# Investigating factors of Internet delay

**GRADE LEVEL:** 5th through 8th

**TIME NEEDED:** An average of three 50-minute class periods.

**PURPOSE:** To introduce basic computer science problems into the middle school classroom.

**OBJECTIVES:**

1. Students will learn about PING and Tracert.
2. Students will learn how to use PING and Tracert to study Internet delay.
3. Students will understand why PING and Tracert is a widely used diagnostic tool for the computer science industry.
4. Students will learn how to collect raw data.
5. Students will learn how to use the StudyWorks!® to create graphs.
6. Students will learn to interpret data using the trends found in graphs to draw conclusions on what factors affect Internet delay.

**MATERIALS:**

A class set of computers with Internet connections and the StudyWorks!® program.
(students may be paired for this activity)
Data sheets created by teacher (The StudyWorks!® program can be used to do this) see appendix A
Class printer to print out graphs

**CONCEPTS/SKILLS LEARNED AND MASTERED THROUGH THIS ACTIVITY:**

1. Students will be able to perform PING from the command screen.
2. Students will understand RTT (Round Trip Time).
3. Students will be able to collect data (RTT) using each factor tested.
4. Students will be able to create graphs in StudyWorks!® of the RTT data.
5. Students will be able to inferences based on the data collected.

**SUNSHINE STATE STANDARDS**
M.A.B.4.3
M.A.D.1.3
M.A.D.2.3
M.A.E.1.3
M.A.E.3.3

**TEACHING DIRECTIONS:**
1. This activity should be done over three 50-minute class periods. **Day 1** should be reserved for review of skills and concepts that need to be mastered in order to be successful with this activity. These skills and concepts are:

        a) Graphing x-y plots and parts of a graph.
        b) Basic computer skills such as typing, using the mouse, saving to the a:/drive etc.
        c) How to access and use the command screen.
        d) How to create a line graph in StudyWorks!®.

2. **Day 2** should be used to introduce PING, Tracert and the experiment. PING stands for "Packet InterNet Groper". PING and Tracert are two of the most widely used diagnostic tools for many test and measurements of the Internet system, including our experiment on Internet Delay and the factors that cause it. The PING program works much like a sonar echo-location (explain echo-location if your students aren't familiar with it). The program sends a small packet of information to a specified computer, which then sends a reply back to your computer. You can use PING to perform many network tests.
You can use analogies to illustrate how PING works. One really good analogy is the mailing of a magazine subscription order and actually receiving the magazine using the US postal service. You can use this analogy to discuss time, distance and traceroutes . See appendix B for this analogy.
Use day 2 to show students how to PING and Tracert. See appendix C and D for instructions on how to PING and Tracert .

3. **Day 3** we will use PING to track RTT for packet size, to trace route and track any packet loss, and distance. Explain to your students why this is an important issue to study. Encourage discussion of this issue. Explain that in order to make the Internet system more effective we need to understand what are the major causes of Internet Delay. In this activity we will assume that some of the factors are the **size** of the information, **the route or number of hops** to the site being traveled to, and the **distance** to the site. With each factor we will collect the average RTT in milliseconds (ms) for each variable. We will use 5 variables for each factor and create a graph of each factor. For example testing packet size we can PING 100 bytes, 1000 bytes, 10000 bytes, 30000 bytes and 60000 bytes each PING will produce an average RTT in ms we can then plot each variable tested on a line graph in StudyWorks!®

4. Once all the data is collected the students will use the StudyWorks!® program to create their line graphs. Students will then analyze the data and answer the conclusions questions that you create for them.

5. The teacher can choose whatever sites they wish to have their students PING. My students will PING some Ohio universities for size of packets, US cities for number of hops and cities around the world for distance. The students will look for packet loss and troubleshoot where the packets were lost by performing a traceroute and pathping.

   a) **Size:** Use 0 to 65500 bytes.
   - www.osu.edu
   - www.ohiou.edu
   - www.udayton.edu
   - www.kent.edu
   - www.miami.muohio.edu

   b) **Traceroute** (number of hops)
   - www.seattle.com
   - www.la.com
   - www.santafe.com
   - www.detroit.com
   - www.denver.com

   c) **Distance** (in miles compared to time in ms)
   You can have the students use a distance calculator such as the one found on www.indo.com/distance/ to get the distance in miles from your city to the city they wish.
   - www.kcl.ac.uk  (London England)
   - www.csu.edu.au (Sydney Australia)
   - www.cstnet.net.cn (Beijing China)
   - www.utoronto.ca (Toronto Canada)
   - www.southafrica.co.za (South Africa)

6. Once all the data is collected and recorded have the students put the results into the StudyWorks! Program. If you do not have the StudyWorks program then you can have your students draw the graphs or use Microsoft Excel. For instructions on how to create a graph in StudyWorks! See appendix E.
7. After the graphs are made assign your class some analysis questions to help tie the lesson together.
8. Last the students should write a conclusion.

# Appendix A

## Data Sheet

**Factor 1 - Packet Size**: Use 0 to 65500 bytes.

| Number of bytes | RTT in milliseconds (ms) |
|---|---|
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |

**Factor 2 - Number of Packet loss**

| Number of Packets sent | Number of packets received | Number of packets lost | Packet loss in % |
|---|---|---|---|
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |

**Factor 3 - Distance from site**

| Distance in miles | RTT in milliseconds (ms) |
|---|---|
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |

## Appendix B

**The Mail Analogy**

The analogy we will be using for the Internet is the United States Postal Service.

