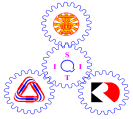


NameID SectionSeat No.....



Sirindhorn International Institute of Technology Thammasat University

Final Examination Answers: Semester 2/2008

Course Title : ITS413 Internet Technologies and Applications

Instructor : Dr Steven Gordon

Date/Time : Wednesday 4 March 2009, 13:30-16:30

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.
- Turn off all communication devices (mobile phone etc.) and leave them under your seat.
- Write your name, student ID, section, and seat number clearly on the answer sheet.
- The space on the back of each page can be used if necessary.
- Packet formats for selected protocols are given for reference at the back of the exam.

Multiple Choice Questions [24 marks]

Select the most accurate answer. Clearly circle (or indicate) your final answer. You must select only one answer. Each question is worth 1.5 marks.

1. Consider a network with N hosts. The traffic from all hosts must pass a single bottleneck link. Each host may run a different number of TCP-based applications, and each application may use a different number of TCP connections. Assume all conditions are the same (link speeds, packet sizes, buffer sizes, delays etc.). In general:

- a) **The capacity of the bottleneck link will be shared equally among each TCP connection.**
- b) The capacity of the bottleneck link will be shared equally among each source host.
- c) The capacity of the bottleneck link will be shared equally among each application.
- d) Both (a) and (b) are true.
- e) Both (a) and (c) are true.
- f) Both (b) and (c) are true.
- g) All of (a), (b) and (c) are true.

2. Throughout the lifetime of a single TCP connection:

- a) The RTT will be constant
- b) The congestion window must be constant
- c) The advertised window must be constant
- d) The segment size must be constant
- e) The sending rate must be constant

f) None of the above

3. Assuming for a TCP source $cwnd = 10\text{KB}$, $awnd = 15\text{KB}$, $RTT = 50\text{ms}$ and $ssthresh = 5\text{KB}$, then the current sending rate is approximately:

- a) 100 KB/s
- b) 200 KB/s**
- c) 250 KB/s
- d) 300 KB/s
- e) 500 KB/s
- f) 750 KB/s

4. TCP assumes:

- a) A received ACK indicates congestion has decreased in the network
- b) A received ACK indicates congestion has increased in the network
- c) A lost packet indicates congestion has increased in the network
- d) A lost packet indicates congestion has decreased in the network
- e) Both (a) and (c)**
- f) Both (b) and (d)

g)None of the above

5.The Internet Group Management Protocol (IGMP) is used to:

- a)**Inform multicast routers of members of a multicast group**
- b)Forward multicast packet to all members of a multicast group
- c)Find a route from source to all members of a multicast group
- d)Send acknowledgements from multicast group members to the source
- e)None of the above

6.A feature(s) of RTP is:

- a)ACKs are used to ensure reliable transmission
- b)Windows are used to provide efficient data transfer
- c)**Timestamps are used to assist with playback of content at the destination**
- d)Both (a) and (b)
- e)Both (a) and (c)
- f)Both (b) and (c)
- g)None of the above

7.For multimedia applications, the content from multiple sources can be combined into a single stream using:

- a)IP Multicast
- b)SS7
- c)SIP
- d)**RTP Mixing**
- e)RTP Translation
- f)None of the above

8.A common signalling protocol used in IP telephony networks is:

- a)SS7
- b)RTSP
- c)RTCP
- d)**SIP**
- e)VoIP
- f)IPTV

9.IPTV is best described as:

- a)Viewing TV content on your computer
- b)Downloading TV and video files over an IP network, and viewing once downloaded
- c)Accessing video web sites, such as Youtube, via the Internet
- d)Viewing TV and video content in real-time in your web browser
- e)**Delivering high quality video content to TVs in real-time via an IP network**

f)Using multicast and P2P file sharing to efficiently download high quality video content

10.The bottleneck in IPTV networks is most often:

a)ISP access network

b)ISP core network

c)User's home network

d)Distribution network of TV station

e)Public Internet

f)The telephone network (PSTN)

