A tcpdump Tutorial with Examples — 50 Ways to Isolate Traffic

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TCPDUMP is without question the *premier network analysis tool* because it provides both power and simplicity in one interface.

THE TCP HEADER

This tutorial will show you how to isolate traffic in various ways—from IP, to port, to protocol, to application-layer traffic—to make sure you find exactly what you need as quickly as possible.

MY OTHER TUTORIALS

tcpdump is the tool everyone should learn as their base for packet analysis.

Let's start with a basic command that will get us HTTPS traffic:

```
tcpdump -nnSX port 443
```

```
04:45:40.573686 IP 78.149.209.110.27782 > 172.30.0.144.443: Flags [.], ack
278239097, win 28, options [nop,nop,TS val 939752277 ecr 1208058112], length 0
   0x0000:  4500 0034 0014 0000 2e06 c005 4e8e d16e  E..4........N..n
   0x0010:  ac1e 0090 6c86 01bb 8e0a b73e 1095 9779  ....l......>...y
   0x0020:  8010 001c d202 0000 0101 080a 3803 7b55  ............8.{U
   0x0030:  4801 8100
```

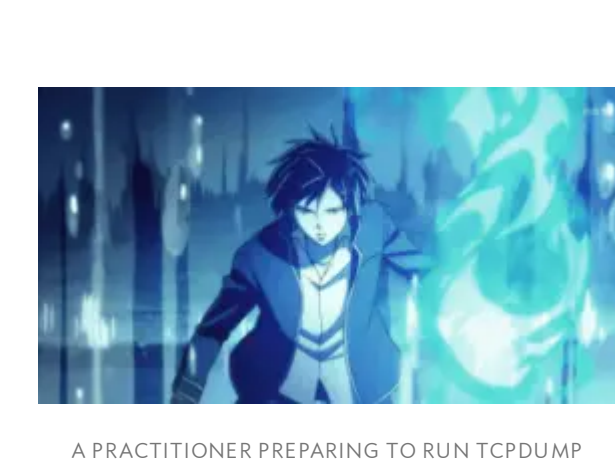
Install tcpdump with apt install tcpdump (Ubuntu), or yum install tcpdump (Redhat/Centos)

This showed some HTTPS traffic, with a hex display visible on the right portion of the output (alas, it's encrypted). Just remember—when in doubt, run the command above with the port you're interested in, and you should be on your way.

You can get a single packet with -c 1, or *n* number with -c n.

Examples

Now that you are able to get basic traffic, let's step through numerous examples that you are likely to need during your job in networking, security, or as any type of PacketWizard™.



A PRACTITIONER PREPARING TO RUN TCPDUMP

PacketWizard™ isn't really trademarked, but it should be.

Everything on an interface

Just see what's going on, by looking at what's hitting your interface.

```
tcpdump -i eth0
```

Or get *all* interfaces with -i any.

Find Traffic by IP

One of the most common queries, using host, you can see traffic that's going to or from 1.1.1.1.

```
tcpdump host 1.1.1.1
```

```
06:20:25.593207 IP 172.30.0.144.39270 > one.one.one.one.domain:
12790+ A? google.com.
(28) 06:20:25.594510 IP one.one.one.one.domain > 172.30.0.144.39270:
12790 1/0/0 A 172.217.15.78 (44)
```

Expression Types:

host, net, and port.

Directions:

src and dst.

Types:

host, net, and port.

Protocols:

tcp, udp, icmp, and many more.

Filtering by Source and/or Destination

If you only want to see traffic in one direction or the other, you can use src and dst.

```
tcpdump src 1.1.1.1
tcpdump dst 1.0.0.1
```

Finding Packets by Network

To find packets going to or from a particular network or subnet, use the net option.

```
tcpdump net 1.2.3.0/24
```

You can combine this with the src and dst options as well.

Get Packet Contents with Hex Output

Hex output is useful when you want to see the content of the packets in question, and it's often best used when you're isolating a few candidates for closer scrutiny.

```
tcpdump -c 1 -X icmp
```

```
0x0000:  14ed bbcb a901 24f5 a28c 11dc 0800 4500  ......$.......E.
0x0010:  0054 fa08 0000 4001 ef6b c0a8 1a25 acd9  .T....@..k...%..
0x0020:  098e 0800 1ad7 2b0b 0000 5c35 aa44 000c  ......+...\5.D..
0x0030:  c094 0809 0a0b 0c0d 0e0f 1011 1213 1415  ................
0x0040:  1617 1819 1a1b 1c1d 1e1f 2021 2223 2425  ..........!"#$%
0x0050:  2627 2829 2a2b 2c2d 2e2f 3031 3233 3435  &'()*+,-./012345
0x0060:  3637                                     67
```

A SINGLE ICMP PACKET VISIBLE IN HEX

Show Traffic Related to a Specific Port

You can find specific port traffic by using the port option followed by the port number.

```
tcpdump port 3389
tcpdump src port 1025
```

Common Options:

-nn : Don't resolve hostnames *or* port names.

