Netflow

Malicious activities detection

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Goal

Being able to detect (most of) malicious activities without having to read logs

- Logs are boring, reading them takes a lot of time
- Graphic visualisation is more effective, fast and fun

Being able to detect some other activities (tor, worms, slow scan, tunnel ...) by scripts

Netflow/IPFIX/sFlow

NetFlow

At first a Cisco technology on routers

IPFIX

IETF standard (RFC5101, RFC5102)

IPFIX = NetFlow v10

sFlow

Very similar to NetFlow (softwares who collect/analyse are the same)

Mostly implemented on switches

How it works

A flow is a set of packets with common characteristics within a given time frame and a given direction:

Ingress interface, L3 information (src/dst IP), L4 information (tcp/udp w src/dst ports, icmp, esp, ...)

Start time, duration, number of packets and bytes

A session (for example a HTTP file download) will produce two flows (inbound + outbound)

How it works

The cache contains 64k entries (default)

A flow expires:

- After 15 seconds of inactivity (default)
- After 30 minutes of activity (default)
- When the RST or FIN flag is set
- If the cache is full

How it works

Routers/Switches send flows to collector (2055/udp)

- Work with most of router/switch vendors (NetFlow or sFlow), even with OpenvSwitch or VMware vSphere
- On Linux routers there is an iptables module ipt-netflow (I haven't tested it).

Many open source collectors are available

- We'll focus on nfdump/nfsen

Nfdump/Nfsen

Nfdump

Set of command line tools to collect (nfcapd), to search into flow (nfdump), and few other tools (replay flows for example)

Nfsen

Web based graphic representation of flows

Graphs are made using filters (something like pcap ones)

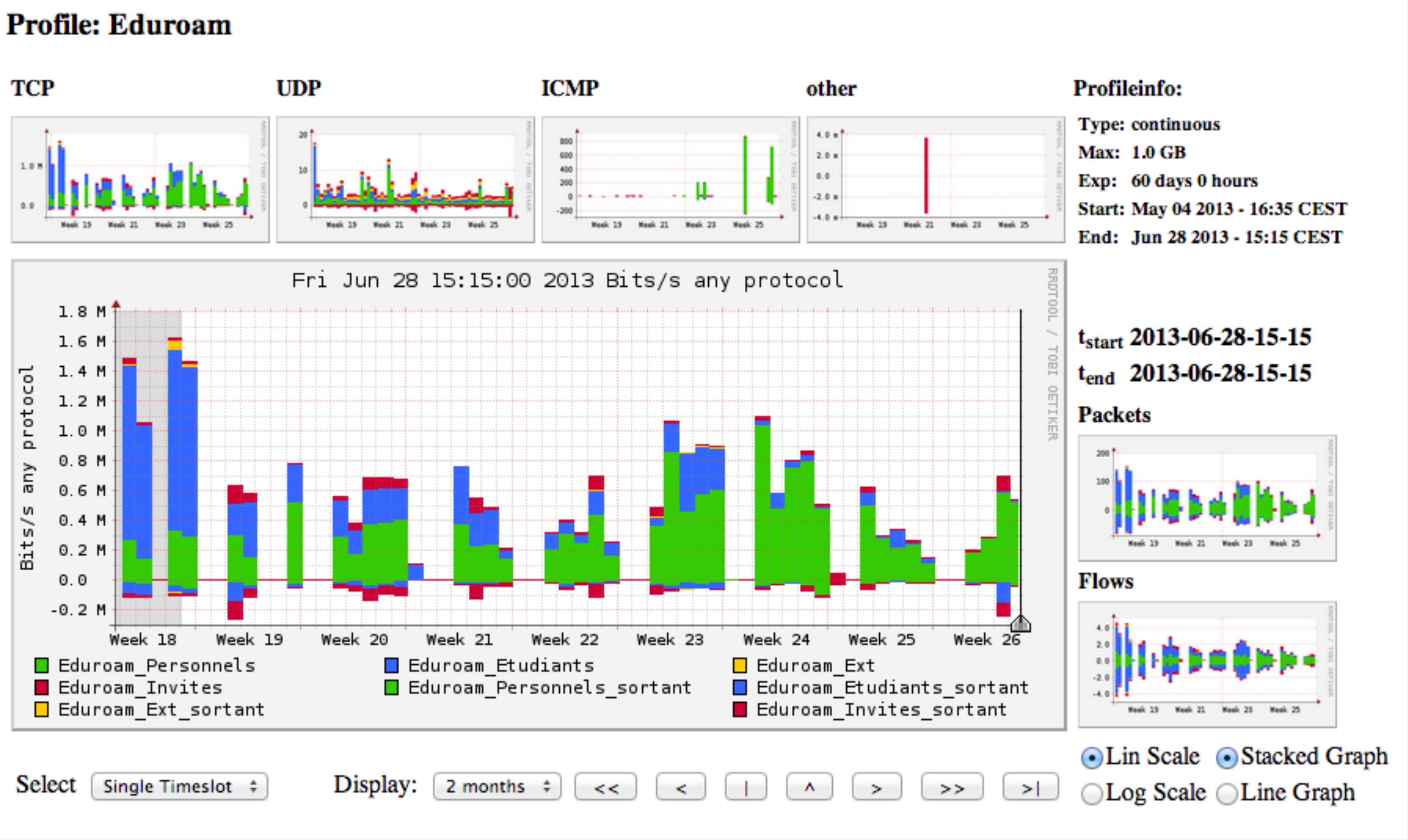
Graph activities by port, host, networks,...

Nfdump/Nfsen

The following examples are based on my university network (Lille)

- On the Wan Router
- 10 GB of flow data saved each month

Some examples



Profile: Eduroam

TCP

UDP

ICMP

other

Profileinfo:

Type: continuous
Max: 1.0 GB
Exp: 60 days 0 hours
Start: May 04 2013 - 16:35 CEST
End: Jun 28 2013 - 15:15 CEST

Fri Jun 28 15:15:00 2013 Bits/s any protocol

🟩 Eduroam_Personnels
🟥 Eduroam_Invites
🟨 Eduroam_Ext_sortant
🟦 Eduroam_Etudiants
🟩 Eduroam_Personnels_sortant
🟨 Eduroam_Ext
🟦 Eduroam_Etudiants_sortant
🟥 Eduroam_Invites_sortant

t_{start} 2013-06-28-15-15
t_{end} 2013-06-28-15-15

Packets

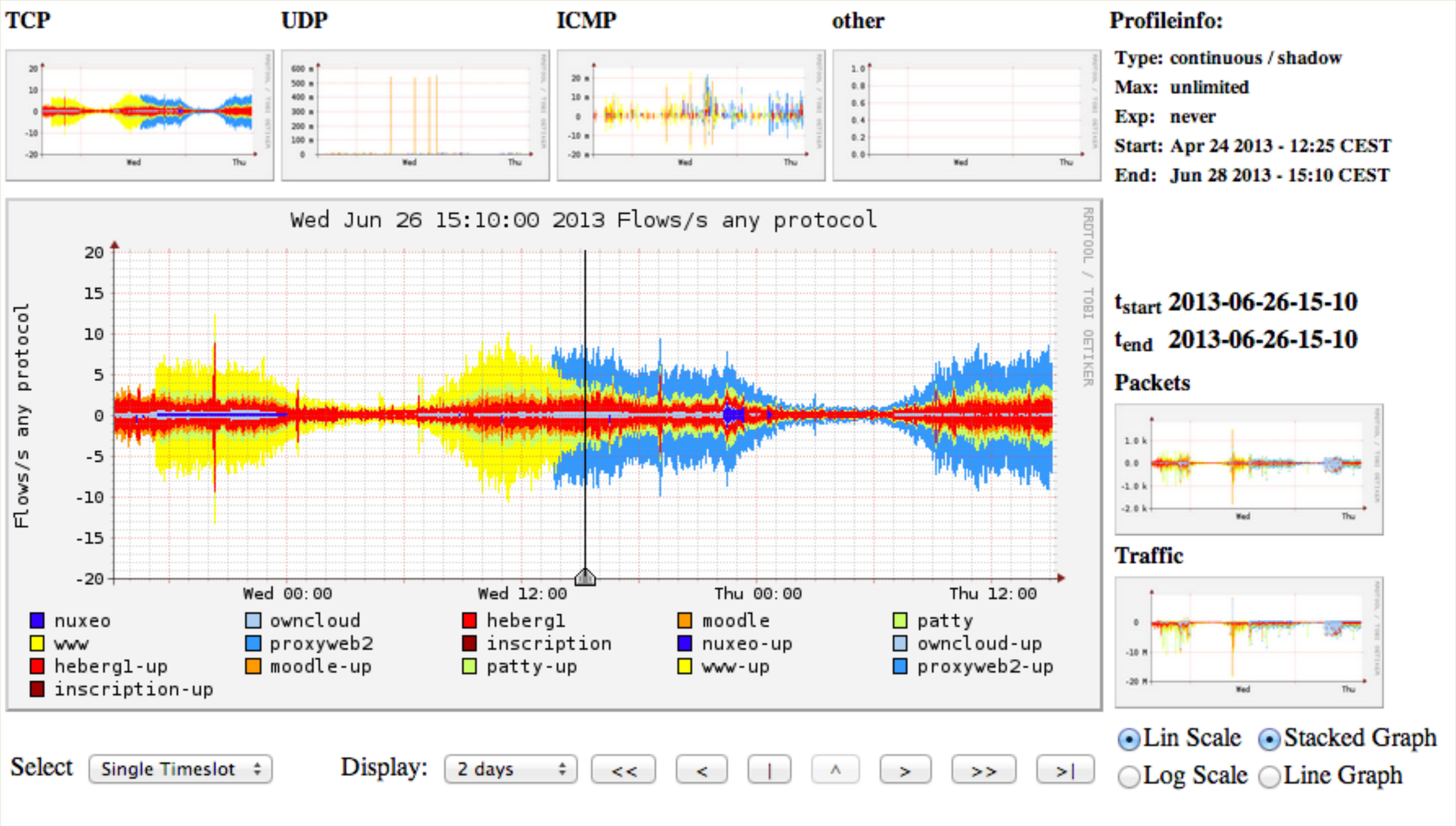
Flows

Select: Single Timeslot

Display: 2 months

● Lin Scale ● Stacked Graph
○ Log Scale ○ Line Graph

Eduroam wireless users (students, staff, guests)



Profileinfo:

Type: continuous / shadow
Max: unlimited
Exp: never
Start: Apr 24 2013 - 12:25 CEST
End: Jun 28 2013 - 15:10 CEST