11.If cost was not an issue, which technology is best suited for IPTV:

a)Coaxial Cable

b)ADSL2+

c)Fibre-to-the-Node

d)Fibre-to-the-Curb

e)Fibre-to-the-Home

f)Wireless LAN

12.What protocol is used between a peer and a tracker in Bittorrent?

a)HTTP

b)P2P

c)PEX (Peer Exchange Protocol)

d)UDP

e)RTP

f)RTSP

13.A 1GB torrent is using a block size of 10KB and piece size of 100KB. There are 50 seeds and 200 leechers in the swarm. Which of the following is false?

a)To download the entire torrent, a peer would have to send at least 10,000 Request messages.

b)The torrent contains only a single file.

c)The availability of the torrent is greater than 1.

d)Both (a) and (b)

e)Both (a) and (c)

f)Both (b) and (c)

g)All the above

14.Peer X is being choked by Peer Y in a Bittorrent network. Which of the following is true?

a)Peer X can download from Peer Y.

b)Peer X cannot upload to Peer Y.

c)Peer Y cannot download from Peer X

d)Peer X cannot download from Peer Y.

e)None of the above

15.What component of a web search engine keeps two lists of URLs (visited and to be visited)?

a)Retrieval Engine

b)Ranker

c)Crawler

d)Indexer

e)Robot Exclusion Handler

f)None of the above

16.Which of the following are examples of a query independent rank criteria?

a)Number of query terms in a page

b)Closeness of query terms in a page

c)Number of links to a page

d)Number of times a page has been accessed

e)Both (a) and (b)

f)Both (c) and (d)

General Questions [62 marks]

Question 1 [4 marks]

The following algorithms/events change the value of the Congestion Window (cwnd) in TCP congestion control:

1. Additive Increase
2. Slow Start
3. Loss detected by Timeout
4. Loss detected by Duplicated ACKs

The following equations describe how the new Congestion Window is calculated. Match the correct algorithm/event above to the equation below by writing the number of the algorithm/event:

- a) $cwnd_{new} = MSS$ Answer: _____
- b) $cwnd_{new} = cwnd_{old} + MSS$ Answer: _____
- c) $cwnd_{new} = cwnd_{old} + MSS * MSS / cwnd_{old}$ Answer: _____
- d) $cwnd_{new} = \text{minimum}(ssthresh, cwnd_{old})$ Answer: _____

Answer

- a. 3
- b. 2
- c. 1
- d. 4

Question 2 [10 marks]

Consider a company using VoIP for all internal phone calls. All computers are connected via switched 100Mb/s Fast Ethernet. The VoIP application uses the G.711 codec.

The G.711 voice codec takes 100 samples of voice per second, with each sample 80 Bytes. A VoIP application using G.711 and RTP sends 2 voice samples per RTP packet (that is, 160 Byte payload).

a) At what rate does the G.711 voice codec generate voice data? [1 mark]

Answer

100 samples per second, with each sample 80 bytes, means 8,000 Bytes per second or 64kb/s.

b) How many packets per second does the VoIP application send? [1 mark]

Answer

100 samples per second and 2 samples per packet, means 50 packets per second.

c) Draw a protocol stack for a computer using the VoIP application. Consider all the protocols used by the VoIP application. [3 marks]

Answer

VoIP Application

RTP

UDP

IP

Ethernet DLL

Ethernet PHY

d) What is the bandwidth (or throughput) consumed on the company LAN to support each two-way voice call? [3 marks]

Answer

50 packets per second. Each packet contains 160 bytes of data, 20 byte IP header, 8 byte UDP header, 12 byte RTP header and 18 byte Ethernet header/trailer. 218 bytes per packet, means 10,900 Bytes per second for each direction, so 21,800 Bytes per second per call.

e) The G.729 codec has a sample size of 10 Bytes (instead of 80 Bytes in G.711 – sampling rate is the same as G.711). Explain an advantage and disadvantage of using G.729 in the company network (compared to using G.711). [2 marks]

Answer

The smaller sample size

Advantage: the smaller sample size (and same sampling rate) mean lower LAN bandwidth is

needed to send the data (allowing room for more voice calls or other traffic).

