Datanet Assignment 1

Network Tools

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ABSTRACT
An overview of the basic tools used for analyzing the behaviour of network systems. In a practical approach by experimenting with these tools we lead into a discussion of more theoretical topics in network technologies.

General Terms
Experimentation, Measurement

Keywords
Network, Tools

1. INTRODUCTION
I will briefly go over the system and network setup used to perform the practical aspects discussed throughout the document. Having provided these one can more easily reason the results of the measurements to be discussed later.

1.1 System Setup
The system used ran in the virtual machine environment VirtualBox (4.3.8).

OS / Kernel	Arch Linux / 3.14.1-1-ARCH
User / Host	casperbhansen / arch

All programs used were acquired through *pacman*, which is the standard package manager for Arch Linux.

1.2 Network Setup
The network was driven via the host computer, as a bridged connection, through the host system running Mac OS 10.9.2.

Speed (Up/Down)	1 Mbit / 10 Mbit
Connection	Wireless

Because the connection is bridged, the test results should suffer little impact. However, since the connection is wireless some induced latency is to be expected.

2. LATENCY AND BANDWIDTH
By experimentation with tools like `ping`, `traceroute` and `wget` on the chosen target network hosts and a discussion of the results we can attempt to draw a few conclusions.

2.1 Chosen Targets
For convenience, I have listed the target network hosts that will be tested against. Each target is assigned a shorthand label for easy reference.

Label	Location	URL
AU	Australia	`http://ftp.au.debian.org/debian/`
DK	Denmark	`http://ftp.dk.debian.org/debian/`
JP	Japan	`http://ftp.jp.debian.org/debian/`
UK	England	`http://ftp.uk.debian.org/debian/`
US	America	`http://ftp.us.debian.org/debian/`

The targets were chosen with the intend of producing a variety of results. The tests were conducted in Denmark, making the Danish mirror the closest. England comes in second as it is relatively close to Denmark. For the remainder of the targets many factors can influence which is the fastest and slowest, so I won't be making any guesses — these were selected for exactly this reason.

2.2 Ping
The `ping` program sends out an ICMP[1] `ECHO_REQUEST` datagram, consisting of an IP-address ICMP header and a timeval structure[`ping` manual page]. An `ECHO_REQUEST` can be thought of as the *"ping"* itself, which basically asks the target network host to send back an ICMP `ECHO_REPLY`, also known as a *"pong"*.

Target	Minimum	Average	Maximum
DK	31.649 ms	33.972 ms	36.685 ms
UK	42.757 ms	52.393 ms	71.944 ms
US	120.464 ms	193.454 ms	243.455 ms
JP	350.175 ms	391.000 ms	434.614 ms
AU	424.835 ms	461.892 ms	502.756 ms

Figure 1: Ping summary of results

The above table shows the set of results for each target, sorted by average response time.

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[1]ICMP — Acronym for *Internet Control Message Protocol.*

As to be expected, the fastest response time was the destination closest to the source (DK).

2.3 Trace Route

Examining the `traceroute` outputs (see section A.1) for the chosen targets (see section 2.1) we look at the routes taken to reach the destination. We begin by highlighting the most interesting case. Before performing the test, I would have guessed that the route taken to reach Australia would have been through Asia — that is, I had expected it to choose a guided media route over an unguided.

Figure 2: Visual representation of a traceroute from Denmark to Australia

However, by the route taken, as represented in the above figure, we see that two satellite relay routes are taken. This was unexpected as the unguided media of satellite links produce a substantially high latency, mostly due to the signal propagation delay, suggested[1, p. 21] to be around 280 ms.

Before leaving Denmark, the route taken must at least pass an ISP central, as such lines 2–8 are found in all of the `traceroute` outputs. Lines 4–7 constitute the local ISP, while line 8 constitutes the global ISP.

2.4 Wget

Using a tool such as `wget` we can download files from the internet. For purposes of testing stability of a network connection over time, I've chosen a rather large file to download; the latest (at the time of writing) distribution of Arch Linux.

