CSC4200/5200 – COMPUTER NETWORKING

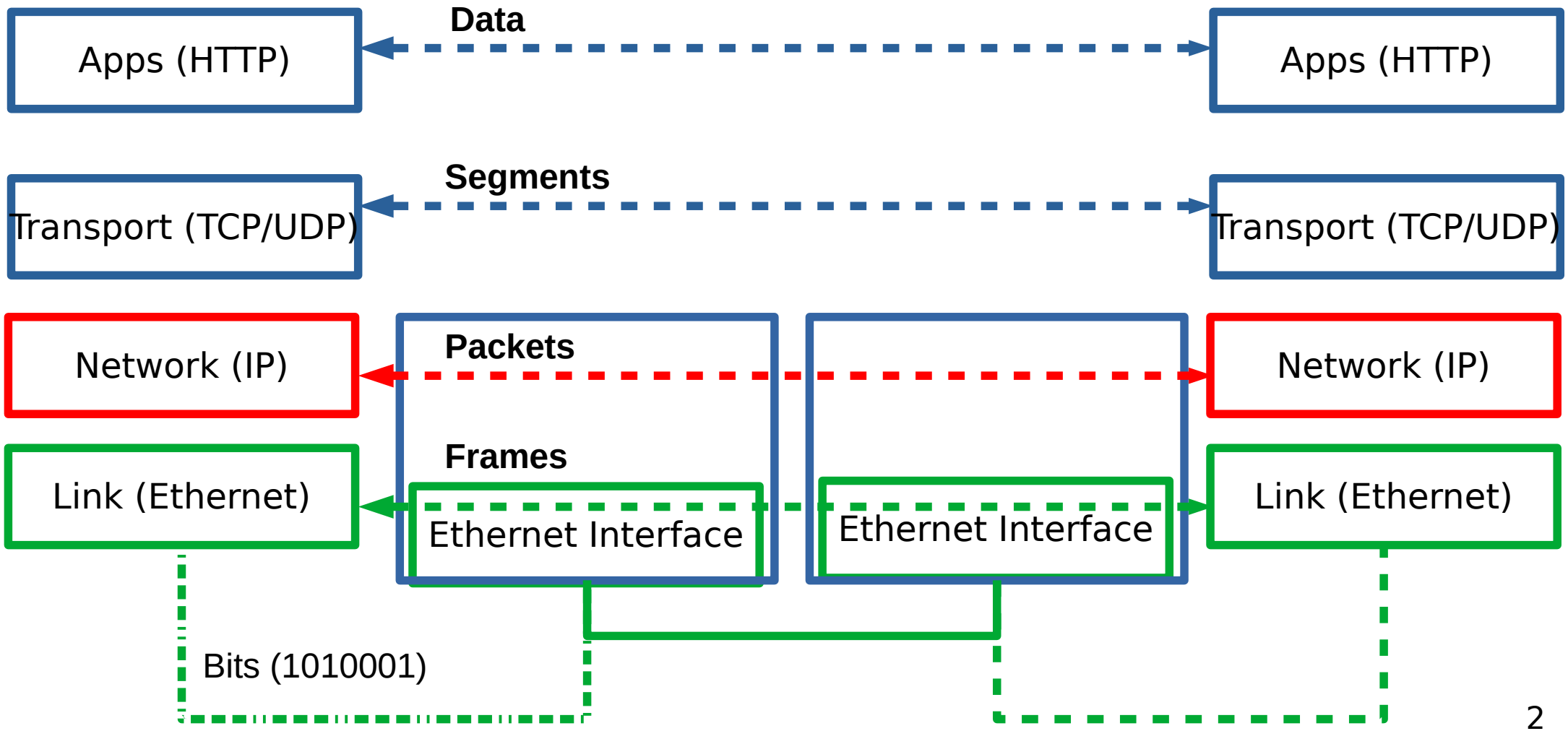
Instructor: Susmit Shannigrahi

INTERNETWORKING

sshannigrahi@tntech.edu

GTA: dereddick42@students.tntech.edu

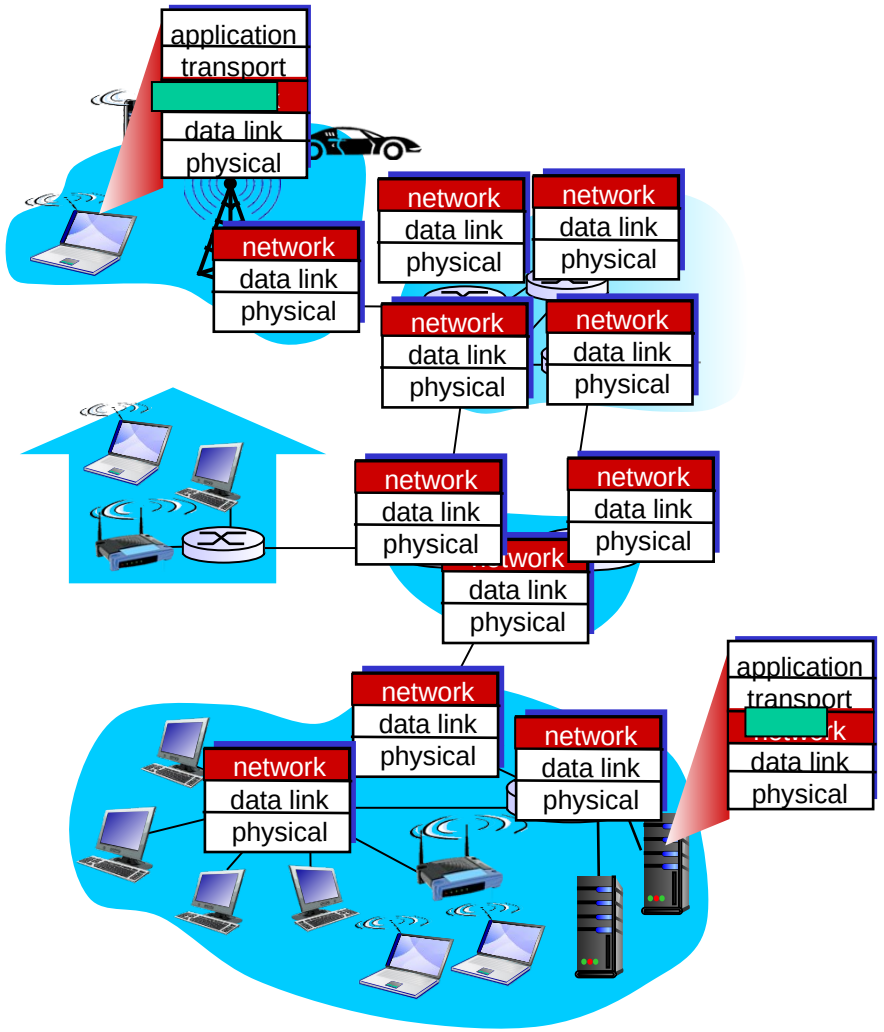
Tennessee TECH


Apps (HTTP)
Data
Apps (HTTP)
Transport (TCP/UDP)
Segments
Transport (TCP/UDP)
Network (IP)
Packets
Network (IP)
Link (Ethernet)
Frames
Ethernet Interface
Ethernet Interface
Link (Ethernet)
Bits (1010001)

So far...

