

CompTIA A+ Core 1 Exam 220-1101

Lesson 5



Configuring Network Addressing and Internet Connections

Objectives

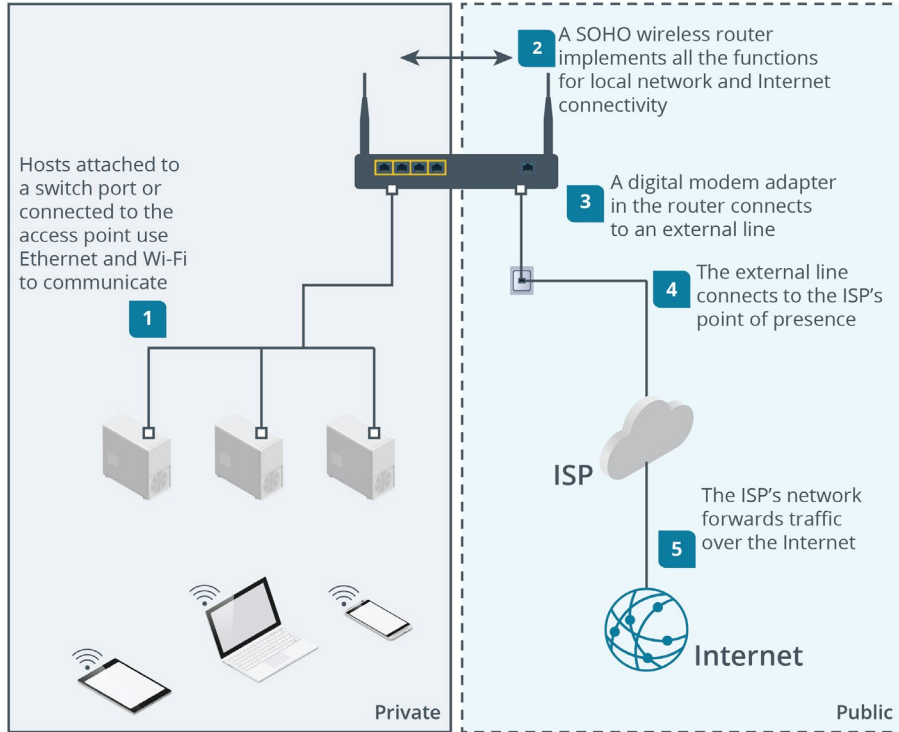
- Compare Internet connection types
- Use basic TCP/IP concepts
- Compare protocols and ports
- Compare network configuration concepts

