TCPdump(1)

NAME

```
   tcpdump - dump traffic on a network
```

SYNOPSIS

```
   tcpdump [ -deflnNOpqStvx ] [ -c count ] [ -F file ]
           [ -i interface ] [ -r file ] [ -s snaplen ]
           [ -w file ] expression
```

DESCRIPTION

Tcpdump prints out the headers of packets on a network interface that match the boolean *expression*. Under SunOS: You must be root to invoke *tcpdump* or it must be installed setuid to root. Under Ultrix: Any user can invoke *tcpdump* once the super-user has enabled promiscuous-mode operation using `pfconfig(8)`. Under BSD: Access is controlled by the permissions on `/dev/bpf0`, etc.

OPTIONS

-c *count*
Exit after receiving *count* packets.

-d
Dump the compiled packet-matching code to standard output and stop.

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

-f
Print `foreign' internet addresses numerically rather than symbolically (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 *file*
Use *file* as input for the filter expression. An additional *expression* given on the command line is ignored.

-i *interface*
Listen on *interface*. If unspecified, tcpdump searches the system interface list for the lowest numbered, configured up interface (excluding loopback). Ties are broken by choosing the earliest match.

-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''.

-n
Don't convert addresses (i.e., host addresses, port numbers, etc.) to names.

-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 for some other reason; hence, `-p' cannot be used as an abbreviation for `ether host {localhost} or broadcast`.

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

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

-s *snaplen*
Snarf *snaplen* bytes of data from each packet rather than the default of 68 (with 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 capture the protocol information you're interested in.

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

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

-tt
Print an unformatted timestamp on each dump line.

-v
(Slightly more) verbose output. For example, the time to live and type of service information in an IP packet is printed.

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

-w *file*
Write the raw packets to *file* rather than parsing and printing them out. They can later be printed with the -r option. Standard 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.

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 tranfer 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 qualifier, src or dst is assumed.

proto qualifiers restrict the match to a particular protocol. Possible protos are: ether, fddi, ip, arp, rarp, decnet, lat, moprc, mopdl, 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 specified 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 contain other fields, but you cannot name them explicitly in a filter expression.]

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 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 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 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, which may be either an address or a name.

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.

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 traffic, 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.

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 icmp, udp, nd, 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.

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 conventions, 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`

Trueif the packet is an IP multicast packet.

`ether proto` *protocol*

True if the packet is of ether type protocol. Protocol can be a number or a name like ip, arp, or rarp. Note these identifiers are also keywords and must be escaped via backslash (\). [In the case of FDDI (e.g., `fddi protocol arp'), the protocol identification comes from the 802.2 Logical Link Control (LLC) header, which is usually layered on top of the FDDI header. tcpdump assumes, when filtering on the protocol identifier, that all FDDI packets include an LLC header, and that the LLC header is in so-calledSNAPformat.]

`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`, `arp`, `rarp`, `decnet`

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.

`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 ether, fddi, ip, arp, rarp, 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 operations. 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 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-localhost.

```
   tcpdump 'tcp[13] & 3 != 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[0] != 8 and icmp[0] != 0"
```

OUTPUTFORMAT

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.

(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 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.

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 ucb-vax.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, name server or authority 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 authority 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 96 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.

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, 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 offset 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 parseble.

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 discarded). 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 requesting 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, jssmag.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 indicates 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 fragment 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. Second, 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 timestamp is the current clock time in the form

```
   hh:mm:ss.frac
```

and is as accurate as the kernel's clock (e.g, +-10ms on a Sun-3). 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 (of course, with Sun's lousy clock resolution this time lag is negligible.)

SEE ALSO

```
      traffic(1C), nit(4P), bpf(4)
```

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BUGS

The clock resolution on most Suns is pathetic (20ms). If you want to use the timestamp to generate some of the important performance distributions (like packet interarrival time) it's best to watch something that generates packets slowly (like an Arpanet gateway or a MicroVax running VMS).

NIT doesn't let you watch your own outbound traffic, BPF will. We recommend that you use the latter.

tcpdump for Ultrix requires Ultrix version 4.0 or later; the kernel has to have been built with the packetfilter pseudo-device driver (see packetfilter(4)). In order to watch either your own outbound or inbound traffic, you will need to use Ultrix version 4.2 or later, and you will have to have used the pfconfig(8) command to enable ``copyall'' mode.

Under SunOS 4.1, the packet capture code (or Streams NIT) is not what you'd call efficient. Don't plan on doing much with your Sun while you're monitoring a busy network.

On Sun systems prior to release 3.2, NIT is very buggy. If run on an old system, tcpdump may crash the machine.

Some attempt should be made to reassemble IP fragments or, at least to compute the right length for the higher level protocol.

Name server inverse queries are not dumped correctly: The (empty) question section is printed rather than real query in the answer section. Some believe that inverse queries are themselves a bug and prefer to fix the program generating them rather than tcpdump.

Apple Ethertalk DDP packets could be dumped as easily as KIP DDP packets but aren't. Even if we were inclined to do anything to promote the use of Ethertalk (we aren't), LBL doesn't allow Ethertalk on any of its networks so we'd would have no way of testing this code.

A packet trace that crosses a daylight savings time change will give skewed time stamps (the time change is ignored).

Filters expressions that manipulate FDDI headers assume that all FDDI packets are encapsulated Ethernet packets. This is true for IP, ARP, and DECNET Phase IV, but is not true for protocols such as ISO CLNS. Therefore, the filter may inadvertently accept certain packets that do not properly match the filter expression.