Exercise
for Lecture “P2P Systems”

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Exercise No. 2
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Submission either via Moodle or on paper before the exercise.
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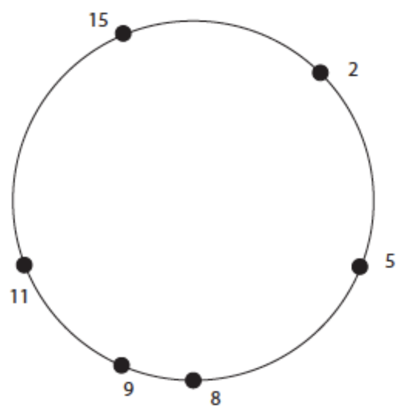
Surname (Nachname):	
First name (Vorname):	
ID# (Matrikelnummer):	

Problem 2.1 - Pastry Addressing

The following address space ring for this problem is given. The markers represent the available peers in the Pastry DHT. (Note: Although hexadecimal notation is common in Pastry, in this figure, we use decimal notation for simplification.)



A) How many bits does an identifier (NodeID) have in this address space, and what is the largest possible address?

B) Let the DHT parameter b to be configured to 2. How many digits are then used for node and item ids? What would be the according string representations of the nodes in the above example?

Problem 2.2 - Pastry Routing Complexity

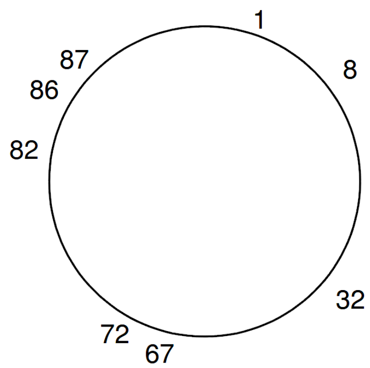
Given is a Pastry DHT with the following properties:

$\|L\| = 0,$	the leaf set is empty.
$N = 2^k, k \in \mathbb{N},$	the number of nodes in the DHT is a power of 2.
$b,$	is an arbitrary constant value.

Pastry's routing algorithm converges in not more than $\log_{2^b} N$ hops. Prove the theorem.
Hint: consider the size of the set of possible target nodes during the routing process.

Problem 2.3 - 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.

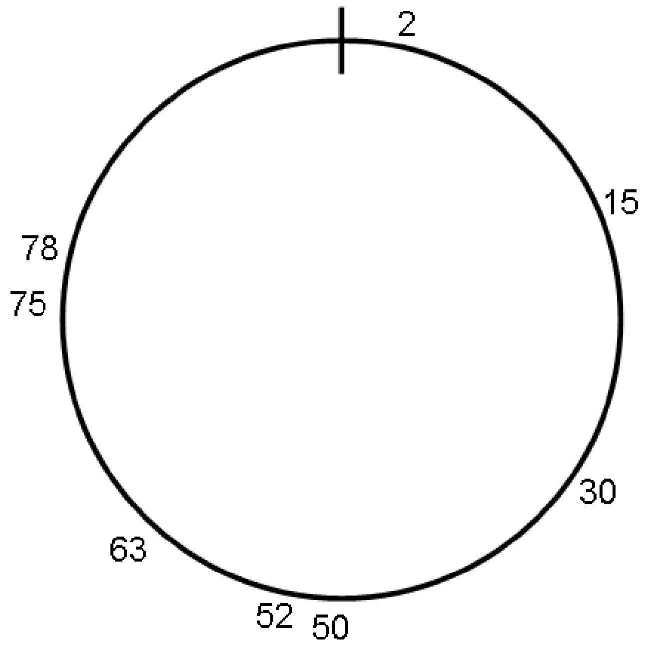


A) How many fingers are needed if the GUID range is between 0 and 99? Which formula provides the i-th finger of node n? Provide the fingers table for node 82. Which is the responsibility area of node 82 in this Chord network?

B) 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.

Problem 2.4 - Chord network

Consider the Chord network with an identifier space ranging from 0 to 99 as shown in the figure. In this network, 8 nodes participate having the following Globally Unique Identifiers (GUIDs): 2, 15, 30, 50, 52, 63, 75, 78.



A) Please derive a formula for calculating the the ith finger in the routing table at node n.

B) How many fingers are needed if the GUID range is between 0 and 99?

C) Provide the finger table for node 50.

D) Which is the responsibility area of node 50 in this Chord network?

E) Node 50 is performing a lookup request with input value 16. How many steps are needed assuming that the network is stabilized? Show the followed path to the destination.

Problem 2.5 - Structured Overlay Networks

A) Choose the right answer:

		TRUE	FALSE
i)	Search complexity of O(1) is not possible in a DHT.	☐	☐
ii)	DHTs use different address spaces for data and nodes.	☐	☐
iii)	Introducing *Virtual Servers* for load balancing helps reducing the number of nodes without any load.	☐	☐
iv)	Chord automatically replicates stored application data items among each node's list of successors.	☐	☐

B) Which of the both mechanisms (Replication and Redundancy) is beneficial if the data items stored in the DHT are (i) small or (ii) large?

C) Certain mechanisms in DHTs (which?) require availability of many different hash functions. How can such functions be derived from an initial hash function $h_0(\cdot)$ such as *SHA-1*?

D) How shall an identifier (NodeID) be created in a structured overlay network? How can a malicious peer exploit arbitrary NodeID creation?

E) Explain why using pointers with the *Power of Two Choices* load balancing algorithm implies an increased overall load for the system?

F) Explain the steps of Chord's "Stabilize" function in case a node A does not know about its newly joined successor in the ring. Assume that all predecessor relations are up-to-date.