Disadvantage: the smaller sample size will mean the quality reconstructed at the receiver will be poorer.

Question 3 [8 marks]

Consider the three P2P systems: Napster, Gnutella and Fasttrack. For the following features, indicate which P2P system is best characterised by the feature. You must circle only one answer (although there may be more than one correct answer). “None” means none of the three P2P systems have that feature.

a) Uses a central index server	Napster	Gnutella	Fasttrack	None
b) Super-peers	Napster	Gnutella	Fasttrack	None
c) Fastest search	Napster	Gnutella	Fasttrack	None
d) Content stored on central server	Napster	Gnutella	Fasttrack	None
e) Single point of failure		Napster	Gnutella	Fasttrack
None				
f) Fully distributed	Napster	Gnutella	Fasttrack	None
g) Selected peers store index data	Napster	Gnutella	Fasttrack	None
h) Search queries are flooded	Napster	Gnutella	Fasttrack	None

Question 4 [20 marks]

Consider a P2P system using a Chord Distributed Hash Table (DHT). The possible set of peers are shown in Figure 1.

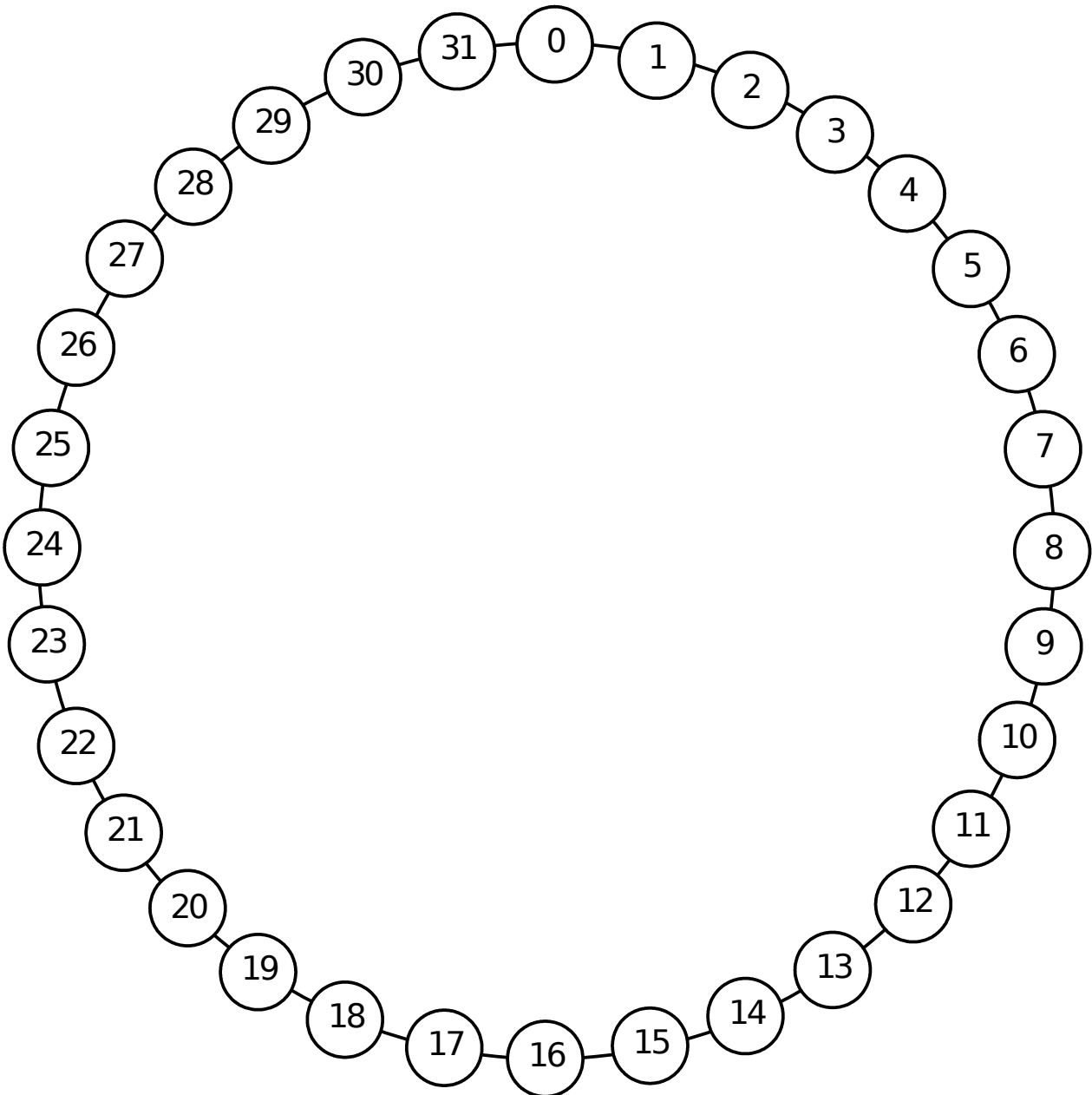


Figure 1: Chord DHT

Assume currently the network contains 8 peers. The hash function H is used to determine the peer ID from the peers IP address and port number:

$$\text{PeerID} = H(\text{IP} + \text{Port})$$

The 8 current peers have IDs: 3, 8, 12, 13, 16, 18, 23 and 25.

When peer X has a file to share, that peer calculates the hash of the filename to find the Key:

$$\text{Key} = H(\text{Filename})$$

Peer X then sends a message to the peer that indexes that Key. The message contains the IP address and port of Peer X and the filename so the receiving peer (Peer Y) knows which peer has

