Peer-to-Peer Systems
Exercise 4
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Peer-to-Peer Systems – Exercise
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General Remarks

Welcome to the exercise for the lecture Peer-to-Peer Systems.
Please follow the general remarks regarding the organization of the exercise.

- The lecture's website is to be found here:
  `http://tsn.hhu.de/teaching/lectures/2014ws/p2p.html`
- For further inquiries, please contact the lecturer under the following email address: `graffi@cs.uni-duesseldorf.de`

Problem 4.1 - Visualization of Chord on Peerfact-Sim.KOM

In order to evaluate peer-to-peer protocols, simulations are typically used. They allow to investigate the behavior and interactions of a large set of nodes. e.g. 1000 nodes. Simulations allow to measure the expected quality of service of a protocol (e.g. Chord) under specific circumstances. In this exercise, we evaluate the performance of Chord with 51 nodes in a visualized environment. In order to answer the following questions, please download and install the p2p simulator PeerfactSim.KOM from `http://www.tsn.hhu.de/teaching/lectures/2014ws/p2p.html`. You also have to download and install gnuplot `http://www.gnuplot.info/` to visualize the results.

a) Visualizing Chord

Simulate the config-file /config/visualization/chord.xml. In the visualization you can switch between two different views for Chord. Describe what is used as a basis for the positions of the nodes in Chord in the schematic and the topological view. Also describe in this context the meaning of GNP - global network positioning. Please make following modifications. Change the churn to be active from minute 30m on instead of minute 90m. Please also let the nodes

in Latin America start lookups from minute 35 on and extend the simulation time to 120m.

Solution:

GNP refers to the global network positiong. This is an approach to create a multi-dimensional map of the world which allows a node-embedding, in which the distances between two nodes are fitting the delay-distances in reality. A visualization according to this map is shown in a topological view. In contrast to this, the schematic view shows the nodes placed in a ring according to their node IDs.

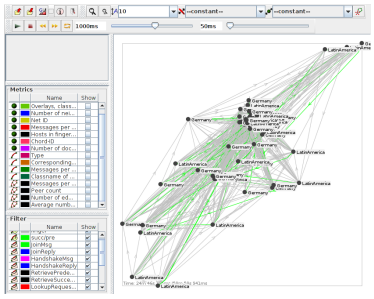

Figure 1: Topological view in Chord: Node placement according to the global network coordinates

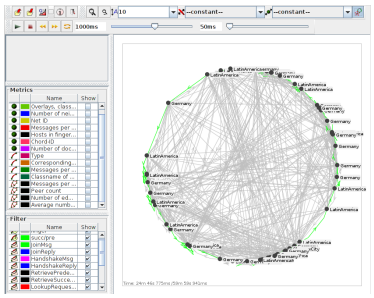

Figure 2: Schematic view in Chord: Node placement according to their Chord coordinates

b) Inspecting the simulation results

Having gained insights in the configuration and the visualization of the overlay, next we inspect the simulation results. With the previous simulation of Chord the simulation results have been written to the outputs folder. The folder with the current date as the suffix, the string "chord" and the seed as the suffix lists the metrics corresponding to the simulation. The gnuplot script files have been also generated automatically. Please note, that not all gnuplot-files are always

applicable, thus errors might be thrown if you try to plot them all. Make a careful selection and plot the corresponding graphs to answer the following questions:

- What is the number of nodes in the simulation, how does it change over time?
- When have lookups been initiated and resolved. How many lookups does a node initiate in maximum?
- What is the average and median hop count per lookup?
- What is the overhead (in terms of forwarded messages, served messages and outgoing traffic) over all nodes, is there an imbalance?

Solution:

The next figures shows the number of nodes in the simulation over time.

