



Introduction to Networks & Distributed Computing

CECS 327





Performance - Latency

Latency = Propagation Delay + Transmit Time + Queuing & Processing Delay
= $T_p + T_x + T_q$

T_p (Propagation Delay) = (***Distance across link***)/(***Speed-of-light delay***)

T_x (Transmit Time) = (***Size of data***)/(***Throughput***)

T_q (Queuing & Processing Delay) = *This is hard to measure so a statistically generated value or a constant is used. (**depends on congestion**)*

where

Distance = length of the wire over which the data will travel (usually **meters/sec**)

Speed-of-light = effective speed of light over the channel

Size = size of the packet (**usually bits**)

Throughput = #bits/(unit time) at which the packet is transmitted (usually **bits/sec**)

Delay X Bandwidth

Delay-bandwidth **product** as a measure of *network capacity*

Latency (**delay**) length of the pipe and bandwidth the width of the pipe



Network as a pipe MK

Delay of 50 ms and bandwidth of 45 Mbps

50×10^{-3} seconds \times 45×10^6 bits/second

2.25×10^6 bits = 280 KB data.



Performance

- Chapter 1: Prob. 4 (a) and (b)
 - Hint: Propagation= $RTT/2$
- Chapter 1: Prob. 6



Performance - Tools

Two tools for probing the Internet are available on most computers:

ping -- sends a message to the specified computer and waits for a response. **ping** reports its findings.

```
Microsoft Windows [Version 6.1.7601]
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C:\Users\gg363d>ping www.yahoo.com

Pinging atsv2-fp-shed.wg1.b.yahoo.com [2001:4998:c:1023::5] with 32 bytes of data:
Reply from 2001:4998:c:1023::5: time=42ms
Reply from 2001:4998:c:1023::5: time=43ms
Reply from 2001:4998:c:1023::5: time=43ms
Reply from 2001:4998:c:1023::5: time=42ms

Ping statistics for 2001:4998:c:1023::5:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 42ms, Maximum = 43ms, Average = 42ms

C:\Users\gg363d>
```

Performance - Tools

Traceroute (tracert) -- sends a message to the specified computer reporting the intermediate computers along the path to the destination.

traceroute: gaia.cs.umass.edu to www.eurecom.fr

Three delay measurements from
gaia.cs.umass.edu to cs-gw.umass.edu

```
1 cs-gw (128.119.240.254) 1 ms 1 ms 2 ms
2 border1-rt-fa5-1-0.gw.umass.edu (128.119.3.145) 1 ms 1 ms 2 ms
3 cht-vbns.gw.umass.edu (128.119.3.130) 6 ms 5 ms 5 ms
4 jn1-at1-0-0-19.wor.vbns.net (204.147.132.129) 16 ms 11 ms 13 ms
5 jn1-so7-0-0-0.wae.vbns.net (204.147.136.136) 21 ms 18 ms 18 ms
6 abilene-vbns.abilene.ucaid.edu (198.32.11.9) 22 ms 18 ms 22 ms
7 nycm-wash.abilene.ucaid.edu (198.32.8.46) 22 ms 22 ms 22 ms 8
62.40.103.253 (62.40.103.253) 104 ms 109 ms 106 ms
9 de2-1.de1.de.geant.net (62.40.96.129) 109 ms 102 ms 104 ms
10 de.fr1.fr.geant.net (62.40.96.50) 113 ms 121 ms 114 ms
11 renater-gw.fr1.fr.geant.net (62.40.103.54) 112 ms 114 ms 112 ms
12 nio-n2.cssi.renater.fr (193.51.206.13) 111 ms 114 ms 116 ms
13 nice.cssi.renater.fr (195.220.98.102) 123 ms 125 ms 124 ms
14 r3t2-nice.cssi.renater.fr (195.220.98.110) 126 ms 126 ms 124 ms
15 eurecom-valbonne.r3t2.ft.net (193.48.50.54) 135 ms 128 ms 133 ms
16 194.214.211.25 (194.214.211.25) 126 ms 128 ms 126 ms
17 * * *
18 * * *
19 fantasia.eurecom.fr (193.55.113.142) 132 ms 128 ms 136 ms
```

trans-oceanic link

* means no response (probe lost, router not replying)

Q: The delay to router Router 10 > The delay to router 11, why?