The file to be downloaded is 565.182.464 bytes in size L. With a downstream bandwidth R of 10 Mbit/s at our disposal, we can calculate the expected time it takes to download the file, given that the circumstances are optimal.

$$\frac{L}{R} = \frac{565.182.464 \text{ bytes} \cdot 8 \text{ bits}}{10 \text{ Mbit/s} \cdot 1024^2} = 431,2 \text{ seconds} \qquad (1)$$

As evident from the output of `wget` (see figure 3), the transmission delay, as calculated above, is relatively close to the time it took to download the file, which took 9 minutes and 20 seconds. Or, 560 seconds, to be more precise, making

the transmission delay the dominant term of the total delay. The remainder of the total delay constitutes processing, queuing and propagation delay. This example was selected to exemplify the transmission delay. Had we chosen a small target file that required a one or more satellite links, the propagation delay would likely become the dominant term, as the signal would take longer to reach, or propagate, to us.

```
1  > wget http://mirrors.dotsrc.org/archlinux/iso
      /2014.05.01/archlinux-2014.05.01-dual.iso
2  --2014-05-01 17:38:33-- http://mirrors.dotsrc.
      org/archlinux/iso/2014.05.01/archlinux
      -2014.05.01-dual.iso
3  Resolving mirrors.dotsrc.org (mirrors.dotsrc.
      org)... 130.225.254.116, 2001:878:346::116
4  Connecting to mirrors.dotsrc.org (mirrors.
      dotsrc.org)|130.225.254.116|:80...
      connected.
5  HTTP request sent, awaiting response... 200 OK
6  Length: 565182464 (539M) [application/x-iso9660
      -image]
7  Saving to: 'archlinux-2014.05.01-dual.iso'
8
9  2014-05-01 17:47:53 (986 KB/s) - 'archlinux
      -2014.05.01-dual.iso' save
      [565182464/565182464]
```

Figure 3: Output log from `wget`

3. HTTP PROTOCOL

Using the tool `Wireshark` we can examine the data transmission correspondence between a client and a server. With the intent of gaining an understanding of how a network application can improve its performance by employing the concept of caching.

3.1 Hypothesis

Recently requested data is likely to be requested more than once when browsing the web. Therefore any intermediary channels (e.g. proxy servers) should cache these data for future requests, including the local client. This alleviates unnecessary network traffic. By this I reason that the second trace should be far smaller than the first.

3.2 Experiment

A web browser (in this case, we will use Google's Chromium) is cleared of all of its cached data. The URL `http://www.diku.dk/` is then requested. Upon having received the response the browser is closed and reopened, and the same URL is revisited. The traces are then compared.

3.3 Results

The first —uncached— trace produces a massive amount of data transmissions; 1987 recorded transmissions to be exact. The following —cached— trace produces a mere 106 (see section A.2) recorded transmissions. These results are in agreement with the posed hypothesis.

4. REFERENCES

[1] James F. Kurose, Keith W. Ross,
    Computer Networking, A Top-Down Approach,
    Pearson Education, Sixth Edition, 2013

APPENDIX

A. OUTPUT LOGS

A.1 Trace route

```
1  traceroute to ftp.au.debian.org (218.100.43.30), 30 hops max, 60 byte packets
2   1  * * *
3   2  192.168.1.1 (192.168.1.1)  2.040 ms  2.705 ms  3.846 ms
4   3  95.166.146.1 (95.166.146.1)  23.213 ms  23.585 ms  23.605 ms
5   4  ae12.mr5.hoer.dk.ip.fullrate.dk (90.185.4.86)  25.879 ms  26.658 ms  26.812 ms
6   5  ae7.mr1.vby.dk.ip.fullrate.dk (90.185.4.241)  27.187 ms  27.667 ms  30.054 ms
7   6  ae6.mr1.fb.dk.ip.fullrate.dk (90.185.5.81)  28.387 ms  27.724 ms  27.059 ms
8   7  xe-3-1-0-0.boanqp7.dk.ip.tdc.net (62.242.107.165)  27.146 ms  22.462 ms  22.626 ms
9   8  192.38.7.38 (192.38.7.38)  23.423 ms  22.812 ms  23.410 ms
10  9  10ge16-1.core1.fra1.he.net (184.105.223.201)  46.541 ms  46.854 ms  46.314 ms
11  10  100ge5-2.core1.par2.he.net (72.52.92.13)  45.871 ms  46.932 ms  47.549 ms
12  11  10ge15-1.core1.ash1.he.net (184.105.213.93)  136.272 ms  136.221 ms  129.401 ms
13  12  10ge11-1.core1.pao1.he.net (184.105.213.177)  188.501 ms  188.355 ms  188.890 ms
14  13  10ge3-4.core1.sjc1.he.net (72.52.92.114)  189.966 ms  190.828 ms  190.152 ms
15  14  vocus.gigabitethernet2-13.core1.sjc1.he.net (64.71.184.46)  190.542 ms  190.779 ms  190.087 ms
16  15  ten-0-0-2-2.cor02.sjc01.ca.VOCUS.net (114.31.199.244)  393.977 ms  393.102 ms  394.017 ms
17  16  ten-0-5-0-0.cor01.syd04.nsw.VOCUS.net.au (114.31.199.37)  392.851 ms  393.299 ms ten-0-2-0-2.
        cor01.syd04.nsw.VOCUS.net.au (114.31.199.45)  393.131 ms
18  17  ten-0-2-0-2.cor03.syd03.nsw.VOCUS.net.au (175.45.72.224)  393.361 ms  393.112 ms  393.781 ms
19  18  ten-0-0-0-0.cor01.per02.wa.VOCUS.net.au (114.31.206.127)  394.104 ms  394.531 ms  395.996 ms
20  19  ge-0-1-0.bdr01.per02.wa.VOCUS.net.au (114.31.206.85)  395.440 ms  394.372 ms  392.435 ms
21  20  as10084.cust.bdr01.per02.wa.VOCUS.net.au (114.31.207.14)  393.275 ms  391.829 ms  391.882 ms
22  21  103.2.119.135 (103.2.119.135)  392.442 ms * *
23  22  * * *
24  23  * * *
25  24  * * *
26  25  * * *
27  26  * mirror.waia.asn.au (218.100.43.30)  408.346 ms  408.303 ms
```