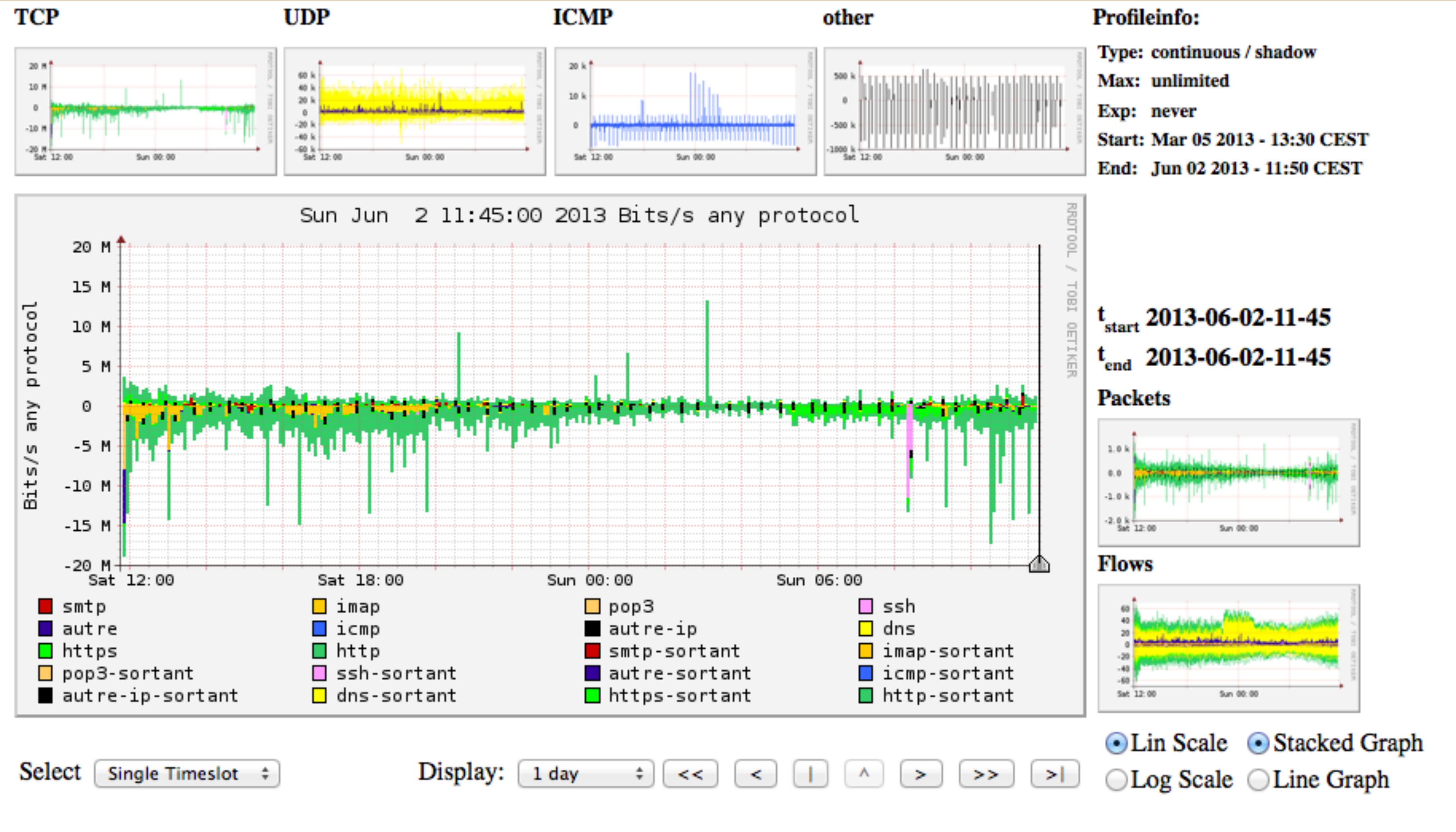
t_{start} **2013-06-26-15-10**
t_{end} **2013-06-26-15-10**

🟦 nuxeo	▢ owncloud	🟥 hebergl	🟧 moodle	🟩 patty
🟨 www	🟦 proxyweb2	🟥 inscription	🟦 nuxeo-up	▢ owncloud-up
🟥 hebergl-up	🟧 moodle-up	🟩 patty-up	🟨 www-up	🟦 proxyweb2-up
🟥 inscription-up				

● Lin Scale ● Stacked Graph
○ Log Scale ○ Line Graph

Few servers

Graph by ports



Profileinfo:

Type: continuous / shadow

Max: unlimited

Exp: never

Start: Mar 05 2013 - 13:30 CEST

End: Jun 02 2013 - 11:50 CEST

t_{start} 2013-06-02-11-45

t_{end} 2013-06-02-11-45

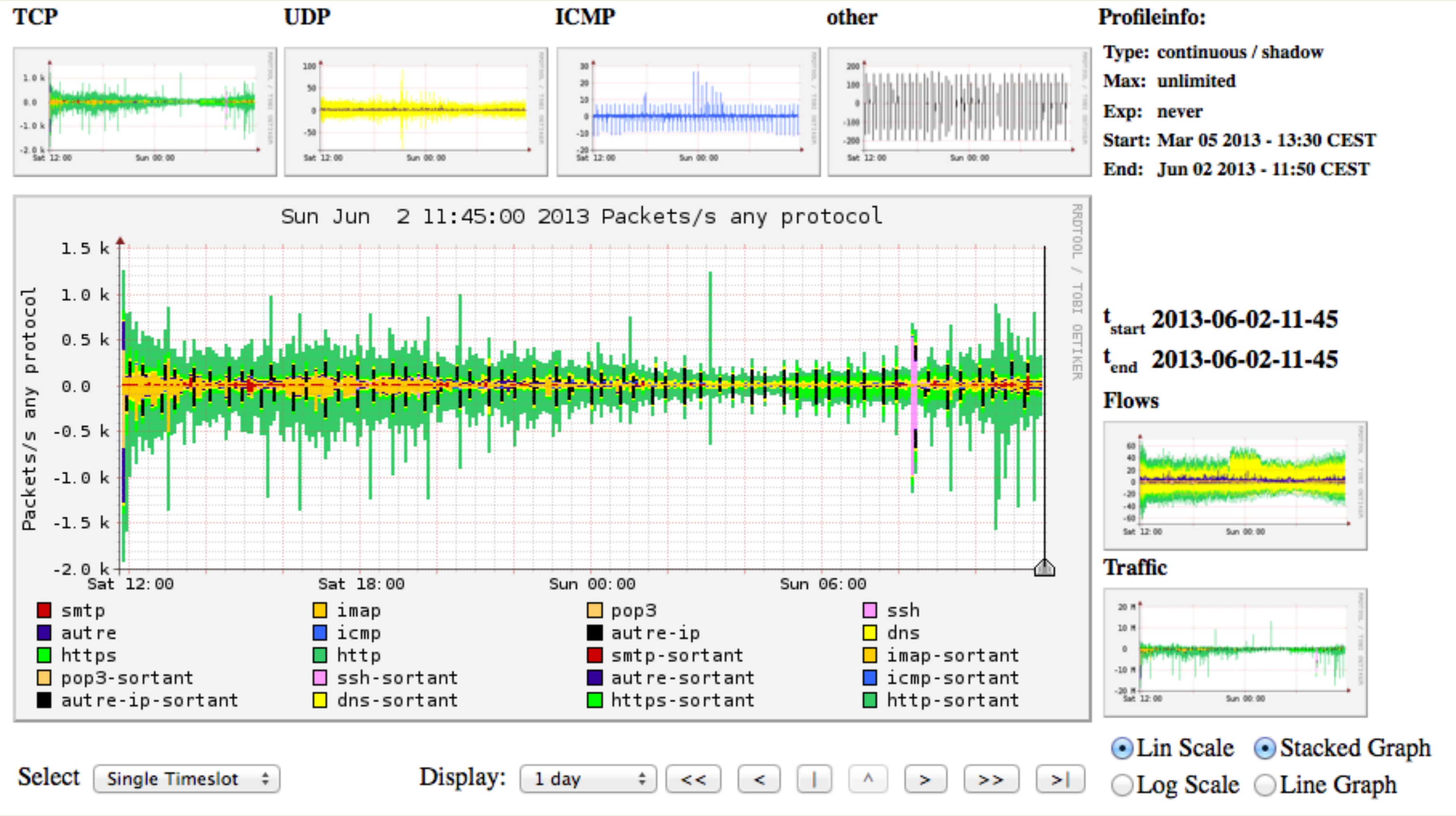
Select: Single Timeslot

Display: 1 day

● Lin Scale ● Stacked Graph

○ Log Scale ○ Line Graph

Bytes



Profileinfo:

Type: continuous / shadow

Max: unlimited

Exp: never

Start: Mar 05 2013 - 13:30 CEST

End: Jun 02 2013 - 11:50 CEST

t_{start} 2013-06-02-11-45

t_{end} 2013-06-02-11-45

🟥 smtp	🟧 imap	🟧 pop3	🟪 ssh
🟦 autre	🟦 icmp	⬛ autre-ip	🟨 dns
🟩 https	🟩 http	🟥 smtp-sortant	🟧 imap-sortant
🟧 pop3-sortant	🟪 ssh-sortant	🟦 autre-sortant	🟦 icmp-sortant
⬛ autre-ip-sortant	🟨 dns-sortant	🟩 https-sortant	🟩 http-sortant

