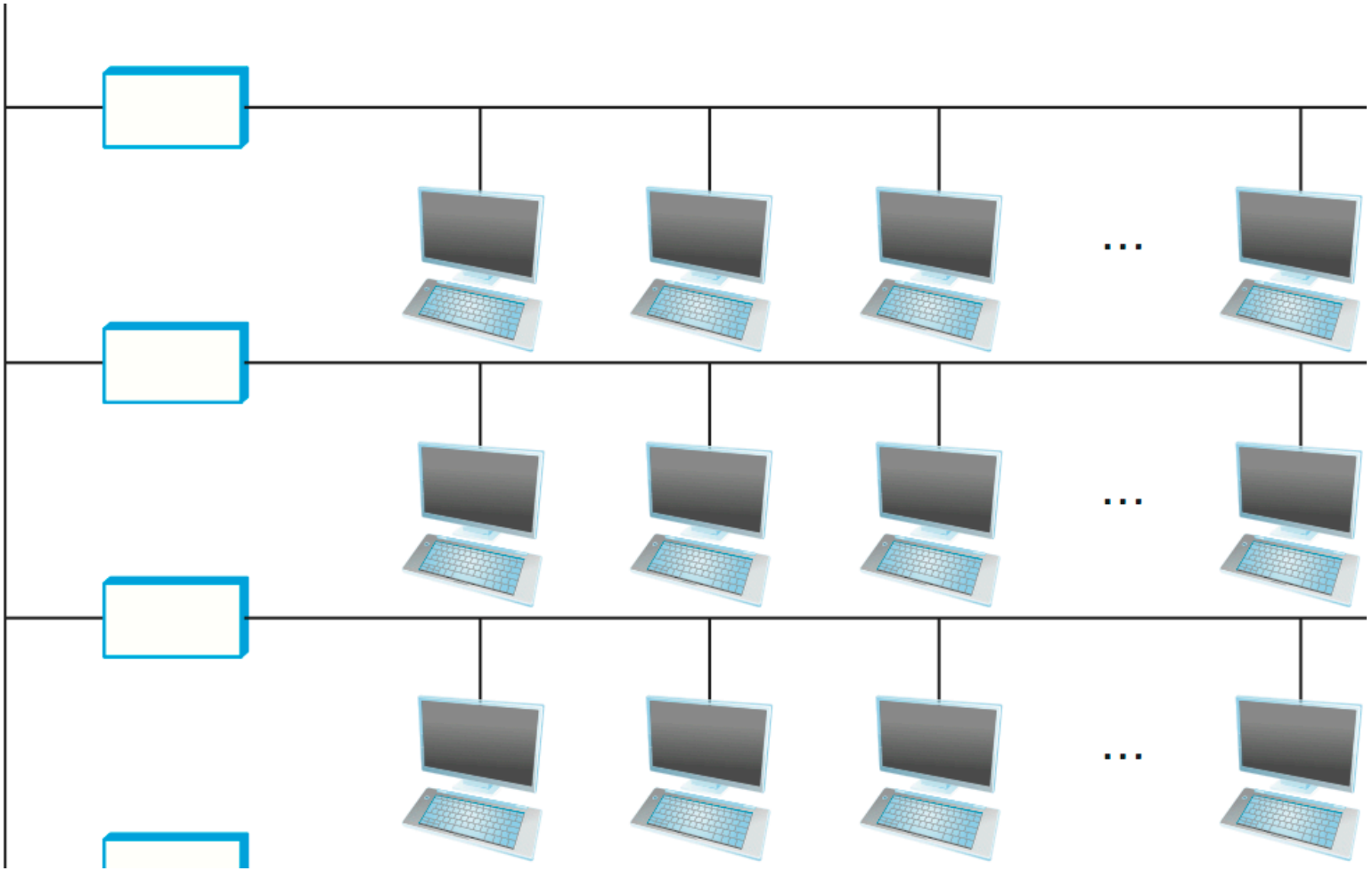
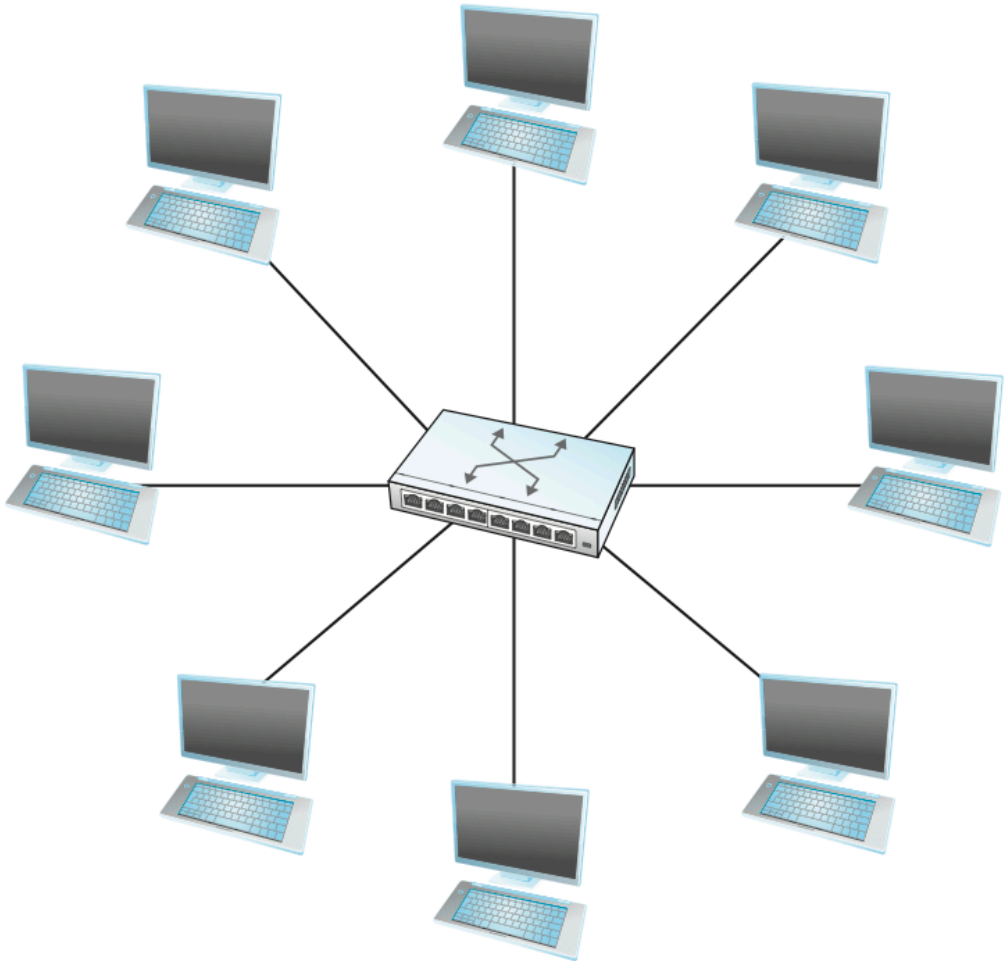
Switching and Bridging