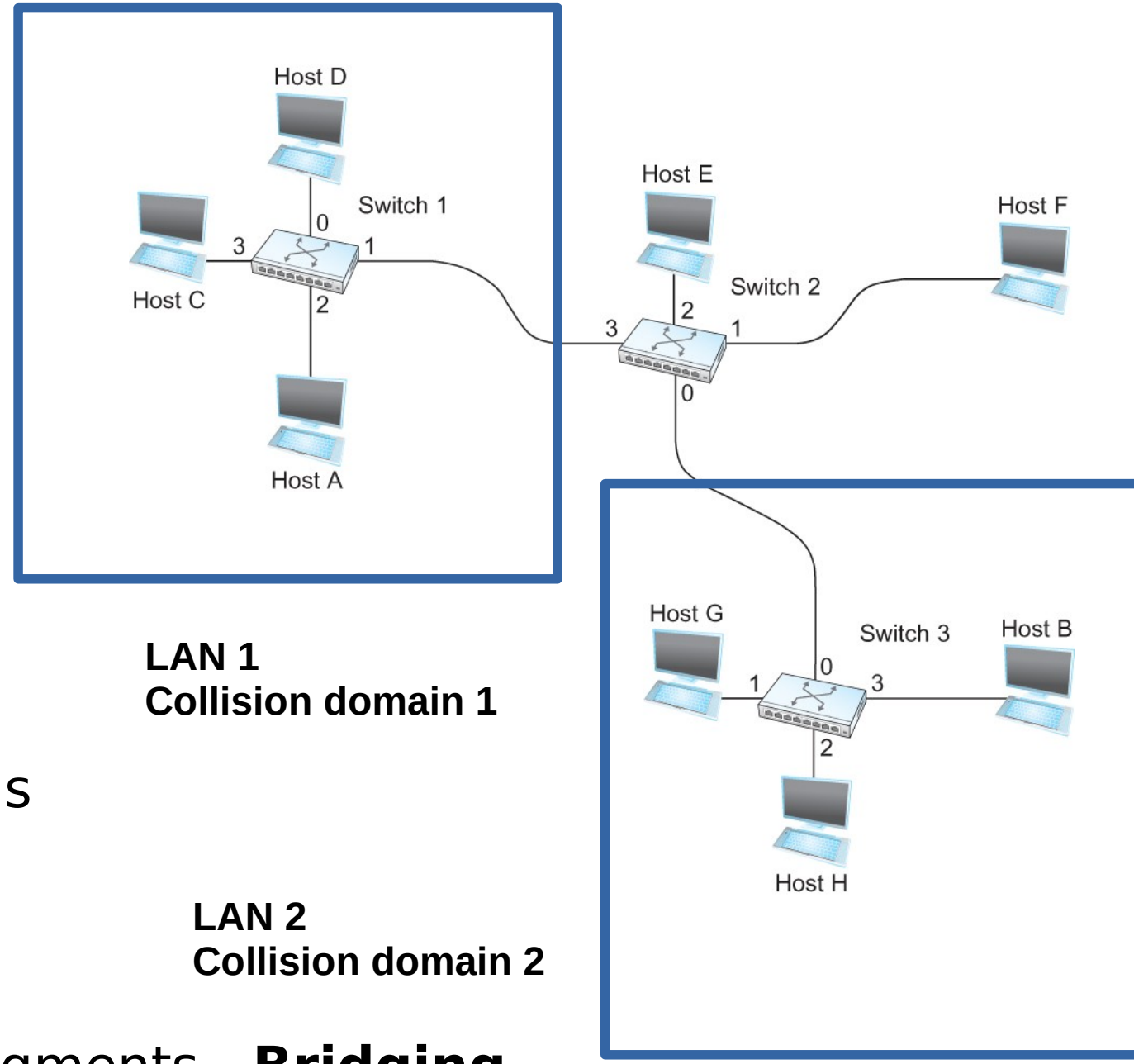
- we saw how to build a local network
- How do we interconnect different types of networks to build a large global network?

Why another layer?

