Microsoft® Official Course

Module 5

Implementing IPv4
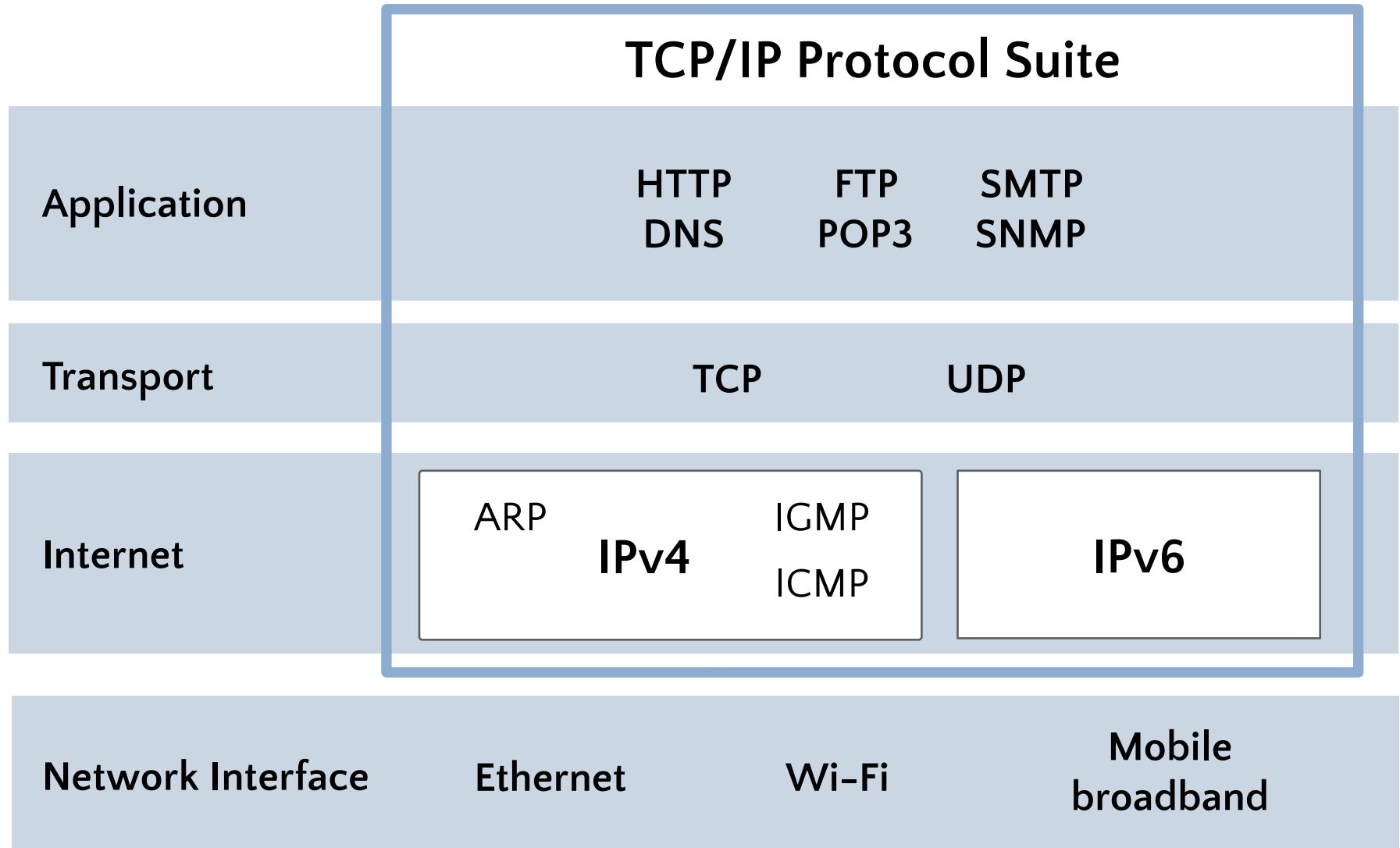
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Module Overview

- Overview of TCP/IP
  Understanding IPv4 Addressing
  Subnetting and Supernetting
  Configuring and Troubleshooting IPv4