COS 460 - Fall 2019



Ethernet as we know it

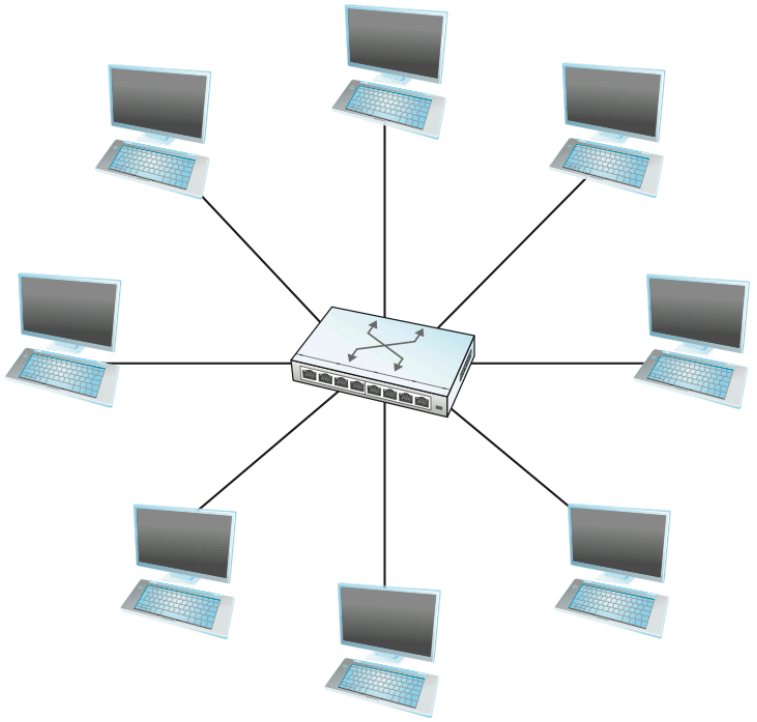
All hosts connected to same “wire”
All hosts see the same signals



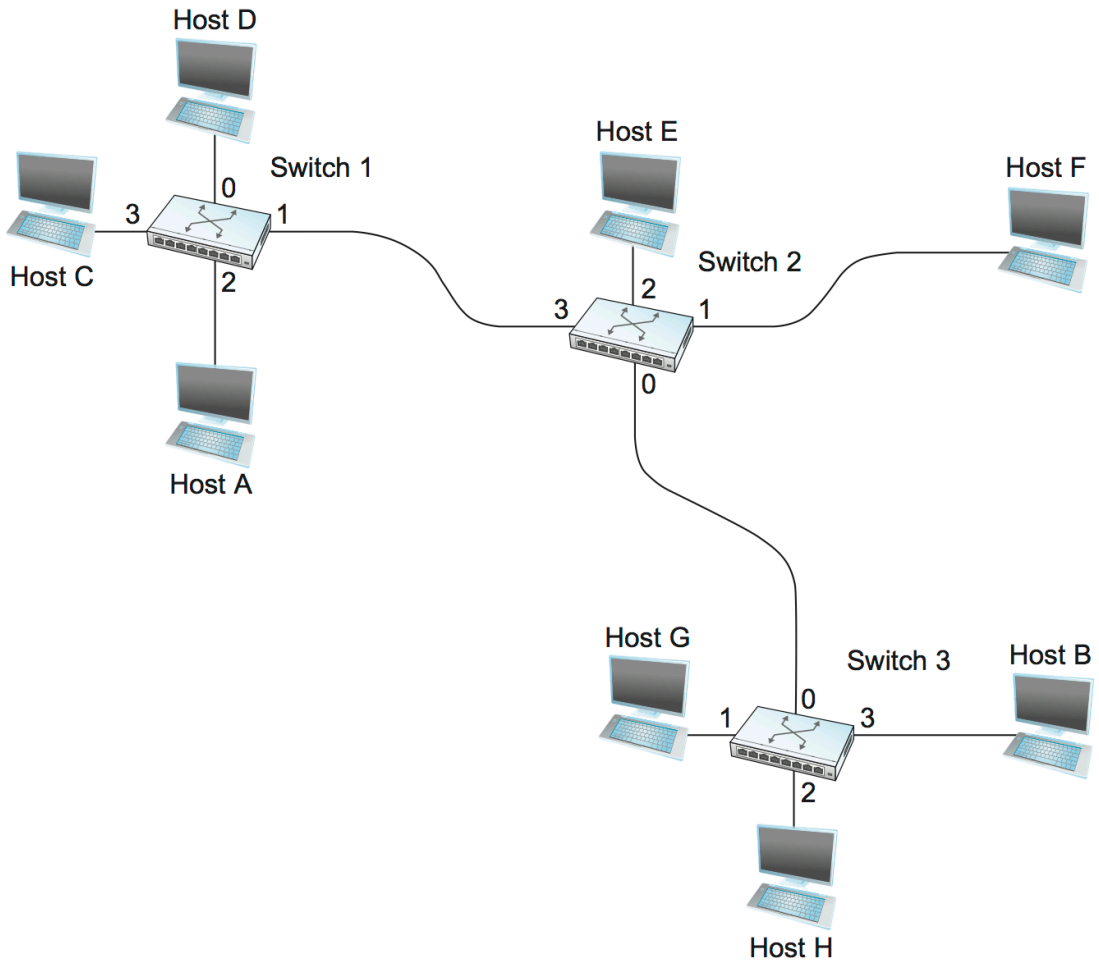
The Star Topology

Hosts connected to central intelligent “switch”

The Star Topology



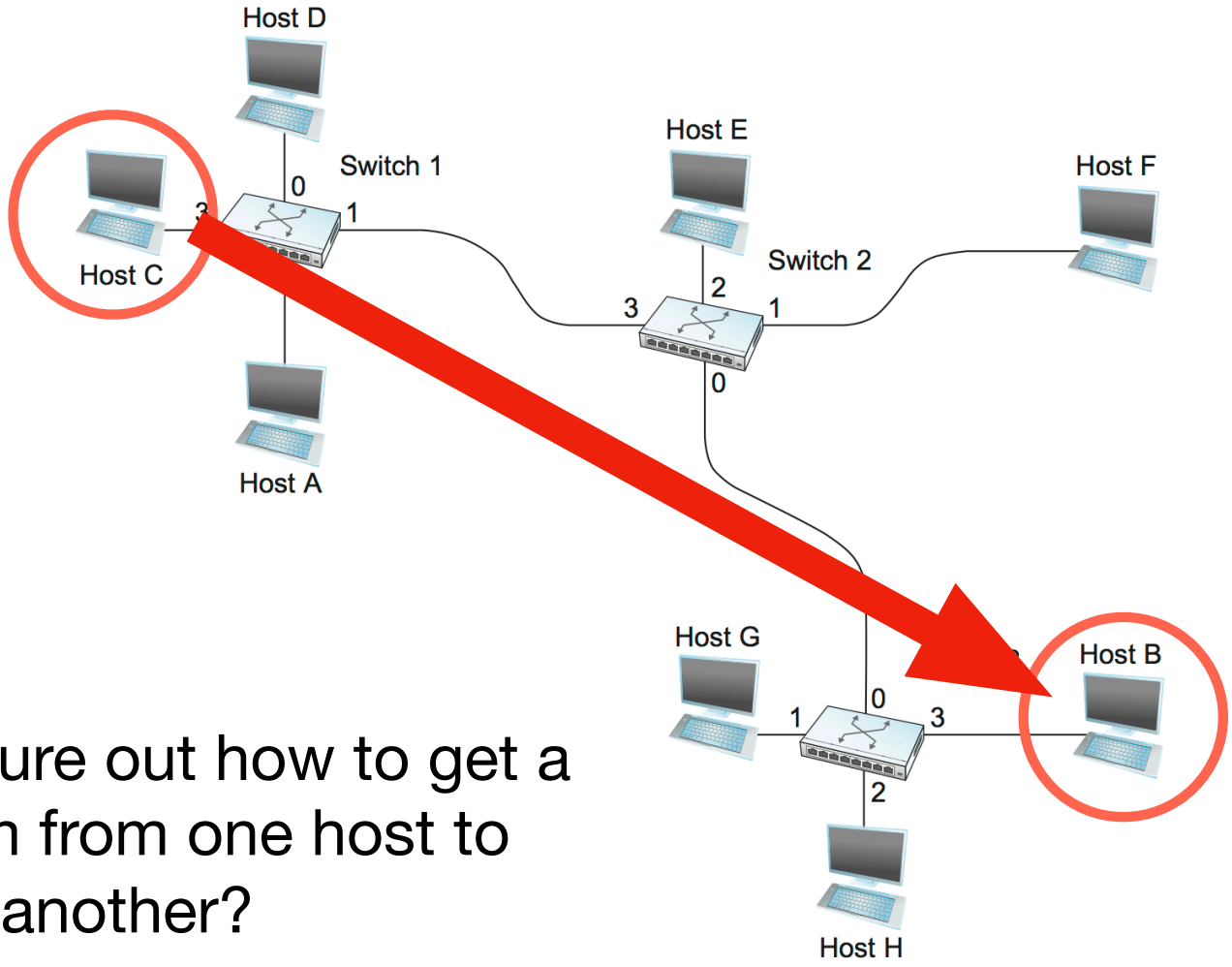
- Fixed number of ***ports***
- Interconnect **hosts** or **switches**
  - …to form larger networks
- No reduction in performance of network*