Figure 4: Traceroute results of `ftp.au.debian.org`

```
1  traceroute to ftp.us.debian.org (64.50.236.52), 30 hops max, 60 byte packets
2   1  * * *
3   2  192.168.1.1 (192.168.1.1)  3.229 ms  3.255 ms  4.095 ms
4   3  95.166.146.1 (95.166.146.1)  86.445 ms  86.459 ms  86.431 ms
5   4  ae12.mr5.hoer.dk.ip.fullrate.dk (90.185.4.86)  24.661 ms  25.280 ms  26.238 ms
6   5  ae7.mr1.vby.dk.ip.fullrate.dk (90.185.4.241)  29.014 ms  29.097 ms  29.100 ms
7   6  ae6.mr1.fb.dk.ip.fullrate.dk (90.185.5.81)  29.099 ms  26.113 ms  26.051 ms
8   7  xe-3-1-0-0.boanqp7.dk.ip.tdc.net (62.242.107.165)  25.365 ms * 60.600 ms
9   8  as0-0.ashbnqp1.us.ip.tdc.net (83.88.31.141)  167.962 ms  165.583 ms  165.689 ms
10  9  asbnvabrd01.peering.tds.net (206.126.236.64)  175.860 ms  175.882 ms  175.814 ms
11  10  chcgildtcor52-tg0-0-0-4.network.tds.net (64.50.233.254)  198.151 ms  197.993 ms  194.202 ms
12  11  ftp-chi.osuosl.org (64.50.236.52)  196.709 ms  196.197 ms  196.220 ms
```

Figure 5: Traceroute results of `ftp.us.debian.org`

```
1  traceroute to ftp.dk.debian.org (130.225.254.116), 30 hops max, 60 byte packets
2   1  * * *
3   2  192.168.1.1 (192.168.1.1)  2.390 ms  3.050 ms  4.316 ms
4   3  95.166.146.1 (95.166.146.1)  23.476 ms  23.707 ms  24.049 ms
5   4  ae12.mr5.hoer.dk.ip.fullrate.dk (90.185.4.86)  27.199 ms  27.110 ms  26.996 ms
6   5  ae7.mr1.vby.dk.ip.fullrate.dk (90.185.4.241)  27.742 ms  28.268 ms  30.166 ms
7   6  ae6.mr1.fb.dk.ip.fullrate.dk (90.185.5.81)  26.537 ms  29.747 ms  29.065 ms
8   7  xe-3-0-0-0.boanqp7.dk.ip.tdc.net (195.215.109.229)  27.682 ms  21.897 ms  23.054 ms
9   8  te-dix.ly0.core.fsknet.dk (192.38.7.1)  24.600 ms  22.870 ms  23.429 ms
10  9  130.226.249.194 (130.226.249.194)  31.864 ms  31.770 ms  32.246 ms
11  10  kvaser.dotsrc.org (130.225.254.116)  32.534 ms  31.577 ms  32.237 ms
```