- The TCP/IP Protocol Suite
  Protocols in the TCP/IP Suite
  TCP/IP Applications
  What Is a Socket?
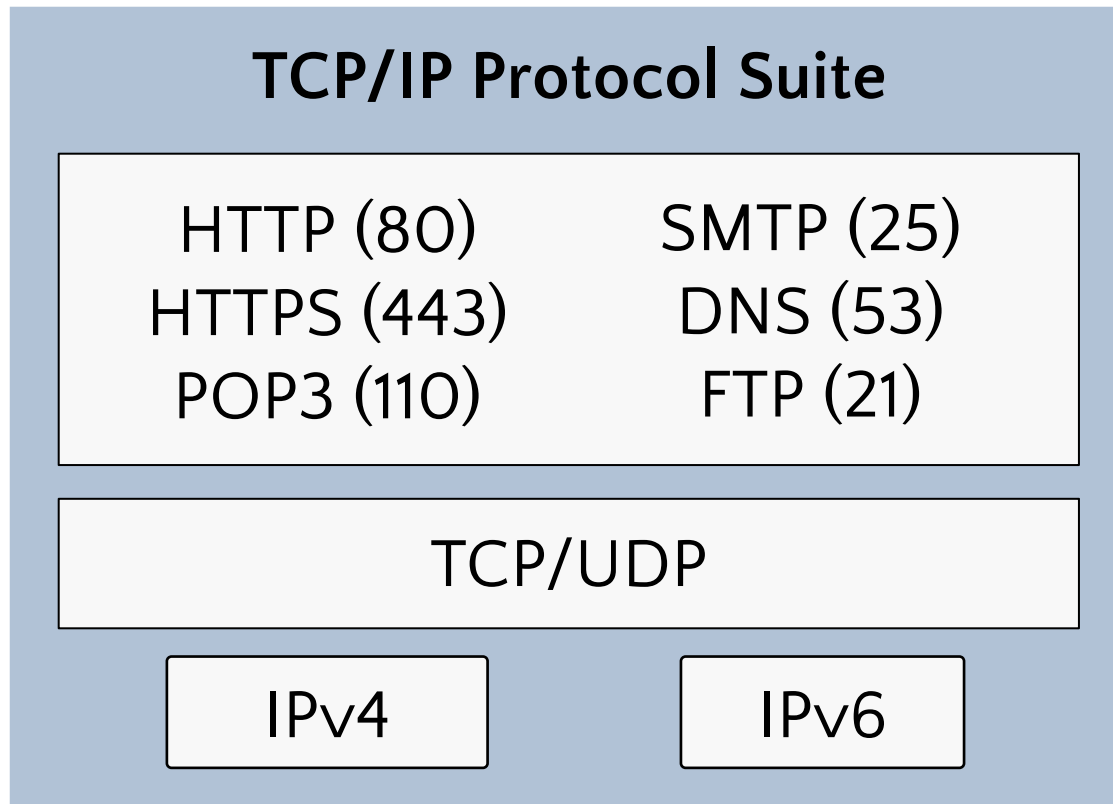
The TCP/IP Protocol Suite

TCP/IP Protocol Suite

Application	HTTP FTP SMTP DNS POP3 SNMP
Transport	TCP UDP
Internet	ARP IGMP **IPv4** ICMP **IPv6**
Network Interface	Ethernet Wi–Fi Mobile broadband

Protocols in the TCP/IP Suite

OSI	TCP/IP	TCP/IP Protocol Suite	
Application Presentation Session	Application	HTTP	DNS
		FTP	POP3
		SMTP	SNMP
Transport	Transport	TCP	UDP
Network	Internet	ARP IPv4 IGMP ICMP	IPv6
Data Link Physical	Network Interface	Ethernet Wi-Fi	Mobile broadband

Some common application layer protocols:

- HTTP
- HTTPS
- FTP
- RDP
- SMB
- SMTP
- POP3

What Is a Socket?

A socket is a combination of an IP address, a transport protocol, and a port

TCP/IP Protocol Suite

HTTP (80)	SMTP (25)
HTTPS (443)	DNS (53)
POP3 (110)	FTP (21)

TCP/UDP

IPv4   IPv6

- IPv4 Addressing
  Public and Private IPv4 Addresses
  How Dotted Decimal Notation Relates to Binary Numbers
  Simple IPv4 Implementations
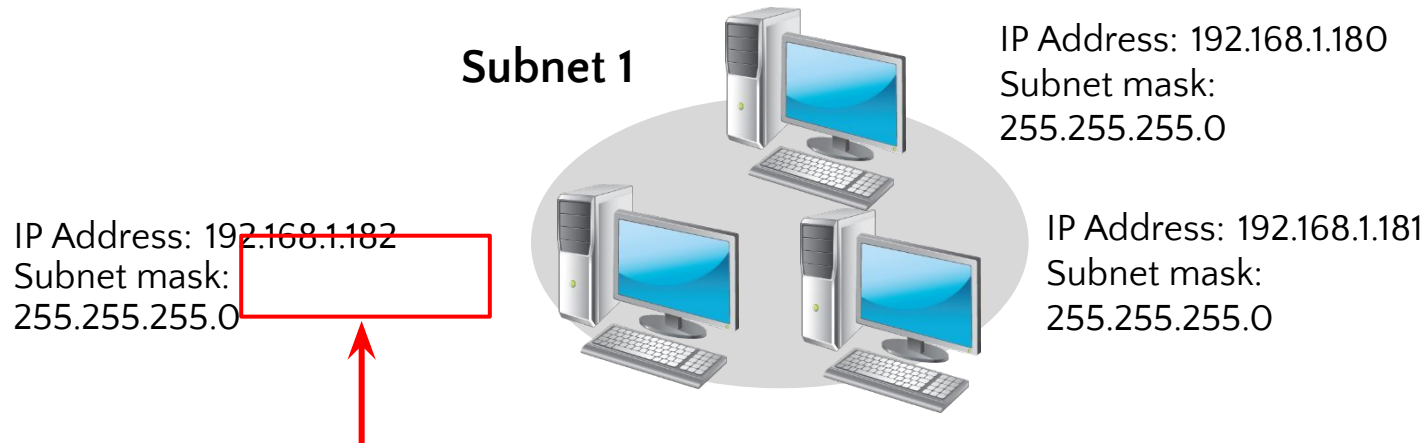 More Complex IPv4 Implementations