The Star Topology

interconnecting networks

Interconnected Stars



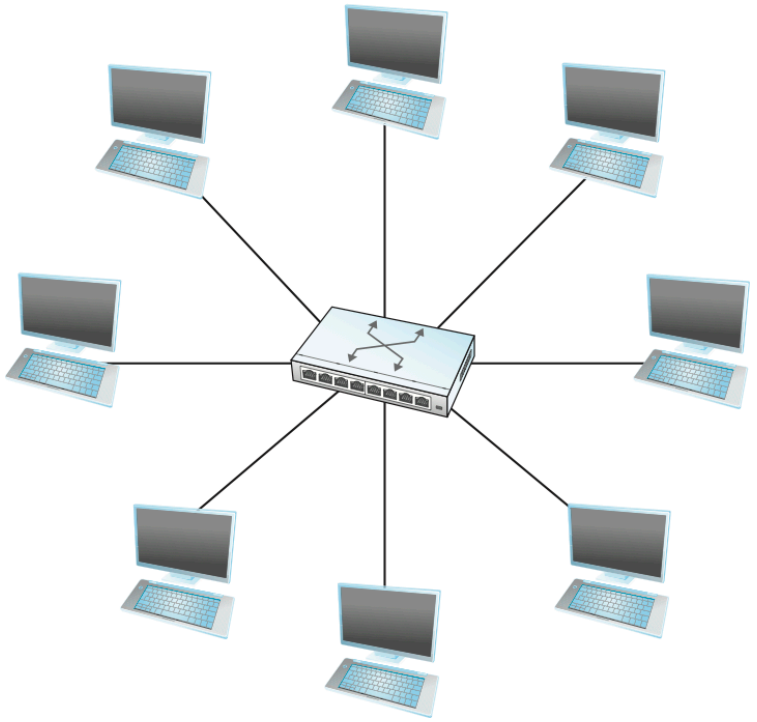
How do figure out how to get a datagram from one host to another?

let's just worry about any path right now. later we will talk about routing.

Some Switching Options

1. Datagram Switching
2. Virtual Circuit Switching
3. Source Routing

Datagram Switching

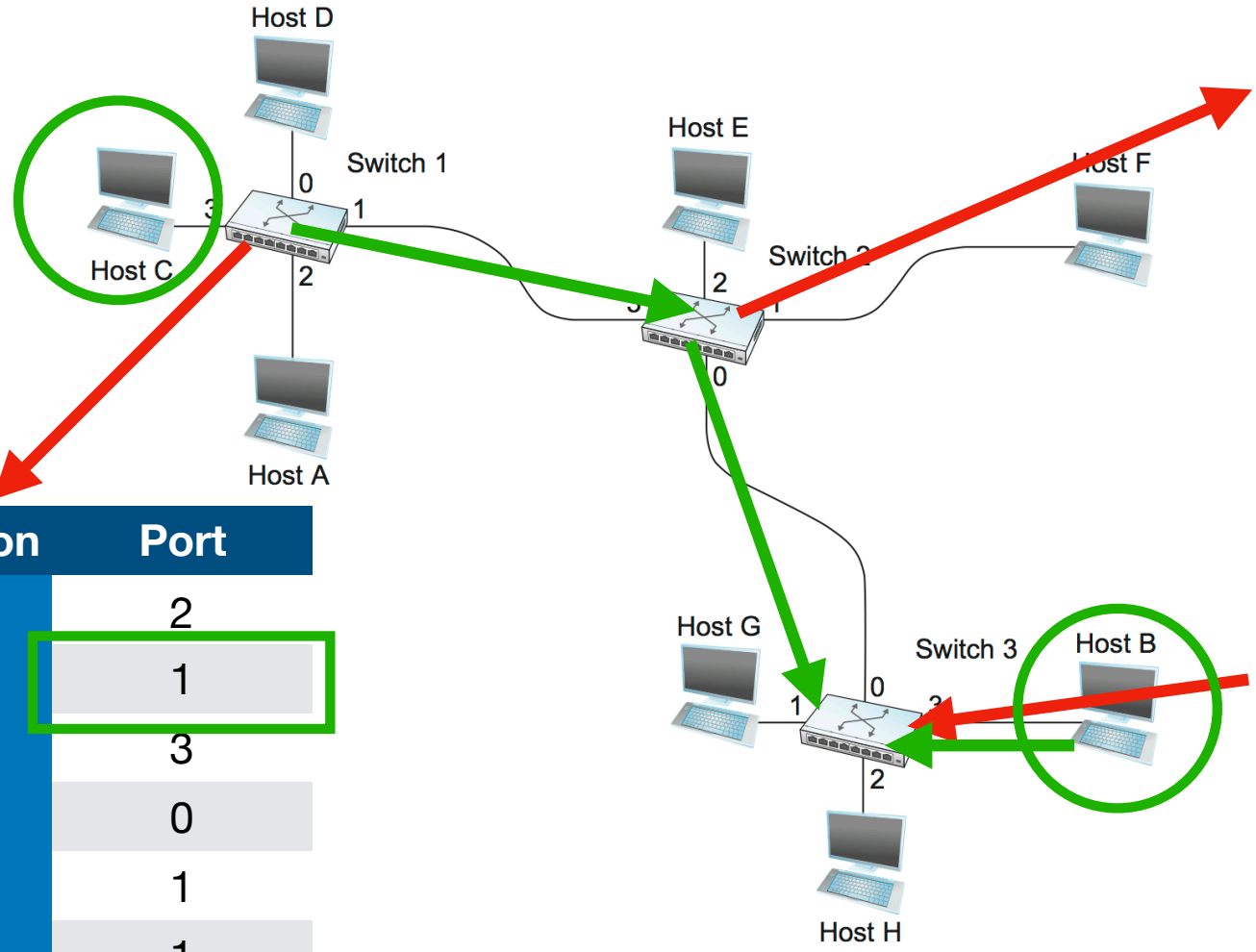


- Run **Ethernet protocol** on each link
- **Broadcast** when needed

Datagram Switching

- A host can send a packet **anywhere** at **any time** (*connectionless*)
- When sending, the host does not know if the network can deliver it or not (*unreliable*)
- Each packet is **delivered independently** of all other packets
- Switches and links fail, alternate paths route around problems

