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

Sirindhorn International Institute of Technology
Thammasat University

Final Examination: Semester 2/2009

Course Title : ITS413 Internet Technologies and Applications

Instructor : Dr Steven Gordon

Date/Time : Wednesday 10 March 2010, 13:30-16:30

Instructions:

- This examination paper has 16 pages (including this page).
- Conditions of Examination
  Closed book
  No dictionary
  Non-programmable calculator is allowed
- Students are not allowed to be out of the exam room during examination. Going to the restroom may result in score deduction.
- Turn off all communication devices (mobile phone etc.) and leave them under your seat.
- Write your name, student ID, section, and seat number clearly on the answer sheet.

Questions [100 marks]

Question 1 [8 marks]

Consider the following scenario. SIIT uses voice over IP for all internal calls (that is, between SIIT staff and faculty within Bangkadi/Rangsit, as well as between Bangkadi and Rangsit). The only link between Bangkadi and Rangsit is a 2Mb/s bi-directional WiMax link (that is, 2Mb/s in one direction and 2Mb/s in the other direction). The LANs at Bangkadi and Rangsit are all 1Gb/s Ethernet – sufficient capacity for the WiMax link to be the bottleneck. If all VoIP phones are equipped to use G.726-based application (see details below), what is the maximum number of voice calls that can be supported between Bangkadi and Rangsit at the same time? You may ignore the impact of delay, jitter and packet loss, and assume the VoIP application uses RTP over UDP. Assume WiMax uses the same frame format as Ethernet. Although you should consider the frame headers, you can ignore any other overheads of Ethernet/WiMax. Clearly show all your calculations and any assumptions.

G.726 codec: Sample size: 20 Bytes; Sample interval: 5ms; RTP voice payload size: 80 Bytes

Question 2 [17 marks]

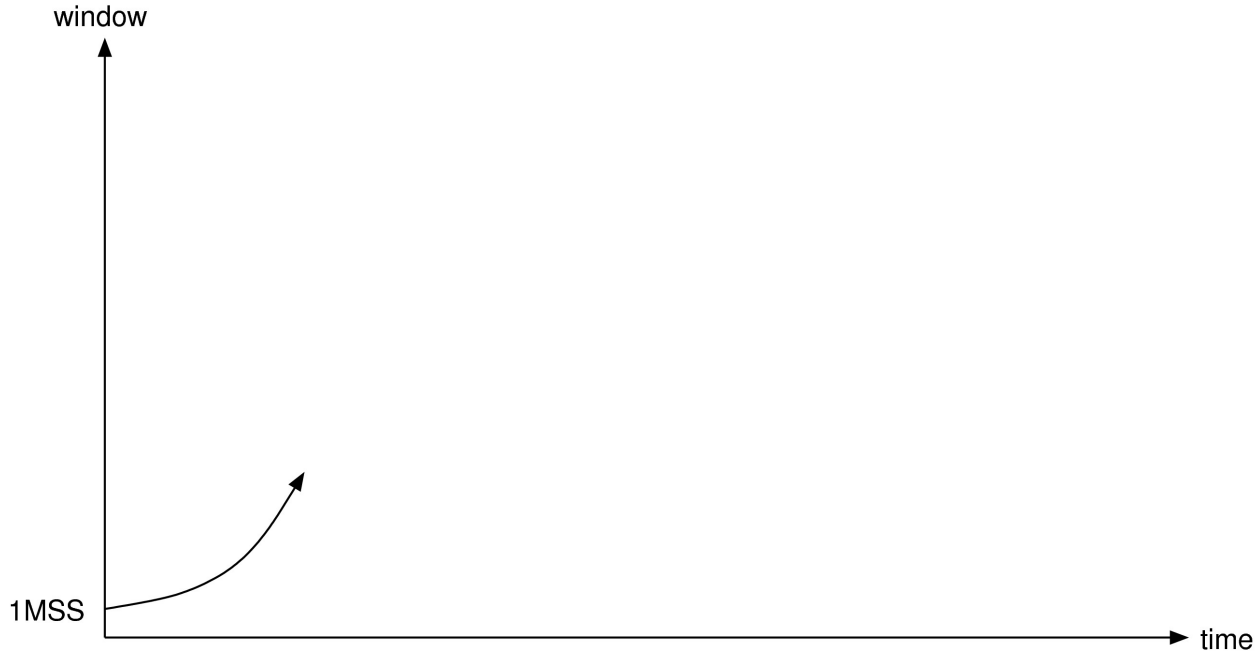
a) A TCP source maintains a variable, called *window*, that limits the number of bytes that can be sent before having to wait for an acknowledgement. The value of *window* is calculated from two values (also referred to as windows). What are they names of the two windows? [1 mark]

b) How does the TCP source calculate *window* from the two windows in the answer above? [1 mark]