IPv4 Addressing

- Each networked computer must be assigned a unique IPv4 address
- Network communication for a computer is directed to the IPv4 address of the computer
- Each IPv4 address contains:
  - ✔ Network ID, identifying the network
  - ✔ Host ID, identifying the computer
- The subnet mask identifies which part of the IPv4 address is the network ID (255) and which is the host ID (0)

IP address	172	16	0	10
Subnet mask	255	255	0	0
Network ID	172	16	0	0
Host ID	0	0	0	10

IPv4 Addressing

An IPv4 configuration identifies a computer to other computers on a network

Subnet 1

IP Address: 192.168.1.180
Subnet mask:
255.255.255.0

IP Address: 192.168.1.182
Subnet mask:
255.255.255.0

IP Address: 192.168.1.181
Subnet mask:
255.255.255.0

Dotted decimal representation of the address and subnet mask

Default gateway defines the preferred router

Subnet 2

IP Address: 192.168.2.200
Subnet mask:
255.255.255.0

IP Address: 192.168.2.202
Subnet mask:
255.255.255.0

IP Address: 192.168.2.201
Subnet mask:
255.255.255.0

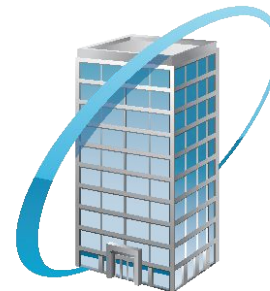# Public and Private IPv4 Addresses

Public

- Required by devices and hosts that connect directly to the Internet
- Must be globally unique
- Routable on the Internet
- Must be assigned by IANA/RIR

Private

- Not routable on the Internet
  - 10.0.0.0/8
  - 172.16.0.0/12
  - 192.168.0.0./16
- Can be assigned locally by an organization
- Must be translated to access the Internet

Dotted decimal notation is based on the decimal number system, but computers use IP addresses in binary

Within an 8-bit octet, each bit position has a decimal value:
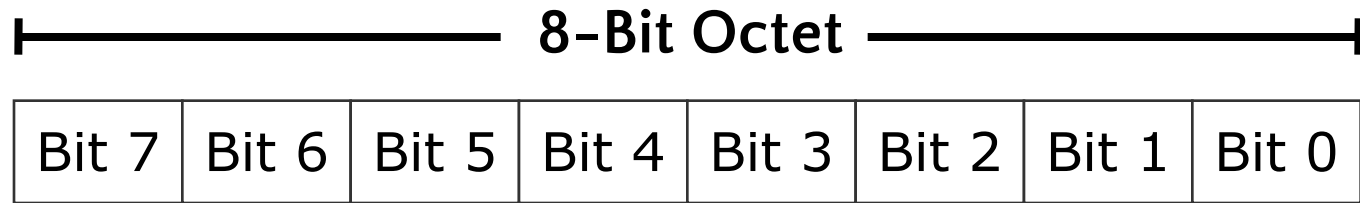
- A bit that is set to 0 always has a zero value
- A bit that is set to 1 can be converted to a decimal value
- The low-order bit represents a decimal value of 1
- The high-order bit represents a decimal value of 128

