

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

# Sirindhorn International Institute of Technology Thammasat University

**Final Examination: Semester 1, 2010**

**Course Title:** ITS323 Introduction to Data Communications

**Instructor:** Steven Gordon

**Date/Time:** Friday 15 October 2010; 9:00–12:00

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**Instructions:**

- This examination paper has 19 pages (including this page).
- Conditions of Examination: Closed book; No dictionary; Non-programmable calculator is allowed
- Students are not allowed to be out of the exam room during examination. Going to the restroom may result in score deduction.
- Students are not allowed to have communication devices (e.g. mobile phone) in their possession.
- Write your name, student ID, section, and seat number clearly on the front page of the exam, and on any separate sheets (if they exist).

## Multiple Choice Questions [28 marks]

**Write your answers in the table at the end of the multiple choice questions.** Choose only one answer (there is only one correct answer for each question). 2 marks for a correct answer. 0 marks for an incorrect or no answer.

1. A disadvantage of circuit switching (versus datagram packet switching) is:
  - (a) It is difficult to guarantee performance for delivery of data
  - (b) As new connections are requested they may be blocked
  - (c) Data is likely to be dropped at switches
  - (d) Switches are complex because they must process every piece of data
  - (e) A larger delay (than datagram packet switching) will always occur when transferring the same amount of data
2. Normally UDP would be implemented as:
  - (a) Part of a user application, such as web browser, email client or audio/video streaming application.
  - (b) An application installed by users that want to use UDP
  - (c) Hardware on the LAN/WAN interface cards
  - (d) Software in the operating system
  - (e) Device drivers that control the LAN/WAN interface cards
3. The type of switching used in IP networks is:
  - (a) Datagram packet switching
  - (b) Virtual circuit packet switching
  - (c) Circuit switching
  - (d) Ethernet switching
  - (e) None of the above
4. With some adaptive routing protocols information about the network (e.g. topology, link costs) comes from all nodes and is updated on a periodic basis. For normal flooding, where does the information come from and how is it updated?
  - (a) All nodes, periodic updates
  - (b) All nodes, continuous updates
  - (c) All nodes, no updates
  - (d) No nodes, periodic updates
  - (e) No nodes, continuous updates
  - (f) No nodes, no updates
  - (g) Neighbour nodes, periodic updates
  - (h) Neighbour nodes, continuous updates

5. Select the correct set of features provided by IP:
- (a) Addressing, error control, security
  - (b) Connection-oriented, multiplexing, flow control
  - (c) Connection-less, addressing, multiplexing
  - (d) Addressing, flow control, quality of service
  - (e) Addressing, error control, connection-less
  - (f) Flow control, addressing, multiplexing
6. Which protocol provides flow control, error control and connection management:
- (a) ARP
  - (b) DNS
  - (c) ICMP
  - (d) HTTP
  - (e) TCP
  - (f) UDP
7. Consider virtual circuit packet switching. A has 3 packets to send to B, via 2 switches. The transmission time of a packet is 10ms and the link propagation delay is 2ms. A connect request packet has a transmission time of 1ms, as does a connect response. All links are identical. Assuming no queuing or processing delay, if A has data to send at time 0, at what time is the data fully received at B?
- (a) 30 ms
  - (b) 36 ms
  - (c) 54 ms
  - (d) 56 ms
  - (e) 74 ms
  - (f) 80 ms
8. In IP:
- (a) Fragmentation may occur at the source host only, with re-assembly at the routers and destination host
  - (b) Fragmentation may occur at the source host and routers, with re-assembly at the routers and destination host
  - (c) Fragmentation may occur at the source host only, with re-assembly at the destination host only
  - (d) Fragmentation may occur at the source host and routers, with re-assembly at the destination host only
  - (e) Fragmentation and re-assembly is not implemented.

9. Which is the most common data rate used today in IEEE 802.3 Ethernet LANs?
- (a) 1 Mb/s
  - (b) 10 Mb/s
  - (c) 11 Mb/s
  - (d) 54 Mb/s
  - (e) 100 Mb/s
  - (f) 200 Mb/s
10. When using link state routing, the most important information in a link state packet created by router A is:
- (a) Number of links that router A has to other nodes
  - (b) Number of hops from router A to every other router in the network
  - (c) Addresses of routers that are directly linked to router A
  - (d) Addresses of all other routers in the network
  - (e) Number of hops that the packet should be forwarded
  - (f) Current cost of all links in the network
11. Which technology is best described as being designed for short-range, low data rate, long battery lifetime:
- (a) Wireless LAN
  - (b) Ethernet
  - (c) Round Robin
  - (d) Token Ring
  - (e) ZigBee
  - (f) WiMax
12. Wireless LAN, Bluetooth, WiMax and ZigBee include standards:
- (a) Developed by IETF, for the physical and data link layers
  - (b) Developed by IETF, for the network layer
  - (c) Developed by IEEE, for the physical layer only
  - (d) Developed by IEEE, for the physical and data link layers
  - (e) Developed by ITU, for the network layer
  - (f) Developed by ITU, for the physical layer only

