how a Link State Announcement from the Galway router would be disseminated throughout the network? 6 MARKS

c) What route will a PC attached to the Dublin router normally take to get to the Galway router? What would happen with OSPF if the link between the Galway and Athlone became unavailable for some reason? 5 MARKS

d) Suppose a company was using the RIP dynamic routing protocol on its routers, what reasons would you give to persuade them to change to OSPF instead? In this context explain the difference between Distance Vector and Link State routing. 5 MARKS

e) Assume that the routers are running Mikrotik RouterOS. The Galway, Cork and Dublin routers need to be setup as DHCP Servers for the local network with the host device. What configuration commands are required to enable this feature on a Mikrotik router? 4 MARKS

NUI Galway
OÉ Gaillimh

Semester 1 Examinations 2018 / 2019

Exam Code(s)	3BCT
Exam(s)	Third Year Computer Science & Information Technology
Module Code(s)	CT3531
Module(s)	Networks and Data Communications 2
Paper No.	1
External Examiner(s)	Dr. J. Howe
Internal Examiner(s)	Prof. M. Madden *Dr. D. Chambers

Instructions: Answer any 4 questions.
All questions carry equal marks.

Duration	2 hrs
No. of Pages	6
Department(s)	Information Technology
Requirements	None

Question 1

a) How do bandwidth and throughput differ? 4 MARKS

b) Why should you be concerned about the number of devices on a single LAN (broadcast domain)? 4 MARKS

c) How do Virtual LANs help control broadcast traffic? In this context explain the purpose of the 802.1Q protocol. 6 MARKS

d) What makes traffic flow in Voice over IP networks challenging to characterize and plan for and why are wireless LANs often implemented as individual VLANs? 5 MARKS

e) Describe the purpose and operation of the Spanning Tree Protocol. 6 MARKS

Question 2

Assume that you are working for a large corporation that wants to use the private IP address range starting at 172.16.0.0 for its internal network. The company management wants to be able to have a minimum of 30 separate sites in Ireland with a subnet for each site, with at least 2000 host IP addresses available per subnet. You are requested to design the network layout. Answer the following questions and fully explain the logic behind each answer:

a) What subnet mask will need to be used for the individual subnets in Ireland? 6 MARKS

b) What are the valid host addresses and the broadcast addresses for the first and second subnets in Ireland? 4 MARKS

c) The company has operations in 15 other European countries and each country has been allocated a /16 address range. These individual /16 address ranges are contiguous and Ireland has been allocated the first of these ranges. What route summary (or supernet) could be used to define a single routing entry for all of the European address ranges? 6 MARKS

d) What other private IP ranges could the company use if needed? 4 MARKS

e) When is it appropriate to use IP private addressing versus public addressing? 5 MARKS

Question 3

a) Explain how traceroute works and what it shows. 5 MARKS

b) State and differentiate the three main means of interconnecting an Autonomous System with another Autonomous System. 3 MARKS

c) Describe briefly each of the following: Internet Exchange Point, Border Gateway Protocol, Asymmetric Route 6 MARKS

d) Describe what a Route Server is, what function it performs and why it is necessary. 5 MARKS

e) The result of a running 'show bgp ipv4 unicast 140.203.0.0/16' on an internet facing BGP router of an ISP in Ireland is shown below. What is the best path from that ISP to the NUI Galway network (140.203.0.0/16)? Explain in your answer how the best path is chosen in this case. 6 MARKS

```
rtr01#show bgp ipv4 unicast 140.203.0.0/16

BGP routing table entry for 140.203.0.0/16

Paths: (3 available, best #x)
  174 3356 1213 1213
    154.50.192.49 from 154.50.192.49 (154.26.32.227)
      Localpref 100, valid, external
  1213
    194.88.240.15 from 194.88.240.8 (194.88.240.8)
      Localpref 400, valid, external
  1213
    83.220.203.172 from 83.220.203.172 (83.220.203.170)
      Localpref 300, valid, internal
```

Question 4

a) How does a security plan differ from a security policy and why is it important to achieve buy-in from users, managers, and technical staff for the security policy? 6 MARKS

b) What are some methods for keeping hackers from viewing and changing router and switch configuration information? How can a network manager secure a wireless network? 7 MARKS

c) Outline briefly the three main functions provided by a Packet Filter in Linux. Which firewall chain is used in IPTABLES for packets that are NOT destined for a local process running on the device itself? Explain in detail the purpose of the following two firewall rules that are defined using IPTABLES format:

```
iptables -A FORWARD –p tcp –s 93.107.200.110 --syn –j DROP

iptables -A PREROUTING -t nat -p icmp -d 137.189.89.176 \
                -j DNAT --to 137.189.89.178
```

12 MARKS

Question 5 Consider the example network shown in Figure 1 below:

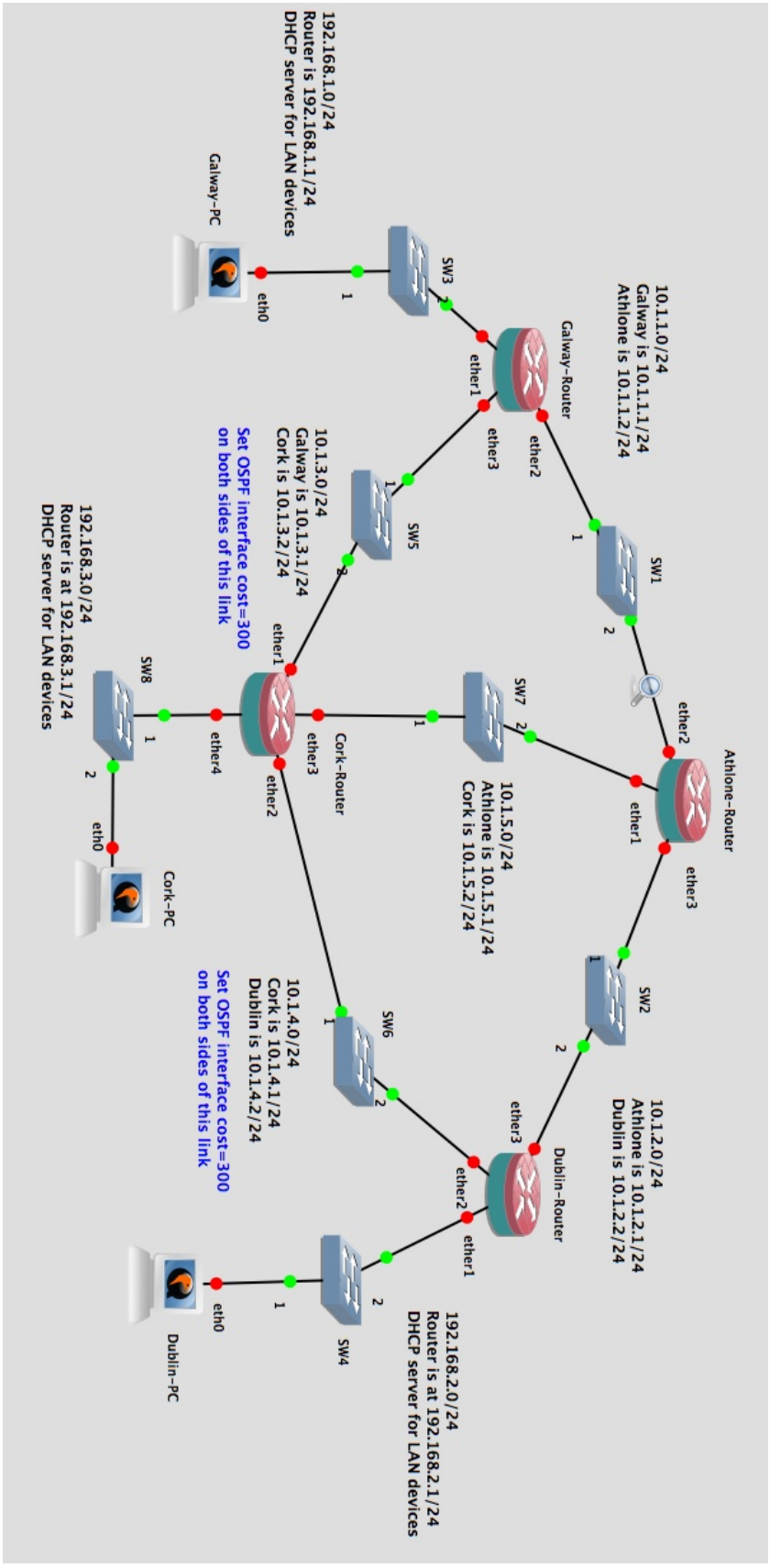

Figure 1 - Example Network

Answer the following questions in relation to this network:

a) Describe the operation and purpose of the OSPF protocol in the network shown. What is the Link State Database and how is Dijkstra's Algorithm used by OSPF in this context? 5 MARKS

b) Describe the format of an OSPF Link State Announcement. Explain how a Link State Announcement from the Galway router would be disseminated throughout the network? 6 MARKS

c) What route will a PC attached to the Galway router normally take to get to the Cork router? What would happen with OSPF if the link between the Galway and Athlone became unavailable for some reason? 5 MARKS

d) Suppose a company was using the RIP dynamic routing protocol on its routers, what reasons would you give to persuade them to change to OSPF instead? In this context explain the difference between Distance Vector and Link State routing. 5 MARKS

e) Assume that the routers are running Mikrotik RouterOS. What configuration command is required to enable the redistribution of locally connected non-OSPF networks to other routers using OSPF? 4 MARKS

Autumn Examinations 2018

Exam Code(s)	3BCT
Exam(s)	BSc Computer Science & Information Technology
Module Code(s)	CT3531
Module(s)	Networks and Data Communications 2
Paper No.	1
External Examiner(s)	Dr. J. Howe
Internal Examiner(s)	Prof. M. Madden
	*Dr. D. Chambers

Instructions: Answer any 4 questions.
All questions carry equal marks.

Duration	2 hrs
No. of Pages	5
Department(s)	Information Technology
Requirements	None

Question 1

a) What are the main phases of network design as per the top-down network design approach? 5 MARKS

b) What are some typical technical goals for organizations today when undertaking network design? 5 MARKS

c) How is Availability typically measured or expressed? How might it be possible to achieve "Five Nines" in this context? 5 MARKS

d) When considering protocol behavior, what is the difference between relative network utilization and absolute network utilization? 5 MARKS

e) What architectural and environmental factors should you consider for a new wireless installation? 5 MARKS

Question 2

Assume that you are working for a large corporation that is using the private IP address range 10.1.0.0/16 for its internal network. The company management wants to be able to accommodate at least 30 departments with a subnet for each department and maximum number of 4000 hosts per subnet. You are requested to design the network layout. Answer the following questions and fully explain the logic behind each answer:

a) What subnet mask will need to be used? 5 MARKS

b) What is the maximum number of subnets that the company network can accommodate given that there are at least 4000 hosts per subnet? 5 MARKS

c) What are the valid host addresses on the first and last subnets? 5 MARKS

d) What other private IP ranges could the company use if needed? 5 MARKS

e) When is it appropriate to use IP private addressing versus public addressing? 5 MARKS

Question 3

a) When is it appropriate to use static versus dynamic addressing? 4 MARKS

b) List and describe six different types of traffic flows. 6 MARKS

c) Why should you be concerned about broadcast traffic? 5 MARKS

d) How do IETF specifications for QoS affect different types of network traffic? 5 MARKS

e) What are the advantages and disadvantages of the various options for multi-homing an Internet connection? 5 MARKS

Question 4

a) How does a security plan differ from a security policy and why is it important to achieve buy-in from users, managers, and technical staff for the security policy? 6 MARKS

b) What are some methods for keeping hackers from viewing and changing router and switch configuration information? How can a network manager secure a wireless network? 7 MARKS

c) Outline briefly the three main functions provided by a Packet Filter in Linux. Which firewall chain is used in IPTABLES for packets that are NOT destined for a local process running on the device itself? Explain in detail the purpose of the following two firewall rules that are defined using IPTABLES format:

```
iptables -A FORWARD –p tcp –s 93.107.200.110 --syn –j DROP

iptables -A PREROUTING -t nat -p icmp -d 137.189.89.176 \
                -j DNAT --to 137.189.89.178
```

12 MARKS

Question 5

Consider the example network shown in Figure 1 below:

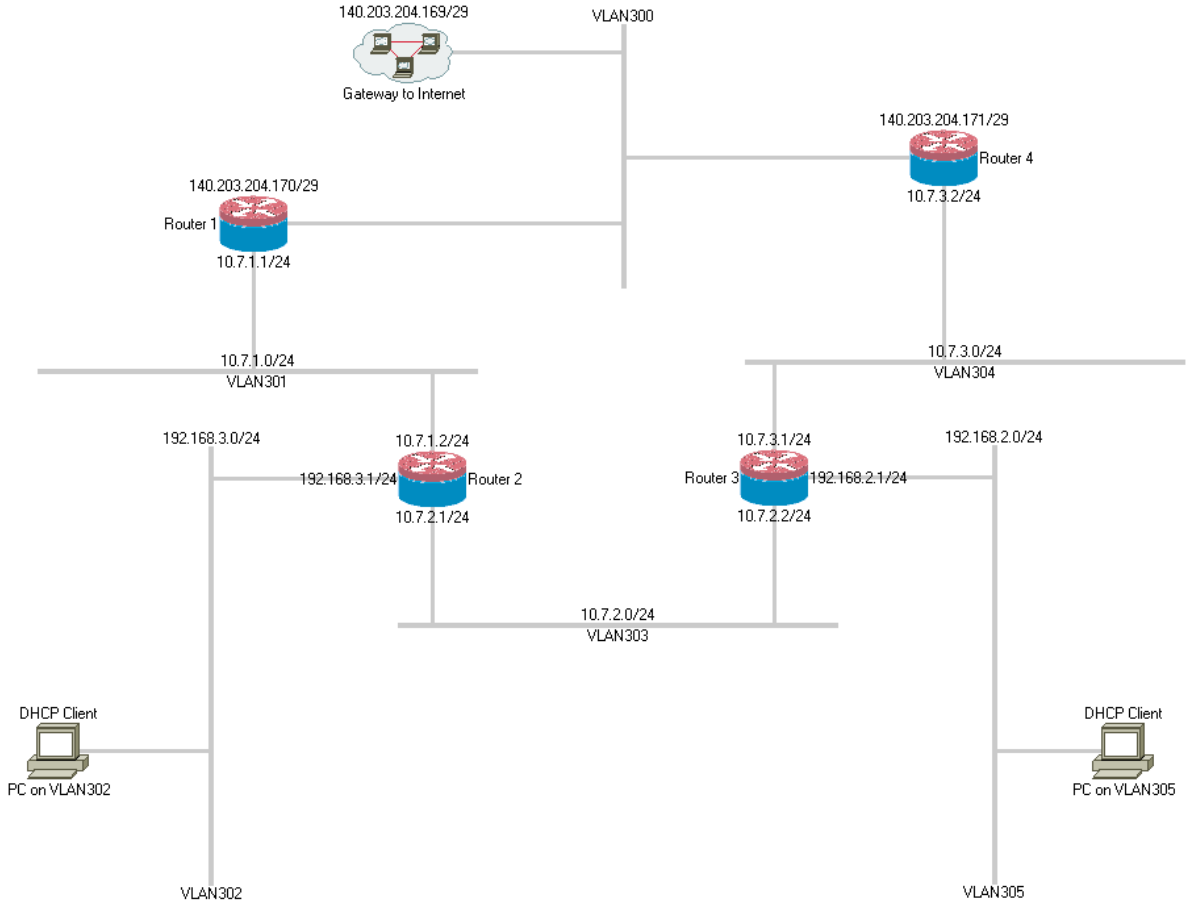

Figure 1 - Example Network

Router 1 has two connected interfaces with the IP addresses shown in Figure 1. It has a NAT firewall rule for internal traffic routed to the internet via this router, as well as a default route to the internet via gateway 140.203.204.169. It has OSPF enabled on the interface connected to Router 2 and it redistributes its default route to other routers via OSPF. The OSPF cost of the interface linking to Router 2 uses the default value of 10.

Router 2 has three connected interfaces with the IP addresses shown in Figure 1. It acts as a DHCP Server for subnet 192.168.3.0/24 and has OSPF enabled on the interfaces connected to Router 1 and Router 3. It also redistributes connected networks so that other OSPF routers will have a route for the 192.168.3.0/24 subnet. The OSPF cost of the interfaces linking to Router 1 and Router 2 both use the default value of 10.

[Q5 continued overleaf]

Router 3 has three connected interfaces with the IP addresses shown in Figure 1. It acts as a DHCP Server for subnet 192.168.2.0/24 and has OSPF enabled on the interfaces connected to Router 2 and Router 4. It also redistributes connected networks so that other OSPF routers will have a route for the 192.168.2.0/24 subnet. The OSPF cost of the interfaces linking to Router 2 uses the default value of 10. However, the OSPF cost on the interface connecting to Router 4 has been set to 300.

Router 4 has two connected interfaces with the IP addresses shown in Figure 1. It has a NAT firewall rule for internal traffic routed to the internet via this router, as well as a default route to the internet via gateway 140.203.204.169. It has OSPF enabled on the interface connected to Router 3 and it redistributes its default route to other routers via OSPF. The OSPF cost on the interface linking to Router 3 has been set to 300.

Answer the following questions in relation to this network:

a: Describe the operation and purpose of the OSPF protocol in the network shown. What is the Link State Database and how is Dijkstra's Algorithm used by OSPF in this context? 8 MARKS

b: What route will a PC attached to VLAN302 and VLAN305 normally take to get to the internet? What would happen with OSPF if the interface between Router 1 and Router 2 became unavailable for some reason? How would the resulting Link State Announcements be disseminated throughout the network? 7 MARKS

c: What is an Autonomous System? In this context explain the purpose of the Border Gateway Protocol (BGP). 5 MARKS

d: Suppose a company was using the RIP dynamic routing protocol on its routers, what reasons would you give to persuade them to change to OSPF instead? 5 MARKS

NUI Galway
OÉ Gaillimh

Semester 1 Examinations 2017 / 2018

Exam Code(s)	3BCT
Exam(s)	Third Year Computer Science & Information Technology
Module Code(s)	CT3531
Module(s)	Networks and Data Communications 2
Paper No.	1
External Examiner(s)	Dr. J. Howe
Internal Examiner(s)	Dr. M. Schukat *Dr. D. Chambers

Instructions: Answer any 4 questions.
All questions carry equal marks.

Duration	2 hrs
No. of Pages	5
Department(s)	Information Technology
Requirements	None

Question 1

a) What are the main phases of network design as per the top-down network design approach? 5 MARKS

b) How do bandwidth and throughput differ? 5 MARKS

c) How can one improve network efficiency and what tradeoffs may be necessary in order to improve network efficiency? 5 MARKS

d) When considering protocol behavior, what is the difference between relative network utilization and absolute network utilization? 5 MARKS

e) What architectural and environmental factors should you consider for a new wireless installation? 5 MARKS

Question 2

Assume that you are working for a large corporation that is using the private IP address range 192.168.0.0/16 for its internal network. The company management wants to be able to accommodate at least 60 departments with up to 1000 hosts per department. You are requested to design the network layout. Answer the following questions and fully explain the logic behind each answer:

a) What subnet mask will need to be used? 5 MARKS

b) What are the valid host addresses on the first and second subnets? 5 MARKS

c) What other private IP ranges could the company use if needed? 5 MARKS

d) When is it appropriate to use IP private addressing versus public addressing? 5 MARKS

e) How will devices using IP addresses in the 192.168.0.0/16 range be able to access the internet, given that this is a private IP range? 5 MARKS

