FIRERACK

FireRack

Network Monitoring and Troubleshooting Guide

Revision: rfs-051208-1

FIRERACK

Table of Contents

Introduction

This guide describes the tools and techniques available in FireRack to identify and deal with problem machines on your network.

The specific areas this document deals with are:

1. Bandwidth congestion
2. Port scanning activity
3. Worm infection

If your firewall(s) have the accounting module enabled, much of the information you'll need to trace these problems can be found on the FMS web interface. The next section deals briefly with the FMS traffic statistics available in the web interface. This gives you a very high level and user-friendly view of what is happening on your network.

The remainder of this document then deals with the command line tools available on the firewalls themselves. These tools can provide you with a great deal of detail not available in the web interface, as the latter deals only in statistics, rather than dealing with individual packets and connection. Also, the command line tools provide you with real-time data, whereas the date in the web interface is updated every 5 minutes.

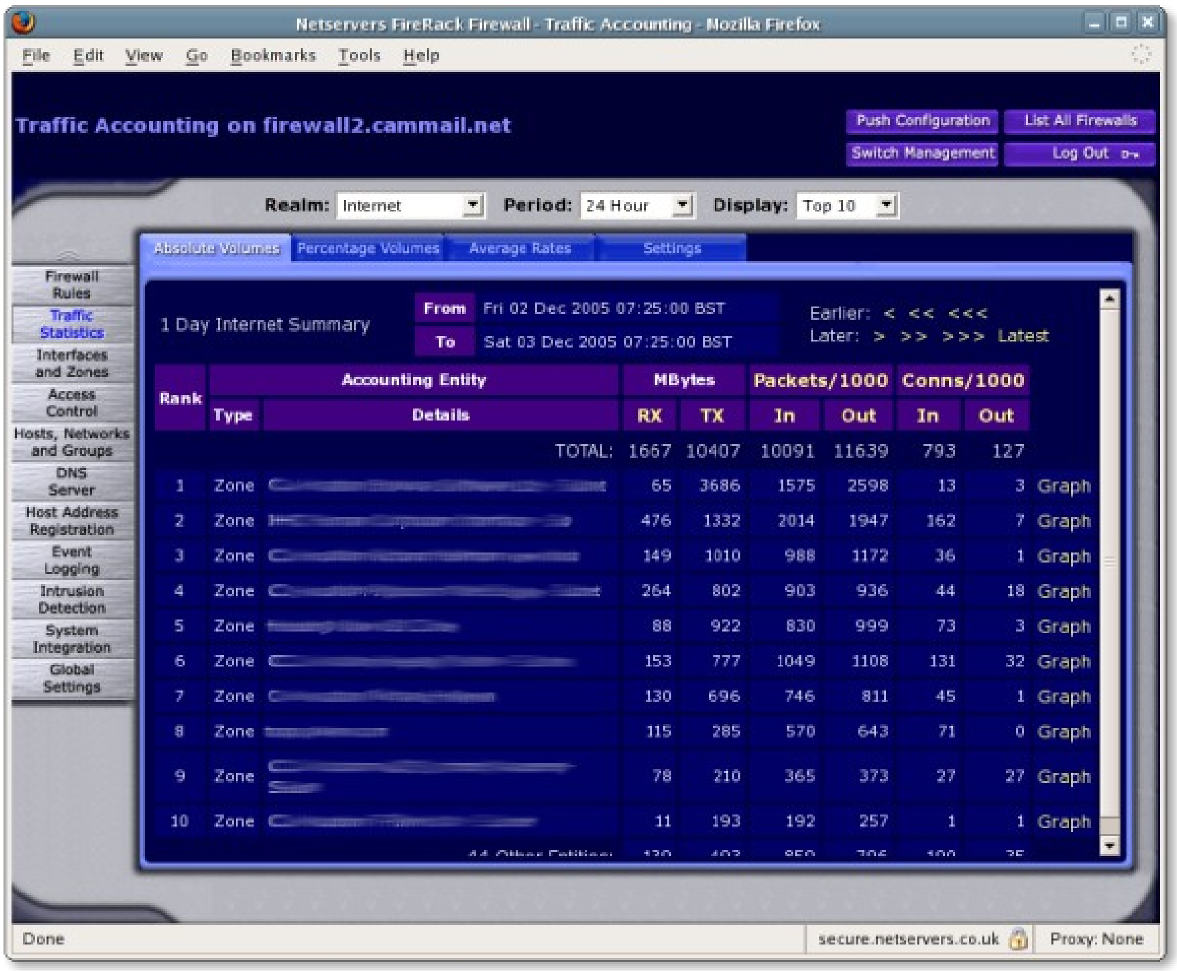
FMS Traffic Statistics

The Traffic Statistics feature can be enabled on a per security zone basis. This chapter does not cover the setting up of this feature, and assumes that you have already done so.

Typically these statistics are collected from the firewall, by the FMS, every five minutes. As long as the problem you are investigating as been occurring for 5 minutes or more, these statistics may prove useful.

The statistics gathered are as follows:

Column	*Description*	*Useful for*
MBytes	Number of Megabytes transferred	Identifying heavy bandwidth users – possibly compromised machines running FTP or P2P repositories
Packets/1000	Number of packets sent and received – In thousands	High packet rates place a disproportionally high load on firewalls. Voice over IP (VoIP) is an example of a high packet rate application. With VoIP, although the packet count may be high, the connection count should be relatively low (see below).
Conns/1000	Number of connection attempts made – In thousands	This can be very useful for highlighting port scanning machines. They will typically have a very high number of connection attempt relative to the number of bytes or packets.



Traffic Accounting on firewall2.cammail.net

Realm: Internet Period: 24 Hour Display: Top 10

1 Day Internet Summary

From Fri 02 Dec 2005 07:25:00 BST
To Sat 03 Dec 2005 07:25:00 BST

Rank	Accounting Entity		MBytes		Packets/1000		Conns/1000		
	Type	Details	RX	TX	In	Out	In	Out	
		TOTAL:	1667	10407	10091	11639	793	127	
1	Zone	[redacted]	65	3686	1575	2598	13	3	Graph
2	Zone	[redacted]	476	1332	2014	1947	162	7	Graph
3	Zone	[redacted]	149	1010	988	1172	36	1	Graph
4	Zone	[redacted]	264	802	903	936	44	18	Graph
5	Zone	[redacted]	88	922	830	999	73	3	Graph
6	Zone	[redacted]	153	777	1049	1108	131	32	Graph
7	Zone	[redacted]	130	696	746	811	45	1	Graph
8	Zone	[redacted]	115	285	570	643	71	0	Graph
9	Zone	[redacted]	78	210	365	373	27	27	Graph
10	Zone	[redacted]	11	193	192	257	1	1	Graph

When setting up your traffic accounting for each zone, you will have selected whether to collect a single set of statistics for the zone, or to collect per registered host statistics for that zone. For the purposes of tracking down individual machines that are abusing bandwidth, or port scanning, per registered hosts statistics are far more useful than per security zone.

As you can see above, for each entity being monitored, there is a row showing the number of bytes and packets sent and received by that entity. By changing the **Period** and **Display** options at the top of the screen, you can chose how many entities to display, and over what period. To detect port scanners active in the last 15 minutes, simply chose “15 minutes” for the period, and chose the appropriate number of hosts to display (e.g. “Top Ten”).

By default the data is ordered by the total number of bytes to and from the entity (the sum of sent and received). You can change the order of the rows by clicking on the links at the top of columns you want to sort by. If for instance you want to sort by the number of connection attempts coming from an entity, you would click on **OUT** column under **Conns/1000**.

Realms and network segments

Traffic accounting in FireRack is grouped into different Realms. A realm is a group of networks or subnets. This enables you to view statistics for your Internet connection separately to your local networks.

Please bear this in mind as you search the statistics. Some worms may only scan your local are network, and the firewall can only record packets that have passed through it. Depending on the layout of your network, you may want to examine multiple realms, or consider the possibility that the activity you are looking for doesn’t even pass through the firewall.

Monitoring and packet sniffing tools

Overview

FireRack has a variety of monitoring tools available on the console. These include:

- bwm
- iptraf
- tcpdump
- ngrep

Each one of these tools give you a different way of looking at your network traffic. It is important to understand the strengths and limitations of these tools to get the most out of them.

Notes regarding NAT (Redirection and Masquerading):

When you use these monitoring tools, you will be seeing the true source and destination of the packets, not the translated addresses.

For Masquerading (SNAT) this means that although the firewall is masquerading an internal host's IP address as the packet leaves the firewall, the packets you will see

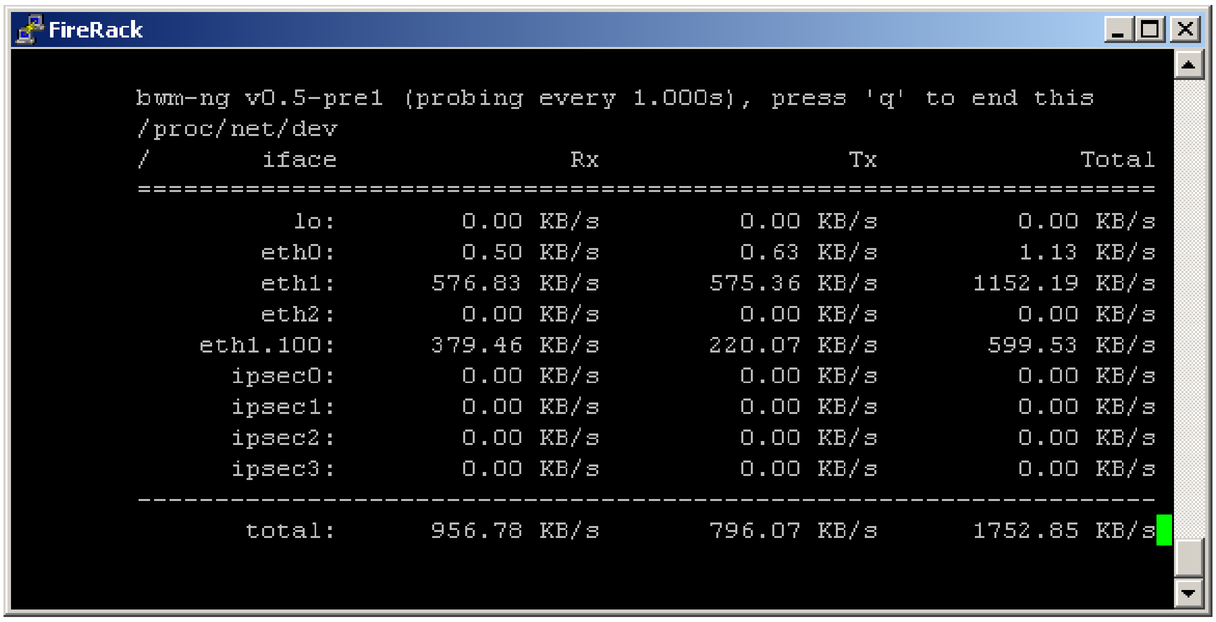
are not yet masqueraded. This enables you to identify the true source of a packet.

For Redirection (DNAT), the packet sniffers will show your the new destination of the packets, not the original destination which you overrode with your redirection rule.

bwm

BWM stands for BandWidth Monitor. It shows summary information about the number of kBytes per second and packets per second passing through interfaces on the firewall. If you're suffering from generally poor performance, but you are not sure of the source of the problem, this tool might provide a clue.

