Fishnet 1 Demo
- Ping me (flooding)
- Network topology (neighbor discovery)

Fishnet 2 Out
- Link state routing (read Peterson 4.2.3)
- (Extra credit) Routing policy

- Feedback:
  - Fewer bugs & bug fix releases
  - Clearer instructions

Last week...
- How can we provide reliable communication between two processes over an unreliable network?
  - ARQ & sliding window
  - RTT estimation
  - Ports & the transport layer
  - Connection setup & teardown
This week...

- How can we get packets across the network efficiently in the face of node failure & mobility?
  - Bridging and spanning trees (today)
  - Distance vector routing
  - Link state routing
  - Mobility

Flooding robustness

- What if a packet is dropped?
- What if a new node is added?
- What if a node goes down?
- What if a node moves?

Flooding & Efficiency

- Do we ever send messages that aren't needed?

Redundant Messages
Aside: Commutative & Transitive Neighbors

- Commutative
  - If Alice can hear Bob, Bob can hear Alice.
- Transitive
  - If Alice hears Bob and Bob hears Carol, then Alice hears Carol.

- Point-to-point:
- Shared Ethernet segment:
- Wireless:

Backward Learning Algorithm

- To optimize overall performance:
  - Bridge forwards iff destination not on local segment
- How does the bridge know?

Why stop at one bridge?

Problem:

Solution:

Spanning tree algorithm

- Goals:
  - Self-configuring
  - Self-healing
Step 1: Choosing a root node

- How can we pick a distinct node?

Step 2: Grow shortest paths to root

- How can we break ties?

Complete algorithm (1)

- Each bridge sends periodic messages to all neighbors containing:
  - Its address
  - Root address
  - Distance to root (in hops)

Complete algorithm (2)

- Initially, each node thinks it is root!
- If it hears of a better root...
  - Updates root and shortest path to root
  - And sends new message (if needed)
- If it hears of a better path...
  - Updates best path
  - And sends new message (if needed)
- Only forward packets along best paths
Example: What does B3 send & receive?

Spanning tree efficiency

• Messages to discover tree:
  – Best case:
  – Worst case:

• Copies of each forwarded message:

Spanning tree robustness

• What if a packet is dropped?
• What if a new node appears?
• What if a node disappears?
• What if a node moves?

Spanning tree limitations

• LAN bridges form an effective small-scale network
  – Plug and play for real!

• Why can’t we build a large network using bridges?
Key Concepts

- Backward learning & spanning trees make flooding more efficient
  - But there are limits to this strategy …

- Next time: Distance vector routing

Algorhyme

I think that I shall never see
a graph more lovely than a tree.
A tree whose crucial property
is loop-free connectivity.
A tree that must be sure to span
so packet can reach every LAN.
First, the root must be selected.
By ID, it is elected.
Least-cost paths from root are traced.
In the tree, these paths are placed.
A mesh is made by folks like me,
then bridges find a spanning tree.

[Radia Perlman, "An algorithm for distributed computation of a spanning tree in an extended LAN." Symposium on Data Communications, 1985.]