

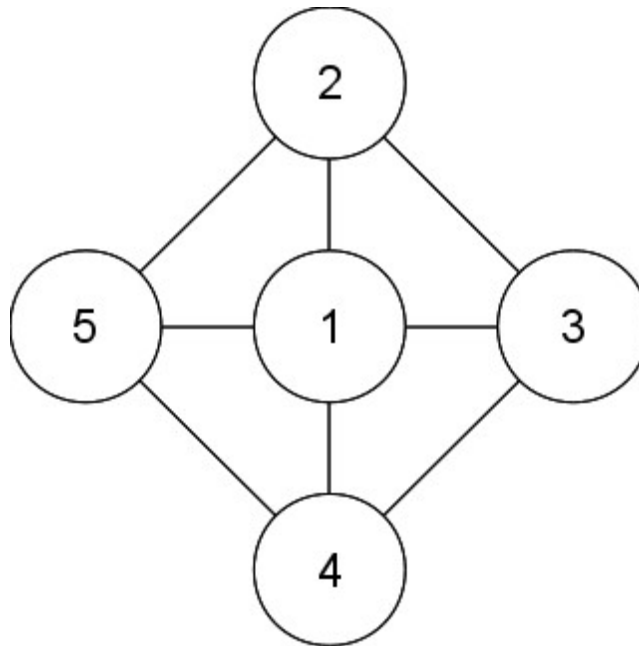
Computer Networks

what is a network?

fundamentally, it's just a bunch of connected entities

we typically these entities “nodes”

we call these connections “links”



in this figure, node 1 is connected to every other node

how does node 1 send a message to node 4?

how does node 1 send a message to node 2?

how does node 5 send a message to node 3?

how many ways can node 4 send a message to node 2?

sending messages from one node to another requires each node to know how to “get to” the desired node

we call the process of sending a message along a path (that may not directly be the desired node) routing

so each node can “route” a message in some way so that it will eventually get to the desired node

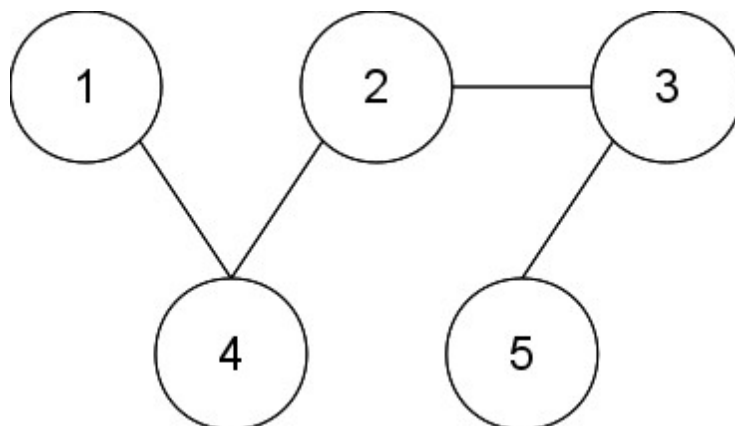
so if node 5 wants to send a message to node 2, it know that it is directly connected to it

this is possible via its routing table

and it can simply send the message directly to node 2

however if it wants to send a message to node 3, it must go through some other node

in this case, it can go through 1, 2, or 4 since each of these is directly connected to node 3.



suppose node 1 wants to send a message to node 5

clearly there is only one path, but here's how it works:

- node 1 is connected only to node 4, so it will send its message to node 4

- when node 4 gets the message, it sees that it is directed to node 5

- it looks in its routing table and sees that any message intended for node 5 must go to node 2

- so it sends it along to node 2

- and when node 2 gets the message, it sees that it is directed to node 5

- it looks in its routing table and sees that any message intended for node 5 must go to node 3

- so it sends it along to node 3

- and when node 3 gets the message, it sees that it is directed to node 5

- it looks in its routing table and sees that it is directly connected to node 5

- so it sends it along to node 5

how are nodes really “numbered?”

just like your home address, computers on a network have an address of their own called an ip address

it is composed of 4 sets of numbers separated by a dot (.)

each set of numbers can range from 0-255

e.g., 138.47.102.211

this is called ipv4

how many possible ip addresses can exist?

0-255 represents 256 total numbers

each “octet” of an ip address can have up to 256 choices

$256 * 256 * 256 * 256 = 256^4 = 4,294,967,296$ unique ip addresses

we are running out of them so someone came up with ipv6

there are now 8 “octets” ranging from 0-65535 (65536 possible numbers)

so there are now $65536^8 = 3.4 \times 10^{38}$ unique ip addresses!

but this change requires infrastructure changes/modifications

so its implementation hasn't happened yet

what do messages really look like?

some messages are short; others are long

to make this efficient, messages are split up into packets

each packet is composed of:

- a source ip address (the sender)

- a target ip address (the receiver)

- a sequence number (to preserve the order of the message)

- a part of the message

e.g., the message “Meet me at midnight by the park.” from node 1 to node 5 may be split up like this:

“1/5/1/Meet”

“1/5/2/ me ”

“1/5/3/at m”

“1/5/4/idni”

“1/5/5/ght ”

“1/5/6/by t”

“1/5/7/he p”

“1/5/8/ark.”

and it may be sent in any order!

a packet may also be delayed on its way for some reason

so the receiver may get the packets out of order

but no worries since each packet has a sequence number

“1/5/5/ght ”

“1/5/6/by t”

"1/5/8/ark."
"1/5/1/Meet"
"1/5/3/at m"
"1/5/2/ me "
"1/5/4/idni"
"1/5/7/he p"

node 5 can recreate the message by concatenating the message part of the packets in order
Meet/ me /at m/idni/ght /by t/he p/ark.

"Meet me at midnight by the park."

****EXERCISE (strings+)**

in the "real world," nodes are machines and links are connections made up of cabling or sent through the air!
nodes can be computers, routers, switches, and more
links can be made up of ethernet cable, fiber optic cable, or sent wirelessly

at home you may have a wireless network of some sort that your computers are connected to
ultimately, you get internet access
that might look like this:

