Teaching Network Infrastructure to High School Students

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Winchester Thurston School

The next 90 minutes…

- Background information
- The class
- Projects
  - Mapping project
  - Chat programming
- Processing
- Questions

Winchester Thurston School

- Independent School
- Located in Pittsburgh, PA
- ~240 students in HS

Scope and Sequence

- Technical Foundations
- 4 Trimester Electives
  - Technical Programming
  - Robotics and Engineering
  - Technical Design
  - Technical Infrastructures
- AP Computer Science
- Advanced CS Innovations

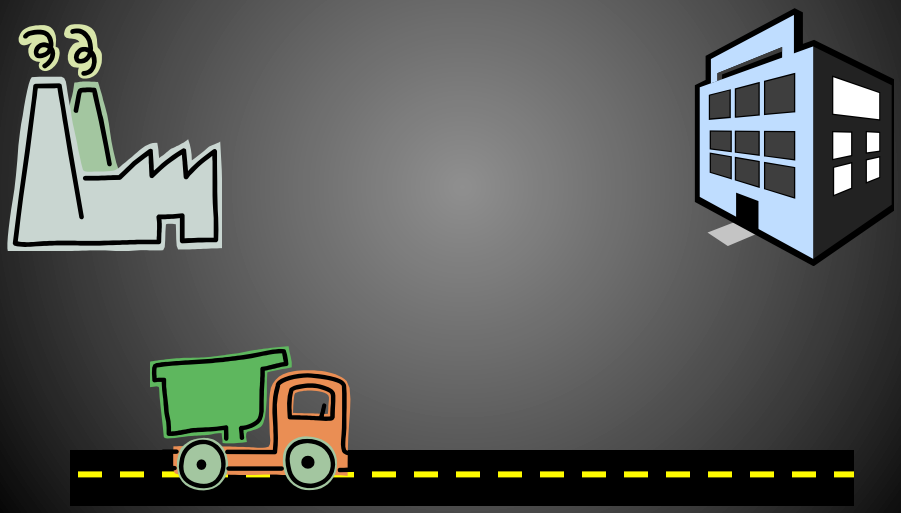
Technical Infrastructures

- Offered third trimester of 2012
- Requirements:
  - Teach network infrastructure concepts to High School students
  - Prepare them for AP Computer Science

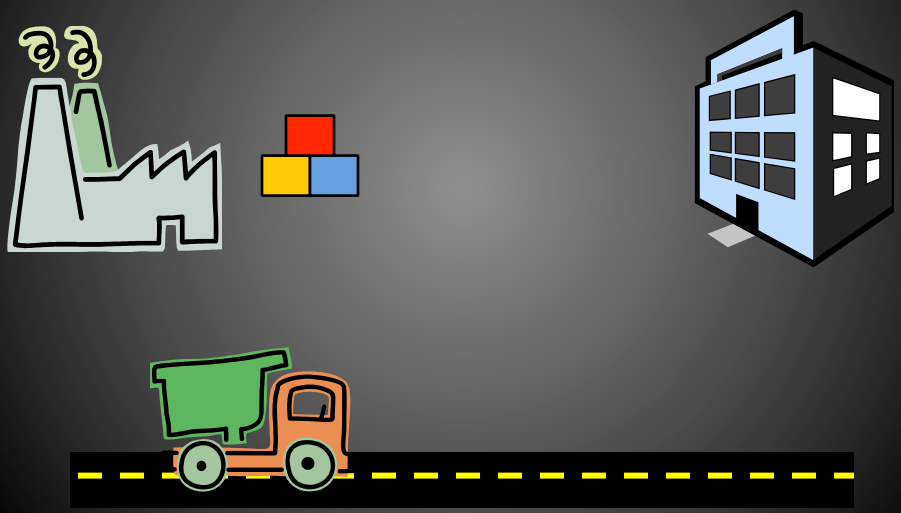
What is the Internet?

The Internet is a computer network that interconnects millions of computing devices throughout the world

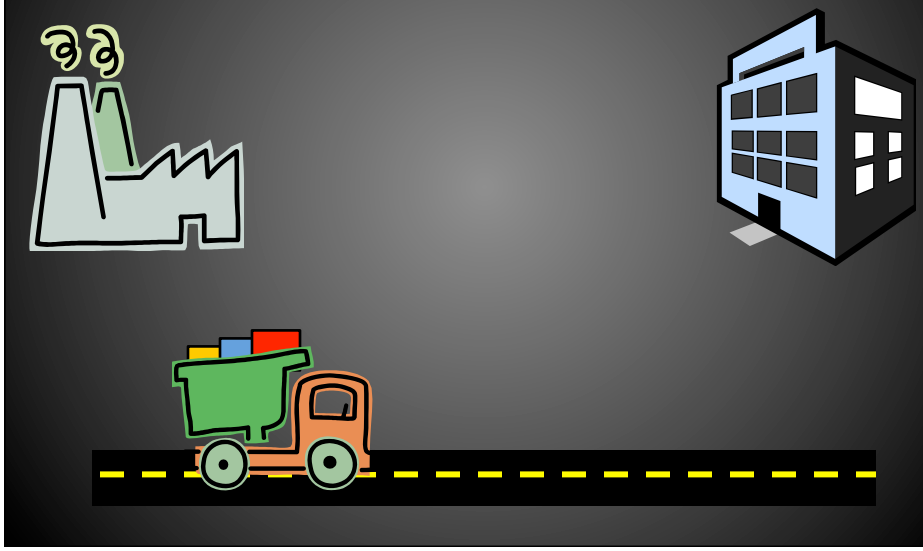
Factory needs to move large amount of cargo to some destination warehouse located thousands of miles away



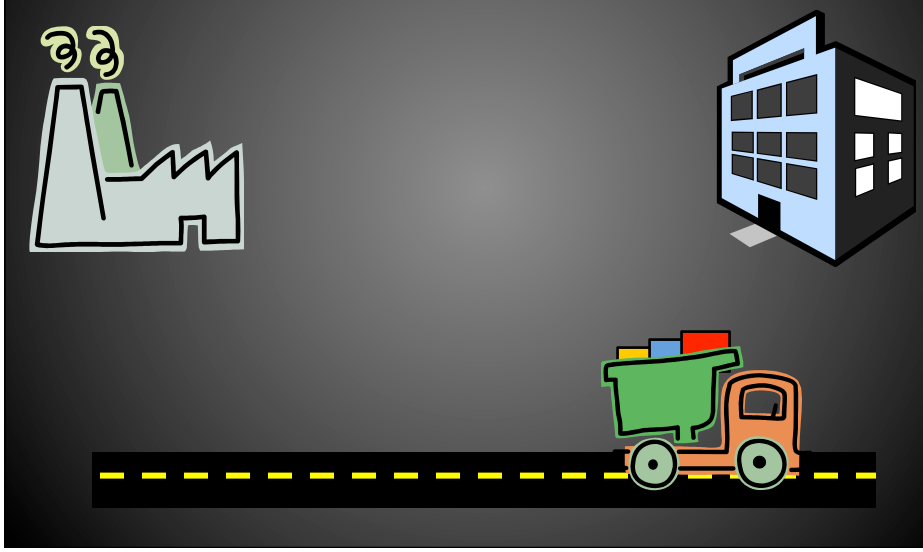
At factory, cargo is segmented and loaded into a fleet of trucks



Each of trucks then independently travels through the network of highways, roads and intersections to the destination warehouse



At destination warehouse, the cargo is unloaded and grouped with the rest of cargo arriving from same shipment



The Analogy

- Packet switched networks (which transport packets) are in many ways similar to transportation networks of highways, roads, and intersections (which transport vehicles).

The Analogy Explained…

- Packets = trucks
- Communication links = highways and roads
- Packet switches = intersections
- End systems = buildings
- Trucks take path through transportation network, packet takes path through computer network

First project

- Show the traveling packets using `tracert` command
- The command will show the IP addresses associated with the hops along the route to the destination

- `> tracert www.google.com` produces the following:

- Tracing route to www.google.com [74.125.115.99] over a maximum of 30 hops:

```
1    2 ms    1 ms    1 ms  192.168.1.1
2    9 ms   12 ms   18 ms  96.179.232.1
3   10 ms   16 ms    9 ms  ge-6-16-ur02.pittsburgh.pa.pitt.comcast.net [68.85.234.13]
4   22 ms    9 ms    8 ms  te-8-1-ur01.pennhills.pa.pitt.comcast.net [68.87.173.58]
5   13 ms   15 ms   10 ms  te-0-11-0-1-ar03.mckeesport.pa.pitt.comcast.net [68.85.75.41]
6   22 ms   36 ms   20 ms  pos-1-4-0-0-cr01.ashburn.va.ibone.comcast.net [68.86.94.161]
7   21 ms   17 ms   19 ms  pos-0-5-0-0-pe01.ashburn.va.ibone.comcast.net [68.86.87.14]
8   22 ms   22 ms   78 ms  75.149.231.62
9   47 ms   25 ms   24 ms  209.85.252.80
10  32 ms   32 ms   31 ms  209.85.243.114
11  34 ms   32 ms   33 ms  64.233.174.117
12  31 ms    *      59 ms  209.85.253.185
13  39 ms   33 ms   34 ms  vx-in-f99.1e100.net [74.125.115.99]
```

- Trace complete.

- The idea of project:

```
1    2 ms    1 ms    1 ms  192.168.1.1
2    9 ms   12 ms   18 ms  96.179.232.1
3   10 ms   16 ms    9 ms  ge-6-16-ur02.pittsburgh.pa.pitt.comcast.net [68.85.234.13]
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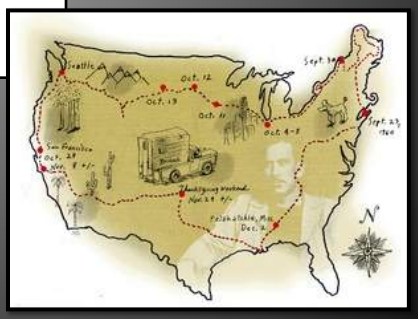

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4 22 ms 9 ms 8 ms te-8-1-ur01.pennhills.pa.pitt.comcast.net [68.87.173.58]
5 13 ms 15 ms 10 ms te-0-11-0-1-ar03.mckeesport.pa.pitt.comcast.net [68.85.75.41]
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9 47 ms 25 ms 24 ms 209.85.252.80
10 32 ms 32 ms 31 ms 209.85.243.114
11 34 ms 32 ms 33 ms 64.233.174.117
12 31 ms * 59 ms 209.85.253.185
13 39 ms 33 ms 34 ms vx-in-f99.1e100.net [74.125.115.99]

- Trace complete.

- These highlighted numbers are the IP addresses for the stops along the way to the destination.

```
1    2 ms    1 ms    1 ms  192.168.1.1
2    9 ms   12 ms   18 ms  96.179.232.1
3   10 ms   16 ms    9 ms  ge-6-16-ur02.pittsburgh.pa.pitt.comcast.net [68.85.234.13]
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```

Copy these numbers down

1. 192.168.1.1
2. 96.179.232.1
3. 68.85.234.13
4. 68.87.173.58
5. 68.85.75.41
6. 68.86.94.161
7. 68.86.87.14
8. 75.149.231.62
9. 209.85.252.80
10. 209.85.243.114
11. 64.233.174.117
12. 209.85.253.185
13. 74.125.115.99

Convert the addresses to a number using the following formula:

1. 192.168.1.1
2. 96.179.232.1
3. 68.85.234.13
4. 68.87.173.58
5. 68.85.75.41
6. 68.86.94.161
7. 68.86.87.14
8. 75.149.231.62
9. 209.85.252.80
10. 209.85.243.114
11. 64.233.174.117
12. 209.85.253.185
13. 74.125.115.99

IPNUM = 16777216*w + 65536*x + 256*y + z where

IP Address = w.x.y.z

The reverse of this formula is

w = int (ipnum / 16777216) % 256;
x = int (ipnum / 65536) % 256;
y = int (ipnum / 256) % 256;
z = int (ipnum) % 256;

Where % is the mod operator.

Converted numbers look like this:

1. 3232235777
2. 1622403073
3. 1146481165
4. 1146596666
5. 1146440489
6. 1146511009
7. 1146509070
8. 1268115262
9. 3512073296
10. 3512071026
11. 1089056373
12. 3512073657
13. 1249735523

- Take each number and look it up in chart provided on USB drive called:

  GeoLiteCity-Blocks.csv
- This will provide you with a location number for each IP Number

