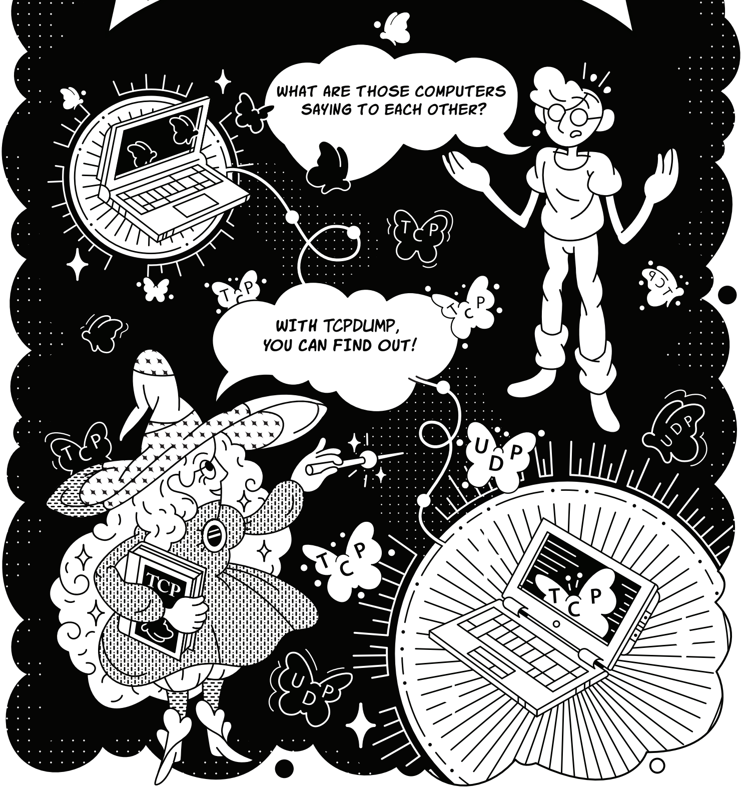
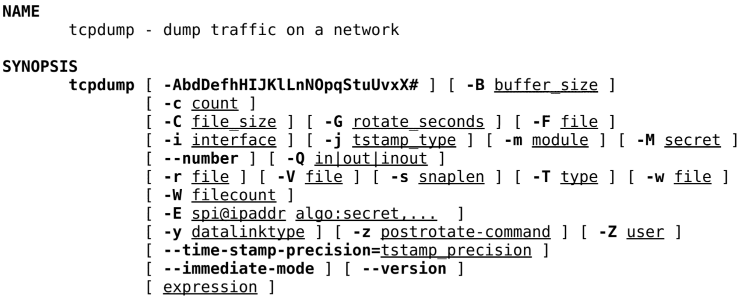
let's learn tcpdump

by Julia Evans


WHAT ARE THOSE COMPUTERS SAYING TO EACH OTHER?
WITH TCPDUMP, YOU CAN FIND OUT!
TCP
UDP
TCP
UDP

what's this?

The man page for tcpdump starts like this:



```
NAME
       tcpdump - dump traffic on a network

SYNOPSIS
       tcpdump [ -AbdDefhHIJKlLnNOpqStuUvxX# ] [ -B buffer_size ]
               [ -c count ]
               [ -C file_size ] [ -G rotate_seconds ] [ -F file ]
               [ -i interface ] [ -j tstamp_type ] [ -m module ] [ -M secret ]
               [ --number ] [ -Q in|out|inout ]
               [ -r file ] [ -V file ] [ -s snaplen ] [ -T type ] [ -w file ]
               [ -W filecount ]
               [ -E spi@ipaddr algo:secret,...  ]
               [ -y datalinktype ] [ -z postrotate-command ] [ -Z user ]
               [ --time-stamp-precision=tstamp_precision ]
               [ --immediate-mode ] [ --version ]
               [ expression ]
```

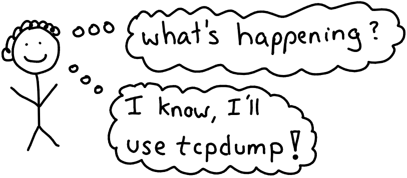
that is SO MANY options omg
it's ok! you only need to know like 3!
I'm going to tell you why I ♡ tcpdump and how to get started!

