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Network Startup Resource Center

Registry Operations Curriculum

Network Performance Definitions and Analysis

Network Performance Metrics

- Planning performance management
- Metrics
    - -Network
    - -*Systems*
    - -*Services*
- Definitions

Planning

- What's the intention?
  - *Baselining, Troubleshooting, Planning growth*
  - Defend yourself from accusations -”it's the network!”
- Who is the information for?
  - Administration, NOC, customers
  - How to structure and present the information
- Reach: Can I measure everything?
  - Impact on devices (measurements and measuring)
  - Balance between amount of information and time to get it

Metrics

Network performance metrics

- Channel capacity, nominal & effective
- Channel utilization
- Delay and *jitter*
- Packet loss and errors

Metrics

System performance metrics

- Availability
- Memory, CPU Utilization, *load*, *I/O wait*, etc.

Service performance metrics

- Wait time / Delay
- Availability
- How can I justify maintaining the service?
- Who is using it? How often?
- Economic value? Other value?

Common Network Performance Measurements

- Relative to traffic:
  - -Bits per second
  - -Packets per second
  - -*Unicast* vs. *non-unicast* packets
  - -Errors
  - -Dropped packets
  - -Flows per second
  - -Round trip time (RTT)
  - -Jitter (variation between packet RTT)

Nominal Channel Capacity

- The maximum number of bits that can be transmitted for a unit of time (eg: bits per second)
- Depends on:
  - -Bandwidth of the physical medium
    - Cable
    - Electromagnetic waves
  - -Processing capacity for each transmission element
  - -Efficiency of algorithms in use to access medium
  - -Channel encoding and compression

Effective Channel Capacity

- Always a fraction of the nominal channel capacity
- Dependent on:
  - -Additional overhead of protocols in each layer
  - -Device limitations on both ends
    - Flow control algorithm efficiency, etc.
      - For example: TCP

Channel Utilization

- What fraction of the nominal channel capacity is actually in use
- Important!
  - Future planning
    - What utilization growth rate am I seeing?
    - For when should I plan on buying additional capacity?
    - Where should I invest for my updates?
  - Problem resolution
    - Where are my bottlenecks, etc.

95^{th} Percentile

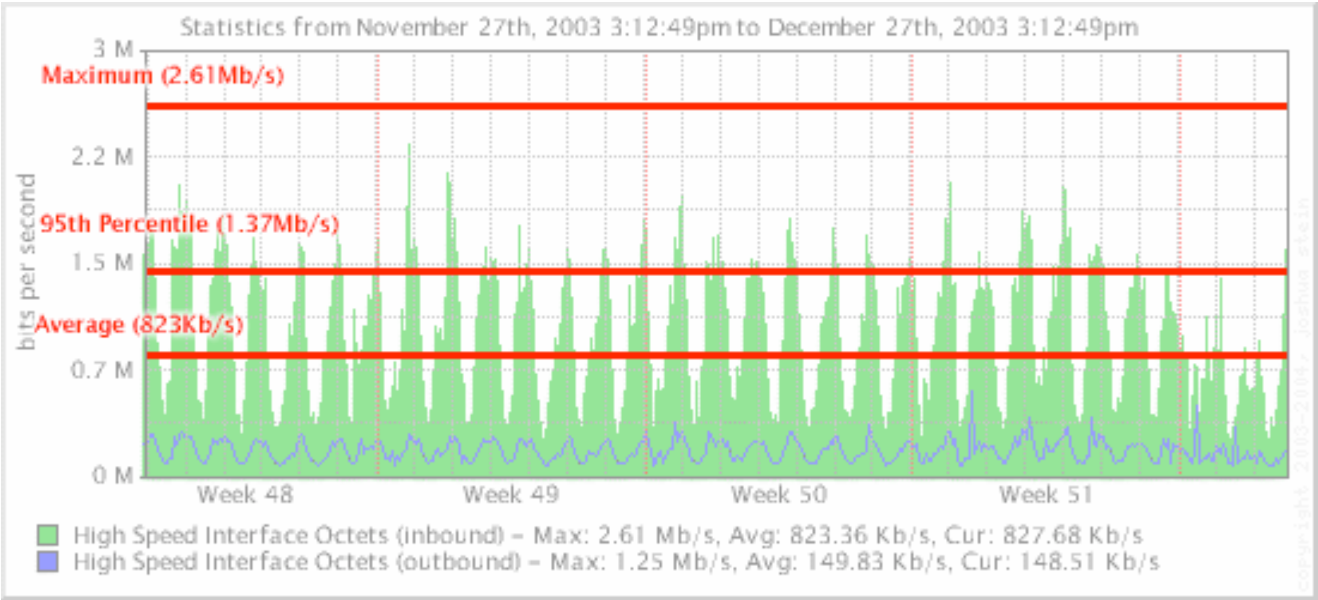
- The smallest value that is larger than 95% of the values in a given sample
- This means that 95% of the time the channel utilization is equal to or *less* than this value

  -Or rather, the peaks are discarded from consideration
- Why is this important in networks?

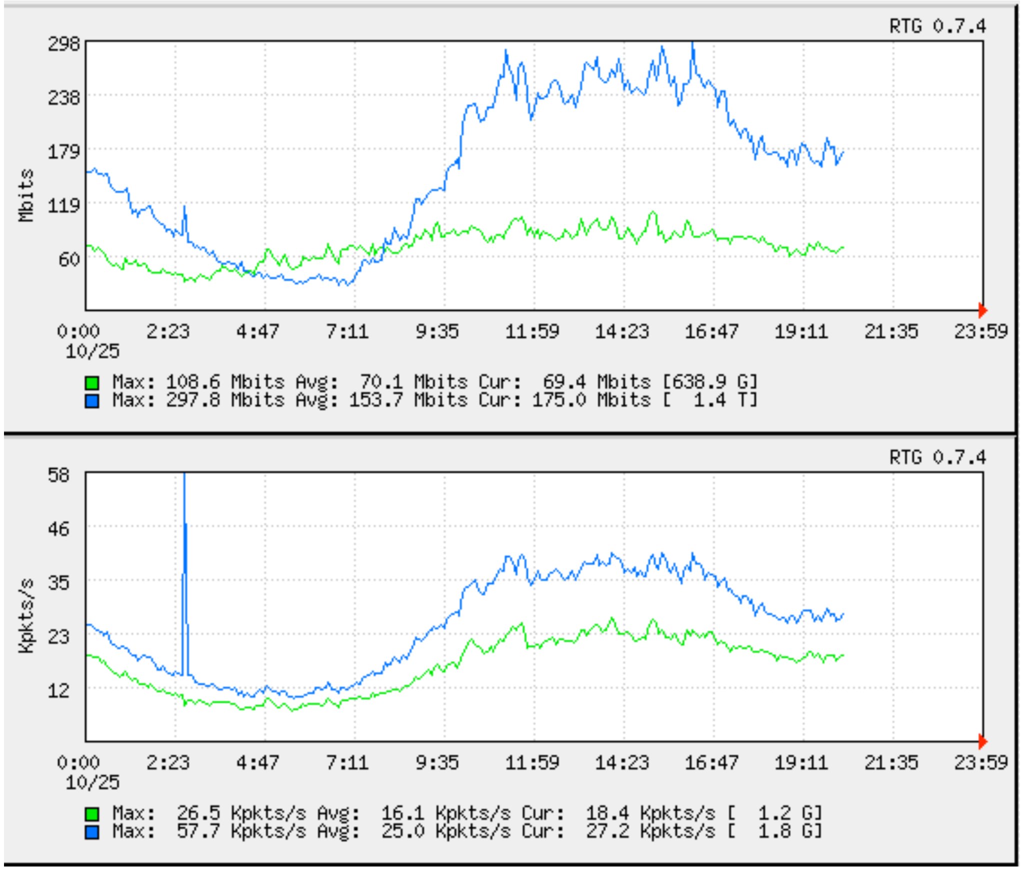
  -Gives you an idea of the standard, sustained channel utilization.