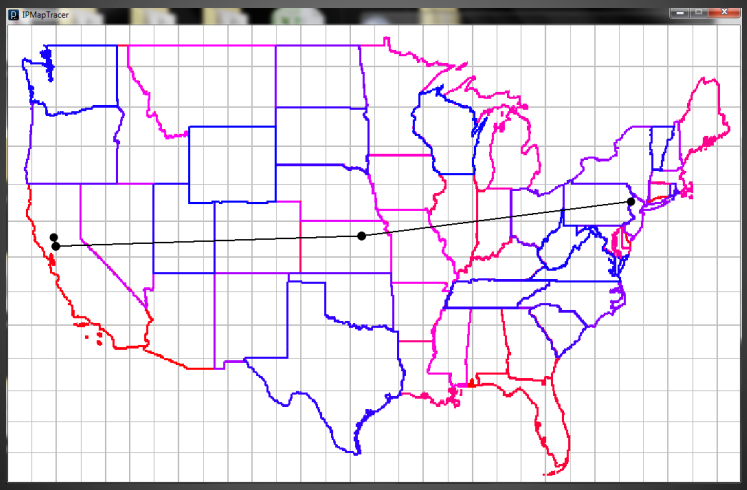
Location Numbers for each IP Number

1. 3232235777
2. 1622403073
3. 1146481165
4. 1146596666
5. 1146440489
6. 1146511009
7. 1146509070
8. 1268115262
9. 3512073296
10. 3512071026
11. 1089056373
12. 3512073657
13. 1249735523

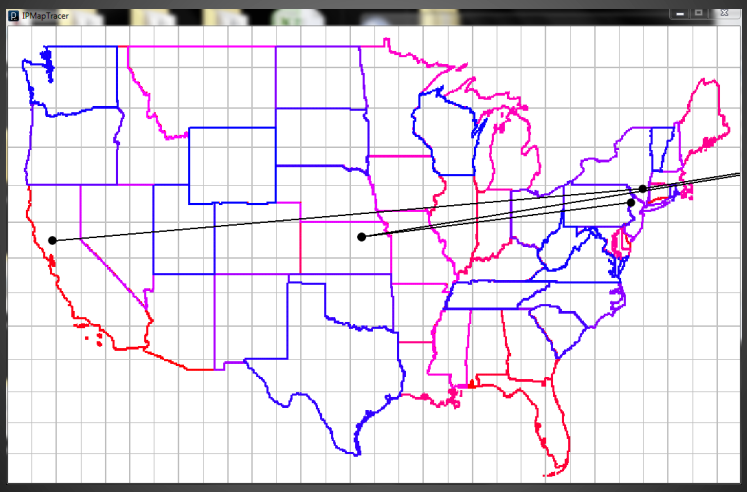
From each location number, you can look up the corresponding latitude and longitude in *GeoLiteCity-Location.csv*

From these Latitudes and Longitudes, you can display them on a map!

www.google.com

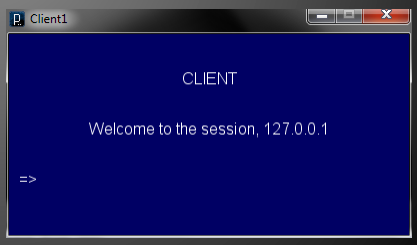


www.wikipedia.org



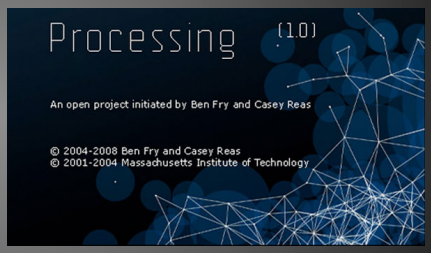
Another project:

- Students understand that IP addresses indicate a location on the network.
- Using Processing write a chat program/game that utilizes network infrastructure and IP addresses.



Processing

- Processing is a Java variant that scaffolds well to Java
- Quick creation of UI and graphical projects
- Uses Java syntax
- Students are well prepared for AP Computer Science from their use of Processing



Statistics

- 13 students took class
  - 3 females/10 males
  - 3 females/5 males went on to take AP CS
- Of 8 that took AP CS, 7 got a 4 or 5
  - 1 was unable to take it due to medical reasons
- Of 13 taking class, five students had NO programming experience
  - Of those five with no prior experience programming, 2 took AP CS and both earned 4s on the test

Questions

- If you were to teach a networking concept at your school, where/when would you teach it?
- What length of time would you have to teach this module on networking?
- What would you be interested in teaching the students?
- Yours?


THANK YOU.