If all bits in an octet are set to 1, then the octet's decimal value is 255, the highest possible value of an octet:
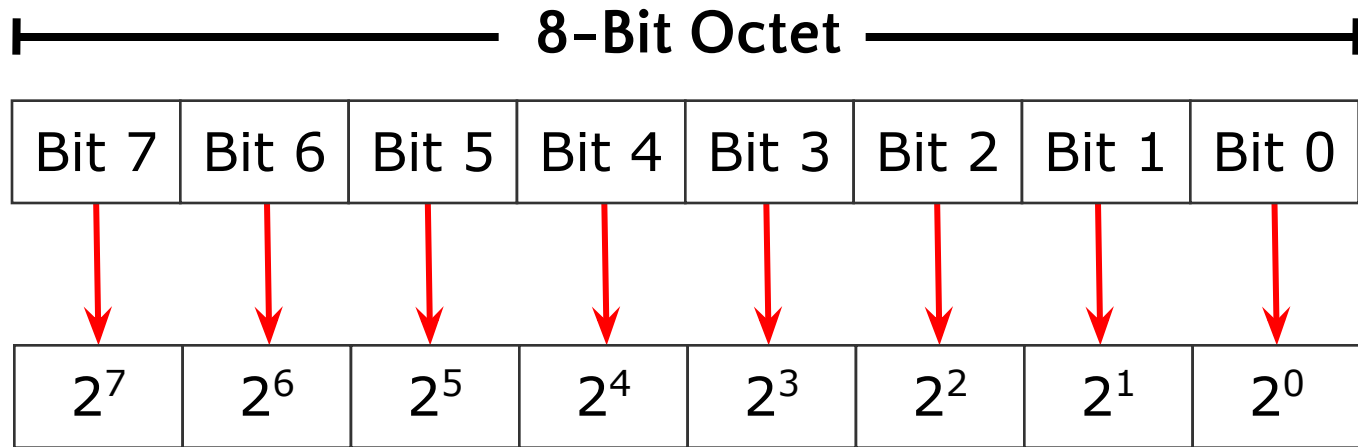
$$128 + 64 + 32 + 16 + 8 + 4 + 2 + 1$$
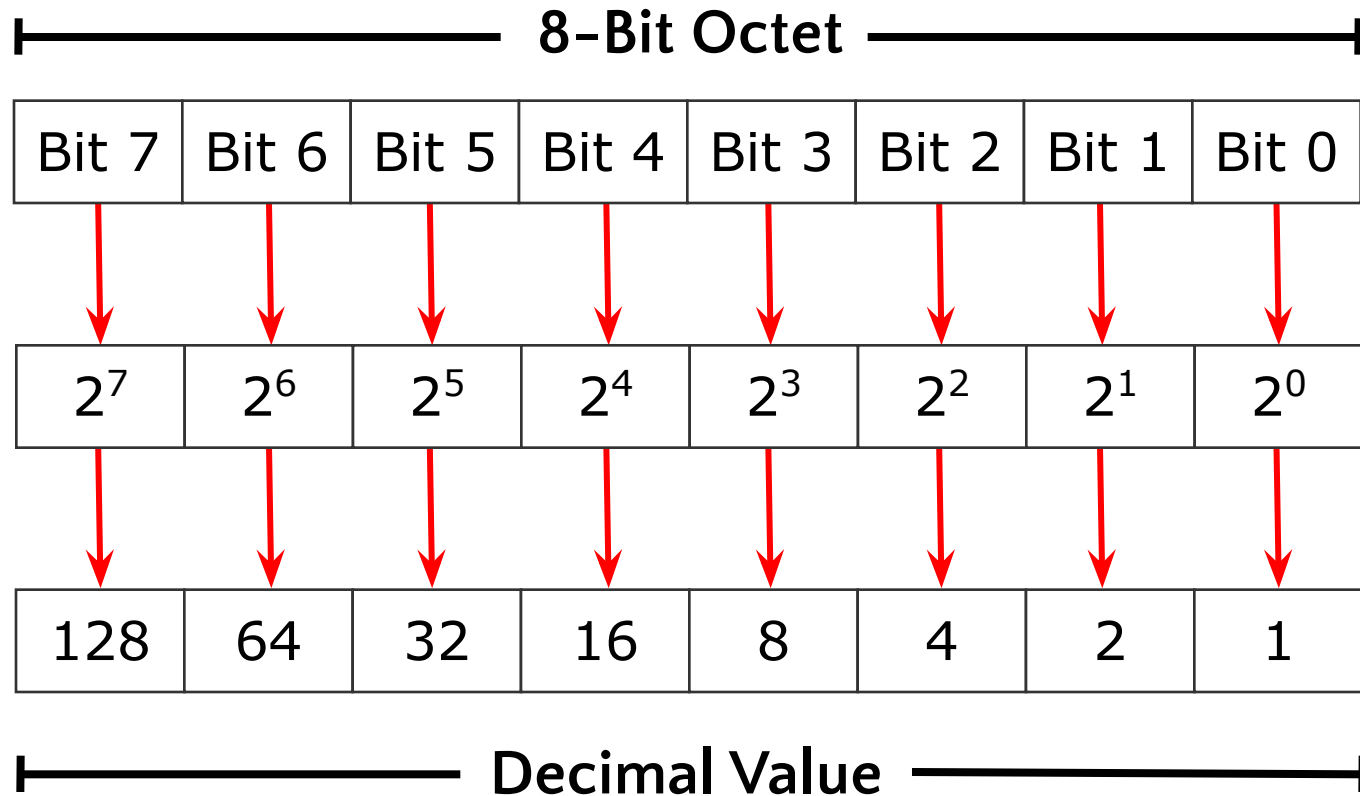
How Dotted Decimal Notation Relates to Binary Numbers

