

Network Health Monitoring System

Zeeshan Siddiqui, Dr. Abdallah Shami, Dimitrios Michael Manias, Ibrahim Shaer
Department of Electrical and Computer Engineering

Problem

- With so many devices connected to the Internet, connections need to be monitored for delays and packet loss to ensure proper functioning.
- A client wants to develop an application that will allow its customers to examine the network quality at the location in which they have placed an Internet service such as a database, or server.
- Based on data received from that location, customers can gain insights and make informed decisions to change locations of their Internet service, or not.

Background

- Data is sent throughout computer networks in packets.
- One message can be divided into multiple packets.
- Common problems that occur during packet transmissions include:
 - **Delays** – the time it takes for packets to be transmitted from one network endpoint to another.
 - **Packet Loss** – packets become corrupt and/or do not reach the endpoint.
- **Delays and packet loss** can occur due to a variety of factors including:
 - **Transmission delays** – the time it takes for a packet to be transmitted based on transmission rate.
 - **Queuing delays** – when an intermediate network device receives packets faster than it can forward the packets to the next place, causing delays in forwarding packets, and possibly packet loss due to overflow in queue.
 - **Propagation delays** – delays caused by the transmission medium's propagation speed and the distance between the two endpoints (ex. Ethernet cables speed is faster than wireless).
- To measure connection quality, two key computer network utilities can be used:
 - **Ping** – a set of packets of equal length are sent from a source to a specified destination. If the destination successfully receives a packet, it replies to the source by sending a packet of same length. The round-trip time from the source sending a packet and receiving a reply is measured as well as the # of packets lost.
 - **TraceRoute** – a packet is sent from a source to a specified destination. The path the packet took to reach the destination is recorded. The “path” refers to the different network devices, or “hops”, that packet had to travel through to reach the destination. The time it took to reach each hop is recorded.

Solution

- Our team developed a web application where customers of the client can set up probes in various locations across the computer network.
- These probes will periodically run Ping and TraceRoute tests to various destinations across the Internet, to gather data about the quality of the network at that location.
- The data includes round trip times (latency), packet loss (%), and network paths (from Trace Route) between source probes to several destinations.
- The data is then organized and formatted in a simple chart or diagram for the user to understand the quality of network connections.
- Since the data is collected periodically, the user can observe network connections data overtime, and see trends in the quality of the connections to make a decision about migrating to a new location or not.