Screenshot:



```
  bwm-ng v0.5-pre1 (probing every 1.000s), press 'q' to end this
  /proc/net/dev
  /       iface                 Rx                 Tx              Total
  ==================================================================
             lo:         0.00 KB/s          0.00 KB/s          0.00 KB/s
           eth0:         0.50 KB/s          0.63 KB/s          1.13 KB/s
           eth1:       576.83 KB/s        575.36 KB/s       1152.19 KB/s
           eth2:         0.00 KB/s          0.00 KB/s          0.00 KB/s
       eth1.100:       379.46 KB/s        220.07 KB/s        599.53 KB/s
         ipsec0:         0.00 KB/s          0.00 KB/s          0.00 KB/s
         ipsec1:         0.00 KB/s          0.00 KB/s          0.00 KB/s
         ipsec2:         0.00 KB/s          0.00 KB/s          0.00 KB/s
         ipsec3:         0.00 KB/s          0.00 KB/s          0.00 KB/s
  ------------------------------------------------------------------
          total:       956.78 KB/s        796.07 KB/s       1752.85 KB/s
```

Please see the manual for bwm on page [page] of this guide for more information on how to use this tool.

iptraf

iptraf is a command line IP LAN monitor that generates various network statistics including TCP info, UDP counts, ICMP and OSPF information, Ethernet load info, node stats, IP checksum errors, and others.

If the command is issued without any command-line options, the program comes up in interactive mode, with the various facilities accessed through the main menu.

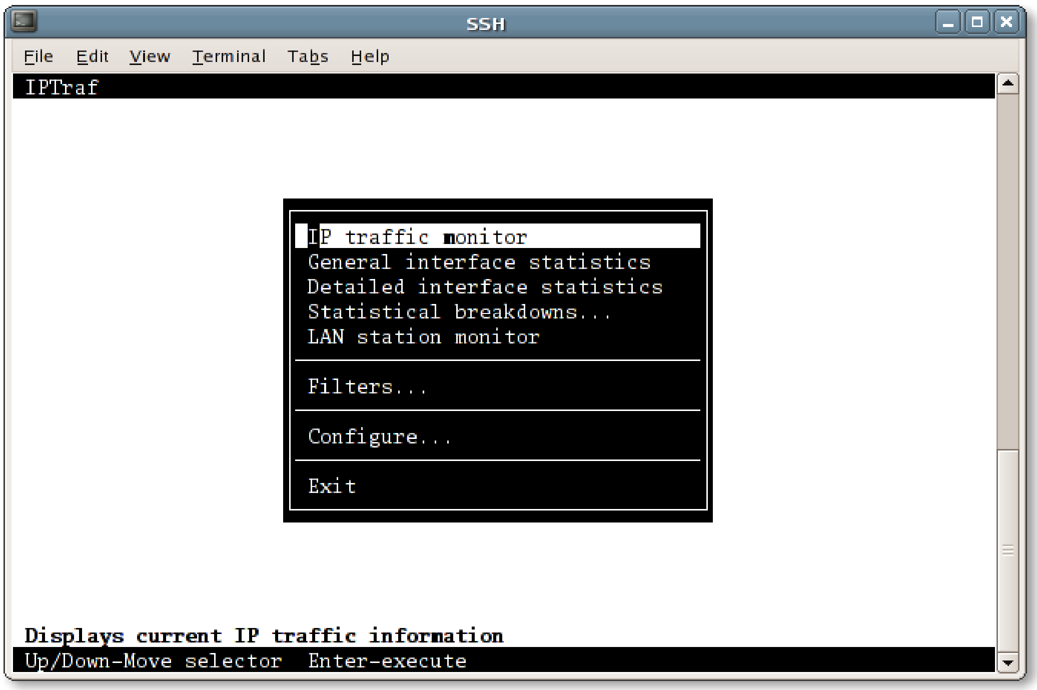
As the IP traffic monitor is connection oriented, it is not usually the best tool to identify port scanning activity. Each probe in a typical port-scan is a single packet to a single destination IP address and port. Consequently such activity is unlikely to have a high packet (or byte) count for each connection.

If however the problem you are investigating is being caused by a relatively small number of connections using high byte or packet rates, the IPTraf should prove very useful.

Examples:

If you were aware that that the device eth1 was under heavy load and were interested in which hosts or connections might be responsible, you might to the following:

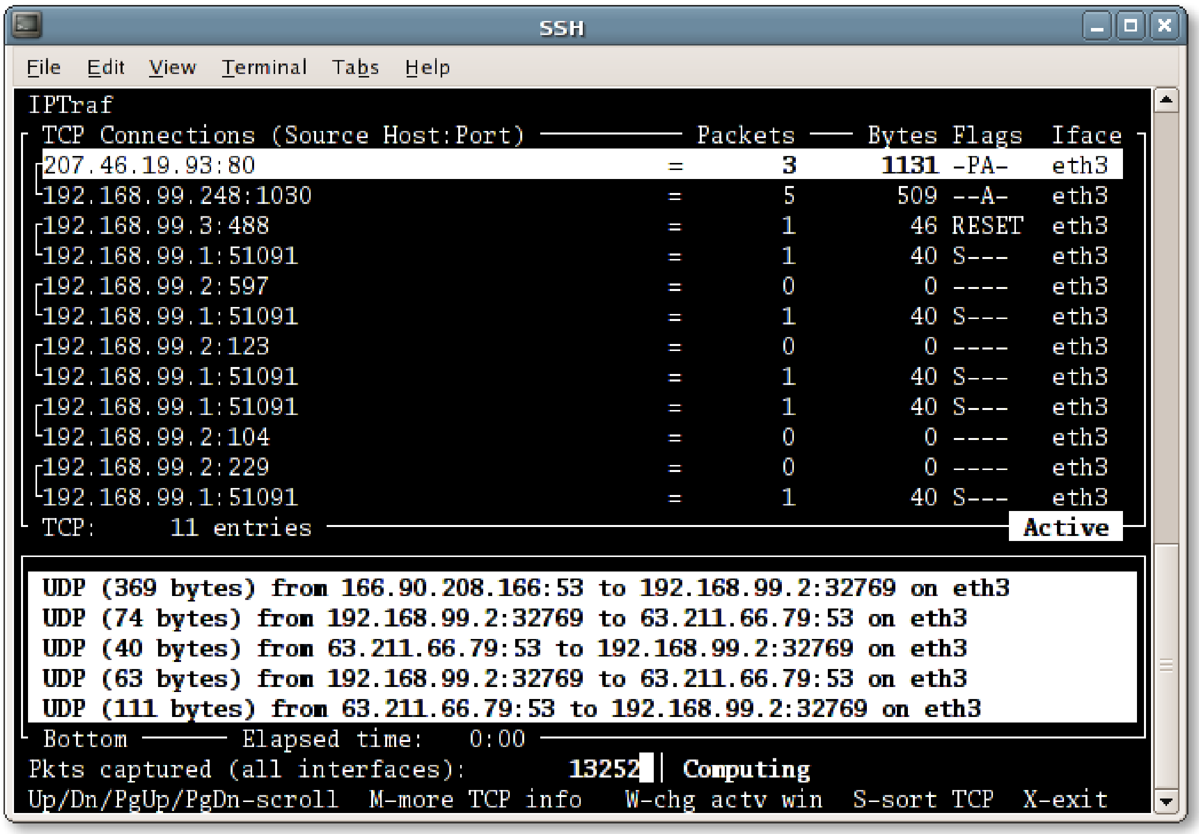
1. SSH onto the active firewall
2. Run "iptraf"



```
IPTraf

                    IP traffic monitor
                    General interface statistics
                    Detailed interface statistics
                    Statistical breakdowns...
                    LAN station monitor

                    Filters...

                    Configure...

                    Exit

Displays current IP traffic information
Up/Down-Move selector  Enter-execute
```

3. From the main menu select "IP traffic monitor"
4. Select the interface of interest (e.g. eth1)

5. The traffic monitor starts running. Note the hot key options displayed at the bottom of the screen. “S” for sort in particular:



```
IPTraf
┌ TCP Connections (Source Host:Port) ─────────── Packets ─── Bytes Flags  Iface ┐
│┌207.46.19.93:80                          =         3      1131 -PA-   eth3
│└192.168.99.248:1030                      =         5       509 --A-   eth3
│┌192.168.99.3:488                         =         1        46 RESET  eth3
│└192.168.99.1:51091                       =         1        40 S---   eth3
│┌192.168.99.2:597                         =         0         0 ----   eth3
│└192.168.99.1:51091                       =         1        40 S---   eth3
│┌192.168.99.2:123                         =         0         0 ----   eth3
│└192.168.99.1:51091                       =         1        40 S---   eth3
│┌192.168.99.1:51091                       =         1        40 S---   eth3
│└192.168.99.2:104                         =         0         0 ----   eth3
│┌192.168.99.2:229                         =         0         0 ----   eth3
│└192.168.99.1:51091                       =         1        40 S---   eth3
└ TCP:      11 entries ──────────────────────────────────────────────── Active ┘
 UDP (369 bytes) from 166.90.208.166:53 to 192.168.99.2:32769 on eth3
 UDP (74 bytes) from 192.168.99.2:32769 to 63.211.66.79:53 on eth3
 UDP (40 bytes) from 63.211.66.79:53 to 192.168.99.2:32769 on eth3
 UDP (63 bytes) from 192.168.99.2:32769 to 63.211.66.79:53 on eth3
 UDP (111 bytes) from 63.211.66.79:53 to 192.168.99.2:32769 on eth3
└ Bottom ───── Elapsed time:   0:00 ─────────────────────────────────────────────┘
Pkts captured (all interfaces):       13252 | Computing
Up/Dn/PgUp/PgDn-scroll  M-more TCP info   W-chg actv win  S-sort TCP  X-exit
```

6. Select “S”. You can now choose to sort the list by (P)acket count or (B)yte count.
7. The display now ranks the connections in the order you specified.
8. The resort the display, repeat step 6, as many times as you like

For further information on using IPTraf, please see the manual at the and of this guide.

tcpdump

tcpdump is a straightforward packet sniffer. By default it puts the ethernet card in question into "promiscuous" mode and dumps information about those packets to the console. In order to make effective use of this tool, it's worth spending the time to learn the syntax used for filtering, or extending its output.

The basic form of a tcpdump command is as follows:

```
#tcpdump -n -i eth0
```

-n	turns off DNS lookups
-i	is used to specify the interface to operate on

You can stop tcpdump at any time by pressing Ctrl-C

Typing the above command will produce a stream if lines describing the packets seen on the interface in question. The output should look something like this:

```
23:11:06.853903 192.168.30.6.53760 > 192.168.99.2.22: . ack 76033 win 32584
<nop,nop,timestamp 3931728054 858328436> (DF) [tos 0x8]
23:11:06.854280 192.168.99.2.22 > 192.168.30.6.53760: . 141585:142993(1408) ack 48
win 8600 <nop,nop,timestamp 858330058 3931728054> (DF) [tos 0x8]
23:11:06.854393 192.168.99.2.22 > 192.168.30.6.53760: . 142993:144401(1408) ack 48
win 8600 <nop,nop,timestamp 858330058 3931728054> (DF) [tos 0x8]
23:11:06.854539 192.168.99.2.22 > 192.168.30.6.53760: . 144401:145809(1408) ack 48
win 8600 <nop,nop,timestamp 858330058 3931728054> (DF) [tos 0x8]
23:11:07.041595 192.168.30.6.53760 > 192.168.99.2.22: . ack 78849 win 32584
<nop,nop,timestamp 3931728244 858328535> (DF) [tos 0x8]
23:11:07.041979 192.168.99.2.22 > 192.168.30.6.53760: . 145809:147217(1408) ack 48
win 8600 <nop,nop,timestamp 858330245 3931728244> (DF) [tos 0x8]
23:11:07.042094 192.168.99.2.22 > 192.168.30.6.53760: . 147217:148625(1408) ack 48
win 8600 <nop,nop,timestamp 858330245 3931728244> (DF) [tos 0x8]
23:11:07.042218 192.168.99.2.22 > 192.168.30.6.53760: . 148625:150033(1408) ack 48
win 8600 <nop,nop,timestamp 858330245 3931728244> (DF) [tos 0x8]
```

The most interesting piece of data is usually the source and destination IP addresses and ports (highlighted in red). In the above example we've highlighted a packet from 192.168.99.2 (port 22) to 192.168.30.6 (port 53760).

If you are searching for the source of a port scan, you would hope to see a large number of packets from the same source address.

Filtering the output

If you, or other operators are connected to the firewall using ssh on the interface you're watching you'll immediately see a problem. Your own ssh packets could well dominate the tcpdump output. You will probably want to filter this data out.