  -ISPs use this measure to bill customers with “larger” connections.

95th Percentile



Bits per second vs Packets p.s.

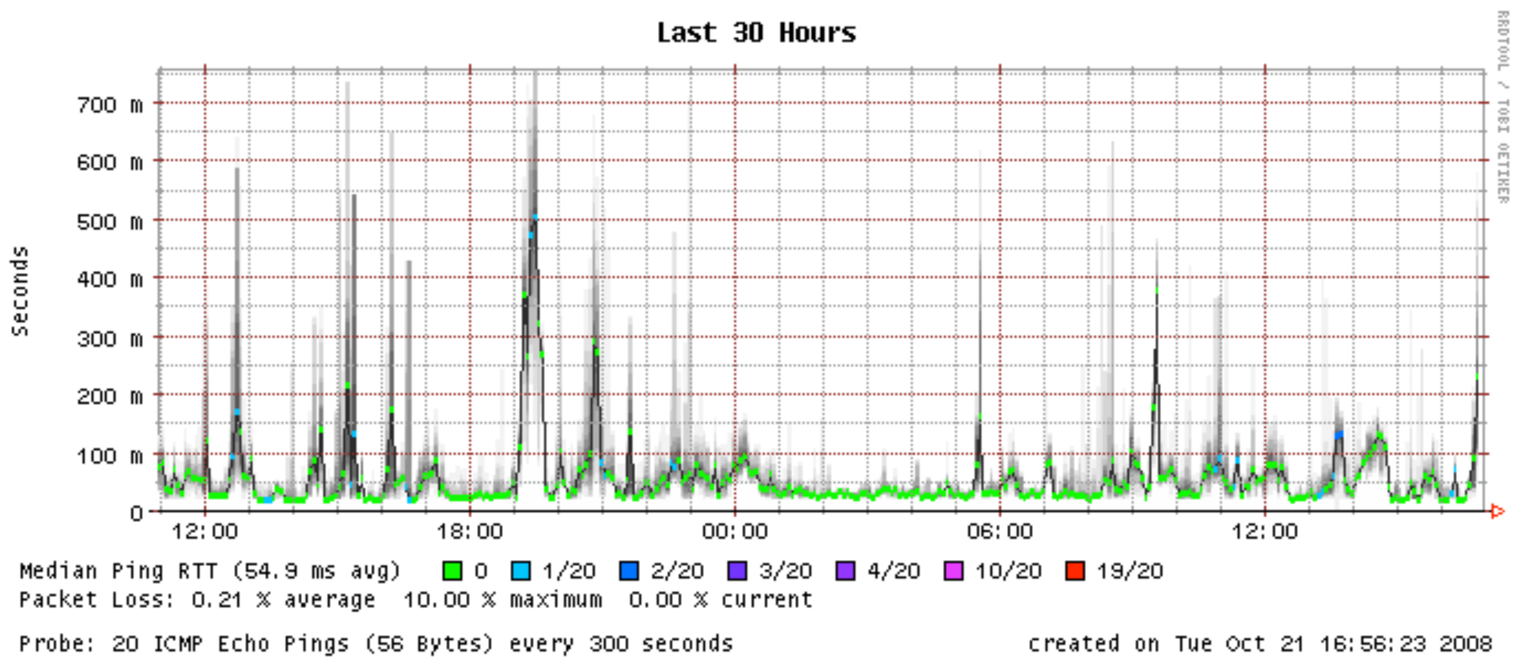


End-to-end Delay

The time required to transmit a packet along its <u>entire path</u>

- *Created by an application, handed over to the OS, passed to a network card (NIC), encoded, transmitted over a physical medium (copper, fibre, air), received by an intermediate device (switch, router), analyzed, retransmitted over another medium, etc.*
- The most common measurement uses *ping* for total round-trip-time (RTT).

Historical Measurement of Delay



Types of Delay

Causes of end-to-end delay:

- Processor delays
- Buffer delays
- Transmission delays
- Propagation delays

Processing Delay

Required time to analyze a packet header and decide where to send the packet (eg. a routing decision)

- Inside a router this depends on the number of entries in the routing table, the implementation of data structures, hardware in use, etc.

This can include error verification / checksumming (i.e. IPv4, IPv6 header checksum)

Queuing Delay

- The time a packet is enqueued until it is transmitted
- The number of packets waiting in the queue will depend on traffic intensity and of the type of traffic
- Router queue algorithms try to adapt delays to specific preferences, or impose equal delay on all traffic.

Transmission Delay

The time required to push all the bits in a packet on the transmission medium in use

For N=Number of bits, S=Size of packet, d=delay

d = S/N

For example, to transmit 1024 bits using Fast Ethernet (100Mbps):

d = 1024/1x10e8 = 10.24 micro seconds

Propagation Delay

- Once a bit is 'pushed' on to the transmission medium, the time required for the bit to propagate to the end of its physical trajectory
- The velocity of propagation of the circuit depends mainly on the actual distance of the physical circuit
- In the majority of cases this is close to the speed of light.