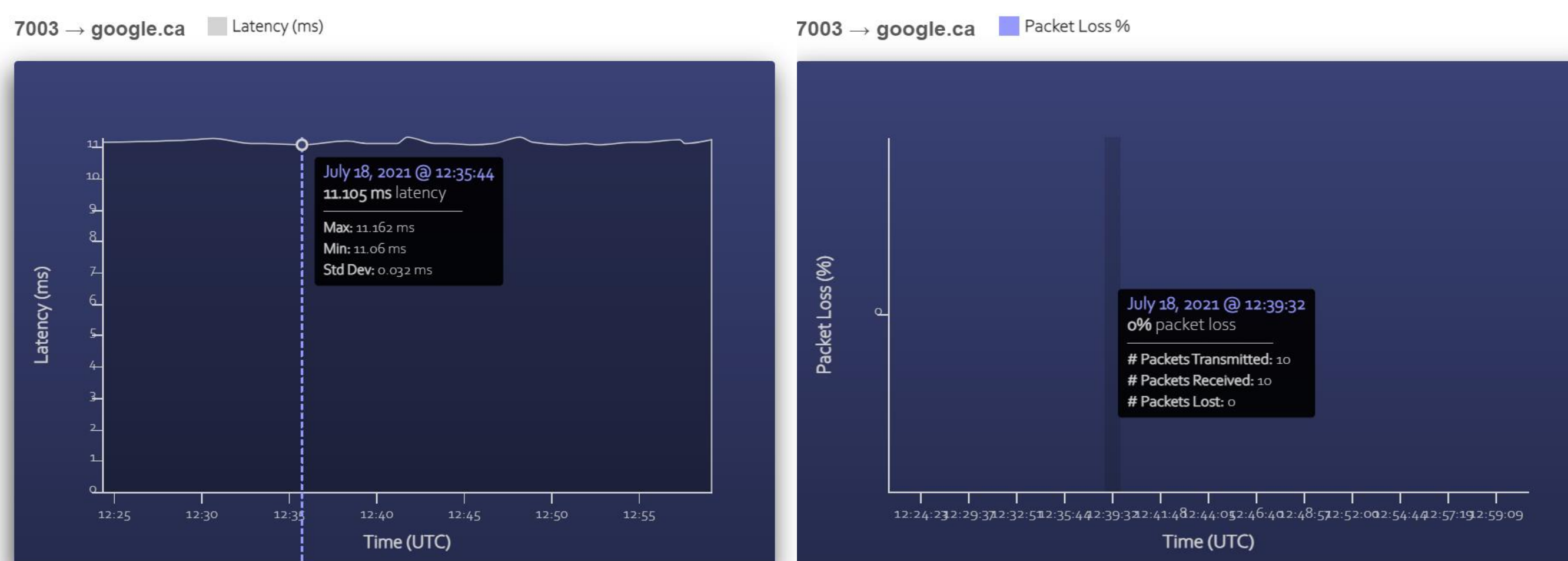


Figure 1.0: On left, area graph showing average latency (round-trip time) from Ping tests done between July 17, 2021 to July 19, 2021, from source probe 7003 to destination google.ca. Hovering over a point causes a box to appear displaying additional statistics. On right, bar graph showing packet loss (%) from Ping tests done between July 17, 2021 to July 19, 2021, from source probe 7003 to destination google.ca (note that no bars are visible since there was 0% packet loss during this selected time range). These graphs are found on the Path View page. Hovering over a bar causes a box to appear displaying additional information.

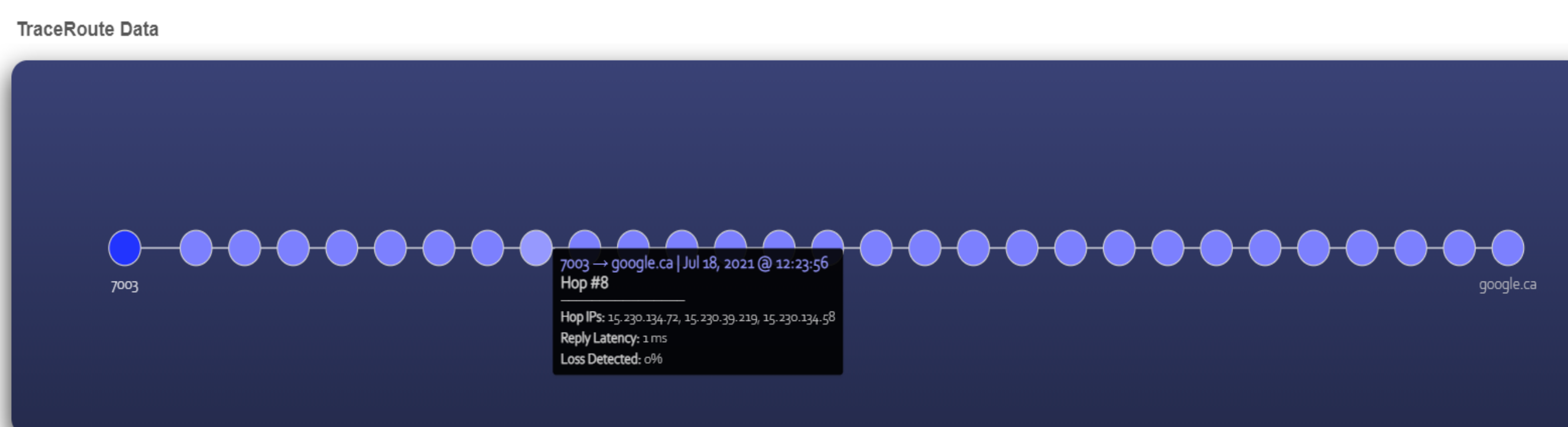


Figure 2.0: Tree diagram displaying TraceRoute data from source probe 7003 to destination google.ca. Each circle is a node depicting a “hop” which an intermediate network endpoint that the packet travels before reaching its destination. Hovering over a node causes a box to appear displaying additional information about the hop.

Contribution to Project

Main Objective: to develop the code of a front-end web application that provides tools and information for customers to manage their probes and view statistics, visualized as graphs and diagrams, about how their probes are running.

Technologies Used

- JavaScript language
- React framework
- Material-UI library (provided out-of-box UI components)
- visx (Airbnb Data Visualization Library)
- React Testing Library and Jest
- Amazon Web Services (API Gateway, DynamoDB, Lambda)

Tasks Accomplished

- Learned how to write JavaScript code using a framework called React which provided pre-built features to simplify front-end web development.
- Developed user interface components in the front-end application which can be divided into the following pages:
 - **Dashboard Page** – displays a customer’s probes and regions, and events, such as problems or warnings, concerning any of their probes.
 - **Probes and Regions Configuration Page** – page where the customer can create/edit a region or probe.
 - **Probe Tests Page** – page where the customer can observe data from Ping tests done between a selected source probe and one or more destinations, within a specified time range. An area graph is used to visualize the latency (round-trip time) data, and a bar graph is used to visualize the packet loss data. See *Figure 1.0* for a screenshot of a sample area and bar graph.
 - **Path View Page** – page where the customer can observe data from TraceRoute tests done between a selected source probe and one or more destinations, within a specified time range. A tree diagram is used to visualize the TraceRoute paths and each hop. See *Figure 2.0* for a screenshot of a sample tree diagram.
 - **Add New Customer Page** – page where the website administrator can add a new customer. A customer can then have access and create their own probes and regions.
 - **Add New User Page** – page where the website administrator can add a new user.
- Other components that were developed include:
 - **Site Header** – UI component that displays the administrator’s name and their customers. Selecting a customer pulls that customer’s probe and region data from the database.
 - **Navigation Pane** – UI component that provide links to the key pages specified above.