You might have a clear idea what you are looking for, in which case you will want to specify a filter that shows only that traffic. Alternatively, you could start by displaying all packets and then systematically exclude uninteresting traffic as you see it.

To exclude your own and other peoples SSH traffic, you might type:

```
#tcpdump -n -i eth0 not port 48001
```

If you only wanted to see packets going to port 135, you might type:

```
#tcpdump -n -i eth0 dst port 135
```

The “dst” option stands for destination. We will only see packets going to port 135, not any packets returning from port 135. To see packet going to and from port 135, simply drop the dst option.

To see all port 135 traffic for all hosts excluding a known host (e.g. 192.168.30.2) you would type the following:

```
#tcpdump -n -i eth0 dst port 135 and not host 192.168.30.2
```

To see only tcp packets with the syn flag set, and where the destination port is 135, type:

```
#tcpdump -n -i eth0 tcp[13] == 2 and dst port 135
```

For more information on tcpdump, please see the manual page at the end of this document.

ngrep

This tool can search some or all of the packets on an interface for a particular string or sequence of bytes. The ports, sources and destinations can be filtered in a similar way to tcpdump filters.

To find packets on the network interface eth0 containing the word “edonkey” you would type:

```
#ngrep -d eth0 edonkey
```

Snippets of all packets containing that string are dumped to the console in a similar fashion to tcpdump.

In addition to the simple string match shown, it will also accept regular expressions and hex sequences. Please see the ngrep manual page for more information.

Examining Argus logs

FireRack can run multiple instances of the argus listener. Each listener is bound to a specific tcp port. Typically your FMS will be configured to connect to these ports and write the resulting traffic flow data to disk.

This data can them be analysed using the provided tools, including “ra”.

INCOMPLETE

For more information about argus visit:
http://qosient.com/argus/

Dynamic Groups as blacklists

The Dynamic Groups feature allows you to dynamically or manually add IP addresses to a list in response to certain events. Once an IP address is added to the group, you can make use of it by matching against that Dynamic Group and either a source or a destination address in a firewall rule.

You can create these dynamic groups in advance and pre-configure a set of rule to govern how hosts on the list should be treated. Once you have determined that a host on your network is misbehaving, you can manually add its address to this list. It then instantaneously becomes subject to those predefined rules.

INCOMPLETE

Port scan and worm detection

INCOMPLETE

Manual Pages

IPTRAF(8)

```
NAME
       iptraf - Interactive Colorful IP LAN Monitor

SYNOPSIS
       iptraf  {  [  -f ] [ -q ] [ { -i iface | -g | -d iface | -s iface | -z
       iface | -l iface } [ -t timeout ] [ -B [ -L logfile ] ] ] | [ -h ] }

DESCRIPTION
       iptraf is an ncurses-based IP LAN monitor that generates various  net-
       work statistics including TCP info, UDP counts, ICMP and OSPF informa-
       tion, Ethernet load info, node stats, IP checksum errors, and  others.

       If the command is issued without any command-line options, the program
       comes up in interactive mode, with  the  various  facilities  accessed
       through the main menu.


OPTIONS
       These options can also be supplied to the command:

       -i iface
              immediately  start  the  IP  traffic  monitor  on the specified
              interface, or all interfaces if "-i all" is specified

       -g     immediately start the general interface statistics

       -d iface
              allows you to immediately start the detailed on  the  indicated
              interface (iface)

       -s iface
              allows  you  to  immediately monitor TCP and UDP traffic on the
              specified interface (iface)

       -z iface
              shows packet counts by size on the specified interface

       -l iface
              start the LAN station monitor on the  specified  interface,  or
              all LAN interfaces if "-l all" is specified

       -t timeout
              tells  IPTraf  to  run  the specified facility for only timeout
              minutes.  This option is used only with one of the above param-
              eters.

       -B     redirect  standard  output to /dev/null, closes standard input,
              and forks the program into the background.  Can  be  used  only
              with one of the facility invocation parameters above.  Send the
              backgrounded process a USR2 signal to terminate.

       -L logfile
              allows you to specify an alternate log file name.  The  default
              log  file  name  is  based  on  either  the  interface selected
              (detailed interface  statistics,  TCP/UDP  service  statistics,
              packet  size  breakdown),  or  the instance of the facility (IP
              traffic monitor, LAN station monitor).  If a path is not speci-
              fied, the log file is placed in /var/log/iptraf

       -f     clears  all locks and counters, causing this instance of IPTraf
              to think itâs the first one running.  This should only be  used
              to recover from an abnormal termination or system crash.

       -q     no longer needed, maintained only for compatibility.

       -h     shows a command summary

SIGNALS
```

```
        SIGUSR1 - rotates log files while program is running
        SIGUSR2 - terminates an IPTraf process running in the background.


FILES
        /var/log/iptraf/*.log - log file
        /var/run/iptraf/* - important IPTraf data files


SEE ALSO
        Documentation/* - complete documentation written by the author


AUTHOR
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MANUAL AUTHOR
       Frederic Peters (fpeters@debian.org), using iptraf --help General man-
       ual page modifications by Gerard Paul Java (riker@mozcom.com)



                               IPTraf Help Page                     IPTRAF(8)
```

BWM

```
USAGE
-----

USAGE: bwm-ng [OPTION] ... [CONFIGFILE]
Options:
  -t, --timeout <msec>    displays stats every <msec> (1msec = 1/1000sec)
                          default: 500
  -d, --dynamic           show values dynamicly (Byte KB or MB)
  -a, --allif [mode]      where mode is one of:
                          0=show only up (and selected) interfaces
                          1=show all up interfaces (default)
                          2=show all and down interfaces
  -p, --packets           show packets/s instead of KB/s
  -I, --interfaces <list> show only interfaces in <list> (comma seperated), or
                          if list is prefaced with % show all but interfaces
                          in list
  -S, --sumhidden         count hidden interfaces for total
  -D, --daemon            fork into background and daemonize
  -h, --help              displays this help
  -V, --version           print version info

Input:
  -i, --input <method>    input method, one of: netstat proc libstatgrab
  -f, --procfile <file>   filename to read raw data from. (/proc/net/dev)
  -n, --netstat <path>    use <path> as netstat binary

Output:
  -o, --output <method>   output method, one of: plain, curses, csv, html
  -C, --csvchar <char>    delimiter for csv
  -F, --csvfile <file>    output file for csv (default stdout)
  -H, --htmlrefresh <num> meta refresh for html output
  -H, --htmlheader        show <html> and <meta> frame for html output
  -c, --count <num>       number of query/output for plain & csv
                          (ie 1 for one single output)

Keybindings (curses only):
  'q'     exit
  '+'     increases timeout by 100ms
  '-'     decreases timeout by 100ms
  'k','d' switch KB and auto assign Byte/KB/MB
  'a'     cycle: show all interfaces, only those which are up,
                 only up and not hidden
  's'     sum hidden ifaces to total aswell or not
  'n'     cycle: input methods
  'p'     switch show packets or Byte/s
```

