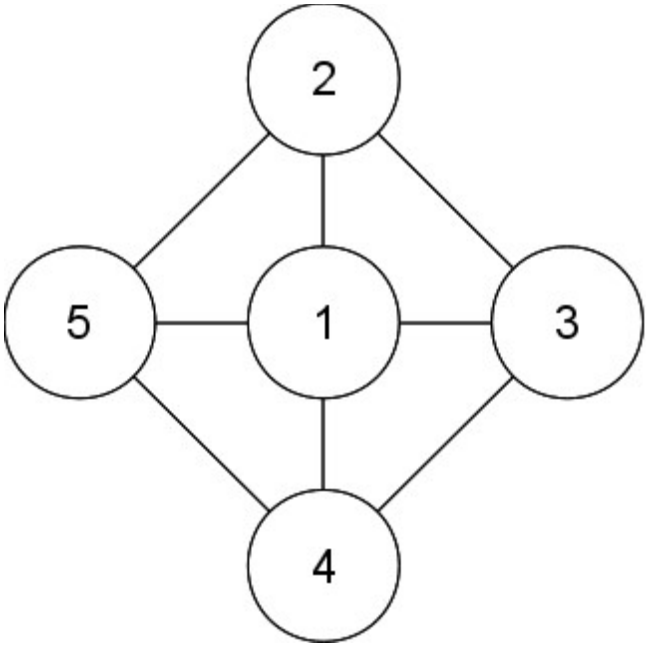
Intro to networks

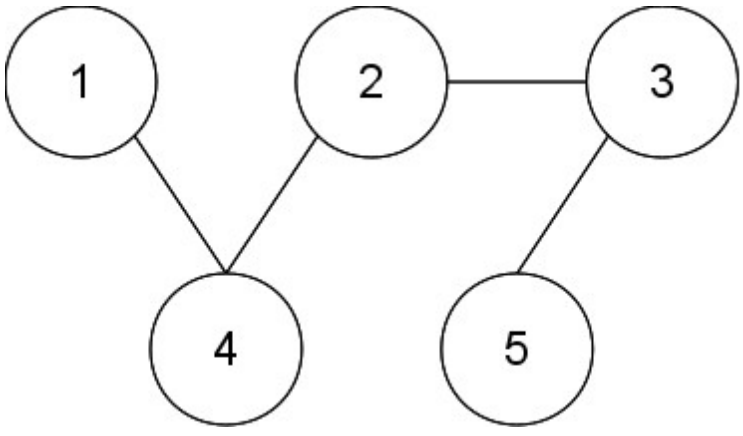
what is a network?

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 = 3.4x10^38 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."

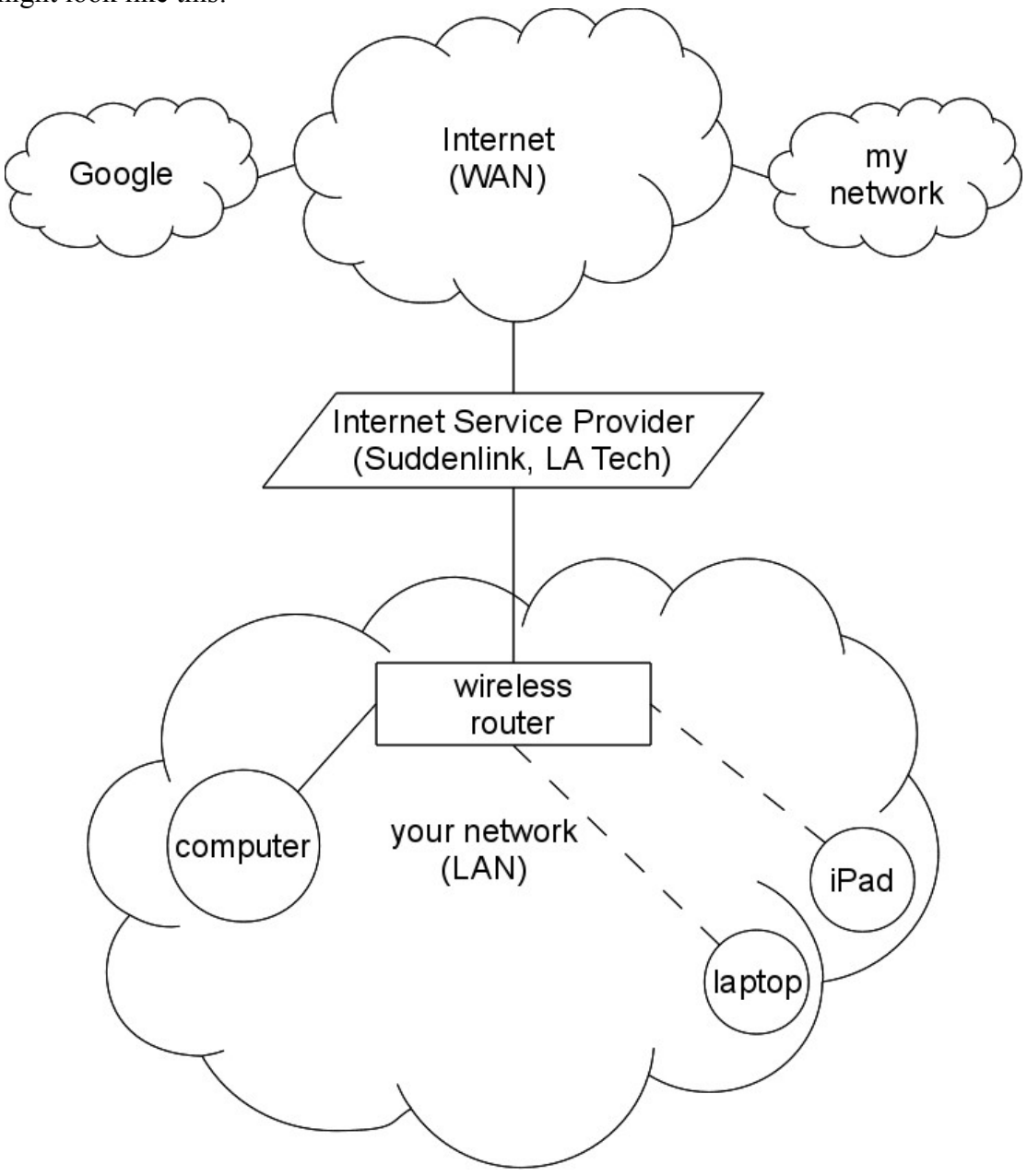
in the "real world," nodes are machines and links are connections made up of cabling or sent through the air!

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:



more on IP addresses

in this class, you will usually be manually setting IP addresses
this means no Internet
you will do this during cyber storm

usually at home, your IP address is something like 192.168.1.n
the 192.168.1.* space is carved out of all IP addresses
it's not addressable over the Internet
so I can have such an address in my home network (LAN)
and so can you
in fact, they can be the same!
we both have a WAN port that connects us to our ISP
that is an addressable IP address
but just a single one per entity (like my household, yours, etc)

192.168.1.n is 256 total addresses
when setting up an IP address to such a network, we need to specify a netmask
the netmask tells the overall range of IP addresses
e.g., 192.168.1.0 to 192.168.1.255 (256 total addresses)
the netmask for this is 255.255.255.0
255 → the octet doesn't change
0 → the octet has the full 0-255 range
there are other netmasks that can further restrict the range
but this is for a networking course

there are other IP address ranges that are carved out
10.n.n.n
what's the netmask for this range?
255.0.0.0
we will use this for cyber storm
a team may use 10.3.n.n
its netmask would be 255.255.0.0

the internet in 1973!