

Pings and Pongs:
A Journey with Networks, Their Hosts
and Their Routes

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Introduction

In this paper, discussion topics include Networks and what they are, tracing programs and what they do, using a software that will assist in identifying the path of hosts used to ping to devices located over 2000 miles, in ten different scenarios, and finally a thorough comparison of these pings.

Background – Networks

You can think of a network as a graph, a collection of edges and vertices. In laymen terms edges are otherwise known as lines and vertices as nodes. Networks are made up of nodes that represent locations and lines that represent both physical and virtual communication lines. These lines interconnect computers to routers to web servers and vice versa, forming a matrix of networks that allow humans to communicate via numerous hardware devices. Figures 1 can help you visualize these connections in a very basic sense.

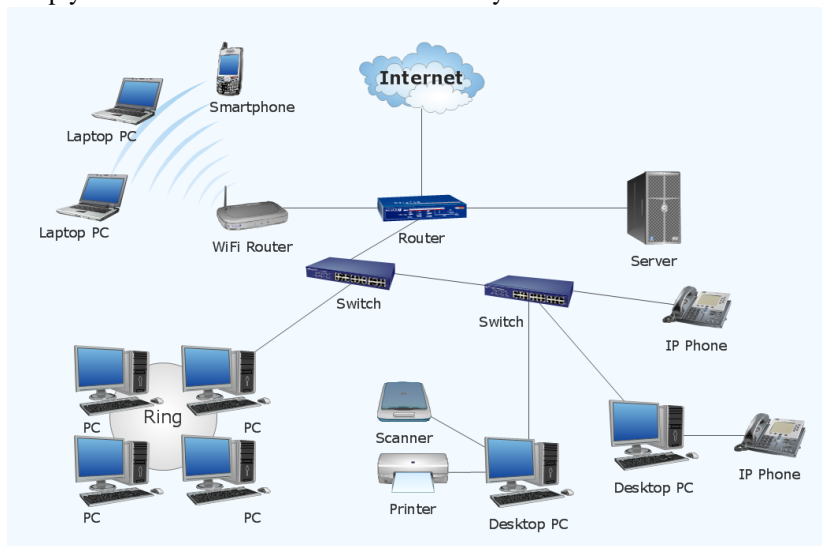


Figure 1 - (Source: <http://www.conceptdraw.com/How-To-Guide/network-diagram>)

These networks allow for us to exchange and share data, communicate and socialize, and offer services and resources. Take web surfing for example, thousands of web pages are located in different databases and are hosted by a myriad of servers (the program that facilitates communication). The user uses a device to send data through the browser to these servers using a Hyper Text Transfer Protocol (HTTP) request. These servers then recognize this request and retrieve information in relation to the data requested. They then send this information back to the user allowing them to view a web page. In this example the user is utilizing the network to retrieve information that is provided as a service. These locations where the data is accessed are referred to as DNS (domain name system) root servers. DNS servers function is to carry and transmit data from one computer to another.

The DNS is a database that houses all the information pertaining to IP (Internet Protocol) addresses and domain names online. Internet Protocol addresses can be thought of as identification numbers commonly represent by a series of digits referred to as IPv4. These numbers are separated by periods (i.e. 192.165.5.148). These Protocols are standards set by organizations to keep standardized formats for data in a variety of forms. As people soon realized, IP numbers were very difficult to memorize and therefore, domain names otherwise known as website names (i.e.