Question 3

a) When is it appropriate to use static versus dynamic addressing? 4 MARKS

b) Why should you be concerned about the number of devices on a single LAN (broadcast domain)? 5 MARKS

c) How do Virtual LANs help control broadcast traffic? In this context explain the purpose of the 802.1Q protocol. 6 MARKS

d) What makes traffic flow in Voice over IP networks challenging to characterize and plan for and why are wireless LANs often implemented as individual VLANs? 5 MARKS

e) How do IETF specifications for QoS affect different types of network traffic? 5 MARKS

Question 4

a) How does a security plan differ from a security policy and why is it important to achieve buy-in from users, managers, and technical staff for the security policy? 6 MARKS

b) Describe three methods for keeping hackers from viewing and changing router and switch configuration information? How can a network manager secure a wireless network? 7 MARKS

c) Outline briefly the three main functions provided by a Packet Filter in Linux. Which firewall chain is used in IPTABLES for packets that are NOT destined for a local process running on the device itself? 6 MARKS

d) Explain in detail the purpose of the following two firewall rules that are defined using IPTABLES format:

```
iptables  -A INPUT –p tcp –-syn –j DROP

iptables -A PREROUTING -t nat -p icmp -d 137.189.89.176 \
                -j DNAT --to 137.189.89.178
```

6 MARKS

Question 5

Consider the example network shown in Figure 1 below:

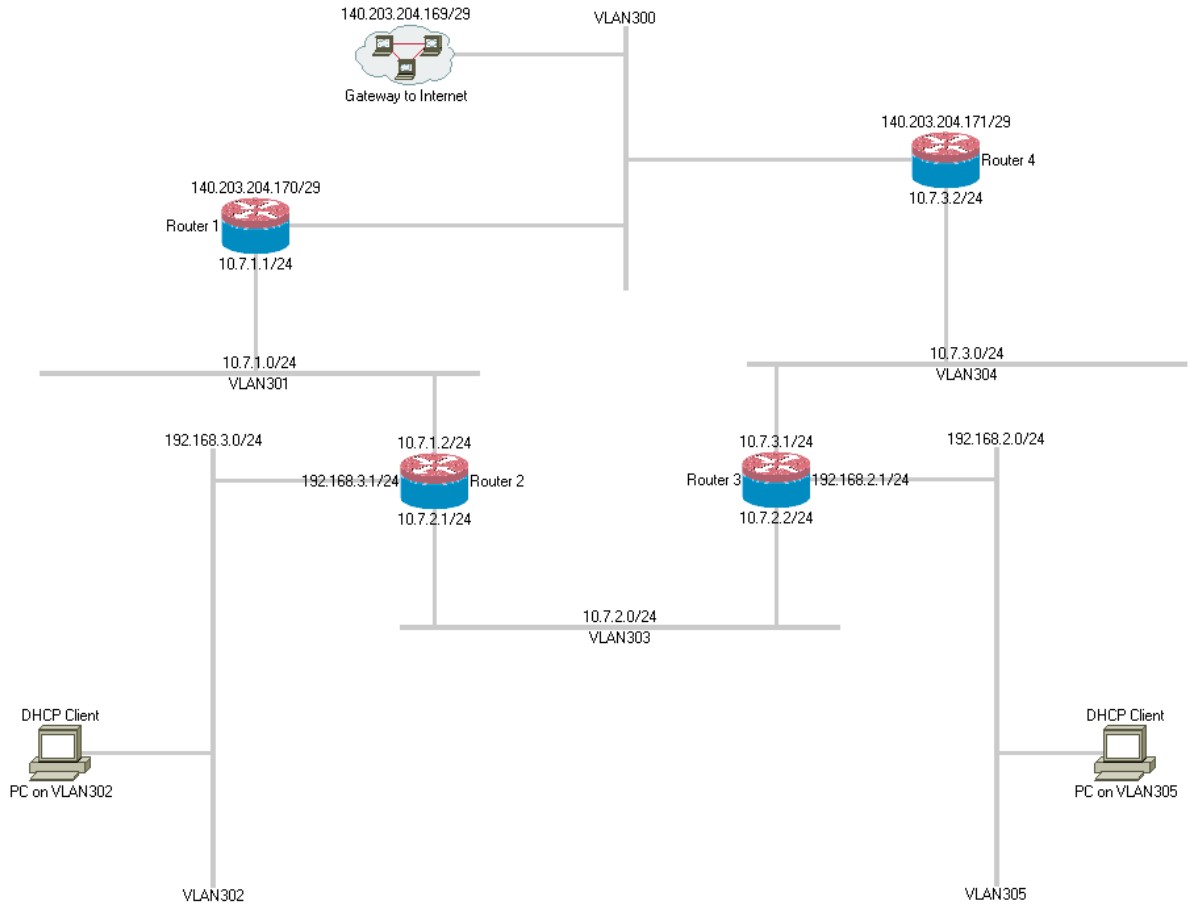

Figure 1 - Example Network

Router 1 has two connected interfaces with the IP addresses shown in Figure 1. It has a NAT firewall rule for internal traffic routed to the internet via this router, as well as a default route to the internet via gateway 140.203.204.169. It has OSPF enabled on the interface connected to Router 2 and it redistributes its default route to other routers via OSPF. The OSPF cost of the interface linking to Router 2 uses the default value of 10.

Router 2 has three connected interfaces with the IP addresses shown in Figure 1. It acts as a DHCP Server for subnet 192.168.3.0/24 and has OSPF enabled on the interfaces connected to Router 1 and Router 3. It also redistributes connected networks so that other OSPF routers will have a route for the 192.168.3.0/24 subnet. The OSPF cost of the interfaces linking to Router 1 and Router 2 both use the default value of 10.

[Q5 continued overleaf]

Router 3 has three connected interfaces with the IP addresses shown in Figure 1. It acts as a DHCP Server for subnet 192.168.2.0/24 and has OSPF enabled on the interfaces connected to Router 2 and Router 4. It also redistributes connected networks so that other OSPF routers will have a route for the 192.168.2.0/24 subnet. The OSPF cost of the interfaces linking to Router 2 uses the default value of 10. However, the OSPF cost on the interface connecting to Router 4 has been set to 300.

Router 4 has two connected interfaces with the IP addresses shown in Figure 1. It has a NAT firewall rule for internal traffic routed to the internet via this router, as well as a default route to the internet via gateway 140.203.204.169. It has OSPF enabled on the interface connected to Router 3 and it redistributes its default route to other routers via OSPF. The OSPF cost on the interface linking to Router 3 has been set to 300.