Figure 6: Traceroute results of `ftp.dk.debian.org`

```
1   traceroute to ftp.jp.debian.org (150.65.7.130), 30 hops max, 60 byte packets
2    1  * * *
3    2  192.168.1.1 (192.168.1.1)  1.993 ms  3.346 ms  3.231 ms
4    3  95.166.146.1 (95.166.146.1)  67.411 ms  67.611 ms  67.727 ms
5    4  ae12.mr5.hoer.dk.ip.fullrate.dk (90.185.4.86)  25.533 ms  25.434 ms  29.797 ms
6    5  ae7.mr1.vby.dk.ip.fullrate.dk (90.185.4.241)  26.944 ms  39.368 ms  39.432 ms
7    6  ae6.mr1.fb.dk.ip.fullrate.dk (90.185.5.81)  27.441 ms  27.675 ms  27.159 ms
8    7  xe-3-0-0-0.boanqp7.dk.ip.tdc.net (195.215.109.229)  27.449 ms  21.171 ms  21.817 ms
9    8  ae1-0.ldn4nqp1.uk.ip.tdc.net (83.88.22.7)  42.700 ms  41.755 ms  41.867 ms
10   9  xe-7-3.r00.londen03.uk.bb.gin.ntt.net (83.231.199.245)  42.112 ms  42.254 ms  43.294 ms
11  10  ae-2.r23.londen03.uk.bb.gin.ntt.net (129.250.4.133)  60.708 ms  60.943 ms  55.127 ms
12  11  ae-3.r22.amstnl02.nl.bb.gin.ntt.net (129.250.5.198)  49.134 ms  49.347 ms  59.960 ms
13  12  ae-3.r25.tokyjp05.jp.bb.gin.ntt.net (129.250.4.64)  338.152 ms  335.390 ms  335.485 ms
14  13  ae-2.r01.tokyjp01.jp.bb.gin.ntt.net (129.250.3.243)  334.653 ms  333.867 ms  333.557 ms
15  14  ge-0-7-0-18.r01.tokyjp01.jp.ce.gin.ntt.net (203.105.72.18)  331.837 ms  311.390 ms  320.438 ms
16  15  ve-62.cisco2.komatsu.wide.ad.jp (203.178.136.242)  321.835 ms  328.035 ms  320.183 ms
17  16  * * *
18  17  ftp.jaist.ac.jp (150.65.7.130)  408.055 ms  407.620 ms  407.352 ms
```

Figure 7: Traceroute results of `ftp.jp.debian.org`

```
1   traceroute to ftp.uk.debian.org (83.142.228.128), 30 hops max, 60 byte packets
2    1  * * *
3    2  192.168.1.1 (192.168.1.1)  1.824 ms  2.944 ms  4.596 ms
4    3  95.166.146.1 (95.166.146.1)  24.191 ms  24.116 ms  24.473 ms
5    4  ae12.mr5.hoer.dk.ip.fullrate.dk (90.185.4.86)  24.849 ms  25.781 ms  26.401 ms
6    5  ae7.mr1.vby.dk.ip.fullrate.dk (90.185.4.241)  27.511 ms  28.423 ms  28.335 ms
7    6  ae6.mr1.fb.dk.ip.fullrate.dk (90.185.5.81)  29.200 ms  29.709 ms  28.692 ms
8    7  xe-3-1-0-0.boanqp7.dk.ip.tdc.net (62.242.107.165)  26.933 ms  21.081 ms  22.540 ms
9    8  ae1-0.alb2nqp7.dk.ip.tdc.net (83.88.21.83)  23.506 ms  23.866 ms  24.522 ms
10   9  tinet.xe-3-3-0-0.alb2nqp7.dk.ip.tdc.net (195.215.109.102)  54.891 ms  54.351 ms  53.767 ms
11  10  xe-11-0-2.lon11.ip4.tinet.net (141.136.107.245)  43.491 ms  43.140 ms  42.577 ms
12  11  iomart-hosting-gw.ip4.tinet.net (77.67.74.102)  43.151 ms  43.349 ms  40.993 ms
13  12  593.net1.north.dc5.as20860.net (62.233.127.174)  41.948 ms  41.663 ms  41.725 ms
14  13  87.117.211.42 (87.117.211.42)  45.222 ms  43.913 ms  43.572 ms
15  14  free.hands.com (83.142.228.128)  43.375 ms  43.934 ms  43.697 ms
```

