CPSC 441
COMPUTER COMMUNICATIONS

FINAL EXAM

Department of Computer Science
University of Calgary
Professor Carey Williamson

April 21, 2012

This is a CLOSED BOOK exam. Textbooks, notes, laptops, personal digital assistants, and cellular phones are NOT allowed. However, **calculators are permitted**.

It is a 120 minute exam, with a total of 80 marks. There are 18 questions, and 9 pages (including this cover page). Please read each question carefully, and write your answers legibly in the space provided. You may do the questions in any order you wish, but please USE YOUR TIME WISELY.

When you are finished, please hand in your exam paper and sign out. Good luck!

Student Name: _____

Student ID: _____

Score: _____ / 80 = _____ %

Multiple Choice

Choose the best answer for each of the following 12 questions, for a total of 12 marks.

1 1. The flow control technique used in most versions of TCP is:

(a) rate-based

(b) window-based

(c) credit-based

(d) all of the above

(e) none of the above

1 2. In traditional network architectures, congestion control is a technique implemented:

(a) at the application layer

(b) at the transport layer

(c) at the network layer

(d) at the datalink layer

(e) at the physical layer

1 3. Asynchronous Transfer Mode (ATM) is a technology from the 1990's that provides:

(a) a datagram network service model with fixed-size packets

(b) a datagram network service model with variable-size packets

(c) a virtual circuit network service model with fixed-size packets

(d) a virtual circuit network service model with variable-size packets

(e) all of the above

1 4. Part of the motivation for deploying IPv6 on today's Internet is:

(a) the ability to charge Internet users 50% more than before

(b) a tighter (28-bit) address space to reduce IP header overhead

(c) a change from connection-less to connection-oriented service in the network core

(d) better support for mobility, security, and Quality of Service (QoS)

(e) all of the above

1 5. Network Address Translation (NAT) is arguably distasteful because:

(a) it shields many IP hosts from attack via the Internet

(b) it expands the potential use of the scarce IPv4 address space

(c) it violates the principle of layered protocol design

(d) it makes Skype, media streaming, and P2P incredibly easy to use

(e) none of the above

1 6. The "tunneling" technique of IP-in-IP encapsulation can be used to support:

(a) mobile hosts who want to retain their IP-level identity while roaming

(b) "islands" of IPv6 connectivity within a predominantly IPv4 network

(c) multicast datagram delivery in an overlay network

(d) all of the above

(e) none of the above

1 7. The Point to Point Protocol (PPP):

(a) is a connection-oriented datalink layer protocol

(b) is intended for dialup modem access to the Internet

(c) uses flag-based framing with variable-sized frames

(d) uses byte stuffing (when needed) to distinguish data from control

(e) all of the above

1 8. The protocol used to map from an IP address to a MAC-layer address is:

(a) Domain Name Service (DNS)

(b) Dynamic Host Configuration Protocol (DHCP)

(c) Address Resolution Protocol (ARP)

(d) Reverse Address Resolution Protocol (RARP)

(e) none of the above

1 9. The MAC sublayer:

(a) is only needed on point-to-point links

(b) is only needed on broadcast links

(c) is only needed for Apple computers

(d) provides secure communication using a Message Authentication Code

(e) all of the above

1 10. The primary MAC-layer protocol used in IEEE 802.11b wireless networks is:

(a) ALOHA

(b) Slotted ALOHA

(c) CSMA/CD

(d) CSMA/CA

(e) none of the above

1 11. The use of global timing synchronization in Slotted ALOHA:

(a) doubles the overall efficiency compared to CSMA

(b) halves the overall efficiency compared to CSMA

(c) doubles the overall efficiency compared to Pure ALOHA

(d) halves the overall efficiency compared to Pure ALOHA

(e) none of the above

1 12. Following a collision, the IEEE 802.3 (Ethernet) protocol recommends:

(a) doing an immediate Fast Retransmit

(b) entering Slow Start

(c) entering Fast Recovery

(d) calling your insurance agent

(e) none of the above

Protocol Stack

10 13. The diagram below shows the Internet protocol stack that we studied in CPSC 441. On the left side of the diagram, write the term associated with the **logical unit of data** exchanged by each layer. On the right of the diagram, give an **example protocol** associated with each particular layer.

