Guidelines for Addressing and Naming

- Use a structured model for addressing and naming
- Assign addresses and names hierarchically
- Decide in advance if you will use
  - Central or distributed authority for addressing and naming
  - Public or private addressing
  - Static or dynamic addressing and naming

Advantages of Structured Models for Addressing & Naming

- It makes it easier to
  - Read network maps
  - Operate network management software
  - Recognize devices in protocol analyzer traces
  - Meet goals for usability
  - Design filters on firewalls and routers
  - Implement route summarization

Public IP Addresses

- Managed by the Internet Assigned Numbers Authority (IANA)
- Users are assigned IP addresses by Internet service providers (ISPs).
- ISPs obtain allocations of IP addresses from their appropriate Regional Internet Registry (RIR)

Regional Internet Registries (RIR)

- American Registry for Internet Numbers (ARIN) serves North America and parts of the Caribbean.
- RIPE Network Coordination Centre (RIPE NCC) serves Europe, the Middle East, and Central Asia.
- Asia-Pacific Network Information Centre (APNIC) serves Asia and the Pacific region.
- Latin American and Caribbean Internet Addresses Registry (LACNIC) serves Latin America and parts of the Caribbean.
- African Network Information Centre (AfriNIC) serves Africa.

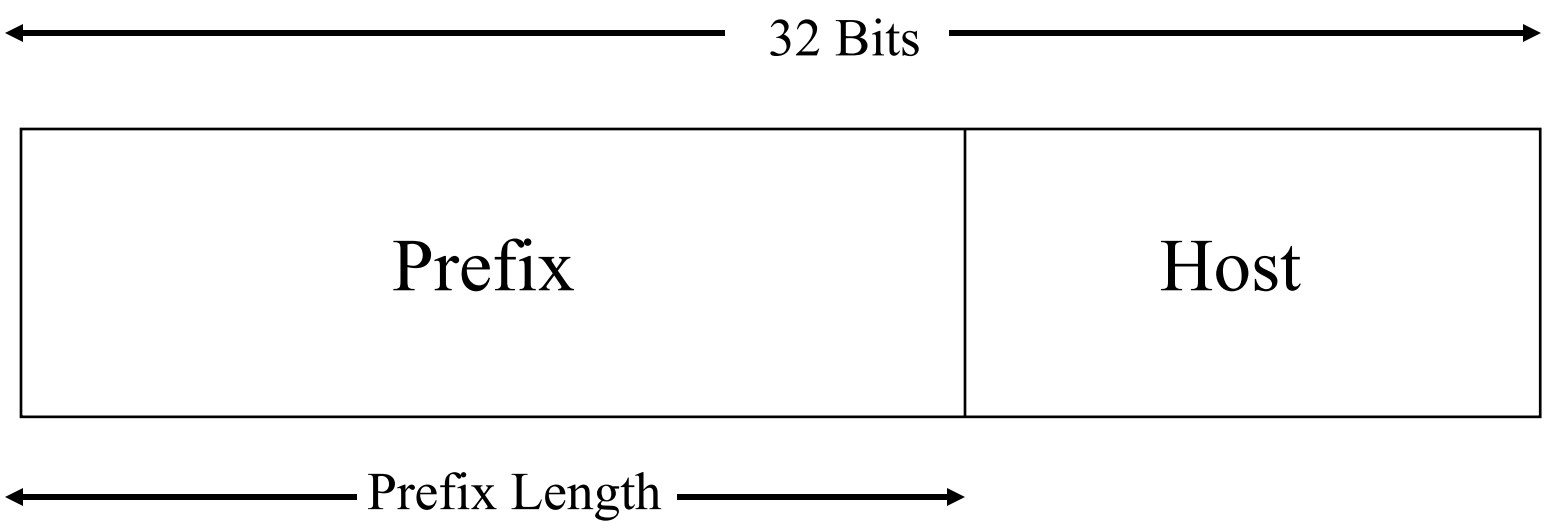
Private Addressing

- 10.0.0.0 – 10.255.255.255
- 172.16.0.0 – 172.31.255.255
- 192.168.0.0 – 192.168.255.255

Criteria for Using Static Vs. Dynamic Addressing

- The number of end systems
- The likelihood of needing to renumber
- The need for high availability
- Security requirements
- The importance of tracking addresses
- Whether end systems need additional information
  - (DHCP can provide more than just an address)