Datagram Forwarding

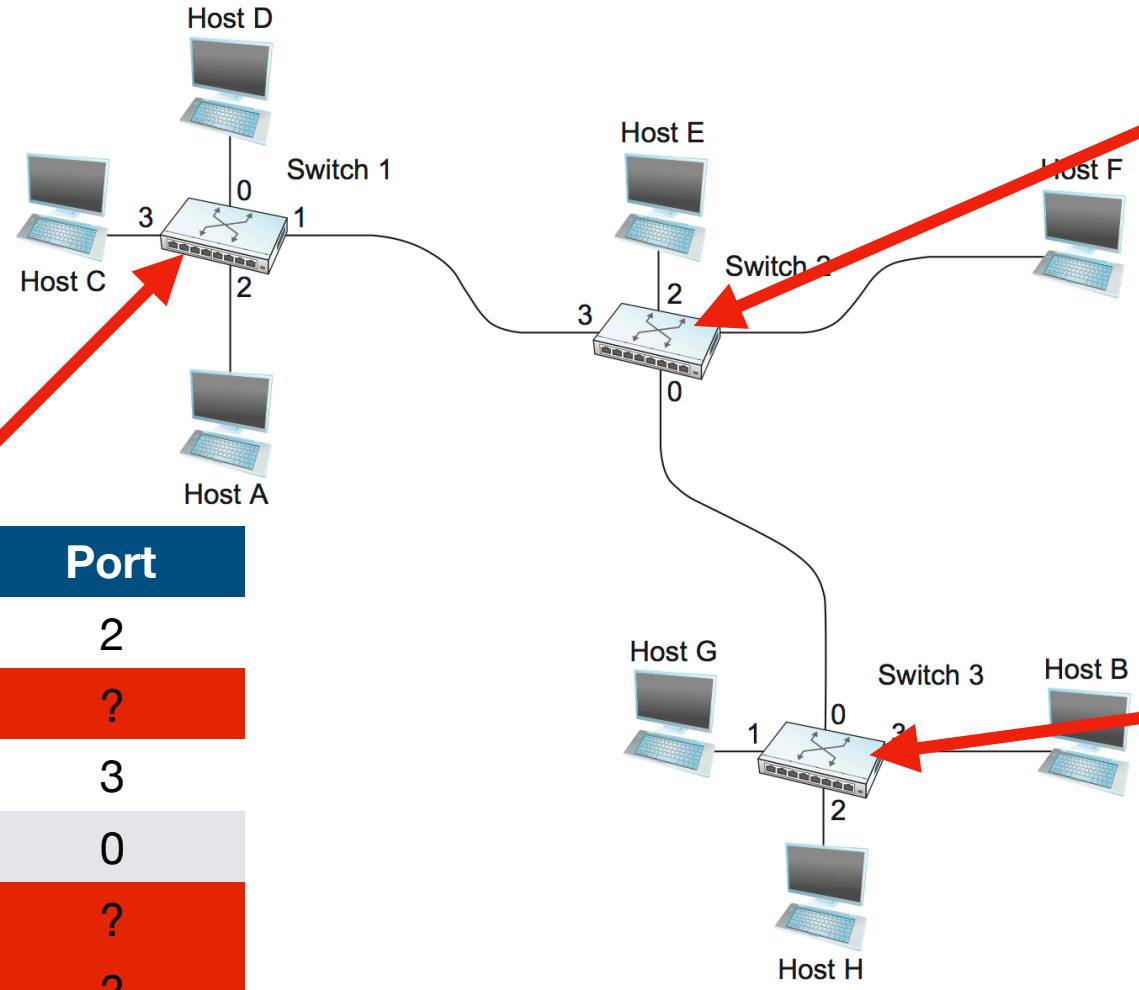


Destination	Port
A	2
B	1
C	3
D	0
E	1
F	1
G	1
H	1
...	...

Destination	Port
A	3
B	0
C	3
D	3
E	2
F	1
...	...

Destination	Port
A	0
B	3
C	0
D	0
E	0
F	0

Forwarding Tables

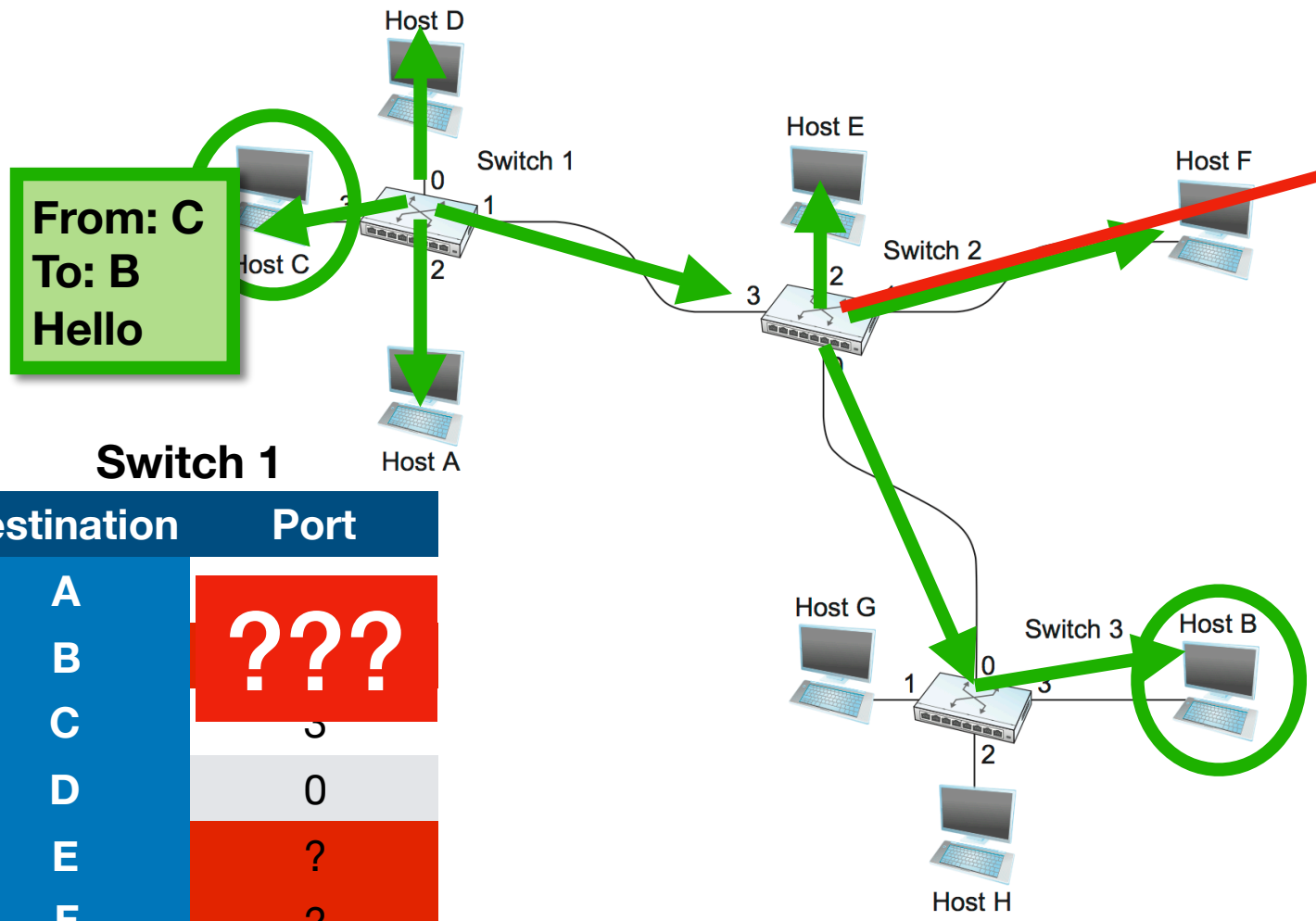


Destination	Port
A	2
B	?
C	3
D	0
E	?
F	?
G	?
H	?
...	...