the file to share. This index information is stored at Peer Y. Table 1 lists the files that have already been made available for sharing using this method (e.g. Peer 3 has the file siit.mpg available to share, and the index information has been sent to the relevant peer).

Peer with file	Filename	Key = H(Filename)
3	siit.mpg	0
13	answers.avi	14
13	movie.avi	7
23	tu.mov	6
18	ubuntu.iso	25

Table 1: Shared Files

The following tables show the Chord routing tables created by each peer in the network. (The actual IP address and port numbers of neighbours are omitted – only the peer ID is shown).

Peer 3			
Positions		Neighbour	Key Space
1	4	8	4
2	5	8	5 → 6
4	7	8	7 → 10
8	11	12	11 → 18
16	19	23	19 → 2

Peer 16			
Positions		Neighbour	Key Space
1	17	18	17
2	18	18	18 → 19
4	20	23	20 → 23
8	24	25	24 → 31
16	0	3	0 → 15

Peer 8			
Positions		Neighbour	Key Space
1	9	12	9
2	10	12	10 → 11
4	12	12	12 → 15
8	16	16	16 → 23
16	24	25	24 → 7

Peer 18			
Positions		Neighbour	Key Space
1	19	23	19
2	20	23	20 → 21
4	22	23	22 → 25
8	26	3	26 → 1
16	2	3	2 → 17

Peer 12			
Positions		Neighbour	Key Space
1	13	13	13
2	14	16	14 → 15
4	16	16	16 → 19
8	20	23	20 → 27
16	28	3	28 → 11

Peer 23			
Positions		Neighbour	Key Space
1	24	25	24
2	25	25	25 → 26
4	27	3	27 → 30
8	31	3	31 → 6
16	7	8	7 → 22

Peer 13			
Positions	Neighbour	Key Space	
1 14	16	14	
2 15	16	15 → 16	
4 17	18	17 → 20	
8 21	23	21 → 28	
16 29	3	29 → 12	

Peer 25			
Positions	Neighbour	Key Space	
1 26	3	26	
2 27	3	27 → 28	
4 29	3	29 → 0	
8 1	3	1 → 8	
16 9	12	9 → 24	

a) What is the maximum number of peers allowed in the network? [1 mark]

