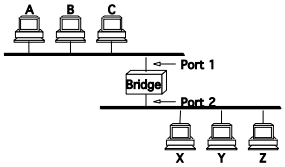
Bridges and Extended LANs

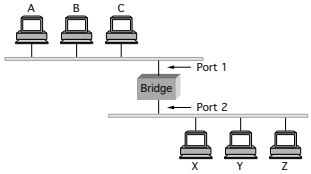
- LANs have physical limitations (e.g., 2500m)
- Connect two or more LANs with a bridge
  - accept and forward strategy
  - level 2 connection (does not add packet header)



- Ethernet Switch = Bridge on Steroids

Learning Bridges

- Do not forward when unnecessary
- Maintain forwarding table

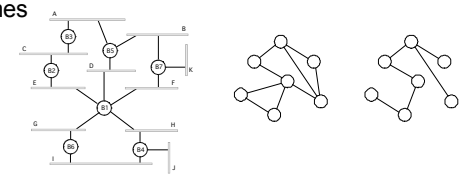


Host	Port
A	1
B	1
C	1
X	2
Y	2
Z	2

- Learn table entries based on source address
- Table is an optimization; need not be complete
- Always forward broadcast frames

Spanning Tree Algorithm

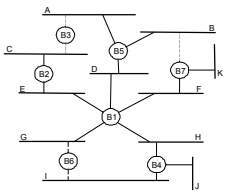
- Problem: loops - no mechanism to remove looping frames



- Bridges run a distributed spanning tree algorithm
  - select which bridges actively forward
  - developed by Radia Perlman
  - now IEEE 802.1 specification

Algorithm Overview

- Each bridge has unique id (e.g., B1, B2, B3)
- Select bridge with smallest id as root
- Select bridge on each LAN closest to root as designated bridge
  - Each bridge forwards frames over each LAN for which it is the designated bridge



Algorithm Details

- Bridges exchange configuration messages
  - id for bridge sending the message
  - id for what the sending bridge believes to be root bridge
  - distance (hops) from sending bridge to root bridge
- Each bridge records current best configuration message for each port
- Initially, each bridge believes it is the root

Algorithm Detail (cont)

- When learn not root, stop generating config messages
  - in steady state, only root generates configuration messages
- When learn not designated bridge, stop forwarding config messages
  - in steady state, only designated bridges forward config messages
- Root continues to periodically send config messages
- If any bridge does not receive config message after a period of time, it starts generating config messages claiming to be the root

Broadcast and Multicast

- Forward all broadcast/multicast frames
  - current practice
- Learn when no group members downstream
- Accomplished by having each member of group G send a frame to bridge multicast address with G in source field

Tcpdump trace

- tcpdump -p

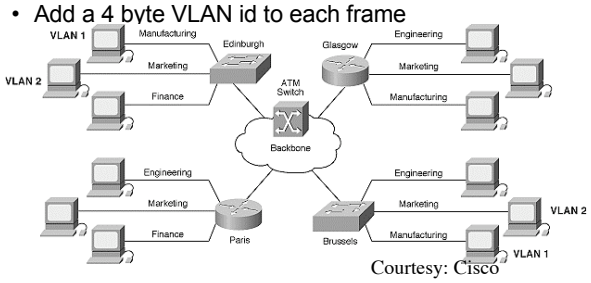
```
02:21:52.651816 802.1d config 0000.00:02:2d:71:03:ef.0001 root 0000.00:02:2d:71:03:ef
    pathcost 0 age 0 max 20 hello 2 fdelay 15
02:21:53.263956 engr-fe21.gw.nd.edu > ALL-SYSTEMS.MCAST.NET: igmp query v2 [tos 0xc0]
    [ttl 1]
02:25:22.656898 CDP v2, ttl=180s DevID '013183892(hub24-1b.hub.nd.edu)' Addr (1): IPv4
    129.74.24.67 PortID '5/10' CAP 0x0e[|cdp]
```

Limitations of Bridges

- Do not scale
  - spanning tree algorithm does not scale - traffic gets bridged through the root bridge
    - Spanning tree is designed to avoid loops, not traffic balancing: redundant routes are ignored
  - broadcast does not scale
- Do not accommodate heterogeneity
- Caution: beware of transparency

VLAN

- Create virtual lans (broadcast domains) without rewiring
- Add a 4 byte VLAN id to each frame



Courtesy: Cisco

SmartBridges

- http://www.researchchannel.com/programs/uw/Asx/cse_smbr_1300k.asx
- http://www.uwtv.org/programs/displayevent.asp?rid=782
- Hybrid between IP routing and bridging