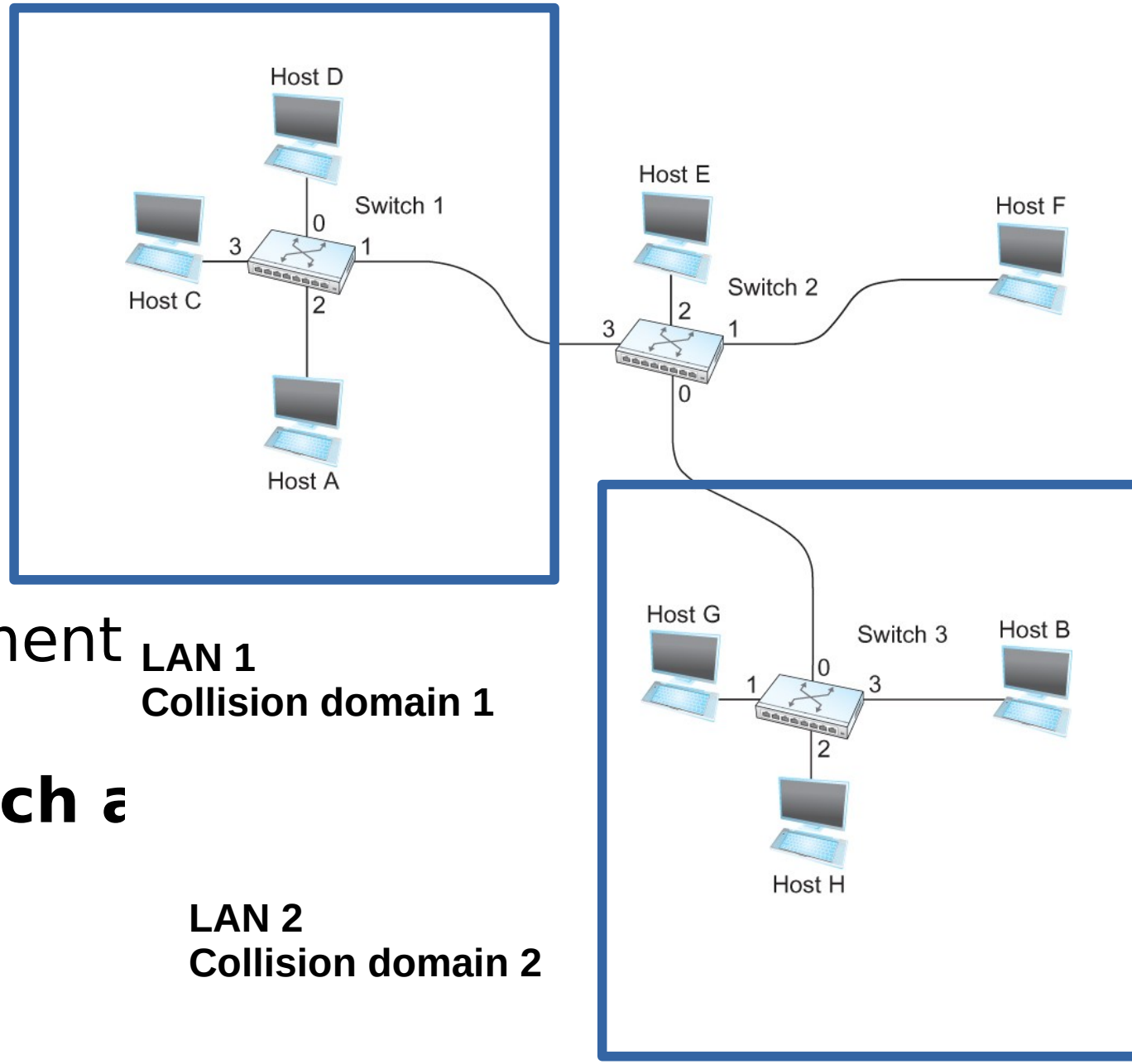


Switching

- Switch
  - A mechanism to interconnect links to form a large network
  - Forward **frames**
  - Separate the collision domains
  - Filter packets between LANs
  - Connects two or more LAN segments - **Bridging**



Switches are Self learning!



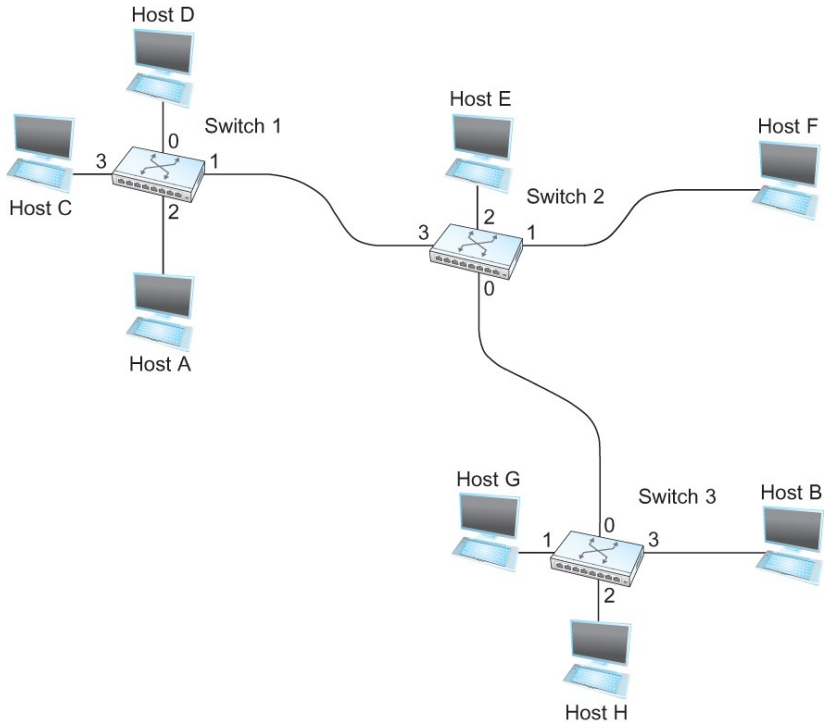
- No configuration needed
- Send frames to needed segment
- **How do they construct such a table?**

Switches are self learning!

- Inspect the source MAC address
  - **What is a mac address?**
- Associate mac address and incoming interface
- Store this association for later use, (for some time)
  - aging-timer

Switching Table

- To decide how to forward a packet, a switch consults a *forwarding table*

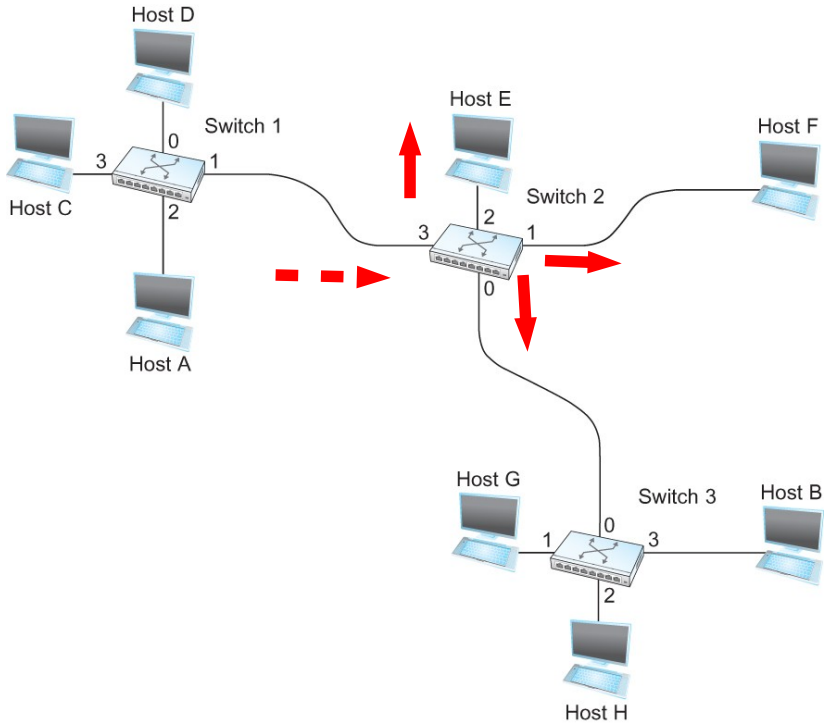


Destination	Port
A	3
B	0
C	3
D	3
E	2
F	1
G	0
H	0

Forwarding Table for Switch 2

Switching Table

- Unknown destination → send out on all Interfaces **(flooding)**
  - **Skip the incoming interface**