Destination	Port
A	?
B	?
C	?
D	?
E	2
F	1
...	...

Destination	Port
A	?
B	3
C	?
D	?
E	?
F	?

Forwarding Tables



Switch 1

Destination	Port
A	???
B	
C	3
D	0
E	?
F	?
G	?
H	?
...	...

Switch 2

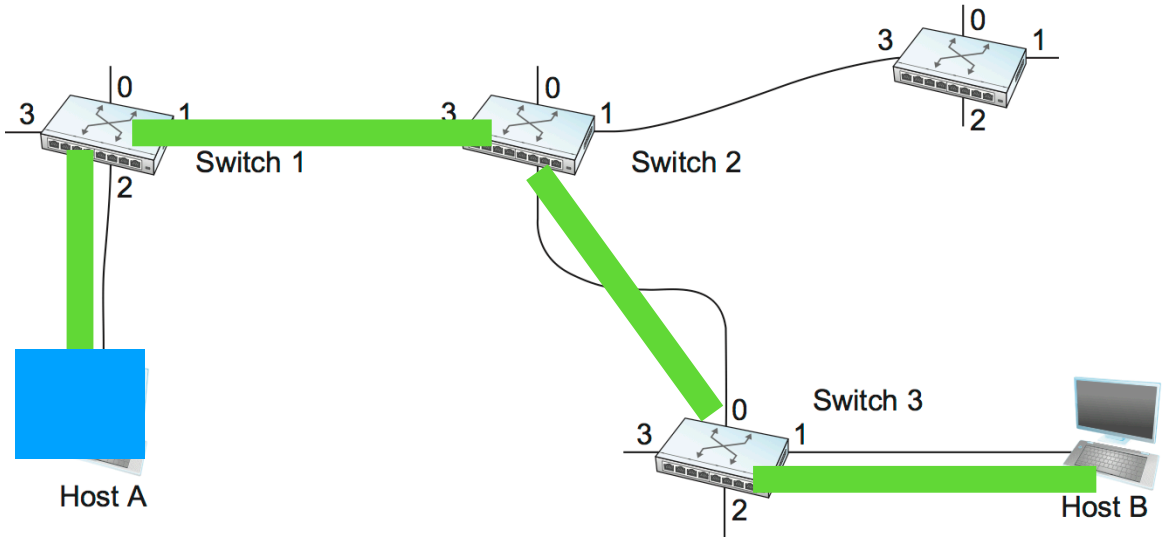
Destination	Port
A	3
B	?
C	?
D	?
E	2
F	1
...	...

Switch 3

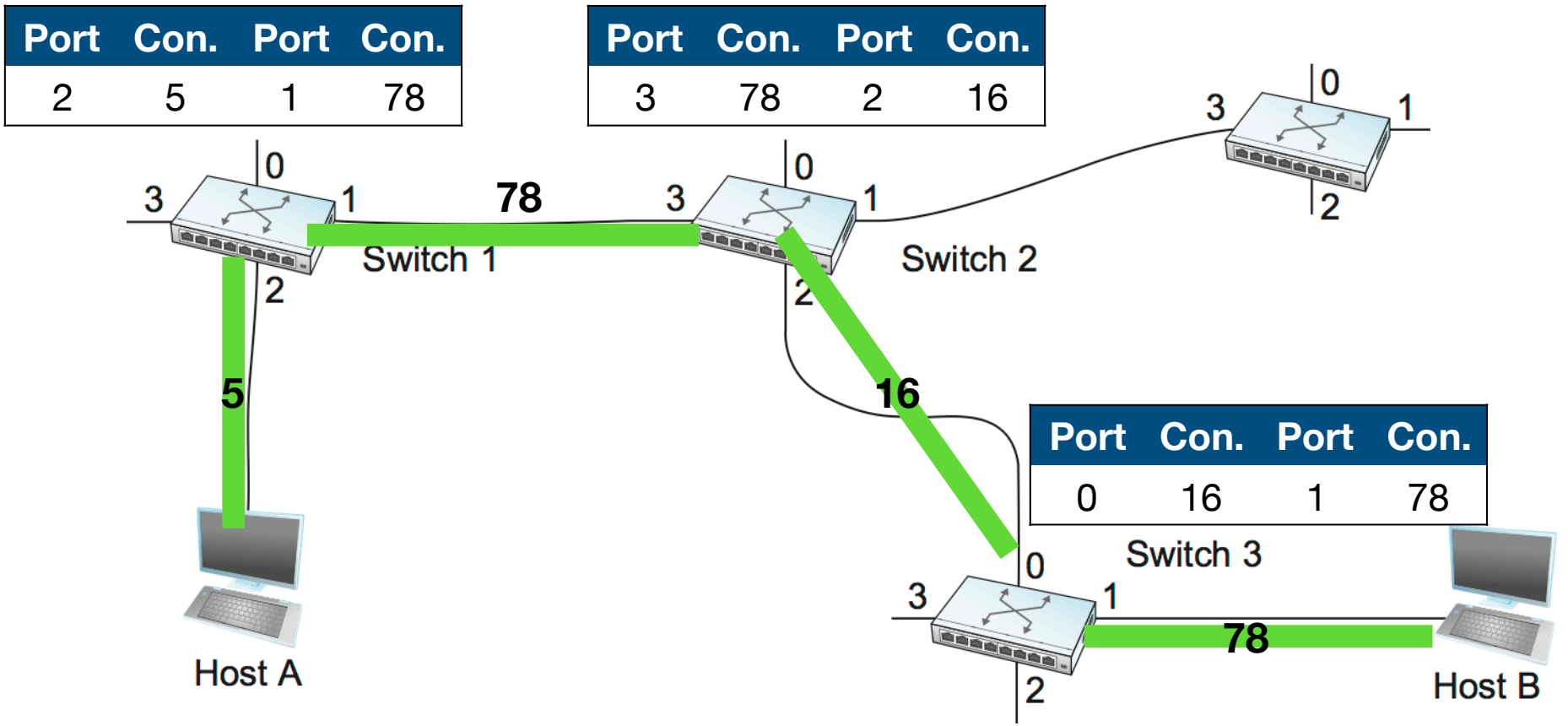
Destination	Port
A	3
B	3
C	?
D	?
E	?
F	?

Virtual Circuit Switching

- Set up connection between hosts through network
- Datagrams then go through connection
- Only need addresses to set up connection



Virtual Circuit Switching



How do we set up the connection?