The Two Parts of an IP Address



Prefix Length

- An IP address is accompanied by an indication of the prefix length
  - Subnet mask
  - /Length
- Examples
  - 192.168.10.1 255.255.255.0
  - 192.168.10.1/24

Subnet Mask

- 32 bits long
- Specifies which part of an IP address is the network/subnet field and which part is the host field
  - The network/subnet portion of the mask is all 1s in binary.
  - The host portion of the mask is all 0s in binary.
  - Convert the binary expression back to dotted-decimal notation for entering into configurations.
- Alternative
  - Use slash notation (for example /24)
  - Specifies the number of 1s

Subnet Mask Example

- 11111111 11111111 11111111 00000000
- What is this in slash notation?
- What is this in dotted-decimal notation?

Another Subnet Mask Example

- 11111111 11111111 11110000 00000000
- What is this in slash notation?
- What is this in dotted-decimal notation?

One More Subnet Mask Example

- 11111111 11111111 11111000 00000000
- What is this in slash notation?
- What is this in dotted-decimal notation?

Designing Networks with Subnets

- Determining subnet size
- Computing subnet mask
- Computing IP addresses

Addresses to Avoid When Subnetting

- A node address of all ones (broadcast)
- A node address of all zeros (network)
- A subnet address of all ones (all subnets)
- A subnet address of all zeros (confusing)
  - Cisco IOS configuration permits a subnet address of all zeros with the **ip subnet-zero** command

Practice

- Network is 172.16.0.0
- You want to divide the network into subnets.
- You will allow 600 nodes per subnet.
- What subnet mask should you use?
- What is the address of the first node on the first subnet?
- What address would this node use to send to all devices on its subnet?

More Practice

- Network is 172.16.0.0
- You have eight LANs, each of which will be its own subnet.
- What subnet mask should you use?
- What is the address of the first node on the first subnet?
- What address would this node use to send to all devices on its subnet?

One More

- Network is 192.168.55.0
- You want to divide the network into subnets.
- You will have approximately 25 nodes per subnet.
- What subnet mask should you use?
- What is the address of the last node on the last subnet?
- What address would this node use to send to all devices on its subnet?

IP Address Classes

- Classes are now considered obsolete
- But you have to learn them because
  - Everyone in the industry still talks about them!
  - You may run into a device whose configuration is affected by the classful system

Classful IP Addressing

Class	First Few Bits	First Byte	Prefix Length	Intent
A	0	1-126*	8	Very large networks
B	10	128-191	16	Large networks
C	110	192-223	24	Small networks
D	1110	224-239	NA	IP multicast
E	1111	240-255	NA	Experimental

*Addresses starting with 127 are reserved for IP traffic local to a host.

Division of the Classful Address Space

Class	Prefix Length	Number of Addresses per Network
A B C	8 16 24	2^{24}-2 = 16,777,214 2^{16}-2 = 65,534 2^{8}-2 = 254

