University of Massachusetts Amherst

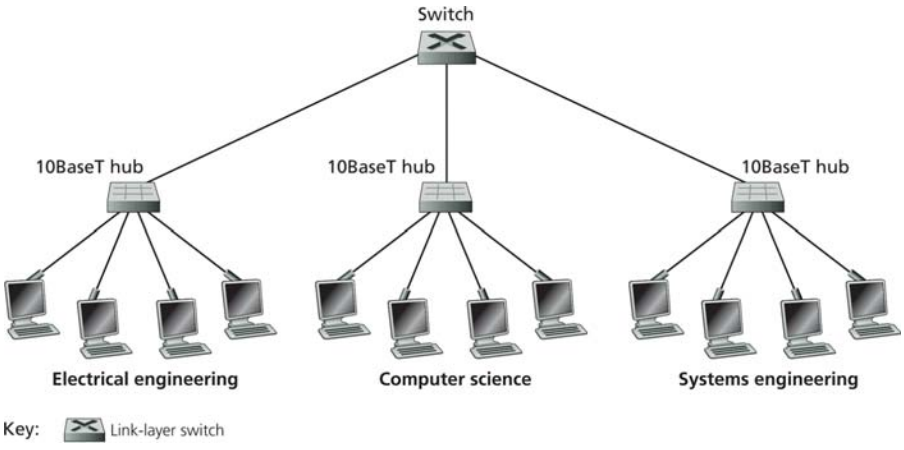
ECE697AA – Lectures 19

Bridges and Switches: Spanning Tree Algorithm

Tilman Wolf
Department of Electrical and Computer Engineering
11/13/08

Network of Switches

- How are frames routed in this network?



Network of Switches

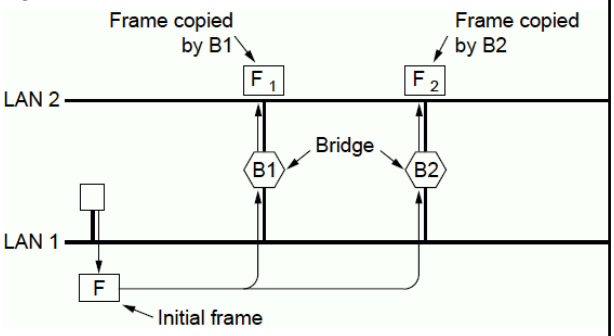
- How are frames routed in this network?
  - Self-learning algorithm / backward learning algorithm
- Switch table maintains information on NIC location

Address	Interface	Time
01-12-23-34-45-56	2	9:39
62-FE-F7-11-89-A3	1	9:32
7C-BA-B2-B4-91-10	3	9:36
....	....	....

  - Filtering and forwarding
    - » Frame only transmitted on output where NIC could be
    - » Switch learns location when observing transmission
  - Timeout to allows change in network topology
- What is the problem with this approach?

Switches

- Realistic networks have redundant paths and cycles
  - What happens with self-learning algorithm?
    - » Stations appear on multiple sides of switch
    - » Possible duplication of packets
- Duplication example:
  - (Figures from Andrew S. Tanenbaum: Computer Networks)
- How bad can duplication become?
  - What is the worst possible scenario?

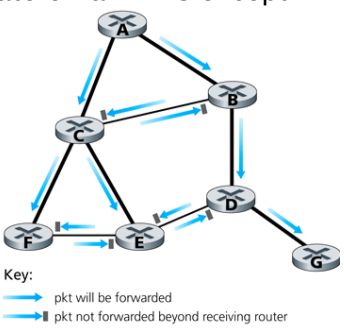


Flooding

- Loops are problematic when flooding
  - Uncontrolled flooding leads to “broadcast storm”
- How can information be flooded efficiently?

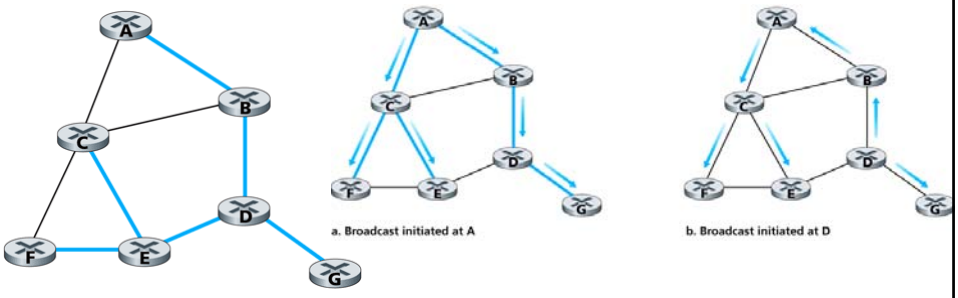
Controlled Flooding

- How can information be flooded efficiently?
- Sequence number-controlled flooding
  - Flooding packets carry sequence number
    - » Incremented once per flood
  - Nodes remember previously seen sequence numbers
    - » Ignore packets that were previously seen
  - When new packet is received, duplicate on all links except the link where it was received
- Reverse path forwarding
  - When broadcast packet is received, check if it arrived on link that is on shortest path to source
    - » If so, broadcast on all links except where it was received
    - » If not, ignore
- Can we do better?