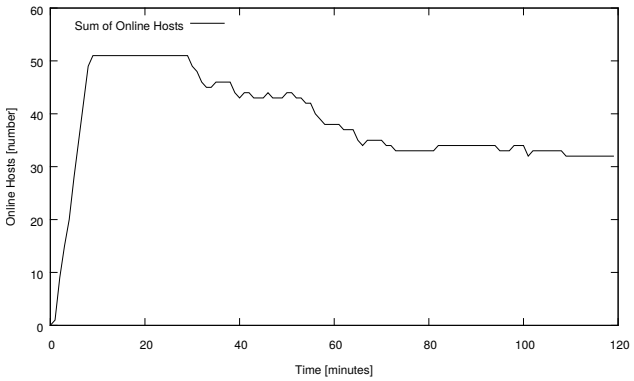

Figure 3: Connectivity: Online Hosts

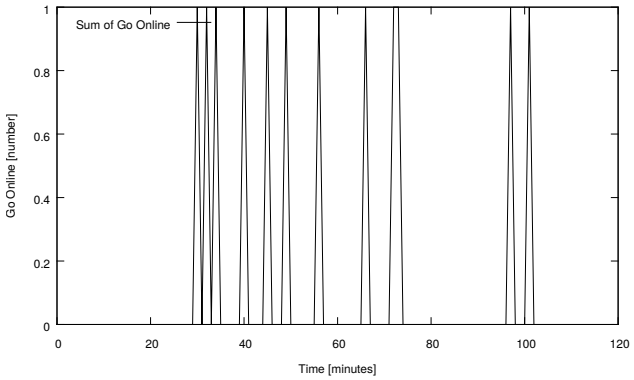

Figure 4: Connectivity: Nodes going online

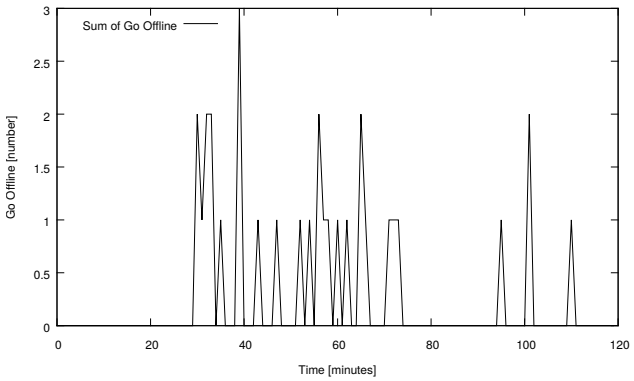

Figure 5: Connectivity: Nodes going offline

Statistics on the initiated and resolved lookups. Lookups are initiated in the time between 20m and 60m. In maximum a node initated 73 lookups.