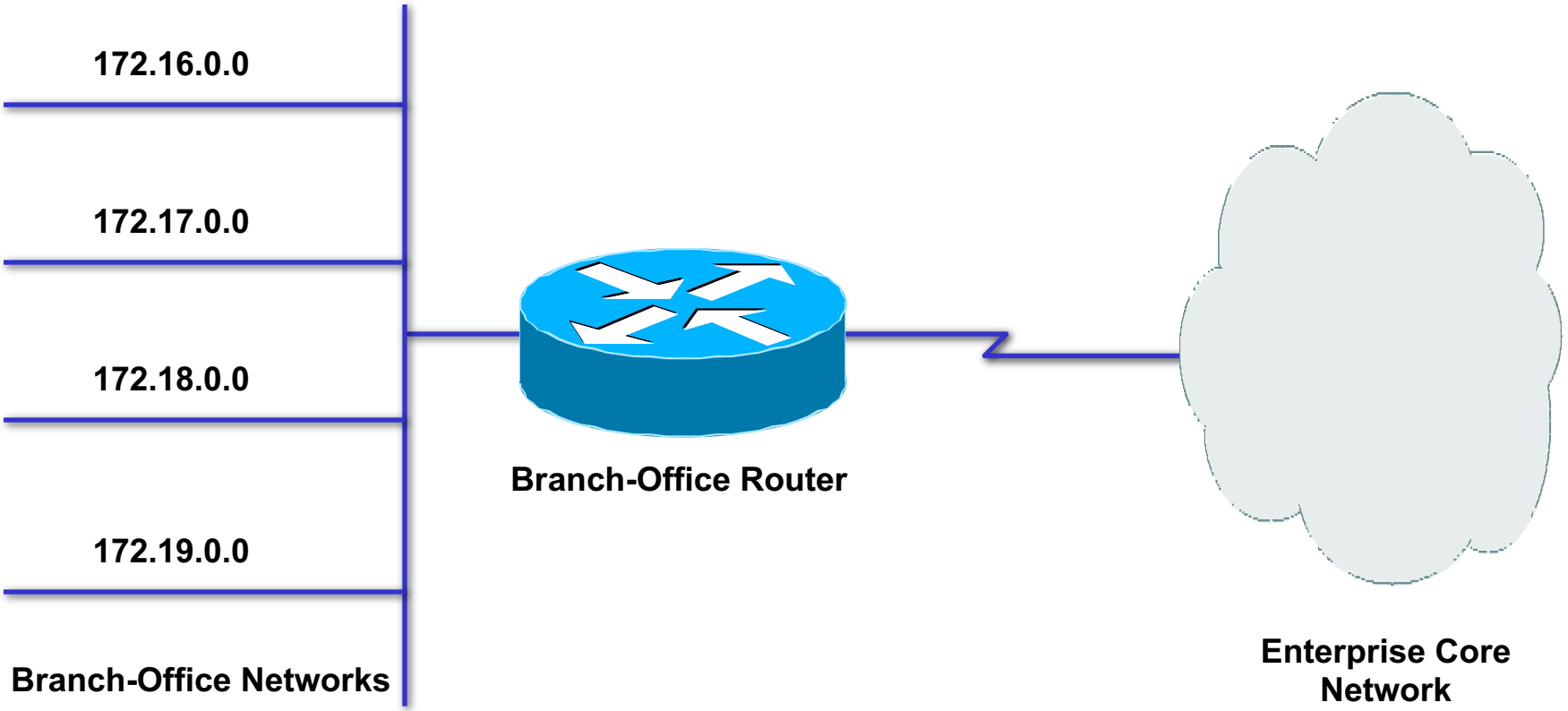
Classful IP is Wasteful

- Class A uses 50% of address space
- Class B uses 25% of address space
- Class C uses 12.5% of address space
- Class D and E use 12.5% of address space

Classless Addressing

- Prefix/host boundary can be anywhere
- Less wasteful
- Supports route summarization
  - Also known as
    - Aggregation
    - Supernetting
    - Classless routing
    - Classless inter-domain routing (CIDR)
    - Prefix routing

Supernetting



- Move prefix boundary to the left
- Branch office advertises 172.16.0.0/14

172.16.0.0/14 Summarization

Second Octet in Decimal	Second Octet in Binary
16	**00010**00
17	**00010**01
18	**00010**10
19	**00010**11

Guidelines for Assigning Names

- Names should be
  - Short
  - Meaningful
  - Unambiguous
  - Distinct
  - Case insensitive
- Avoid names with unusual characters
  - Hyphens, underscores, asterisks, and so on

Domain Name System (DNS)

- Maps names to IP addresses
- Supports hierarchical naming
  - example: frodo.rivendell.middle-earth.com
- A DNS server has a database of resource records (RRs) that maps names to addresses in the server's "zone of authority"
- Client queries server
  - Uses UDP port 53 for name queries and replies
  - Uses TCP port 53 for zone transfers

DNS Details

- Client/server model
- Client is configured with the IP address of a DNS server
  - Manually or DHCP can provide the address
- DNS *resolver software* on the client machine sends a query to the DNS server. Client may ask for *recursive lookup*.

DNS Recursion

- A DNS server may offer *recursion,* which allows the server to ask other servers
  - Each server is configured with the IP address of one or more root DNS servers.
- When a DNS server receives a response from another server, it replies to the resolver client software. The server also caches the information for future requests.
  - The network administrator of the authoritative DNS server for a name defines the length of time that a non-authoritative server may cache information.

Summary

- Use a systematic, structured, top-down approach to addressing and naming
- Assign addresses in a hierarchical fashion
- Distribute authority for addressing and naming where appropriate
- IPv6 looms in our future…

Review Questions

- Why is it important to use a structured model for addressing and naming?
- When is it appropriate to use IP private addressing versus public addressing?
- When is it appropriate to use static versus dynamic addressing?