For d = distance, s = propagation velocity

PD = d/s

Transmission vs. Propagation

Can be confusing at first

Consider this example:

Two 100 Mbps circuits

- 1 km of optic fiber
- Via satellite with a distance of 30 km between the base and the satellite

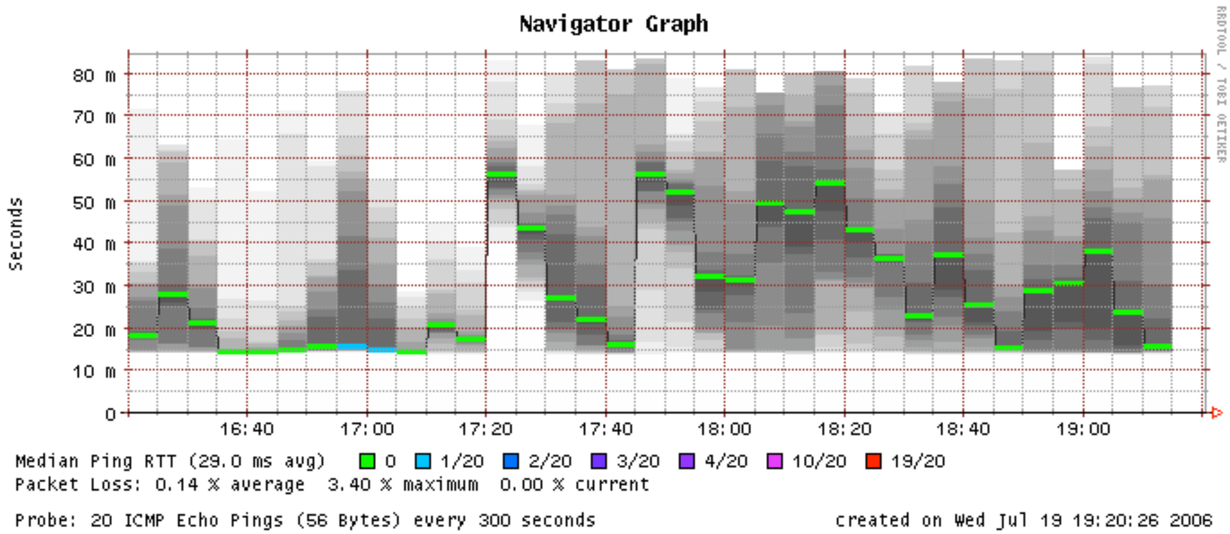
For two packets of the same size which will have the larger transmission delay? Propagation delay?

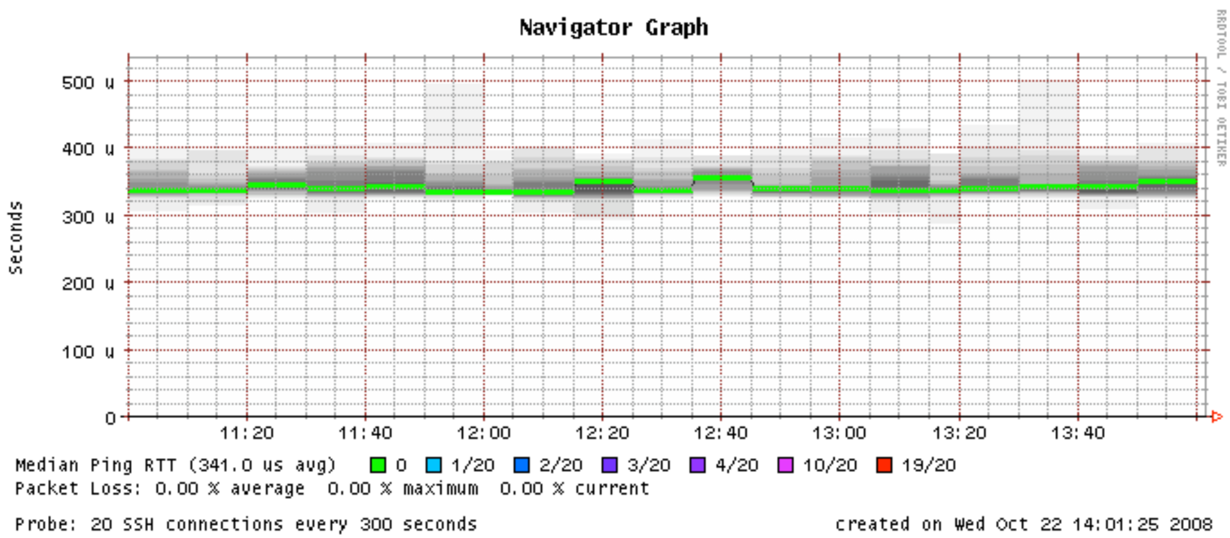
Packet Loss

Occurs due to the fact that buffers are not infinite in size

- When a packet arrives to a buffer that is full the packet is discarded.
- Packet loss, if it must be corrected, is resolved at higher levels in the network stack (transport or application layers)
- Loss correction using retransmission of packets can cause yet more congestion if some type of (flow) control is not used (to inform the source that it's pointless to keep sending more packets at the present time)

Jitter


Navigator Graph
Seconds
80 m
70 m
60 m
50 m
40 m
30 m
20 m
10 m
0
16:40
17:00
17:20
17:40
18:00
18:20
18:40
19:00
RRDTOOL / TOBI OETIKER
Median Ping RTT (29.0 ms avg) 0 1/20 2/20 3/20 4/20 10/20 19/20
Packet Loss: 0.14 % average 3.40 % maximum 0.00 % current
Probe: 20 ICMP Echo Pings (56 Bytes) every 300 seconds
created on Wed Jul 19 19:20:26 2006


Navigator Graph
Seconds
500 u
400 u
300 u
200 u
100 u
0
11:20
11:40
12:00
12:20
12:40
13:00
13:20
13:40
RRDTOOL / TOBI OETIKER
Median Ping RTT (341.0 us avg) 0 1/20 2/20 3/20 4/20 10/20 19/20
Packet Loss: 0.00 % average 0.00 % maximum 0.00 % current
Probe: 20 SSH connections every 300 seconds
created on Wed Oct 22 14:01:25 2008

Flow Control and Congestion

- Limits the transmission amount (rate) because the receiver cannot process packets at the same rate that packets are arriving.
- Limit the amount sent (transmission rate) because of loss or delays in the circuit.

Controls in TCP

IP (Internet Protocol) implements service that not connection oriented.

- There is no mechanism in IP to deal with packet loss.

TCP (Transmission *Control* Protocol) implements flow and congestion control.

