Ethernet Switching

Computer Networks, Lecture 14

Aditya Badola

Indian Institute of Technology, Bombay

March 7, 2021

Overview

1. Recap of the previous lecture
2. Switching
3. Populating the forwarding table
   - Multiple ports
4. Spanning Tree Protocol
   - Electing the root node
   - Assigning the root port and the designated port

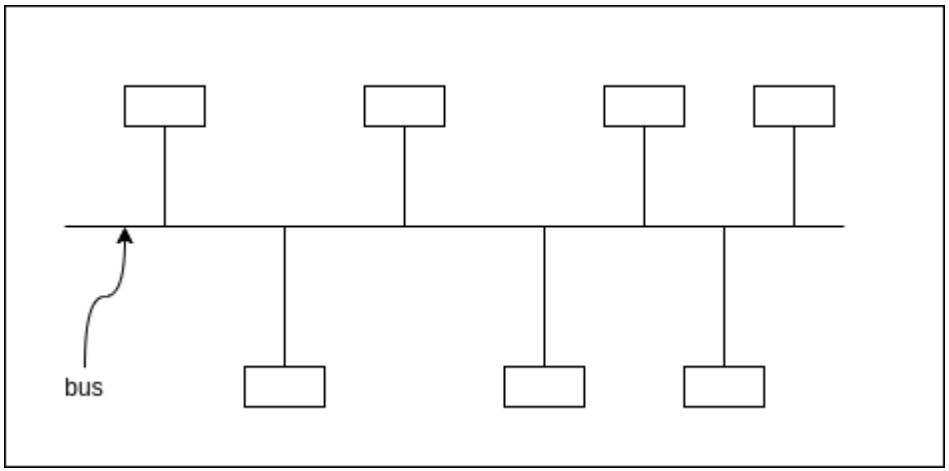
Recap of the previous lecture

- Unlicensed and licensed bands
- TDMA, FDMA
- OFDM(A) protocol in WiFi, 4G
- CDMA, Spreading Codes

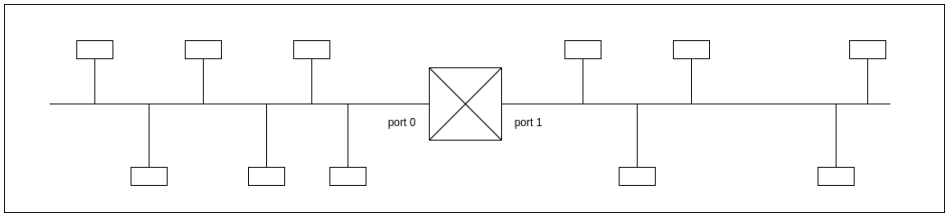
Switching

- L2 Switches: use MAC addresses to switch (ethernet switches are also called bridges)
- L3 Switches (Routers): use IP addresses to switch

Why switching?



This topology will not scale up to more than a few nodes, or else there will be collisions all the time.



Instead, we use a **switch** to connect LANs, to intelligently forward frames (only if the sender and the receiver are on the either side of the switch). **Intelligent isolation** to reduce collisions, and thus provides scalability.

The switch has a **forwarding table** (say):

Destination	**Port Number**
A	0
B	0
C	0
D	0
E	1
F	1

Populating the forwarding table

Filling the table manually, is not practical/efficient. We need to populate the table automatically and dynamically.

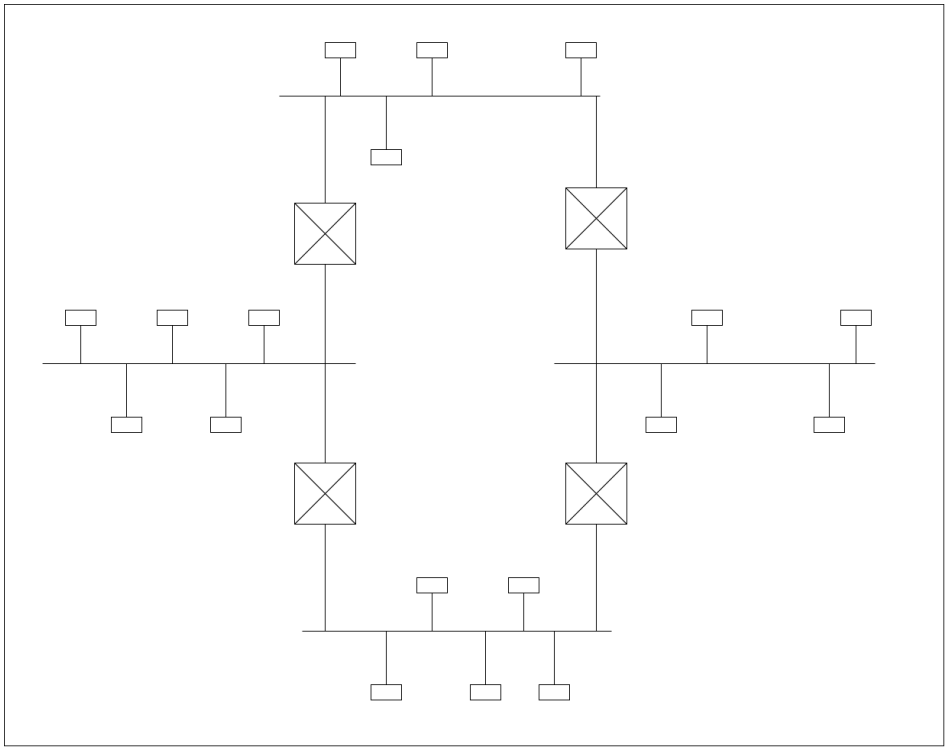
MAC address is a unique 6-byte identifier hardcoded in the card. Each company is allocated a range of MAC addresses that it can use for cards it manufactures. A MAC address should be used **only once**.