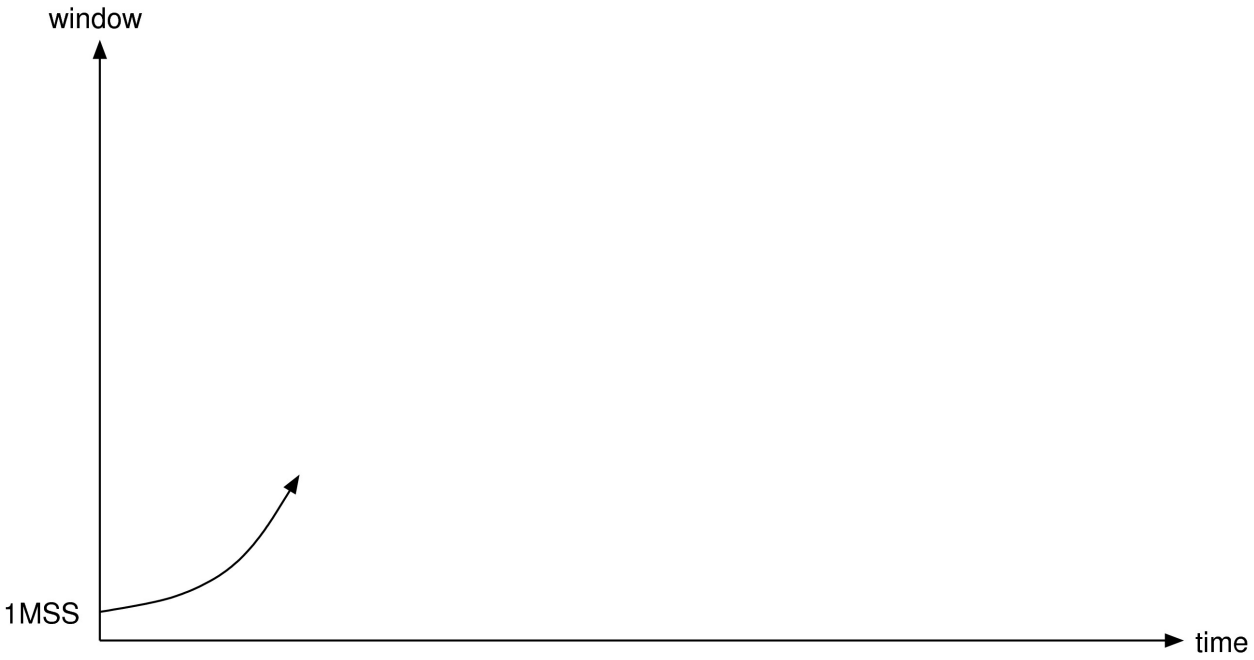
c) Explain the purpose of the two windows from part (a). [3 marks]

The following cases require you to draw a plot of the value of TCP source *window* over time. The plot does not have to be exact or to scale, but should clearly show the different phases (additive increase, slow start, responses to loss, etc.) and how they differ. That is, the shape of the plot should be clear. You should also show the slow start threshold on your plot. As a guide, the initial values of the window are given. You should assume the time on the horizontal axis is a long period, meaning the slow start threshold should be reached within that time.

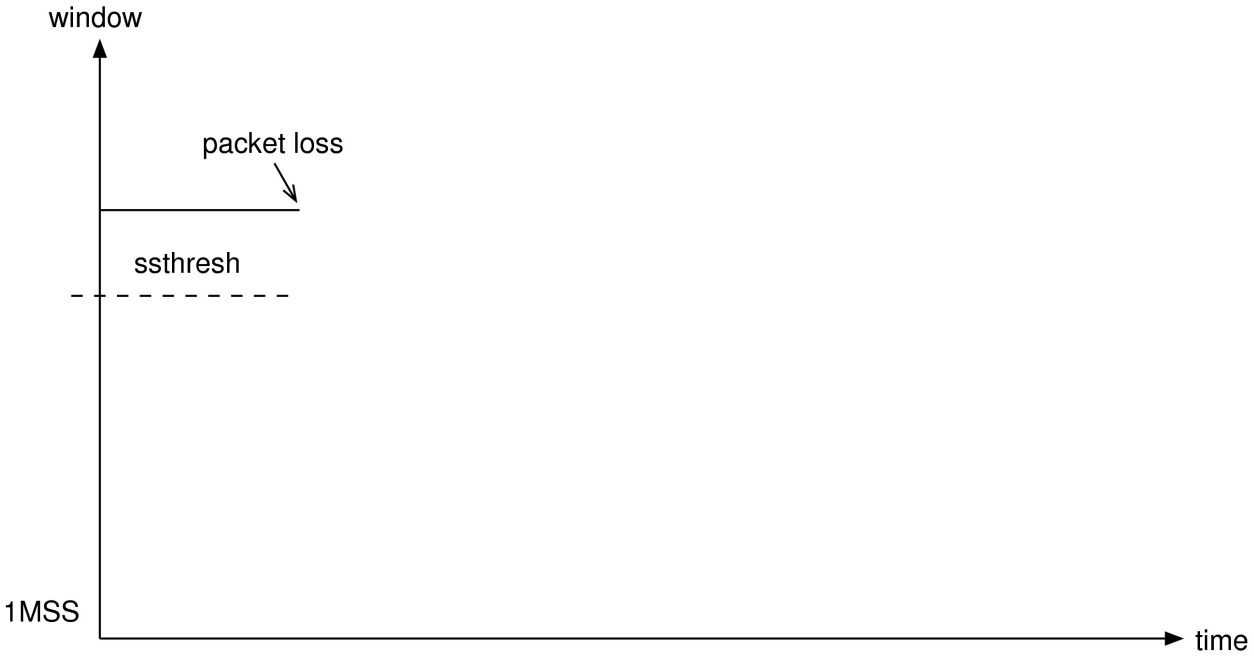
d) Buffer space at receiver is infinite. No packet loss. [3 marks]



e) Buffer space at receiver is less than slow start threshold. No packet loss. [3 marks]



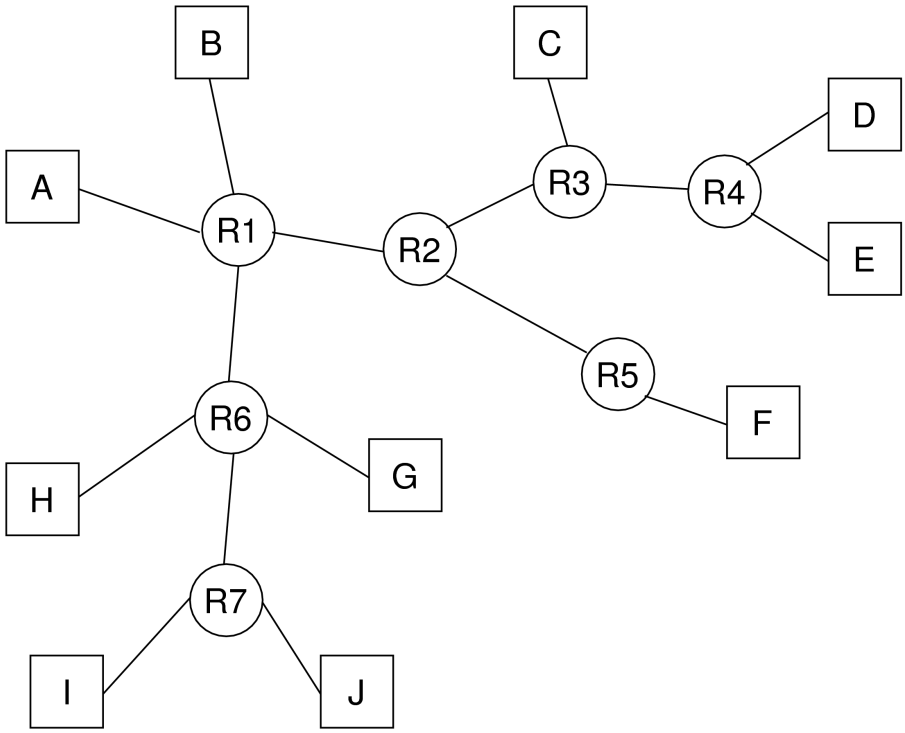
f) Buffer space at receiver is finite and greater than slow start threshold. Loss due to 3rd duplicate ACK occurs. Note that the diagram below shows the current value of the window when the loss occurs as a solid line. [3 marks]



g) Explain why TCP source responds differently when there is a loss due to a timeout compared to when there is a loss due to a 3rd duplicate ACK. [3 mark]

Question 3 [13 marks]

Consider the IP network in the figure below. A packet is to be sent from one source to multiple destinations.