↑
JULIA EVANS
@b0rk
http://jvns.ca
↗
my blog!

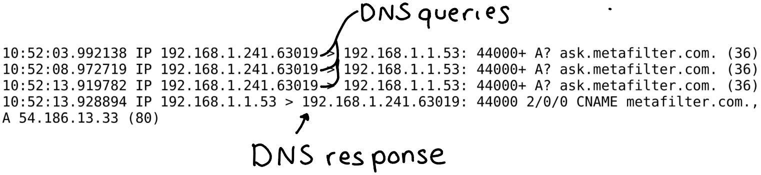
What is tcpdump for?

tcpdump captures network traffic and prints it out for you.

For example! Yesterday DNS lookups on my laptop were slow



$ sudo tcpdump -n -i any port 53



```
10:52:03.992138 IP 192.168.1.241.63019 > 192.168.1.1.53: 44000+ A? ask.metafilter.com. (36)
10:52:08.972719 IP 192.168.1.241.63019 > 192.168.1.1.53: 44000+ A? ask.metafilter.com. (36)
10:52:13.919782 IP 192.168.1.241.63019 > 192.168.1.1.53: 44000+ A? ask.metafilter.com. (36)
10:52:13.928894 IP 192.168.1.1.53 > 192.168.1.241.63019: 44000 2/0/0 CNAME metafilter.com.,
A 54.186.13.33 (80)
```

This means that there were 3 DNS queries (at 10:52:03, 10:52:08, 10:52:13), but only the 3rd one got a response!

I figured my router was probably the problem, I restarted it, and my internet was fast again!

Let's learn how to debug problems with tcpdump!

Questions you can answer with tcpdump

→ what DNS queries is my laptop sending?

"tcpdump -i any port 53"

→ I have a server running on port 1337. Are any packets arriving at that port at ALL???

"tcpdump -i any port 1337"

→ What packets are coming into my server from IP 1.2.3.4?

"tcpdump port 1337 and host 1.2.3.4"

→ show me all DNS queries that fail

"tcpdump udp[11]&0xf==3"

(complicated but it works!)

→ how long are the TCP connections on this box lasting right now?

"tcpdump -w packets.pcap"

and analyze packets.pcap in Wireshark

what tcpdump output means

Every line of tcpdump output represents a packet.

The parts I usually pay attention to are:

- ★ source + dest IP address and port
- ★ timestamp
- ★ which TCP flags (good for spotting the beginning of a TCP connection)
- ★ the DNS query, for DNS packets
- ★ that's it!

UDP packet:

timestamp

source IP

port

dest IP (my router)

port

```
10:52:03.992138 IP 192.168.1.241.63019 > 192.168.1.1.53: 44000+
A? ask.metafilter.com. (36)
```

DNS query ID

DNS query

TCP packet:

TCP flags "." means ACK

```
11:36:26.353797 IP 192.168.1.241.45296 > 192.241.182.146.443: Flags [.],
ack 2291349910, win 319, options [nop,nop,TS val 10967552 ecr 580196754],
 length 0
```

Ever seen a "Connection refused' error? Here's what that looks like in tcpdump!

SYN

```
12:16:38.944390 IP6 localhost.48680 > localhost.8999: Flags [S]
12:16:38.944458 IP6 localhost.8999 > localhost.48680: Flags [R.]
```

RST

ACK

We sent a SYN to open the connection but the server replied with a "RST" packet. That gets translated to "connection refused".

BPF filters!

tcpdump uses a small language called BPF to let you filter packets.

When you run $ sudo tcpdump port 53, "port 53" is a BPF filter. Here's a quick guide!

→ port 53

checks if the source port OR the dest port is 53. Matches TCP port 53 and UDP port 53.

→ host 192.168.3.2

checks if the source or dest IP is 192.168.3.2

→ host 11.22.33.44 and port 80

you can use 'and', 'or', and 'not'

→ src port 80

→ dest port 80

→ tcp port 80

are what they look like ☺

so are
src host 1.2.3.4
dest host 1.2.3.4

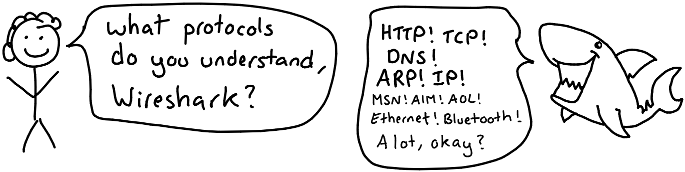
→ udp[11]&0xf==3

you can do bit math like this on packet contents. This checks for the DNS response code "NXDOMAIN"!