Lesson 5

Topic 5A

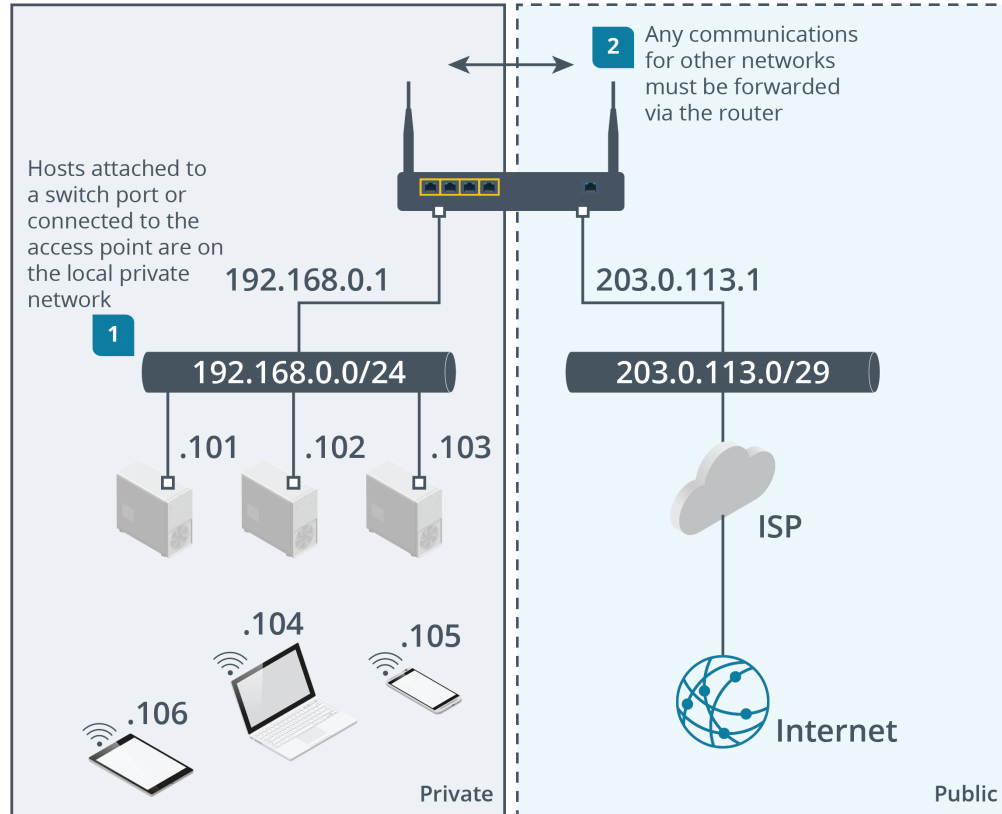
Compare Internet Connection Types

Internet Connection Types and Modems (Slide 1 of 2)



- The Internet
 - Internet eXchange Points (IXPs)
 - Internet Service Providers (ISPs)
- Point of presence (PoP)
 - Point-to-point WAN links
 - Digital modem types
- Routers versus modems

Internet Connection Types and Modems (Slide 2 of 2)



Digital Subscriber Line Modems

- Broadband Internet access over last mile copper telephone wiring
- Asymmetrical DSL (ADSL)
 - Faster downlink than uplink
- Symmetric DSL
- DSL modem
 - RJ-45 cable to router
 - RJ-11 cable to phone point
 - Splitters to filter voice calls



Image © 123RF.com

Cable Modems



Image © 123RF.com

- Cable access TV (CATV) networks
 - Hybrid fiber coax (HFC)
 - Data Over Cable Service Interface Specification (DOCSIS)
- Cable modem
 - RJ-45 cable to router
 - Coax cable with F-type connector to external port

Fiber To the Curb and Fiber to the Premises

- Fiber to the curb (FTTC)
 - Service provider runs fiber to a street cabinet
 - Very high bit rate DSL (VDSL) over last 300m or 100m
- Fiber to premises (FTTP) or “full fiber”
 - Passive optical network (PON) serves multiple subscribers
 - Fiber is run to optical network terminal (ONT) installed at customer premises
 - ONT converts optical to electrical and is connected to customer router



Image by artush © 123RF.com

Fixed Wireless Internet Access

- Geostationary orbital satellite Internet access
 - High latency
 - Digital Video Broadcast Satellite (DVB-S) modem
- Low Earth orbital satellite Internet access
 - Antenna alignment
- Wireless Internet service provider (WISP)
 - Point-to-point microwave

Cellular Radio Internet Connections

- 3G
 - Global System for Mobile Communication (GSM) providers
 - Subscriber Identity Module (SIM) card
 - Code Division Multiple Access (CDMA) providers
- 4G
 - Long Term Evolution (LTE) converged standard using SIM cards
- 5G
 - Connection through array of massive MIMO antennas
 - Roaming and fixed access

Routers



Image © 123RF.com

- Logical network addressing and forwarding in an internetwork
- LAN router
 - Establish logical subnetworks
- WAN router
 - Connect LANs to the Internet
 - Connect LANs across public/service provider networks

Firewalls

- Enforce rules for allowed and blocked traffic
- Network access control list (ACL)
 - Source and destination network addresses
 - Protocol types and ports
 - Allow versus block
- Implementation
 - Dedicated appliance
 - Built in function of router
 - Network firewalls versus personal/host firewalls

Firewall: Rules: WAN

<input type="checkbox"/>	Protocol	Source	Port	Destination	Port	Gateway	Schedule	Description ⓘ	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>								Automatically generated rules	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>		IPv4 *	<bogons>	*	*	*	*	Block bogon IPv4 networks from WAN	<input type="checkbox"/>				
<input type="checkbox"/>		IPv6 *	<bogonsv6>	*	*	*	*	Block bogon IPv6 networks from WAN	<input type="checkbox"/>				
<input type="checkbox"/>		IPv4 *	10.0.0.0/8,127.0.0.0/8,100.64.0.0/10,172.16.0.0/12,192.168.0.0/16	*	*	*	*	Block private networks from WAN	<input type="checkbox"/>				
<input type="checkbox"/>		IPv6 *	fc00::/7	*	*	*	*	Block private networks from WAN	<input type="checkbox"/>				
<input type="checkbox"/>		IPv4 ICMP	*	*	This Firewall	*	*	Allow ping to firewall interface	<input type="checkbox"/>				
<input type="checkbox"/>		IPv4 TCP	*	*	SCREENED net	80 (HTTP)	*	Allow web access (unencrypted)	<input type="checkbox"/>				
<input type="checkbox"/>		IPv4 TCP	MAILHOSTS	*	SCREENED net	25 (SMTP)	*	Allow SMTP access from secure mail gateway	<input type="checkbox"/>				
	pass	block	reject		log	in	first match						
	pass (disabled)	block (disabled)	reject (disabled)		log (disabled)	out	last match						
	Active/Inactive Schedule (click to view/edit)												
	Alias (click to view/edit)												

Screenshot used with permission from OPNsense

Review Activity: Internet Connection Types

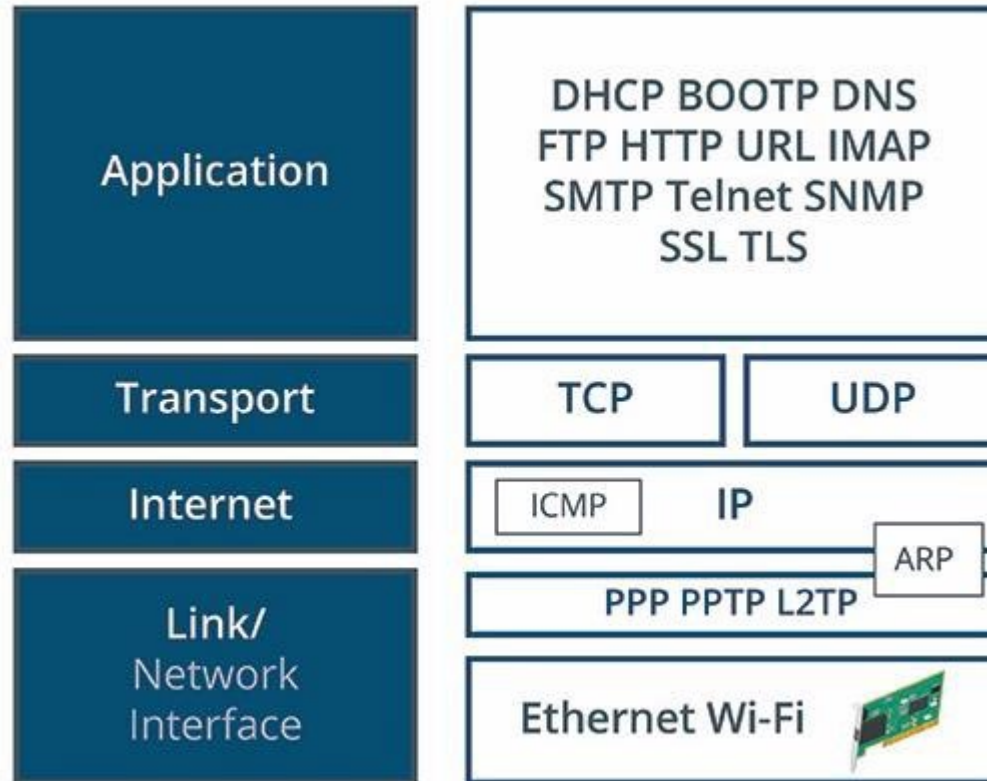
- Internet Connection Types and Modems
- Digital Subscriber Line Modems
- Cable Modems
- Fiber to the Curb and Fiber to the Premises
- Fixed Wireless Internet Access
- Cellular Radio Internet Connections
- Routers
- Firewalls

Lesson 5

Topic 5B

Use Basic TCP/IP Concepts

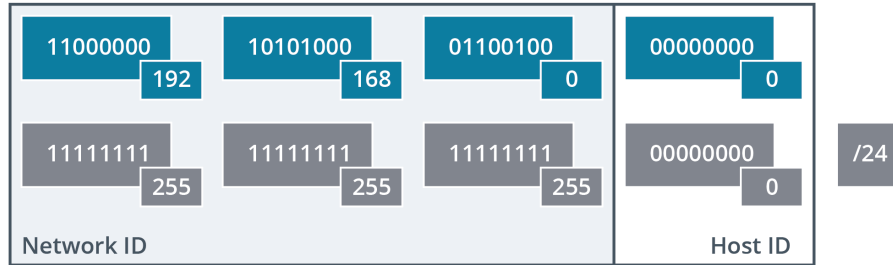
TCP/IP



IPv4 Addressing

- 32 binary digits
 - 11000000101010000000000000000001
- Divide into four octets
 - 11000000 10101000 00000000 00000001
- Express each octet as decimal value (dotted decimal)
 - 192 . 168 . 0 . 1

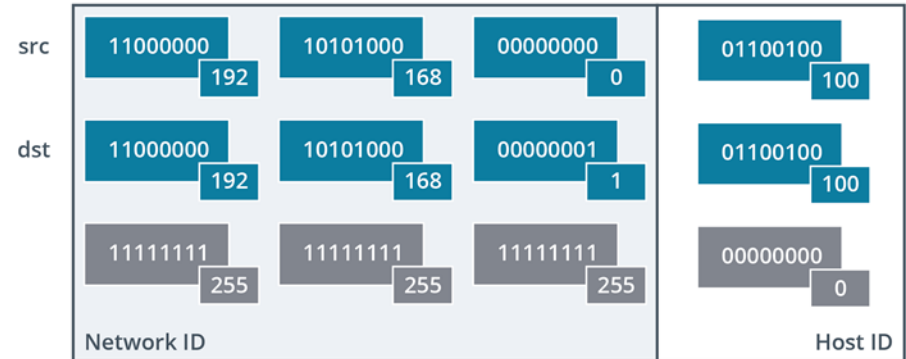
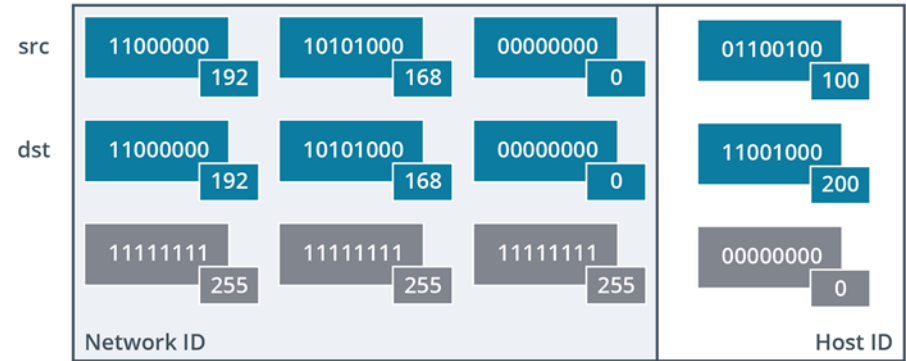
Network Prefixes