In the following cases, calculate the minimum number of packets that must be transmitted by the hosts and routers. For example, if host C sends a packet to host D, then the answer is 3: C transmits a packet to R3, R3 transmits a packet to R4 and R4 transmits a packet it D. State any assumptions if you make them.

a) Source A is to send a packet to the destination hosts B, C, D, G, J using unicast. [3 marks]

b) Source A is to send a packet to the destination hosts B, C, D, G, J using multicast. [3 marks]

c) Source A is to send a packet to the destination hosts B, H, G, I, J using multicast. [3 marks]

d) If the data being sent by the source host was from a live TV event, when multicast is being used what protocol can be used to allow a new destination host (e.g. host F) to also receive the packets? [1 mark]

e) Explain the difference between anycast, multicast and broadcast. [3 marks]

Question 4 [10 marks]

Service differentiation or soft QoS is provided by the DiffServ architecture in IP networks. Consider two DiffServ-capable hosts sending packets via a DiffServ-capable router.

a) Explain how the hosts may use *packet marking* so that, for example, the video packets from host A receive different QoS than the data packets from host B. [2 marks]

b) Explain what the routers does to give the video packets of host A different QoS than the data packets of host B. [2 marks]

Hard QoS is provided by the IntServ architecture in IP networks.

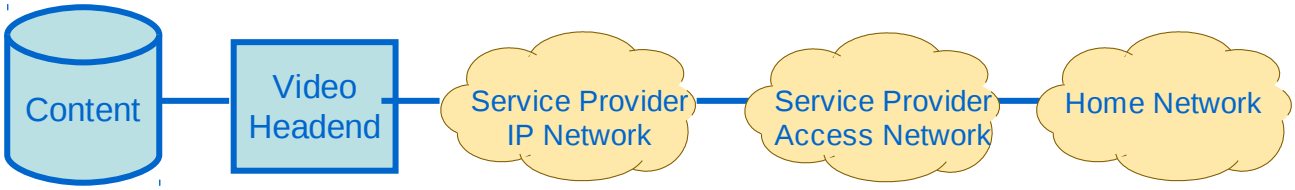
c) Explain the difference between soft QoS and hard QoS. [2 marks]

d) Explain the concepts of *resource reservation* and *admission control* in IntServ, including how they ensure hard QoS. You should also give examples of resources reserved. [4 marks]

Question 5 [13 marks]

a) Explain the difference between IPTV, File-based TV distribution and Internet (or Net) TV. You should also mention the network (or type of network) that each are delivered over. [2 marks]

The figure below shows a typical structure of an IPTV network.



b) What portion of the network is the performance bottleneck? [1 mark]

c) List two network technologies that may be suitable for delivering IPTV into a home (that is, the technology used to connect your home to a larger service provider network). You must give accurate names or abbreviations of standards/protocols, referring to versions if necessary. [2 marks]

d) Fibre-to-the-X may be used to refer to a range of different fibre-based technologies, where X can have different names.

i. List two possible Fibre-to-the-X technologies for IPTV [1 mark]

ii. Describe briefly the two technologies [2 marks]

iii. Explain the trade-offs (advantages and disadvantages) between the two technologies [2 marks]

e) For the delivery of HDTV channels to users over the Service Provider IP Network, the bandwidth requirement of the network may be measured in terms of number of channels delivered. However, for the delivery of Video on Demand to users, the bandwidth requirement of the Service Provider IP Network may be measured in terms of number of VoD subscribers. Explain why the bandwidth requirement is measured with different metrics for the different services (TV versus VoD). [3 marks]

Question 6 [10 marks]

Two challenges of using P2P systems for sharing resources are: *searching* and *data transfer*. This question is only about searching.

a) In Napster-like P2P systems an *index* is stored on a central server. What is the index (that is, what important information does it contain)? [2 marks]

b) Where is the index information stored in a FastTrack P2P system? [2 marks]

c) Explain how searching works in a FastTrack P2P system. As a guide, you should clearly explain the steps for all typical cases of where the queried resource may be located (e.g. the conditions when a response to a query is returned). You should state which nodes send the queries, and to what destinations and using what method. [4 marks]

d) Explain an advantage that FastTrack has compared to Gnutella. ("Explain an advantage" means state what the advantage is and state why it is present in FastTrack but not Gnutella). [1 mark]

e) Explain a disadvantage that FastTrack has compared to Gnutella. [1 mark]

Question 7 [11 marks]

Consider BitTorrent for data transfer in P2P systems.

a) What is the difference between a seed and a leecher in a BitTorrent swarm? [1 mark]

b) Consider three files, A, B and C, are to be shared a single torrent T. Explain the relationship between the files, torrent, blocks and pieces. [2 marks]

c) Where can a peer find the IP address of a tracker of a swarm it wants to join to obtain torrent T? [1 mark]

d) What application-level protocol is used for communications between the peer and the tracker? [1 mark]