TCPDUMP

```
TCPDUMP(8)                                                       TCPDUMP(8)

NAME
       tcpdump - dump traffic on a network

SYNOPSIS
       tcpdump [ -adeflnNOpqRStuvxX ] [ -c count ]
               [ -C file_size ] [ -F file ]
               [ -i interface ] [ -m module ] [ -r file ]
               [ -s snaplen ] [ -T type ] [ -U user ] [ -w file ]
               [ -E algo:secret ] [ expression ]

DESCRIPTION
       Tcpdump  prints  out the headers of packets on a network interface that
       match the boolean expression.  It can also be run  with  the  -w  flag,
       which  causes  it to save the packet data to a file for later analysis,
       and/or with the -r flag, which causes it to read from  a  saved  packet
       file  rather  than  to  read  packets from a network interface.  In all
       cases, only packets that match expression will be processed by tcpdump.

       Tcpdump  will,  if not run with the -c flag, continue capturing packets
       until it is interrupted by a SIGINT signal (generated, for example,  by
       typing your interrupt character, typically control-C) or a SIGTERM sig-
       nal (typically generated with the kill(1) command); if run with the  -c
       flag,  it  will  capture packets until it is interrupted by a SIGINT or
       SIGTERM signal or the specified number of packets have been  processed.

       When tcpdump finishes capturing packets, it will report counts of:

              packets  ``received  by filter'' (the meaning of this depends on
              the OS on which you're running tcpdump, and possibly on the  way
              the OS was configured - if a filter was specified on the command
              line, on some OSes it counts packets regardless of whether  they
              were  matched  by  the  filter  expression, and on other OSes it
              counts only packets that were matched by the  filter  expression
              and were processed by tcpdump);

              packets  ``dropped  by  kernel''  (this is the number of packets
              that were dropped, due to a lack of buffer space, by the  packet
              capture  mechanism in the OS on which tcpdump is running, if the
              OS reports that information to applications; if not, it will  be
              reported as 0).
       On  platforms  that  support  the SIGINFO signal, such as most BSDs, it
       will report those counts when it receives a SIGINFO signal  (generated,
       for  example, by typing your ``status'' character, typically control-T)
       and will continue capturing packets.

OPTIONS
       -a     Attempt to convert network and broadcast addresses to names.

       -c     Exit after receiving count packets.

       -C     Before  writing  a  raw  packet to a savefile, check whether the
              file is currently larger than file_size and, if  so,  close  the
              current  savefile and open a new one.  Savefiles after the first
              savefile will have the name specified with the -w flag,  with  a
              number after it, starting at 2 and continuing upward.  The units
              of  file_size  are  millions  of  bytes  (1,000,000  bytes,  not
              1,048,576 bytes).

       -d     Dump  the compiled packet-matching code in a human readable form
              to standard output and stop.

       -dd    Dump packet-matching code as a C program fragment.

       -ddd   Dump packet-matching code as decimal numbers  (preceded  with  a
              count).

       -e     Print the link-level header on each dump line.

       -E     Use  algo:secret  for  decrypting IPsec ESP packets.  Algorithms
              may be des-cbc, 3des-cbc, blowfish-cbc, rc3-cbc, cast128-cbc, or
              none.   The  default is des-cbc.  The ability to decrypt packets
              is only  present  if  tcpdump  was  compiled  with  cryptography
```

```
          enabled.   secret  the ascii text for ESP secret key.  We cannot
          take arbitrary binary value at this moment.  The option  assumes
          RFC2406  ESP, not RFC1827 ESP.  The option is only for debugging
          purposes, and the use of this option with truly `secret' key  is
          discouraged.   By  presenting IPsec secret key onto command line
          you make it visible to others, via ps(1) and other occasions.

   -f     Print `foreign' internet addresses numerically rather than  sym-
          bolically  (this  option is intended to get around serious brain
          damage in Sun's yp server ? usually it hangs forever translating
          non-local internet numbers).

   -F     Use  file  as  input  for  the filter expression.  An additional
          expression given on the command line is ignored.

   -i     Listen on interface.  If unspecified, tcpdump searches the  sys-
          tem interface list for the lowest numbered, configured up inter-
          face (excluding loopback).  Ties are broken by choosing the ear-
          liest match.

          On  Linux  systems with 2.2 or later kernels, an interface argu-
          ment of ``any'' can be used to capture packets from  all  inter-
          faces.   Note  that  captures  on the ``any'' device will not be
          done in promiscuous mode.

   -l     Make stdout line buffered.  Useful if you want to see  the  data
          while capturing it.  E.g.,
          ``tcpdump  -l  |  tee     dat''     or     ``tcpdump  -l       >
          dat  &  tail  -f  dat''.

   -m     Load SMI MIB module definitions from file module.   This  option
          can  be used several times to load several MIB modules into tcp-
          dump.

   -n     Don't convert host addresses to names.   This  can  be  used  to
          avoid DNS lookups.

   -nn    Don't convert protocol and port numbers etc. to names either.

   -N     Don't  print  domain name qualification of host names.  E.g., if
          you give this flag then tcpdump will print  ``nic''  instead  of
          ``nic.ddn.mil''.

   -O     Do  not  run the packet-matching code optimizer.  This is useful
          only if you suspect a bug in the optimizer.

   -p     Don't put the interface into promiscuous mode.   Note  that  the
          interface  might  be  in promiscuous mode for some other reason;
          hence, `-p' cannot be used as an abbreviation  for  `ether  host
          {local-hw-addr} or ether broadcast'.

   -q     Quick  (quiet?) output.  Print less protocol information so out-
          put lines are shorter.

   -R     Assume ESP/AH packets to be based on old specification  (RFC1825
          to  RFC1829).   If specified, tcpdump will not print replay pre-
          vention field.  Since there is  no  protocol  version  field  in
          ESP/AH  specification,  tcpdump  cannot  deduce  the  version of
          ESP/AH protocol.

   -r     Read packets from file (which was created with the  -w  option).
          Standard input is used if file is ``-''.

   -S     Print absolute, rather than relative, TCP sequence numbers.

   -s     Snarf  snaplen  bytes  of  data from each packet rather than the
          default of 68 (with SunOS's NIT, the minimum  is  actually  96).
          68  bytes is adequate for IP, ICMP, TCP and UDP but may truncate
          protocol information from  name  server  and  NFS  packets  (see
          below).   Packets  truncated  because  of a limited snapshot are
          indicated in the output with ``[|proto]'', where  proto  is  the
          name of the protocol level at which the truncation has occurred.
          Note that taking larger snapshots both increases the  amount  of
          time it takes to process packets and, effectively, decreases the
          amount of packet buffering.  This may cause packets to be  lost.
          You  should  limit snaplen to the smallest number that will cap-
          ture the protocol information  you're  interested  in.   Setting
```

```
              snaplen  to 0 means use the required length to catch whole pack-
              ets.

       -T     Force packets selected by "expression"  to  be  interpreted  the
              specified  type.   Currently known types are cnfp (Cisco NetFlow
              protocol), rpc (Remote Procedure Call), rtp (Real-Time  Applica-
              tions protocol), rtcp (Real-Time Applications control protocol),
              snmp (Simple Network Management  Protocol),  vat  (Visual  Audio
              Tool), and wb (distributed White Board).

       -t     Don't print a timestamp on each dump line.

       -tt    Print an unformatted timestamp on each dump line.

       -U     Drops  root  privileges and changes user ID to user and group ID
              to the primary group of user.

              Note!  Red Hat Linux automatically drops the privileges to  user
              ``pcap'' if nothing else is specified.

       -ttt   Print  a  delta  (in micro-seconds) between current and previous
              line on each dump line.

       -tttt  Print a timestamp in default format proceeded by  date  on  each
              dump line.

       -u     Print undecoded NFS handles.

       -v     (Slightly  more) verbose output.  For example, the time to live,
              identification, total length and options in  an  IP  packet  are
              printed.   Also  enables additional packet integrity checks such
              as verifying the IP and ICMP header checksum.

       -vv    Even more verbose output.  For example,  additional  fields  are
              printed  from  NFS  reply  packets,  and  SMB  packets are fully
              decoded.

       -vvv   Even more verbose output.  For example, telnet SB ... SE options
              are  printed in full.  With -X telnet options are printed in hex
              as well.

       -w     Write the raw packets to file rather than parsing  and  printing
              them  out.  They can later be printed with the -r option.  Stan-
              dard output is used if file is ``-''.

       -x     Print each packet (minus its link level  header)  in  hex.   The
              smaller  of  the entire packet or snaplen bytes will be printed.
              Note that this is the entire link-layer packet, so for link lay-
              ers  that  pad  (e.g.  Ethernet), the padding bytes will also be
              printed when  the  higher  layer  packet  is  shorter  than  the
              required padding.

       -X     When printing hex, print ascii too.  Thus if -x is also set, the
              packet  is  printed  in  hex/ascii.   This  is  very  handy  for
              analysing new protocols.  Even if -x is not also set, some parts
              of some packets may be printed in hex/ascii.


        expression
              selects which packets will  be  dumped.   If  no  expression  is
              given,  all  packets on the net will be dumped.  Otherwise, only
              packets for which expression is `true' will be dumped.

              The expression consists of one or more  primitives.   Primitives
              usually  consist  of  an  id (name or number) preceded by one or
              more qualifiers.  There are three different kinds of qualifier:

              type   qualifiers say what kind of thing the id name  or  number
                     refers to.  Possible types are host, net and port.  E.g.,
                     `host foo', `net 128.3', `port 20'.  If there is no  type
                     qualifier, host is assumed.

              dir    qualifiers  specify  a  particular  transfer direction to
                     and/or from id.  Possible directions are src, dst, src or
                     dst  and  src and dst.  E.g., `src foo', `dst net 128.3',
                     `src or dst port ftp-data'.  If there is  no  dir  quali-
                     fier,  src  or  dst  is  assumed.  For `null' link layers
                     (i.e. point to point protocols such as slip) the  inbound
                     and  outbound qualifiers can be used to specify a desired
                     direction.

              proto  qualifiers restrict the match to a  particular  protocol.
                     Possible protos are: ether, fddi, tr, ip, ip6, arp, rarp,
                     decnet, tcp and udp.  E.g., `ether  src  foo',  `arp  net
                     128.3',  `tcp  port 21'.  If there is no proto qualifier,
                     all protocols  consistent  with  the  type  are  assumed.
                     E.g.,  `src  foo'  means  `(ip  or  arp or rarp) src foo'
                     (except the latter is not legal syntax), `net bar'  means
                     `(ip  or  arp or rarp) net bar' and `port 53' means `(tcp
                     or udp) port 53'.

              [`fddi' is actually an alias for `ether'; the parser treats them
              identically  as meaning ``the data link level used on the speci-
              fied network interface.''  FDDI  headers  contain  Ethernet-like
              source  and  destination  addresses, and often contain Ethernet-
              like packet types, so you can filter on these FDDI  fields  just
              as  with  the analogous Ethernet fields.  FDDI headers also con-
              tain other fields, but you cannot name them explicitly in a fil-
              ter expression.

              Similarly,  `tr'  is  an  alias  for `ether'; the previous para-
              graph's statements about FDDI headers also apply to  Token  Ring
              headers.]

              In  addition  to  the  above, there are some special `primitive'
              keywords that don't  follow  the  pattern:  gateway,  broadcast,
              less,  greater  and  arithmetic  expressions.   All of these are
              described below.

              More complex filter expressions are built up by using the  words
              and,  or and not to combine primitives.  E.g., `host foo and not
              port ftp and not port  ftp-data'.   To  save  typing,  identical
              qualifier lists can be omitted.  E.g., `tcp dst port ftp or ftp-
              data or domain' is exactly the same as `tcp dst port ftp or  tcp
              dst port ftp-data or tcp dst port domain'.

              Allowable primitives are:

              dst host host
                     True  if  the  IPv4/v6 destination field of the packet is
                     host, which may be either an address or a name.

              src host host
                     True if the IPv4/v6 source field of the packet is host.

              host host
                     True if either the IPv4/v6 source or destination  of  the
                     packet is host.  Any of the above host expressions can be
                     prepended with the keywords, ip, arp, rarp, or ip6 as in:
                          ip host host
                     which is equivalent to:
                          ether proto \ip and host host
                     If  host  is  a  name  with  multiple  IP addresses, each
                     address will be checked for a match.

              ether dst ehost
                     True if the ethernet destination address is ehost.  Ehost
                     may  be  either  a name from /etc/ethers or a number (see
                     ethers(3N) for numeric format).

              ether src ehost
                     True if the ethernet source address is ehost.

              ether host ehost
                     True if either the ethernet source or destination address
                     is ehost.

              gateway host
                     True  if  the  packet  used host as a gateway.  I.e., the
                     ethernet source or destination address was host but  nei-
                     ther the IP source nor the IP destination was host.  Host
                     must be a name and must be found both  by  the  machine's
                     host-name-to-IP-address  resolution mechanisms (host name
                     file, DNS, NIS, etc.) and by the machine's  host-name-to-
                     Ethernet-address   resolution   mechanism   (/etc/ethers,
                     etc.).  (An equivalent expression is
                          ether host ehost and not host host
                     which can be used with either names or numbers for host /
                     ehost.)   This  syntax does not work in IPv6-enabled con-
                     figuration at this moment.

              dst net net
                     True if the IPv4/v6 destination address of the packet has
                     a  network  number of net.  Net may be either a name from
                     /etc/networks or a network number  (see  networks(4)  for
                     details).

              src net net
                     True  if  the  IPv4/v6 source address of the packet has a
                     network number of net.

              net net
                     True if either the IPv4/v6 source or destination  address
                     of the packet has a network number of net.

              net net mask netmask
                     True if the IP address matches net with the specific net-
                     mask.  May be qualified with src or dst.  Note that  this
                     syntax is not valid for IPv6 net.

              net net/len
                     True  if  the  IPv4/v6 address matches net with a netmask
                     len bits wide.  May be qualified with src or dst.

              dst port port
                     True if the packet is ip/tcp, ip/udp, ip6/tcp or  ip6/udp
                     and  has  a destination port value of port.  The port can
                     be a number or a name used in /etc/services (see  tcp(4P)
                     and  udp(4P)).   If  a name is used, both the port number
                     and protocol are checked.  If a number or ambiguous  name
                     is  used, only the port number is checked (e.g., dst port
                     513 will print both tcp/login traffic and  udp/who  traf-
                     fic,  and  port  domain  will  print  both tcp/domain and
                     udp/domain traffic).

              src port port
                     True if the packet has a source port value of port.

              port port
                     True if either the source  or  destination  port  of  the
                     packet is port.  Any of the above port expressions can be
                     prepended with the keywords, tcp or udp, as in:
                          tcp src port port
                     which matches only tcp packets whose source port is port.

              less length
                     True  if  the  packet  has a length less than or equal to
                     length.  This is equivalent to:
                          len <= length.

              greater length
                     True if the packet has a length greater than or equal  to
                     length.  This is equivalent to:
                          len >= length.

              ip proto protocol
                     True if the packet is an IP packet (see ip(4P)) of proto-
                     col type protocol.  Protocol can be a number  or  one  of
                     the  names  icmp,  icmp6, igmp, igrp, pim, ah, esp, vrrp,
                     udp, or tcp.  Note that the  identifiers  tcp,  udp,  and
                     icmp  are also keywords and must be escaped via backslash
                     (\), which is \\ in the C-shell.  Note that  this  primi-
                     tive does not chase the protocol header chain.

              ip6 proto protocol
                     True  if  the  packet  is an IPv6 packet of protocol type
                     protocol.  Note that this primitive does  not  chase  the
                     protocol header chain.

              ip6 protochain protocol
                     True  if the packet is IPv6 packet, and contains protocol
                     header with type protocol in its protocol  header  chain.
                     For example,
                          ip6 protochain 6
                     matches  any  IPv6 packet with TCP protocol header in the
                     protocol header chain.  The packet may contain, for exam-
                     ple, authentication header, routing header, or hop-by-hop
                     option header, between IPv6 header and TCP  header.   The
                     BPF  code emitted by this primitive is complex and cannot
                     be optimized by BPF optimizer code in  tcpdump,  so  this
                     can be somewhat slow.

              ip protochain protocol
                     Equivalent  to  ip6  protochain protocol, but this is for
                     IPv4.

              ether broadcast
                     True if the packet is an ethernet broadcast packet.   The
                     ether keyword is optional.

              ip broadcast
                     True  if the packet is an IP broadcast packet.  It checks
                     for both the all-zeroes and  all-ones  broadcast  conven-
                     tions, and looks up the local subnet mask.

              ether multicast
                     True  if the packet is an ethernet multicast packet.  The
                     ether  keyword  is  optional.   This  is  shorthand   for
                     `ether[0] & 1 != 0'.

              ip multicast
                     True if the packet is an IP multicast packet.

              ip6 multicast
                     True if the packet is an IPv6 multicast packet.

              ether proto protocol
                     True  if  the packet is of ether type protocol.  Protocol
                     can be a number or one of the names ip, ip6,  arp,  rarp,
                     atalk,  aarp,  decnet,  sca, lat, mopdl, moprc, iso, stp,
                     ipx, or netbeui.  Note these identifiers  are  also  key-
                     words and must be escaped via backslash (\).

                     [In  the  case  of  FDDI  (e.g., `fddi protocol arp') and
                     Token Ring (e.g., `tr protocol arp'), for most  of  those
                     protocols,  the  protocol  identification  comes from the
                     802.2 Logical Link Control (LLC) header, which is usually
                     layered on top of the FDDI or Token Ring header.

                     When  filtering  for most protocol identifiers on FDDI or
                     Token Ring, tcpdump checks only the protocol ID field  of
                     an  LLC header in so-called SNAP format with an Organiza-
                     tional Unit Identifier (OUI) of  0x000000,  for  encapsu-
                     lated Ethernet; it doesn't check whether the packet is in
                     SNAP format with an OUI of 0x000000.

                     The exceptions are iso, for  which  it  checks  the  DSAP
                     (Destination  Service Access Point) and SSAP (Source Ser-
                     vice Access Point) fields of the LLC header, stp and net-
                     beui,  where  it  checks  the DSAP of the LLC header, and
                     atalk, where it checks for a SNAP-format packet  with  an
                     OUI of 0x080007 and the Appletalk etype.

                     In the case of Ethernet, tcpdump checks the Ethernet type
                     field for most of those  protocols;  the  exceptions  are
                     iso,  sap,  and netbeui, for which it checks for an 802.3
                     frame and then checks the LLC header as it does for  FDDI
                     and  Token  Ring,  atalk,  where  it  checks both for the
                     Appletalk etype in an Ethernet frame and for a  SNAP-for-
                     mat  packet  as  it  does  for FDDI and Token Ring, aarp,
                     where it checks for the Appletalk ARP etype in either  an
                     Ethernet  frame  or  an  802.2  SNAP frame with an OUI of
                     0x000000, and ipx, where it checks for the IPX  etype  in
                     an  Ethernet  frame,  the IPX DSAP in the LLC header, the
                     802.3 with no LLC header encapsulation of  IPX,  and  the
                     IPX etype in a SNAP frame.]

              decnet src host
```