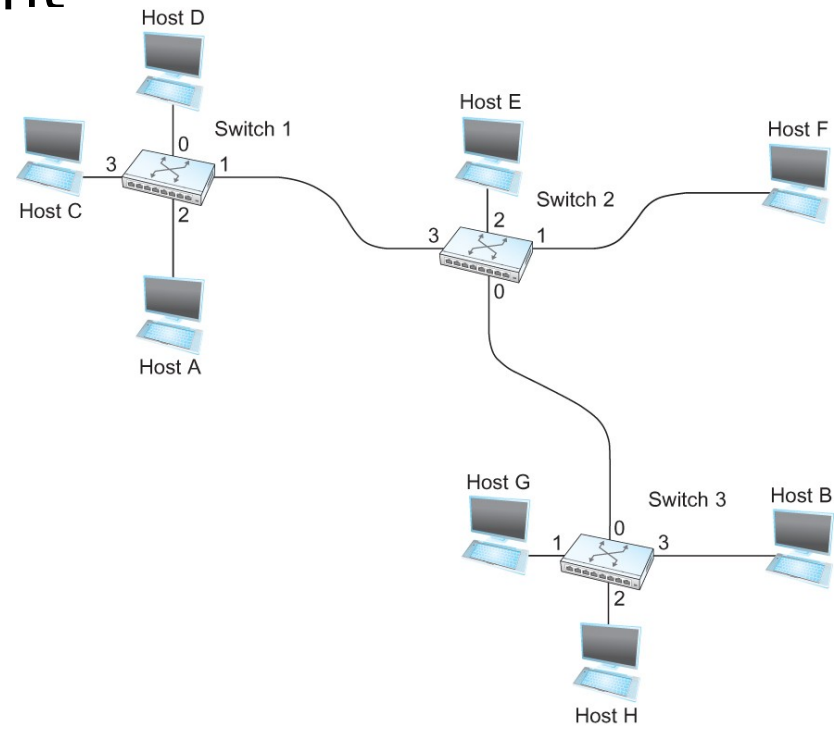


Destination, Port	
	--
A	3
B	0
C	3
D	3
E	2
F	1
G	0
H	0

Forwarding Table for Switch 2

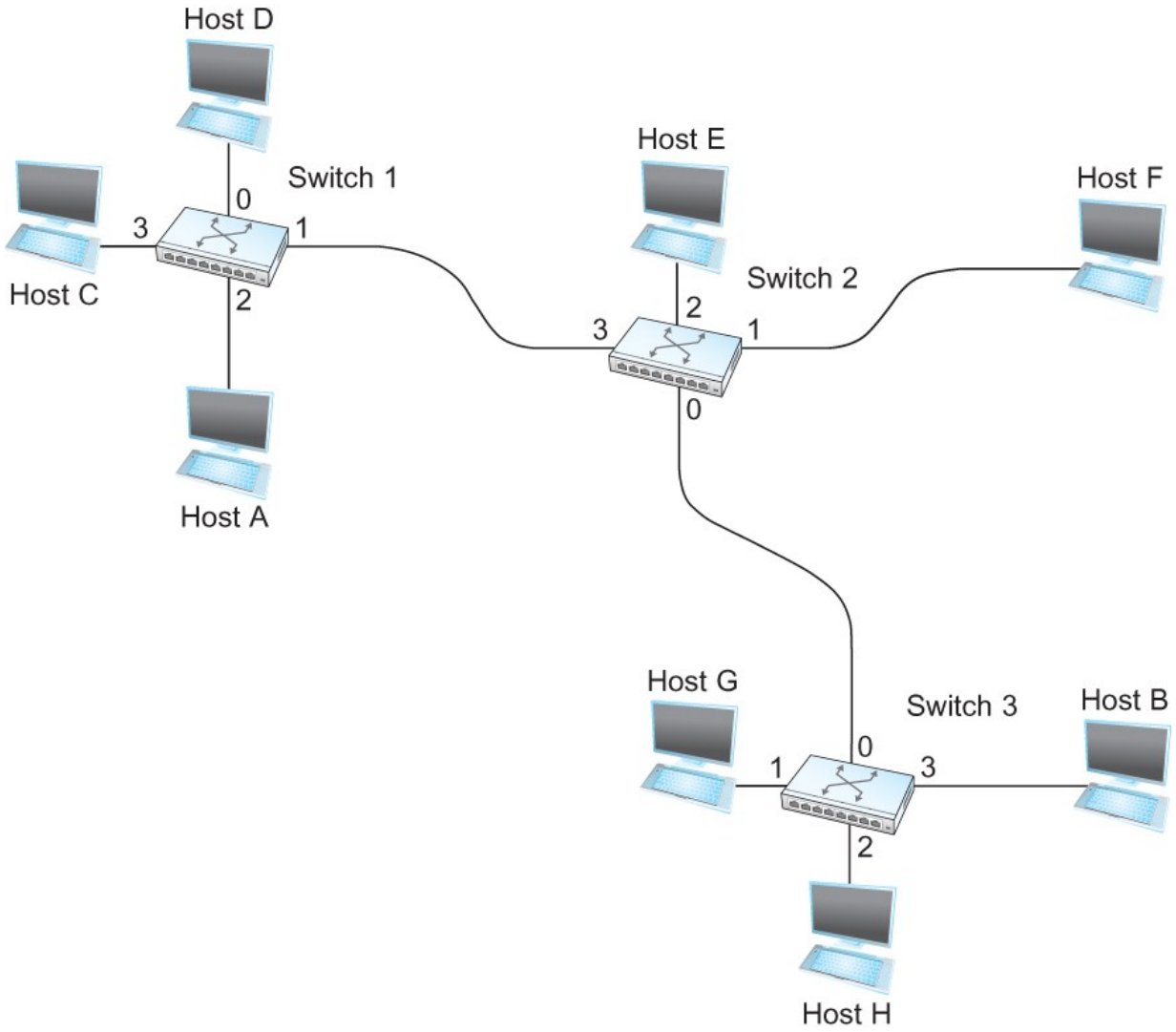
Switching Table Algorithm

- Create the table first!
  - **For each packet**
    - If destination address in arriving segment
      - Drop
    - If destination is in another segment
      - Forward
    - If destination unknown
      - Flood!

