Communication Networks 2
Exercise 9 - Peer-to-Peer Networking

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Problem 1 P2P Gnutella

Which routing scheme does Gnutella use?

◯ (A) Flooding
◯ (B) Random walk
◯ (C) Greedy routing
◯ (D) Bubblecast
◯ (E) Broadcast

Solution:

⊗(A) Flooding
◯(B) Random walk
◯(C) Greedy routing
◯(D) Bubblecast
◯(E) Broadcast

Problem 2 P2P DHT Interface

Which of the following P2P methods are part of a typical DHT interface?

◯(A) I, III, V
◯(B) all except I
◯(C) II, V
◯(D) I, IV
◯(E) II

Solution:

◯(A) I, III, V
◯(B) all except I
◯(C) II, V
⊗(D) I, IV
◯(E) II

Problem 3 P2P DHT Concept

Which of the following P2P networks are based on the DHT concept?

◯(A) II, III, V
◯(B) all except I
◯(C) II, V

◯(D) I, IV
◯(E) II

Solution:
⊗(A) II, III, V
◯(B) all except I
◯(C) II, V
◯(D) I, IV
◯(E) II

Problem 4 Gnutella Messages

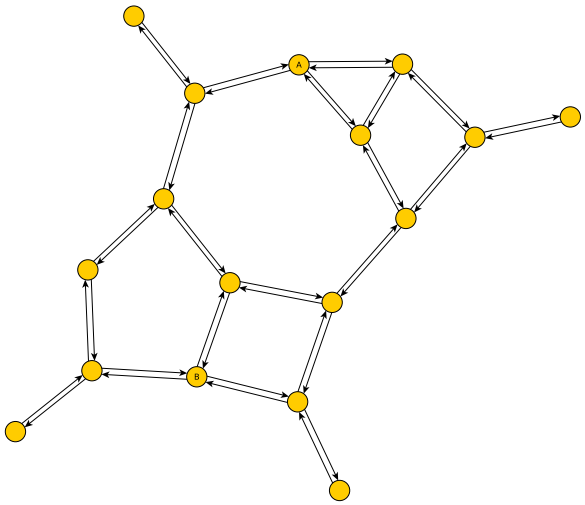
Please indicate all the different message types which are used by the Gnutella 0.4 protocol and explain their purpose.

Solution:

Message Type	**Purpose**
Ping	Actively discover hosts in the network
Pong	Answer to ping message, includes information about connected Gnutella servents.
Query	Searching in the Gnutella network
Query Hit	Response to a query message, can obtain several matching files of one servent
HTTP	HTTP is used to transfer files via HTTP GET
Push	Push message is sent to circumvent firewalls

Problem 5 Gnutella TTL

Given the Gnutella network as shown in the figure below. Assume that Peer A wants to search for a file which is only located on Peer B. What is the minimum TTL needed in order to find the file?



Solution:
Starting from node A the query message is flooded through the network. After four hops Peer B is reached which means that the TTL has to be at least 4.

Problem 6 Gnutella Scalability

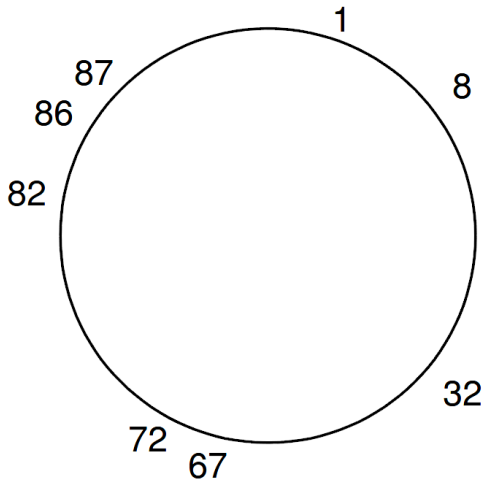
The Gnutella 0.4 protocol has proven not be scalable. Please explain why and give two possible solutions to improve the scalability of the system.

Solution:
Gnutella 0.4 uses flooding to find files in the network. Even at lower request rates, the bandwidth needed to route all query messages and their respective answers throught the network is very high. To overcome these scalability issues, two different approaches have been proposed:

- Random walk as done by Gia
- Superpeers as done by Gnutella 0.6

Problem 7 Chord Network

Consider the Chord network shown in the figure. In this network, 8 nodes participate having the following Globally Unique Identifiers (GUIDs):
1, 8, 32, 67, 72, 82, 86, 87.



How many fingers are needed if the GUID range is between 0 and 99? Which formula provides the ith finger of node n? Provide the fingers table for node 82.

Solution:

7 fingers are needed to cover the identifier space ($2^7 = 128 > 100$, which is the size of the address space). The ith finger for node n is given by $f_n(i) = Successor(n + 2^i)$. Alternatively it can be $f_n(i) = n + 2^i \bmod 100$. The finger table is given in the table on the right side.

Problem 8 Chord Network-Cont.1

What is the responsibility area of node 82 in this Chord network?

Solution:
Node 82 is responsible for the identifier space (73, 82).

finger	node
0	86
1	86
2	86
3	1
4	1
5	32
6	67

Problem 9 Chord Network-Cont.2

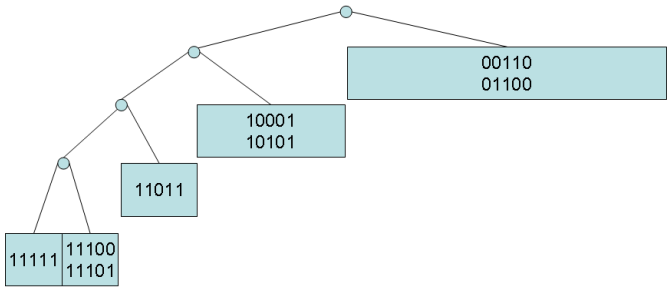
Node 82 is performing a lookup request with input value 7. How many steps are needed assuming that the network is stabilized? Show the followed path until the destination.

Solution:
Node 82 will forward the query to node 1, since it is the closest peer not exceeding the lookup value. Then, Node 1 will forward the query to Node 8, which is responsible to provide the final answer. 2 steps are needed to forward the query to the final destination.

Problem 10 kademlia

In the following task we will have a look at the routing table construction of Kademlia. We use a 5-bit long identifier space. The bucket-factor is $k = 2$. The alpha factor is $\alpha = 2$. We assume all nodes being online and available. Please construct the routing table for node 11001 for the following sequence of nodes being introduced:
10001, 00110, 11100, 01100, 00010, 10101, 11101, 10111, 11111, 11011.

Solution:



Problem 11 kademlia-Cont.1

Assume, we want to route a message from node 11001 to the nodes closest to ID 10111. Which nodes are selected from the routing table during the first routing step?

Solution:
The nodes 10001 and 10101 are selected from the routing table as they are the closest nodes to the ID given the α factor of 2.

Problem 12 kademlia-Cont.2

How large is the distance between the node 11001 and the nodes selected in the task before measured in the Kademlia distance metric?

Solution:

1 1 0 0 1
XOR
1 0 0 0 1
———————

$0\ 1\ 0\ 0\ 0 = 0 \cdot 2^4 + 1 \cdot 2^3 + 0 \cdot 2^2 + 0 \cdot 2^1 + 0 \cdot 2^1 = 8$

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1 1 0 0 1
XOR
1 0 1 0 1
———————

$0\ 1\ 1\ 0\ 0 = 0 \cdot 2^4 + 1 \cdot 2^3 + 1 \cdot 2^2 + 0 \cdot 2^1 + 0 \cdot 2^1 = 12$