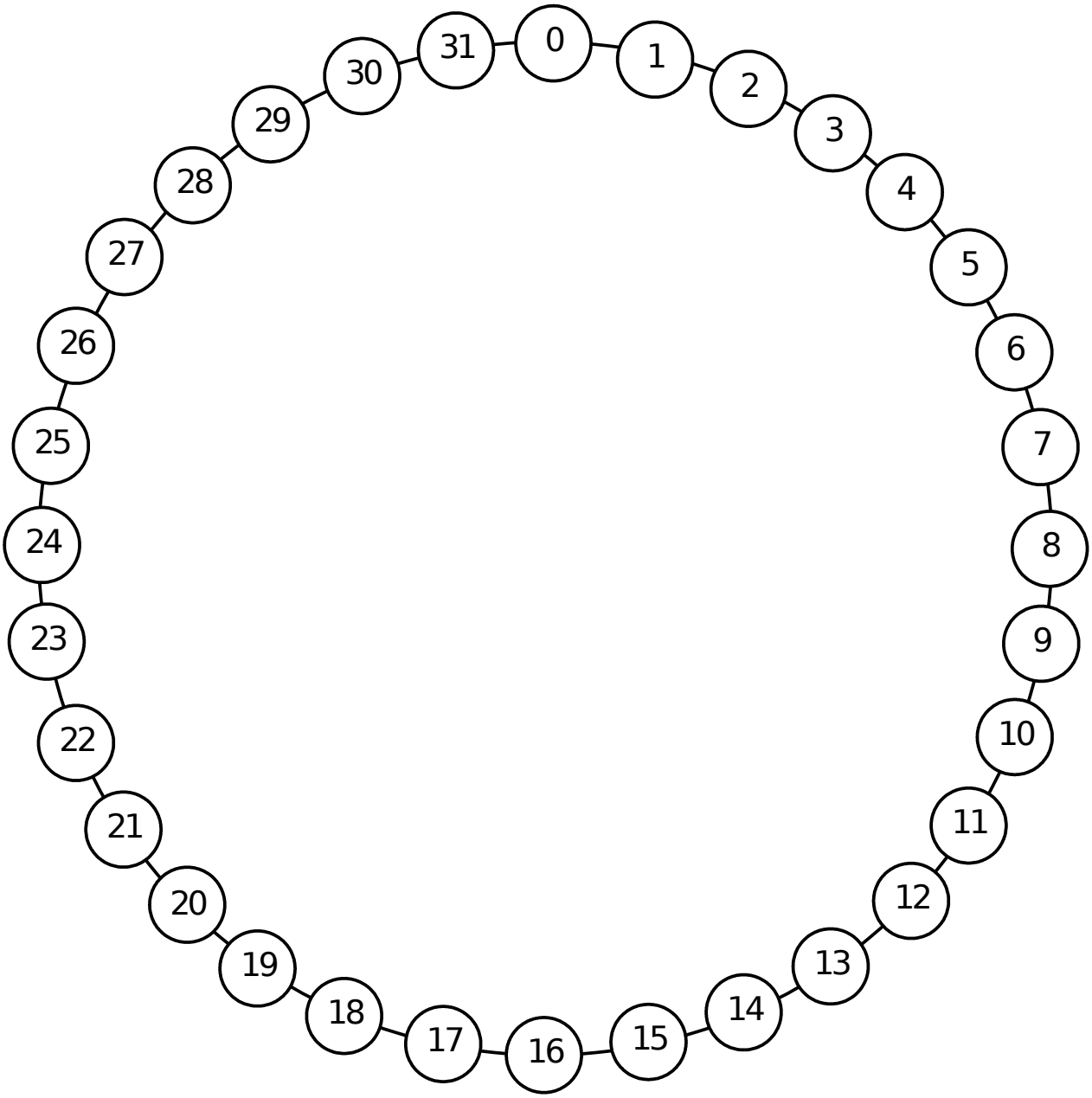
e) Where can a peer find the IP addresses of other peers in a swarm to obtain torrent T? [1 mark]

f) Assume a peer may maintain 30 TCP connections to remote peers at a time. Some of the remote peers may be *choked* while the others are *unchoked*. Explain what this means. [3 marks]

g) Which of the following P2P systems is closest to BitTorrent: Napster, Gnutella, FastTrack? Explain your answer. [2 marks]

Question 8 [18 marks]

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



Assume currently the network contains 7 peers. The hash function H is used to determine the peer ID from the peers IP address and port number:

PeerID = H(IP + Port)

The 7 current peers have IDs: 2, 6, 8, 13, 17, 22, 30.

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

Key = H(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.