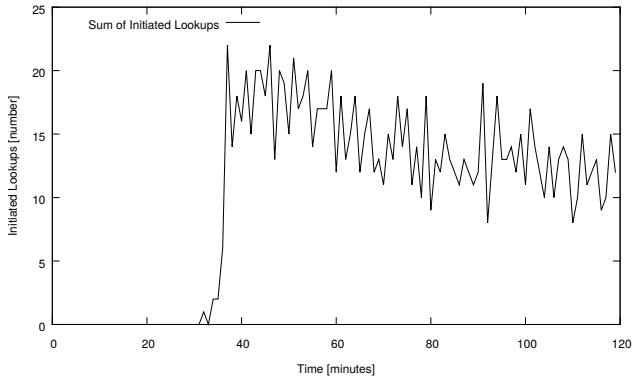

Figure 6: DHTOverlay: Initiated Lookups

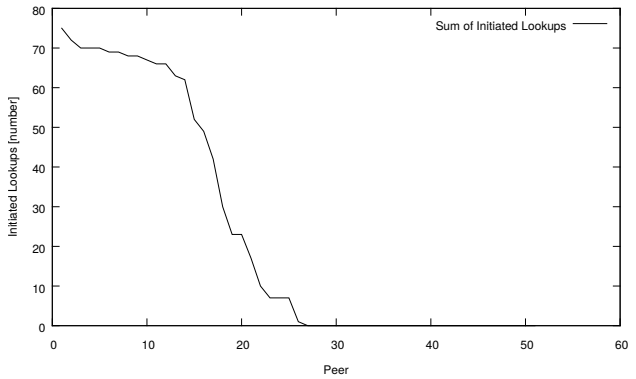

Figure 7: DHTOverlay: Peers Sorted - Initiated Lookups

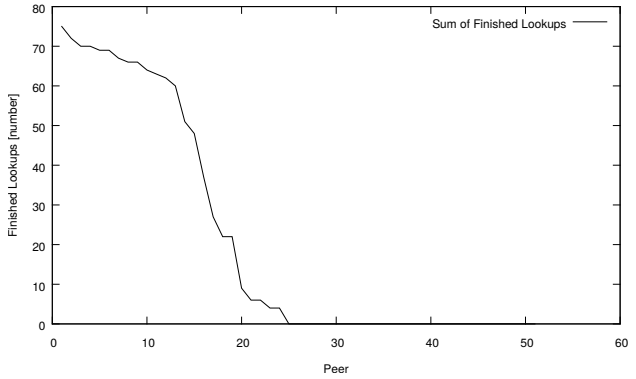

Figure 8: DHTOverlay: Peers Sorted - Finished Lookups

Statistics on the the hop count

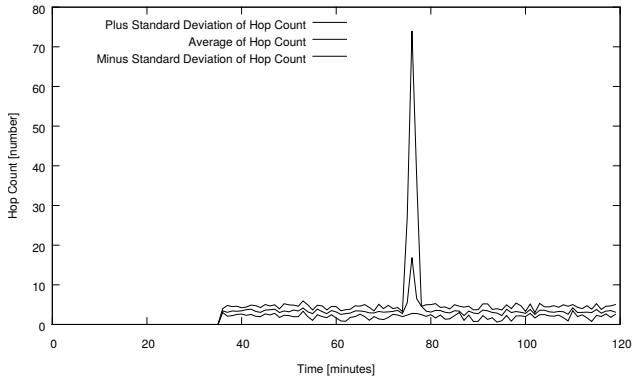

Figure 9: DHTOverlay: Hop Count

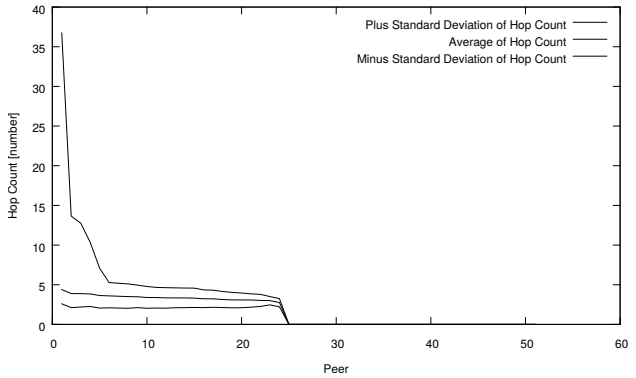

Figure 10: DHTOverlay: Peers Sorted - Hop Count - Average

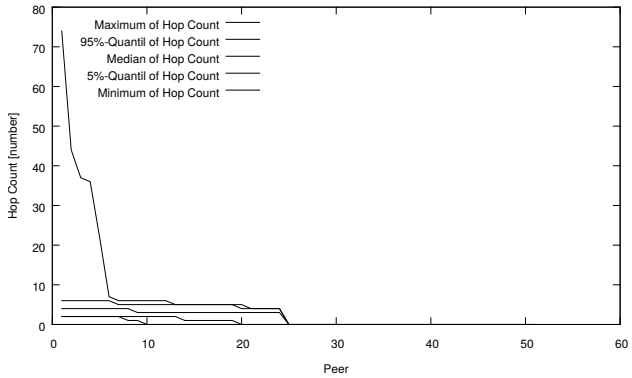

Figure 11: DHTOverlay: Peers Sorted - Hop Count - Median

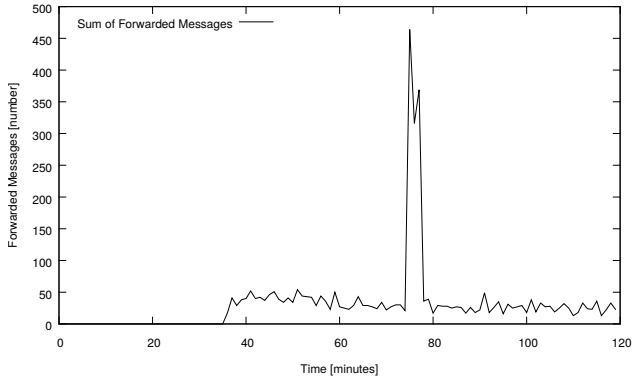

Figure 12: DHTOverlay: Forwarded Messages

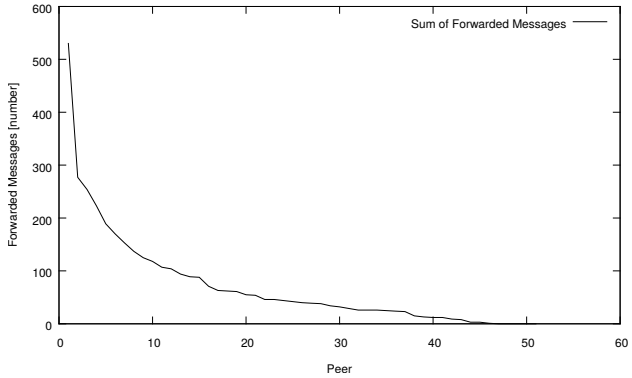

Figure 13: DHTOverlay: Peers Sorted - Forwarded Messages

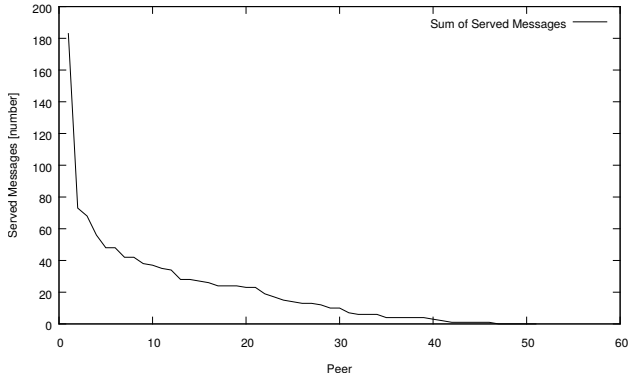