- Only on the ends as the intermediate nodes at the network level do not talk TCP

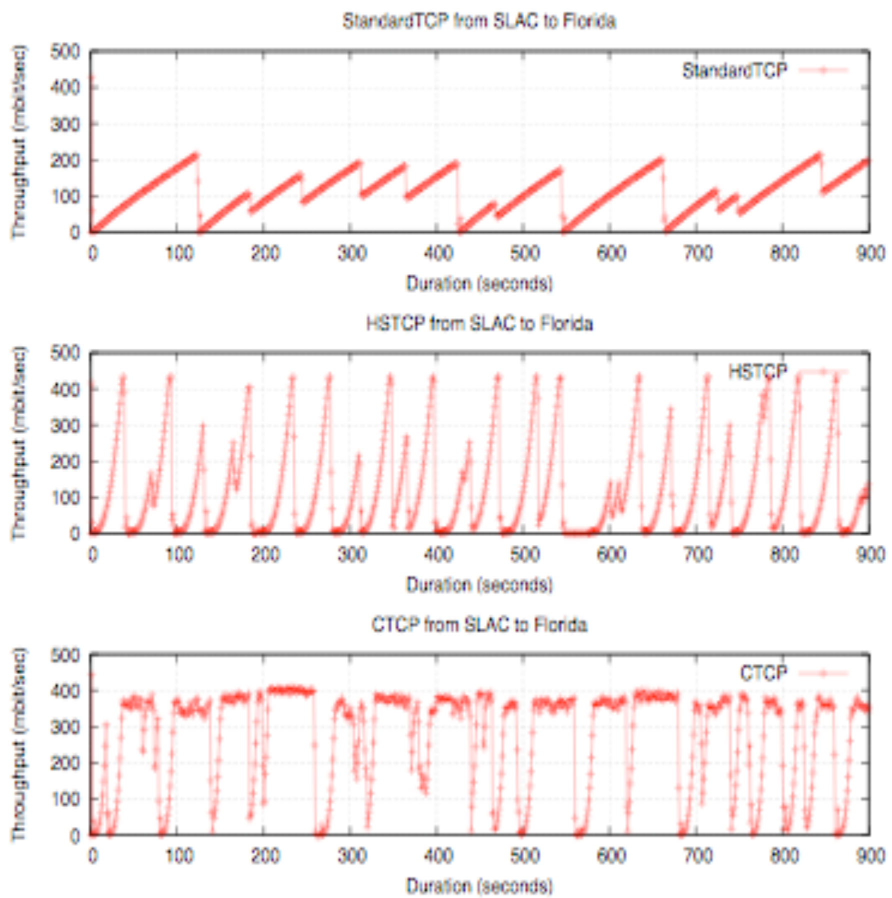
Congestion vs. Flow in TCP

Flow: controlled by window size (RcvWindow), which is sent by the receiving end.

Congestion: controlled by the value of the congestion window (Congwin)

- Maintained independently by the sender
- This varies based on the detection of packets lost
  - Timeout or receiving three ACKs repeated
- **Behaviors:**
  - Additive Increments / Multiplicative Decrements (AIMD)
  - Slow Start
  - React to *timeout* events

Different TCP Congestion Control Algorithms



Questions?

?

Local Analysis

As we know...

Before we blame the network, let's verify whether the problem is ours.

- **What can go wrong locally?**
  - Hardware problems
  - Excessive load (CPU, memory, I/O)
- **What's considered 'normal'?**
  - Use analysis tools frequently
    - Become familiar with the normal state and values for your machine.
  - **It is essential to maintain history**
    - SNMP agents and databases

Linux Performance Analysis

Three main categories:

- Processes
  - Processes that are executing (running)
  - Processes that are waiting (sleeping)
    - waiting their turn
    - blocked
- Memory
  - Real
  - Virtual
- I/O (Input/Output)
  - Storage
  - Network

Key Indicators

Insufficent CPU

- Number of processes waiting to execute is always high
- High CPU utilization (load avg.)

Insufficient memory

- Very little free memory
- Lots of swap activity (swap in, swap out)

Slow I/O

- Lots of blocked processes
- High number of block transfers

Local Analysis

Luckily, in Unix there are dozens of useful tools that give us lots of useful information about our machine

Some of the more well-known include:

– vmstat	- tcpdump
– top	- wireshark (ethereal)
– lsof	- iptraf
– netstat	- iperf

vmstat

Show periodic summary information about processes, memory, pagin, I/O, CPU state, etc

```
vmstat <-options> <delay> <count>
```

```
# vmstat 2
procs -----------memory---------- ---swap-- -----io---- --system-- ----cpu----
 r  b   swpd   free   buff  cache   si   so    bi    bo   in    cs us sy id wa
 2  0 209648  25552 571332 2804876    0    0     3     4    3     3 15 11 73  0
 2  0 209648  24680 571332 2804900    0    0     0   444  273 79356 16 16 68  0
 1  0 209648  25216 571336 2804904    0    0     6  1234  439 46735 16 10 74  0
 1  0 209648  25212 571336 2804904    0    0     0    22  159 100282 17 21 62  0
 2  0 209648  25196 571348 2804912    0    0     0   500  270 82455 14 18 68  0
 1  0 209648  25192 571348 2804912    0    0     0   272  243 77480 16 15 69  0
 2  0 209648  25880 571360 2804916    0    0     0   444  255 83619 16 14 69  0
 2  0 209648  25872 571360 2804920    0    0     0   178  220 90521 16 18 66  0
```

top

- Basic performance tool for Unix/Linux environments
- Periodically show a list of system performance statistics:
  - CPU use
  - RAM and SWAP memory usage
  - Load average (cpu utilization)
  - Information by process

top cont.

- **Information by process (most relevant columns shown):**
  - PID: Process ID
  - USER: user running (owner) of the process
  - %CPU: Percentage of CPU utilization by the process since the last sample
  - %MEM: Percentage of physical memory (RAM) used by the process
  - TIME: Total CPU time used by the process since it was started

Load Average

- Average number of active processes in the last 1, 5 and 15 minutes
  - A simple yet useful measurement
  - Depending on the machine the acceptable range considered to be normal can vary:
    - Multi-processor machines can handle more active processes per unit of time (than single processor machines)

top

Some useful *interactive* keyboard commands for *top*

- **f** : Add or remove columns
- **F** : Specify which column to order by
- **<** , **>** : Move the column on which we order
- **u** : Specify a specific user
- **k** : Specify a process to kill (stop)
- **d** , **s** : Change the display update interval

netstat

Show us information about:

- Network connections
- Routing tables
- Interface (NIC) statistics
- Multicast group members

netstat

Some useful options

-n: Show addresses, ports and userids in numeric form

-r: Routing table

-s: Statistics by protocol

-i: Status of interfaces

-l: Listening sockets

--tcp, **--udp**: Specify the protocol

-A: Address family [inet | inet6 | unix | etc.]