Figure 8: Traceroute results of `ftp.uk.debian.org`

A.2 Cached Wireshark Trace

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000000	192.168.1.46	89.150.129.22	DNS	65	Standard query 0x351b SOA local
2	0.001674000	192.168.1.46	89.150.129.22	DNS	65	Standard query 0x8117 SOA local
3	0.024265000	89.150.129.22	192.168.1.46	DNS	140	Standard query response 0x351b No such name
4	0.024269000	89.150.129.22	192.168.1.46	DNS	140	Standard query response 0x8117 No such name
5	0.024346000	192.168.1.46	89.150.129.22	ICMP	70	Destination unreachable (Port unreachable)
6	0.024346000	192.168.1.46	89.150.129.22	ICMP	70	Destination unreachable (Port unreachable)
7	0.353931000	192.168.1.46	89.150.129.22	DNS	65	Standard query 0xfaee SOA local
8	0.354490000	192.168.1.46	89.150.129.22	DNS	65	Standard query 0xe659 SOA local
9	0.376952000	89.150.129.22	192.168.1.46	DNS	140	Standard query response 0xfaee No such name
10	0.377010000	192.168.1.46	89.150.129.22	ICMP	70	Destination unreachable (Port unreachable)
11	0.377596000	89.150.129.22	192.168.1.46	DNS	140	Standard query response 0xe659 No such name
12	0.377661000	192.168.1.46	89.150.129.22	ICMP	70	Destination unreachable (Port unreachable)

```
14 | 13 0.986103000    192.168.1.46          130.225.96.108         TCP      78       52847 > http [
   | SYN] Seq=0 Win=65535 Len=0 MSS=1460 WS=16 TSval=779269731 TSecr=0 SACK_PERM=1
15 | 14 1.011384000    130.225.96.108        192.168.1.46           TCP      74       http > 52847 [
   | SYN, ACK] Seq=0 Ack=1 Win=5792 Len=0 MSS=1460 SACK_PERM=1 TSval=1423919103 TSecr
   | =779269731 WS=4
16 | 15 1.011540000    192.168.1.46          130.225.96.108         TCP      66       52847 > http [
   | ACK] Seq=1 Ack=1 Win=131760 Len=0 TSval=779269756 TSecr=1423919103
17 | 16 1.011737000    192.168.1.46          130.225.96.108         HTTP     419      GET / HTTP/1.1
18 | 17 1.036875000    130.225.96.108        192.168.1.46           TCP      66       http > 52847 [
   | ACK] Seq=1 Ack=354 Win=6864 Len=0 TSval=1423919110 TSecr=779269756
19 | 18 1.037543000    130.225.96.108        192.168.1.46           HTTP     555      HTTP/1.1 302
   | Found  (text/html)
20 | 19 1.037643000    192.168.1.46          130.225.96.108         TCP      66       52847 > http [
   | ACK] Seq=354 Ack=490 Win=131264 Len=0 TSval=779269781 TSecr=1423919110
21 | 20 1.040260000    192.168.1.46          130.225.96.108         TCP      78       52848 > http [
   | SYN] Seq=0 Win=65535 Len=0 MSS=1460 WS=16 TSval=779269784 TSecr=0 SACK_PERM=1
22 | 21 1.062992000    130.225.96.108        192.168.1.46           TCP      74       http > 52848 [
   | SYN, ACK] Seq=0 Ack=1 Win=5792 Len=0 MSS=1460 SACK_PERM=1 TSval=1423919116 TSecr
   | =779269784 WS=4
23 | 22 1.063097000    192.168.1.46          130.225.96.108         TCP      66       52848 > http [
   | ACK] Seq=1 Ack=1 Win=131760 Len=0 TSval=779269806 TSecr=1423919116
24 | 23 1.063256000    192.168.1.46          130.225.96.108         HTTP     516      GET / HTTP/1.1
25 | 24 1.089604000    130.225.96.108        192.168.1.46           TCP      66       http > 52848 [
   | ACK] Seq=1 Ack=451 Win=6864 Len=0 TSval=1423919123 TSecr=779269806
26 | 25 1.106907000    130.225.96.108        192.168.1.46           TCP      1514     [TCP segment of
   | a reassembled PDU]
27 | 26 1.108188000    130.225.96.108        192.168.1.46           TCP      1514     [TCP segment of
   | a reassembled PDU]
28 | 27 1.108263000    192.168.1.46          130.225.96.108         TCP      66       52848 > http [
   | ACK] Seq=451 Ack=2897 Win=129616 Len=0 TSval=779269849 TSecr=1423919127
29 | 28 1.109421000    130.225.96.108        192.168.1.46           TCP      1514     [TCP segment of
   | a reassembled PDU]
30 | 29 1.109569000    192.168.1.46          130.225.96.108         TCP      66       52848 > http [
   | ACK] Seq=451 Ack=4345 Win=131072 Len=0 TSval=779269850 TSecr=1423919127
31 | 30 1.133119000    130.225.96.108        192.168.1.46           TCP      1514     [TCP segment of
   | a reassembled PDU]
32 | 31 1.134455000    130.225.96.108        192.168.1.46           TCP      1514     [TCP segment of
   | a reassembled PDU]
33 | 32 1.134535000    192.168.1.46          130.225.96.108         TCP      66       52848 > http [
