ACIT 2620

Principles of Enterprise Networking

By: Yves Rene Shema

Routing Protocols

Review: Layer 2

- Link layer (layer 2) handles sending datagrams to hosts directed connected within the same LAN
- Limited broadcast, cannot cross network’s boundaries

Review: Layer 3

- Network layer handles sending datagrams across network boundaries - internetworking
- IP address consists of two parts: network ID and host ID
- Hosts and routers look at the network ID to determine if a destination address is local or outside

Review: Routing table

- Hosts and routers maintain a routing table used in making routing decisions
- Each entry in a routing table (called route) represents a possible path a datagram might take to reach its destination

Review: Routing table

- Each route in a routing table has 4 main components:
  - Destination value
  - Subnet mask
  - Gateway or interface address
  - Route cost or metric

Review: Routing table

- Example:

```
[admin@netdev1 ~]$ ip route
default via 10.0.255.250 dev enp0s3 proto bird metric 32
10.0.15.0/24 dev enp0s8 proto bird scope link metric 32
10.0.15.0/24 dev enp0s8 proto kernel scope link src 10.0.15.254 metric 101
10.0.16.0/24 via 10.0.255.252 dev enp0s3 proto bird metric 32
10.0.255.0/24 dev enp0s3 proto bird scope link metric 32
10.0.255.0/24 dev enp0s3 proto kernel scope link src 10.0.255.251 metric 100
[admin@netdev1 ~]$
```

Route types: Connected

- Directly attached, local-network (to the router) addresses.
- Identified in the routing table with “scope link”
- These routes are automatically updated whenever the interface is reconfigured or shut down

Route types: Static

- Manually configured routes.
- Identified in the routing table with “proto static”

Route types: Dynamic

- Automatically created and maintained by routing protocols.
- Identified in the routing table by the name of the protocol that created them

Route types: Default

- Specifies the gateway to use when the routing table does not contain a path for the destination network.
- Commonly points to the next router in the path to the ISP
- Identified by the word “default” or subnet “0.0.0.0/0” in the destination value field

Determine packet's next hop

Based on the following routing table:

```
default via 172.16.31.254 dev eth1 proto zebra metric 10
172.16.16.0/22 via 172.16.31.249 dev eth1 proto zebra metric 20
172.16.20.0/22 via 172.16.31.250 dev eth1 proto zebra metric 20
172.16.24.0/22 dev eth0 proto kernel scope link src 172.16.27.254
172.16.28.0/23 via 172.16.31.252 dev eth1 proto zebra metric 20
172.16.30.0/24 via 172.16.31.253 dev eth1 proto zebra metric 20
172.16.31.0/24 dev eth1 proto kernel scope link src 172.16.31.251
```

a) What is next hop destination of a datagram addressed to **172.16.27.70**?

b) What is next hop destination of a datagram addressed to **172.16.32.100**?

c) What is next hop destination of a datagram addressed to **172.16.23.23**?

d) What is next hop destination of a datagram addressed to **172.16.18.200**?

Determine packet's next hop

Based on the following routing table:

```
default via 2001:2019:12:FFFF::FFFF dev eth0 proto kernel metric 1024
2001:2019:12:ffff::/64 dev eth0 proto kernel metric 256
2001:2019:12:1fff::/64 dev eth1 proto kernel metric 256
2001:2019:12:2fff::/64 dev eth2 proto kernel metric 256
2001:2019:12:1001::/64 via 2001:2019:12:1fff::50 dev eth1 metric 1024
fe80::/64 dev eth0 proto kernel metric 256
fe80::/64 dev eth1 proto kernel metric 256
fe80::/64 dev eth2 proto kernel metric 256
```