Peer with file	Filename	Key = H(Filename)
2	siit.mpg	5
8	answers.avi	31
17	movie.avi	14
17	tu.mov	26
22	ubuntu.iso	13

Table 1: Shared Files

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

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

Filename	Indexer
siit.mpg	
answers.avi	
movie.avi	
tu.mov	
ubuntu.iso	

A new peer with ID 27 joins the network. This new peer also shares a file, its413.tgz, which has a key value of 0.

c) Which peer is the indexer of the new file, its413.tgz? [0.5 mark]

d) Explain what else changes after peer 27 joins the network. [2 marks]

e) Complete the Chord routing tables (that is, fill in the blank spaces). (Note that you must give the *actual* neighbour in the table). Remember, there are now 8 peers in the network. [6 marks]

Peer 2		
Positions	**Neighbour**	**Key Space**
1		
2		
4		
8		
16		

Peer 6		
Positions	**Neighbour**	**Key Space**
1		
2		
4		
8		
16		

Peer 8		
Positions	**Neighbour**	**Key Space**
1		
2		
4		
8		
16		

Peer 13		
Positions	**Neighbour**	**Key Space**
1		
2		
4		
8		
16		

Peer 17		
Positions	**Neighbour**	**Key Space**
1		
2		
4		
8		
16		

Peer 22		
Positions	**Neighbour**	**Key Space**
1		
2		
4		
8		
16		

Peer 27		
Positions	**Neighbour**	**Key Space**
1		
2		
4		
8		
16		

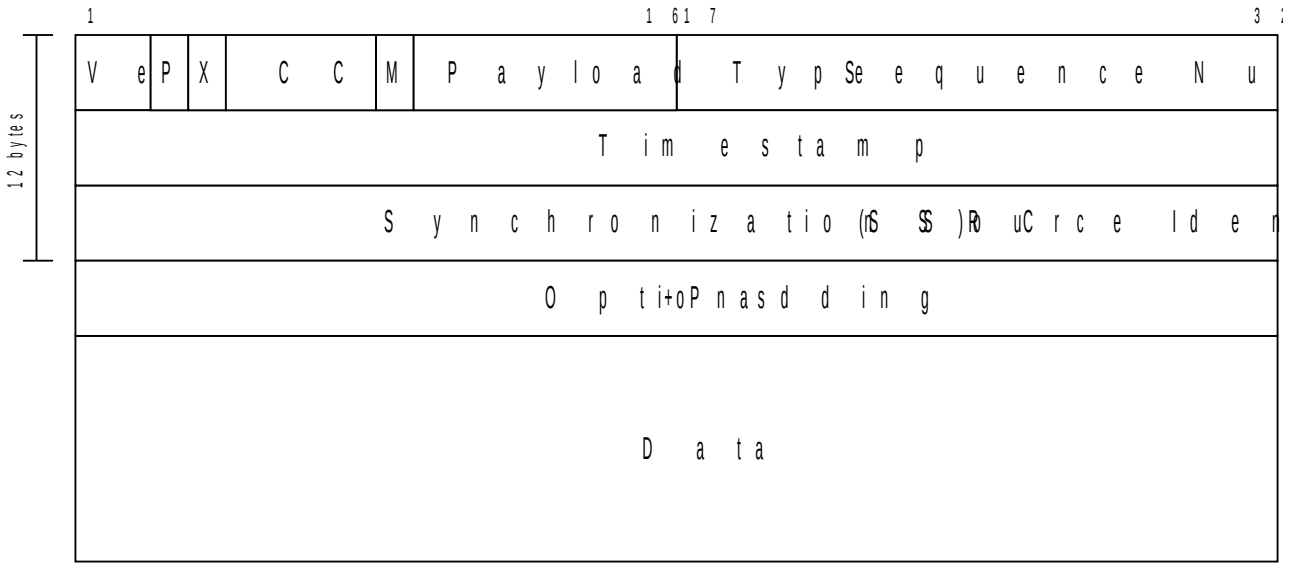
Peer 30		
Positions	**Neighbour**	**Key Space**
1		
2		
4		
8		
16		

f) Peer 13 is searching for the file siit.mpg. 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]