   | ACK] Seq=451 Ack=7241 Win=129616 Len=0 TSval=779269874 TSecr=1423919133
34 | 33 1.136240000    130.225.96.108        192.168.1.46           TCP      1514     [TCP segment of
   | a reassembled PDU]
35 | 34 1.136315000    192.168.1.46          130.225.96.108         TCP      66       52848 > http [
   | ACK] Seq=451 Ack=8689 Win=131072 Len=0 TSval=779269875 TSecr=1423919133
36 | 35 1.137171000    130.225.96.108        192.168.1.46           TCP      1514     [TCP segment of
   | a reassembled PDU]
37 | 36 1.138470000    130.225.96.108        192.168.1.46           TCP      1514     [TCP segment of
   | a reassembled PDU]
38 | 37 1.138546000    192.168.1.46          130.225.96.108         TCP      66       52848 > http [
   | ACK] Seq=451 Ack=11585 Win=129616 Len=0 TSval=779269877 TSecr=1423919133
39 | 38 1.159513000    130.225.96.108        192.168.1.46           TCP      1514     [TCP segment of
   | a reassembled PDU]
40 | 39 1.159621000    192.168.1.46          130.225.96.108         TCP      66       52848 > http [
   | ACK] Seq=451 Ack=13033 Win=129616 Len=0 TSval=779269898 TSecr=1423919140
41 | 40 1.160668000    130.225.96.108        192.168.1.46           TCP      1514     [TCP segment of
   | a reassembled PDU]
42 | 41 1.160723000    192.168.1.46          130.225.96.108         TCP      66       52848 > http [
   | ACK] Seq=451 Ack=14481 Win=131072 Len=0 TSval=779269899 TSecr=1423919140
43 | 42 1.162906000    130.225.96.108        192.168.1.46           TCP      1514     [TCP segment of
   | a reassembled PDU]
44 | 43 1.163352000    130.225.96.108        192.168.1.46           TCP      1514     [TCP segment of
   | a reassembled PDU]
45 | 44 1.163406000    192.168.1.46          130.225.96.108         TCP      66       52848 > http [
   | ACK] Seq=451 Ack=17377 Win=129616 Len=0 TSval=779269901 TSecr=1423919140
46 | 45 1.165171000    130.225.96.108        192.168.1.46           TCP      1514     [TCP segment of
   | a reassembled PDU]
47 | 46 1.165235000    192.168.1.46          130.225.96.108         TCP      66       52848 > http [
   | ACK] Seq=451 Ack=18825 Win=131072 Len=0 TSval=779269903 TSecr=1423919140
48 | 47 1.166437000    130.225.96.108        192.168.1.46           TCP      1514     [TCP segment of
   | a reassembled PDU]
49 | 48 1.167551000    130.225.96.108        192.168.1.46           TCP      1514     [TCP segment of
   | a reassembled PDU]
50 | 49 1.167594000    192.168.1.46          130.225.96.108         TCP      66       52848 > http [
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                          ACK] Seq=451 Ack=21721 Win=129616 Len=0 TSval=779269905 TSecr=1423919141
51        50 1.169571000     130.225.96.108        192.168.1.46        TCP     1514    [TCP segment of
                          a reassembled PDU]
52        51 1.169646000     192.168.1.46        130.225.96.108        TCP     66      52848 > http [
                          ACK] Seq=451 Ack=23169 Win=131072 Len=0 TSval=779269907 TSecr=1423919141
53        52 1.183656000     130.225.96.108        192.168.1.46        TCP     1514    [TCP segment of
                          a reassembled PDU]
54        53 1.183768000     192.168.1.46        130.225.96.108        TCP     66      52848 > http [
                          ACK] Seq=451 Ack=24617 Win=129616 Len=0 TSval=779269921 TSecr=1423919146
55        54 1.185133000     130.225.96.108        192.168.1.46        TCP     1514    [TCP segment of
                          a reassembled PDU]
56        55 1.185197000     192.168.1.46        130.225.96.108        TCP     66      52848 > http [
                          ACK] Seq=451 Ack=26065 Win=131072 Len=0 TSval=779269922 TSecr=1423919146
57        56 1.187048000     130.225.96.108        192.168.1.46        TCP     1514    [TCP segment of
                          a reassembled PDU]
58        57 1.187922000     130.225.96.108        192.168.1.46        TCP     1514    [TCP segment of
                          a reassembled PDU]
59        58 1.187986000     192.168.1.46        130.225.96.108        TCP     66      52848 > http [
                          ACK] Seq=451 Ack=28961 Win=129616 Len=0 TSval=779269923 TSecr=1423919146