Virtual Circuit Setup

- Signaling protocol, out of band data between switches
- Host embeds global unique address of destination
- Broadcast like through switches to find destination
- Circuit set up on return path confirmations

Virtual Circuit Switching

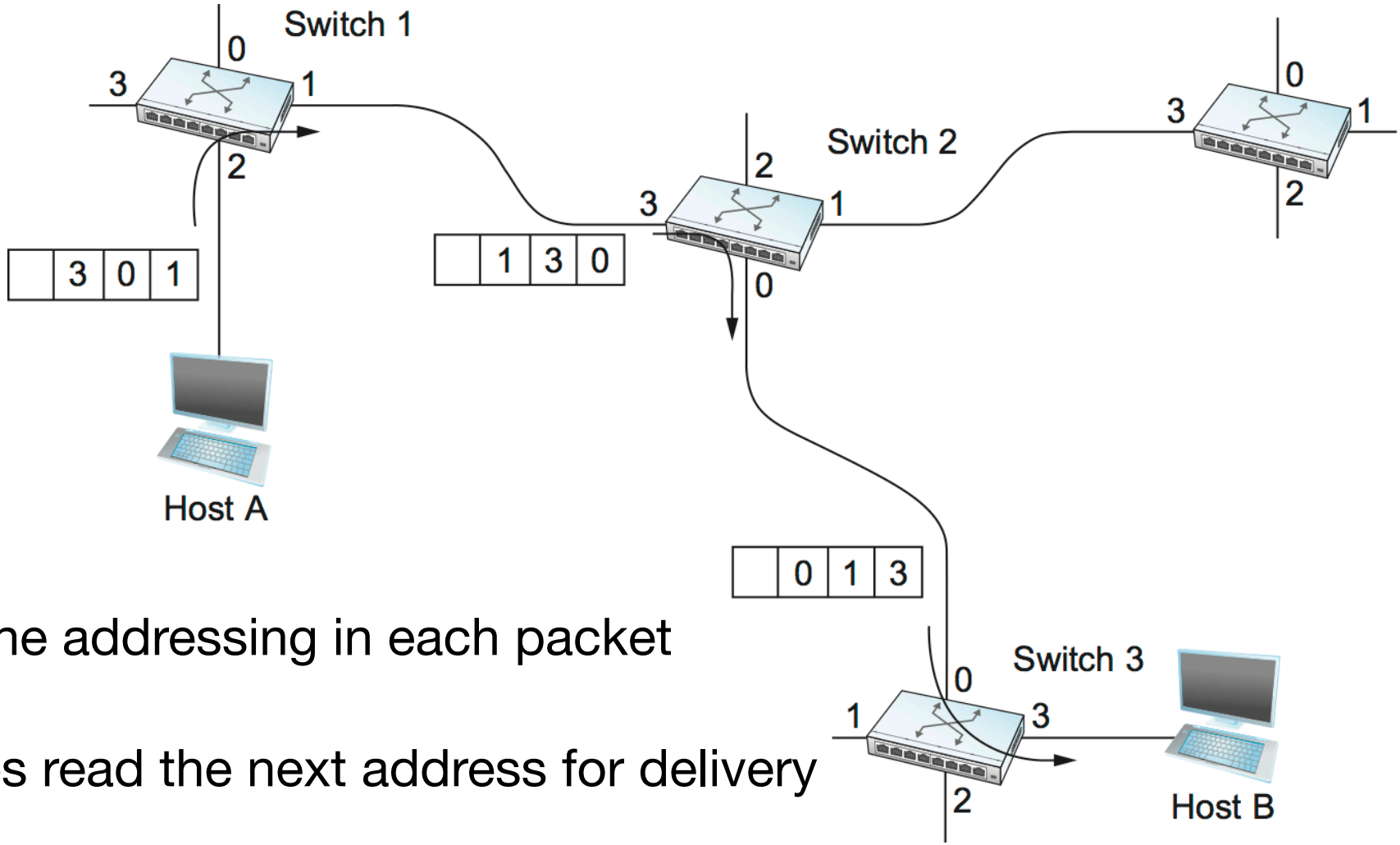
Pros:

- Less overhead on individual packets (less addressing)
- Less variability in delivery time across network
- Lots of knowledge about the network after setup (times, buffers, etc.)
- Quality of Service (QoS) easier* to implement

Cons:

- At least 1 x RTT to setup connection
- If switch or link fails, need to make new connection
- Convoluted out-of-band setup and signaling needed.

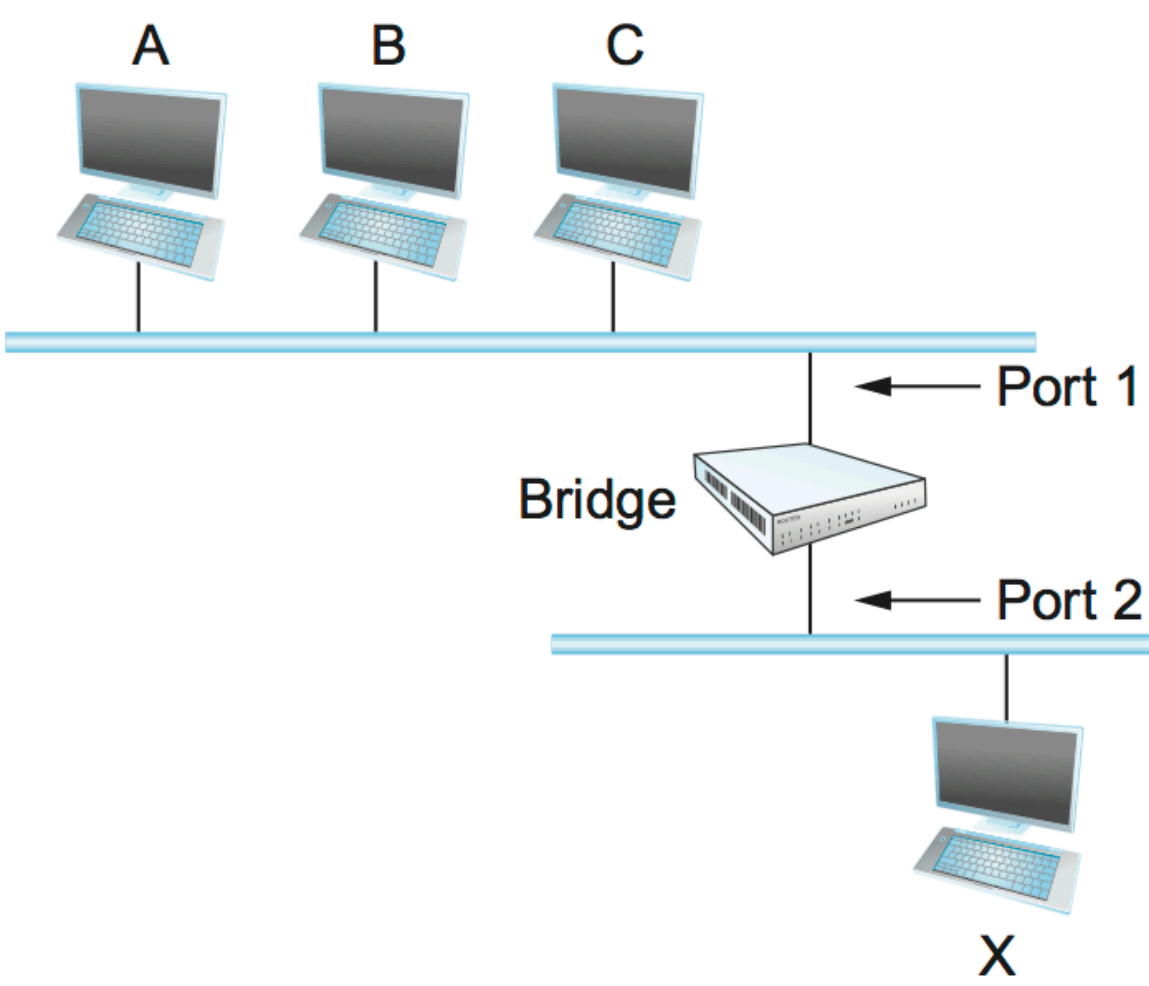
Source Routing



- Put all the addressing in each packet
- Switches read the next address for delivery
- “Rotate” the address field to create return path

Bridges and L2 Switches

- Learning Bridges
- Spanning Tree Algorithm
- Broadcast and Multicast
- Limitations