- Initially, the table is empty.
- Suppose, A sends an ethernet frame to B.
- Discerns that A is at port 0.
- It does not know where B is, so forwards it on port 1 (by default).
- The table is populated based on the port number of the sender.
- **What if a node is unplugged from one side, and plugged to the other side?** Each entry in the table has a timeout (expiry time). We delete the entry if it has been a while since we heard from that node, that is, after the expiry time.

Multiple (more than two) ports

- Forward to all the ports, if the destination is not in the table.
- Populate the table based on the sender's port.

Spanning Tree Protocol



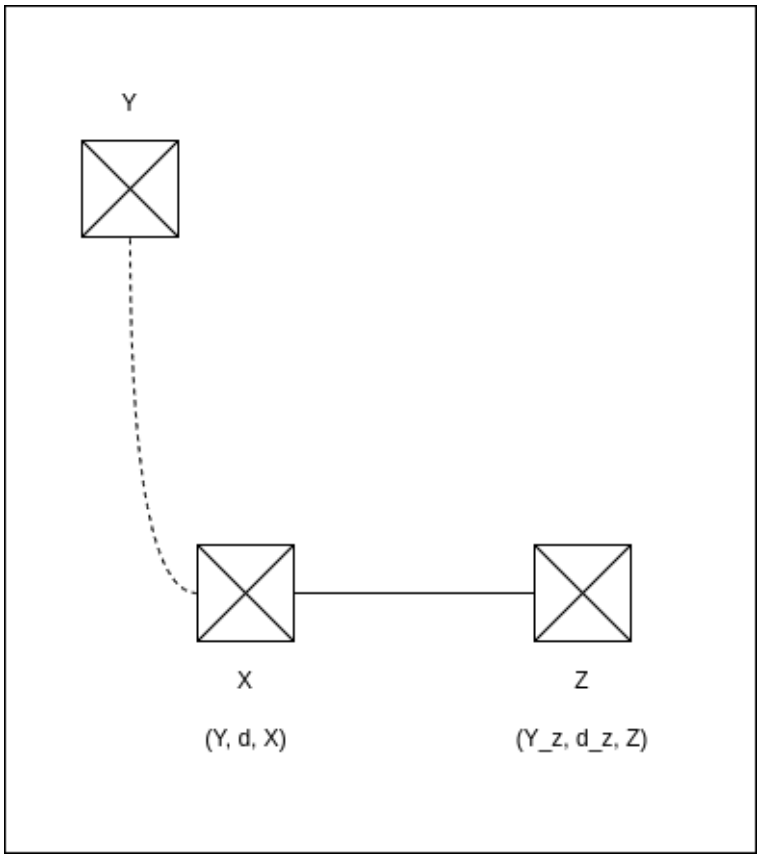
Suppose A sends a frame such that the destination is not in the forwarding table. Thus, the frame may keep getting forwarded *forever*, eating up the bandwidth. We use the **spanning tree protocol** (▸ Radia Perlman)

- Elect a root bridge.
- Each bridge finds which port is closest to the root, and assigns this port as the **root port**. (we will see the tie-breaking rule)
- Root ports are supposed to be the active ports.
- All bridges connected to a LAN, elect one among them to forward frames on that LAN (**designated port**).
- Designated ports are supposed to be the active ports.
- Any port which is neither a root port nor a designated port, is disabled.

Electing the root node

- Each bridge has a bridge ID. The bridge with the lowest ID is elected as root. Bridge ID:

  If we want a particular root node, we assign a lower value of configurable part, for higher priority.
- Each bridge tells its neighbours:
  - Y: smallest ID heard till now
  - d: distance from Y
  - X: my ID



If $Y < Y_z$, then $Y_z = Y$ and
$d_z = d + \texttt{dist}(X, Z)$

If $Y = Y_z$ but $d + \texttt{dist}(X, Z) < d_z$, then
$d_z = d + \texttt{dist}(X, Z)$.

Assigning the root port and the designated port

- **Root port:** (for a port) If more than one ports have the smallest distance to the root, then the tie-break is based in ID (smallest) of neighbours on ports.
- **Designated port:** (for a LAN) Tie-break is based on IDs of bridges.
- Ports that are neither RP nor DP, are disabled.

Speed	**Cost**
10 Gbps	2
1 Gbps	4
100 Mbps	19
10 Mbps	100

Table: Distances can be configured like this.

References

CS224 Computer Networks

Lecture 14 (Spring 2021)

Prof. Vinay Joseph Ribeiro