Prof. Dr. Thorsten Strufe
Stefanie Roos
{strufe,roos}@cs.tu-darmstadt.de

Fachgebiet Peer-to-Peer Netzwerke
Fachbereich Informatik
Technische Universität Darmstadt

Exercise 7

for **Peer-to-Peer Networks** - winter term 2012/2013

(04.12.2012)

Deadline for submission: 11.12.2012 1:30 PM

Guidelines

- Exercises annoted by **G#** are intended to be discussed and solved in class without grading, whereas exercises annoted with **H#** are supposed to be solved in groups and be handed in for grading.
  This does not mean, that ungraded exercises are less important.
- Please submit your solutions until the beginning (1:30 PM) of the next exercise in the coming week. Solutions can either be dropped in the letterbox in front of A110 or handed in personally on the beginning of the exercise. **Electronic submission is no more allowed!**
- Note that points are only given if your solution is clearly legible. Unreadable submissions will not be rated! (Machine written submissions are allowed)
- Written assignments are to be solved in groups of 2-3 participants while programming assignments have to be done in groups of four to six participants.
- Always annotate your solutions on the handed in sheet with names and matriculation numbers. If you have privacy concerns, you are allowed to omit your name and tell it to us personally.
- Please subscribe to the mailing list:
  `https://mail.rbg.informatik.tu-darmstadt.de/mailman/listinfo.cgi/p2p-lecture-ws12`
- By submitting any processed exercises or program code you hereby commit to the "Grundregeln der wissenschaftlichen Ethik am Fachbereich Informatik" (see also `http://www.informatik.tu-darmstadt.de/de/sonstiges/plagiarismus/`).
  This especially means, that you should always write in your own words. However if you use external materials, you have to cite them correctly.
  We will not accept solutions that only rely on literal citations.

G#7.1 Kademlia

Consider Kademlia with an 8-bit Identifier Space and $k = 2$.

a) Buckets

How many nodes are in one bucket?

b) Routing Tables

Assume there are 8 nodes with the following identifiers:

- $n_0 = 0000\ 1011_2$

- $n_1 = 0001\ 1011_2$
- $n_2 = 0010\ 0011_2$
- $n_3 = 0110\ 1011_2$
- $n_4 = 0111\ 1111_2$
- $n_5 = 1000\ 1000_2$
- $n_6 = 1010\ 0000_2$
- $n_7 = 1111\ 0101_2$

Assuming that the routing tables are completely full, i.e. a bucket is either full or there are no more nodes that fall into that bucket, give one possible routing table for n_0 and n_7?
How many possible routing tables are there for n_0 and n_7?

c) Update Policy

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?

d) Lookup Algorithm

Explain Kademlia's node lookup algorithm (i.e., locating the k closest nodes to a given node ID) as given on page 3 of the paper Steiner et a. "Evaluating and Improving the content access in KAD". With the previously discussed DNS queries in mind, is this an iterative or a recursive lookup algorithm? Justify your answer.

H#7.1 KAD (20 Points)

Read the paper "Attacking the KAD network" by Wang et. al, and answer the following questions in your own words.

a) Summary (3 Points)

Write a short 4-5 sentence abstract about the findings of the paper.

b) Kademlia vs. KAD Routing Tables (6 Points)

Explain the difference in the routing tables between Kademlia and KAD. How should this influence the average degree and the average number of nodes contacted during routing?

Consider a 8-bit identifier space, and a bucket size of $k = 1$. Furthermore, each ID is taken by exactly one node. Give the routing table of the node with identifier $0000\ 0000_2$ for both Kademlia and KAD. In case, there are several possible neighbors, choose the one with the smallest ID.

c) Request (3 Points)

Describe the `HELLO_REQ`, `SEARCH_REQ`, and `KADEMLIA_REQ` messages and their purpose in the protocol!

d) Sorting Buckets (2 Points)

Describe how buckets in Kademlia are rearranged. What is the purpose of this mechanism, especially with regard to the update policy?

e) Attacks (6 Points)

Name and explain three attacks described in the paper.