Answer the following questions in relation to this network:

a: Describe the operation and purpose of the OSPF protocol in the network shown. What is the Link State Database and how is Dijkstra's Algorithm used by OSPF in this context? 5 MARKS

b: Describe the format of an OSPF Link State Announcement. Explain how how a Link State Announcement from Router 2 would be disseminated throughout the network? 6 MARKS

c: What route will a PC attached to VLAN302 and VLAN305 normally take to get to the internet? What would happen with OSPF if the interface between Router 2 and Router 3 became unavailable for some reason? 5 MARKS

d: Suppose a company was using the RIP dynamic routing protocol on its routers, what reasons would you give to persuade them to change to OSPF instead? In this context explain the difference between Distance Vector and Link State routing. 5 MARKS

e: What is an Autonomous System? In this context explain the purpose of an Internet Exchange Point (IXP). 4 MARKS

Autumn Examinations 2017

Exam Code(s)	3BCT
Exam(s)	Third Year Computer Science & Information Technology
Module Code(s)	CT3531
Module(s)	Networks and Data Communications 2
Paper No.	1
External Examiner(s)	Dr. J. Power
Internal Examiner(s)	Dr.. M. Schukat
	*Dr. D. Chambers

Instructions: Answer any 4 questions.
All questions carry equal marks.

Duration	2 hrs
No. of Pages	5
Department(s)	Information Technology
Requirements	None

Question 1

a) What are the main phases of network design as per the top-down network design approach? 5 MARKS

b) What are some typical technical goals for organizations today when undertaking network design? 5 MARKS

c) How is Availability typically measured or expressed? How might it be possible to achieve "Five Nines" in this context? 5 MARKS

d) When considering protocol behavior, what is the difference between relative network utilization and absolute network utilization? 5 MARKS

e) What architectural and environmental factors should you consider for a new wireless installation? 5 MARKS

Question 2

Assume that you are working for a large corporation that is using the private IP address range 172.16.0.0/16 for its internal network. The company management wants to be able to accommodate at least 30 departments with a maximum number of 2000 hosts per department. You are requested to design the network layout. Answer the following questions and fully explain the logic behind each answer:

a) What subnet mask will need to be used? 5 MARKS

b) What is the maximum number of subnets that the company network can accommodate given that there are at least 2000 hosts per subnet? 5 MARKS

c) What are the valid host addresses on the first and last subnets? 5 MARKS

d) What other private IP ranges could the company use if needed? 5 MARKS

e) When is it appropriate to use IP private addressing versus public addressing? 5 MARKS

Question 3

a) When is it appropriate to use static versus dynamic addressing? 4 MARKS

b) List and describe six different types of traffic flows. 6 MARKS

c) Why should you be concerned about broadcast traffic? 5 MARKS

d) How do IETF specifications for QoS affect different types of network traffic? 5 MARKS

e) What are the advantages and disadvantages of the various options for multi-homing an Internet connection? 5 MARKS

Question 4

a) How does a security plan differ from a security policy and why is it important to achieve buy-in from users, managers, and technical staff for the security policy? 6 MARKS

b) What are some methods for keeping hackers from viewing and changing router and switch configuration information? How can a network manager secure a wireless network? 7 MARKS

c) Outline briefly the three main functions provided by a Packet Filter in Linux. Which firewall chain is used in IPTABLES for packets that are NOT destined for a local process running on the device itself? Explain in detail the purpose of the following two firewall rules that are defined using IPTABLES format:

```
iptables  -A INPUT –p tcp –-syn –j DROP

iptables -A PREROUTING -t nat -p icmp -d 137.189.89.176 \
                -j DNAT --to 137.189.89.178
```

12 MARKS

Question 5

Consider the example network shown in Figure 1 below:

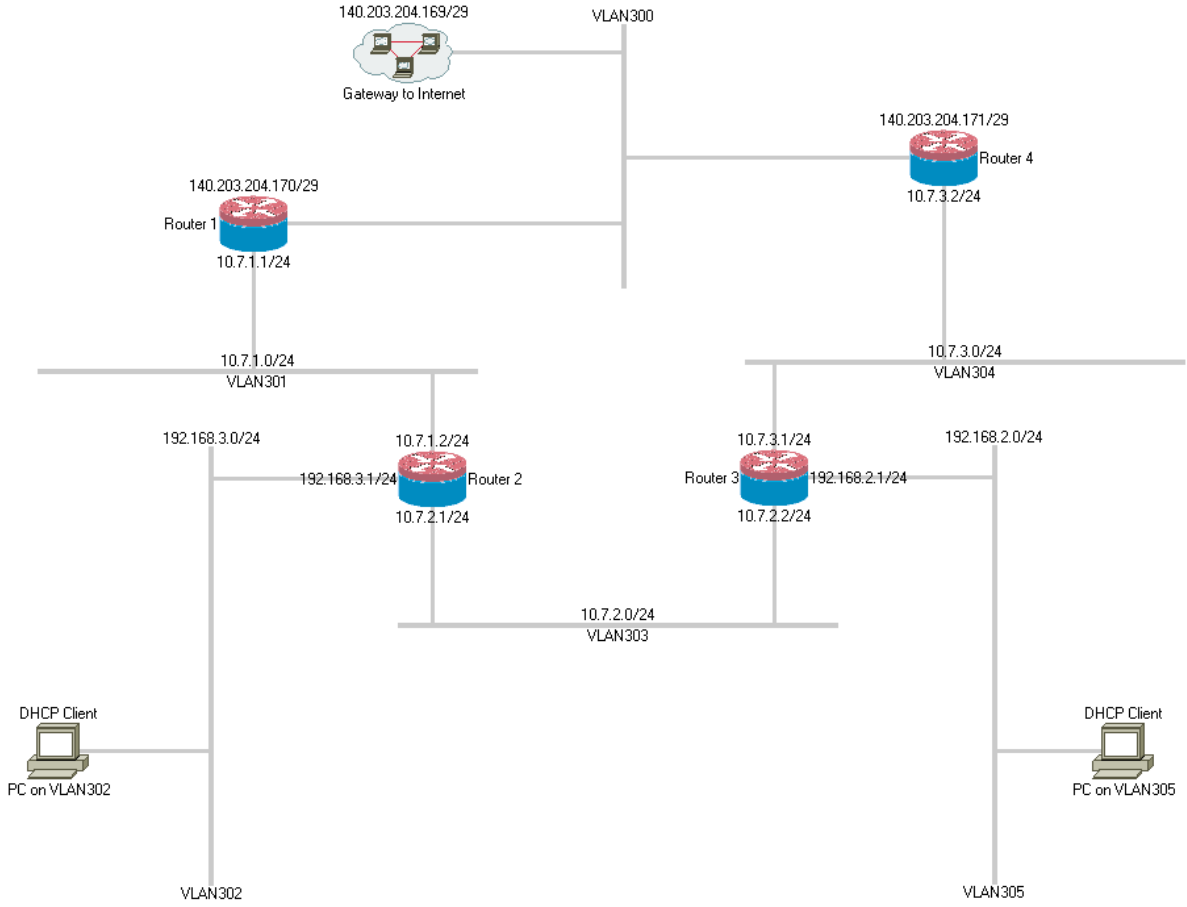

Figure 1 - Example Network

Router 1 has two connected interfaces with the IP addresses shown in Figure 1. It has a NAT firewall rule for internal traffic routed to the internet via this router, as well as a default route to the internet via gateway 140.203.204.169. It has OSPF enabled on the interface connected to Router 2 and it redistributes its default route to other routers via OSPF. The OSPF cost of the interface linking to Router 2 uses the default value of 10.