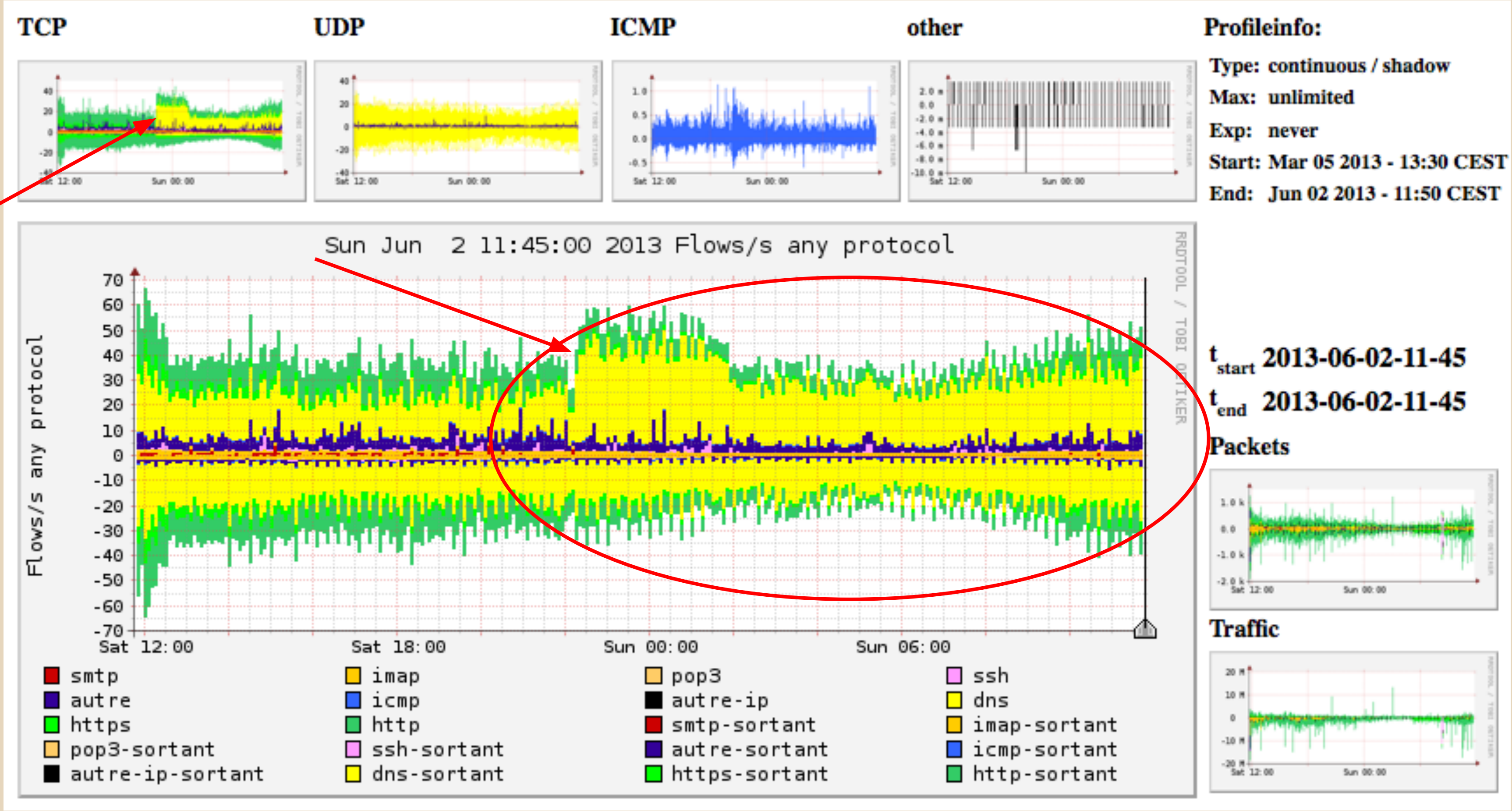
● Lin Scale ● Stacked Graph

○ Log Scale ○ Line Graph

Select Single Timeslot

Display: 1 day

Packets



Profileinfo:

Type: continuous / shadow

Max: unlimited

Exp: never

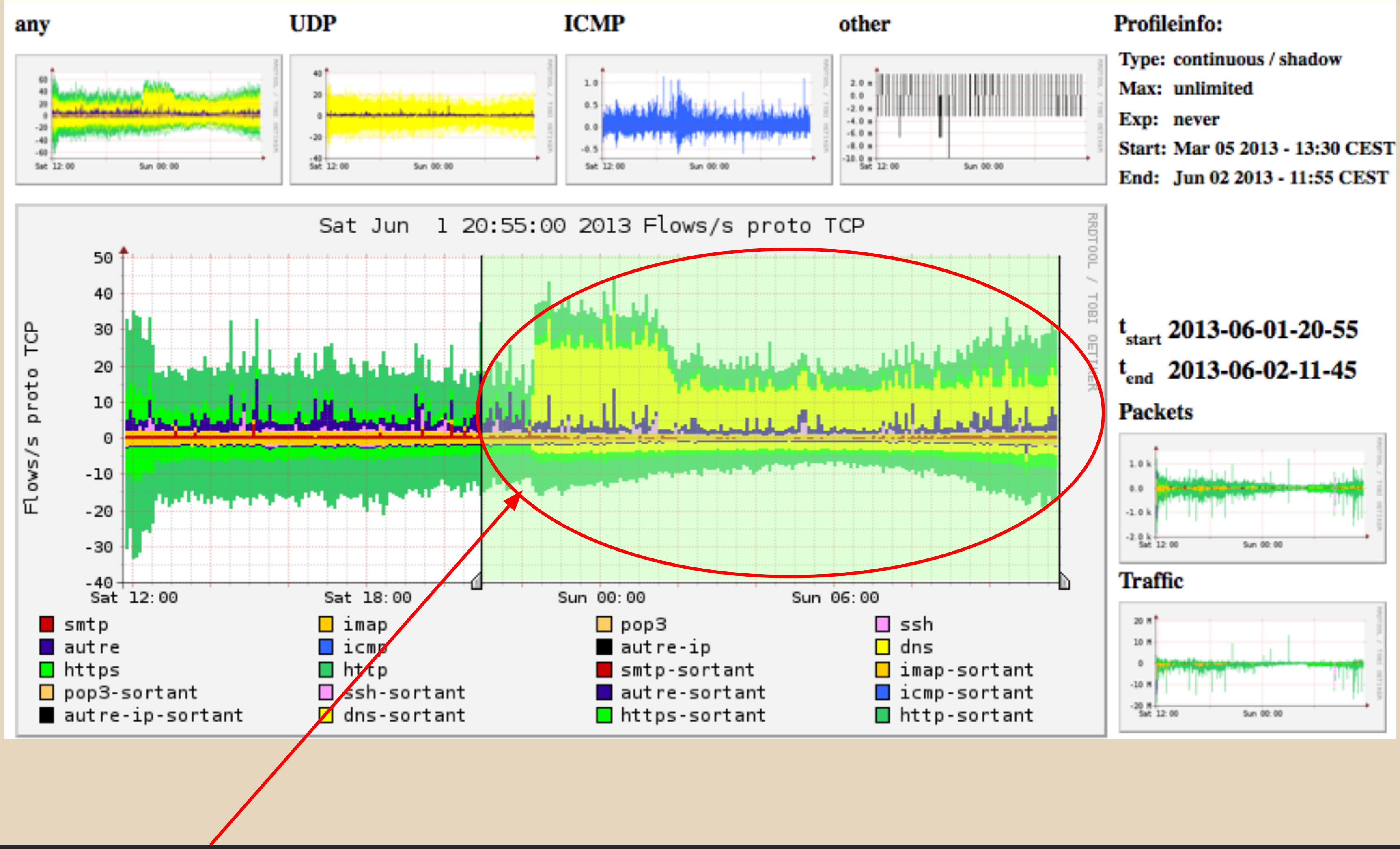
Start: Mar 05 2013 - 13:30 CEST

End: Jun 02 2013 - 11:50 CEST

t_{start} 2013-06-02-11-45

t_{end} 2013-06-02-11-45

Flows

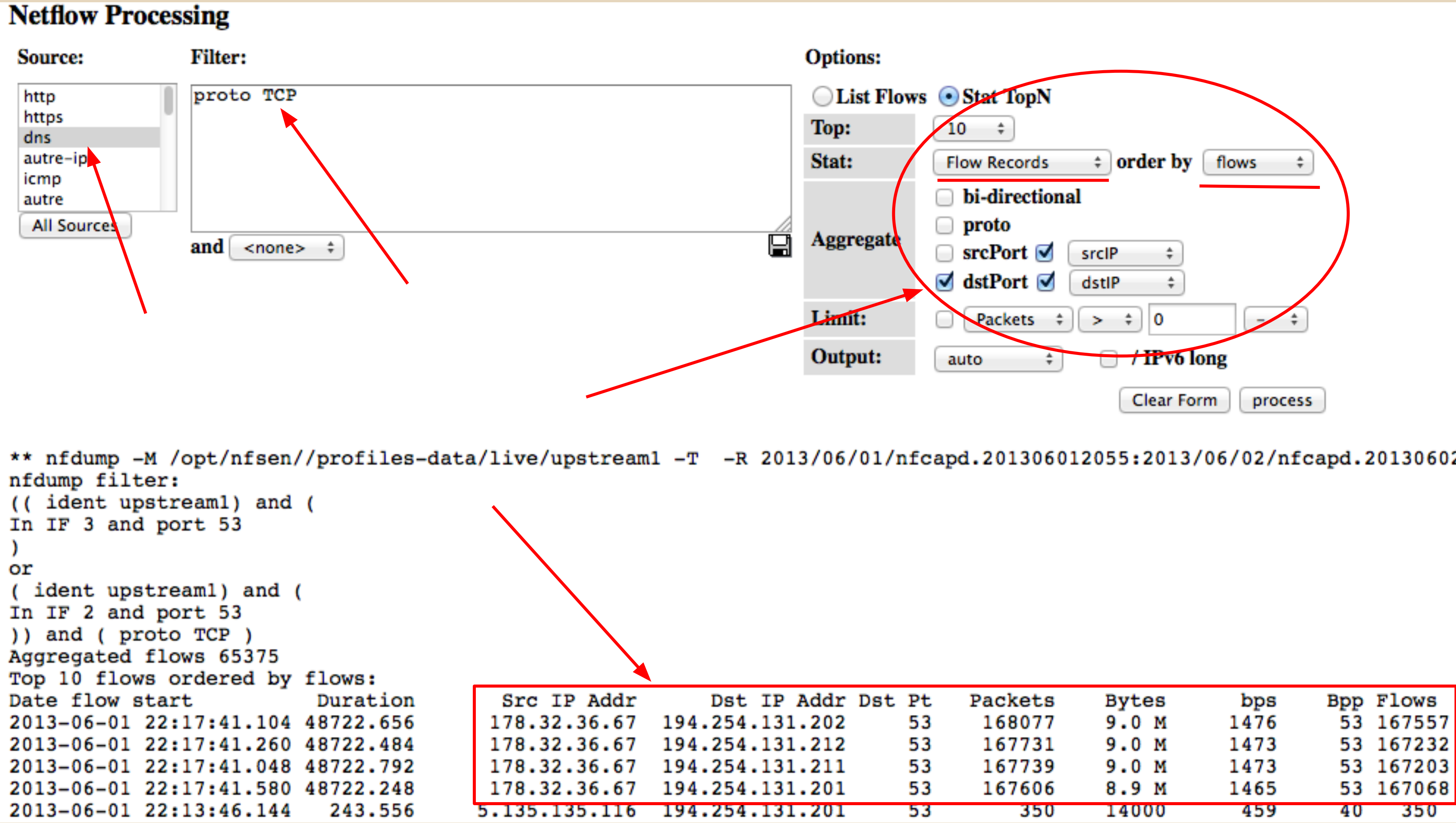


Profileinfo:

Type: continuous / shadow
Max: unlimited
Exp: never
Start: Mar 05 2013 - 13:30 CEST
End: Jun 02 2013 - 11:55 CEST

t_{start} 2013-06-01-20-55
t_{end} 2013-06-02-11-45

TCP Flows



Netflow Processing

Source:

- http
- https
- dns
- autre-ip
- icmp
- autre

All Sources

Filter:

```
proto TCP
```

and <none>

Options:

○ List Flows ● Stat TopN

Top: 10

Stat: Flow Records order by flows

Aggregate:
□ bi-directional
□ proto
□ srcPort ☑ srcIP
☑ dstPort ☑ dstIP

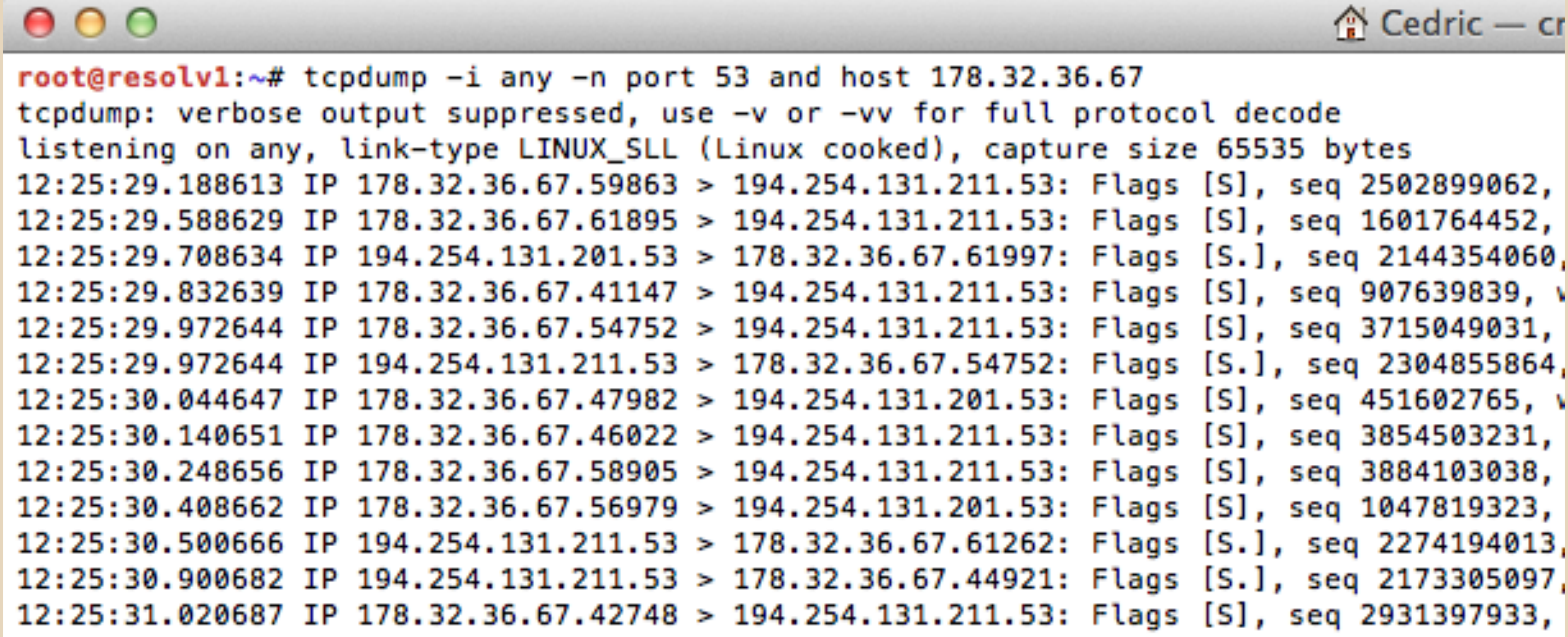
Limit: □ Packets > 0 -

Output: auto □ / IPv6 long

Clear Form process

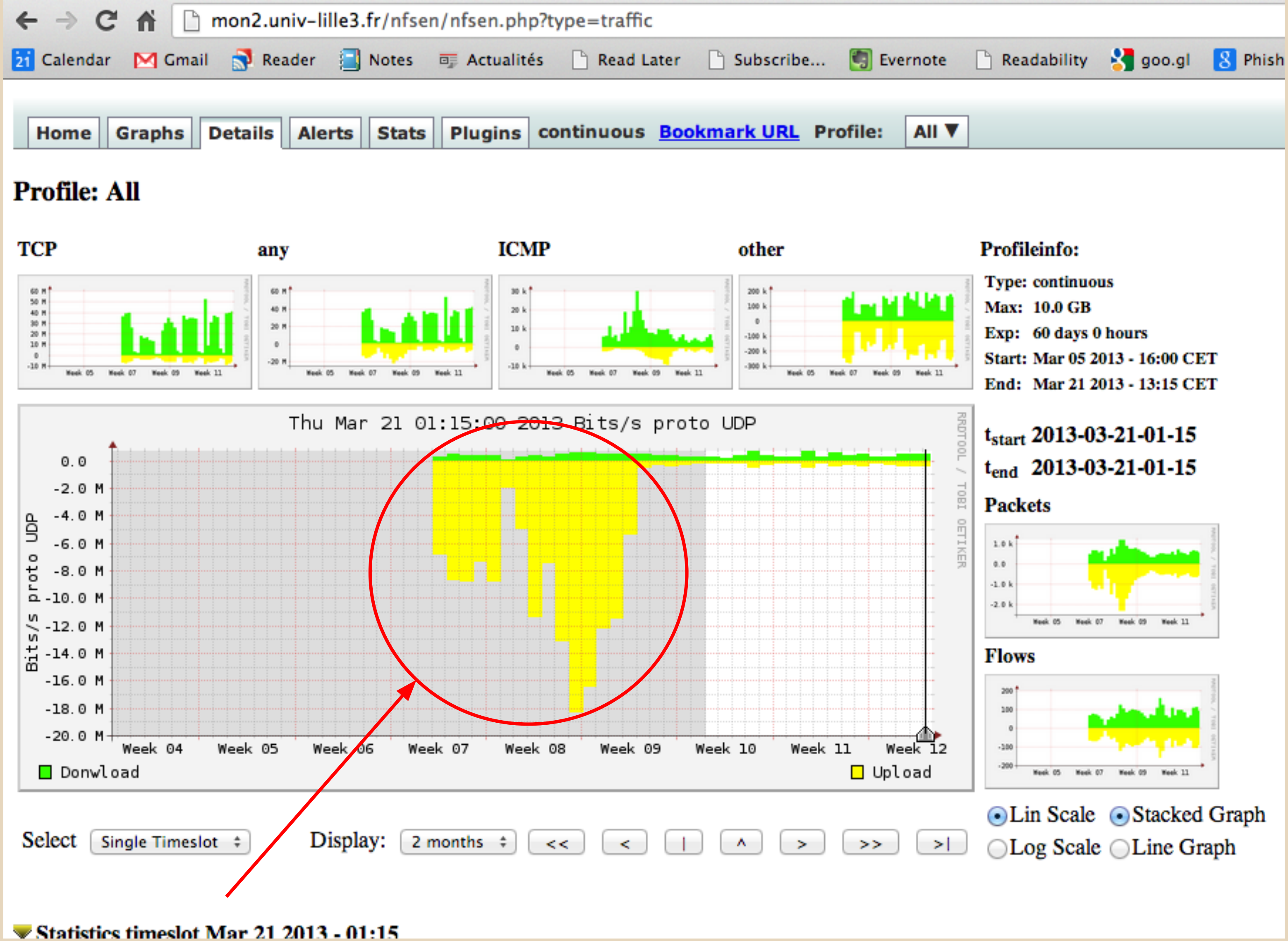
```
** nfdump -M /opt/nfsen//profiles-data/live/upstream1 -T  -R 2013/06/01/nfcapd.201306012055:2013/06/02/nfcapd.2013060
nfdump filter:
(( ident upstream1) and (
In IF 3 and port 53
)
or
( ident upstream1) and (
In IF 2 and port 53
)) and ( proto TCP )
Aggregated flows 65375
Top 10 flows ordered by flows:
Date flow start          Duration     Src IP Addr       Dst IP Addr Dst Pt    Packets    Bytes      bps    Bpp Flows
2013-06-01 22:17:41.104 48722.656    178.32.36.67   194.254.131.202    53     168077    9.0 M     1476     53 167557
2013-06-01 22:17:41.260 48722.484    178.32.36.67   194.254.131.212    53     167731    9.0 M     1473     53 167232
2013-06-01 22:17:41.048 48722.792    178.32.36.67   194.254.131.211    53     167739    9.0 M     1473     53 167203
2013-06-01 22:17:41.580 48722.248    178.32.36.67   194.254.131.201    53     167606    8.9 M     1465     53 167068
2013-06-01 22:13:46.144   243.556   5.135.135.116   194.254.131.201    53        350    14000      459     40    350
```

Analysis



```
root@resolv1:~# tcpdump -i any -n port 53 and host 178.32.36.67
tcpdump: verbose output suppressed, use -v or -vv for full protocol decode
listening on any, link-type LINUX_SLL (Linux cooked), capture size 65535 bytes
12:25:29.188613 IP 178.32.36.67.59863 > 194.254.131.211.53: Flags [S], seq 2502899062,
12:25:29.588629 IP 178.32.36.67.61895 > 194.254.131.211.53: Flags [S], seq 1601764452,
12:25:29.708634 IP 194.254.131.201.53 > 178.32.36.67.61997: Flags [S.], seq 2144354060,
12:25:29.832639 IP 178.32.36.67.41147 > 194.254.131.211.53: Flags [S], seq 907639839,
12:25:29.972644 IP 178.32.36.67.54752 > 194.254.131.211.53: Flags [S], seq 3715049031,
12:25:29.972644 IP 194.254.131.211.53 > 178.32.36.67.54752: Flags [S.], seq 2304855864,
12:25:30.044647 IP 178.32.36.67.47982 > 194.254.131.201.53: Flags [S], seq 451602765,
12:25:30.140651 IP 178.32.36.67.46022 > 194.254.131.211.53: Flags [S], seq 3854503231,
12:25:30.248656 IP 178.32.36.67.58905 > 194.254.131.211.53: Flags [S], seq 3884103038,
12:25:30.408662 IP 178.32.36.67.56979 > 194.254.131.201.53: Flags [S], seq 1047819323,
12:25:30.500666 IP 194.254.131.211.53 > 178.32.36.67.61262: Flags [S.], seq 2274194013,
12:25:30.900682 IP 194.254.131.211.53 > 178.32.36.67.44921: Flags [S.], seq 2173305097,
12:25:31.020687 IP 178.32.36.67.42748 > 194.254.131.211.53: Flags [S], seq 2931397933,
```

hping?