13. Which of the following statements about internetworking is true?
- (a) A host can have only one network interface
  - (b) A host may send a packet with a router as destination
  - (c) A router always has two network interfaces
  - (d) A router cannot be a source of IP datagrams
  - (e) A host may forward IP datagrams
  - (f) A subnet has only one router attached
  - (g) None of the above
14. Consider a stop-and-wait ARQ protocol used over a 1Mb/s link. What is the maximum throughput that can be achieved if data frames contain a maximum of 1000 Bytes of data and the link propagation delay is 21ms (ignore the size of ACKs and headers; answer is rounded to nearest Kb/s):
- (a) 20 Kb/s
  - (b) 23 Kb/s
  - (c) 160 Kb/s
  - (d) 186 Kb/s
  - (e) 381 Kb/s
  - (f) 1 Mb/s

<i>Question</i>	<i>Answer</i>
1	
2	
3	
4	
5	
6	
7	

<i>Question</i>	<i>Answer</i>
8	
9	
10	
11	
12	
13	
14	

**Question 1** [11 marks]

A TCP connection is established using a three-way handshake, as illustrated in Figure 1.

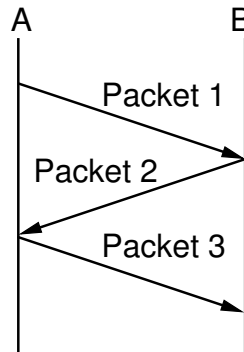


Figure 1: TCP Three-Way Handshake

A web browser, assigned port number 50123 by the operating system on computer A, initiates a connection to a web server on computer B. The IP address of A is 1.2.3.4 and the IP address of B is 5.6.7.8. The web browser has 200 Bytes of data to send to B. Assume to reduce the number of packets sent, the first data sent by A is *piggybacked* on the last three-way handshake packet. Assume the initial sequence number chosen by A is 1111, and chosen by B is 2222. Assume no optional fields are used in IP or TCP headers.

- (a) For each of the packets in the three-way handshake, give the values of the selected header fields by completing the tables below (for Flags, give the abbreviation of the flag(s) that is set to 1): [9 marks]

i. Packet 1:

<i>Protocol</i>	<i>Field</i>	<i>Value</i>
IP	Total Length	
IP	Source Address	
IP	Destination address	
TCP	Source Port	
TCP	Destination Port	
TCP	Sequence Number	
TCP	Flags	

ii. Packet 2:

<i>Protocol</i>	<i>Field</i>	<i>Value</i>
IP	Source Address	
IP	Destination address	
TCP	Source Port	
TCP	Destination Port	
TCP	Sequence Number	
TCP	Acknowledgement Number	
TCP	Flags	

iii. Packet 3:

<i>Protocol</i>	<i>Field</i>	<i>Value</i>
IP	Total Length	
TCP	Sequence Number	
TCP	Acknowledgement Number	
TCP	Flags	

- (b) Comparing TCP to UDP, explain a disadvantage of using TCP as a transport protocol when an application only has a small amount of data to send across an internet that has a large end-to-end delay. [2 marks]

## Question 2 [13 marks]

Assuming classless IP addressing is used, answer the following questions by **writing your answers in the table on the next page**. Unless otherwise stated, give all IP addresses in dotted decimal notation.

- (a) For a host with IP address 183.79.14.203 with subnet mask 255.255.0.0: [3 marks]
- What is the network address?
  - What is the directed broadcast address?
  - If classful addressing was used, what class would this IP address belong to?
- (b) For a host with IP address 43.64.209.17/10: [4 marks]
- What is the network address?
  - What is the directed broadcast address?
  - What is the subnet mask (in dotted decimal notation)?
  - What is the maximum number of hosts that can attach to this subnet?
- (c) A host does not yet have an IP address configured, nor does it know its network address. [3 marks]
- Give an IP address that the host can send to in order to send to itself.
  - Give an IP address that the host can send to in order to deliver an IP datagram to all nodes on its subnet.
  - For the case of part (ii), give the source address of the IP datagram.
- (d) For a router with IP address 10111110000011111000000000000100 and host *on a different subnet to the router* with IP address 190.15.244.12: [3 marks]
- What is the IP address of the router (in dotted decimal notation)?
  - What is the subnet mask of the router (in slash or dotted decimal notation) that allows the most hosts to attach to the routers subnet?