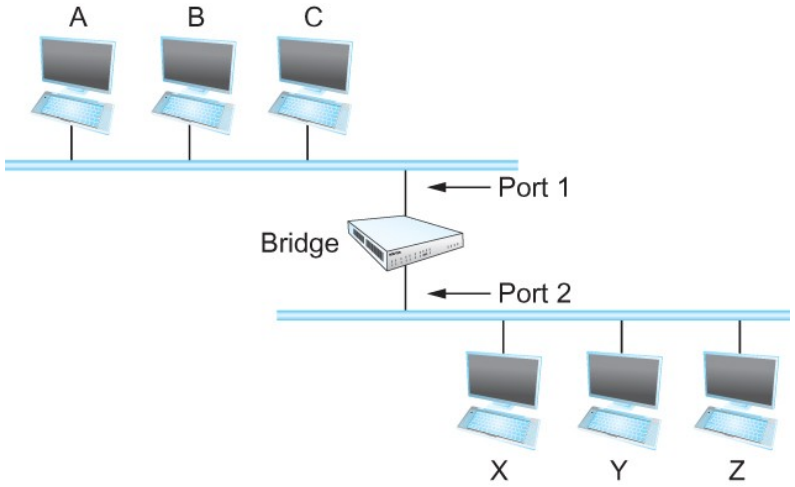


Switching Table Algorithm

- **Send frame from C to F**
- Switch 1 →
  - Notes C is on Interface 3
  - Floods
- Switch 2 →
  - Notes C is on Interface 3
  - Floods
- Host F replies
  - Switch 2 notes F is on Interface 1
  - Sends back over Interface 3
- Switch 1 notes F is on Interface 1
  - Sends back over Interface 3
  - Host c receives frame



Bridges

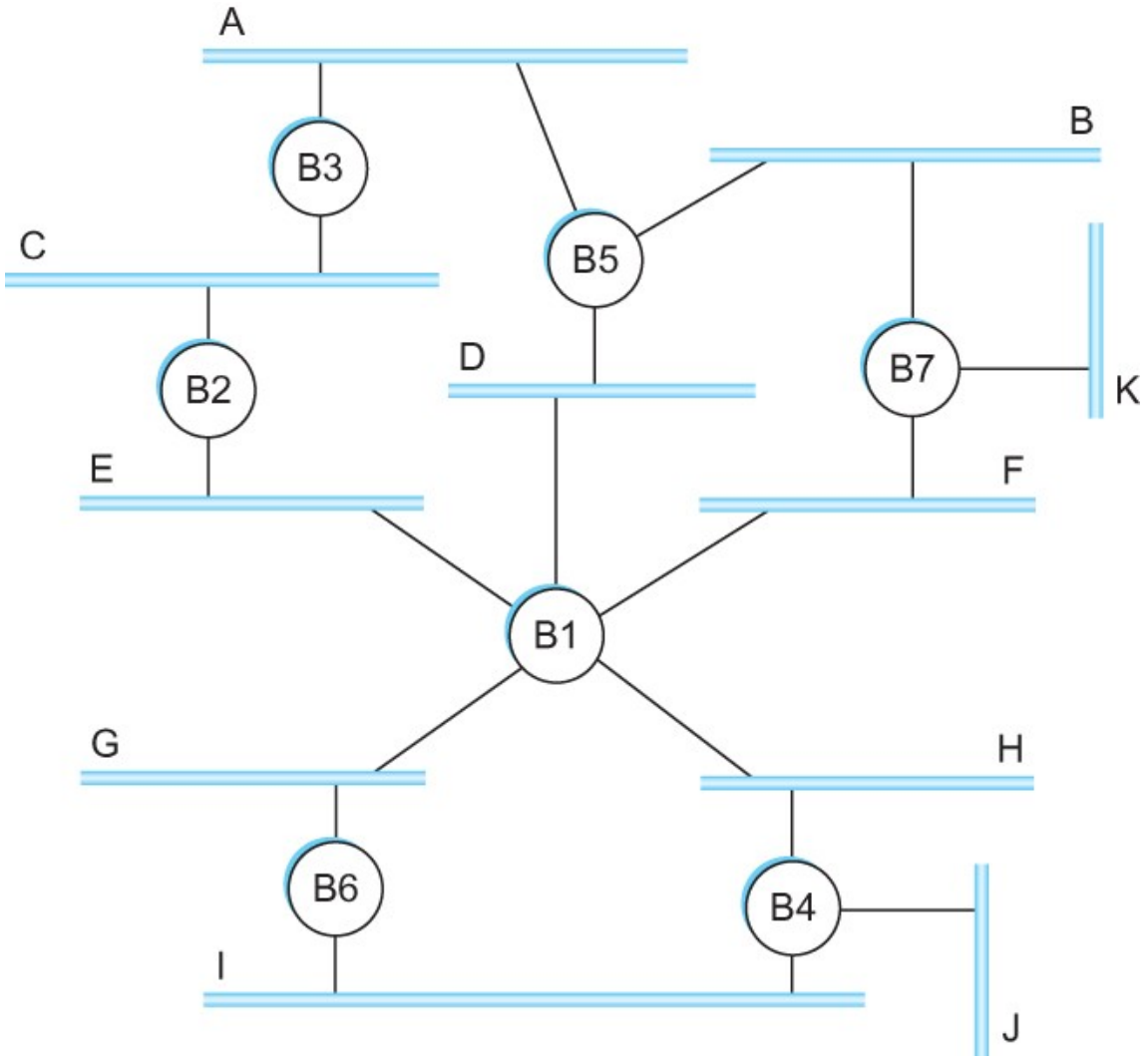


- Bridges and LAN Switches
  - Class of switches that is used to forward packets between shared-media LANs such as Ethernets
  - Known as LAN switches
  - Referred to as Bridges

- Suppose you have a pair of Ethernets that you want to interconnect
  - One approach is put a repeater in between them, physical limitations