|←——————————————— 8–Bit Octet ———————————————→|

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

How Dotted Decimal Notation Relates to Binary Numbers

8–Bit Octet

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0

How Dotted Decimal Notation Relates to Binary Numbers

8–Bit Octet

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
128	64	32	16	8	4	2	1

Decimal Value

Simple IPv4 Implementations

Class A (/8)
Large Network

Network ID	Host ID

0

w   x   y   z
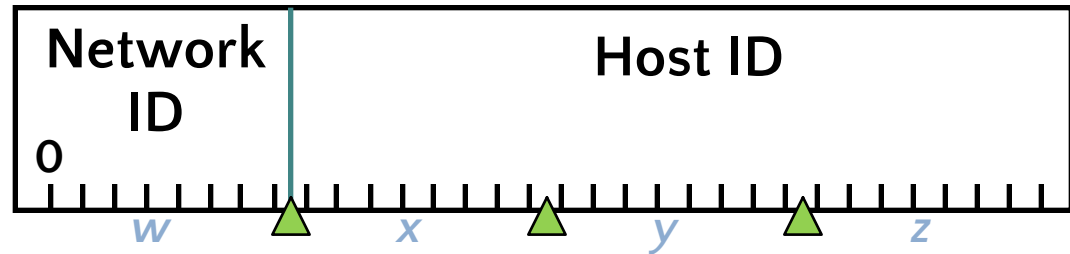
Class B (/16)
Medium

Network

Network ID	Host ID

10

w   x   y   z

Class C (/24)
Small Network

Network ID	Host ID

110

w   x   y   z

More Complex IPv4 Implementations

172.16.16.0/22

172.16.20.0/22

172.16.17.0/24

172.16.17.1

172.16.16.0/20

172.16.24.0/22

172.16.18.0/24

172.16.17.254

172.16.28.0/22
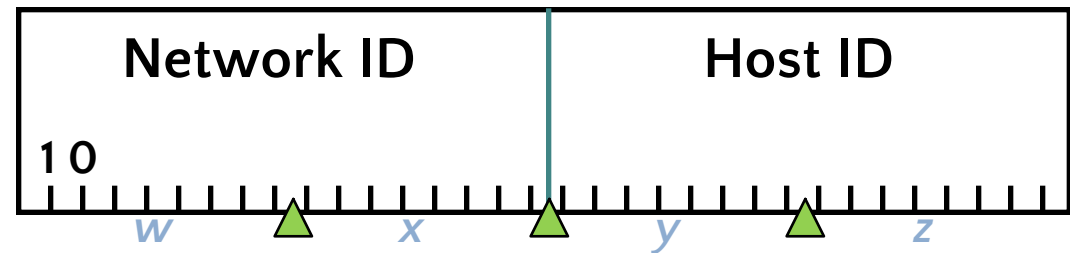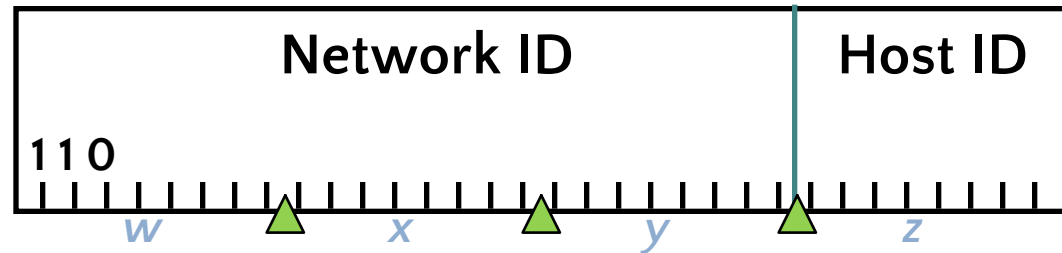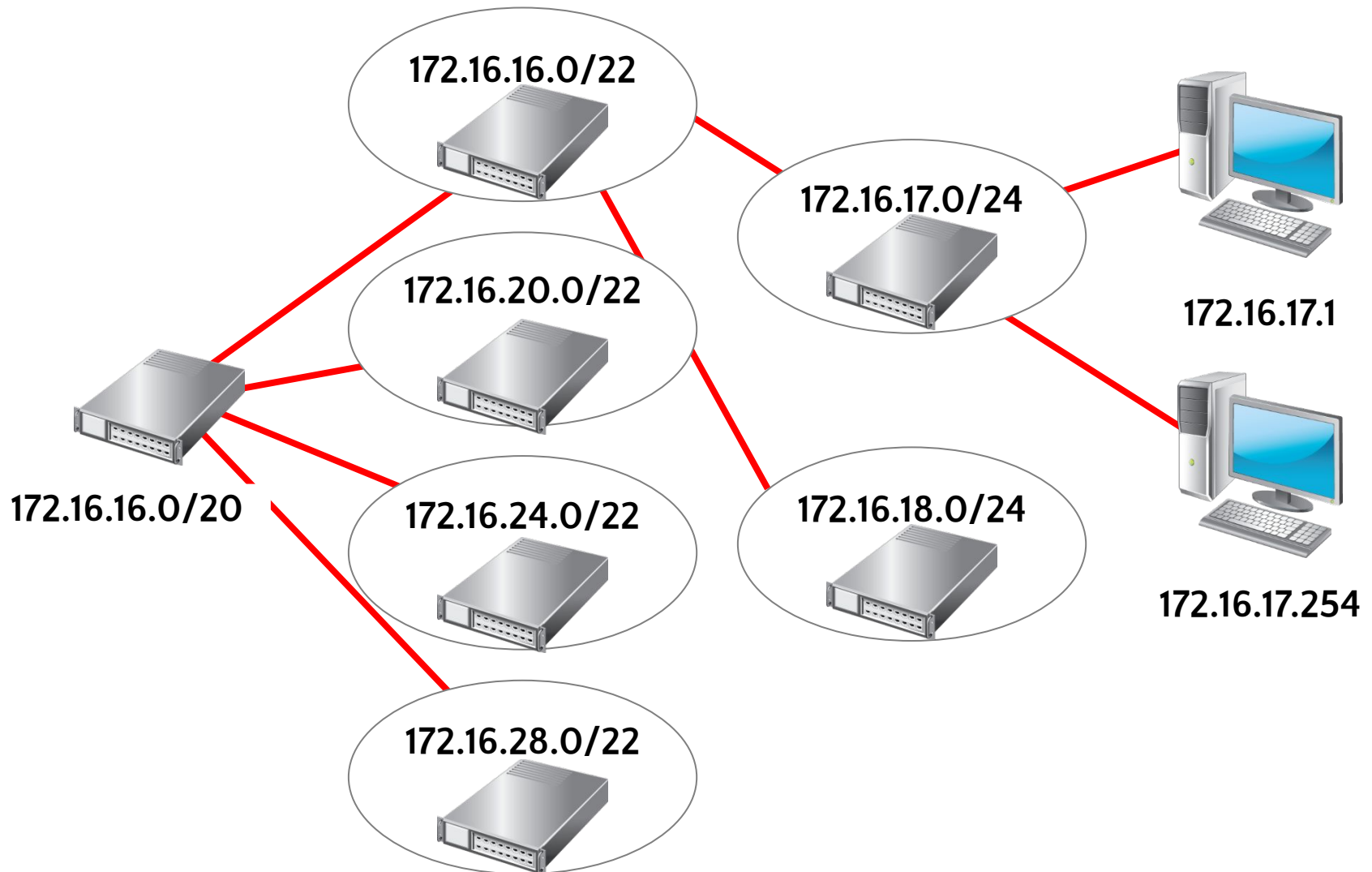
Lesson 3: Subnetting and Supernetting