Answer

32 peers.

b) What is the maximum number of different files allowed in the network? [1 mark]

Answer

32 files.

c) Complete the Chord routing tables (that is, fill in the blank spaces). (Note that you must give the *actual* neighbour in the table) [6 marks]

d) For each file, indicate the peer that maintains the index. [2.5 marks]

Filename	Indexer
siit.mpg	3
answers.avi	16
movie.avi	8
tu.mov	8
ubuntu.iso	25

e) With the current 8 peers in the network (and assuming more files may be added), what is the maximum number of files that peer 12 may contain index information for? [1 mark]

Answer

4 (files with key 12, 11, 10 and 9).

f) Peer 3 is searching for the file ubuntu.iso. Referring to the routing tables, explain how the search is performed (that is, to which peers is the search query sent, and why). [3 marks]

Answer

The file has key 25. Peer 3 sends a search query to peer 23 since key 25 is within its key space.

Peer 23 sends a search query to peer 25 since key 25 is within its key space. Peer 25 has the file and responds (either via 23 or direct to 3).

Assume you are designing a Chord DHT for a company network with a maximum of 4000 users, and you expect approximately 10,000 different files may be shared.

g)What is the minimum length (in bits) of the output of the hash function? Explain your answer. [1.5 marks]

Answer

The number of possible hash values should be greater than the maximum of the number of users/files. With 14 bit hash output, there are 16384 possible values, which is sufficient for the number of expected files.

h)What is the maximum number of routing table entries (rows) needed for each node? [1 mark]

Answer

14

i)A modification of Chord may be to maintain routes to peers which are 1, 2, 4, 8, 10, 12, 14, ... positions away. Explain an advantage and disadvantage of this approach. [3 marks]

Answer

Advantage: a peer maintains routes to many other peers, and hence a search will be very fast.

Disadvantage: maintaining routes to many nodes requires extra overhead (distributing routing information)

Question 5 [8 marks]

Explain the following delivery mechanism and give an example application (or application protocol) that is commonly used by the mechanism.

a)Unicast [2 marks]

Answer

Send from a single source to a single destination. Example: web browser (client to server).

b)Broadcast [2 marks]

Answer

Send from a single source to all hosts in a network. Example network management (DHCP)

c)Multicast [2 marks]

Answer

Send from a single source to selected hosts in a network. Example: video streaming

d)Anycast [2 marks]

Answer

Send from a single source to any one of a selected group of hosts. Example: DNS

Question 6 [7 marks]

Consider the times at which 6 packets were transmitted by a source and received by the destination (all times are relative to an initial clock value and measured in milliseconds (ms); the clocks at source and destination are synchronised):

Packet	Transmit Time	Received Time
1	10	45
2	20	57
3	30	63
4	40	77
5	50	87
6	60	97

a)What is the average delay experienced in the network? [1 mark]

Answer

Average of: 35, 37, 33, 37, 37, 37 = 36ms

b)What is the jitter experienced in the network? [1 mark]

Answer

Average of: 2, 4, 4, 0, 0 = 2ms

c)Playback buffers are often used to compensate for jitter. Explain how a playback buffer can be used in this case, and how it reduces the effect of jitter. [1 mark]

Answer

When a packet is received, it is buffered before played at the receiver. The time of buffering is such that the playback occurs at a regular interval.

d)Using a playback buffer, what is the preferred playback time of each of the 6 packets? [2 marks]

Answer

47, 57, 67, 77, 87, 97.

e)One disadvantage of playback buffers is the additional complexity/memory needed. What is another disadvantage of using a playback buffer? Use the example 6 packets to explain. [2 marks]

Answer

An additional delay is introduced before playback starts. In this example, playback starts at time 47 (delay of 37ms), as opposed 45 (delay of 45ms), i.e. an extra 2ms delay.