-p: Show the name of each process for each port

-c: Show output/results continuously

netstat

Examples:

```
# netstat -n --tcp -c
Active Internet connections (w/o servers)
Proto Recv-Q Send-Q Local Address              Foreign Address            State
tcp        0    272 ::ffff:192.188.51.40:22     ::ffff:128.223.60.27:60968 ESTABLISHED
tcp        0      0 ::ffff:192.188.51.40:22     ::ffff:128.223.60.27:53219 ESTABLISHED

# netstat -lnp --tcp
Active Internet connections (only servers)
Proto Recv-Q Send-Q Local Address              Foreign Address            State       PID/Program name
tcp        0      0 0.0.0.0:199                0.0.0.0:*                  LISTEN      11645/snmpd
tcp        0      0 0.0.0.0:3306               0.0.0.0:*                  LISTEN      1997/mysqld
```

```
# netstat -ic
Kernel Interface table
Iface       MTU Met    RX-OK RX-ERR RX-DRP RX-OVR    TX-OK TX-ERR TX-DRP TX-OVR Flg
eth0       1500   0  2155901      0      0      0   339116      0      0      0 BMRU
lo        16436   0    18200      0      0      0    18200      0      0      0 LRU
eth0       1500   0  2155905      0      0      0   339117      0      0      0 BMRU
lo        16436   0    18200      0      0      0    18200      0      0      0 LRU
eth0       1500   0  2155907      0      0      0   339120      0      0      0 BMRU
lo        16436   0    18200      0      0      0    18200      0      0      0 LRU
eth0       1500   0  2155910      0      0      0   339122      0      0      0 BMRU
lo        16436   0    18200      0      0      0    18200      0      0      0 LRU
eth0       1500   0  2155913      0      0      0   339124      0      0      0 BMRU
```

netstat cont.

Examples:

```
# netstat -tcp -listening --program
Active Internet connections (only servers)
Proto Recv-Q Send-Q Local Address           Foreign Address         State       PID/Program name
tcp        0      0 *:5001                  *:*                     LISTEN      13598/iperf
tcp        0      0 localhost:mysql         *:*                     LISTEN      5586/mysqld
tcp        0      0 *:www                   *:*                     LISTEN      7246/apache2
tcp        0      0 t60-2.local:domain      *:*                     LISTEN      5378/named
tcp        0      0 t60-2.local:domain      *:*                     LISTEN      5378/named
tcp        0      0 t60-2.local:domain      *:*                     LISTEN      5378/named
tcp        0      0 localhost:domain        *:*                     LISTEN      5378/named
tcp        0      0 localhost:ipp           *:*                     LISTEN      5522/cupsd
tcp        0      0 localhost:smtp          *:*                     LISTEN      6772/exim4
tcp        0      0 localhost:953           *:*                     LISTEN      5378/named
tcp        0      0 *:https                 *:*                     LISTEN      7246/apache2
tcp6       0      0 [::]:ftp                [::]:*                  LISTEN      7185/proftpd
tcp6       0      0 [::]:domain             [::]:*                  LISTEN      5378/named
tcp6       0      0 [::]:ssh                [::]:*                  LISTEN      5427/sshd
tcp6       0      0 [::]:3000               [::]:*                  LISTEN      17644/ntop
tcp6       0      0 ip6-localhost:953       [::]:*                  LISTEN      5378/named
tcp6       0      0 [::]:3005               [::]:*                  LISTEN      17644/ntop
```

netstat cont.

```
$ sudo netstat -atup
Active Internet connections (servers and established) (if run as root PID/Program name is included)
Proto Recv-Q Send-Q Local Address           Foreign Address         State       PID/Program name
tcp        0      0 *:35586                 *:*                     LISTEN      2540/ekpd
tcp        0      0 localhost:mysql         *:*                     LISTEN      2776/mysqld
tcp        0      0 *:www                   *:*                     LISTEN      14743/apache2
tcp        0      0 d229-231.uoregon:domain *:*                     LISTEN      2616/named
tcp        0      0 *:ftp                   *:*                     LISTEN      3408/vsftpd
tcp        0      0 localhost:domain        *:*                     LISTEN      2616/named
tcp        0      0 *:ssh                   *:*                     LISTEN      2675/sshd
tcp        0      0 localhost:ipp           *:*                     LISTEN      3853/cupsd
tcp        0      0 localhost:smtp          *:*                     LISTEN      3225/exim4
tcp        0      0 localhost:953           *:*                     LISTEN      2616/named
tcp        0      0 *:https                 *:*                     LISTEN      14743/apache2
tcp6       0      0 [::]:domain             [::]:*                  LISTEN      2616/named
tcp6       0      0 [::]:ssh                [::]:*                  LISTEN      2675/sshd
tcp6       0      0 ip6-localhost:953       [::]:*                  LISTEN      2616/named
udp        0      0 *:50842                 *:*                                 3828/avahi-daemon:
udp        0      0 localhost:snmp          *:*                                 3368/snmpd
udp        0      0 d229-231.uoregon:domain *:*                                 2616/named
udp        0      0 localhost:domain        *:*                                 2616/named
udp        0      0 *:bootpc                *:*                                 13237/dhclient
udp        0      0 *:mdns                  *:*                                 3828/avahi-daemon:
udp        0      0 d229-231.uoregon.ed:ntp *:*                                 3555/ntpd
udp        0      0 localhost:ntp           *:*                                 3555/ntpd
udp        0      0 *:ntp                   *:*                                 3555/ntpd
udp6       0      0 [::]:domain             [::]:*                              2616/named
udp6       0      0 fe80::213:2ff:fe1f::ntp [::]:*                              3555/ntpd
udp6       0      0 ip6-localhost:ntp       [::]:*                              3555/ntpd
udp6       0      0 [::]:ntp                [::]:*                              3555/ntpd
```

lsof (LiSt of Open Files)

- lsof is particularly useful because in Unix everything is a file: unix sockets, ip sockets, directories, etc.
- Allows you to associate open files by:

-p: PID (Process ID)

-i : A network address (protocol:port)

-u: A user

lsof

- **Example:**
  - First, using *netstat -ln –tcp* determine that port 6010 is open and waiting for a connection (LISTEN)

```
# netstat -ln --tcp
Active Internet connections (only servers)
Proto Recv-Q Send-Q Local Address               Foreign Address             State

tcp        0      0 127.0.0.1:6010              0.0.0.0:*                   LISTEN
tcp        0      0 127.0.0.1:6011              0.0.0.0:*                   LISTEN
```

lsof

Determine what process has the port (6010) open and what other resources are being used:

```
# lsof -i tcp:6010
COMMAND   PID    USER    FD   TYPE DEVICE SIZE NODE NAME
sshd      10301  root    6u   IPv4  53603       TCP localhost.localdomain:x11-ssh-offset (LISTEN)
sshd      10301  root    7u   IPv6  53604       TCP [::1]:x11-ssh-offset (LISTEN)
```

```
# lsof -p 10301
COMMAND    PID USER   FD    TYPE      DEVICE    SIZE    NODE NAME
sshd     10301 root  cwd     DIR         8,2    4096       2 /
sshd     10301 root  rtd     DIR         8,2    4096       2 /
sshd     10301 root  txt     REG         8,2  379720 1422643 /usr/sbin/sshd
sshd     10301 root  mem     REG         8,2   32724 1437533 /usr/lib/libwrap.so.0.7.6
sshd     10301 root  mem     REG         8,2   15088 3080329 /lib/libutil-2.4.so
sshd     10301 root  mem     REG         8,2   75632 1414093 /usr/lib/libz.so.1.2.3
sshd     10301 root  mem     REG         8,2   96040 3080209 /lib/libnsl-2.4.so
sshd     10301 root  mem     REG         8,2  100208 1414578 /usr/lib/libgssapi_krb5.so.2.2
sshd     10301 root  mem     REG         8,2   11684 1414405 /usr/lib/libkrb5support.so.0.0
sshd     10301 root  mem     REG         8,2   10368 3080358 /lib/libsetrans.so.0
sshd     10301 root  mem     REG         8,2    7972 3080231 /lib/libcom_err.so.2.1
sshd     10301 root  mem     REG         8,2   30140 1420233 /usr/lib/libcrack.so.2.8.0
sshd     10301 root  mem     REG         8,2   11168 3080399 /lib/security/pam_succeed_if.so
...
```

lsof cont.

