Routing on the Internet

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The Network Layer: Routing & Addressing

Outline

- Network layer services
- Routing algorithms
  - Least cost path computation algorithms
  - Hierarchical routing
    - Connecting networks of networks
- IP Internet Protocol
  - Addressing
  - IPv6
- Routing on the Internet
  - Intra-domain routing
  - Inter-domain routing
- Router architecture
Routing on the Internet

The Internet AS hierarchy

Inter-AS border (exterior gateway) routers

Intra-AS (interior gateway) routers

The Internet AS Hierarchy

Intra-AS routing

- Also known as “Interior Gateway Protocols” (IGPs)
- Most common IGPs:
  - RIP: Routing Information Protocol (Distance-vector like routing)
  - OSPF: Open Shortest Path First (Link-state routing)
  - IGRP: Interior Gateway Routing Protocol (Cisco proprietary)
**The Internet AS Hierarchy**

**Inter-AS Routing**

- Border Gateway Protocol (BGP) is the *de facto* standard
- *Path Vector* protocol:
  - Similar to Distance Vector protocol
  - Each Border Gateway advertises to adjacent nodes (peers) the *entire AS path* (*i.e.*, sequence of AS numbers) to a destination
  - *e.g.*, Gateway X may send its path to destination Z:
    \[ \text{path (XZ)} = X, Y_1, Y_2, Y_3, \ldots, Z \]
- BGP messages are exchanged using TCP

**Internet Inter-AS Routing**

**BGP**

- Suppose gateway X sends a path to peer gateway W
- W may or may not select the path advertised by X
  - Cost, policy ("don’t route via competitor X’s network"), or loop prevention reasons
- If W selects the path advertised by X to Z, then:
  \[ \text{path (WZ)} = W + \text{path (XZ)} \]
- Note that X can control its incoming traffic by controlling its route advertisements to adjacent border gateways:
  - If X does not want to route traffic to Z, then X will not advertise any routes to Z
Putting It All Together

Intra-AS & Inter-AS Routing

The Internet AS Hierarchy

Why different intra- and inter-AS routing?

- Policy:
  - Inter-AS: administration wants control over how its traffic routed and who routes through its network
  - Intra-AS: single administration, so no “policy” decisions needed
- Scale:
  - Hierarchical routing saves table size, reduced update traffic
- Performance:
  - Intra-AS: can focus on performance
  - Inter-AS: policy may dominate over performance