# Peer to Peer Systems 11/02/2016
# Master Degree in Computer Science,
# Computer Science and Networking, Business Informatics

**Exercise 1 (10 pt)**

**Part a - Fundamentals of Distributed Hash Tables**

- describe four fundamentals characteristics of Distributed Hash Tables.
- Why DHTs poorly support complex queries?
- DHT guarantee that any request for a data item stored in the system will be successful.Why? Does such a guarantee exist in unstructured P2P systems?

**Part b - Searching in the Chord System**

Figure 1 depicts a Chord ring consisting of 10 peers $a_1$, $a_2$, ..., $a_{10}$ for a given 4-bit identifier space. In the blue marked rectangle, the last binary values is the node ID, the other values are the keys stored on that node. The node IDs is also written in red in base 10. For instance, node $a_5$ has the node ID $10_{10}=1010_2$ and stores the data items with the keys $1000_2$ and $1001_2$ whereas node $a_6$ has the ID $1_{10}=0001_2$ and does not store any data item at the moment.

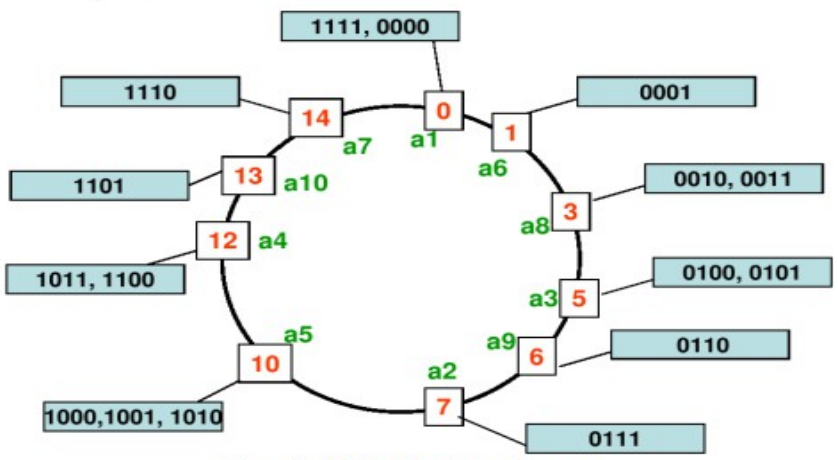


*Figure 1. A 4-bit Chord identifier space*

- show the content of the finger table of at least three nodes.
- how many steps do the following nodes need to perform a search request for the given data item (motivate the answer):
  (a8, 1010), (a2, 0100), (a6, 0001)?

**Exercise 2 (8pt)** After having given the formal definition of the clustering coefficient of a network, you are asked to draw two graphs with the following properties.

- a connected graph with 8 nodes and a clustering coefficient C approximatively equal to 0.5. Prove that the graph satisfies the required propery by calculating C.
- a connected graph with 5 nodes and at least 5 links and C equal to 0. Calculate C for the graph.

**Exercise 3 (6pt)** Describe a *distributed peer sampling service* for P2P systems. Give an example of an application using this service.

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