1. You fill out and mail a postcard that falls out of your favorite magazine so that you'll start receiving a subscription to it.
2. The mailman that covers your delivery area picks up the card from you and brings it to the local post office.
3. At the post office, it is determined that your postcard has to cross the country to be delivered, so it begins its journey through "The USA," which represents the network of post offices on the way to the final destination.
4. After crossing the country, your postcard goes to the "Main Post Office," which checks all incoming mail to make sure it is still on track. Think of it like California's State Central Post Office, where all letters are checked for destination addresses in California.
5. Your postcard then gets sent from local post office to local post office, until finally it arrives at the one that delivers the mail to the Magazine Subscriptions destination.
6. The mailman with the right delivery area delivers your postcard, and then your subscription begins, with the magazine leaving the Magazine Subscriptions location on its way back to you following the route in reverse.

The Internet isn't much more complicated then that! The names are different but the concepts are similar:

- Routers do the work of post offices
- Ethernet handles the mailman's job for each delivery area
- The Internet stands for the USA
- A Web server might be a destination computer, serving Web pages instead of magazine subscriptions

## Appendix C

## How to PING

You can perform a ping on a windows computer by opening a MSDOS window and then
type "ping" followed by the domain name or IP address of the computer you wish to
ping. You can list the available options with the command "ping -?".

```
Command Prompt                                                    _ |8| x|
Microsoft Windows 2000 [Version 5.00.2195]
(C) Copyright 1985-2000 Microsoft Corp.

c:\>Ping www.yahoo.com

Pinging www.yahoo.akadns.net [216.109.125.67] with 32 bytes of data:

Reply from 216.109.125.67: bytes=32 time=50ms TTL=50
Reply from 216.109.125.67: bytes=32 time=30ms TTL=50
Reply from 216.109.125.67: bytes=32 time=30ms TTL=50
Reply from 216.109.125.67: bytes=32 time=30ms TTL=50

Ping statistics for 216.109.125.67:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 30ms, Maximum =  50ms, Average =  35ms

c:\>_
```

Gives the RTT
in milliseconds

## Appendix D

### How to Trace route

The tracert command works much like the PING command. It is used to determine the path that a packet takes to reach a destination. To tracert simply access a MSDOS command screen and type "tracert" then the domain name or IP address and hit enter.

```
 Command Prompt                                                     _ |8| x
Microsoft Windows 2000 [Version 5.00.2195]
(C) Copyright 1985-2000 Microsoft Corp.

c:\>tracert www.yahoo.com

Tracing route to www.yahoo.akadns.net [216.109.125.79]
over a maximum of 30 hops:

  1    <10 ms    <10 ms    <10 ms  vlan2.enb-msfc.net.usf.edu [131.247.3.254]
  2    <10 ms    <10 ms    <10 ms  vlan254.wan-msfc.net.usf.edu [131.247.254.40]
  3     10 ms     10 ms    <10 ms  f9.ba01.b001841-0.tpa01.atlas.cogentco.com [66.2
50.5.201]
  4    <10 ms     10 ms     10 ms  g9-1.core01.tpa01.atlas.cogentco.com [66.28.66.9
3]
  5    <10 ms     10 ms     10 ms  p5-0.core01.mco01.atlas.cogentco.com [66.28.4.14
1]
  6     10 ms     10 ms     10 ms  p14-0.core01.jax01.atlas.cogentco.com [66.28.4.1
54]
  7     10 ms     20 ms     20 ms  p5-0.core01.atl01.atlas.cogentco.com [66.28.4.13
8]
  8     20 ms     20 ms     30 ms  p5-0.core02.dca01.atlas.cogentco.com [66.28.4.16
2]
  9     30 ms     30 ms     30 ms  p15-1.pr01.iad01.atlas.psi.net [154.54.1.190]
 10     20 ms     41 ms     30 ms  so-3-2-0.edge1.Washington1.Level3.net [209.0.227
.105]
 11     30 ms     30 ms     30 ms  so-5-0-0.gar2.Washington1.Level3.net [209.244.11
.13]
 12     30 ms     30 ms     30 ms  gige9-1.ipcolo1.Washington1.Level3.net [64.159.1
8.99]
 13     30 ms     30 ms     30 ms  unknown.Level3.net [63.210.59.254]
 14     30 ms     30 ms     40 ms  v130.bas1-m.dcn.yahoo.com [216.109.120.142]
 15     30 ms     30 ms     30 ms  w6.www.dcn.yahoo.com [216.109.125.79]

Trace complete.
```

## Appendix E

### StudyWorks!

1. Open a StudyWorks worksheet.
2. Open the "insert" menu and select "component"
3. Choose "input a table" and click on finish.
4. The program will insert a table into the worksheet. Where the cursor is blinking you must name that data that is going into that table.
5. Enter your data into the table.
6. Repeat steps 2-5 to enter your next set of data

7. To create a graph select the "insert" menu and choose "graph".
8. Choose the x-y plot choice.
9. Where the cursor is blinking put the name of "x-axis" data. Next click on the "y-axis" and enter the name of your "y-axis" data.
10. Click outside the graph and the program will plot your graph.