Spanning Tree

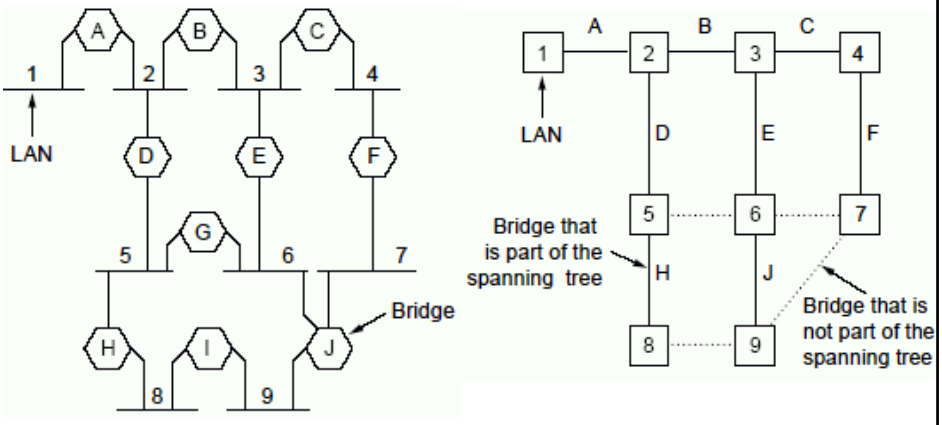
- Controlled flooding still causes duplicate packets on link
- Spanning tree selects subset of links to be used



- How can we construct spanning tree?
  - What do we do with links that do not belong to tree?

Spanning-Tree Algorithm

- Convert actual topology into tree structure
  - Turn off selected bridges



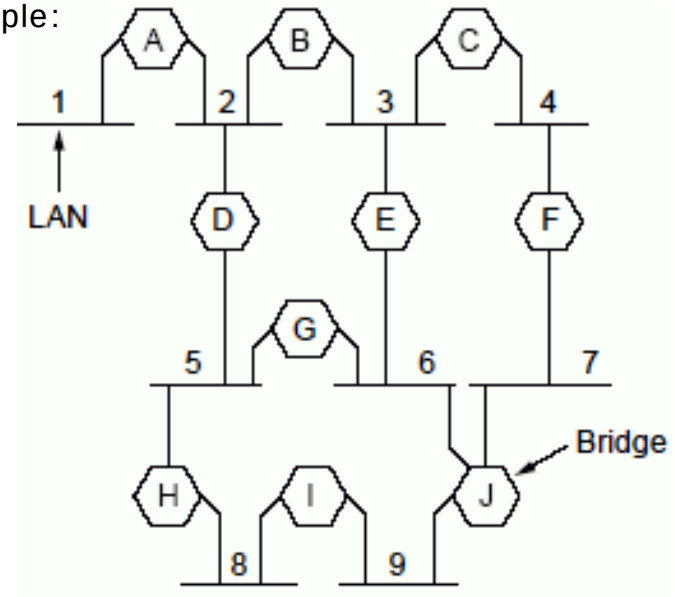
  - If we turn off bridge, why bother installing it?

Spanning-Tree Algorithm

- Idea:
  - Determine root node of tree
  - Determine shortest-path spanning tree from root
- Exchange of HELLO messages
  - Message contains:
    - » Transmitting bridge ID
    - » ID of bridge assumed to be root
    - » Length of best known path to root
- Protocol
  - Switches start out as root
    - » If message with smaller root ID is discovered, accept new root
  - "Designated bridge" has shortest path to root on LAN
    - » Root broadcasts periodic HELLO
    - » Designated bridges forward HELLO on their LAN

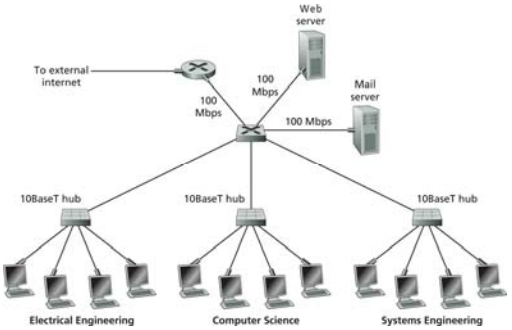
Spanning-Tree Algorithm

- Example:



Switches vs. Routers

- Why don't we use only switches?
  - Size and search speed in lookup table does not scale
  - Spanning tree is not always optimal routing
  - Routing loops cannot be detected
  - Vulnerable to broadcast storms
  - Nodes need large ARP tables
- Why don't we use only routers?
  - Difficult to configure
  - Expensive
- Usually combination of switches and routers



Homework

- Read
  - Miguel Á. Ruiz-Sánchez, Ernst W. Biersack, and Walid Dabbous, "Survey and taxonomy of IP address lookup algorithms," IEEE Network, vol. 15, no. 2, pp. 8–23, Mar. 2001.
- SPARK
  - Assessment quiz