6.033 Spring 2016

Lecture #9

- Scalable Routing
- Policy Routing
- BGP
goal of a routing protocol: allow each switch to know, for every node \textit{dst} in the network, a route to \textit{dst}
goal of a routing protocol: allow each switch to know, for every node $\text{dst}$ in the network, a **minimum-cost** route to $\text{dst}$
goal of a routing protocol: build a routing table at each switch, such that `routing_table[dst]` contains a **minimum-cost route** to `dst`
Distributed Routing

1. Nodes learn about their neighbors via the **HELLO** protocol

2. Nodes learn about other reachable nodes via advertisements

3. Nodes determine the minimum-cost routes (of the routes they know about)
# Comparison of Routing Protocols

<table>
<thead>
<tr>
<th></th>
<th>Distance-vector</th>
<th>Link-state</th>
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<tbody>
<tr>
<td><strong>Node X’s advertisement format</strong></td>
<td>list of all nodes X knows about and the current costs to those nodes</td>
<td>list of all X’s neighbors and the <strong>link costs</strong> to those nodes</td>
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<tr>
<td><strong>Who receives X’s advertisement</strong></td>
<td>X’s neighbors</td>
<td>all nodes (via flooding)</td>
</tr>
<tr>
<td><strong>Integration</strong></td>
<td>Bellman-Ford</td>
<td>Dijkstra’s Algorithm</td>
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**problem:** neither distance-vector nor link-state routing will scale to the size of the Internet
Scalable Routing

1. **path-vector routing**: advertisements include the path, to better detect routing loops

2. **hierarchy of routing**: route between ASes, and then within an AS

3. **topological addressing**: assign addresses in contiguous blocks to make advertisements smaller
problem: ASes also need a means to implement policy
Common AS Relationships

**customer/provider ("transit")**
customer pays provider for transit

**peers**
peers allow (free*) mutual access to each other’s customers

*as long as the amount of traffic in each direction is roughly equal
Export Policies

goal: make money

customer/provider ("transit")

providers tell everyone about themselves their customers, and tell their customers about everyone

peers

peers tell each other about their customers
Import Policies

goal: make money

customer > peer > provider

(and then a variety of other attributes when this rule isn’t sufficient)
does BGP scale?
• To route on the Internet means to route at an enormous scale. We deal with scale via three techniques: path-vector routing, a hierarchy of routing, and topological addressing.

• BGP provides a means for autonomous systems to do policy routing. While the protocol is simple, how it works in practice is enormously complex due to competing economic interests, among other things.

• Though BGP works on the Internet today, its ability (or inability) to scale is becoming a concern as the Internet continues to grow.