Technische Universität München
Informatik VIII
Netzarchitekturen und Netzdienste
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Master Lecture on Computer Networks (IN2907)

Project 2
To be handed in by: 2011-01-31, 10h

The goal of this project is to gain general insights on Internet topology and routing issues from a practical point of view. For obtaining this knowledge, different kinds of active measurements will be used. At first, you will familiarize yourself with various `traceroute` tools, determine the best one and draw logical maps of the Internet. Your second task is then to try different approaches for IP geolocation, and to use your results for drawing geographical Internet maps.

Grading of this project will take into account the quality of your approach to setup the measurements *(comparability)*, to organize the measured data *(transparency)*, to evaluate the measurements *(thoroughness)*, to document the results *(expressiveness)*, and to interpret/explain the results *(reasoning)*. Each task description provides hints on how to perform, analyze and document the measurements. You are nevertheless free to use your own tools and approaches to improve your results!

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Task 1 `traceroute`

The outcome of this task will be a logical graph showing different paths to multiple targets.

Please download and install the following `traceroute` tools:

- **Standard traceroute** (`tracert` or `traceroute` preinstalled under your OS)
- **NANOG traceroute** (`ftp://ftp.login.com/pub/software/traceroute/`)
- **Paris traceroute** (`http://www.paris-traceroute.net/`)

Ⓐ Make yourself familiar with their features, differences, strenghts and weaknesses and describe your findings in detail. Which tool is most appropriate for the analysis of routing and topology issues?

Ⓑ Use these tools to perform path measurements from at least two different locations (e.g. from university and your home place) to the targets listed below.

www.fu-berlin.de	www.uzh.ch	www.cam.ac.uk	www.univ.kiev.ua
www.univ-paris1.fr	www.uam.es	www.unifg.it	www.ntnu.no
moabit.net.in.tum.de	www.caida.org	www.google.com	loki.muenchen.de
google-public-dns-a.google.com	www.bsu.by	www.ut.ee	www.ucd.ie

Describe, interpret and compare the outcome, and answer the following questions:
- Compare your results for the two locations. Are there any distinctive differences?
- Can you identify *special purpose hops* (like load balancers, MPLS routers, etc.)?
- Are there multiple IP addresses potentially belonging to the same physical router?

Note: Do not hand-in raw traceroute output, but preprocess and refine the data to support your conclusions!

Ⓒ Generate a logical graph of the path measurements for each of the tools, and identify structurally important nodes. Also generate a logical path of all measurements and compare the results of the tools.

A simple way to produce graphs could be `Graphviz` (`http://www.graphviz.org/`) and its different layout engines. Please see the DOT language (`http://www.graphviz.org/doc/info/lang.html`) for details.

Note: Mark your measurement points and the targets, and try to graphically handle anomalies and additional path information obtained by the various tools in a reasonable way!

Task 2 `geolocation`

The outcome of this task will be a map showing the geographic distribution of hops along Internet paths.

Choose one of the data sets (from one of the traceroute tools) of the previous task. Your next step is to use this data to analyze the network in a geographical way. To do so, you have to geolocate each IP address in your data set according to the following 3 methods:

- **Reverse DNS name analysis**:
  Check the reverse name for every IP address and try to infer the corresponding router's geolocation, e.g. `zr-`<u>`fra`</u>`1-te0-7-0-1.x-win.dfn.de` may be a router located in <u>Fra</u>nkfurt.

- **HostIP** (`http://www.hostip.info/`):
  Query the HostIP database for a geolocation.

- **MaxMind** (`http://www.maxmind.com/`):
  Query the MaxMind database for a geolocation.

- *Ping-based geolocation* (exemplary for one traceroute):
  Use the available `ping` services on RIPE's looking glasses (`http://www.ris.ripe.net/cgi-bin/lg/index.cgi`) to measure minimal round trip times to the target IP addresses. Calculate upper bounds for the maximum distances from these systems to the targets (resulting from the propagation speed of light). Draw accordingly sized circles around the measurement nodes and place the targets in the center of the resulting intersection area (*multilateration*).
  Hint: You should infer the measurement nodes' locations from the position of the corresponding Internet Exchange Point (IX). **It is sufficient to geolocate one single path.**

Ⓐ Make yourself familiar with these approaches. Describe their differences, strenghts and weaknesses. Which method is most accurate for finding a geographic location? Why?

Ⓑ Use all methods to locate each IP in your data set. Compare your results and explain your findings.

Ⓒ Generate a geographical map of the path measurements for each of the geolocation methods.

A simple way to produce maps could be `Google Maps` (`http://code.google.com/apis/maps/index.html`), but you are free to use other sources of map drawing as well.

Note: Try to identify geographic points of interest, where a significant amount of Internet infrastructure is located.

Organizational issues

You are encouraged to work in groups of two. Please hand in your results by 31st Jan, 2010, 10h. Your results have to be packed in a single archive, and submitted via the web interface at `http://www.net.in.tum.de/de/lehre/ws0910/vorlesungen/masterkurs-rechnernetze/`.