Profile: All

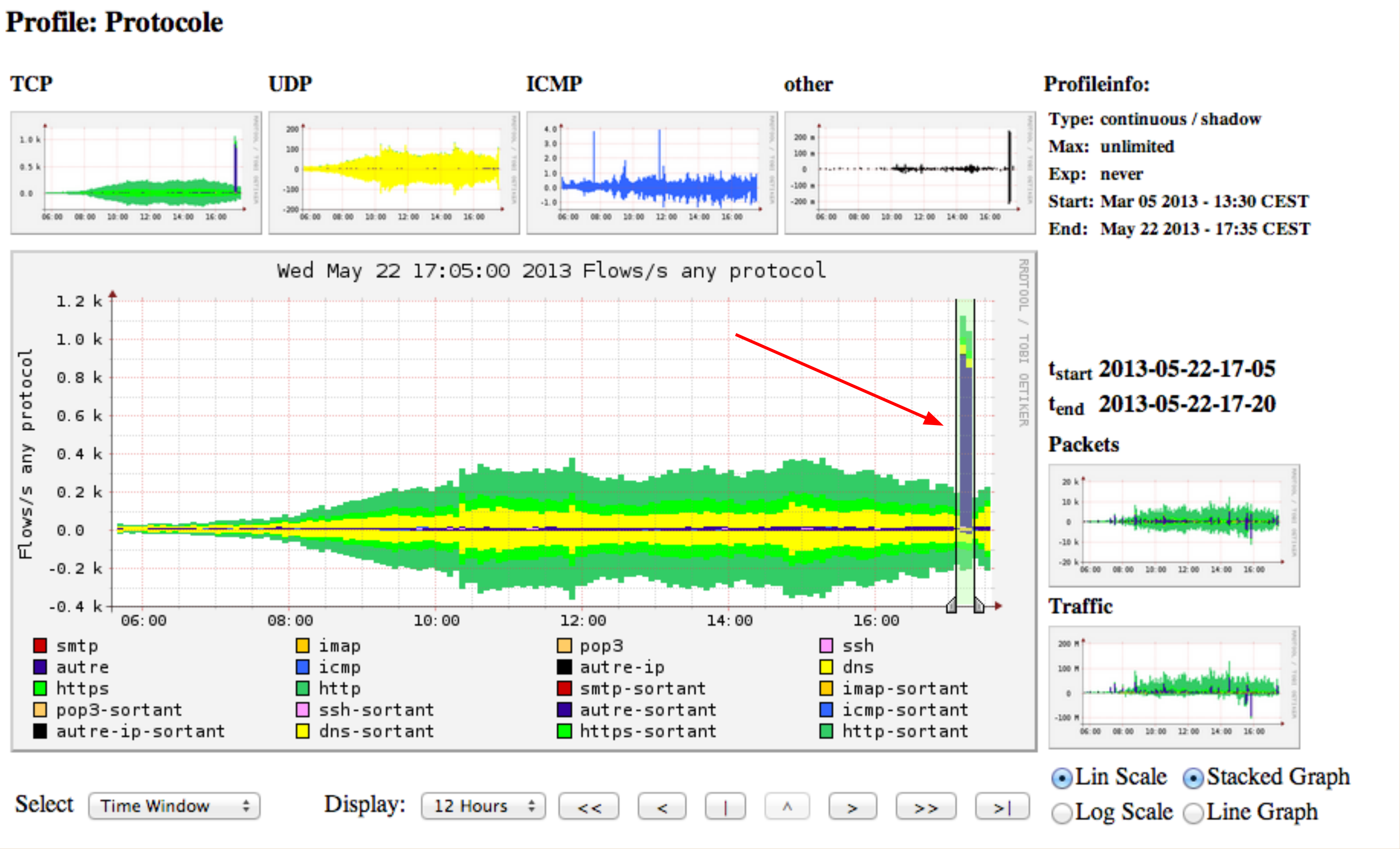
Profileinfo:

Type: continuous
Max: 10.0 GB
Exp: 60 days 0 hours
Start: Mar 05 2013 - 16:00 CET
End: Mar 21 2013 - 13:15 CET

t_{start} 2013-03-21-01-15
t_{end} 2013-03-21-01-15

Statistics timeslot Mar 21 2013 - 01:15

Misconfiguration
Open recursive DNS



Profile: Protocole

Profileinfo:

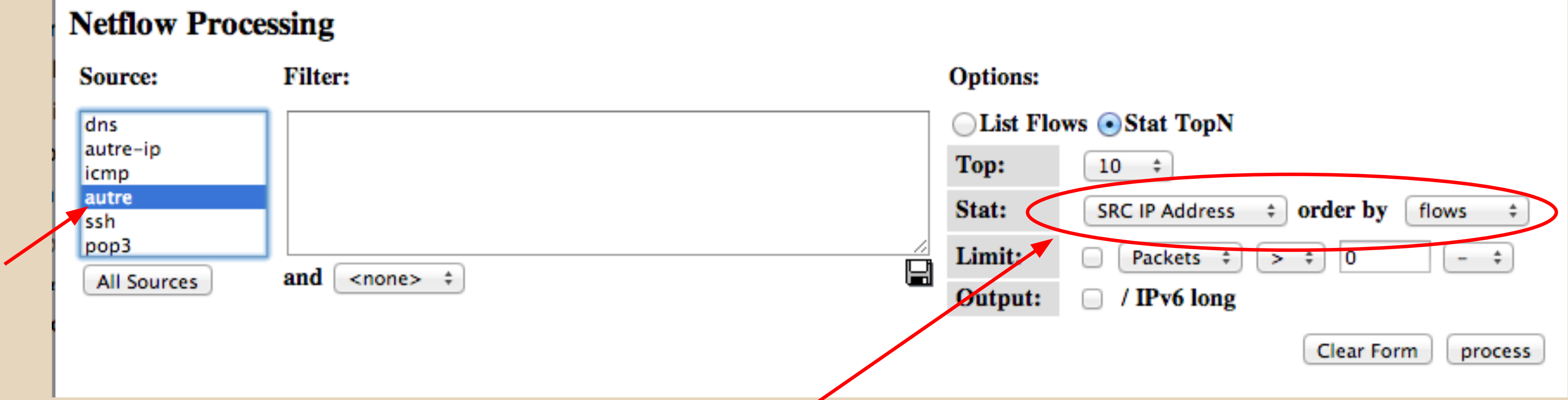
Type: continuous / shadow
Max: unlimited
Exp: never
Start: Mar 05 2013 - 13:30 CEST
End: May 22 2013 - 17:35 CEST

t_{start} 2013-05-22-17-05
t_{end} 2013-05-22-17-20

Select: Time Window
Display: 12 Hours

● Lin Scale ● Stacked Graph
○ Log Scale ○ Line Graph

nmap /24



Netflow Processing

Source:

- dns
- autre-ip
- icmp
- autre
- ssh
- pop3

All Sources

Filter:

and <none>

Options:

○ List Flows ● Stat TopN

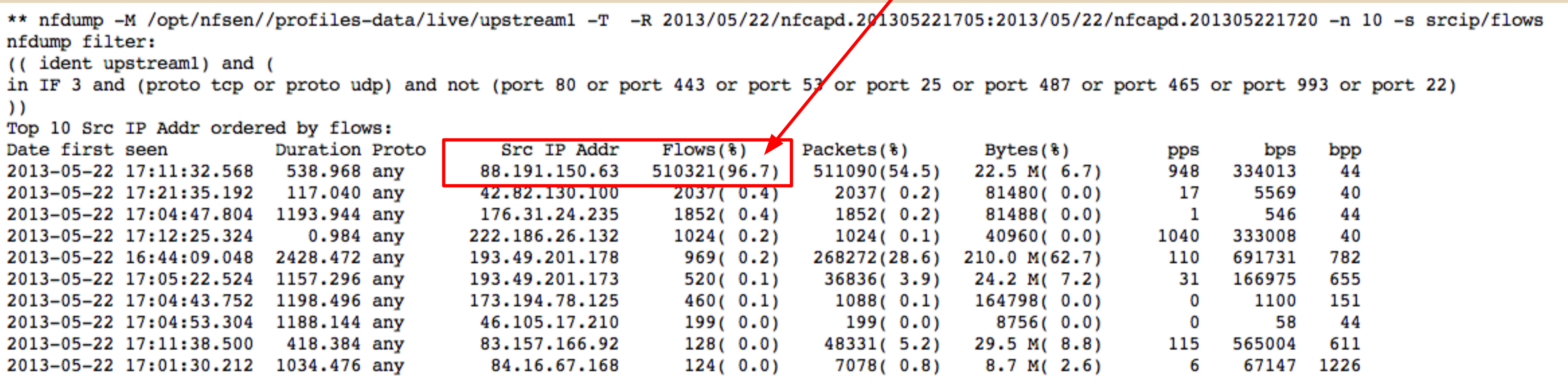
Top: 10

Stat: SRC IP Address order by flows

Limit: □ Packets > 0 -

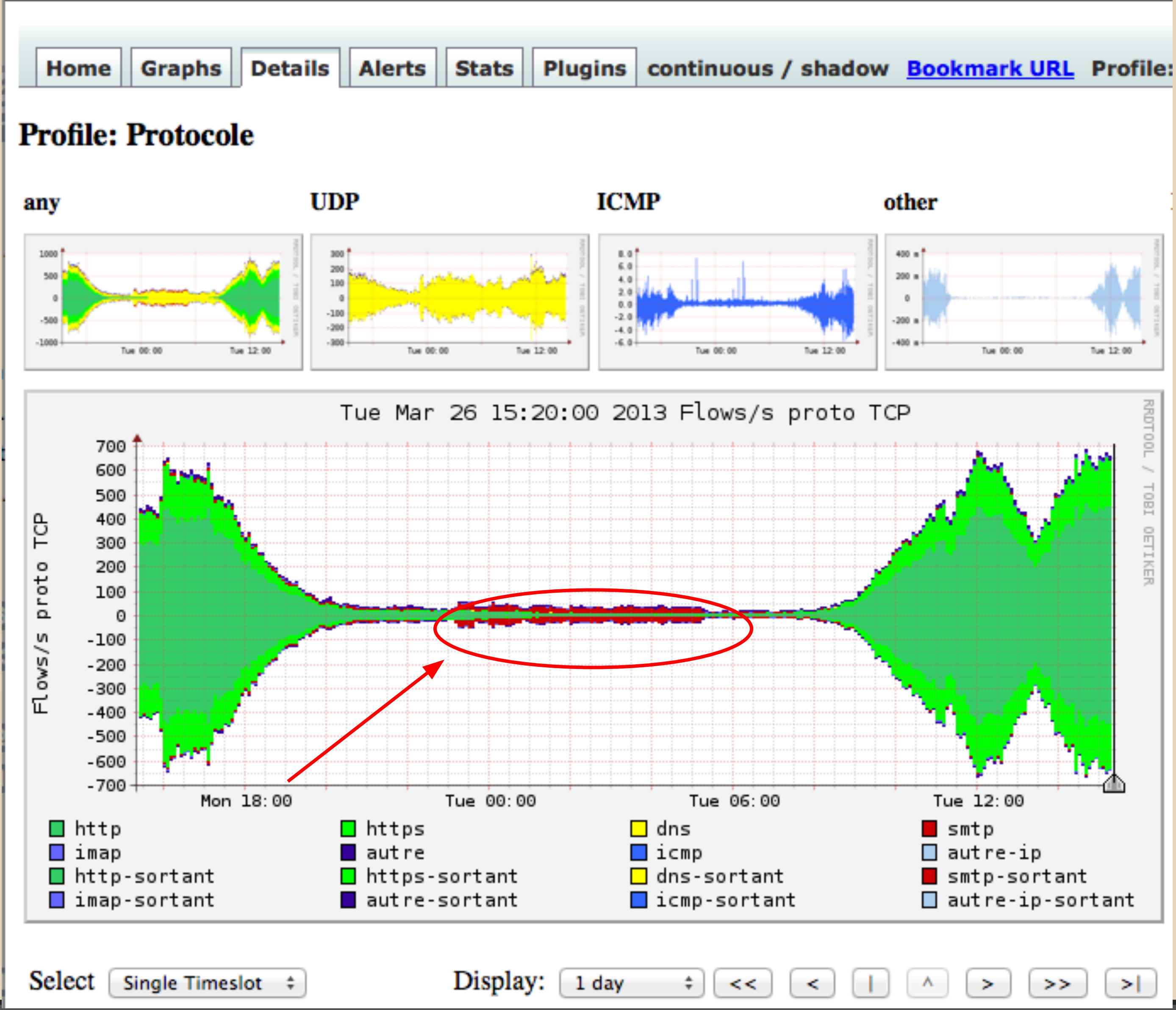
Output: □ / IPv6 long

Clear Form process



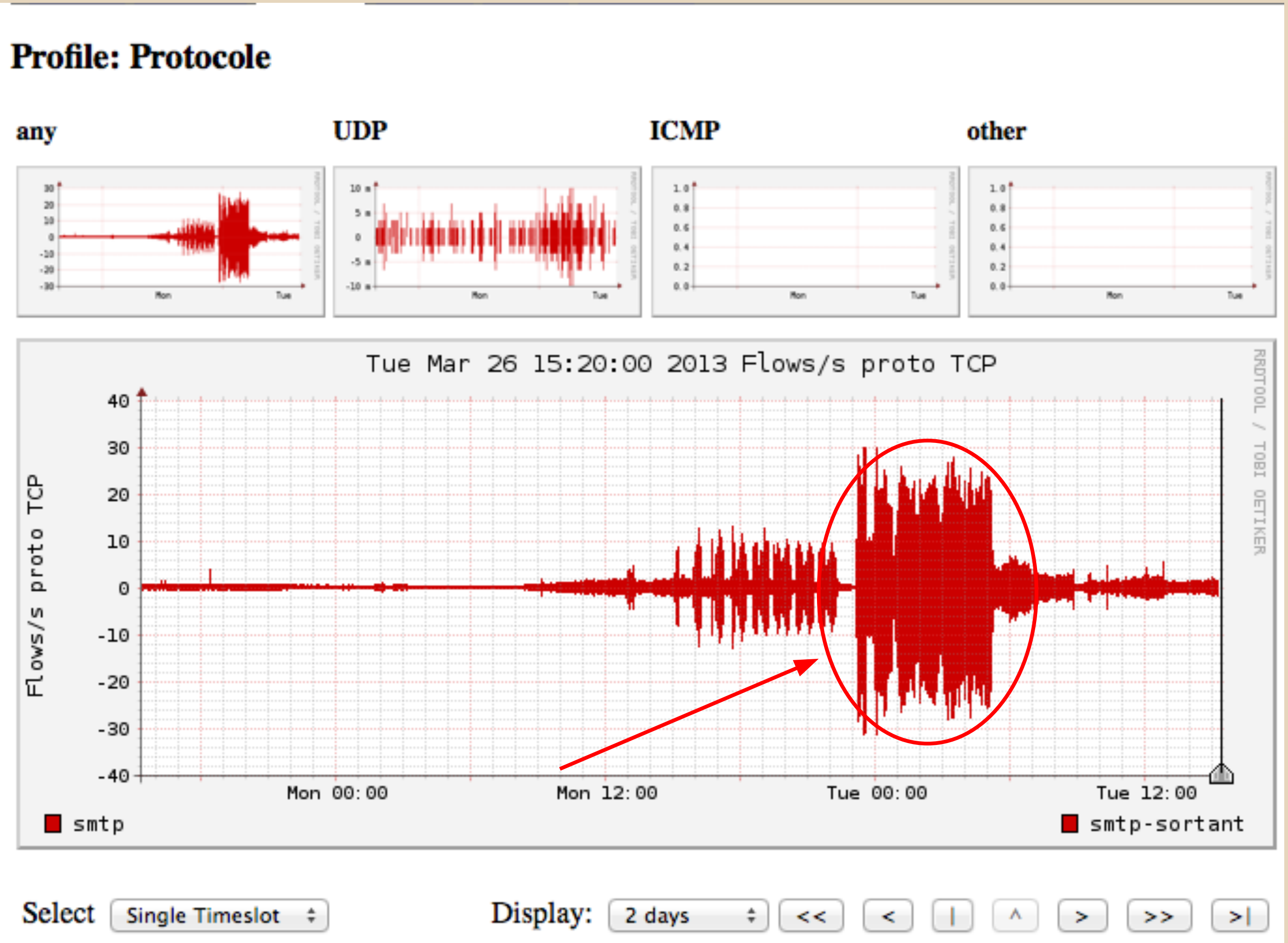
```
** nfdump -M /opt/nfsen//profiles-data/live/upstream1 -T  -R 2013/05/22/nfcapd.201305221705:2013/05/22/nfcapd.201305221720 -n 10 -s srcip/flows
nfdump filter:
(( ident upstream1) and (
in IF 3 and (proto tcp or proto udp) and not (port 80 or port 443 or port 53 or port 25 or port 487 or port 465 or port 993 or port 22)
))
Top 10 Src IP Addr ordered by flows:
Date first seen          Duration Proto      Src IP Addr    Flows(%)     Packets(%)       Bytes(%)         pps      bps   bpp
2013-05-22 17:11:32.568   538.968 any      88.191.150.63  510321(96.7)   511090(54.5)   22.5 M( 6.7)     948   334013    44
2013-05-22 17:21:35.192   117.040 any      42.82.130.100    2037( 0.4)     2037( 0.2)    81480( 0.0)      17     5569    40
2013-05-22 17:04:47.804  1193.944 any      176.31.24.235    1852( 0.4)     1852( 0.2)    81488( 0.0)       1      546    44
2013-05-22 17:12:25.324     0.984 any     222.186.26.132    1024( 0.2)     1024( 0.1)    40960( 0.0)    1040   333008    40
2013-05-22 16:44:09.048  2428.472 any     193.49.201.178     969( 0.2)   268272(28.6)  210.0 M(62.7)     110   691731   782
2013-05-22 17:05:22.524  1157.296 any     193.49.201.173     520( 0.1)    36836( 3.9)   24.2 M( 7.2)      31   166975   655
2013-05-22 17:04:43.752  1198.496 any     173.194.78.125     460( 0.1)     1088( 0.1)   164798( 0.0)       0     1100   151
2013-05-22 17:04:53.304  1188.144 any      46.105.17.210     199( 0.0)      199( 0.0)     8756( 0.0)       0       58    44
2013-05-22 17:11:38.500   418.384 any      83.157.166.92     128( 0.0)    48331( 5.2)   29.5 M( 8.8)     115   565004   611
2013-05-22 17:01:30.212  1034.476 any       84.16.67.168     124( 0.0)     7078( 0.8)    8.7 M( 2.6)       6    67147  1226
```

