Internet Routing (IP)

Chapter 27

Propagation of routing information used to create and update routing tables.

Dynamic Routing

- Most routers use dynamic routing.
- An exception might be a small network such as a small business connected to one ISP.
- Most routers need to exchange information as in the example. R1 needs to know about Net 3.
- Each router runs route propagation software.

Routing in the Global Internet

- To limit routing traffic, the Internet uses a two-level routing hierarchy.
- Routers and networks are divided into groups.
- All routers within a group exchange routing information.
- At least one router in each group summarizes the information before passing it on to other groups.
- Such a group of routers in connected networks is called an Autonomous System (AS).

Two Types of Internet Routing Protocols

- Interior Gateway Protocols (IGPs) are used inside Autonomous Systems.
- Exterior Gateway Protocols (EGPs) are used outside Autonomous Systems.

Optimal Routes, Metrics, and IGPs

- The “best” route might depend on throughput, delay, jitter, etc.
- But, most routers use a Routing Metric based on administrative cost and hop count.
- IGPs use routing metrics, but EGPs do not.
  - EGP just chooses a (any) path.
  - EGP cannot evaluate “best” routes because it does not know the internal rules of the IGPs.
**Routes and Data Traffic**

- Data traffic for a given destination flows in exactly the opposite direction of the routing traffic.

![Diagram](image1)

**Border Gateway Protocol (BGP)**

- BGP is the most popular EGP in the Internet.
- BGP-4 has the following characteristics.
  - Routing among autonomous systems
  - Provision for policies
    - Allows restriction of advertisement of some paths.
    - Facilities for transit routing. Each participating AS
      - **Transit** if AS agrees to pass traffic through.
      - **Stuck** if AS does not agree to pass traffic.
    - Multi-homed – AS with multiple external connections.
  - Reliable transport
    - Uses TCP for all communications.
  - Routing Arbiter is a central database of all destinations with ISP information.

**Routing Information Protocol (RIP)**

- RIP is a popular IGP.
  - Hop count metric
  - Unreliable transport
    - RIP uses UDP.
  - Broadcast or multicast delivery
  - Support for default route propagation
  - Distance vector algorithm
  - Passive version for hosts
    - Listen only

**RIP version 2 Message Format**

![Message Format](image2)

**Open Shortest Path First Protocol**

- OSPF is more suited for large organizations than RIP. It also is a popular IGP.
  - Full CIDR and subnet support
  - Authenticated message exchange
    - Prevents duping by sending false information.
  - Can import routes from BGP
  - Link-State algorithm
  - Support for multi-access networks
    - For Ethernet, a single router is chosen to advertise the route.

**Example OSPF Graph**

![Graph](image3)

- Each pair of routers connected by a network periodically probe one another and then broadcast a link-status message to other routers.
- OSPF allows an AS to be divided into “Areas,” subnets much like mini AS’s.
Multicast Routing
- Multicast routing is considerably different from unicast routing.
- Dynamic group membership. An application can join or leave a multicast group at any time by informing a nearby router.
- Anonymous senders. Neither a sender nor a receiver knows the number or identity of the group members. Routers and hosts do not know which application will send a datagram to a group because an arbitrary application can. Senders do not need to join the group.

Internet Group Multicast Protocol
- IGMP allows a host to inform a nearby router whenever it needs to join or leave a group.
  - It defines the host, not the application(s), to be a group member.

Forwarding and Discovery Techniques
- A router must take action when one of its hosts joins a multicast group.
- The size and topology of groups can vary widely.
- Multicast routing protocols must change quickly.
  - Flood-and-Prune, good for a small campus.
  - Configuration-and-Tunneling, good for geographically dispersed group.
  - Core-Based Discovery, allows multicast to scale gracefully from a small group in one area to a large group with members at arbitrary locations.

Multicast Protocols
- Distance Vector Multicast Routing Protocol (DVMRP)
- Core Based Trees (CBT)
- Protocol Independent Multicast -- Sparse Mode (PIM-SM)
- Protocol Independent Multicast -- Dense Mode (PIM-DM)
- Multicast extensions to the Open Shortest Path First protocol (MOSPF)
- The Internet does not currently have an Internet-wide multicast routing facility.