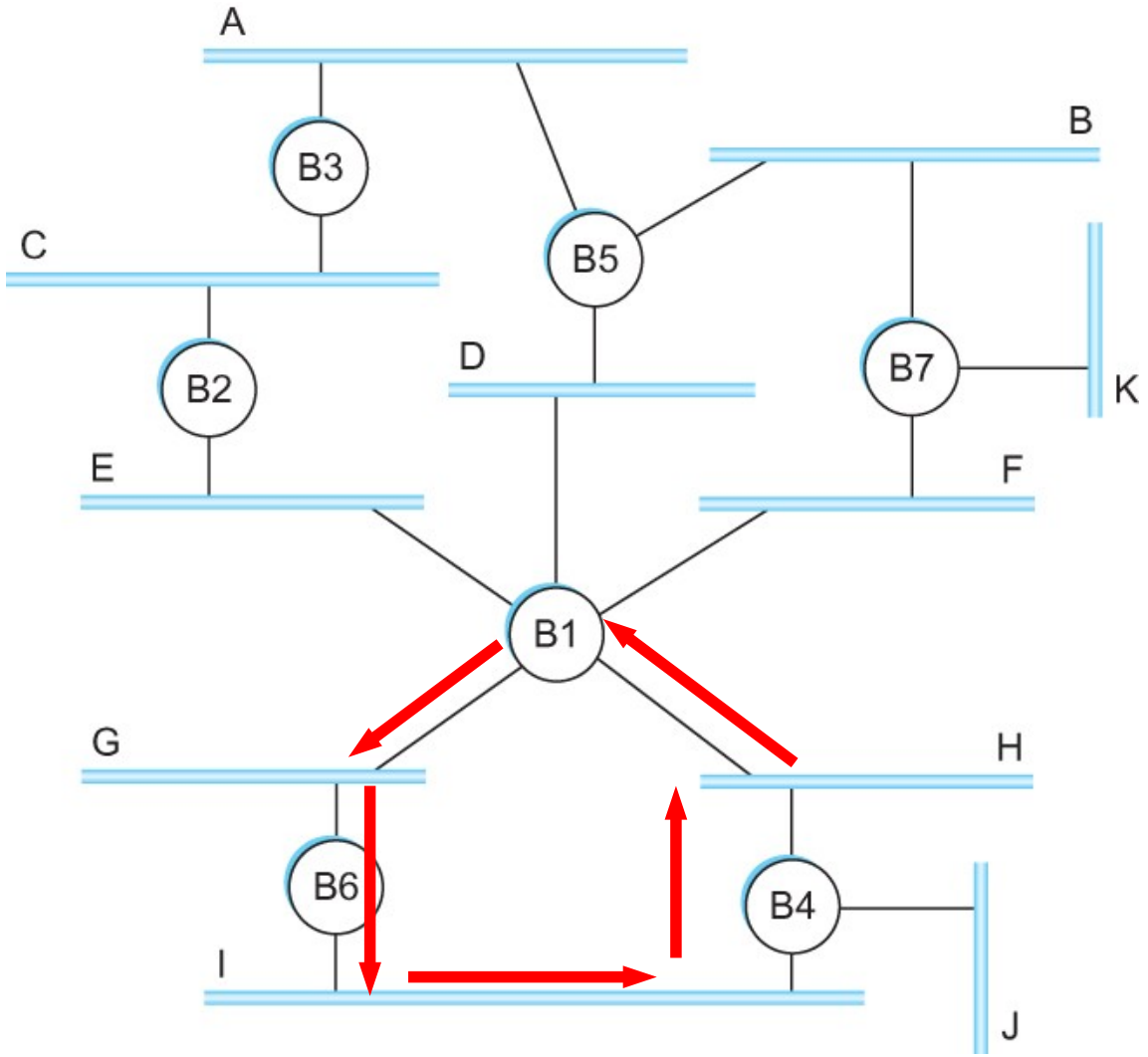
- An alternative would be to put a node between the two Ethernets and have the node forward frames from one Ethernet to the other
  - This node is called a **Bridge**
  - A collection of LANs connected by one or more bridges is usually said to form an **Extended LAN**

Flooding over bridges causes forwarding loops



Spot the loop
Why?

Loop

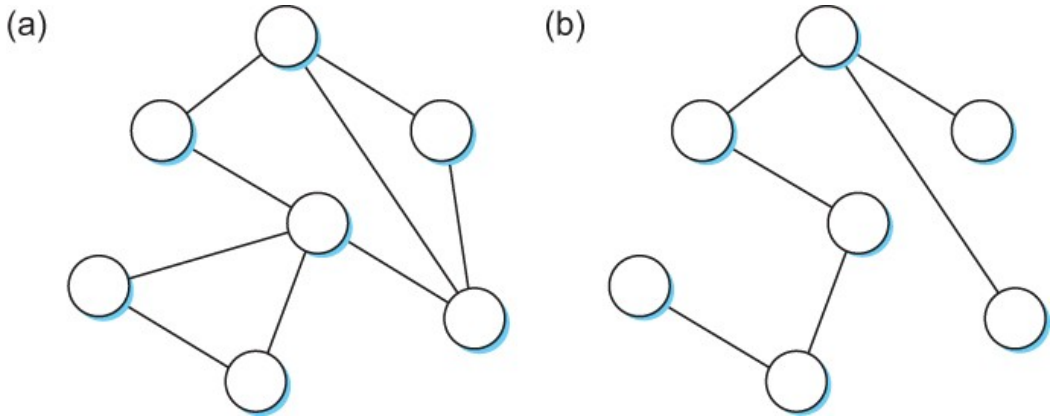


Spot the loop
Why?

Solution? Spanning Tree

Think of the extended LAN as being represented by a graph that possibly has loops (cycles)

- A spanning tree is a sub-graph of this graph that covers all the vertices but contains no cycles
- Spanning tree keeps all the vertices of the original graph but throws out some of the edges



Example of (a) a cyclic graph; (b) a corresponding spanning tree.

How do we create a spanning tree?

- Properties: No loops

- How?
  - Selectively flood

  - Distributed algorithm, no coordination!
  - Automatic reconciliation when failure occurs

How do we create a spanning tree?