nmap /24



Profile: Protocole

email account used to send spam

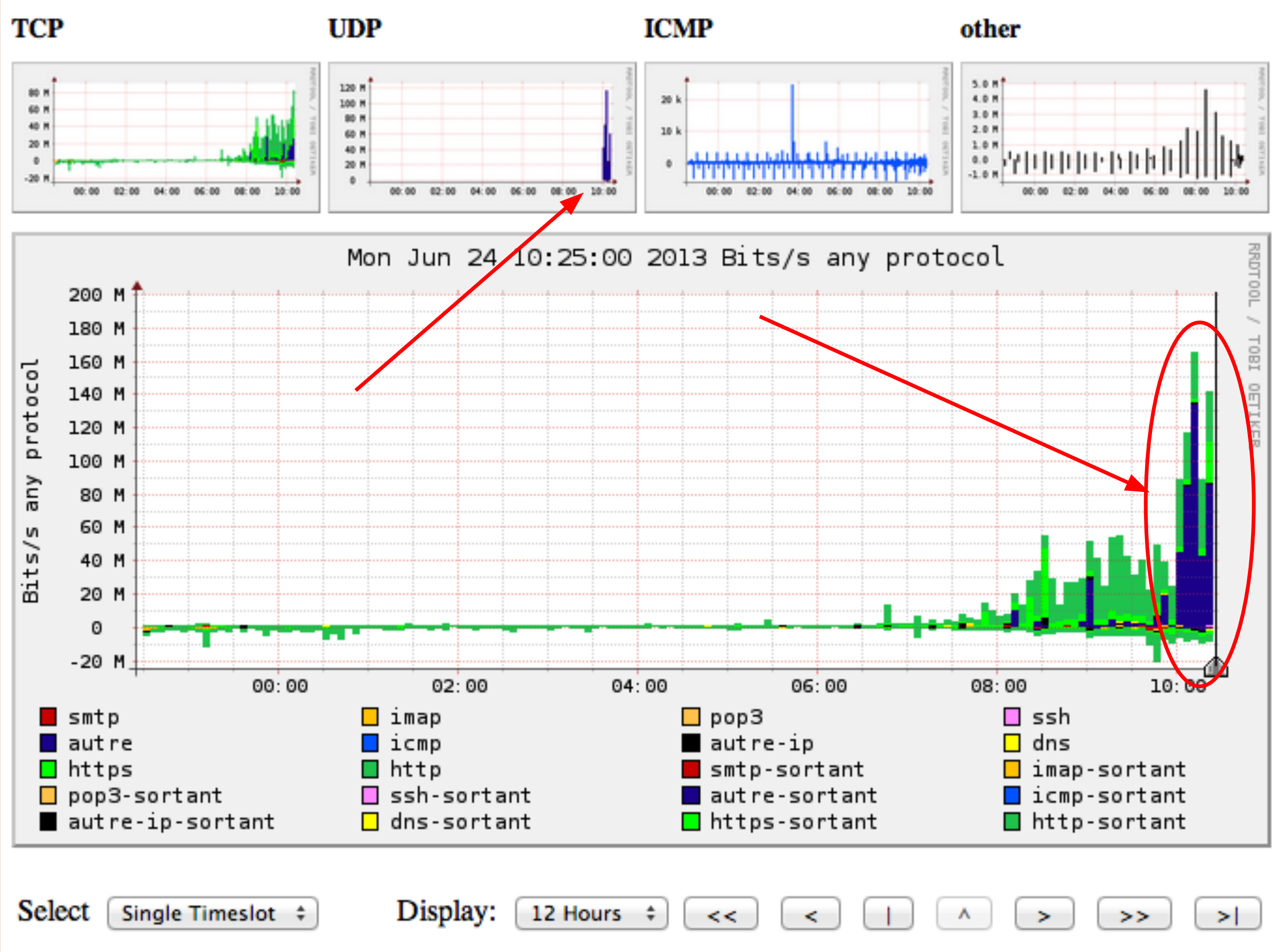


Profile: Protocole

Select: Single Timeslot

Display: 2 days

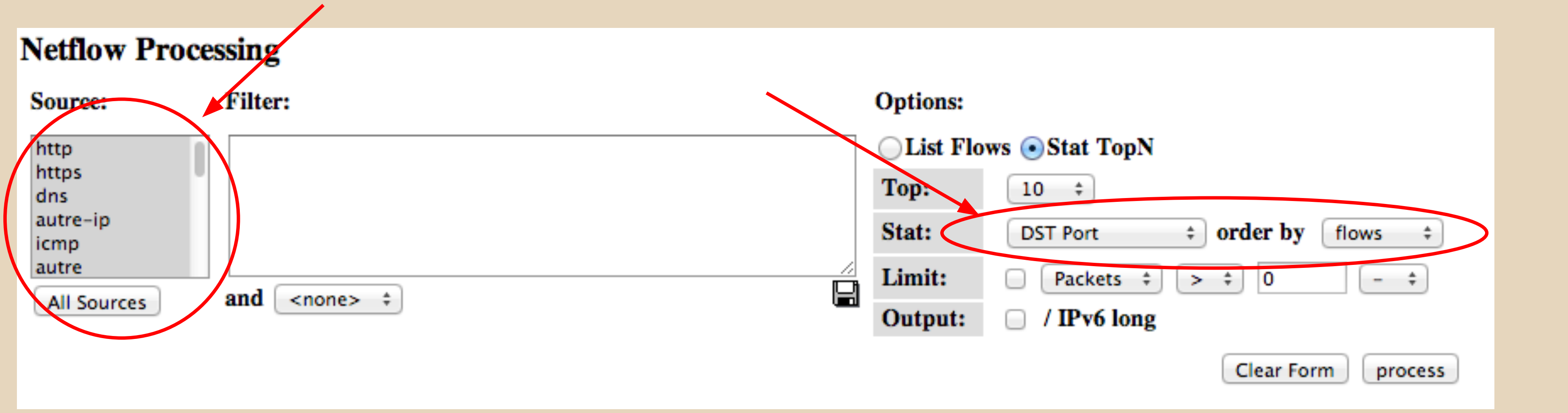
email account used to send spam



Select: Single Timeslot

Display: 12 Hours

Bittorents (uTB)



Netflow Processing

Source:

http
https
dns
autre-ip
icmp
autre

All Sources

Filter:

and <none>

Options:

○ **List Flows** ● **Stat TopN**

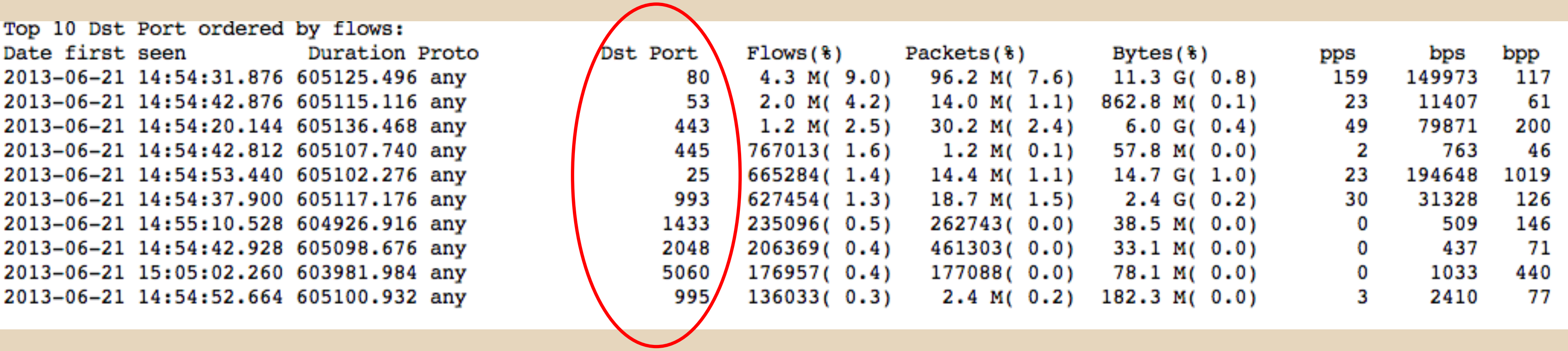
Top: 10

Stat: DST Port **order by** flows

Limit: □ Packets > 0 -

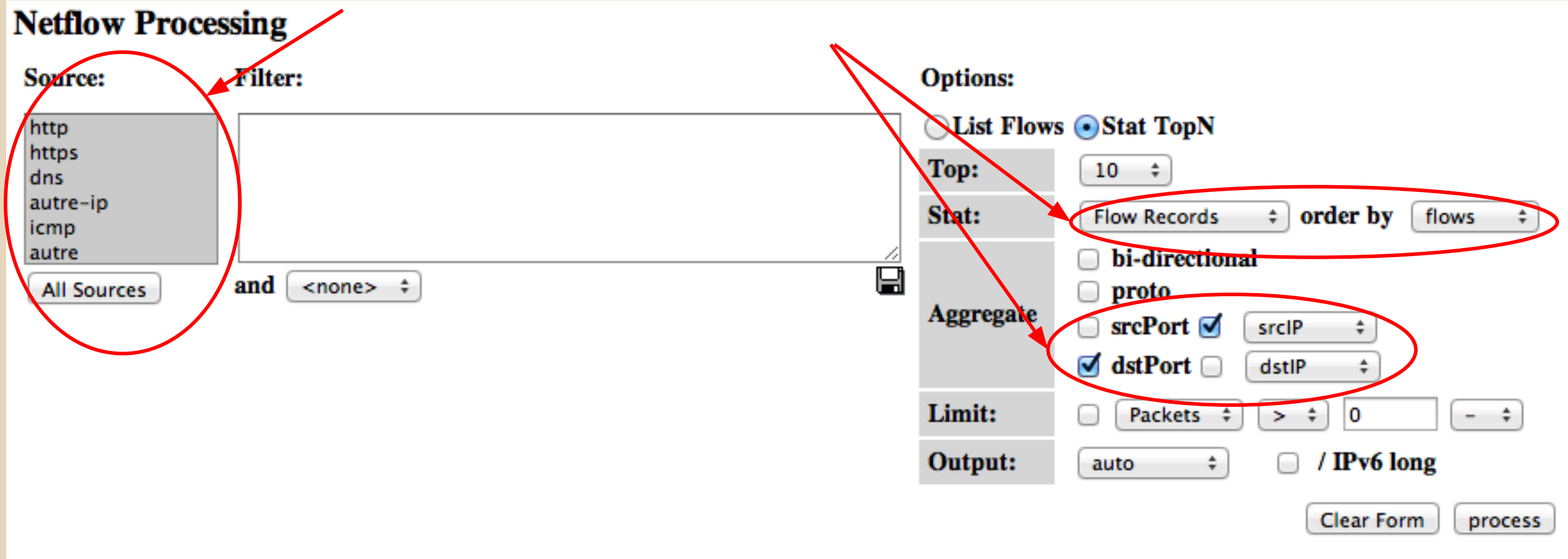
Output: □ **/ IPv6 long**

Clear Form process



```
Top 10 Dst Port ordered by flows:
Date first seen          Duration Proto          Dst Port   Flows(%)     Packets(%)       Bytes(%)         pps      bps   bpp
2013-06-21 14:54:31.876 605125.496 any                 80    4.3 M( 9.0)   96.2 M( 7.6)   11.3 G( 0.8)     159   149973   117
2013-06-21 14:54:42.876 605115.116 any                 53    2.0 M( 4.2)   14.0 M( 1.1)  862.8 M( 0.1)      23    11407    61
2013-06-21 14:54:20.144 605136.468 any                443    1.2 M( 2.5)   30.2 M( 2.4)    6.0 G( 0.4)      49    79871   200
2013-06-21 14:54:42.812 605107.740 any                445  767013( 1.6)    1.2 M( 0.1)   57.8 M( 0.0)       2      763    46
2013-06-21 14:54:53.440 605102.276 any                 25  665284( 1.4)   14.4 M( 1.1)   14.7 G( 1.0)      23   194648  1019
2013-06-21 14:54:37.900 605117.176 any                993  627454( 1.3)   18.7 M( 1.5)    2.4 G( 0.2)      30    31328   126
2013-06-21 14:55:10.528 604926.916 any               1433  235096( 0.5)   262743( 0.0)   38.5 M( 0.0)       0      509   146
2013-06-21 14:54:42.928 605098.676 any               2048  206369( 0.4)   461303( 0.0)   33.1 M( 0.0)       0      437    71
2013-06-21 15:05:02.260 603981.984 any               5060  176957( 0.4)   177088( 0.0)   78.1 M( 0.0)       0     1033   440
2013-06-21 14:54:52.664 605100.932 any                995  136033( 0.3)    2.4 M( 0.2)  182.3 M( 0.0)       3     2410    77
```

Most scanned ports



Netflow Processing

Source:

http
https
dns
autre-ip
icmp
autre

All Sources

Filter:

and <none>

Options:

○ List Flows ● Stat TopN

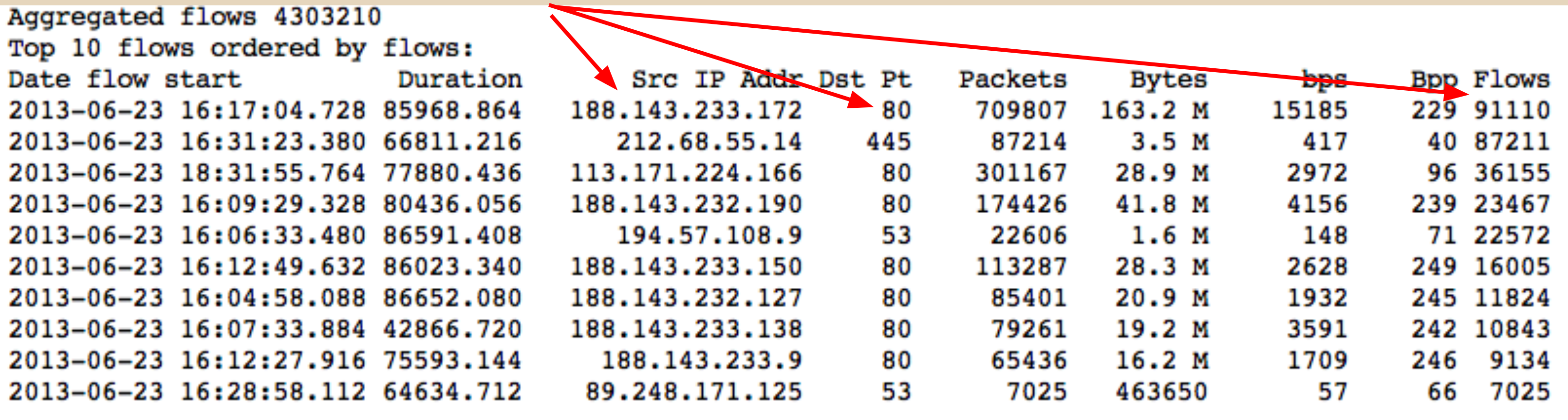
Top: 10

Stat: Flow Records order by flows

Aggregate:
□ bi-directional
□ proto
□ srcPort ☑ srcIP
☑ dstPort □ dstIP

Limit: □ Packets > 0 -

Output: auto □ / IPv6 long



```
Aggregated flows 4303210
Top 10 flows ordered by flows:
Date flow start          Duration        Src IP Addr Dst Pt   Packets    Bytes      bps   Bpp Flows
2013-06-23 16:17:04.728 85968.864   188.143.233.172     80    709807  163.2 M    15185   229 91110
2013-06-23 16:31:23.380 66811.216      212.68.55.14    445     87214    3.5 M      417    40 87211
2013-06-23 18:31:55.764 77880.436   113.171.224.166     80    301167   28.9 M     2972    96 36155
2013-06-23 16:09:29.328 80436.056   188.143.232.190     80    174426   41.8 M     4156   239 23467
2013-06-23 16:06:33.480 86591.408      194.57.108.9     53     22606    1.6 M      148    71 22572
2013-06-23 16:12:49.632 86023.340   188.143.233.150     80    113287   28.3 M     2628   249 16005
2013-06-23 16:04:58.088 86652.080   188.143.232.127     80     85401   20.9 M     1932   245 11824
2013-06-23 16:07:33.884 42866.720   188.143.233.138     80     79261   19.2 M     3591   242 10843
2013-06-23 16:12:27.916 75593.144     188.143.233.9     80     65436   16.2 M     1709   246  9134
2013-06-23 16:28:58.112 64634.712    89.248.171.125     53      7025   463650       57    66  7025
```

Horizontal scan

Malicious activities detection by command line

Command line search

Tunnels

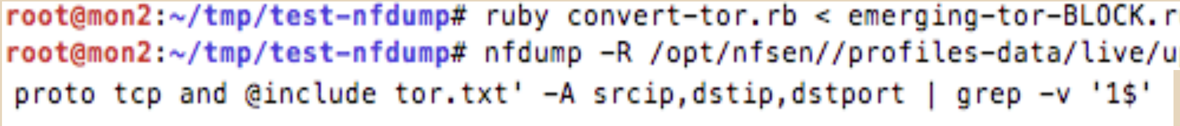
Very long flows with few traffic -> HTTP/HTTPS Tunnel

Big amount on data on UDP/53 -> DNS Tunnel

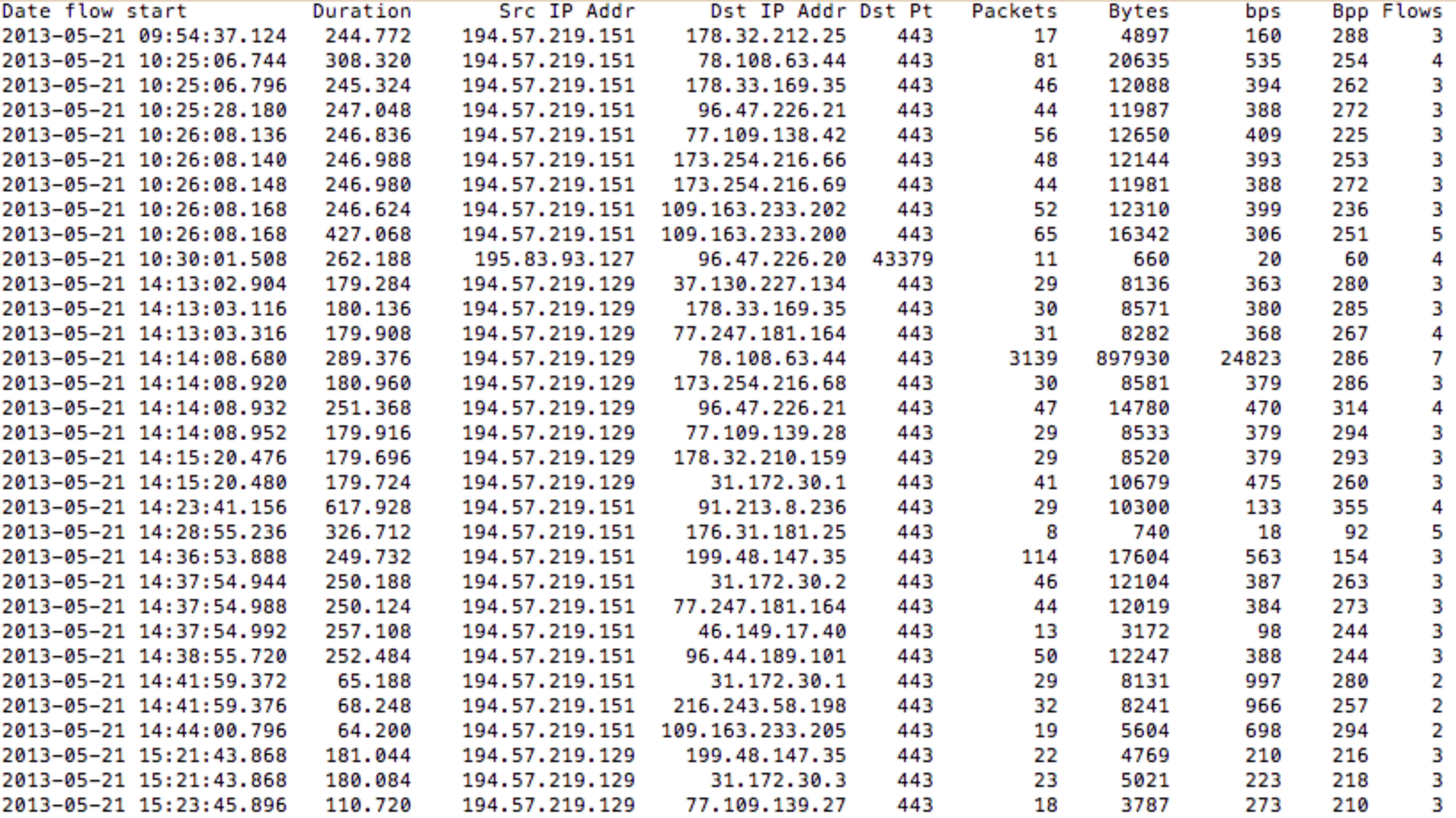
SSH Tunnel is harder to detect...

Malware or Tor traffic

Use public list of IP addresses of CC / Tor Node http://rules.emergingthreats.net/blockrules/emerging-tor-BLOCK.rules



```
root@mon2:~/tmp/test-nfdump# ruby convert-tor.rb < emerging-tor-BLOCK.rules > tor.txt
root@mon2:~/tmp/test-nfdump# nfdump -R /opt/nfsen//profiles-data/live/upstream1/2013/05/21/ -m -c 1000  'in IF 2 and
 proto tcp and @include tor.txt' -A srcip,dstip,dstport | grep -v '1$'
```



```
Date flow start          Duration     Src IP Addr     Dst IP Addr Dst Pt    Packets    Bytes      bps    Bpp Flows
2013-05-21 09:54:37.124   244.772  194.57.219.151   178.32.212.25    443         17     4897      160    288     3
2013-05-21 10:25:06.744   308.320  194.57.219.151    78.108.63.44    443         81    20635      535    254     4
2013-05-21 10:25:06.796   245.324  194.57.219.151   178.33.169.35    443         46    12088      394    262     3
2013-05-21 10:25:28.180   247.048  194.57.219.151    96.47.226.21    443         44    11987      388    272     3
2013-05-21 10:26:08.136   246.836  194.57.219.151   77.109.138.42    443         56    12650      409    225     3
2013-05-21 10:26:08.140   246.988  194.57.219.151   173.254.216.66   443         48    12144      393    253     3
2013-05-21 10:26:08.148   246.980  194.57.219.151   173.254.216.69   443         44    11981      388    272     3
2013-05-21 10:26:08.168   246.624  194.57.219.151 109.163.233.202    443         52    12310      399    236     3
2013-05-21 10:26:08.168   427.068  194.57.219.151 109.163.233.200    443         65    16342      306    251     5
2013-05-21 10:30:01.508   262.188   195.83.93.127    96.47.226.20  43379         11      660       20     60     4
2013-05-21 14:13:02.904   179.284  194.57.219.129  37.130.227.134    443         29     8136      363    280     3
2013-05-21 14:13:03.116   180.136  194.57.219.129   178.33.169.35    443         30     8571      380    285     3
2013-05-21 14:13:03.316   179.908  194.57.219.129  77.247.181.164    443         31     8282      368    267     4
2013-05-21 14:14:08.680   289.376  194.57.219.129    78.108.63.44    443       3139   897930    24823    286     7
2013-05-21 14:14:08.920   180.960  194.57.219.129  173.254.216.68    443         30     8581      379    286     3
2013-05-21 14:14:08.932   251.368  194.57.219.129    96.47.226.21    443         47    14780      470    314     4
2013-05-21 14:14:08.952   179.916  194.57.219.129   77.109.139.28    443         29     8533      379    294     3
2013-05-21 14:15:20.476   179.696  194.57.219.129  178.32.210.159    443         29     8520      379    293     3
2013-05-21 14:15:20.480   179.724  194.57.219.129     31.172.30.1    443         41    10679      475    260     3
2013-05-21 14:23:41.156   617.928  194.57.219.151    91.213.8.236    443         29    10300      133    355     4
2013-05-21 14:28:55.236   326.712  194.57.219.151   176.31.181.25    443          8      740       18     92     5
2013-05-21 14:36:53.888   249.732  194.57.219.151   199.48.147.35    443        114    17604      563    154     3
2013-05-21 14:37:54.944   250.188  194.57.219.151     31.172.30.2    443         46    12104      387    263     3
2013-05-21 14:37:54.988   250.124  194.57.219.151  77.247.181.164    443         44    12019      384    273     3
2013-05-21 14:37:54.992   257.108  194.57.219.151    46.149.17.40    443         13     3172       98    244     3
2013-05-21 14:38:55.720   252.484  194.57.219.151   96.44.189.101    443         50    12247      388    244     3
2013-05-21 14:41:59.372    65.188  194.57.219.151     31.172.30.1    443         29     8131      997    280     2
2013-05-21 14:41:59.376    68.248  194.57.219.151  216.243.58.198    443         32     8241      966    257     2
2013-05-21 14:44:00.796    64.200  194.57.219.151 109.163.233.205    443         19     5604      698    294     2
2013-05-21 15:21:43.868   181.044  194.57.219.129   199.48.147.35    443         22     4769      210    216     3
2013-05-21 15:21:43.868   180.084  194.57.219.129     31.172.30.3    443         23     5021      223    218     3
2013-05-21 15:23:45.896   110.720  194.57.219.129   77.109.139.27    443         18     3787      273    210     3
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Detecting Tor use

Questions?

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