Figure 14: DHTOverlay: Peers Sorted - Served Messages

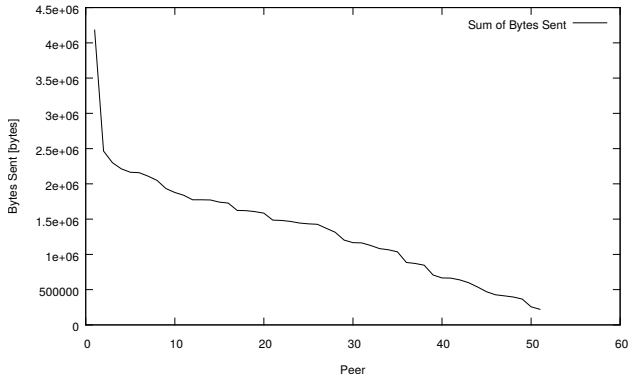

Figure 15: Network: Peers Sorted - Total Bytes Sent

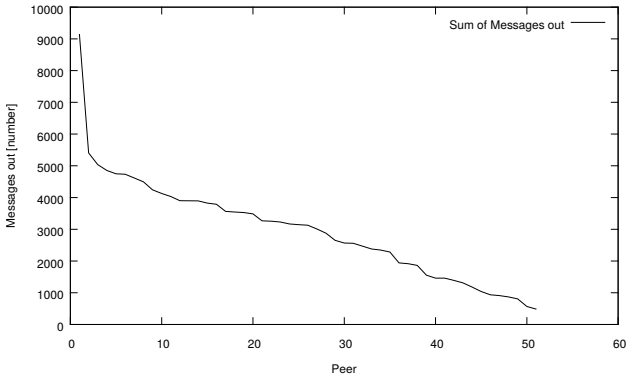

Figure 16: Network: Peers Sorted - Messages Sent

Problem 4.2 - Comparison of Chord and Pastry

In this exercise, we compare Chord to Pastry with respect to the amount of messages both overlays send to maintain the network.

a) Chord and Pastry

For comparison, please simulate the overlays Chord and Pastry with 3 seeds each and compare the results. Here the configuration files from config/education/ are to be used. What are the differences in terms of sent and received messages, especially on the network layer?

Solution:

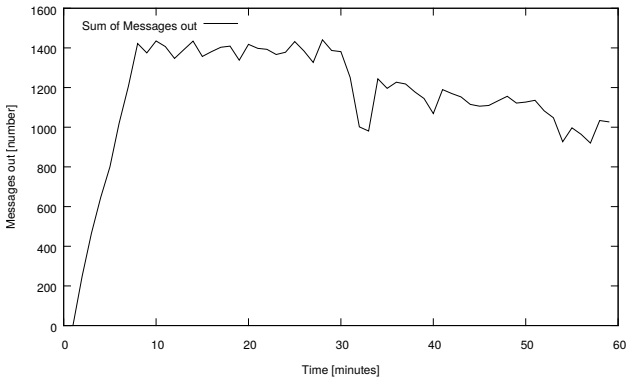

Figure 17: Messages sent in order to maintain Chord ring.