<i>Question</i>	<i>Answer</i>
(a) i.	
(a) ii.	
(a) iii.	
(b) i.	
(b) ii.	
(b) iii.	
(b) iv.	
(c) i.	
(c) ii.	
(c) iii.	
(d) i.	
(d) ii.	

**Question 3** [13 marks]

Consider a small switched Fast Ethernet local area network with six stations: three PCs, one web server, one email server and one router. The router provides a connection to the Internet via a WiMax (IEEE 802.16) link.

- (a) Draw the LAN, showing the devices and links. You can draw “the Internet” as a circle or cloud. *Give each interface a class C IP address.* [6 marks]

- (b) What is the name of the topology used in the LAN? [1 mark]

(c) Draw the protocol stack of the web server, labelling each layer with the protocol/standard used (you may use acronyms). [3 marks]

(d) Draw the protocol stack of the router, labelling each layer with the protocol/standard used (you may use acronyms). [3 marks]

## Question 4 [8 marks]

Consider the following set of DNS servers in the Internet. Each server has a *number*, the *domain* that it manages, its *IP address*, and the current domains in its *cache*. Make the following assumptions:

- Each DNS server knows the IP address of its parent and children DNS servers in a simple DNS hierarchy.
- The Root DNS server manages the top level domains (instead of having separate servers for `.com` and `.th`).
- Each DNS server knows the IP address of web servers (`www`) and FTP servers (`ftp`) within the domain.
- Hosts do not have a DNS cache.

No.	Domain	IP Address	Cache
1	<code>.siit.tu.ac.th</code>	203.131.209.70	<code>www.google.com</code> : 64.233.181.147 <code>ftp.chula.ac.th</code> : 161.200.192.249
2	<code>.cs.tu.ac.th</code>	203.131.208.2	<code>www.tu.ac.th</code> : 203.131.222.38
3	<code>.tu.ac.th</code>	203.131.222.11	<code>www.yahoo.com</code> : 98.137.149.56 <code>www.chula.ac.th</code> : 161.200.192.248
4	<code>.chula.ac.th</code>	161.200.192.4	-
5	<code>.ac.th</code>	122.155.12.37	<code>www.chula.ac.th</code> : 161.200.192.248
7	<code>.google.com</code>	216.239.32.10	<code>www.siit.tu.ac.th</code> : 115.178.61.153 <code>ftp.yahoo.com</code> : 98.137.132.15
8	<code>.yahoo.com</code>	98.137.132.14	<code>www.google.com</code> : 64.233.181.147
9	root	198.41.0.4	-

(a) If a host computer in SIIT's network (which knows the IP address of the SIIT DNS server, that is 203.131.209.70) requests the following domain, indicate the order of DNS servers in which the request goes via. Give your answer as a sequence of DNS server numbers, e.g.  $1 \rightarrow 2 \rightarrow 3$ . [6 marks]

- `www.tu.ac.th`: \_\_\_\_\_
- `ftp.yahoo.com`: \_\_\_\_\_
- `www.chula.ac.th`: \_\_\_\_\_

(b) Assume the responses from the above three requests were cached by the host computer in SIIT. If an application on the host subsequently requests `www.tu.ac.th` then is a DNS request sent to a DNS server? Explain your answer. [2 marks]

### Question 5 [10 marks]

Consider the network in Figure 2. Each router has multiple numbered interfaces (e.g. Router A has interface A1 and A2). There are three LANs shown, with each LAN containing multiple hosts. Router E connects, via interface E2, to another router which then may connect to many more routers and LANs (in other words, assume more LANs can be reached via router E).