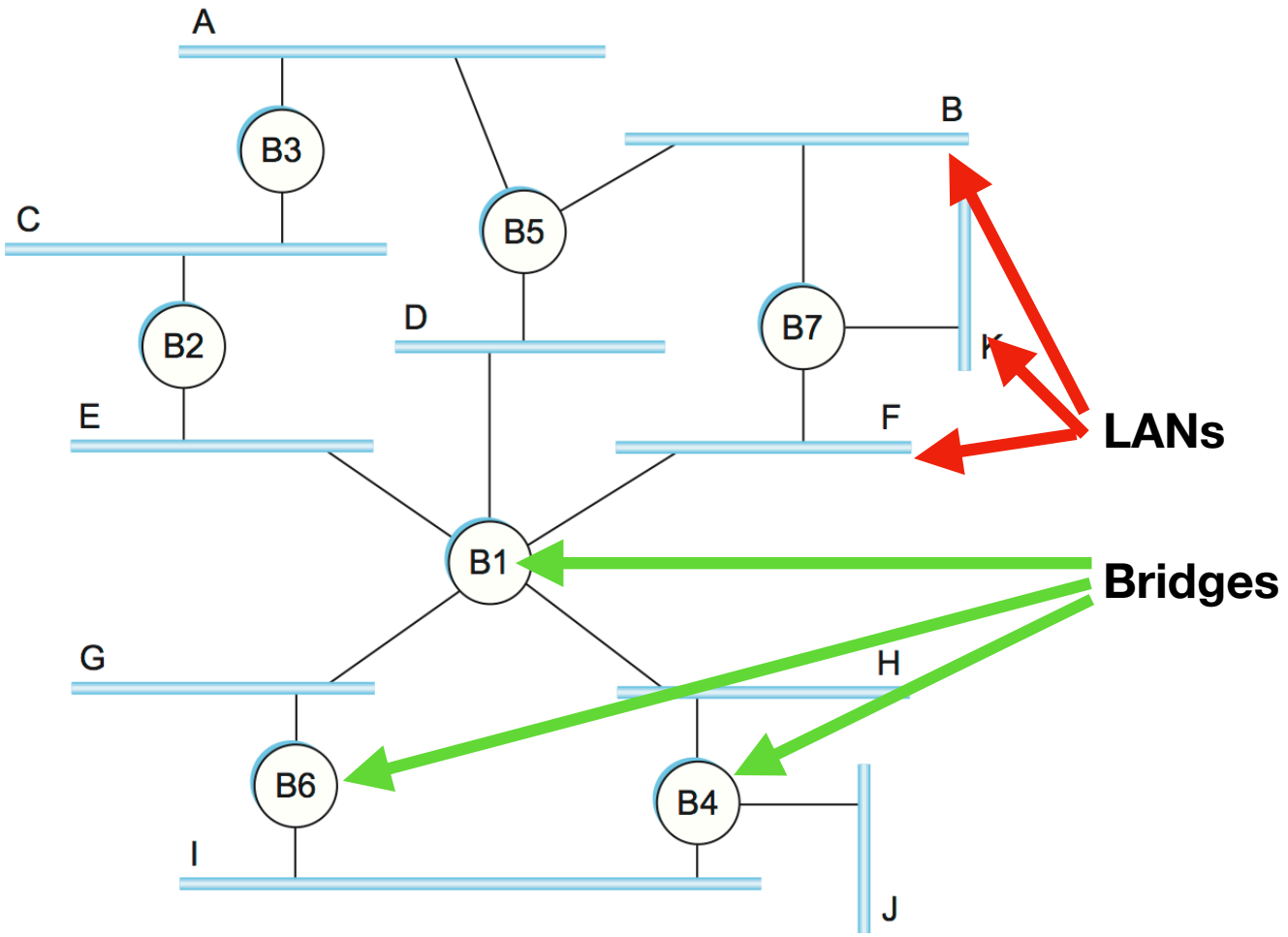


Forwarding Table

Host	Port
A	1
B	1
C	1
…	…
X	2
Y	2
Z	2

Learning Bridge

Same as we saw earlier, listen to the source addresses on each port (*promiscuously*)



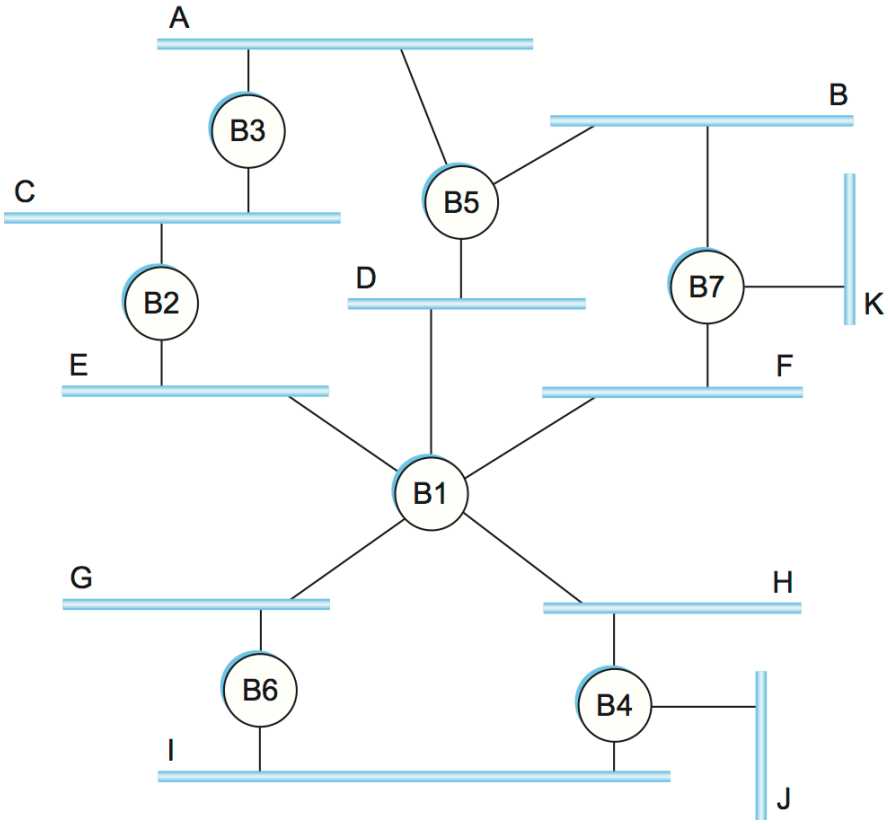
More Complex Connections

When the extended LAN has a **loop** in it, our previous strategies may have delivery problems

