Network Routing - I (Without Failures)
Lecture 19
6.02 Fall 2009
November 16, 2009

- Forwarding. Distributed routing.
- Distance-vector protocol with Bellman-Ford step
- Link-state protocol with Dijkstra’s shortest-paths

The Problem: Finding Paths

• How to find a good path (or paths) between any two nodes?
• Addressing (how to name nodes)
• Forwarding (how does a switch process a packet)
• Routing (building and updating data structures to ensure that forwarding works)

Forwarding

- Core function is conceptually simple
  • lookup(dst_addr) in routing table returns route (i.e., outgoing link) for packet
  • enqueue(packet, link_queue)
  • send(packet) along outgoing link
- And do some book-keeping before enqueue
  • Decrement hop limit (TTL); if 0, discard packet
  • Recalculate checksum (in IP, header checksum)

Routing Table Structure

Table @ B

<table>
<thead>
<tr>
<th>Destination</th>
<th>Link (next-hop)</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>ROUTE L1</td>
<td>18</td>
</tr>
<tr>
<td>B</td>
<td>“Self”</td>
<td>0</td>
</tr>
<tr>
<td>C</td>
<td>L1</td>
<td>11</td>
</tr>
<tr>
<td>D</td>
<td>L0</td>
<td>4</td>
</tr>
<tr>
<td>E</td>
<td>L1</td>
<td>16</td>
</tr>
</tbody>
</table>

Shortest Path Routing

- Each node wants to find the path with minimum total cost to other nodes
- We use the term “shortest path” even though we’re interested in min cost (and not min #hops)
- Several possible distributed approaches
  • Vector protocols, esp. distance vector (DV)
  • Link-state protocols (LS)

Distributed Routing: A Common Plan

- Determining live neighbors
  • HELLO protocol (periodic) - next lecture
  • Common to both DV and LS protocols
- Advertisement step (periodic)
  • Send some information to all neighbors
- Integration step
  • Compute routing table using info from advertisements
**Distance Vector Routing**

- Advertisement: Each node periodically announces a vector of (destination:pathcost) tuples to all its neighbors.
- Integration: On hearing advertisement, run Bellman-Ford step:
  - If (current cost to dest > cost in advertisement + linkcost), update cost, route.

**Link-State Routing**

- Advertisement step:
  - Information about its links to its neighbors.
  - Neighbors re-send on their links \(\rightarrow\) flooding.
  - Result: Each node discovers map of the network.
- Integration: Each node runs the same shortest path algorithm over its map.
  - If each node implements computation correctly and each node has the same map, then routing tables will be correct.

**Integration Step: Dijkstra's alg**

- Many algorithms: We’ll study Dijkstra’s.

**Dijkstra's Algorithm Example**

Suppose we want to find paths from A to other nodes.

**Summary**

- The network layer implements the “glue” that achieves connectivity.
- Does addressing, forwarding, and routing.
- Forwarding entails a routing table lookup; the table is built using a routing protocol.
- DV protocol: distributes route computation; each node advertises its best routes to neighbors.
- LS protocol: distributes (floods) neighbor information; centralizes route computation using shortest-path algorithm.