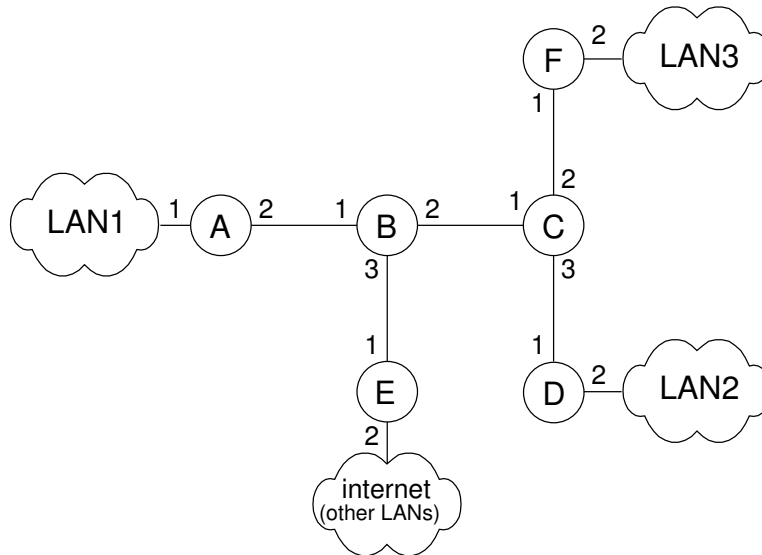


Figure 2: Routed Network

Assuming the destinations may be in any of the three LANs or in any LANs beyond router E, complete the following routing tables. You may use as many rows as necessary. Use \* to indicate a wild card (any value). Use *direct* to indicate direct delivery to the destination. Use the LAN name to refer to a network (e.g. LAN1). Use the router name and interface to refer to a next router (e.g. A1). Assume rows in the routing table are processed in order (from top to bottom).

Router A		Router B		Router C		LAN2 Host	
<i>Dest</i>	<i>Next</i>	<i>Dest</i>	<i>Next</i>	<i>Dest</i>	<i>Next</i>	<i>Dest</i>	<i>Next</i>

## Question 6 [8 marks]

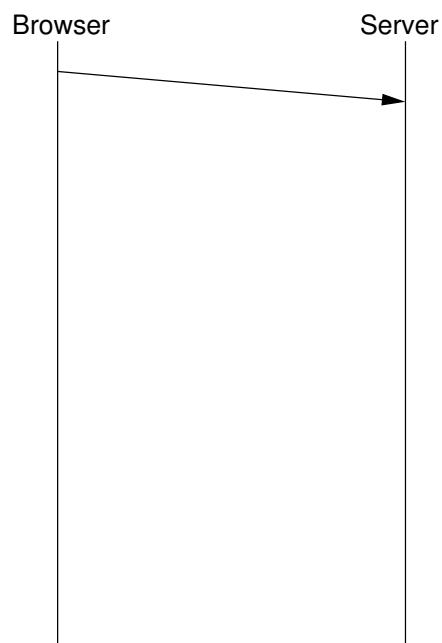
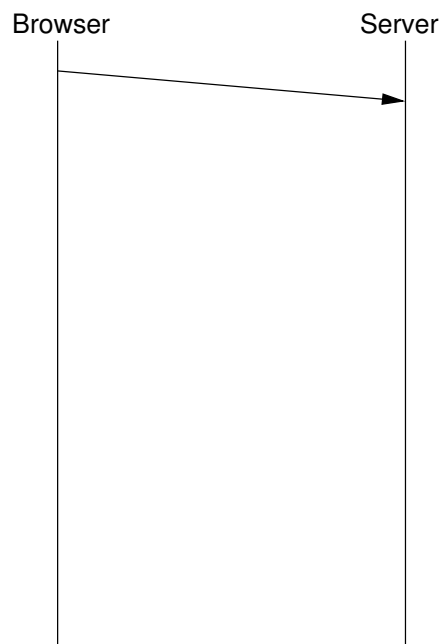
Assume a web browser is running with port 54321 on a host with IP address 1.2.3.4. A web server is running on a host with IP address 5.6.7.8. The contents of the directory the web server makes publicly available is:

/index.html	350 Bytes
/contact.html	500 Bytes
/images/header.png	10,000 Bytes
/images/logo.png	2,000 Bytes
/images/steve.png	5,000 Bytes

The page `index.html` has the images `header.png` and `logo.png` embedded (using HTML code such as ``), as well a link to `contact.html` (e.g. using `<a href="contact.html">contact</a>`). The page `contact.html` has all three images embedded, as well as links to `index.html` and `tobecompleted.html`.

Assume at time 0 seconds the user of the web browser clicks on a link with the URL `http://1.2.3.4/index.html`.