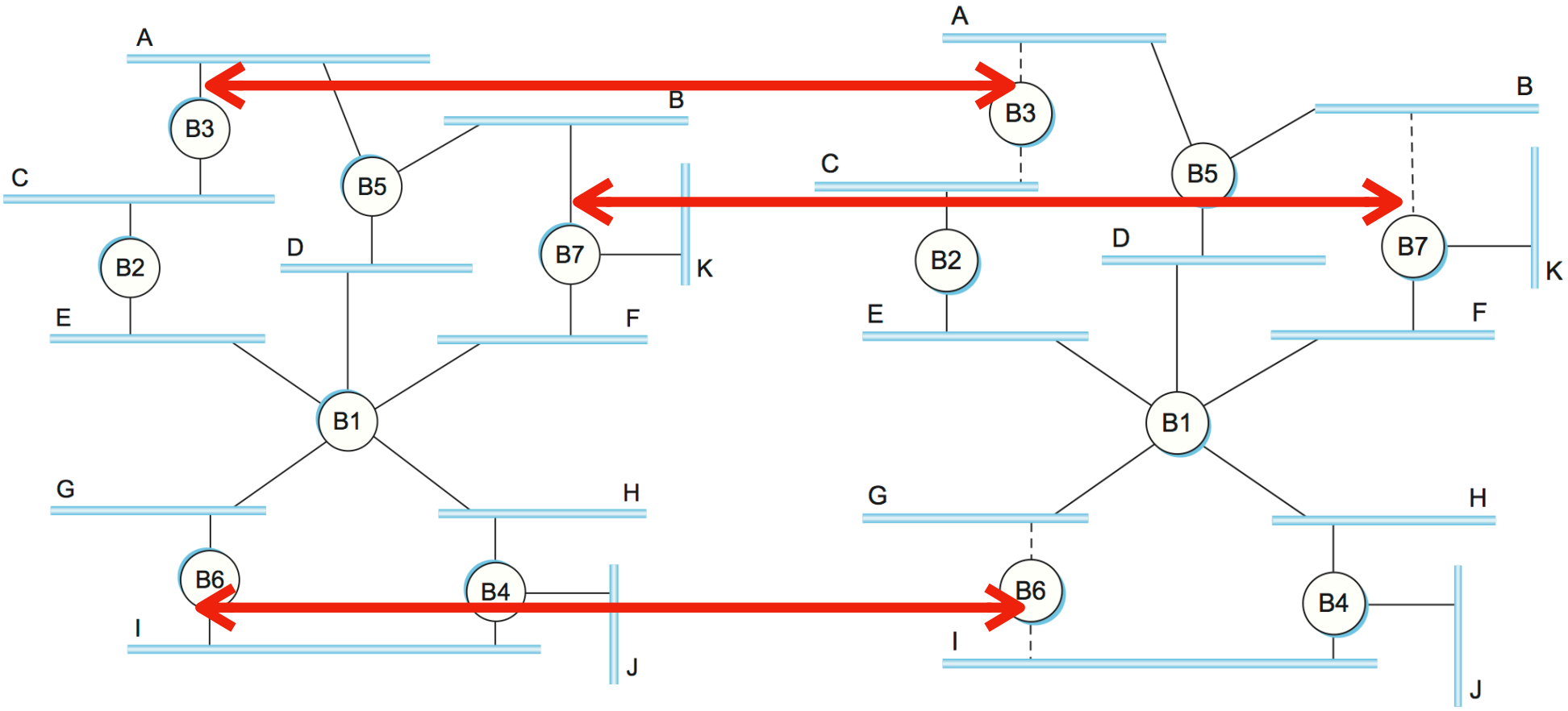
Spanning Tree

The Big Idea

- Bridges **select ports** they will forward packets
- These ports will cover the network **without loops**
- Some switches will **disable** ports to prevent loops
- **Distributed Algorithm**, all bridges run it independently



Spanning Tree Result



Spanning Tree Algorithm

- Exchange Configuration Messages on all ports <BridgeID, RootID, Distance>
  - My Bridge Identifier
  - Bridge I think is the root bridge
  - Distance (in hops) from me to root
- Pretend I'm the root bridge and send out configuration <me, me, 0>
- Record best configuration messages on each port
  - Root ID is smaller than the what I think is the Root ID
  - Root ID is the same but shorter distance
  - Root ID and distance are the same but sending bridge ID is smaller
- If new configuration is better than old one
  - Discard old one
  - Stop generating own configuration messages
  - Send out new configuration adding one (1) to distance field

Another Card Game?

of course!

Broadcast & Multicast

- **Broadcast** — forward out other ports (simple)

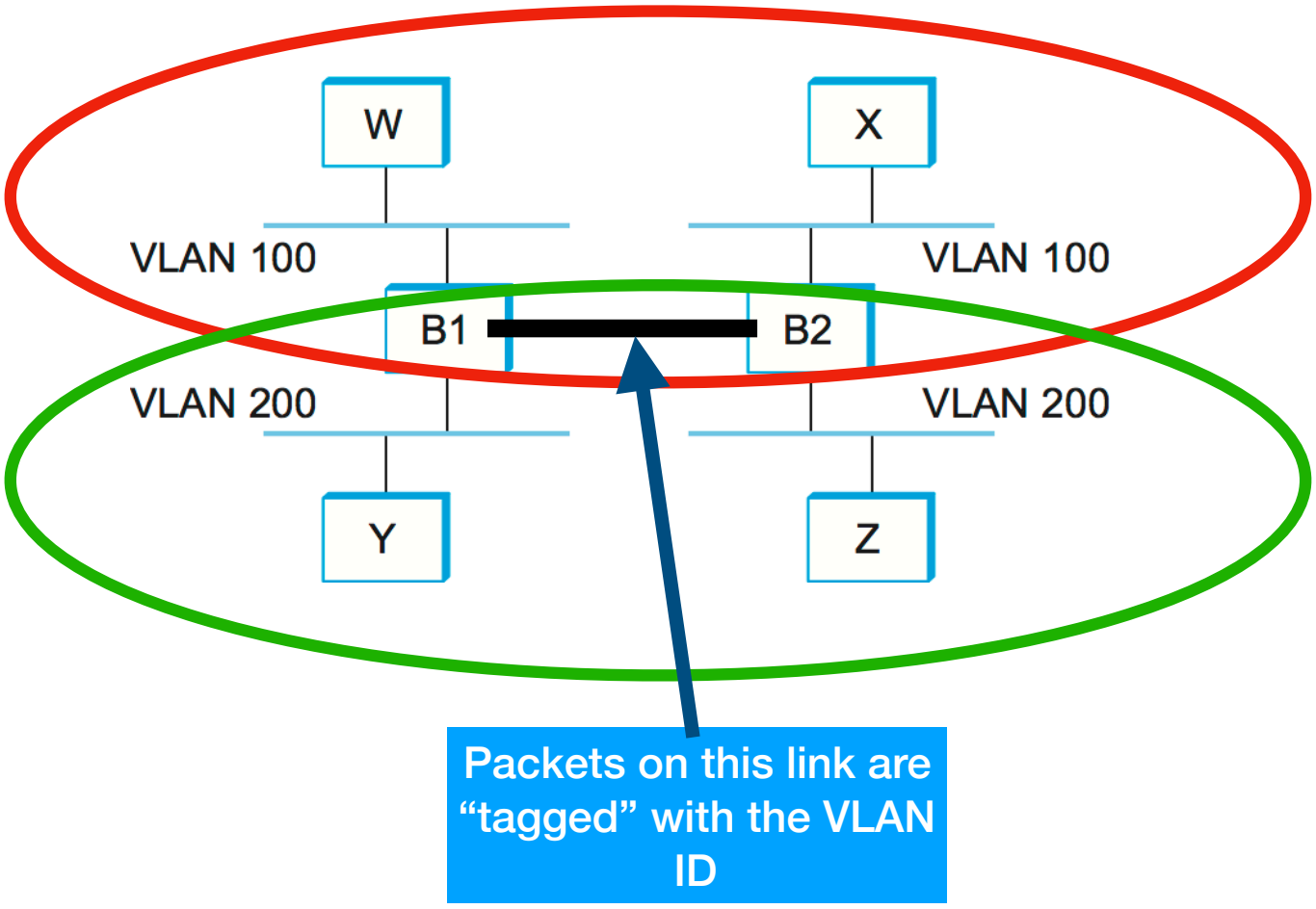
- **Multicast** — forward out other ports (simple)

  - A bridge *could* however be intelligent about it and pay attention to hosts on LANs that subscribe to multicast addresses

Limitations

- Spanning Tree **does not scale well** beyond “tens of” bridges (linear)
- Broadcasting of frames across large network eats up bandwidth
  - Virtual LANs (VLANs) offer a solution to this

Virtual LANs



fin

- **Switching Options**
  - Datagram (connectionless)
  - Circuit Switched (connection-oriented)
  - Source Routing
- **Bridges**
  - Learning
  - Spanning Tree Algorithm
  - Limitations and Virtual LANs