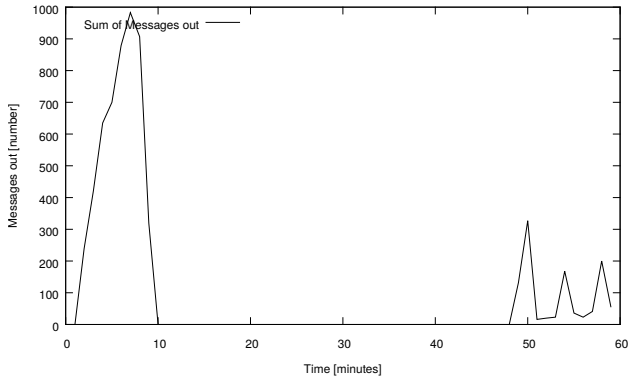

Figure 18: Messages sent in order to maintain pastry overlay.

b) Observations

Explain the outcome of your observations from the previous task a).

Solution:

- In Chord, messages are periodically sent in order to maintain the Chord ring and to prevent the overlay from misbehavior due to failing nodes. Chord's stabilization algorithm follows therefore a *proactive* approach.
- In Pastry, no messages are sent around to maintain the overlay. Nodes change their routing tables whenever they notice other nodes to be failed. Pastry's maintenance protocol is rather *reactive*.

Problem 4.3 - Extension of the EduStar overlay

In the Peer-to-Peer lecture you have been introduced to a very simple overlay, the *EduStar*. In this exercise it is planned to extend and change the overlay slightly. The overlay can be found in the package *org.peerfact.impl.overlay.dht.edu.star* of the simulator.

a) Gnuplot

First, create a simple gnuplot script which allows you to visualize the number of received ping messages in the network. For this task you might consider the simple analyzer class *EduAnalyzer*.

Solution:

```
# nrOfPongs
set term png giant size 800,600 font 'Helvetica,20'
set output 'nrOfPongs.png'
set key top left
set xlabel 'Time [minutes]'
set ylabel 'Sent Pong Messages [number]'
plot 'eduAnalyzer.dat' using 1:2 title 'Pong Messages' with lines axis x1y1
smooth unique
```

b) Online Nodes

Next, extend the analyzer and your gnuplot script with the possibility to plot the number of active nodes in the network.

Solution:

One possibility to solve this task is to introduce a list to which nodes can be added (if online) or from which nodes can be removed (if nodes go offline). For further explanation, please consider the sample implementation of the *eduAnalyzer* from the package *org.peerfact.impl.overlay.dht.edu.star* in the updated version of the simulator.

Gnuplot file:

```
# nrOfNodes
set term png giant size 800,600 font 'Helvetica,20'
set output 'nrOfNodes.png'
set key top left
set xlabel 'Time [minutes]'
set ylabel 'Nodes Online [number]'
plot 'eduAnalyzer.dat' using 1:3 title 'Nodes Online' with lines axis x1y1 smooth
unique
```

c) Churn

As a last step we want to add churn behavior to our simple overlay. Therefore you can extend the method *connectivityChanged(ConnectivityEvent ce)* in the class *StarNode*. Whenever the simulator executes a generated churn event so that the connectivity of one node is affected, this method is called. Now, add the functionality to stop the periodical sending of ping messages in case one node goes offline. If the same node changes it's connectivity to *online* again,

it should start the periodical operation of sending ping messages to the center node again. Try to visualize the churn behavior by using the *EduAnalyzer*.

Solution:

In the class *StarNode*, use method *connectivityChanged(ConnectivityEvent ce)* to influence the initiated operation *pingOperation*. Introduce *start()* and *stop()* method to PingOperation which set the operation active or inactive respectively. For further explanation, please consider the updated version of the *eduStar* overlay in the updated version of the simulator.

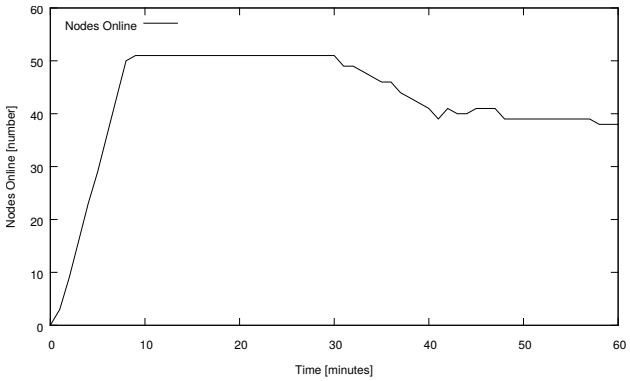

Figure 19: Number of active nodes.