True if the DECNET source address is host, which may be an address of the form ``10.123'', or a DECNET host name. [DECNET host name support is only available on Ultrix systems that are configured to run DECNET.]

decnet dst host
: True if the DECNET destination address is host.

decnet host host
: True if either the DECNET source or destination address is host.

ip, ip6, arp, rarp, atalk, aarp, decnet, iso, stp, ipx, netbeui
: Abbreviations for:
    ether proto p
  where p is one of the above protocols.

lat, moprc, mopdl
: Abbreviations for:
    ether proto p
  where p is one of the above protocols. Note that tcpdump does not currently know how to parse these protocols.

vlan [vlan_id]
: True if the packet is an IEEE 802.1Q VLAN packet. If [vlan_id] is specified, only true is the packet has the specified vlan_id. Note that the first vlan keyword encountered in expression changes the decoding offsets for the remainder of expression on the assumption that the packet is a VLAN packet.

tcp, udp, icmp
: Abbreviations for:
    ip proto p or ip6 proto p
  where p is one of the above protocols.

iso proto protocol
: True if the packet is an OSI packet of protocol type protocol. Protocol can be a number or one of the names clnp, esis, or isis.

clnp, esis, isis
: Abbreviations for:
    iso proto p
  where p is one of the above protocols. Note that tcpdump does an incomplete job of parsing these protocols.

expr relop expr
: True if the relation holds, where relop is one of >, <, >=, <=, =, !=, and expr is an arithmetic expression composed of integer constants (expressed in standard C syntax), the normal binary operators [+, -, *, /, &, |], a length operator, and special packet data accessors. To access data inside the packet, use the following syntax:
    proto [expr : size]
  Proto is one of ether, fddi, tr, ppp, slip, link, ip, arp, rarp, tcp, udp, icmp or ip6, and indicates the protocol layer for the index operation. (ether, fddi, tr, ppp, slip and link all refer to the link layer.) Note that tcp, udp and other upper-layer protocol types only apply to IPv4, not IPv6 (this will be fixed in the future). The byte offset, relative to the indicated protocol layer, is given by expr. Size is optional and indicates the number of bytes in the field of interest; it can be either one, two, or four, and defaults to one. The length operator, indicated by the keyword len, gives the length of the packet.

  For example, `ether[0] & 1 != 0' catches all multicast traffic. The expression `ip[0] & 0xf != 5' catches all IP packets with options. The expression `ip[6:2] & 0x1fff = 0' catches only unfragmented datagrams and frag zero of fragmented datagrams. This check is implicitly applied to the tcp and udp index operations. For instance, tcp[0] always means the first byte of the TCP header, and never means the first byte of an intervening fragment.

```
                     Some offsets and field values may be expressed  as  names
                     rather  than  as  numeric values.  The following protocol
                     header field offsets are available: icmptype  (ICMP  type
                     field),  icmpcode  (ICMP  code  field), and tcpflags (TCP
                     flags field).

                     The following ICMP type field values are available: icmp-
                     echoreply,  icmp-unreach,  icmp-sourcequench,  icmp-redi-
                     rect, icmp-echo,  icmp-routeradvert,  icmp-routersolicit,
                     icmp-timxceed,  icmp-paramprob,  icmp-tstamp, icmp-tstam-
                     preply, icmp-ireq,  icmp-ireqreply,  icmp-maskreq,  icmp-
                     maskreply.

                     The  following TCP flags field values are available: tcp-
                     fin, tcp-syn, tcp-rst, tcp-push, tcp-push, tcp-ack,  tcp-
                     urg.

              Primitives may be combined using:

                     A parenthesized group of primitives and operators (paren-
                     theses are special to the Shell and must be escaped).

                     Negation (`!' or `not').

                     Concatenation (`&&' or `and').

                     Alternation (`||' or `or').

              Negation has highest precedence.  Alternation and  concatenation
              have  equal  precedence  and associate left to right.  Note that
              explicit and tokens, not juxtaposition,  are  now  required  for
              concatenation.

              If  an  identifier  is  given without a keyword, the most recent
              keyword is assumed.  For example,
                   not host vs and ace
              is short for
                   not host vs and host ace
              which should not be confused with
                   not ( host vs or ace )

              Expression arguments can be passed to tcpdump as either a single
              argument or as multiple arguments, whichever is more convenient.
              Generally, if the expression contains Shell  metacharacters,  it
              is  easier  to  pass  it as a single, quoted argument.  Multiple
              arguments are concatenated with spaces before being parsed.

EXAMPLES
       To print all packets arriving at or departing from sundown:
              tcpdump host sundown

       To print traffic between helios and either hot or ace:
              tcpdump host helios and \( hot or ace \)

       To print all IP packets between ace and any host except helios:
              tcpdump ip host ace and not helios

       To print all traffic between local hosts and hosts at Berkeley:
              tcpdump net ucb-ether

       To print all ftp traffic through internet gateway snup: (note that  the
       expression  is  quoted to prevent the shell from (mis-)interpreting the
       parentheses):
              tcpdump 'gateway snup and (port ftp or ftp-data)'

       To print traffic neither sourced from nor destined for local hosts  (if
       you gateway to one other net, this stuff should never make it onto your
       local net).
              tcpdump ip and not net localnet

       To print the start and end packets (the SYN and FIN  packets)  of  each
       TCP conversation that involves a non-local host.
              tcpdump 'tcp[tcpflags] & (tcp-syn|tcp-fin) != 0 and not src and dst net
localnet'

       To print IP packets longer than 576 bytes sent through gateway snup:
```

```
       tcpdump 'gateway snup and ip[2:2] > 576'
```

To print IP broadcast or multicast packets that were not sent via ethernet broadcast or multicast:

```
       tcpdump 'ether[0] & 1 = 0 and ip[16] >= 224'
```

To print all ICMP packets that are not echo requests/replies (i.e., not ping packets):

```
       tcpdump 'icmp[icmptype] != icmp-echo and icmp[icmptype] != icmp-echoreply'
```

OUTPUT FORMAT

The output of tcpdump is protocol dependent. The following gives a brief description and examples of most of the formats.

Link Level Headers

If the '-e' option is given, the link level header is printed out. On ethernets, the source and destination addresses, protocol, and packet length are printed.

On FDDI networks, the '-e' option causes tcpdump to print the `frame control' field, the source and destination addresses, and the packet length. (The `frame control' field governs the interpretation of the rest of the packet. Normal packets (such as those containing IP datagrams) are `async' packets, with a priority value between 0 and 7; for example, `async4'. Such packets are assumed to contain an 802.2 Logical Link Control (LLC) packet; the LLC header is printed if it is not an ISO datagram or a so-called SNAP packet.

On Token Ring networks, the '-e' option causes tcpdump to print the `access control' and `frame control' fields, the source and destination addresses, and the packet length. As on FDDI networks, packets are assumed to contain an LLC packet. Regardless of whether the '-e' option is specified or not, the source routing information is printed for source-routed packets.

(N.B.: The following description assumes familiarity with the SLIP compression algorithm described in RFC-1144.)

On SLIP links, a direction indicator (``I'' for inbound, ``O'' for outbound), packet type, and compression information are printed out. The packet type is printed first. The three types are ip, utcp, and ctcp. No further link information is printed for ip packets. For TCP packets, the connection identifier is printed following the type. If the packet is compressed, its encoded header is printed out. The special cases are printed out as *S+n and *SA+n, where n is the amount by which the sequence number (or sequence number and ack) has changed. If it is not a special case, zero or more changes are printed. A change is indicated by U (urgent pointer), W (window), A (ack), S (sequence number), and I (packet ID), followed by a delta (+n or -n), or a new value (=n). Finally, the amount of data in the packet and compressed header length are printed.

For example, the following line shows an outbound compressed TCP packet, with an implicit connection identifier; the ack has changed by 6, the sequence number by 49, and the packet ID by 6; there are 3 bytes of data and 6 bytes of compressed header:

```
       O ctcp * A+6 S+49 I+6 3 (6)
```

ARP/RARP Packets

Arp/rarp output shows the type of request and its arguments. The format is intended to be self explanatory. Here is a short sample taken from the start of an `rlogin' from host rtsg to host csam:

```
       arp who-has csam tell rtsg
       arp reply csam is-at CSAM
```

The first line says that rtsg sent an arp packet asking for the ethernet address of internet host csam. Csam replies with its ethernet address (in this example, ethernet addresses are in caps and internet addresses in lower case).

This would look less redundant if we had done tcpdump -n:

```
       arp who-has 128.3.254.6 tell 128.3.254.68
       arp reply 128.3.254.6 is-at 02:07:01:00:01:c4
```

If we had done tcpdump -e, the fact that the first packet is broadcast and the second is point-to-point would be visible:

```
       RTSG Broadcast 0806  64: arp who-has csam tell rtsg
       CSAM RTSG 0806  64: arp reply csam is-at CSAM
```

For the first packet this says the ethernet source address is RTSG, the destination is the ethernet broadcast address, the type field contained hex 0806 (type ETHER_ARP) and the total length was 64 bytes.

TCP Packets

(N.B.:The following description assumes familiarity with the TCP protocol described in RFC-793. If you are not familiar with the protocol, neither this description nor tcpdump will be of much use to you.)

The general format of a tcp protocol line is:

```
       src > dst: flags data-seqno ack window urgent options
```

Src and dst are the source and destination IP addresses and ports. Flags are some combination of S (SYN), F (FIN), P (PUSH) or R (RST) or a single `.' (no flags). Data-seqno describes the portion of sequence space covered by the data in this packet (see example below). Ack is sequence number of the next data expected the other direction on this connection. Window is the number of bytes of receive buffer space available the other direction on this connection. Urg indicates there is `urgent' data in the packet. Options are tcp options enclosed in angle brackets (e.g., <mss 1024>).

Src, dst and flags are always present. The other fields depend on the contents of the packet's tcp protocol header and are output only if appropriate.