60        59 1.189452000     130.225.96.108        192.168.1.46        TCP     1514    [TCP segment of
                          a reassembled PDU]
61        60 1.189518000     192.168.1.46        130.225.96.108        TCP     66      52848 > http [
                          ACK] Seq=451 Ack=30409 Win=131072 Len=0 TSval=779269925 TSecr=1423919147
62        61 1.190611000     130.225.96.108        192.168.1.46        TCP     1514    [TCP segment of
                          a reassembled PDU]
63        62 1.191932000     130.225.96.108        192.168.1.46        TCP     1514    [TCP segment of
                          a reassembled PDU]
64        63 1.192012000     192.168.1.46        130.225.96.108        TCP     66      52848 > http [
                          ACK] Seq=451 Ack=33305 Win=129616 Len=0 TSval=779269927 TSecr=1423919147
65        64 1.193689000     130.225.96.108        192.168.1.46        TCP     1514    [TCP segment of
                          a reassembled PDU]
66        65 1.193763000     192.168.1.46        130.225.96.108        TCP     66      52848 > http [
                          ACK] Seq=451 Ack=34753 Win=131072 Len=0 TSval=779269928 TSecr=1423919148
67        66 1.194791000     130.225.96.108        192.168.1.46        TCP     1514    [TCP segment of
                          a reassembled PDU]
68        67 1.196679000     130.225.96.108        192.168.1.46        HTTP    1088    HTTP/1.1 200 OK
                          (text/html)
69        68 1.196750000     192.168.1.46        130.225.96.108        TCP     66      52848 > http [
                          ACK] Seq=451 Ack=37223 Win=130048 Len=0 TSval=779269930 TSecr=1423919148
70        69 1.223494000     192.168.1.46        192.38.110.181        TCP     78      52849 > http [
                          SYN] Seq=0 Win=65535 Len=0 MSS=1460 WS=16 TSval=779269956 TSecr=0 SACK_PERM=1
71        70 1.246923000     192.38.110.181        192.168.1.46        TCP     74      http > 52849 [
                          SYN, ACK] Seq=0 Ack=1 Win=14480 Len=0 MSS=1380 SACK_PERM=1 TSval=2090644521 TSecr
                          =779269956 WS=128
72        71 1.247043000     192.168.1.46        192.38.110.181        TCP     66      52849 > http [
                          ACK] Seq=1 Ack=1 Win=131328 Len=0 TSval=779269979 TSecr=2090644521
73        72 1.247462000     192.168.1.46        192.38.110.181        HTTP    452     GET /nat-sites/
                          diku-sites/datalogi/topgrafik/navnetraek.gif/ HTTP/1.1
74        73 1.272444000     192.168.1.46        192.38.110.181        TCP     78      52850 > http [
                          SYN] Seq=0 Win=65535 Len=0 MSS=1460 WS=16 TSval=779270004 TSecr=0 SACK_PERM=1
75        74 1.273637000     192.38.110.181        192.168.1.46        TCP     66      http > 52849 [
                          ACK] Seq=1 Ack=387 Win=15616 Len=0 TSval=2090644547 TSecr=779269979
76        75 1.281751000     192.38.110.181        192.168.1.46        HTTP    561     HTTP/1.1 302
                          Found  (text/html)
77        76 1.281861000     192.168.1.46        192.38.110.181        TCP     66      52849 > http [
                          ACK] Seq=387 Ack=496 Win=130832 Len=0 TSval=779270013 TSecr=2090644555
78        77 1.282112000     192.38.110.181        192.168.1.46        TCP     66      http > 52849 [
                          FIN, ACK] Seq=496 Ack=387 Win=15616 Len=0 TSval=2090644555 TSecr=779269979
79        78 1.282163000     192.168.1.46        192.38.110.181        TCP     66      52849 > http [
                          ACK] Seq=387 Ack=497 Win=131072 Len=0 TSval=779270013 TSecr=2090644555
80        79 1.292004000     192.168.1.46        5.10.88.211        TCP     78      52851 > http [
                          SYN] Seq=0 Win=65535 Len=0 MSS=1460 WS=16 TSval=779270022 TSecr=0 SACK_PERM=1
81        80 1.296916000     192.38.110.181        192.168.1.46        TCP     74      http > 52850 [
                          SYN, ACK] Seq=0 Ack=1 Win=14480 Len=0 MSS=1380 SACK_PERM=1 TSval=2090644571 TSecr
                          =779270004 WS=128
82        81 1.297020000     192.168.1.46        192.38.110.181        TCP     66      52850 > http [