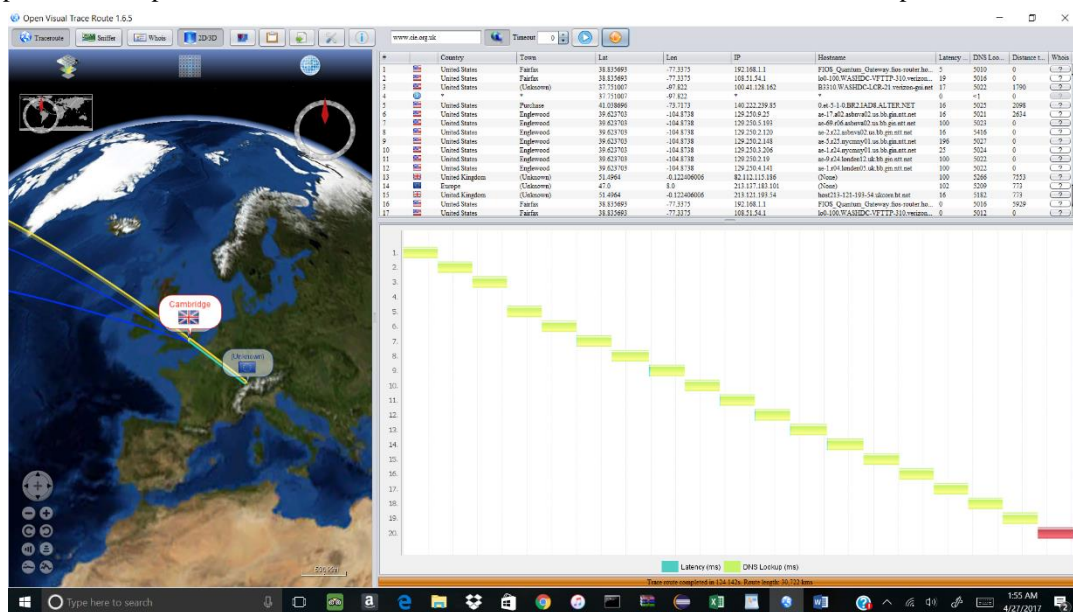
As noted earlier, networks, can be illustrated as links and nodes. Smaller localized networks are commonly referred to as Local Area Networks (LAN) and are interconnected with larger networks to form Metropolitan Area Networks (MAN). Networks that span the face of the globe are known as Wide Area Networks (WAN) [6]. The topology of these networks can range in design and these design variations help aid in communication efficacy. Network topology refers to the fundamental layout of a network and is an important characteristic of them. It defines the paths between different points within a network, the paths being the lines and points referring to the nodes discussed earlier. Topologies is an important concept to consider when using a trace program, the relation will be discussed in the subsequent sections.

Background – Tracing Programs

There are typically two different functionalities that a tracing software uses in networks. The first function is used to determine whether that device is on or offline, this process is known as a ping. The second function is used to trace the source of a network device. A ping sends a message, consisting of 32 bytes of data, to the source to see if a response is administered. A `tracert` command utilizes a computer software tool that measures the time it takes for messages to be sent from the host back to the source and is then used to determine and test the reachability of a host over an Internet Protocol (IP) network [7]. A round trip time is reported for each ping reply received. The ping is measured by the local clock in the computer, from the time the request left to the time the reply was received. Traceroute is the software used in this paper to ping network hosts and can also be used to compute the specific topology of a network in the internet [4]. Traceroute offers a countless number of functionalities, however, for the purpose of this paper we will discuss this program and what it does at a rudimentary level. Our methods will test the basic functionality of this software and the average time it takes for these messages to communicate via hosts.

Methods

First, the software Open Visual Trace Route was downloaded from <https://sourceforge.net/projects/openvisualtrace/>. After this, a suitable domain name was procured, <http://www.cie.org.uk>. This domain name met distance requirements, being over 2000 miles in distance from Virginia, 3,593 miles to be exact. The software was used to ping the IP address associated with this domain name from my location. This function was then repeated ten times and the paths that the packets took from source location to destination were recorded and exported into an excel file.