Here is the opening portion of an rlogin from host rtsg to host csam.

```
       rtsg.1023 > csam.login: S 768512:768512(0) win 4096 <mss 1024>
       csam.login > rtsg.1023: S 947648:947648(0) ack 768513 win 4096 <mss 1024>
       rtsg.1023 > csam.login: . ack 1 win 4096
       rtsg.1023 > csam.login: P 1:2(1) ack 1 win 4096
       csam.login > rtsg.1023: . ack 2 win 4096
       rtsg.1023 > csam.login: P 2:21(19) ack 1 win 4096
       csam.login > rtsg.1023: P 1:2(1) ack 21 win 4077
       csam.login > rtsg.1023: P 2:3(1) ack 21 win 4077 urg 1
       csam.login > rtsg.1023: P 3:4(1) ack 21 win 4077 urg 1
```

The first line says that tcp port 1023 on rtsg sent a packet to port login on csam. The S indicates that the SYN flag was set. The packet sequence number was 768512 and it contained no data. (The notation is `first:last(nbytes)' which means `sequence numbers first up to but not including last which is nbytes bytes of user data'.) There was no piggy-backed ack, the available receive window was 4096 bytes and there was a max-segment-size option requesting an mss of 1024 bytes.

Csam replies with a similar packet except it includes a piggy-backed ack for rtsg's SYN. Rtsg then acks csam's SYN. The `.' means no flags were set. The packet contained no data so there is no data sequence number. Note that the ack sequence number is a small integer (1). The first time tcpdump sees a tcp `conversation', it prints the sequence number from the packet. On subsequent packets of the conversation, the difference between the current packet's sequence number and this initial sequence number is printed. This means that sequence numbers after the first can be interpreted as relative byte positions in the conversation's data stream (with the first data byte each direction being `1'). `-S' will override this feature, causing the original sequence numbers to be output.

On the 6th line, rtsg sends csam 19 bytes of data (bytes 2 through 20 in the rtsg -> csam side of the conversation). The PUSH flag is set in the packet. On the 7th line, csam says it's received data sent by rtsg up to but not including byte 21. Most of this data is apparently sitting in the socket buffer since csam's receive window has gotten 19 bytes smaller. Csam also sends one byte of data to rtsg in this packet. On the 8th and 9th lines, csam sends two bytes of urgent, pushed data to rtsg.

If the snapshot was small enough that tcpdump didn't capture the full TCP header, it interprets as much of the header as it can and then reports ``[|tcp]'' to indicate the remainder could not be interpreted. If the header contains a bogus option (one with a length that's either too small or beyond the end of the header), tcpdump reports it as ``[bad opt]'' and does not interpret any further options (since it's impossible to tell where they start). If the header length indicates options are present but the IP datagram length is not long enough for the options to actually be there, tcpdump reports it as ``[bad hdr length]''.

Capturing TCP packets with particular flag combinations (SYN-ACK, URG-ACK, etc.)

There are 8 bits in the control bits section of the TCP header:

```
       CWR | ECE | URG | ACK | PSH | RST | SYN | FIN
```

Let's assume that we want to watch packets used in establishing a TCP connection. Recall that TCP uses a 3-way handshake protocol when it initializes a new connection; the connection sequence with regard to the TCP control bits is

```
       1) Caller sends SYN
       2) Recipient responds with SYN, ACK
       3) Caller sends ACK
```

Now we're interested in capturing packets that have only the SYN bit set (Step 1). Note that we don't want packets from step 2 (SYN-ACK), just a plain initial SYN. What we need is a correct filter expression for tcpdump.

Recall the structure of a TCP header without options:

```
 0                            15                              31
-----------------------------------------------------------------
|          source port          |       destination port        |
-----------------------------------------------------------------
|                        sequence number                        |
-----------------------------------------------------------------
|                     acknowledgment number                     |
-----------------------------------------------------------------
|  HL   | rsvd  |C|E|U|A|P|R|S|F|        window size            |
-----------------------------------------------------------------
|         TCP checksum          |       urgent pointer          |
-----------------------------------------------------------------
```

A TCP header usually holds 20 octets of data, unless options are present. The first line of the graph contains octets 0 - 3, the second line shows octets 4 - 7 etc.

Starting to count with 0, the relevant TCP control bits are contained in octet 13:

```
 0             7|             15|             23|             31
----------------|---------------|---------------|----------------
|  HL   | rsvd  |C|E|U|A|P|R|S|F|        window size            |
----------------|---------------|---------------|----------------
|               |  13th octet   |               |               |
```

Let's have a closer look at octet no. 13:

```
                |               |
                |---------------|
                |C|E|U|A|P|R|S|F|
                |---------------|
                |7   5   3     0|
```

These are the TCP control bits we are interested in. We have numbered the bits in this octet from 0 to 7, right to left, so the PSH bit is bit number 3, while the URG bit is number 5.

Recall that we want to capture packets with only SYN set. Let's see what happens to octet 13 if a TCP datagram arrives with the SYN bit set in its header:

```
                |C|E|U|A|P|R|S|F|
                |---------------|
                |0 0 0 0 0 0 1 0|
                |---------------|
                |7 6 5 4 3 2 1 0|
```

Looking at the control bits section we see that only bit number 1 (SYN) is set.

Assuming that octet number 13 is an 8-bit unsigned integer in network byte order, the binary value of this octet is

```
       00000010
```

and its decimal representation is

```
   7     6     5     4     3     2     1     0
0*2 + 0*2 + 0*2 + 0*2 + 0*2 + 0*2 + 1*2 + 0*2  =  2
```

We're almost done, because now we know that if only SYN is set, the value of the 13th octet in the TCP header, when interpreted as a 8-bit unsigned integer in network byte order, must be exactly 2.

This relationship can be expressed as

```
       tcp[13] == 2
```

We can use this expression as the filter for tcpdump in order to watch packets which have only SYN set:

```
       tcpdump -i xl0 tcp[13] == 2
```

The expression says "let the 13th octet of a TCP datagram have the decimal value 2", which is exactly what we want.

Now, let's assume that we need to capture SYN packets, but we don't care if ACK or any other TCP control bit is set at the same time. Let's see what happens to octet 13 when a TCP datagram with SYN-ACK set arrives:

```
     |C|E|U|A|P|R|S|F|
     |---------------|
     |0 0 0 1 0 0 1 0|
     |---------------|
     |7 6 5 4 3 2 1 0|
```

Now bits 1 and 4 are set in the 13th octet. The binary value of octet 13 is

```
            00010010
```

which translates to decimal

```
   7     6     5     4     3     2     1     0
0*2 + 0*2 + 0*2 + 1*2 + 0*2 + 0*2 + 1*2 + 0*2   = 18
```

Now we can't just use 'tcp[13] == 18' in the tcpdump filter expression, because that would select only those packets that have SYN-ACK set, but not those with only SYN set. Remember that we don't care if ACK or any other control bit is set as long as SYN is set.

In order to achieve our goal, we need to logically AND the binary value of octet 13 with some other value to preserve the SYN bit. We know that we want SYN to be set in any case, so we'll logically AND the value in the 13th octet with the binary value of a SYN:

```
          00010010 SYN-ACK              00000010 SYN
     AND  00000010 (we want SYN)   AND  00000010 (we want SYN)
          --------                      --------
     =    00000010                 =    00000010
```

We see that this AND operation delivers the same result regardless whether ACK or another TCP control bit is set. The decimal representation of the AND value as well as the result of this operation is 2 (binary 00000010), so we know that for packets with SYN set the following relation must hold true:

```
       ( ( value of octet 13 ) AND ( 2 ) ) == ( 2 )
```

This points us to the tcpdump filter expression

```
            tcpdump -i xl0 'tcp[13] & 2 == 2'
```

Note that you should use single quotes or a backslash in the expression to hide the AND ('&') special character from the shell.

UDP Packets

UDP format is illustrated by this rwho packet:

```
       actinide.who > broadcast.who: udp 84
```
This says that port who on host actinide sent a udp datagram to port who on host broadcast, the Internet broadcast address. The packet contained 84 bytes of user data.

Some UDP services are recognized (from the source or destination port number) and the higher level protocol information printed. In particular, Domain Name service requests (RFC-1034/1035) and Sun RPC calls (RFC-1050) to NFS.

UDP Name Server Requests

(N.B.:The following description assumes familiarity with the Domain Service protocol described in RFC-1035. If you are not familiar with the protocol, the following description will appear to be written in greek.)

Name server requests are formatted as
```
       src > dst: id op? flags qtype qclass name (len)
       h2opolo.1538 > helios.domain: 3+ A? ucbvax.berkeley.edu. (37)
```
Host h2opolo asked the domain server on helios for an address record (qtype=A) associated with the name ucbvax.berkeley.edu. The query id was `3'. The `+' indicates the recursion desired flag was set. The query length was 37 bytes, not including the UDP and IP protocol headers. The query operation was the normal one, Query, so the op field was omitted. If the op had been anything else, it would have been printed between the `3' and the `+'. Similarly, the qclass was the normal one, C_IN, and omitted. Any other qclass would have been printed immediately after the `A'.

A few anomalies are checked and may result in extra fields enclosed in square brackets: If a query contains an answer, authority records or additional records section, ancount, nscount, or arcount are printed as `[na]', `[nn]' or `[nau]' where n is the appropriate count. If any of the response bits are set (AA, RA or rcode) or any of the `must be zero' bits are set in bytes two and three, `[b2&3=x]' is printed, where x is the hex value of header bytes two and three.

UDP Name Server Responses

Name server responses are formatted as
```
       src > dst:  id op rcode flags a/n/au type class data (len)
       helios.domain > h2opolo.1538: 3 3/3/7 A 128.32.137.3 (273)
       helios.domain > h2opolo.1537: 2 NXDomain* 0/1/0 (97)
```
In the first example, helios responds to query id 3 from h2opolo with 3 answer records, 3 name server records and 7 additional records. The first answer record is type A (address) and its data is internet address 128.32.137.3. The total size of the response was 273 bytes, excluding UDP and IP headers. The op (Query) and response code (NoError) were omitted, as was the class (C_IN) of the A record.

In the second example, helios responds to query 2 with a response code of non-existent domain (NXDomain) with no answers, one name server and no authority records. The `*' indicates that the authoritative answer bit was set. Since there were no answers, no type, class or data were printed.

Other flag characters that might appear are `-' (recursion available, RA, not set) and `|' (truncated message, TC, set). If the `question' section doesn't contain exactly one entry, `[nq]' is printed.

Note that name server requests and responses tend to be large and the default snaplen of 68 bytes may not capture enough of the packet to print. Use the -s flag to increase the snaplen if you need to seriously investigate name server traffic. `-s 128' has worked well for me.

SMB/CIFS decoding

tcpdump now includes fairly extensive SMB/CIFS/NBT decoding for data on UDP/137, UDP/138 and TCP/139. Some primitive decoding of IPX and NetBEUI SMB data is also done.

By default a fairly minimal decode is done, with a much more detailed decode done if -v is used. Be warned that with -v a single SMB packet may take up a page or more, so only use -v if you really want all the gory details.

If you are decoding SMB sessions containing unicode strings then you may wish to set the environment variable USE_UNICODE to 1. A patch to auto-detect unicode srings would be welcome.

For information on SMB packet formats and what all te fields mean see www.cifs.org or the pub/samba/specs/ directory on your favourite samba.org mirror site. The SMB patches were written by Andrew Tridgell (tridge@samba.org).

NFS Requests and Replies

Sun NFS (Network File System) requests and replies are printed as:

```
       src.xid > dst.nfs: len op args
       src.nfs > dst.xid: reply stat len op results

       sushi.6709 > wrl.nfs: 112 readlink fh 21,24/10.73165
       wrl.nfs > sushi.6709: reply ok 40 readlink "../var"
       sushi.201b > wrl.nfs:
            144 lookup fh 9,74/4096.6878 "xcolors"
       wrl.nfs > sushi.201b:
            reply ok 128 lookup fh 9,74/4134.3150
```

In the first line, host sushi sends a transaction with id 6709 to wrl (note that the number following the src host is a transaction id, not the source port). The request was 112 bytes, excluding the UDP and IP headers. The operation was a readlink (read symbolic link) on file handle (fh) 21,24/10.731657119. (If one is lucky, as in this case, the file handle can be interpreted as a major,minor device number pair, followed by the inode number and generation number.) Wrl replies `ok' with the contents of the link.

In the third line, sushi asks wrl to lookup the name `xcolors' in directory file 9,74/4096.6878. Note that the data printed depends on the operation type. The format is intended to be self explanatory if read in conjunction with an NFS protocol spec.

If the -v (verbose) flag is given, additional information is printed. For example:

```
       sushi.1372a > wrl.nfs:
            148 read fh 21,11/12.195 8192 bytes @ 24576
       wrl.nfs > sushi.1372a:
            reply ok 1472 read REG 100664 ids 417/0 sz 29388
```

(-v also prints the IP header TTL, ID, length, and fragmentation fields, which have been omitted from this example.) In the first line, sushi asks wrl to read 8192 bytes from file 21,11/12.195, at byte off-set 24576. Wrl replies `ok'; the packet shown on the second line is the first fragment of the reply, and hence is only 1472 bytes long (the other bytes will follow in subsequent fragments, but these fragments do not have NFS or even UDP headers and so might not be printed, depending on the filter expression used). Because the -v flag is given, some of the file attributes (which are returned in addition to the file data) are printed: the file type (``REG'', for regular file), the file mode (in octal), the uid and gid, and the file size.

If the -v flag is given more than once, even more details are printed.

Note that NFS requests are very large and much of the detail won't be printed unless snaplen is increased. Try using `-s 192' to watch NFS traffic.

NFS reply packets do not explicitly identify the RPC operation. Instead, tcpdump keeps track of ``recent'' requests, and matches them to the replies using the transaction ID. If a reply does not closely follow the corresponding request, it might not be parsable.

AFS Requests and Replies

Transarc AFS (Andrew File System) requests and replies are printed as:

```
       src.sport > dst.dport: rx packet-type
       src.sport > dst.dport: rx packet-type service call call-name args
       src.sport > dst.dport: rx packet-type service reply call-name args

       elvis.7001 > pike.afsfs:
            rx data fs call rename old fid 536876964/1/1 ".newsrc.new"
            new fid 536876964/1/1 ".newsrc"
       pike.afsfs > elvis.7001: rx data fs reply rename
```
In the first line, host elvis sends a RX packet to pike. This was a RX data packet to the fs (fileserver) service, and is the start of an RPC call. The RPC call was a rename, with the old directory file id of 536876964/1/1 and an old filename of `.newsrc.new', and a new directory file id of 536876964/1/1 and a new filename  of  `.newsrc'.   The host pike responds with a RPC reply to the rename call (which was success-ful, because it was a data packet and not an abort packet).

In general, all AFS RPCs are decoded at least by RPC call name.   Most AFS RPCs have at least some of the arguments decoded (generally only the `interesting' arguments, for some definition of interesting).

The format is intended to be self-describing, but it will probably not be useful to people who are not familiar with the workings of AFS and RX.

If the -v (verbose) flag is given twice, acknowledgement packets and additional header information is printed, such as the the RX call ID, call number, sequence number, serial number, and the RX packet flags.

If the -v flag is given twice, additional information is printed, such as the the RX call ID, serial number, and the RX packet flags. The MTU negotiation information is also printed from RX ack packets.

If the -v flag is given three times, the security index and service id are printed.

Error codes are printed for abort packets, with the exception of Ubik beacon packets (because abort packets are used to signify a yes vote for the Ubik protocol).

Note that AFS requests are very large and many of the arguments won't be printed unless snaplen is increased. Try using `-s 256' to watch AFS traffic.

AFS reply packets do not explicitly identify the RPC operation. Instead, tcpdump keeps track of ``recent'' requests, and matches them to the replies using the call number and service ID. If a reply does not closely follow the corresponding request, it might not be parsable.

KIP Appletalk (DDP in UDP)

Appletalk DDP packets encapsulated in UDP datagrams are de-encapsulated and dumped as DDP packets (i.e., all the UDP header information is dis-carded).   The file /etc/atalk.names is used to translate appletalk net and node numbers to names. Lines in this file have the form
```
       number    name

       1.254          ether
       16.1      icsd-net
       1.254.110 ace
```
The first two lines give the names of appletalk networks.   The third line gives the name of a particular host (a host is distinguished from a net by the 3rd octet in the number - a net number must have two octets and a host number must have three octets.) The number and name should be   separated   by   whitespace   (blanks   or   tabs).   The /etc/atalk.names file may contain blank lines or comment lines (lines starting with a `#').

Appletalk addresses are printed in the form
```
       net.host.port

       144.1.209.2 > icsd-net.112.220
       office.2 > icsd-net.112.220
       jssmag.149.235 > icsd-net.2
```
(If the /etc/atalk.names doesn't exist or doesn't contain an entry for some appletalk host/net number, addresses are printed in numeric form.) In the first example, NBP (DDP port 2) on net 144.1 node 209 is sending to whatever is listening on port 220 of net icsd node 112. The second line is the same except the full name of the source node is known (`office').   The third line is a send from port 235 on net jssmag node 149 to broadcast on the icsd-net NBP port (note that the broadcast address (255) is indicated by a net name with no host number - for this reason it's a good idea to keep node names and net names distinct in /etc/atalk.names).

NBP (name binding protocol) and ATP (Appletalk transaction protocol) packets have their contents interpreted. Other protocols just dump the protocol name (or number if no name is registered for the protocol) and packet size.

NBP packets are formatted like the following examples:
```
       icsd-net.112.220 > jssmag.2: nbp-lkup 190: "=:LaserWriter@*"
       jssmag.209.2 > icsd-net.112.220: nbp-reply 190: "RM1140:LaserWriter@*" 250
       techpit.2 > icsd-net.112.220: nbp-reply 190: "techpit:LaserWriter@*" 186
```
The first line is a name lookup request for laserwriters sent by net icsd host 112 and broadcast on net jssmag. The nbp id for the lookup is 190. The second line shows a reply for this request (note that it has the same id) from host jssmag.209 saying that it has a laserwriter resource named "RM1140" registered on port 250. The third line is another reply to the same request saying host techpit has laserwriter "techpit" registered on port 186.

ATP packet formatting is demonstrated by the following example:
```
       jssmag.209.165 > helios.132: atp-req  12266<0-7> 0xae030001
       helios.132 > jssmag.209.165: atp-resp 12266:0 (512) 0xae040000
       helios.132 > jssmag.209.165: atp-resp 12266:1 (512) 0xae040000
       helios.132 > jssmag.209.165: atp-resp 12266:2 (512) 0xae040000
       helios.132 > jssmag.209.165: atp-resp 12266:3 (512) 0xae040000
       helios.132 > jssmag.209.165: atp-resp 12266:4 (512) 0xae040000
       helios.132 > jssmag.209.165: atp-resp 12266:5 (512) 0xae040000
       helios.132 > jssmag.209.165: atp-resp 12266:6 (512) 0xae040000
       helios.132 > jssmag.209.165: atp-resp*12266:7 (512) 0xae040000
       jssmag.209.165 > helios.132: atp-req  12266<3,5> 0xae030001
       helios.132 > jssmag.209.165: atp-resp 12266:3 (512) 0xae040000
       helios.132 > jssmag.209.165: atp-resp 12266:5 (512) 0xae040000
       jssmag.209.165 > helios.132: atp-rel  12266<0-7> 0xae030001
       jssmag.209.133 > helios.132: atp-req* 12267<0-7> 0xae030002
```
Jssmag.209 initiates transaction id 12266 with host helios by request- ing up to 8 packets (the `<0-7>'). The hex number at the end of the line is the value of the `userdata' field in the request.

Helios responds with 8 512-byte packets. The `:digit' following the transaction id gives the packet sequence number in the transaction and the number in parens is the amount of data in the packet, excluding the atp header. The `*' on packet 7 indicates that the EOM bit was set.

Jssmag.209 then requests that packets 3 & 5 be retransmitted. Helios resends them then jssmag.209 releases the transaction. Finally, jss- mag.209 initiates the next request. The `*' on the request indicates that XO (`exactly once') was not set.

IP Fragmentation

Fragmented Internet datagrams are printed as
```
       (frag id:size@offset+)
       (frag id:size@offset)
```
(The first form indicates there are more fragments. The second indi- cates this is the last fragment.)

Id is the fragment id. Size is the fragment size (in bytes) excluding the IP header. Offset is this fragment's offset (in bytes) in the original datagram.

The fragment information is output for each fragment. The first frag- ment contains the higher level protocol header and the frag info is printed after the protocol info. Fragments after the first contain no higher level protocol header and the frag info is printed after the source and destination addresses. For example, here is part of an ftp from arizona.edu to lbl-rtsg.arpa over a CSNET connection that doesn't appear to handle 576 byte datagrams:
```
       arizona.ftp-data > rtsg.1170: . 1024:1332(308) ack 1 win 4096 (frag 595a:328@0+)
       arizona > rtsg: (frag 595a:204@328)
       rtsg.1170 > arizona.ftp-data: . ack 1536 win 2560
```
There are a couple of things to note here: First, addresses in the 2nd line don't include port numbers. This is because the TCP protocol information is all in the first fragment and we have no idea what the port or sequence numbers are when we print the later fragments. Sec- ond, the tcp sequence information in the first line is printed as if there were 308 bytes of user data when, in fact, there are 512 bytes (308 in the first frag and 204 in the second). If you are looking for holes in the sequence space or trying to match up acks with packets, this can fool you.

```
       A  packet  with  the  IP  don't fragment flag is marked with a trailing
       (DF).

       Timestamps

       By default, all output lines are preceded by a timestamp.   The  times-
       tamp is the current clock time in the form
              hh:mm:ss.frac
       and  is  as accurate as the kernel's clock.  The timestamp reflects the
       time the kernel first saw the packet.  No attempt is  made  to  account
       for the time lag between when the ethernet interface removed the packet
       from the wire and when the kernel serviced the `new packet'  interrupt.

SEE ALSO
       traffic(1C), nit(4P), bpf(4), pcap(3)

AUTHORS
       The original authors are:

       Van  Jacobson,  Craig  Leres  and  Steven  McCanne, all of the Lawrence
       Berkeley National Laboratory, University of California, Berkeley, CA.

       It is currently being maintained by tcpdump.org.

       The current version is available via http:

              http://www.tcpdump.org/

       The original distribution is available via anonymous ftp:

              ftp://ftp.ee.lbl.gov/tcpdump.tar.Z

       IPv6/IPsec support is added by WIDE/KAME project.   This  program  uses
       Eric Young's SSLeay library, under specific configuration.
```

