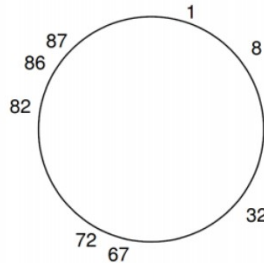


# Peer to Peer Systems 21/07/2016

## Master Degree in Computer Science, Computer Science and Networking, Business Informatics

### Exercise 1 (The Chord DHT) (9 pt)

Consider the Chord network shown in the following figure. In this network, 8 nodes participate, having the following Unique Identifiers (UIs): 1, 8, 32, 67, 7, 82, 86, 87



#### a) Chord Topology

- how many fingers are needed if the UI range is between 0 and 99?
- which formula provides the  $i$ -th finger of node  $n$ ? Provide the fingers table for node 82 according to the format (finger, target id, node id)
- give the responsibility areas of all nodes in this Chord network according to the format (peer ID, from, to).

#### b) Routing in Chord

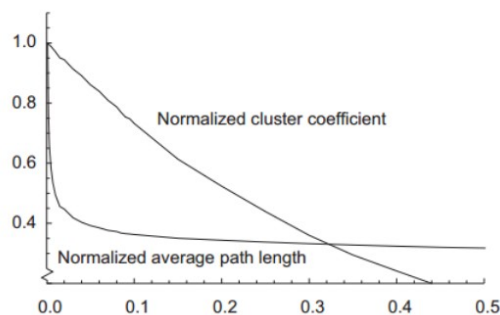
- Node 82 is performing a lookup request with input value 7. How many steps are needed assuming that the network is stabilized? Show the followed path until the destination.

**Exercise 2 (9 pt) (The Kademlia DHT)** Kademlia is a DHT system which is in wide-spread use as it is integrated in several BitTorrent clients.

- what is the benefit of using a symmetric distance metric like XOR in a DHT?
- what routing state information does each Kademlia node store?
- what update policy is used, when a node receives a query from a previously unseen node and the  $k$ -Bucket of the receiving node already contains  $k$  node IDs? What is the rationale behind this update policy?
- explain Kademlia's node lookup algorithm. Is it an iterative or a recursive lookup?

### Exercise 3 (6 pt) (Complex Network modelling)

- describe the construction of a Watts-Strogatz graph  $WS(n, k, p)$ .



- for a  $WS(n, k, p)$  graph, we know that the clustering coefficient and average path length evolve as a function of  $p$  as described in the following figure. What does this graph tell us?

**Exercise 4 (6pt) (Cryptocurrencies)** Describe the *distributed block chain* data structure exploited by the Bitcoin protocol.