-S : Get the entire packet.

-X : Get hex output.

Show Traffic of One Protocol

If you're looking for one particular kind of traffic, you can use tcp, udp, icmp, and many others as well.

```
tcpdump icmp
```

Show only IP6 Traffic

You can also find all IP6 traffic using the protocol option.

```
tcpdump ip6
```

Find Traffic Using Port Ranges

You can also use a range of ports to find traffic.

```
tcpdump portrange 21-23
```

Find Traffic Based on Packet Size

If you're looking for packets of a particular size you can use these options. You can use less, greater, or their associated symbols that you would expect from mathematics.

```
tcpdump less 32
tcpdump greater 64
tcpdump <= 128
```

Reading / Writing Captures to a File (pcap)

It's often useful to save packet captures into a file for analysis in the future. These files are known as PCAP (PEE-cap) files, and they can be processed by hundreds of different applications, including network analyzers, intrusion detection systems, and of course by tcpdump itself. Here we're writing to a file called *capture_file* using the -w switch.

```
tcpdump port 80 -w capture_file
```

You can read PCAP files by using the -r switch. Note that you can use all the regular commands within tcpdump while reading in a file; you're only limited by the fact that you can't capture and process what doesn't exist in the file already.

```
tcpdump -r capture_file
```

Advanced

Now that we've seen what we can do with the basics through some examples, let's look at some more advanced stuff.

More options

Here are some additional ways to tweak how you call tcpdump.

- -X : Show the packet's *contents* in both HEX and ASCII.
- -XX : Same as -X, but also shows the ethernet header.
- -D : Show the list of available interfaces
- -l : Line-readable output (for viewing as you save, or sending to other commands)
- -q : Be less verbose (more quiet) with your output.
- -t : Give human-readable timestamp output.
- -tttt : Give maximally human-readable timestamp output.
- -i eth0 : Listen on the eth0 interface.
- -vv : Verbose output (more v's gives more output).
- -c : Only get *x* number of packets and then stop.
- -s : Define the *snaplength* (size) of the capture in bytes. Use -s0 to get everything, unless you are intentionally capturing less.
- -S : Print absolute sequence numbers.
- -e : Get the ethernet header as well.
- -q : Show less protocol information.
- -E : Decrypt IPSEC traffic by providing an encryption key.

It's All About the Combinations

Being able to do these various things individually is powerful, but the real magic of tcpdump comes from the ability to **combine options in creative ways** in order to isolate exactly what you're looking for. There are three ways to do combinations, and if you've studied programming at all they'll be pretty familiar to you.

1. **AND**
   and or &&
2. **OR**
   or or ||
3. **EXCEPT**
   not or !

Raw Output View

Use this combination to see verbose output, with no resolution of hostnames or port numbers, using absolute sequence numbers, and showing human-readable timestamps.

```
tcpdump -ttnnvvS
```

Here are some examples of combined commands.

From specific IP and destined for a specific Port

Let's find all traffic from 10.5.2.3 going to any host on port 3389.

```
tcpdump -nnvvS src 10.5.2.3 and dst port 3389
```

From One Network to Another

Let's look for all traffic coming from 192.168.x.x and going to the 10.x or 172.16.x.x networks, and we're showing hex output with no hostname resolution and one level of extra verbosity.

```
tcpdump -nvX src net 192.168.0.0/16 and dst net 10.0.0.0/8 or 172.16.0.0/16
```

Non ICMP Traffic Going to a Specific IP

This will show us all traffic going to 192.168.0.2 that is *not* ICMP.

```
tcpdump dst 192.168.0.2 and src net and not icmp
```

Traffic From a Host That Isn't on a Specific Port

This will show us all traffic from a host that isn't SSH traffic (assuming default port usage).

```
tcpdump -vv src mars and not dst port 22
```

As you can see, you can build queries to find just about anything you need. The key is to first figure out *precisely* what you're looking for and then to build the syntax to isolate that specific type of traffic.

Keep in mind that when you're building complex queries you might have to group your options using single quotes. Single quotes are used in order to tell tcpdump to ignore certain special characters—in this case below the "( )" brackets. This same technique can be used to group using other expressions such as host, port, net, etc.

```
tcpdump 'src 10.0.2.4 and (dst port 3389 or 22)'
```

Isolate TCP Flags

You can also use filters to isolate packets with specific TCP flags set.

