

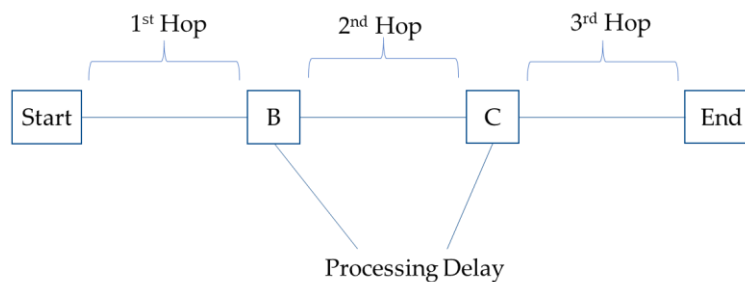
2021 Q21

DELAY, PATHFINDING

To continually monitor our projects, One Energy communicates with our turbines via several programs, sending information through secure computer *networks*. Nearly every computer across the globe is connected through networks, with the help of intermediary machines guiding the data to its destination. The connection between each of these machines is called a hop (as shown in the diagram below).

The messages traveling these networks do not arrive instantly, however – there is a delay between sending and receiving. Two such types of delay are called the *propagation delay* and the *processing delay*. The propagation delay is how much time it takes for the information to travel from one machine to the other (think about propagation delay like the time it takes your words to travel across a field and your friend hearing you). The processing delay is the amount of time it takes the machine to figure out where to send the message next (kind of like the amount of time it takes your friend’s brain to understand spoken words). The processing delay and propagation delay are parts of the *total delay*.

The figure shows a simple network. Each hop has a propagation delay, and machine B and machine C have processing delays.



Level 1: Create a formula that calculates the total delay with the following variables: number of hops, propagation delay, and processing delay. Use that formula to solve for the total delays in the following scenarios. Assume the propagation delay is the same in all connections. Assume the processing delay is the same in all intermediary machines, and zero in the original sender and final receiver.

	Number of Hops (ms)	Propagation Delay (ms)	Processing Delay (ms)
Scenario 1	3	150	200
Scenario 2	4	150	150
Scenario 3	3	200	150

In the OE office, the SCADA wall lets employees interface with the network of each of OE's turbines.



Level 2: Here is a complex network map with multiple paths from start to end. Propagation and processing delays are not uniform across the system. Each propagation delay is listed above each line connecting servers. Each processing delay is listed within each server, represented by a square. All delays are given in milliseconds. What is the delay of the quickest path through the network?