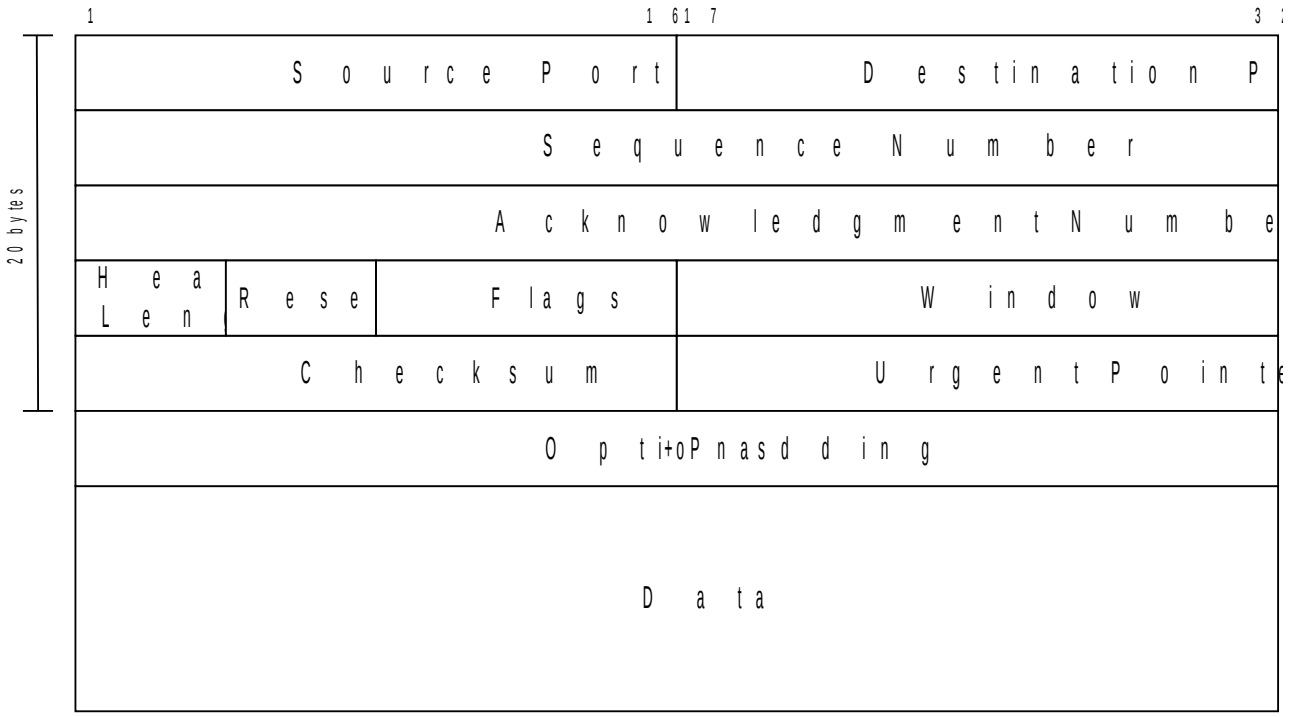
g) Explain the two important objectives of Chord using a structure of neighbours 1,2,4,8,16 ... positions away. [3 marks]

Packet Headers (for Reference)