                          ACK] Seq=1 Ack=1 Win=131328 Len=0 TSval=779270027 TSecr=2090644571
83        82 1.297277000     192.168.1.46        192.38.110.181        HTTP    449     GET /nat-sites/
                          fak-sites/natfak/topgrafik/topkollage.jpg/ HTTP/1.1
84        83 1.324413000     192.38.110.181        192.168.1.46        TCP     66      http > 52850 [
                          ACK] Seq=1 Ack=384 Win=15616 Len=0 TSval=2090644598 TSecr=779270027
85        84 1.327476000     192.38.110.181        192.168.1.46        HTTP    573     HTTP/1.1 302
                          Found  (text/html)
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 86 |    85 1.327564000    192.168.1.46       192.38.110.181      TCP    66    52850 > http [
    |       ACK] Seq=384 Ack=508 Win=130816 Len=0 TSval=779270057 TSecr=2090644601
 87 |    86 1.328170000    192.38.110.181     192.168.1.46        TCP    66    http > 52850 [
    |       FIN , ACK] Seq=508 Ack=384 Win=15616 Len=0 TSval=2090644601 TSecr=779270027
 88 |    87 1.328206000    192.168.1.46       192.38.110.181      TCP    66    52850 > http [
    |       ACK] Seq=384 Ack=509 Win=131072 Len=0 TSval=779270057 TSecr=2090644601
 89 |    88 1.338301000    5.10.88.211        192.168.1.46        TCP    74    http > 52851 [
    |       SYN , ACK] Seq=0 Ack=1 Win=14480 Len=0 MSS=1460 SACK_PERM=1 TSval=4284313738 TSecr
    |       =779270022 WS=128
 90 |    89 1.338416000    192.168.1.46       5.10.88.211         TCP    66    52851 > http [
    |       ACK] Seq=1 Ack=1 Win=131760 Len=0 TSval=779270067 TSecr=4284313738
 91 |    90 1.338645000    192.168.1.46       5.10.88.211         HTTP   464   GET /j.php?a
    |       =3160&u=http%3A%2F%2Fwww.diku.dk%2F&r=0.5601931305136532 HTTP/1.1
 92 |    91 1.362325000    192.168.1.46       192.38.110.181      TCP    66    52849 > http [
    |       FIN , ACK] Seq=387 Ack=497 Win=131072 Len=0 TSval=779270090 TSecr=2090644555
 93 |    92 1.363303000    192.168.1.46       130.225.96.108      HTTP   420   GET /topgrafik/
    |       navnetraek.gif/ HTTP/1.1
 94 |    93 1.369373000    192.168.1.46       192.38.110.181      TCP    66    52850 > http [
    |       FIN , ACK] Seq=384 Ack=509 Win=131072 Len=0 TSval=779270097 TSecr=2090644601
 95 |    94 1.386189000    192.38.110.181     192.168.1.46        TCP    66    http > 52849 [
    |       ACK] Seq=497 Ack=388 Win=15616 Len=0 TSval=2090644660 TSecr=779270090
 96 |    95 1.387478000    5.10.88.211        192.168.1.46        TCP    66    http > 52851 [
    |       ACK] Seq=1 Ack=399 Win=15616 Len=0 TSval=4284313751 TSecr=779270067
 97 |    96 1.388011000    5.10.88.211        192.168.1.46        HTTP   322   HTTP/1.1 200 OK
    |       (application/x-javascript)
 98 |    97 1.388093000    192.168.1.46       5.10.88.211         TCP    66    52851 > http [
    |       ACK] Seq=399 Ack=257 Win=131504 Len=0 TSval=779270114 TSecr=4284313751
 99 |    98 1.389498000    130.225.96.108     192.168.1.46        HTTP   604   HTTP/1.1 302
    |       Found  (text/html)
100 |    99 1.389578000    192.168.1.46       130.225.96.108      TCP    66    52847 > http [
    |       ACK] Seq=708 Ack=1028 Win=130736 Len=0 TSval=779270115 TSecr=1423919198
101 |   100 1.393310000    192.38.110.181     192.168.1.46        TCP    66    http > 52850 [
    |       ACK] Seq=509 Ack=385 Win=15616 Len=0 TSval=2090644668 TSecr=779270097
102 |   101 2.985856000    ZyxelCom_19:a3:47  Broadcast           ARP    42    Who has
    |       192.168.1.38?  Tell 192.168.1.1
103 |   102 3.899835000    192.168.1.46       192.168.1.255       BJNP   58    Printer Command
    |       : Unknown code (2)
104 |   103 3.899945000    192.168.1.46       224.0.0.1           BJNP   58    Printer Command
    |       : Unknown code (2)
105 |   104 4.005913000    ZyxelCom_19:a3:47  Broadcast           ARP    42    Who has
    |       192.168.1.38?  Tell 192.168.1.1
106 |   105 5.036436000    ZyxelCom_19:a3:47  Broadcast           ARP    42    Who has
    |       192.168.1.38?  Tell 192.168.1.1
107 |   106 5.956391000    ZyxelCom_19:a3:47  Broadcast           ARP    42    Who has
    |       192.168.1.38?  Tell 192.168.1.1
```