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| **Grade: 9 - 12** | **Unit: Networking** |
| **N2: Exploring Network Routers & Reliability** **by finding the Longest Traceroute on the Internet** |
| **Topic:** * Network Routers
* Network Reliability
 | **Materials:*** Computer-less Network Activity:
	+ Box of Envelopes (50)
	+ Slips of “Packet” paper (50)
	+ Class set of “Node” Instructions
* Class set of computers, with:
	+ Internet connection
	+ Ability to run command line/ terminal
	+ [Wireshark/tshark](https://www.wireshark.org/download.html) installation
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| **Science & Engineering Practices (SEPs)** | **Disciplinary Core Ideas (DCIs)** | **Crosscutting Concepts (CCs)** |
| * **Not applicable**
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| **APCSP Enduring Knowledge Standards:*** EK6.2.1A The Internet and the systems built on it are hierarchical and redundant.
* EK6.2.1D Routing on the Internet is fault tolerant and redundant.
* EK6.2.2B The redundancy of routing (ie. More than one way to route data) between two points on the Internet increases the reliability of the Internet and helps it scale to more devices and more people.

**CSTA K-12 Computer Science Standards*** 3A-NI-04 Evaluate the scalability and reliability of networks, by describing the relationship between routers, switches, servers, topology, and addressing.
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| **Essential Question:** * What are the factors that affect Network reliability?
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| **Learning Target** | SWBAT identify factors that affect Network reliability. |
| **Engage** | **(THINK-PAIR-SHARE)*** Students answer the following prompt in their notebooks:

“You’re sending a package to your friend in Los Angeles. Describe the steps your package takes to get to them (starting at when you drop off at the post office).”* After 2 minutes, students share their answers with a partner.
* Choose 3 groups to share their answers.
* Highlight answers that include:
	+ Starting Location
	+ Ending Location
	+ Intermediate stops
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| **Explore** | **(COMPUTER-LESS NETWORK ACTIVITY V1)*** Pass out Node Instructions to all students.
* Designate different roles for different students. (Try to do so such that they do not initially know the role of all of the other students.)
	+ Designate 2 students to be “Client” and Server. Generally, choose students at opposite corners of the room. Both Client and Server are given a stack of envelopes, “packet” paper slips.
	+ Designate at least 2 students to be “Dead Nodes”.
	+ Designate all other students to be “Routers”.
* Prompt the Client to begin writing a message.
* Be the referee to make sure students are following their roles.
* Let the Network run until the Server has sent at least one set of packets back to the Client.

**(COMPUTER-LESS NETWORK ACTIVITY V2: DROPPED PACKETS)*** Once students have gotten the hang of the activity, add another level where all messages do not make it back and forth.
* Pass out modified Instructions to students for Version 2.
* Designate additional roles. (You can mix up who is the Client and Server to give more kids a chance to be active.)
	+ “TCP Client” -1
	+ “UDP Client” -1
	+ “Dead Nodes” - designate at least 2
	+ “Client” - 1 or 2
	+ “Routers” - everyone else
* Run the new network.
* Make sure that the Clients realize to ask for missing TCP packets, but not missing UDP packets.
* You may need to help the UDP Client come up with a good message with information that:
	+ Doesn’t change too much OR
	+ Is small and sent often enough that 1 missed packet isn’t harmful.
* Let the network run until you have seen TCP packets dropped, UDP packets dropped, TCP packets requested.
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| **Explain** | * Use the previous activity to have students define the following:
	+ “Packet”
	+ “Router”
	+ “Node”
* “How big of a deal is it if packets get dropped?”
* “Was any particular person/ “node” more important to ensure messages got through?
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| **Extend**  | **(LONGEST ROUTE ACTIVITY)*** Students work in pairs with computers.
* Demonstrate using the traceroute tool on command line.
* Provide worksheet to students to run a traceroute. [TRACEROUTE WORKSHEET]
* Students should run initial traceroutes:
	+ Run a traceroute to Google.com
	+ Run a traceroute to Baidu.cn
	+ Run a traceroute to 8.8.8.8
* After 5 minutes, setup the challenge for students:
	+ Find a path that takes at least 15 hops.
	+ Who can find the longest path? (Prize!)
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| **Evaluate** | * Longest Path group shares
	+ “What makes a path longer or shorter?”
* Discussion “Network Reliability” with Students:
	+ “What happened if a dead node was in between the Client & server?”
	+ “How do you make it fault-tolerant?”
* Exit Slip:
	+ “What can be done to make a network more reliable? (Base your answer on the specific concepts we learned today.)
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| **Differentiation** | * For a lower level, the teacher can choose 1 client and the teacher be the server. The teacher can lead students through the messages altogether.
* For higher levels, the teacher can assign multiple clients and servers, until students can visualize congestion!
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