(I googled to find this and it works! ☺)

♡ Wireshark ♡

Wireshark is an incredibly powerful packet analysis tool!


what protocols do you understand, Wireshark?
HTTP! TCP! DNS! ARP! IP! MSN! AIM! AOL! Ethernet! Bluetooth! A lot, okay?

Things Wireshark has:

- ★ nice graphical interface!
- ★ it can connect TCP packets from the same connection!
- ★ search through your packets easily!

If you want to analyze packets from tcpdump with Wireshark, you can either:

① save a .pcap file and open it with Wireshark

② use this incantation to pipe tcpdump output into Wireshark!

```
ssh some.remote.host tcpdump -pni any -w - -s0 -U port 8888
    | wireshark -k -i -
```

my ♡ favourite ♡ command line arguments

I use these 3 arguments the most:

-i

is for interface

Which network interface to capture packets on. I often use `-i any`. The default interface tcpdump picks isn't always what you want.

Example: `sudo tcpdump -i lo` shows you packets on the local "loopback" interface.

-w

is for write

Instead of printing out packets, write them to a file! This is VERY USEFUL for analyzing the packets later. I use it all the time

Example:

```
sudo tcpdump host 8.8.8.8
                  -w my_packets.pcap
```

saves packets to/from 8.8.8.8 to a file

-c

is for count

When writing to a file, be careful! You don't want to accidentally fill up your hard drive. `-c 10000` will only capture 10,000 packets.

Example:

```
sudo tcpdump -c 1000
             -w my_packets.pcap
             dest port 8080
```

and here are a few more good ones:

-A

This prints out the packet's contents! For example, suppose I have a webserver on port 7777.

```
$ sudo tcpdump -A dest port 7777
```

will show me all the HTTP requests being sent to that server. Only works for HTTP, not HTTPS.

(I like ngrep more than tcpdump -A for looking at HTTP request bodies though ☺)

-n

By default, tcpdump will translate IP addresses to hostnames. -n forces it to just always print out the IP address

-e

is for ethernet

Includes Ethernet information! This shows you the MAC address that the packet came from

Example:
```
sudo tcpdump -e -i any
                port 443
```

-p

makes sure you only get packets that are to or from your computer

network administration tools

Finally, there are a lot more tools than tcpdump! We won't explain them here but here's a list!

ping

"are these computers even connected?"

dig/nslookup

"does that domain exist?"

netstat/ss

"am I using that port?"

ifconfig

"what's my IP address?"

ip

configures interfaces, routes, and more. Successor to ifconfig.

arp

see your ARP table!

ngrep

grep for your network

traceroute/mtr

what servers are on the way to that server?

nc

netcat! Make TCP connections manually!

nftables/iptables

set up firewalls and NAT!

sysctl

configure socket buffer sizes, and more!

ethtool

understand your ethernet connections

nmap

in ur network
scanning ur ports

whois

look up a
domain

lsof

what ports
are being used?

telnet

see if a port on
nother server
a is open

ssh

can't forget
this one ☺

sysctl

configure socket
buffer sizes, and more!

network manager

GUI tool to configure
the network on your
laptop

nethogs/ab/nload iptraf/netperf/iperf iftop/netsniff-ng

lots of performance/
benchmarking tools
(they all do different things)

paping

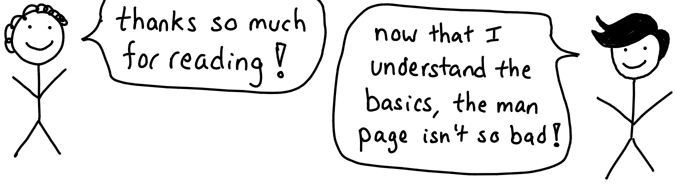
ping, but it
uses TCP

OpenVpn

set up a
VPN!

socat

like netcat,
but more
featureful


thanks so much for reading!
now that I understand the basics, the man page isn't so bad!

like this?
there are more
zines at:
http://jvns.ca/zines

Julia Evans, wizard industries 2017