Exercise 2

Exercises Peer-to-Peer-Systems and Security (SS2011)

Monday 23.5 2011
Hand-in: Thursday 30.5. 2011 in lecture or per mail
Exercise: to be announced

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Rules: There will be five exercise sheets. You have to hand-in 70 % of the assignments, attend atleast 3 exercise courses and present a solution in the exercise course to get the 0.3 bonus..

Task 1 CoolSpots Munich III

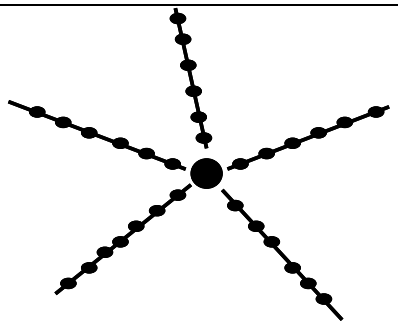
This time you should solve the task to organize the CoolSpots Munich network with a Distributed Hash Table. Use spot_ID = h(GPS coordinate of spot) to store the items. As item descriptions are rather short, the data is stored on the DHT nodes and not only on the node that contributed the item.

a) Briefly describe how a put and get operation works.
b) How can you find an item that is directly at your GPS coordinate?
c) Items at my exact GPS coordinates are not too useful, what do I have to do to look up items close to my GPS coordinate?

Task 2 An unusual topology

The image on the right shows a solar-like topology. Peers are positioned on 5 rays that are connected via a central peer. The topology further imposes the constraint that the largest ray should not be more than twice as large (with respect to number of nodes) as the smallest ray.

a) Describe a topology-preserving join procedure.
b) What is the largest distance in the topology (let s be the number of nodes on the smallest ray without the central node)?
c) What happens when a node fails? What can you do to make the topology resistant to a failure of a single node?



Task 3 Consistent Hashing – Distribution of Interval sizes

In this task we want to compute the distribution of the interval size in systems on the basis of Consistent Hashing like Chord. Let us assume the ID space to be real-valued in the interval [0,1). Without loss of generality we can put our node on the position 0 in the ID space.

a) Nodes are positioned randomly on the basis of uniform random numbers. What the cumulative distribution function (CDF) L of the corresponding uniform distribution.
b) Now calculate the CDF for the minimum of n-1 independent experiments with the distribution from a). Hint: The CDF for the minimum von random variables with CDFs L_1, L_2, L_3, … is given by the forumla $L\_\min = 1 - \prod_i (1 - L_i)$.
c) Now differentiate L_min to get the probability density function l_min.
d) Plot the probability density function l_min.

Task 4 A flexible Chord

The finger table entries in the classic Chord algorithm always point to the first node in the corresponding finger interval. This does not allow the freedom to select a finger among multiple peers. Yet, there are proposals to allow Chord to link to any node in the interval of the finger. If you remember the proof for the complexity of the lookup of O(logn) in Chord, we needed that the distance is halved per step.

Show that despite of that change, Chord still achieves O(logn) hops with high probability.

Task 5 Distance and links

The more links each node in a DHT has, the shorter the distance. Yet, one does not achieve the full benefit of having such links when the strategy is not good.

Assume first, that a node sits on a ring-like ID space which we simplify to the interval [0,1). Each node links to its successor and predecessor. Each node has 100 long distance links. As long-distance links each node links to nodes i=1..100 in the distance i/100.

a) Does this approach achieve logarithmic distance?
b) Does this approach needs further measures to ensure that the ring does not break? What is different in Chord?

Consider also the result of task 4 for the next subtask. Assume now that you add links in distances ¼, ½, ¾, 13/16, 14/16, 15/16, 61/64, 62/64, 63/64, ... The basic idea is to divide the first interval and then the most distant intervals into quarters.

c) How does this approach affect the distance? (Hint: What reduction is achieved within one hop.)