Isolate TCP RST flags.

```
tcpdump 'tcp[13] & 4!=0'
tcpdump 'tcp[tcpflags] == tcp-rst'
```

The filters below find these various packets because tcp[13] looks at offset 13 in the TCP header, the number represents the location within the byte, and the !=0 means that the flag in question is set to 1, i.e. it's on.

Isolate TCP SYN flags.

```
tcpdump 'tcp[13] & 2!=0'
tcpdump 'tcp[tcpflags] == tcp-syn'
```

Isolate packets that have both the SYN and ACK flags set.

```
tcpdump 'tcp[13]=18'
```

Isolate TCP URG flags.

```
tcpdump 'tcp[13] & 32!=0'
tcpdump 'tcp[tcpflags] == tcp-urg'
```

Only the PSH, RST, SYN, and FIN flags are displayed in tcpdump's flag field output. URGs and ACKs are displayed, but they are shown elsewhere in the output rather than in the flags field.

Isolate TCP ACK flags.

```
tcpdump 'tcp[13] & 16!=0'
tcpdump 'tcp[tcpflags] == tcp-ack'
```

Isolate TCP PSH flags.

```
tcpdump 'tcp[13] & 8!=0'
tcpdump 'tcp[tcpflags] == tcp-psh'
```

Isolate TCP FIN flags.

```
tcpdump 'tcp[13] & 1!=0'
tcpdump 'tcp[tcpflags] == tcp-fin'
```

Everyday Recipe Examples

Finally, now that we the theory out of the way, here are a number of quick recipes you can use for catching various kinds of traffic.

Because tcpdump can output content in ASCII, you can use it to search for cleartext content using other command-line tools like grep.

Both SYN and RST Set

```
tcpdump 'tcp[13] = 6'
```

Find HTTP User Agents

```
tcpdump -vvAls0 | grep 'User-Agent:'
```

The -l switch lets you see the traffic as you're capturing it, and helps when sending to commands like grep.

Cleartext GET Requests

```
tcpdump -vvAls0 | grep 'GET'
```

Find HTTP Host Headers

```
tcpdump -vvAls0 | grep 'Host:'
```

Find HTTP Cookies

```
tcpdump -vvAls0 | grep 'Set-Cookie|Host:|Cookie:'
```

Find SSH Connections

This one works regardless of what port the connection comes in on, because it's getting the banner response.

```
tcpdump 'tcp[(tcp[12]>>2):4] = 0x5353482D'
```

Find DNS Traffic

```
tcpdump -vvAs0 port 53
```

Find FTP Traffic

```
tcpdump -vvAs0 port ftp or ftp-data
```

Find NTP Traffic

```
tcpdump -vvAs0 port 123
```

Find Cleartext Passwords

```
tcpdump port http or port ftp or port smtp or port imap or port pop3 or port telnet -lA |
egrep -i -B5 'pass=|pwd=|log=|login=|user=|username=|pw=|passw=|passwd=
|password=|pass:|user:|username:|password:|login:|pass |user '
```

FIND TRAFFIC WITH EVIL BIT

There's a bit in the IP header that never gets set by legitimate applications, which we call the "Evil Bit". Here's a fun filter to find packets where it's been toggled.

```
tcpdump 'ip[6] & 128 != 0'
```

Summary

Here are the takeaways.

1. tcpdump is a valuable tool for anyone looking to get into networking or INFORMATION SECURITY.
2. The raw way it interfaces with traffic, combined with the precision it offers in inspecting packets make it the best possible tool for learning TCP/IP.
3. Protocol Analyzers like Wireshark are great, but if you want to truly master packet-fu, you must become one with tcpdump first.

Check out MY OTHER TUTORIALS as well.

Well, this primer should get you going strong, but THE MAN PAGE should always be handy for the most advanced and one-off usage scenarios. I truly hope this has been useful to you, and feel free to CONTACT ME if you have any questions.

Notes

1. I'm currently (sort of) writing a book on tcpdump for No Starch Press.
2. The leading image is from SECURITYWIZARDRY.COM.
3. Some of the isolation filters borrowed from SÉBASTIEN WAINS.
4. Thanks to Peter at hackertarget.com for inspiration on the new table of contents (simplified), and also for some additional higher-level protocol filters added in July 2018.
5. An anagram for the TCP flags is: UNSKILLED ATTACKERS PESTER REAL SECURITY FOLK.

About The Author

Daniel Miessler is a cybersecurity expert and author of The Real Internet of Things, based in San Francisco, California. Specializing in RECON/OSINT, Application and IoT Security, and Security Program Design, he has 20 years of experience helping companies from early-stage startups to the Global 100. Daniel currently works at a leading tech company in the Bay Area, leads the OWASP Internet of Things Security Project, and can be found writing about the intersection of security, technology, and humans. He is also the creator and host of the Unsupervised Learning podcast and newsletter. ::

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