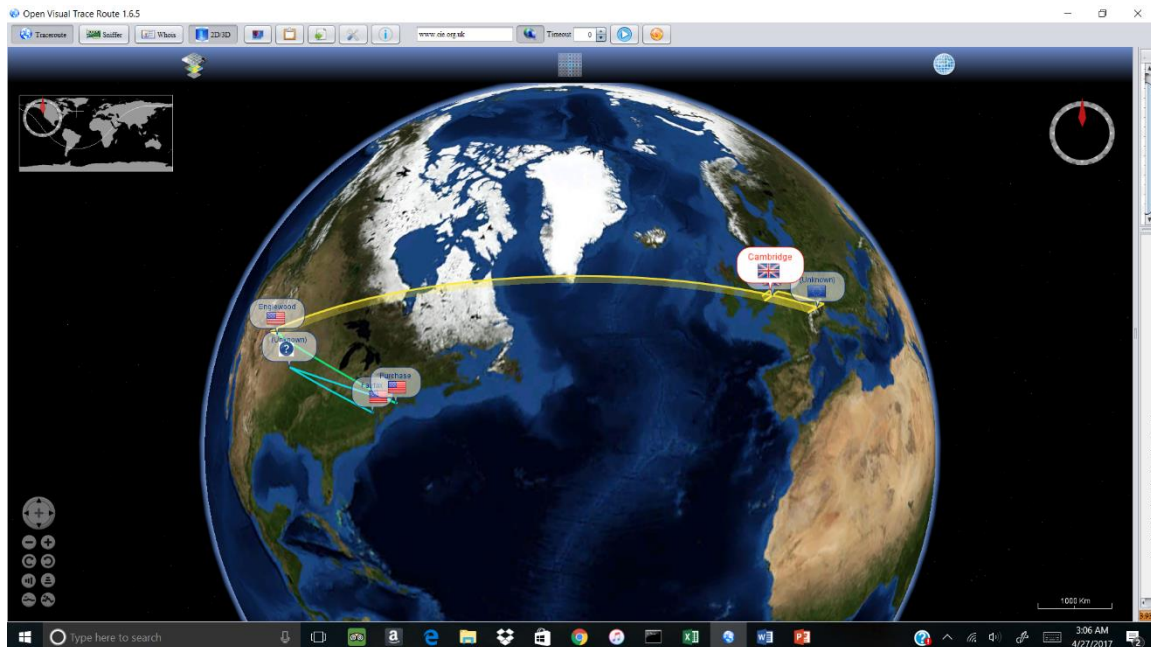


Pictured in the figure above is a screenshot of the software Trace Route, after completion. In the upper right corner, each row listed represents a host network where this ping from our location traveled to. On the left is a diagram of earth that represent how and where exactly these pings are traveling. To the right bottom we have a form of a bar

graph showcasing the latency time of each ping and the DNS lookup for each host. Latency refers to how long it takes one packet to get from source to destination. As mentioned earlier, DNS stands for domain name system, which is the database responsible for storing all of the information pertaining to IP addresses and domain names online. DNS lookup in this graph represents the time it takes in milliseconds for a DNS record to be returned from a DNS server. This software gives a good summarization about the ping route. In the following section a further analysis of the ping routes will be done.

Results and Discussion– Comparing Pings

The traceroutes collected were sampled back to back in this experiment. Based on the 10 different data sets collected the average number of hops for each ping was eighteen. The average route length for each trace was 20,019 kilometers. Out of the 10 pings the average time taken for a trace route completion was 115.22 seconds. As seen in the diagram below these pings utilized a mesh network to send the packet to the correct destination. A network topology refers to the architecture and design of the network. In a mesh network each node relays data and works together with other nodes to distribute this data effectively with the end goal of reaching the destination node. Mesh networks relay messages using a flooding technique or a routing technique. In a routing technique the message propagates along a path by hopping node to node until it finally reaches its destination. In a flooding technique instead of following a specific route from one node to another node, the message is propagated to all nodes in the network, this includes unintentional nodes [8]. We can see that here the routing technique is used.



What's interesting about this diagram produced by the software Open Visual Trace Route is that you see the ping traversing its path multiple times. Due to the distance between the source and the destination node the ping has to take more hops in order to reach its destination. It is important to note that more hops translates to a higher possibility of failure, reduced bandwidth/bottlenecks and higher latency [9].

Conclusions

In this paper networks were introduced at a very high level. A discussion on networks then pursued, on how and for what purpose they operate and also how traffic flows in a network. We used the software Open Visual Trace Route to help administer methods that involved pinging a website ten times, that was located over 2000 miles away. This was conducted in order to see the path in which the message traveled. A thorough analysis was conducted on each individual ping and results were compared with other ping results. Based on our results we can conclude that the topology used in this instance is a mesh topology.

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