- How Bits Are Used in a Subnet Mask or Prefix Length
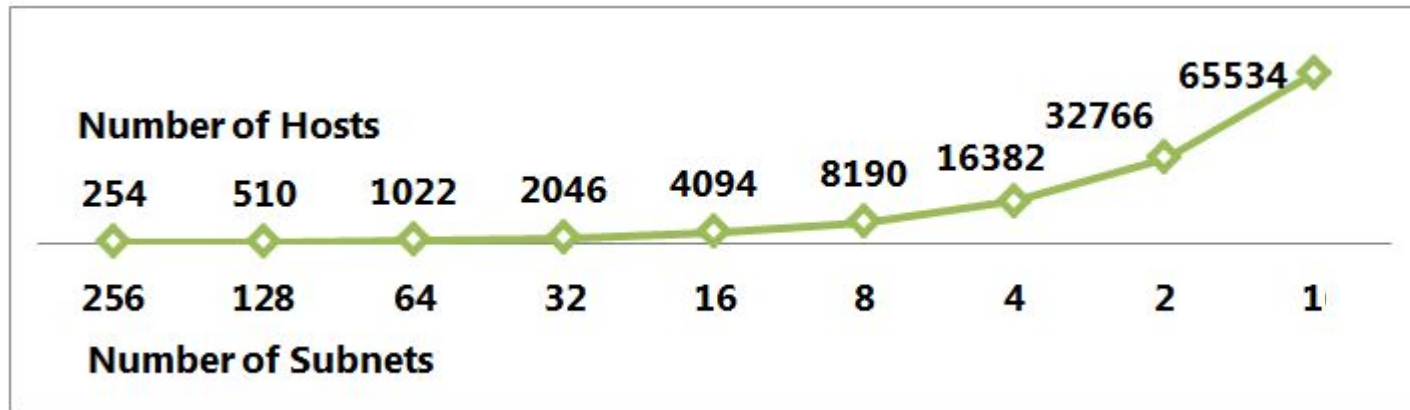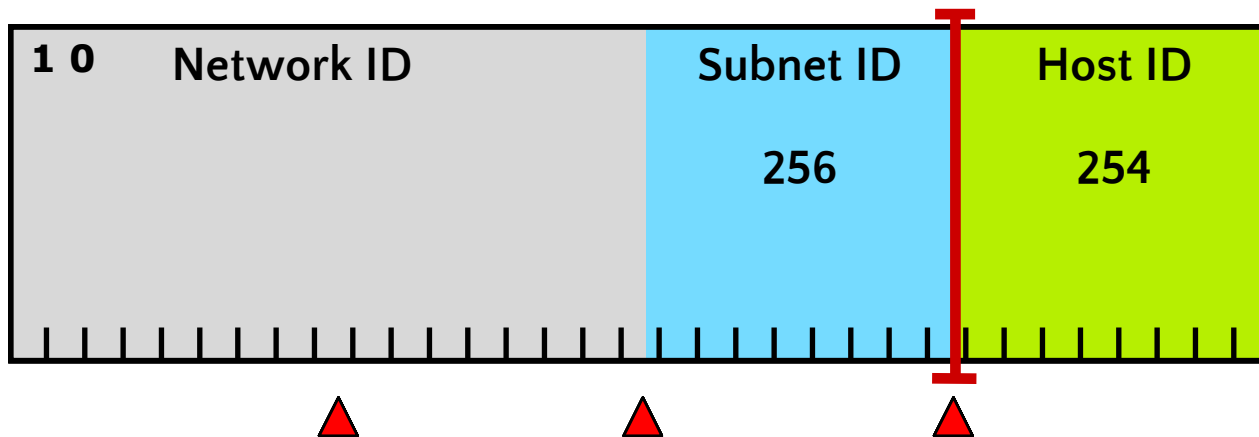 The Benefits of Using Subnetting
  Calculating Subnet Addresses
  Calculating Host Addresses
  Discussion: Creating a Subnetting Scheme for a New Office
  What Is Supernetting?