Router 2 has three connected interfaces with the IP addresses shown in Figure 1. It acts as a DHCP Server for subnet 192.168.3.0/24 and has OSPF enabled on the interfaces connected to Router 1 and Router 3. It also redistributes connected networks so that other OSPF routers will have a route for the 192.168.3.0/24 subnet. The OSPF cost of the interfaces linking to Router 1 and Router 2 both use the default value of 10.

[Q5 continued overleaf]

Router 3 has three connected interfaces with the IP addresses shown in Figure 1. It acts as a DHCP Server for subnet 192.168.2.0/24 and has OSPF enabled on the interfaces connected to Router 2 and Router 4. It also redistributes connected networks so that other OSPF routers will have a route for the 192.168.2.0/24 subnet. The OSPF cost of the interfaces linking to Router 2 uses the default value of 10. However, the OSPF cost on the interface connecting to Router 4 has been set to 300.

Router 4 has two connected interfaces with the IP addresses shown in Figure 1. It has a NAT firewall rule for internal traffic routed to the internet via this router, as well as a default route to the internet via gateway 140.203.204.169. It has OSPF enabled on the interface connected to Router 3 and it redistributes its default route to other routers via OSPF. The OSPF cost on the interface linking to Router 3 has been set to 300.

Answer the following questions in relation to this network:

a: Describe the operation and purpose of the OSPF protocol in the network shown. What is the Link State Database and how is Dijkstra's Algorithm used by OSPF in this context? 8 MARKS

b: What route will a PC attached to VLAN302 and VLAN305 normally take to get to the internet? What would happen with OSPF if the interface between Router 1 and Router 2 became unavailable for some reason? How would the resulting Link State Announcements be disseminated throughout the network? 7 MARKS

c: What is an Autonomous System? In this context explain the purpose of the Border Gateway Protocol (BGP). 5 MARKS

d: Suppose a company was using the RIP dynamic routing protocol on its routers, what reasons would you give to persuade them to change to OSPF instead? 5 MARKS

Semester 1 Examinations 2016 / 2017

Exam Code(s)	3BCT
Exam(s)	Third Year Computer Science & Information Technology
Module Code(s)	CT3531
Module(s)	Networks and Data Communications 2
Paper No.	1
External Examiner(s)	Dr. J. Power
Internal Examiner(s)	Dr.. J. Duggan
	*Dr. D. Chambers

Instructions: Answer any 4 questions.
All questions carry equal marks.

Duration	2 hrs
No. of Pages	5
Department(s)	Information Technology
Requirements	None

Question 1

a) What are the main phases of network design as per the top-down network design approach? 5 MARKS

b) How do bandwidth and throughput differ? 5 MARKS

c) How can one improve network efficiency and what tradeoffs may be necessary in order to improve network efficiency? 5 MARKS

d) When considering protocol behavior, what is the difference between relative network utilization and absolute network utilization? 5 MARKS

e) Why should you characterize the logical structure of an internetwork and not just the physical structure? 5 MARKS

Question 2

Assume that you are working for a large corporation that is using the private IP address range 10.10.0.0/16 for its internal network. The company management wants to be able to accommodate at least 60 sites where each site has its own routed subnet with at least 1000 hosts per department subnet. You are requested to design the network layout. Answer the following questions and fully explain the logic behind each answer:

a) What subnet mask will need to be used? 5 MARKS

b) What is the maximum number of subnets that the company network can accommodate given that there are at least 1000 hosts per subnet? 5 MARKS

c) What are the valid host addresses on the first and second subnets? 5 MARKS

d) What other private IP ranges could the company use if needed? 5 MARKS

e) When is it appropriate to use IP private addressing versus public addressing? 5 MARKS

Question 3

a) What are the three layers of a hierarchical network design? 3 MARKS

b) List and describe six different types of traffic flows. 6 MARKS

c) Why should you be concerned about broadcast traffic and how do Virtual LANs help control broadcast traffic? In this context explain the purpose of the 802.1Q protocol. 6 MARKS

d) What makes traffic flow in voice over IP networks challenging to characterize and plan for and why are wireless LANs often implemented as an individual VLANs? 5 MARKS

e) Describe the purpose and operation of the Spanning Tree Protocol. 5 MARKS

Question 4

a) How does a security plan differ from a security policy and why is it important to achieve buy-in from users, managers, and technical staff for the security policy? 6 MARKS

b) What are some methods for keeping hackers from viewing and changing router and switch configuration information? How can a network manager secure a wireless network? 7 MARKS

c) Outline briefly the three main functions provided by a Packet Filter in Linux. Which firewall chain is used in IPTABLES for packets that are destined for a local process running on the device itself? Explain in detail the purpose of the following firewall rules – the first one is defined using IPTABLES format while the second rule is defined using Mikrotik Router OS format:

```
iptables -A FORWARD –p tcp –s 93.107.200.110 --syn –j DROP

/ip firewall nat add chain=srcnat action=masquerade out-interface=ether2
```

12 MARKS

Question 5

Consider the example network shown in Figure 1 below:

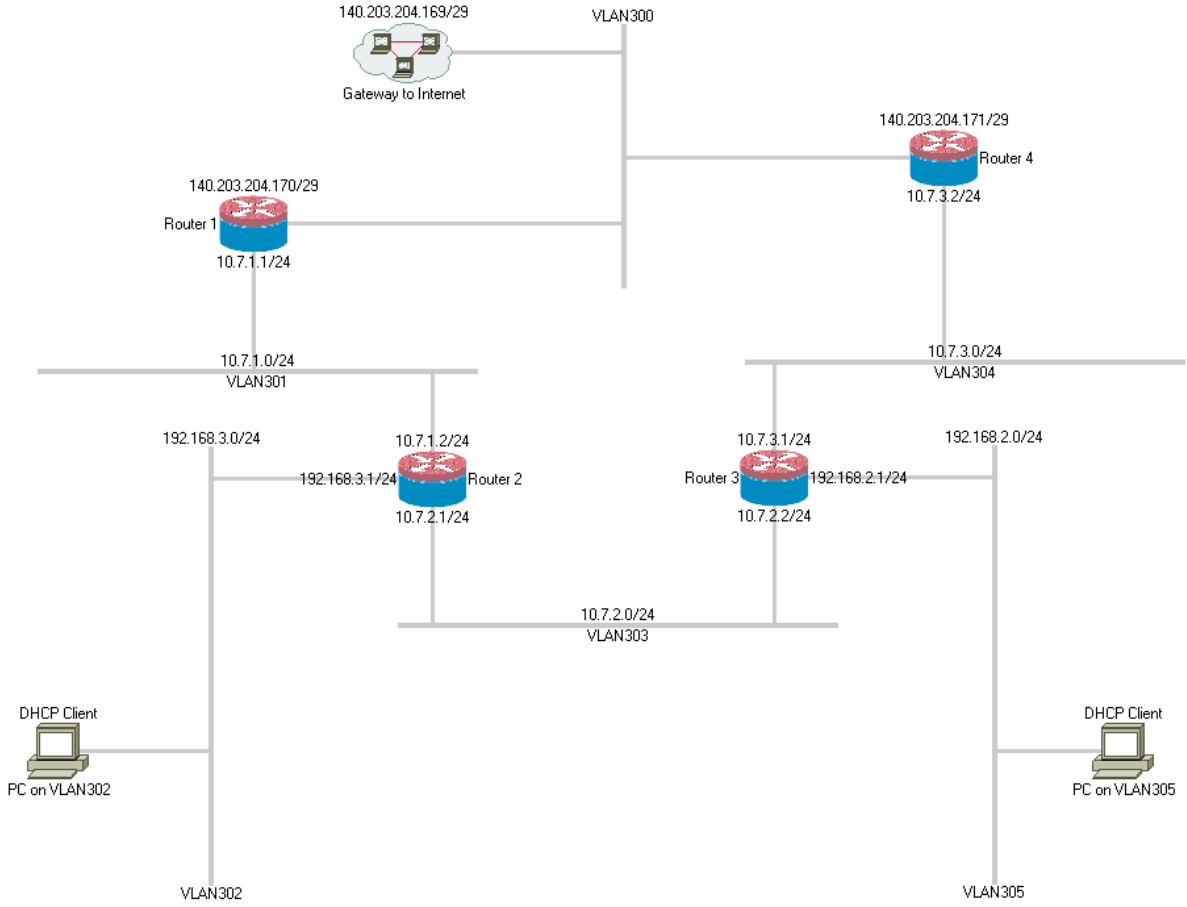

Figure 1 - Example Network

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Router 2 has three connected interfaces with the IP addresses shown in Figure 1. It acts as a DHCP Server for subnet 192.168.3.0/24 and has OSPF enabled on the interfaces connected to Router 1 and Router 3. It also redistributes connected networks so that other OSPF routers will have a route for the 192.168.3.0/24 subnet. The OSPF cost of the interfaces linking to Router 1 and Router 2 both use the default value of 10.

[Q5 continued overleaf]

Router 3 has three connected interfaces with the IP addresses shown in Figure 1. It acts as a DHCP Server for subnet 192.168.2.0/24 and has OSPF enabled on the interfaces connected to Router 2 and Router 4. It also redistributes connected networks so that other OSPF routers will have a route for the 192.168.2.0/24 subnet. The OSPF cost of the interfaces linking to Router 2 uses the default value of 10. However, the OSPF cost on the interface connecting to Router 4 has been set to 300.

Router 4 has two connected interfaces with the IP addresses shown in Figure 1. It has a NAT firewall rule for internal traffic routed to the internet via this router, as well as a default route to the internet via gateway 140.203.204.169. It has OSPF enabled on the interface connected to Router 3 and it redistributes its default route to other routers via OSPF. The OSPF cost on the interface linking to Router 3 has been set to 300.

Answer the following questions in relation to this network:

a: Describe the operation and purpose of the OSPF protocol in the network shown. What is the Link State Database and how is Dijkstra's Algorithm used by OSPF in this context? 8 MARKS

b: What route will a PC attached to VLAN302 and VLAN305 normally take to get to the internet? What would happen with OSPF if the interface between Router 1 and Router 2 became unavailable for some reason? How would the resulting Link State Announcements be disseminated throughout the network? 7 MARKS

c: What is an Autonomous System? In this context explain the purpose of the Border Gateway Protocol (BGP). 5 MARKS

d: Suppose a company was using the RIP dynamic routing protocol on its routers, what reasons would you give to persuade them to change to OSPF instead? 5 MARKS

NUI Galway
OÉ Gaillimh

Autumn Examinations 2016

Exam Code(s)	3BCT
Exam(s)	BSc Computer Science & Information Technology
Module Code(s)	CT3531
Module(s)	Networks and Data Communications 2
Paper No.	1
External Examiner(s)	Dr. J. Power
Internal Examiner(s)	Prof. G. Lyons
	Dr. J. Duggan
	*Dr. D. Chambers

Instructions: Answer any 4 questions.
All questions carry equal marks.

Duration	2 hrs
No. of Pages	3
Department(s)	Information Technology
Requirements	None

Question 1

a) Explain the difference between *Asynchronous* and *Synchronous* transmission of data. Illustrate, using a suitable example, how *Manchester Encoding* can be used to allow a data receiver to recover the clocking information from transitions in the arriving data. 12 MARKS

b) Digital signals transmitted via copper wire can sometimes be exposed to radiated electrical noise that can cause interference and potentially data loss in the received signal, especially if the distance involved is over 10m. Suggest a suitable physical transmission scheme that provides some level of immunity against this type of interference on copper wires. 13 MARKS

Question 2

a) Compute the wavelength of a radio signal having a frequency of 2.4GHz. In what part of the electromagnetic spectrum does this signal belong i.e. would it correctly be described as UHF, Microwave or Infrared? 5 MARKS

b) What is the main advantage of using a Digital Signal instead of an Analog Signal? Suppose we have a communications channel with 25MHz of bandwidth. How many bits/sec can be sent over one of these channels if 128-level digital signals are used? Assume a noiseless channel. 10 MARKS

c) Television channels are generally 6MHz wide (in terms of bandwidth). What is the minimum signal-to-noise ratio required to transmit a 72Mbps data stream through one of these channels? 10 MARKS

Question 3

a) Explain round trip time in the context of Ethernet (IEEE 802.3). The standard minimum frame size allowed on Ethernet (IEEE 802.3) is 64 bytes (from destination address to checksum, including both). Explain the reason behind this limitation. 13 MARKS

b) Most existing wired Local Area Networks are now based on Cat-5 UTP type cabling. Suggest a suitable modulation and encoding scheme that facilitates fully duplex 100Mbps data transmission using one cable pair in each direction. The physical signal that is transmitted over the cable should have a maximum frequency component of about 31.25Mhz. Explain the solution proposed in your answer and why it would work. 12 MARKS