- (a) Complete the 1st diagram on the next page that shows the exchange of HTTP messages between the two computers until the entire page (including images) are displayed in the web browser. For requests you must clearly indicate the file requested. For responses you must indicate the HTTP status code. [6 marks]
- (b) If the user of the web browser then clicks on the link to `tobecompleted.html`, complete the 2nd diagram on the next page showing the exchange of HTTP messages (same format as above). [2 marks]



### Question 7 [9 marks]

Consider the operation of TCP in Figure 3. Assuming a connection had already been established and A had 10,000 Bytes of data to send to B, the figure shows A transmitting the data in 5 segments (each with 2,000 Bytes of data), the 2nd segment being lost, and acknowledgements being sent by B. The transmission time of a segment with data is 10ms, the propagation time from A to B is 10ms (and same in the opposite direction) and the transmission time of an ACK is 2ms. The sequence number inside the TCP header of the first segment is 1. Note that “ACK” means a TCP segment with no data and the ACK flag set to 1. Assume that after transmitting each data segment, A starts a timer with a timeout period of 70ms (that is, the timer for the 1st segment will expire at time 80ms). In parts (a) to (e) assume only the basic retransmission scheme is used in TCP (*not* Fast Retransmit).

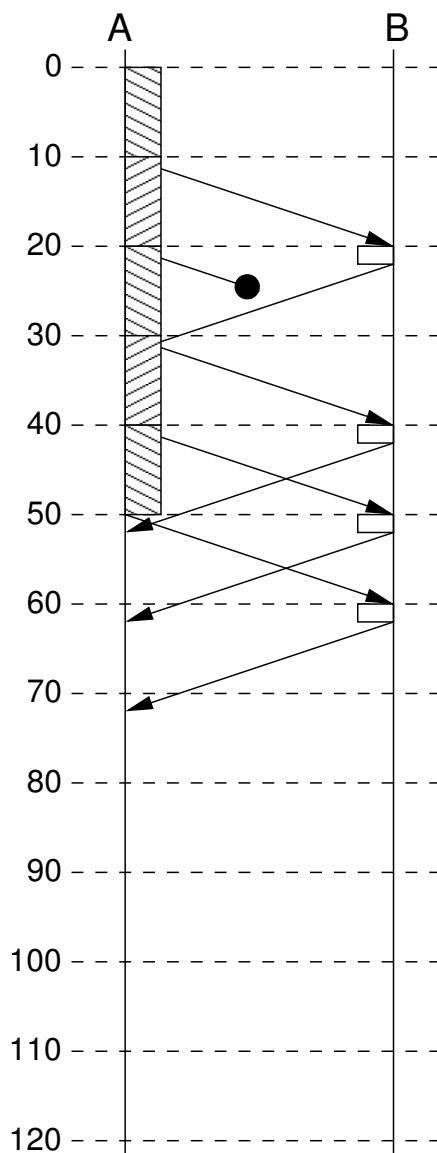


Figure 3: TCP Retransmission



- (a) Of the three ARQ mechanisms we studied (stop-and-wait, go-back-N, selective-reject), which does TCP's retransmission scheme most closely resemble? [1 mark]
- (b) What is the acknowledgement number in the 1st ACK sent by B? [1 mark]
- (c) What is the acknowledgement number in the 4th ACK sent by B? [1 mark]
- (d) At what time has B successfully received all 10,000 Bytes of data? [2 marks]
- (e) One method to increase the efficiency in the case that packets are lost would be to decrease the timeout period (that is, A would spend less time waiting to retransmit). If A used a timeout period of 20ms in the above scenario, explain what would happen (e.g. would the efficiency be increased? Why or why not?) [2 marks]
- (f) If Fast Retransmit scheme was used as well, then at what time would B have successfully received all 10,000 Bytes of data? [2 marks]

## Reference Material

Selected well-known ports:

- FTP 20 and 21
- SSH 22
- Telnet 23
- SMTP 25
- DNS 53
- HTTP 80
- HTTPS 443

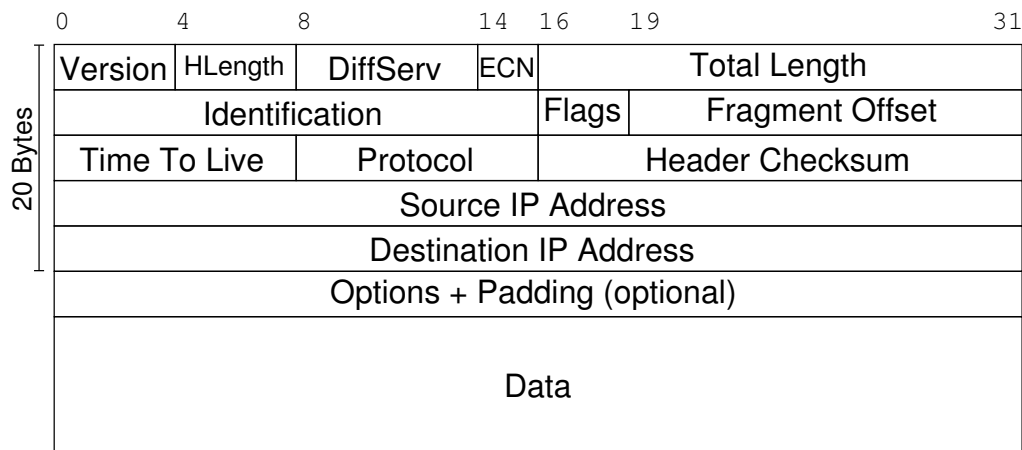


Figure 4: IP Datagram Format. Flags: Reserved, Don't Fragment, More Fragments

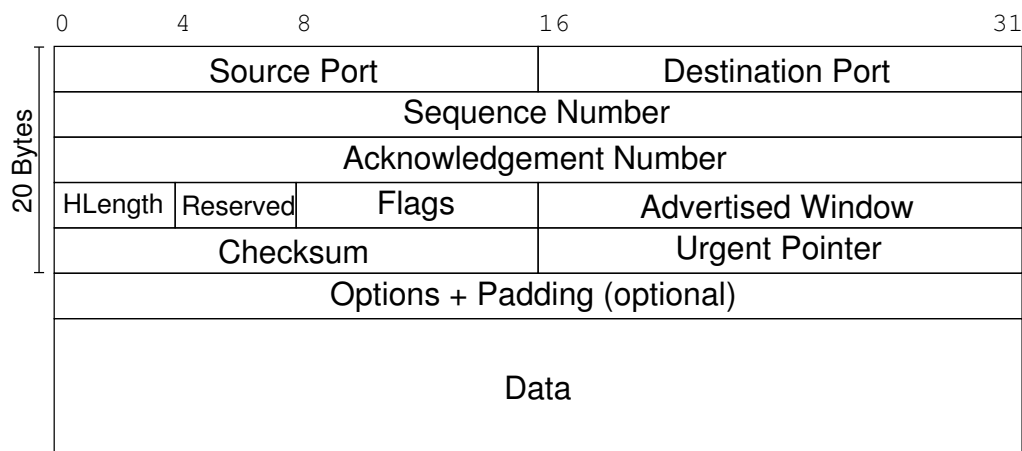


Figure 5: TCP Segment Format. Flags: CWR, ECE, URG, ACK, PSH, RST, SYN, FIN

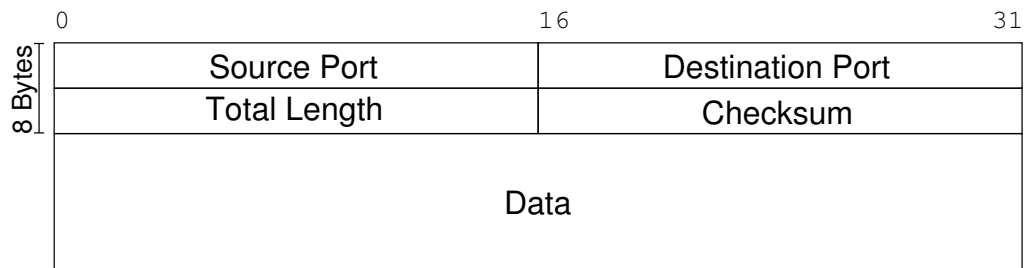


Figure 6: UDP Datagram Format

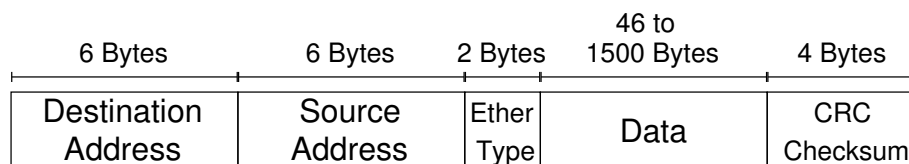


Figure 7: Ethernet Frame Format

Selected HTTP Status Codes:

- 200 Ok
- 304 Not Modified
- 404 Not Found