Logical Unit	Layer	Protocol Example
	Application	
	Transport	
	Network	
	Data Link	
	Physical	

Media Streaming Applications

9 14. The user-perceived experience with media streaming applications depends on the quality of service provided by the underlying protocols in the Internet protocol stack. One design choice is between TCP or UDP at the transport layer, though other issues arise as well.

(a) (3 marks) In the early Internet, UDP was the dominant choice as the transport-layer protocol for media streaming applications. Give three reasons why UDP was used.

(b) (2 marks) In the past decade, TCP has become prevalent as the transport-layer protocol for Internet streaming applications. Give two reasons why TCP is now being used.

(c) (4 marks) What additional challenges arise for media streaming applications when users have mobile wireless devices? How can these be addressed, if at all?

Networking Concepts and Definitions

12 15. For each of the following pairs of terms, **explain each term**, making sure to identify the similarities (if any) and the **key differences** between the two terms.

(a) (3 marks) "client-server" and "peer-to-peer"

(b) (3 marks) "forwarding" and "routing"

(c) (3 marks) "Internet checksum" and "Cyclic Redundancy Check (CRC)"

(d) (3 marks) "Maximum Segment Size (MSS)" and "Maximum Transmission Unit (MTU)"

IP Addressing and Routing

15 16. The techniques used to achieve host-to-host routing of IP datagrams on the Internet have evolved over the years, as the scale and complexity of the Internet have increased.

(a) (2 marks) What are the two logical components of an IPv4 address? What role does each play in the routing and delivery of an IP datagram?

(b) (2 marks) What is an "IP subnet"? How does it affect the routing/delivery of IP datagrams?

(c) (5 marks) What is *class-based* addressing? What is *class-less* addressing? Why was the latter approach (i.e., CIDR) introduced?

(d) (3 marks) What is an *Autonomous System* (AS)? What role does it play in routing?

(e) (3 marks) What is *multicast* routing? What additional complexities arise when trying to support multicast routing on the Internet?

Data Link Layer and Local Area Networks

10 17. Use your knowledge of Ethernet LANs to answer the following questions.

(a) (2 marks) Many enterprise LANs make use of **Ethernet switches** to build large internetworks. List **2** capabilities of an Ethernet switch that are **similar** (or equivalent) to the functionality provided by an Ethernet hub.

(b) (4 marks) List **4** capabilities of an Ethernet switch that are distinctly **different** from (and superior to) the functionality provided by an Ethernet hub.

(c) (3 marks) A wacky professor once proclaimed that the channel access protocol in an Ethernet LAN is a lot like a big roll of toilet paper (TP). Give **three reasons** why this analogy makes sense. That is, identify three distinct aspects of the CSMA/CD channel access protocol that are well-illustrated by the TP example.

(d) (1 mark) Give **one example** where the analogy in (c) fails. That is, identify an aspect of the CSMA/CD protocol that is not well-modeled with the TP example.

The Modern Internet

12 18. One could argue that the original design of the Internet placed the primary emphasis on functionality (i.e., making it work) rather than on **security** or **performance**. While this design has been phenomenally successful, there have been many bumps and hiccups (i.e., unfortunate incidents) along the way, particularly as the scale and heterogeneity of the Internet have increased.

(a) (3 marks) Give **3 examples** of features in early Internet protocols that might have seemed like a good idea at the time, but have inadvertently led to unexpected inefficiencies in protocol **performance** on today's Internet. For each example, make sure to identify the protocol(s) and layer(s) involved, and why the problem occurs.

(b) (3 marks) Give **3 examples** of features in early Internet protocols that inadvertently led to **security** vulnerabilities that have been exploited by the "bad guys" on the Internet. For each example, make sure to identify the protocol(s) and layer(s) involved, and why the problem occurs.

(c) (3 marks) Would IPv6 solve the foregoing problems? If so, how? If not, why not?

(d) (3 marks) If you were designing IPv7, what new feature(s) would you add, and why?

*** THE END ***