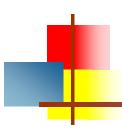


Introduction to Networks & Distributed Computing CECS 327





Performance - Latency

```
Latency = Propagation Delay + Transmit Time + Queuing & Processing Delay = Tp+ Tx+ Tq
```

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

Tx (Transmit Time) = (Size of date)/(Throughput)

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

<u>where</u>

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

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

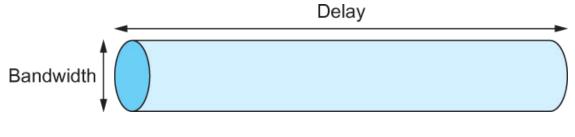
Size = size of the packet (usually bits)

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



Delay-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 $\times 45 \times 10^{6}$ bits/second 2.25×10^{6} bits = 280 KB data.



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

Chapter 1: Prob. 6



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]
Copyright (c) 2009 Microsoft Corporation. All rights reserved.
C:\Users\gg363d>ping_www.yahoo.com
Pinging atsv2-fp-shed.wg1.b.yahoo.com [2001:4998:c:1023::5] with 32 bytes of dat
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>
```



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.cs.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
6abilene-vbns.abilene.ucaid.edu (198.32.11.9) 22 ms 18 ms 22 ms
7nycm-wash.abilene.ucaid.edu (198.32.8.46) 22 ms 22 ms 22 ms 8
                                                                      trans-oceanic
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
                      means no response (probe lost, router not replying)
19 fantasia.eurecom.fr (193.55.113.142) 132 ms 128 ms 136 ms
```

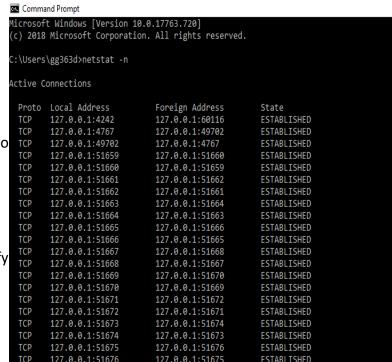
Q: The delay to router Router 10 > The delay to router 11, why?



Netstat

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

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



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

```
Command Prompt

Microsoft Windows [Version 10.0.17763.720]

(c) 2018 Microsoft Corporation. All rights reserved.

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 Dollimore, 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