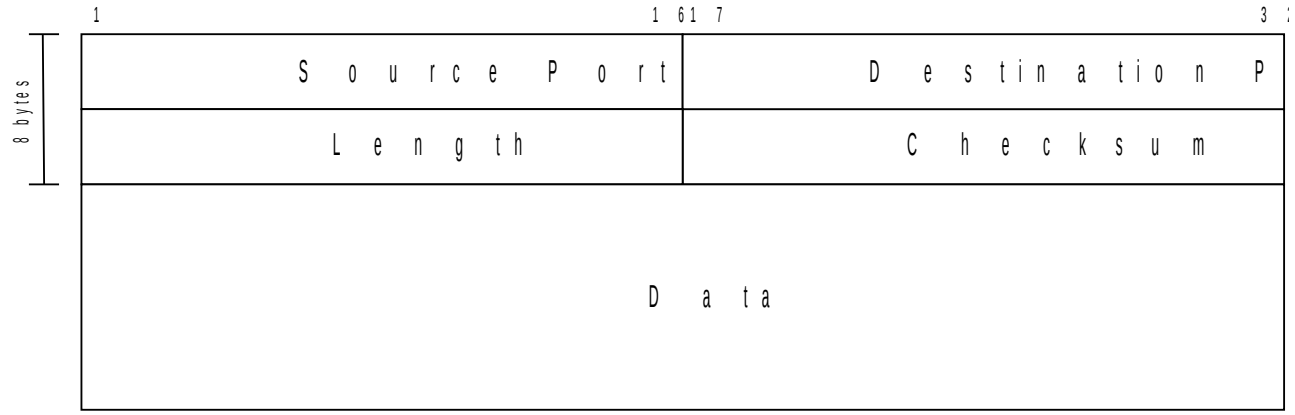
RTP Packet



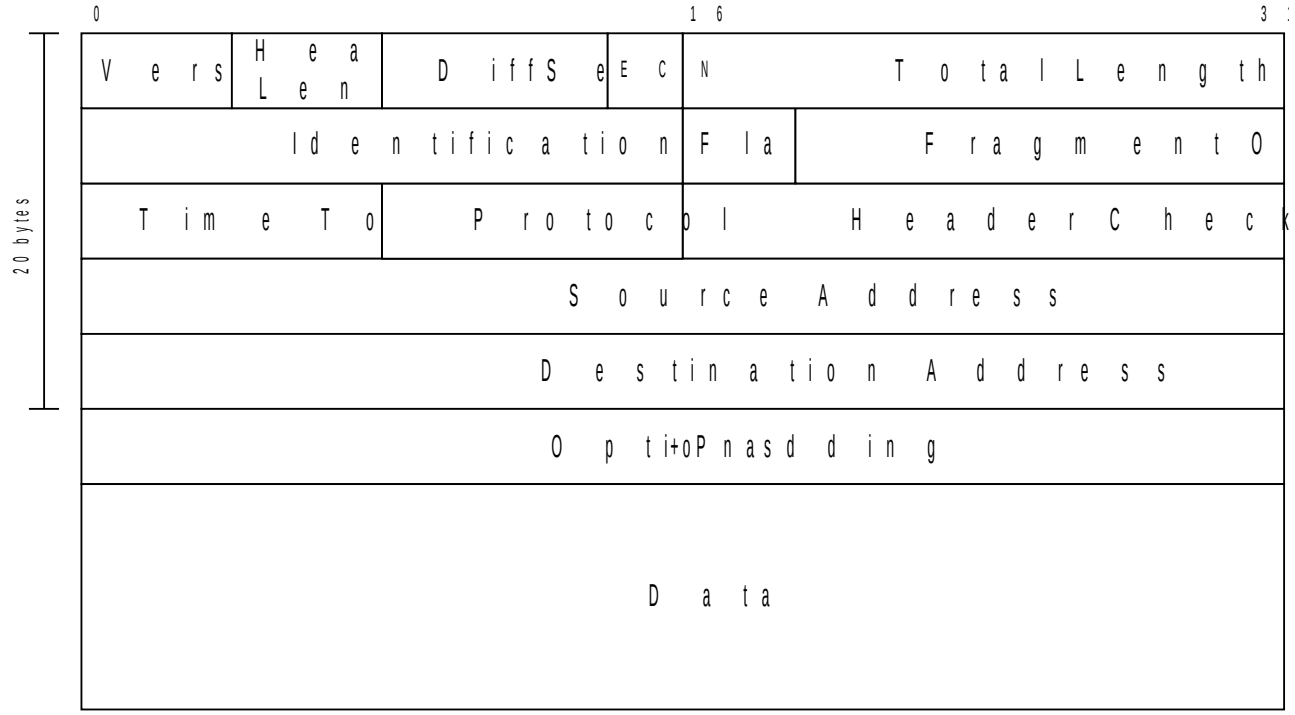
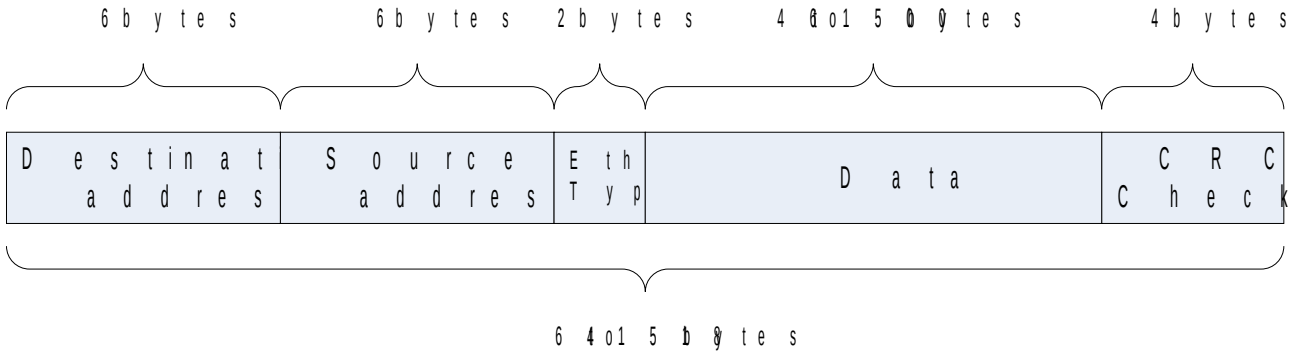
TCP Packet



UDP Packet



IP Packet



Ethernet Frame