NGREP

```
NGREP(8)                         User Manuals                          NGREP(8)



NAME
       ngrep - network grep


SYNOPSIS
       ngrep  <-hNXViwqpevxlDtTRM> <-IO pcap_dump > < -n num > < -d dev > < -A
       num > < -s snaplen > < -S limitlen > < -W normal|byline|single|none > <
       -c cols > < -P char > < -F file > < match expression > < bpf filter >


DESCRIPTION
       ngrep  strives  to provide most of GNU grep’s common features, applying
       them to the network layer.  ngrep is a pcap-aware tool that will  allow
       you  to specify extended regular expressions to match against data pay-
       loads of packets.  It currently recognizes TCP,  UDP  and  ICMP  across
       Ethernet, PPP, SLIP, FDDI and null interfaces, and understands bpf fil-
       ter logic in the same fashion as more  common  packet  sniffing  tools,
       such as tcpdump(8) and snoop(1).



OPTIONS
       -h     Display help/usage information.


       -N     Show  sub-protocol number along with single-character identifier
              (useful when observing raw or unknown protocols).


       -X     Treat the match expression as a  hexadecimal  string.   See  the
              explanation of match expression below.


       -V     Display version information.


       -i     Ignore case for the regex expression.


       -w     Match the regex expression as a word.


       -q     Be quiet; don’t output any information other than packet headers
              and their payloads (if relevant).


       -p     Don’t put the interface into promiscuous mode.


       -e     Show  empty  packets.   Normally  empty  packets  are  discarded
              because  they  have  no  payload to search.  If specified, empty
              packets will be shown, regardless of the specified regex expres-
              sion.


       -v     Invert the match; only display packets that don’t match.


       -x     Dump packet contents as hexadecimal as well as ASCII.


       -l     Make stdout line buffered.


       -D     When reading pcap_dump files, replay them at their recorded time
              intervals (mimic realtime).


       -t     Print a timestamp in  the  form  of  YYYY/MM/DD  HH:MM:SS.UUUUUU
              everytime a packet is matched.
```

```
-T     Print a timestamp in the form of +S.UUUUUU, indicating the delta
       between packet matches.


-R     Do not try to drop privileges to the DROPPRIVS_USER.

       ngrep makes no effort to validate input  from  live  or  offline
       sources  as it is focused more on performance and handling large
       amounts of data than protocol correctness, which is most often a
       fair assumption to make.  However, sometimes it matters and thus
       as a rule ngrep will try to be defensive and drop any root priv-
       ileges it might have.

       There  exist scenarios where this behaviour can become an obsta-
       cle, so this option is provided to end-users who want to disable
       this feature, but must do so with an understanding of the risks.
       Packets can be randomly malformed or even specifically  designed
       to overflow sniffers and take control of them, and revoking root
       privileges is currently the only risk mitigation  ngrep  employs
       against such an attack.  Use this option and turn it off at your
       own risk.


-c cols
       Explicitly set the console width to ``cols''.  Note that this is
       the  console  width, and not the full width of what ngrep prints
       out as payloads; depending on the output mode  ngrep  may  print
       less than ``cols'' bytes per line (indentation).


-F file
       Read  in  the bpf filter from the specified filename.  This is a
       compatibility option for users familiar  with  tcpdump.   Please
       note  that specifying ``-F'' will override any bpf filter speci-
       fied on the command-line.


-P char
       Specify an alternate character to signify non-printable  charac-
       ters when displayed.  The default is ``.''.


-W normal|byline|single|none
       Specify  an alternate manner for displaying packets, when not in
       hexadecimal mode.  The ``byline''  mode  honors  embedded  line-
       feeds,  wrapping  text only when a linefeed is encountered.  The
       ``none'' mode doesn't wrap under any circumstance  (entire  pay-
       load  is displayed on one line).  The ``single'' mode is concep-
       tually the same as ``none'', except that everything including IP
       and  source/destination  header  information is all on one line.
       ``normal'' is the default mode and is  only  included  for  com-
       pleteness.  This option is incompatible with ``-x''.


-s snaplen
       Set the bpf caplen to snaplen (default 65536).


-S limitlen
       Set  the upper limit on the size of packets that ngrep will look
       at.  Useful for looking at only the first  N  bytes  of  packets
       without changing the BPF snaplen.


-I pcap_dump
       Input file pcap_dump into ngrep.  Works with any pcap-compatible
       dump file format.  This option is useful  for  searching  for  a
       wide range of different patterns over the same packet stream.


-O pcap_dump
       Output  matched  packets  to  a pcap-compatible dump file.  This
       feature does not interfere with normal output to stdout.
```

```
-n num Match only num packets total, then exit.


-d dev By default ngrep will select a default interface to  listen  on.
       Use this option to force ngrep to listen on interface dev.


-A num Dump num packets of trailing context after matching a packet.


-W normal|byline|none
       Alter the method by which ngrep displays packet payload.  ''nor-
       mal'' mode  represents  the  standard  behaviour,   ''byline''
       instructs  ngrep  to  respect  embedded  linefeeds  (useful  for
       observing HTTP transactions, for instance), and ''none'' results
       in  the payload on one single line (useful for scripted process-
       ing of ngrep output).


-c cols
       Ignore the detected terminal width and force the column width to
       the specified size.


-P char
       Change the non-printable character from the default ''.'' to the
       character specified.


 match expression
       A match expression is either an extended regular expression,  or
       if the -X option is specified, a string signifying a hexadecimal
       value.  An extended regular  expression  follows  the  rules  as
       implemented  by  the GNU regex library.  Hexadecimal expressions
       can optionally be preceded by '0x'.  E.g., 'DEADBEEF',  '0xDEAD-
       BEEF'.


 bpf filter
       Selects a filter that specifies what packets will be dumped.  If
       no bpf filter is given, all IP  packets  seen  on  the  selected
       interface will be dumped.  Otherwise, only packets for which bpf
       filter is 'true' will be dumped.

The bpf filter consists of one or more primitives.  Primitives  usually
consist  of  an id (name or number) preceded by one or more qualifiers.
There are three different kinds of qualifier:

type   qualifiers say what kind of thing the id name or  number  refers
       to.  Possible types are host, net and port.  E.g., 'host blort',
       'net 1.2.3', 'port 80'.  If there is no type qualifier, host  is
       assumed.

dir    qualifiers  specify  a  particular  transfer direction to and/or
       from id.  Possible directions are src, dst, src or dst  and  src
       and  dst.   E.g.,  'src  foo', 'dst net 1.2.3', 'src or dst port
       ftp-data'.  If there is no dir qualifier, src or dst is assumed.
       For  'null'  link  layers (i.e. point to point protocols such as
       slip) the inbound and outbound qualifiers can be used to specify
       a desired direction.

proto  qualifiers are restricted to ip-only protocols.  Possible protos
       are: tcp , udp and icmp.  e.g., 'udp src foo' or 'tcp port  21'.
       If  there  is  no proto qualifier, all protocols consistent with
       the type are assumed.  E.g., 'src foo' means 'ip  and  ((tcp  or
       udp)  src  foo)',  'net bar' means 'ip and (net bar)', and 'port
       53' means 'ip and ((tcp or udp) port 53)'.

In addition to the above, there are some special  'primitive'  keywords
that  don't  follow  the pattern: gateway, broadcast, less, greater and
arithmetic expressions.  All of these are described below.

More complex filter expressions are built up by using the words and, or
and  not to combine primitives.  E.g., 'host blort and not port ftp and
not port ftp-data'.  To save typing, identical qualifier lists  can  be
omitted.  E.g., 'tcp dst port ftp or ftp-data or domain' is exactly the
same as 'tcp dst port ftp or tcp dst port  ftp-data  or  tcp  dst  port
```

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domain’.

Allowable primitives are:


dst host host
       True  if  the  IP destination field of the packet is host, which
       may be either an address or a name.


src host host
       True if the IP source field of the packet is host.


host host
       True if either the IP source or destination  of  the  packet  is
       host.   Any  of the above host expressions can be prepended with
       the keywords, ip, arp, or rarp as in:
            ip host host
       which is equivalent to:



ether dst ehost
       True if the ethernet destination address is ehost.  Ehost may be
       either  a  name from /etc/ethers or a number (see ethers(3N) for
       numeric format).

ether src ehost
       True if the ethernet source address is ehost.

ether host ehost
       True if either the ethernet source  or  destination  address  is
       ehost.


gateway host
       True  if  the packet used host as a gateway.  I.e., the ethernet
       source or destination address was host but neither the IP source
       nor  the  IP destination was host.  Host must be a name and must
       be found in both /etc/hosts  and  /etc/ethers.   (An  equivalent
       expression is
            ether host ehost and not host host
       which  can  be  used  with  either  names  or numbers for host /
       ehost.)


dst net net
       True if the IP destination address of the packet has  a  network
       number  of net. Net may be either a name from /etc/networks or a
       network number (see networks(4) for details).


src net net
       True if the IP source address of the packet has a network number
       of net.


net net
       True  if  either  the  IP  source  or destination address of the
       packet has a network number of net.


net net mask mask
       True if the IP address matches net with  the  specific  netmask.
       May be qualified with src or dst.


net net/len
       True if the IP address matches net a netmask len bits wide.  May
       be qualified with src or dst.


dst port port
       True if the packet is ip/tcp or ip/udp  and  has  a  destination
       port  value of port.  The port can be a number or a name used in
       /etc/services (see tcp(4P) and udp(4P)).  If  a  name  is  used,
       both  the  port number and protocol are checked.  If a number or
       ambiguous name is used, only the port number is  checked  (e.g.,
       dst port 513 will print both tcp/login traffic and udp/who traf-
       fic, and port domain will print both tcp/domain  and  udp/domain
       traffic).


src port port
       True if the packet has a source port value of port.


port port
       True  if  either the source or destination port of the packet is
       port.  Any of the above port expressions can be  prepended  with
       the keywords, tcp or udp, as in:
            tcp src port port
       which matches only tcp packets whose source port is port.


less length
       True  if  the  packet has a length less than or equal to length.
       This is equivalent to:
            len <= length.


greater length
       True if the packet has a length greater than or equal to length.
       This is equivalent to:
            len >= length.


ip proto protocol
       True if the packet is an ip packet (see ip(4P)) of protocol type
       protocol.  Protocol can be a number or one of the names tcp, udp
       or  icmp.   Note  that the identifiers tcp and udp are also key-
       words and must be escaped via backslash (\), which is \\ in  the
       C-shell.


ip broadcast
       True  if  the  packet  is an IP broadcast packet.  It checks for
       both the all-zeroes  and  all-ones  broadcast  conventions,  and
       looks up the local subnet mask.


ip multicast
       True if the packet is an IP multicast packet.


ip     Abbreviation for:
            ether proto ip

tcp, udp, icmp
       Abbreviations for:
            ip proto p
       where p is one of the above protocols.

expr relop expr
       True  if the relation holds, where relop is one of >, <, >=, <=,
       =, !=, and expr is an arithmetic expression composed of  integer
       constants  (expressed  in  standard C syntax), the normal binary
       operators [+, -, *, /, &, |], a  length  operator,  and  special
       packet  data  accessors.   To access data inside the packet, use
       the following syntax:
            proto [ expr : size ]
       Proto is one of ip, tcp, udp or icmp, and indicates the protocol
       layer for the index operation.  The byte offset, relative to the
       indicated protocol layer, is given by expr.   Size  is  optional
       and  indicates  the number of bytes in the field of interest; it
       can be either one, two, or  four,  and  defaults  to  one.   The
       length  operator, indicated by the keyword len, gives the length
       of the packet.

       For example, 'ether[0] & 1 != 0' catches all multicast  traffic.
       The  expression  'ip[0]  & 0xf != 5' catches all IP packets with
       options. The expression 'ip[6:2] &  0x1fff  =  0'  catches  only
       unfragmented  datagrams  and  frag zero of fragmented datagrams.
```

```
              This check is implicitly applied to the tcp and udp index opera-
              tions.   For instance, tcp[0] always means the first byte of the
              TCP header, and never means the first  byte  of  an  intervening
              fragment.

       Primitives may be combined using:

              A  parenthesized  group of primitives and operators (parentheses
              are special to the Shell and must be escaped).

              Negation (‘!’ or ‘not’).

              Concatenation (‘&&’ or ‘and’).

              Alternation (‘||’ or ‘or’).

       Negation has highest precedence.  Alternation  and  concatenation  have
       equal  precedence  and associate left to right.  Note that explicit and
       tokens, not juxtaposition, are now required for concatenation.

       If an identifier is given without a keyword, the most recent keyword is
       assumed.  For example,
            not host vs and ace
       is short for
            not host vs and host ace
       which should not be confused with
            not ( host vs or ace )

       Expression arguments can be passed to ngrep as either a single argument
       or as multiple arguments, whichever is more convenient.  Generally,  if
       the  expression  contains Shell metacharacters, it is easier to pass it
       as a single, quoted argument.  Multiple arguments are concatenated with
       spaces before being parsed.


DIAGNOSTICS
       Errors from ngrep, libpcap, and the GNU regex library are all output to
       stderr.


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REPORTING BUGS
       Please report bugs to the ngrep’s Sourceforge Bug Tracker, located at

           http://sourceforge.net/projects/ngrep/

       Non-bug, non-feature-request general feedback should  be  sent  to  the
       author directly by email.

*nux                                June 2005                          NGREP(8)
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