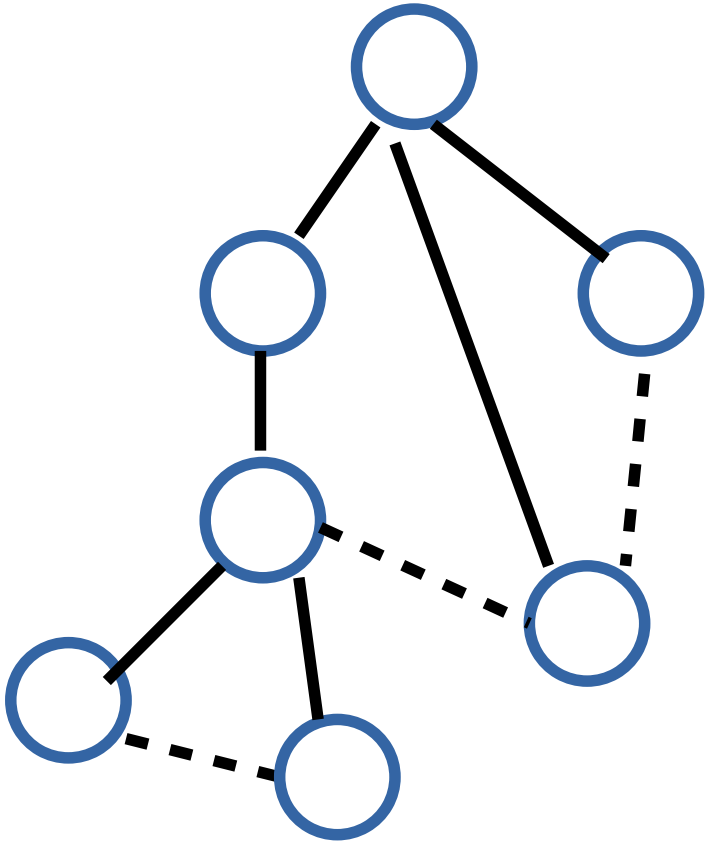
- Properties: No loops

- How?
  - Selectively flood

  - Distributed algorithm, no coordination!
  - Automatic reconciliation when failure occurs

- Switches elect a root
  - The switch with the smallest identifier
  - Each switch identifies if its interface is on the shortest path from the root
  - Exclude if not

- Send message (Y,d,X)
- From x, claims Y is the root, distance is d



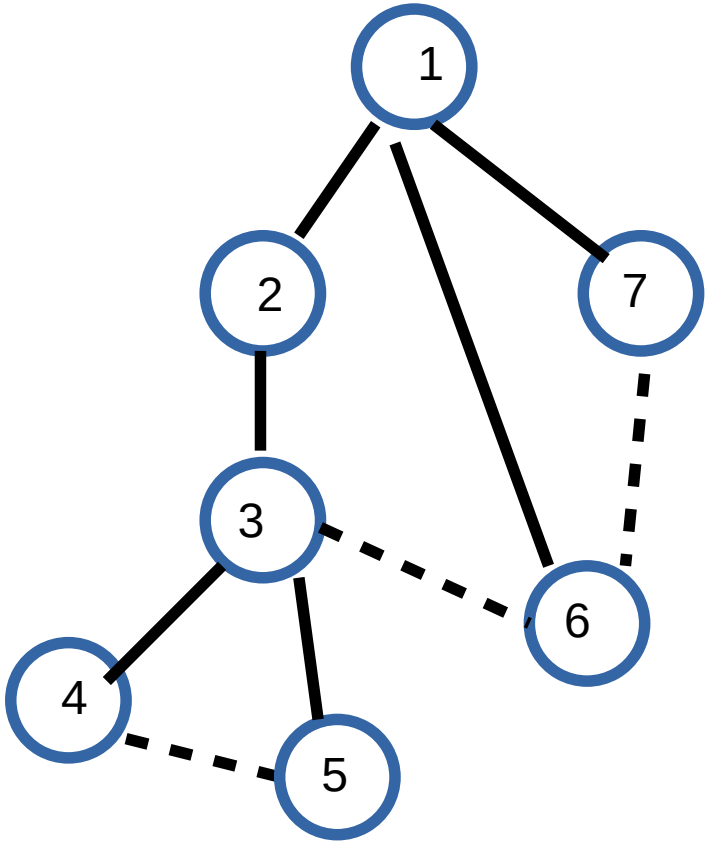
How do we create a spanning tree?

- **Message (Y, d, X) - (to, distance, from)**

- 4 thinks it’s the root

- Sends (4, 0, 4) to 3 and 5
- Receives (3,0,3) from 3
  - Sets it to as the root since 3 < 4

- Receives (3,1,5) from 5
  - Sees that this is a longer path to 3
  - 2 hops vs direct path (1 hop)
  - Removes 4-5 link from the tree



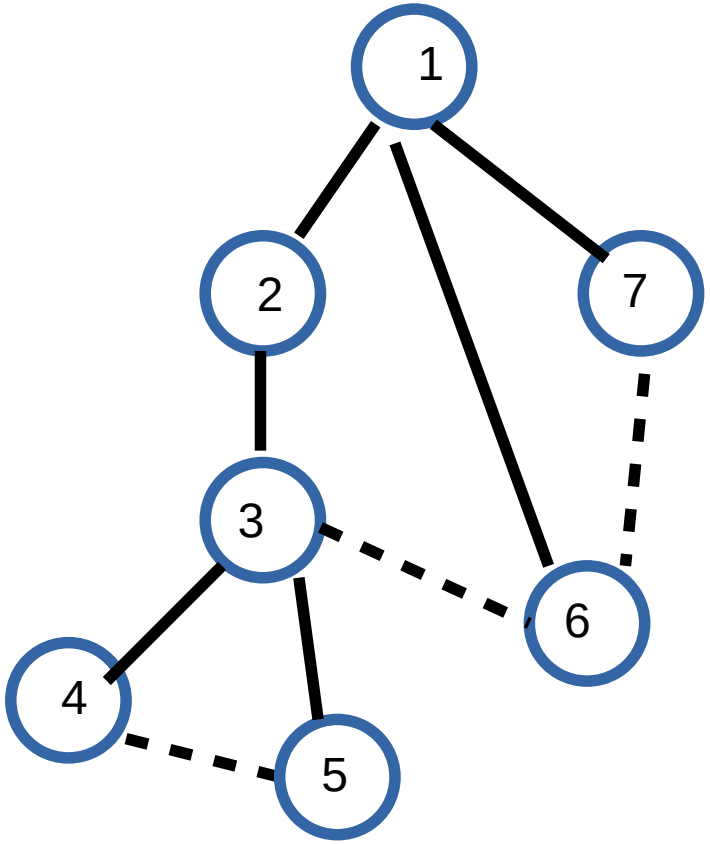
What does 4 do when it hears from 2?