What network services am I running?

```
# lsof -i
COMMAND      PID         USER    FD   TYPE  DEVICE SIZE NODE NAME
firefox     4429       hervey   50u  IPv4 1875852       TCP 192.168.179.139:56890->128.223.60.21:www (ESTABLISHED
named       5378         bind   20u  IPv6   13264       TCP *:domain (LISTEN)
named       5378         bind   21u  IPv4   13267       TCP localhost:domain (LISTEN)
sshd        5427         root    3u  IPv6   13302       TCP *:ssh (LISTEN)
cupsd       5522         root    3u  IPv4 1983466       TCP localhost:ipp (LISTEN)
mysqld      5586        mysql   10u  IPv4   13548       TCP localhost:mysql (LISTEN)
snmpd       6477         snmp    8u  IPv4   14633       UDP localhost:snmp
exim4       6772 Debian-exim    3u  IPv4   14675       TCP localhost:smtp (LISTEN)
ntpd        6859          ntp   16u  IPv4   14743       UDP *:ntp
ntpd        6859          ntp   17u  IPv6   14744       UDP *:ntp
ntpd        6859          ntp   18u  IPv6   14746       UDP [fe80::250:56ff:fec0:8]:ntp
ntpd        6859          ntp   19u  IPv6   14747       UDP ip6-localhost:ntp
proftpd     7185      proftpd    1u  IPv6   15718       TCP *:ftp (LISTEN)
apache2     7246     www-data    3u  IPv4   15915       TCP *:www (LISTEN)
apache2     7246     www-data    4u  IPv4   15917       TCP *:https (LISTEN)
...
iperf      13598         root    3u  IPv4 1996053       TCP *:5001 (LISTEN)
apache2    27088     www-data    3u  IPv4   15915       TCP *:www (LISTEN)
apache2    27088     www-data    4u  IPv4   15917       TCP *:https (LISTEN)
```

tcpdump

- Show received packet headers by a given interface. Optionally filter using boolean expressions.
- Allows you to write information to a file for later analysis.
- Requires administrator (root) privileges to use since you must configure network interfaces (NICs) to be in “promiscuous” mode.

tcpdump

Some useful options:

- **-i** : Specify the interface (ex: -i eth0)
- **-l** : Make stdout line buffered (view as you capture)
- **-v**, **-vv**, **-vvv**: Display more information
- **-n** : Don't convert addresses to names (avoid DNS)
- **-nn** : Don't translate port numbers
- **-w** : Write raw packets to a file
- **-r** : Read packets from a file created by '-w'

tcpdump

Boolean expressions:

- Using the 'AND', 'OR', 'NOT' operators
- Expressions consist of one, or more, primtives, which consist of a qualifier and an ID (name or number):

  Expression ::= [NOT] <primitive> [AND | OR | NOT <primitive> ...]

  <primitive> ::= <qualifier> <name|number>

  <qualifier> ::= <type> | <address> | <protocol>

  <type> ::= host | net | port | port range

  <address> ::= src | dst

  <protocol> ::= ether | fddi | tr | wlan | ip | ip6 | arp | rarp | decnet | tcp | udp

tcpdump

Examples:

- Show all HTTP traffic that originates from 192.168.1.1

```
# tcpdump -lnXvvv port 80 and src host 192.168.1.1
```

- Show all traffic originating from 192.168.1.1 *except* SSH

```
# tcpdump -lnXvvv src host 192.168.1.1 and not port 22
```

Wireshark

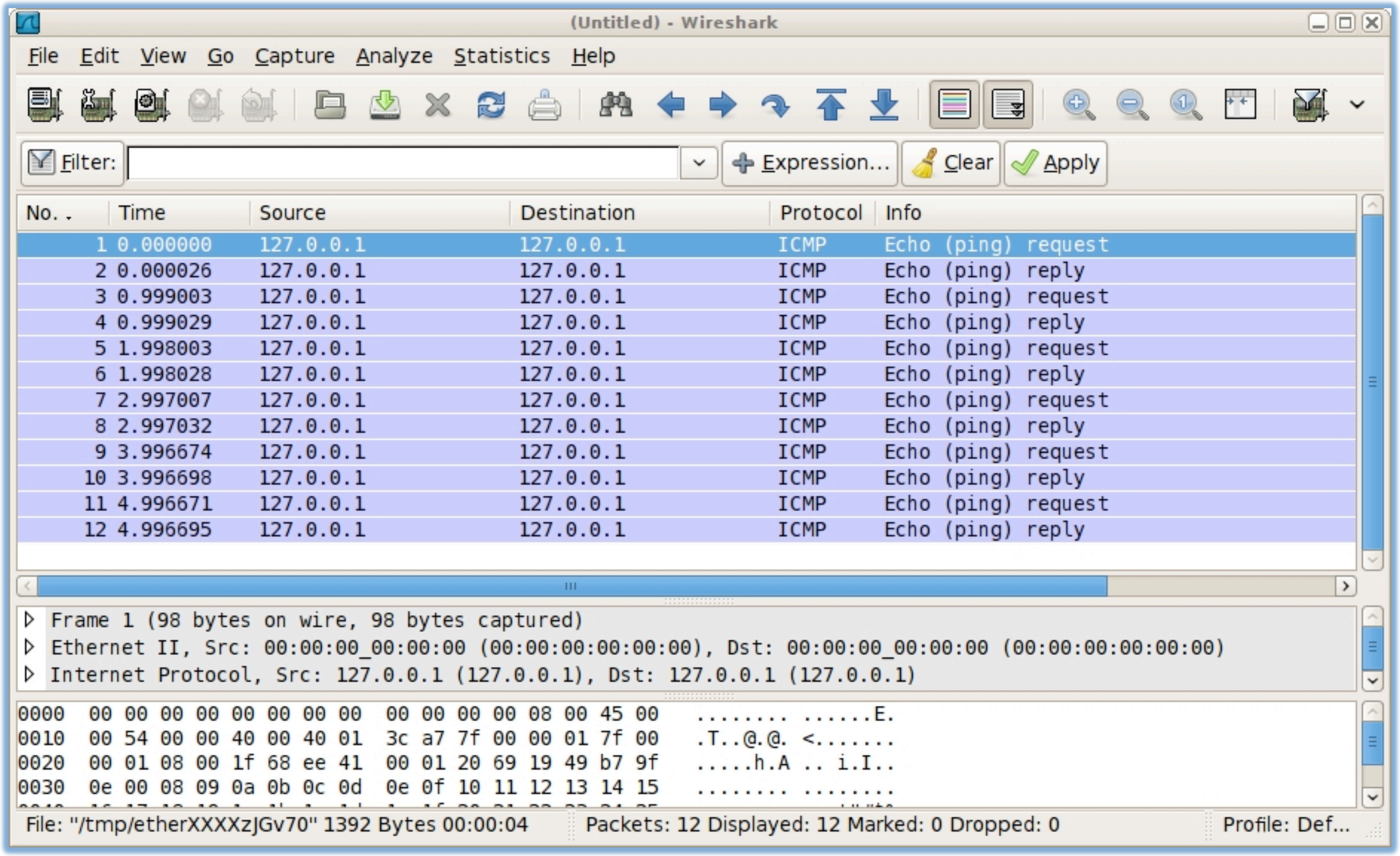
- Wireshark is a graphical packet analyser based on *libpcap*, the same library that *tcpdump* utilizes for capturing and storing packets
- The graphical interface has some advant-ages, including:
  - Hierarchical visualization by protocol (drill-down)
  - Follow a TCP "conversation" (Follow TCP Stream)
  - Colors to distinguish traffic types
  - Lots of statistics, graphs, etc.