Class B Address with Subnet

1 0 Network ID	Subnet ID	Host ID
	256	254

Number of Hosts

254   510   1022   2046   4094   8190   16382   32766   65534

256   128   64   32   16   8   4   2   1

Number of Subnets

The Benefits of Using Subnetting

When you subdivide a network into subnets, you create a unique ID for each subnet that is derived from the main network ID

By using subnets, you can:

- Use a single network address across multiple locations
- Reduce network congestion by segmenting traffic
- Increase security by using firewalls
- Overcome limitations of current technologies

Calculating Subnet Addresses

When determining subnet addresses you should:

- Choose the number of subnet bits based on the number of subnets required

- Use 2^n to determine the number of subnets available from n bits

For five locations, the following three subnet bits are required:

- 5 locations = 5 subnets required

- 2^2 = 4 subnets (not enough)

- 2^3 = 8 subnets

Calculating Host Addresses

When determining host addresses you should:

- Choose the number of host bits based on the number of hosts that you require on each subnet

- Use 2^n-2 to determine the number of hosts that are available on each subnet

For subnets with 100 hosts, seven host bits are required:

- $2^6-2 = 62$ hosts (not enough)

- $2^7-2 = 126$ hosts

Discussion: Creating a Subnetting Scheme for a New Office

- How many subnets are required?

- How many bits are required to create that number of subnets?

- How many hosts are required on each subnet?

- How many bits are required to support that number of hosts?

- What is an appropriate subnet mask that would satisfy these requirements?

20 minutes

What Is Supernetting?

- Supernetting combines multiple small networks into a larger network
- The networks that you combine must be contiguous
- The following table shows an example of supernetting two class C networks

192.168.**00010000**.00000000/24	192.168.16.0 – 192.168.16.255
192.168.**00010001**.00000000/24	192.168.17.0 – 192.168.17.255
192.168.**00010000**.00000000/23	192.168.16.0 – 192.168.17.255

Lesson 4: Configuring and Troubleshooting IPv4

- Configuring IPv4 Manually

  Configuring IPv4 Automatically

  Using Windows PowerShell Cmdlets to Troubleshoot IPv4

  IPv4 Troubleshooting Tools

  The IPv4 Troubleshooting Process

  What Is Microsoft Message Analyzer?

  Demonstration: How to Capture and Analyze Network Traffic by Using Microsoft Message Analyzer

Configuring IPv4 Manually

Configuring IPv4 Manually

Examples using Windows PowerShell cmdlets:

New-NetIPAddress –InterfaceAlias "Local Area Connection" –IPAddress 10.10.0.10
-PrefixLength 24 –DefaultGateway 10.10.0.1

Set-DNSClientServerAddresses –InterfaceAlias "Local Area Connection"
–ServerAddresses 10.12.0.1,10.12.0.2

Example using the netsh command–line tool:

Netsh interface ipv4 set address name="Local Area Connection" source=static addr=10.10.0.10 mask=255.255.255.0 gateway=10.10.0.1

Configuring IPv4 Automatically

DHCP Server with
IPv4 Scope

IPv4 DHCP Client

```
Set-NetIPInterface –InterfaceAlias "Local Area Connection"
–Dhcp Enabled

Restart-NetAdapter –Name "Local Area Connection"
```

New Windows PowerShell cmdlets include:

- Get-NetAdapter

- Restart-NetAdapter

- Get-NetIPInterface

- Get-NetIPAddress

- Get-NetRoute

- Get-NetConnectionProfile

- Get-DNSClientCache

- Get-DNSClientServerAddress

- Register-DnsClient

- Set-DnsClient

- Set-DnsClientGlobalSetting

IPv4 Troubleshooting Tools

Use the following tools to troubleshoot IPv4:

- Ipconfig
- Ping
- Tracert
- Pathping
- Telnet
- Netstat
- Resource Monitor
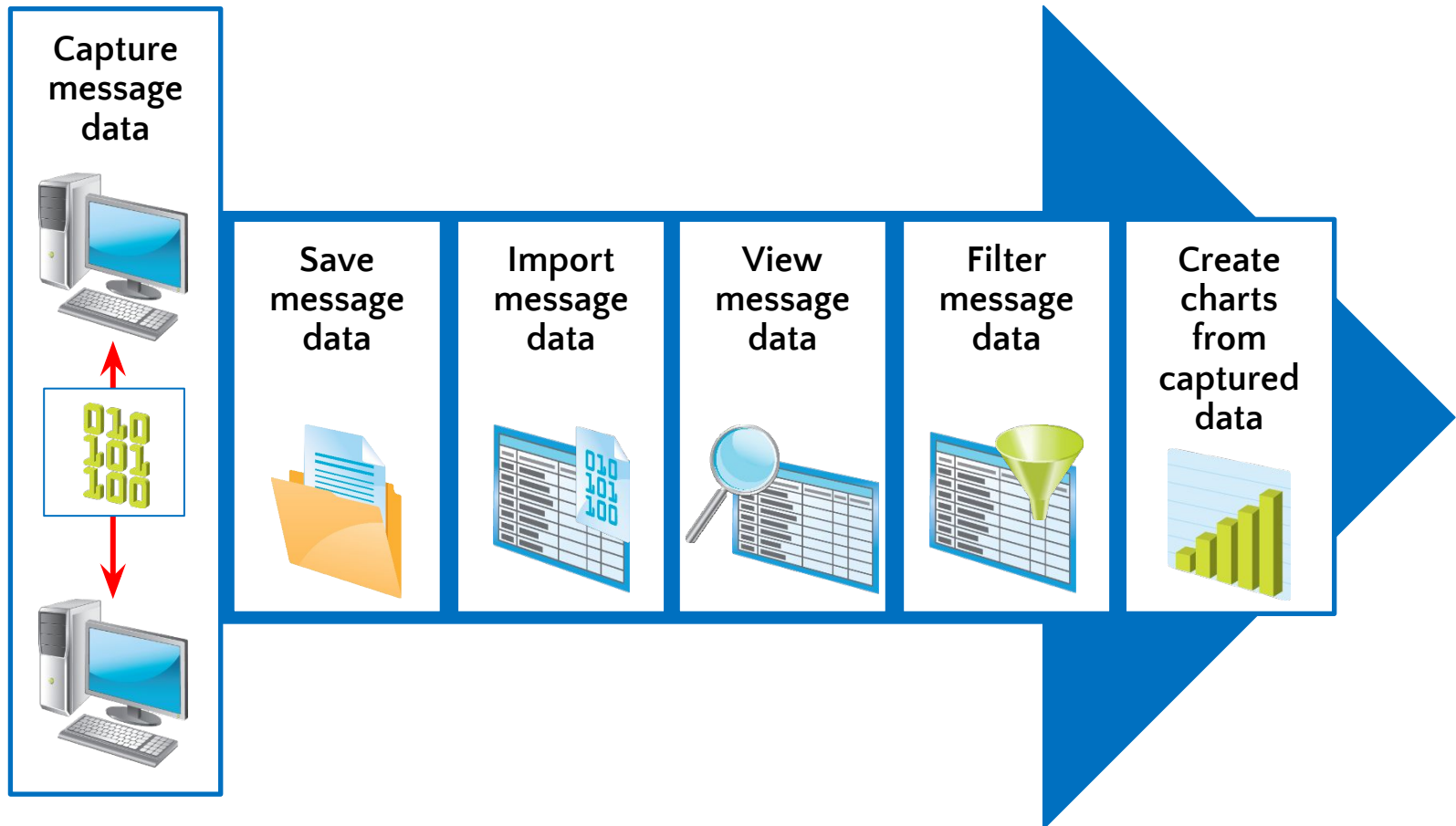- Windows Network Diagnostics
- Event Viewer

The IPv4 Troubleshooting Process

After you identify the scope of the problem, use the following tools to troubleshoot network connectivity:

Verify the network configuration is correct	Get-NetIPAddress	ipconfig
Identify the network path between hosts	Test-NetConnection -TraceRoute	tracert
See if the remote host responds	Test-NetConnection	ping
Test the service on a remote host	Test-NetConnection -Port	Telnet
See if the default gateway responds	Test-NetConnection	ping

You can use Microsoft Message Analyzer to perform the following network analysis tasks:

Capture message data

Save message data

Import message data

View message data

Filter message data

Create charts from captured data

In this demonstration, you will see how to:

- Start a new Capture/Trace in Microsoft Message Analyzer

- Capture packets from a ping request

- Analyze the captured network traffic

- Filter the network traffic

Lab: Implementing IPv4

- Exercise 1: Identifying Appropriate Subnets
  Exercise 2: Troubleshooting IPv4

Logon Information

Virtual machines **20410D-LON-DC1**
    20410D-LON-RTR
    20410D-LON-SVR2

User name **Adatum\Administrator**
Password   **Pa$$w0rd**

Estimated Time: 45 minutes

Lab Scenario

You have recently accepted a promotion to the server support team. One of your first assignments is configuring the infrastructure service for a new branch office.

After a security review, your manager has asked you to calculate new subnets for the branch office to support segmenting network traffic. You also need to troubleshoot a connectivity problem on a server in the branch office.

- Why is variable-length subnetting required in this lab?
  Which Windows PowerShell cmdlet can you use to view the local routing table of a computer instead of using route print?

Module Review and Takeaways

- Review Questions
  Best Practices
  Common Issues and Troubleshooting Tips
- Tools