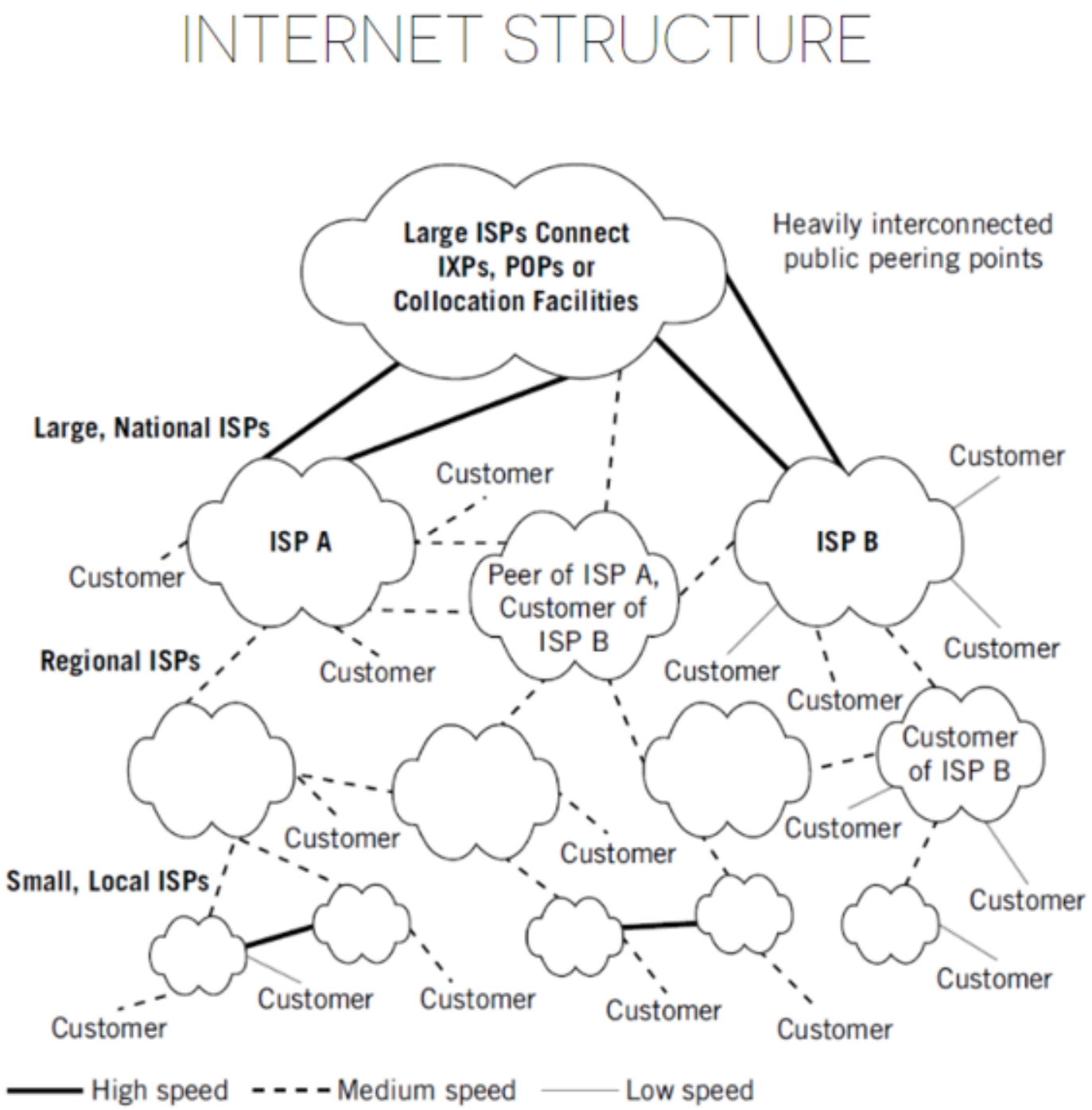
a) What is next hop destination of a datagram addressed to **2001:2019:12:ffff::1**?

b) What is next hop destination of a datagram addressed to **2001:2019:12:1001::ffff**?

c) What is next hop destination of a datagram addressed to **2001:2019:ffff:ffff::1**?

d) What is next hop destination of a datagram addressed to **fe80::c001:37ff:fe6c:0**?

Routing Protocols



Routing protocols: internet structure

- The Internet is composed of interlocking network pieces, much like a jigsaw puzzle.
- Each piece is called an autonomous system (AS), and it’s convenient to think of each ISP as an AS, although this is not strictly true.
- The Autonomous systems connect directly to each other at Points of Presence or via Internet Exchanges Points
- When AS's connect they become peers and setup policies on what routes to exchange.

Routing protocols: learning routes

- Routers initially know IP addresses and prefixes configured on their local interfaces
- Routers communicate with their neighbours to learn the required information about their routing domain to forward packets hop by hop, toward a given destination.
- So routers establish communications with adjacent routers (i.e. those one hop away) and ask them about the routing information they know.

Routing protocols: learning routes

- Each router then builds up a detailed routing information database about the network.
- This exchange of information is governed by routing protocols
- Routing protocols differ depending on whether they are used within a routing domain or between different routing domains

Routing protocols: learning routes

- Within a routing domain, several different interior routing protocols can be used.
- Interior routing protocols, or IGPs, run between the routers inside a single routing domain, or autonomous system (AS)
- Between routing domains on the Internet an exterior Gateway Routing Protocol is used: Border Gateway Protocol (BGP)

Routing protocols: Interior Gateway Protocol (IGP)

- A routing protocol that was designed and intended for use inside a single autonomous system (AS)
- Examples: OSPF, EIGRP, RIP

Routing protocols: Exterior Gateway Protocol (EGP)

- A routing protocol that was designed and intended for use between different autonomous systems
- Examples: BGP

Routing protocols: Functions

- Learn routing information about IP subnets from other neighboring routers.
- Advertise routing information about IP subnets to other neighboring routers.
- If more than one possible route exists to reach one subnet, pick the best route based on a metric.
- If the network topology changes, for example, a link fails, react by advertising that some routes have failed and pick a new currently best route. (This process is called convergence)

Routing protocols: Algorithms

Distance Vector

- Distance may be computed as the number of hops to destination or other metrics such as bandwidth, propagation delay, …
- Vector: router updates in the form of {Dest, Cost}
- Minimum view of network topology
- Wait for route reports from neighboring routers before updating routing table
- Example protocols: RIP, EIGRP, DSDV

Routing protocols: Algorithms

Link-state

- Routing table - List of the known paths and interfaces.
- Link-state advertisement (LSA) - Small packet of routing information that is sent between routers. LSAs describe the state of the interfaces (links) of a router and other information, such as the IP address of each link.
- Topological database - convergence
- Shortest Path First (SPF) algorithm – map of network seen from the point of view of the router. SPF tree used to build routing table

Routing protocols: OSPF

- Link-state algorithm
- Uses LSAs to generate a link-state database
- Stub area: advertised network area which does not participate in LSA
- Use of Designated Router (DR) and Backup Designated Router (BDR) for efficient management of link-state advertisements

Reading List

- Transport Layer
- UDP
- TCP Basics