Question 4

a) Explain briefly the role and function of the RIPE organisation. What kind of information may be found in the RIPE database? 5 MARKS

a) In the context of email handling what does the term "DNS Blacklist" mean and how are these used by mail servers? Describe how email transfer agents cope with the transmission of messages containing multiple parts and in some cases arbitrary binary data e.g. image files. 8 MARKS

b) What are the main enhancements provided in IPv6 over IPv4 and what impact is this protocol likely to have in the way we use the internet? Why has the new protocol not included protocol header support for IP fragments? How many IPv6 addresses are typically being allocated to each customer by ISPs? Give an example of what an IPv6 address will look like. 12 MARKS

Question 5

a) Why does UDP exist? Would it not have been enough to just let user processes send raw IP packets? 5 MARKS

b) NUI Galway uses the public IP address range 140.203.0.0/16 for its internal computer network. The University wants to be able to accommodate at least 30 departments with a maximum number of 2000 hosts per department. You are requested to design the optimum network layout using an individual subnet for each department. What is the maximum number of departments that the University can accommodate? Explain the logic of your answer. What subnet mask should be used? 10 MARKS

c) There are well known problems with the performance of TCP that can occur when a sending application delivers data to TCP one byte at a time or a receiving application reads data from TCP one byte at a time e.g. the individual keystrokes transmitted and received during a remote login session. Suggest a complementary solution to each of these potential problems. 10 MARKS

NUI Galway
OÉ Gaillimh

Semester 1 Examinations 2015 / 2016

Exam Code(s)	3BCT
Exam(s)	Third Year Computer Science & Information Technology
Module Code(s)	CT3531
Module(s)	Networks and Data Communications 2
Paper No.	1
External Examiner(s)	Dr. J. Power
Internal Examiner(s)	Prof. G. Lyons Dr. M. Madden *Dr. D. Chambers

Instructions: Answer any 4 questions.
All questions carry equal marks.

Duration	2 hrs
No. of Pages	4
Department(s)	Information Technology
Requirements	None

Question 1

a) What are the main advantages of using a Digital Signal instead of an Analog Signal? Suppose we have a communications channel with 20MHz of bandwidth. How many bits/sec can be sent over one of these channels if 1024-level digital signals are used? Assume a noiseless channel. 12 MARKS

b) LTE (4G) mobile internet channels are generally about 10MHz wide in terms of bandwidth. What is the minimum signal-to-noise ratio (in decibels) required to transmit a 100Mbps data stream through one of these channels? Also, what is the minimum number of signal levels required in the transmitted digital signal to achieve that data rate? 13 MARKS

Question 2

a) Most existing wired Local Area Networks are now based on Cat-5 UTP type cabling. Suggest a suitable modulation and encoding scheme that facilitates fully duplex 100Mbps data transmission using one cable pair in each direction. The physical signal that is transmitted over the cable should have a maximum frequency component of about 31.25Mhz. 10 MARKS

b) Explain how analog to digital conversion works. In this context, why has the PCM sampling time, as used in digital speech encoding for the telephone network, been set at 125μS? What is the resulting data rate required to transmit a single digitised voice channel using the standard PCM encoding scheme? What type of channel is typically used to aggregate multiples of these voice conversations into a single data stream e.g. using time division multiplexing techniques? 15 MARKS

Question 3

a) What are the main enhancements provided in IPv6 over IPv4 and what impact is this protocol likely to have in the way we use the internet? Why has the new protocol not included protocol header support for IP fragments? How many IPv6 addresses are typically being allocated to each customer by ISPs? Give an example of what an IPv6 address will look like. 12 MARKS

b) There are well known problems with the performance of TCP that can occur when a sending application delivers data to TCP one byte at a time or a receiving application reads data from TCP one byte at a time. An example of what can cause such problems is the individual keystrokes transmitted and received during a remote login session. Explain fully how these problems can occur and describe possible solutions to mitigate against these issues in TCP. 13 MARKS

Question 4

a) Explain briefly the role and function of the RIPE organisation. What kind of information may be found in the RIPE database? 5 MARKS

b) In the context of email handling what does the term "DNS Blacklist" mean and how are these used by mail servers? Describe how email transfer agents cope with the transmission of messages containing multiple parts and in some cases arbitrary binary data e.g. image files. Compare the relative merits of using POP3 vs IMAP for delivery of email to clients. 10 MARKS

c) Describe using an appropriate example the purpose and the operation of the Domain Name System (DNS). What Protocols and Port numbers does DNS normally use? Given the following set of DNS Resource records, if you sent an email to joe@cs.vu.nl what SMTP server(s) could be used to receive and process the incoming message?

```
; Authoritative data for cs.vu.nl
cs.vu.nl.          86400   IN   SOA      star boss (952771,7200,7200,2419200,86400)
cs.vu.nl.          86400   IN   TXT      "Divisie Wiskunde en Informatica."
cs.vu.nl.          86400   IN   TXT      "Vrije Universiteit Amsterdam."
cs.vu.nl.          86400   IN   MX       1 zephyr.cs.vu.nl.
cs.vu.nl.          86400   IN   MX       2 top.cs.vu.nl.

flits.cs.vu.nl.    86400   IN   HINFO    Sun Unix
flits.cs.vu.nl.    86400   IN   A        130.37.16.112
flits.cs.vu.nl.    86400   IN   A        192.31.231.165
flits.cs.vu.nl.    86400   IN   MX       1 flits.cs.vu.nl.
flits.cs.vu.nl.    86400   IN   MX       2 zephyr.cs.vu.nl.
flits.cs.vu.nl.    86400   IN   MX       3 top.cs.vu.nl.
www.cs.vu.nl.      86400   IN   CNAME    star.cs.vu.nl
ftp.cs.vu.nl.      86400   IN   CNAME    zephyr.cs.vu.nl

rowboat                    IN   A        130.37.56.201
                           IN   MX       1 rowboat
                           IN   MX       2 zephyr
                           IN   HINFO    Sun Unix

little-sister              IN   A        130.37.62.23
                           IN   HINFO    Mac MacOS

laserjet                   IN   A        192.31.231.216
                           IN   HINFO    "HP Laserjet IIISi" Proprietary
```

10 MARKS

Question 5

Assume that you are working for a large corporation that is using the private IP address range 172.16.0.0/16 for its internal network. The company management wants to be able to accommodate at least 30 departments where each department has its own routed subnet with at least 2000 hosts per department subnet. You are requested to design the network layout. Answer the following questions and fully explain the logic behind each answer:

a) What subnet mask will need to be used? 5 MARKS

b) What is the maximum number of subnets that the company network can accommodate given that there are at least 2000 hosts per subnet? 5 MARKS

c) What are the valid host addresses on the first and second subnets? 5 MARKS

d) What is the network and broadcast address for the last available subnet? 5 MARKS

e) What other private IP ranges could the company use if needed? 5 MARKS