Wireshark

- Wireshark is what came after *Ethereal*.
- The combination of *tcpdump* and *wireshark* can be quite powerful. For example:

```
# tcpdump -i eth1 -A -s1500 -2 dump.log port 21
$ sudo wireshark -r dump.log
```

Wireshark


(Untitled) - Wireshark
File Edit View Go Capture Analyze Statistics Help
Filter:
Expression...
Clear
Apply
No. Time Source Destination Protocol Info
1 0.000000 127.0.0.1 127.0.0.1 ICMP Echo (ping) request
2 0.000026 127.0.0.1 127.0.0.1 ICMP Echo (ping) reply
3 0.999003 127.0.0.1 127.0.0.1 ICMP Echo (ping) request
4 0.999029 127.0.0.1 127.0.0.1 ICMP Echo (ping) reply
5 1.998003 127.0.0.1 127.0.0.1 ICMP Echo (ping) request
6 1.998028 127.0.0.1 127.0.0.1 ICMP Echo (ping) reply
7 2.997007 127.0.0.1 127.0.0.1 ICMP Echo (ping) request
8 2.997032 127.0.0.1 127.0.0.1 ICMP Echo (ping) reply
9 3.996674 127.0.0.1 127.0.0.1 ICMP Echo (ping) request
10 3.996698 127.0.0.1 127.0.0.1 ICMP Echo (ping) reply
11 4.996671 127.0.0.1 127.0.0.1 ICMP Echo (ping) request
12 4.996695 127.0.0.1 127.0.0.1 ICMP Echo (ping) reply
Frame 1 (98 bytes on wire, 98 bytes captured)
Ethernet II, Src: 00:00:00_00:00:00 (00:00:00:00:00:00), Dst: 00:00:00_00:00:00 (00:00:00:00:00:00)
Internet Protocol, Src: 127.0.0.1 (127.0.0.1), Dst: 127.0.0.1 (127.0.0.1)
0000 00 00 00 00 00 00 00 00 00 00 00 00 08 00 45 00 ....E.
0010 00 54 00 00 40 00 40 01 3c a7 7f 00 00 01 7f 00 .T..@.@. <.......
0020 00 01 08 00 1f 68 ee 41 00 01 20 69 19 49 b7 9f .....h.A .. i.I..
0030 0e 00 08 09 0a 0b 0c 0d 0e 0f 10 11 12 13 14 15 ....
File: "/tmp/etherXXXXzJGv70" 1392 Bytes 00:00:04
Packets: 12 Displayed: 12 Marked: 0 Dropped: 0
Profile: Def...

iptraf

- **Many measurable statistics and functions**
  - By protocol/port
  - By packet size
  - Generates logs
  - Utilizes DNS to translate addresses
- **Advantages**
  - Simplicity
  - Menu-based (uses “curses”)
  - Flexible configuration