- **Message (Y, d, X) - (to, distance, from)**

- 2 hears (1, 0, 1) from 1
- 2 sends (1, 1, 2) to 3
- 3 sends (1, 2, 3) to 5 and 4

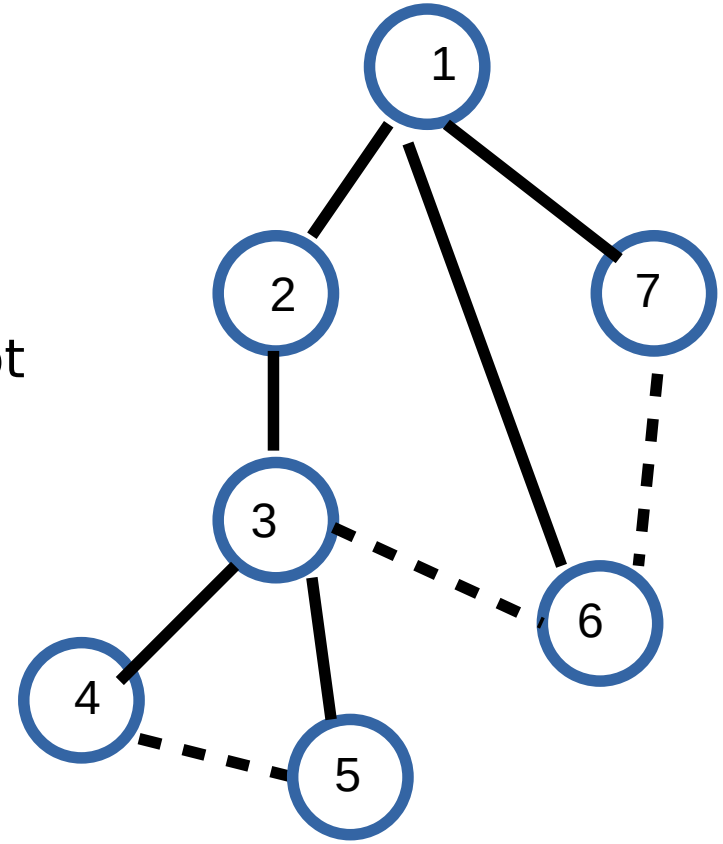
- 4 receives (1, 2, 3) from 3
- 4 receives (1, 3, 5) from 5

- Sets 1 as root (id=1 is < id=4)
- Prunes the 4-5 path since it is 4 hops compared to 3 hops via 3



Failure and Downsides

- Even after the system has stabilized, the root continues to send messages periodically
  - Other bridges continue to forward these messages
- When a bridge fails, the downstream bridges will not receive the configuration messages
  - After waiting a specified period of time, they will once again claim to be the root and the algorithm starts again
- No load balancing



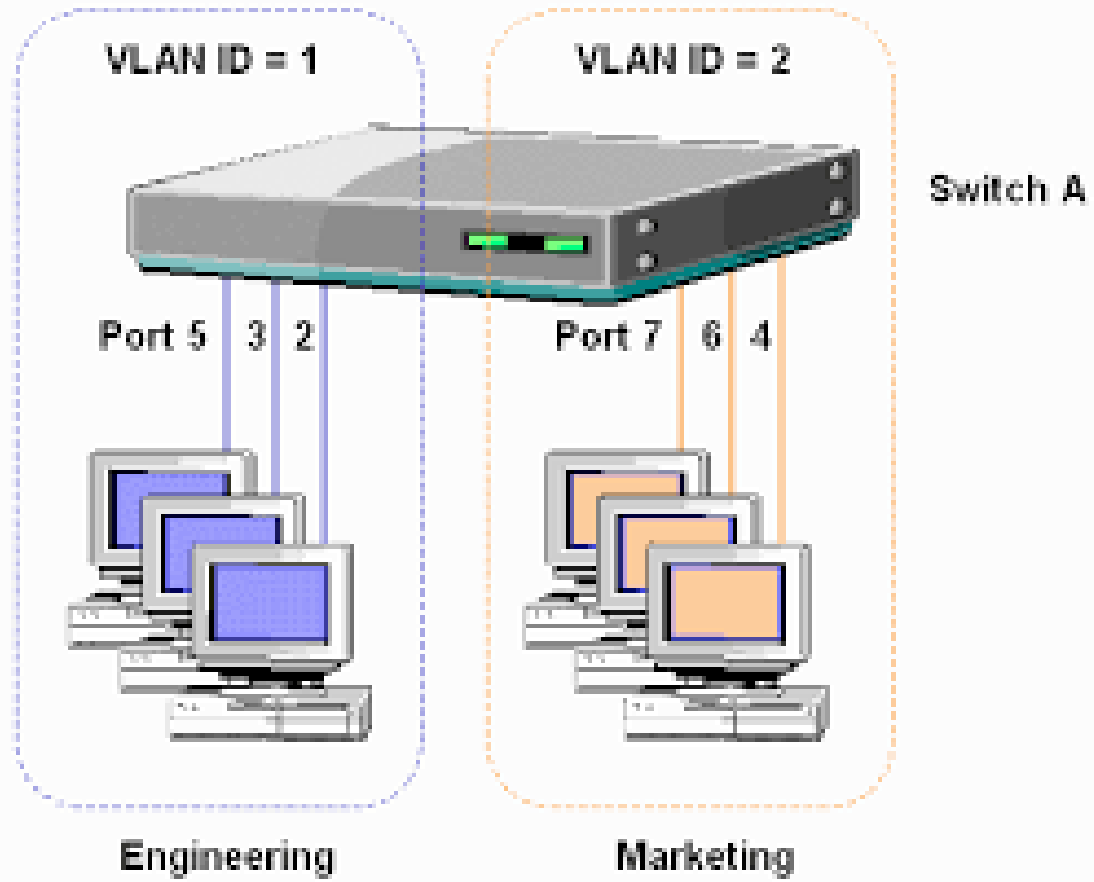
Virtual LAN (VLANs)

- LANs are on the same Ethernet segments
- Does not scale very well – too many wires
- How can we put multiple people in different locations on the same Ethernet segment (LAN)?
- How do we create multiple LANs over the same wire?

Why separate at all?

- LANs are on the same Ethernet segments! Security.
- Isolation – sensitive traffic vs normal traffic
- Containment of traffic – your for loop broke the internet
- How do we create multiple LANs over the same wire?

VLANs



- Switches specify which VLAN is accessible over which interface
- Each interface can have a VLAN color
- Each Mac address can have a interface color
- Add VLAN tag to the Ethernet header

Reading Assignment

Switching Basics – Chapter 3.1

- https://book.systemsapproach.org/internetworking/switching.html#switching-basics
- *Up to (but not including) Virtual Circuit Switching*
- 20 minutes read

- Switched Ethernet, learning bridges, spanning tree algorithm, VLANs – Chapter 3.2
- https://book.systemsapproach.org/internetworking/ethernet.html#switched-ethernet
  - 30-40 minutes read