Question 7 [5 marks]

a) Explain the role of an indexer in a Bittorrent network [1 mark]

Answer

An indexer maintains a list of .torrent files and associated descriptive information. Used for searching for .torrent files.

b) Explain the role of a tracker in a Bittorrent network [1 mark]

Answer

A tracker manages the set of peers in a swarm accessing a torrent. It maintains a list of peers in the swarm and statistics about the swarm.

c) Define the difference between a seed and a leecher in a Bittorrent network [1 mark]

Answer

A seed is a peer that has downloaded all pieces of a torrent (and making them available), while a leecher is a peer that has not yet downloaded all pieces.

d) Once a peer obtains a .torrent file, can Bittorrent be considered as a fully distributed (or decentralised) system? Explain your answer. [2 marks]

Answer

No. The swarm relies on the centralised tracker which keeps track of the peers and swarm statistics. If the tracker fails, then the system will (eventually) fail. This can be overcome by using multiple trackers and DHT techniques.

Packet Formats (for Reference)

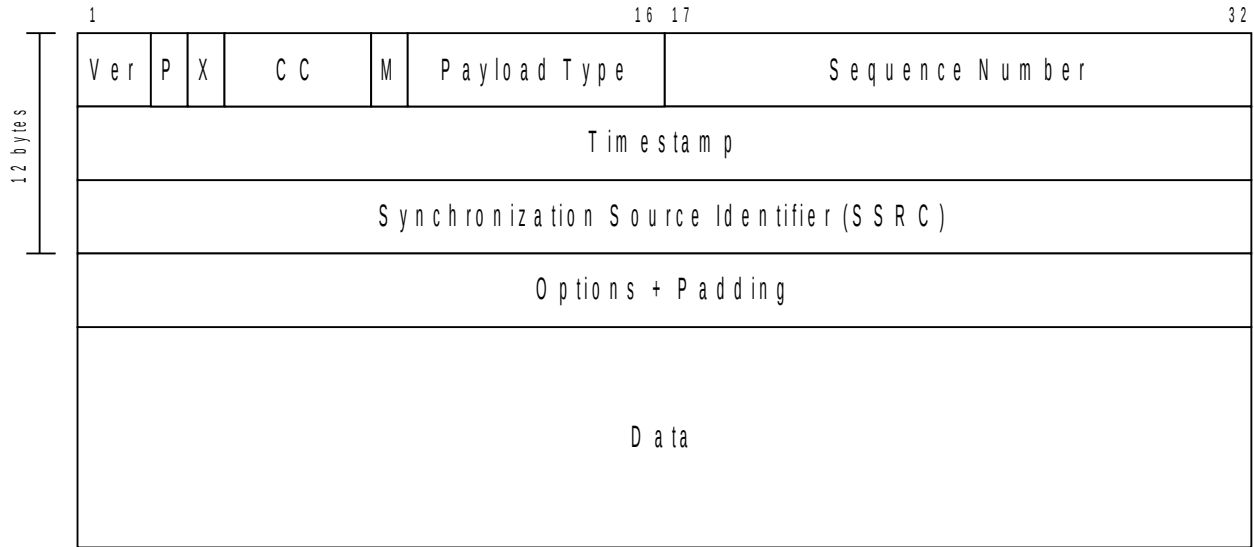


Figure 2: RTP Packet Format

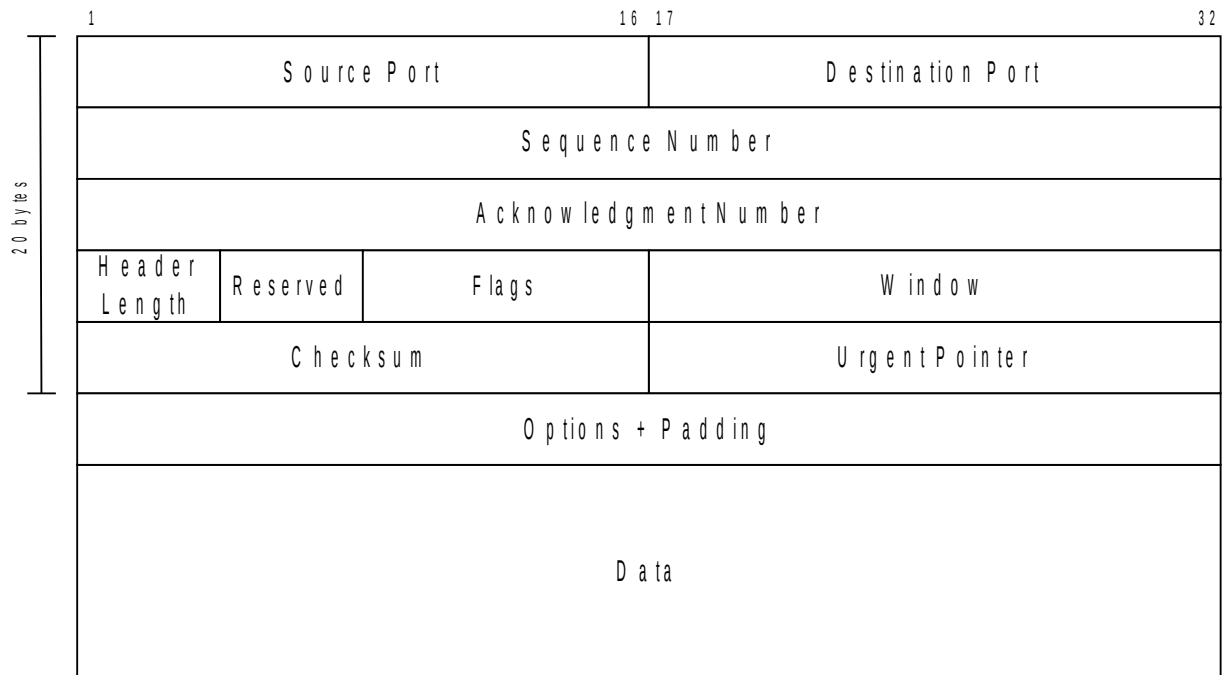


Figure 3: TCP Packet Format

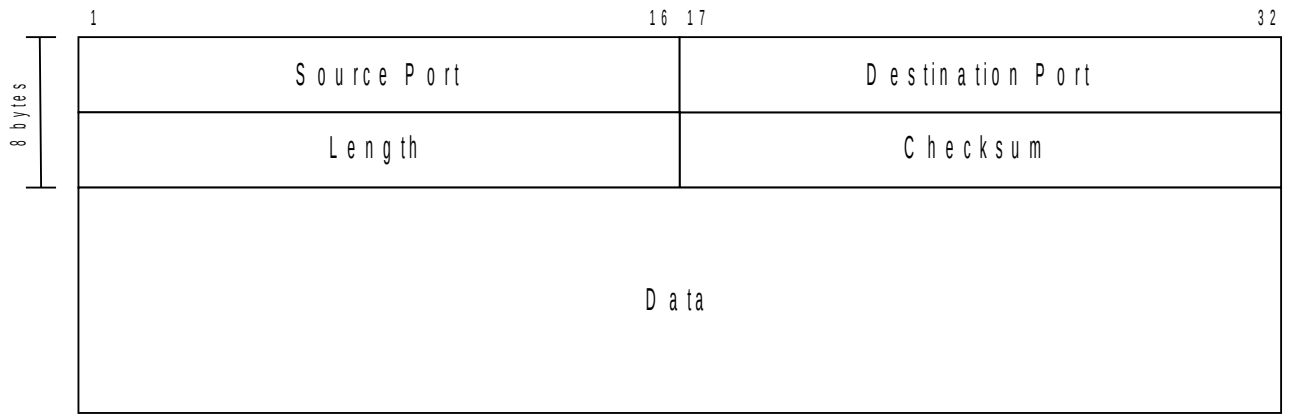


Figure 4: UDP Packet Format

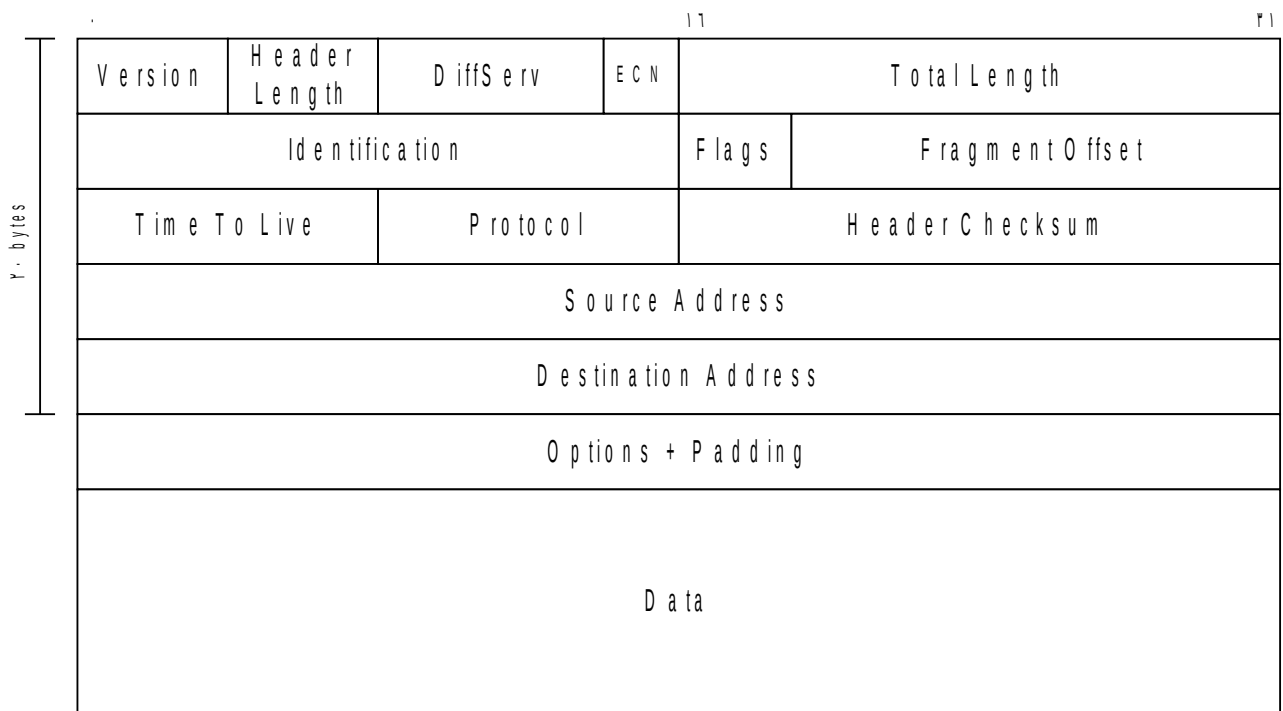


Figure 5: IP Packet Format

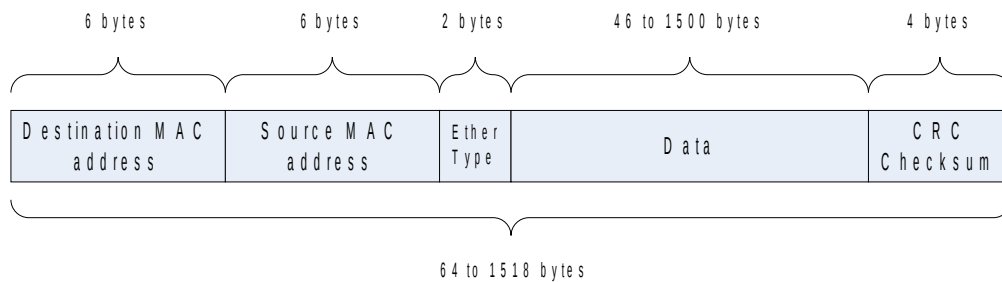


Figure 6: Ethernet Frame Format