Performance - Tools

Netstat

NETSTAT [-a] [-e] [-n] [-s] [-p proto] [-r] [interval]

- a Displays all connections and listening ports.
- e Displays Ethernet statistics. This may be combined with the -s option.
- n Displays addresses and port numbers in numerical form.
- p proto Shows connections for the protocol specified by proto; proto may be TCP or UDP. If used with the -s option to display per-protocol statistics, proto may be TCP, UDP, or IP.
- r Displays the routing table.
- s Displays per-protocol statistics. By default, statistics are shown for TCP, UDP and IP; the -p option may be used to specify a subset of the default.

interval Redisplays selected statistics, pausing interval seconds between each display. Press CTRL+C to stop redisplaying statistics. If omitted, netstat will print the current configuration information once.

```
Command Prompt
Microsoft Windows [Version 10.0.17763.720]
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C:\Users\gg363d>netstat -n

Active Connections

Proto Local Address          Foreign Address         State
TCP    127.0.0.1:4242          127.0.0.1:60116        ESTABLISHED
TCP    127.0.0.1:4767          127.0.0.1:49702        ESTABLISHED
TCP    127.0.0.1:49702         127.0.0.1:4767         ESTABLISHED
TCP    127.0.0.1:51659         127.0.0.1:51660        ESTABLISHED
TCP    127.0.0.1:51660         127.0.0.1:51659        ESTABLISHED
TCP    127.0.0.1:51661         127.0.0.1:51662        ESTABLISHED
TCP    127.0.0.1:51662         127.0.0.1:51661        ESTABLISHED
TCP    127.0.0.1:51663         127.0.0.1:51664        ESTABLISHED
TCP    127.0.0.1:51664         127.0.0.1:51663        ESTABLISHED
TCP    127.0.0.1:51665         127.0.0.1:51666        ESTABLISHED
TCP    127.0.0.1:51666         127.0.0.1:51665        ESTABLISHED
TCP    127.0.0.1:51667         127.0.0.1:51668        ESTABLISHED
TCP    127.0.0.1:51668         127.0.0.1:51667        ESTABLISHED
TCP    127.0.0.1:51669         127.0.0.1:51670        ESTABLISHED
TCP    127.0.0.1:51670         127.0.0.1:51669        ESTABLISHED
TCP    127.0.0.1:51671         127.0.0.1:51672        ESTABLISHED
TCP    127.0.0.1:51672         127.0.0.1:51671        ESTABLISHED
TCP    127.0.0.1:51673         127.0.0.1:51674        ESTABLISHED
TCP    127.0.0.1:51674         127.0.0.1:51673        ESTABLISHED
TCP    127.0.0.1:51675         127.0.0.1:51676        ESTABLISHED
TCP    127.0.0.1:51676         127.0.0.1:51675        ESTABLISHED
```



Performance - Tools

Nslookup

- An interactive program for querying Internet Domain Name System servers
- Converts a hostname into an IP address and vice versa querying DNS
- Useful to identify the subnet a host or node belongs to
- Lists contents of a domain, displaying DNS record

```
GA% Command Prompt
Microsoft Windows [Version 10.0.17763.720]
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C:\Users\gg363d>nslookup www.csulb.edu
Server:  dnspac1.ns.cs.boeing.com
Address:  192.124.60.53

*** dnspac1.ns.cs.boeing.com can't find www.csulb.edu: Non-existent domain
C:\Users\gg363d>
```




References

- Distributed Systems: Concepts and Design. George Coulouris, Jean Dolimore, Tim Kindberg and Gordon Blair. Fifth Edition, Pearson, 2012.
- Computer Networks, Fifth Edition: A Systems Approach (The Morgan Kaufmann Series in Networking).
- Computer Networks and Internets (5th Edition)
- Some slides by Dr. Tracy Bradley Maples