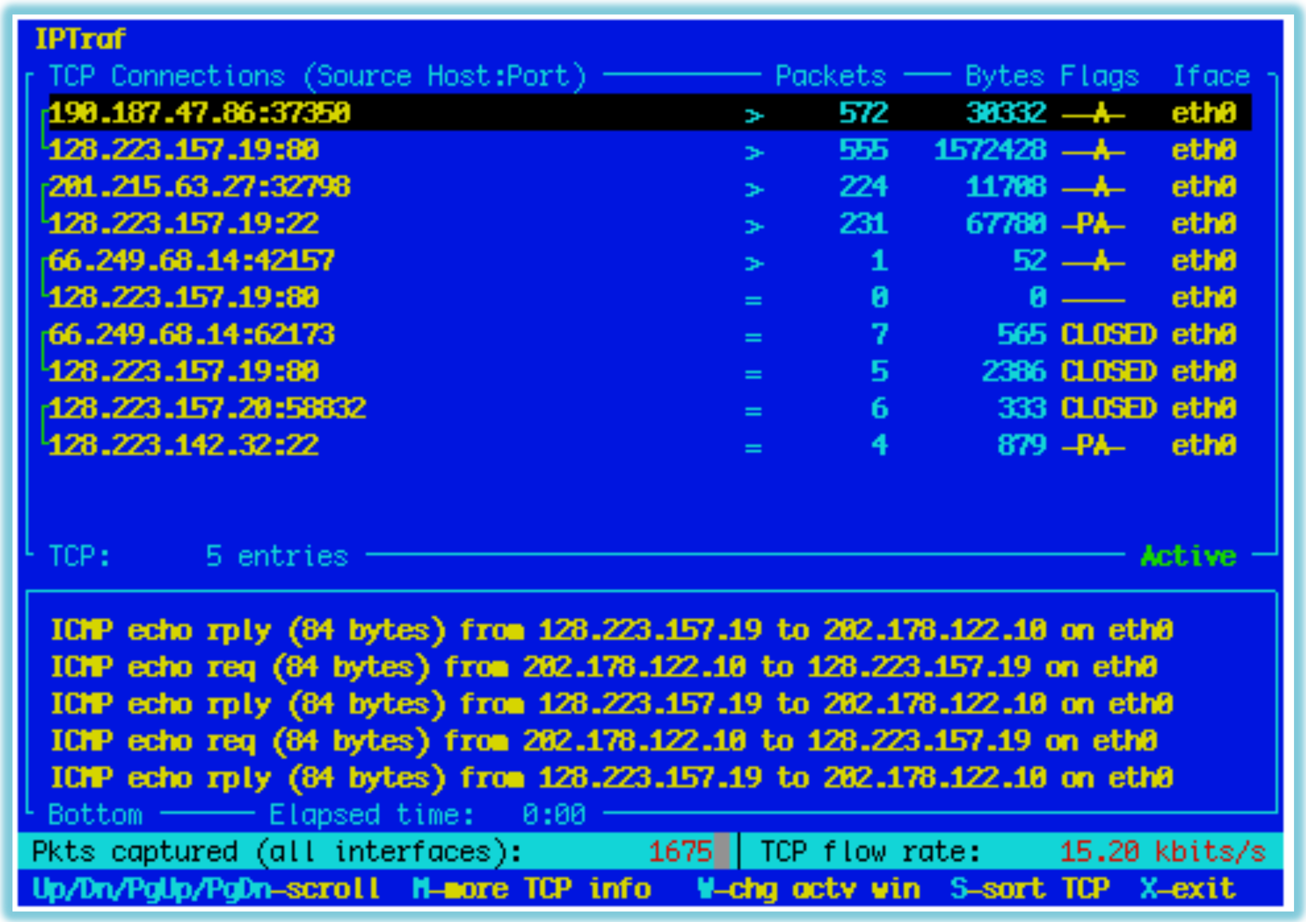
iptraf

- You can run it periodically in the background (-B)
  - It allows you, for example, to run as a cron job to periodically analyze logs.
    - Generate alarms
    - Save in a data base
    - Has a great name... “Interactive Colorful IP LAN Monitor”
    - etc...

Example: `iptraf -i eth1`

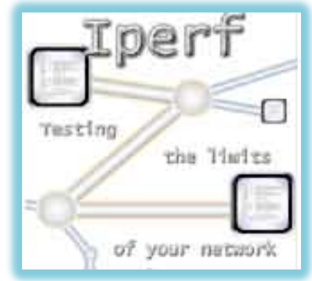
iptraf –i eth0

Sample *iptraf* output from the above command:



iperf

- To measure network throughput between two points
- *iperf* has two modes, *server* and *client*



- Easy to use
- Great to help determine optimal TCP parameters
  - TCP window size (socket buffer)
  - MTU maximum segment size
  - See `man iperf` for more

iperf

- Using UDP you can generate packet loss and *jitter* reports
- You can run multiple parallel sessions using *threads*
- Supports IPv6

iperf parameters

```
Usage: iperf [-s|-c host] [options]
       iperf [-h|--help] [-v|--version]

Client/Server:
  -f, --format    [kmKM]   format to report: Kbits, Mbits, KBytes, MBytes
  -i, --interval  #        seconds between periodic bandwidth reports
  -l, --len       #[KM]    length of buffer to read or write (default 8 KB)
  -m, --print_mss          print TCP maximum segment size (MTU - TCP/IP header)
  -p, --port      #        server port to listen on/connect to
  -u, --udp                use UDP rather than TCP
  -w, --window    #[KM]    TCP window size (socket buffer size)
  -B, --bind      <host>   bind to <host>, an interface or multicast address
  -C, --compatibility      for use with older versions does not sent extra msgs
  -M, --mss       #        set TCP maximum segment size (MTU - 40 bytes)
  -N, --nodelay            set TCP no delay, disabling Nagle's Algorithm
  -V, --IPv6Version        Set the domain to IPv6

Server specific:
  -s, --server             run in server mode
  -U, --single_udp         run in single threaded UDP mode
  -D, --daemon             run the server as a daemon

Client specific:
  -b, --bandwidth #[KM]    for UDP, bandwidth to send at in bits/sec
                           (default 1 Mbit/sec, implies -u)
  -c, --client    <host>   run in client mode, connecting to <host>
  -d, --dualtest           Do a bidirectional test simultaneously
  -n, --num       #[KM]    number of bytes to transmit (instead of -t)
  -r, --tradeoff           Do a bidirectional test individually
  -t, --time      #        time in seconds to transmit for (default 10 secs)
  -F, --fileinput <name>   input the data to be transmitted from a file
  -I, --stdin              input the data to be transmitted from stdin
  -L, --listenport #       port to recieve bidirectional tests back on
  -P, --parallel  #        number of parallel client threads to run
  -T, --ttl       #        time-to-live, for multicast (default 1)
```

iperf - TCP

```
$ iperf -s
------------------------------------------------------------
Server listening on TCP port 5001
TCP window size: 85.3 KByte (default)
------------------------------------------------------------
[  4] local 128.223.157.19 port 5001 connected with 201.249.107.39 port 39601
[  4]  0.0-11.9 sec    608 KBytes    419 Kbits/sec
------------------------------------------------------------

# iperf -c nsrc.org
------------------------------------------------------------
Client connecting to nsrc.org, TCP port 5001
TCP window size: 16.0 KByte (default)
------------------------------------------------------------
[  3] local 192.168.1.170 port 39601 connected with 128.223.157.19 port 5001
[  3]  0.0-10.3 sec    608 KBytes    485 Kbits/sec
```

iperf - UDP

```
# iperf -c host1 -u -b100M
------------------------------------------------------------
Client connecting to nsdb, UDP port 5001
Sending 1470 byte datagrams
UDP buffer size:   106 KByte (default)
------------------------------------------------------------
[  3] local 128.223.60.27 port 39606 connected with 128.223.250.135 port 5001
[  3]  0.0-10.0 sec    114 MBytes  95.7 Mbits/sec
[  3] Sent 81377 datagrams
[  3] Server Report:
[  3]  0.0-10.0 sec    114 MBytes  95.7 Mbits/sec  0.184 ms    1/81378 (0.0012%)

$ iperf -s -u -i 1
------------------------------------------------------------
Server listening on UDP port 5001
Receiving 1470 byte datagrams
UDP buffer size:   108 KByte (default)
------------------------------------------------------------
[  3] local 128.223.250.135 port 5001 connected with 128.223.60.27 port 39606
[  3]  0.0- 1.0 sec  11.4 MBytes  95.4 Mbits/sec  0.184 ms    0/ 8112 (0%)
[  3]  1.0- 2.0 sec  11.4 MBytes  95.7 Mbits/sec  0.177 ms    0/ 8141 (0%)
[  3]  2.0- 3.0 sec  11.4 MBytes  95.6 Mbits/sec  0.182 ms    0/ 8133 (0%)
...
              [ sec  11.4 MBytes  95.7 Mbits/sec  0.177 ms    0/ 8139 (0%)
[  3]  9.0-10.0 sec  11.4 MBytes  95.7 Mbits/sec  0.180 ms    0/ 8137 (0%)
[  3]  0.0-10.0 sec    114 MBytes  95.7 Mbits/sec  0.184 ms    1/81378 (0.0012%)
```

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