- IPv4 address encodes two values
 - Network number (network ID)
 - Host number (host ID)
- Portions are distinguished by a network prefix
 - Bits in prefix set to 1 represent network ID—for example, 24 bits
 - 11111111 11111111 11111111 00000000
 - Written in slash notation as /24
 - Can be expressed as subnet mask in dotted decimal
 - 255.255.255.0

IPv4 Forwarding

- Host must determine whether destination address is on the same network as its source address
- Uses mask to compare network ID in source IP address and destination IP address
- Most hosts send traffic for other networks to the router configured as a default gateway

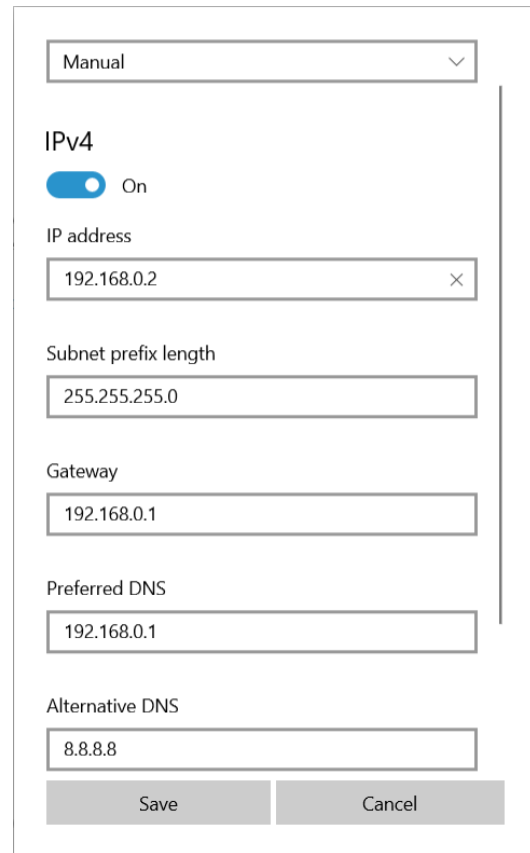


Public and Private Addressing

- Public addresses are routable across the Internet
- Private addresses are restricted to local networks
 - 10.0.0.0/8 (255.0.0.0)
 - 172.16.0.0/12 (255.240.0.0)
 - 192.168.0.0/16 (255.255.0.0)
- Address classes and default subnet masks
- Internet access for privately addressed hosts
 - Network address translation (NAT)
 - Proxy service

IPv4 Host Address Configuration

- IPv4 address and subnet mask
 - First IP in range is network address
 - Last IP is broadcast addresses
 - Hosts can be assigned addresses in-between
- Default gateway
- Domain Name System (DNS) server addresses



A screenshot of a network configuration window for IPv4. At the top, a dropdown menu is set to 'Manual'. Below this, the 'IPv4' section has a toggle switch turned 'On'. The 'IP address' field contains '192.168.0.2'. The 'Subnet prefix length' field contains '255.255.255.0'. The 'Gateway' field contains '192.168.0.1'. The 'Preferred DNS' field contains '192.168.0.1'. The 'Alternative DNS' field contains '8.8.8.8'. At the bottom, there are 'Save' and 'Cancel' buttons.

Field	Value
Configuration Mode	Manual
IPv4 Status	On
IP address	192.168.0.2
Subnet prefix length	255.255.255.0
Gateway	192.168.0.1
Preferred DNS	192.168.0.1
Alternative DNS	8.8.8.8

Screenshot courtesy of Microsoft

Static versus Dynamic Host Address Configuration

The screenshot shows the TP-Link Archer VR900 web interface. The top navigation bar includes the TP-Link logo, the model name 'Archer VR900', and tabs for 'Quick Setup', 'Basic', and 'Advanced'. The 'Advanced' tab is selected, and there are 'Logout' and 'Reboot' buttons. On the left, a sidebar menu shows 'Status', 'Operation Mode', 'Network' (selected), 'Internet', 'LAN Settings' (highlighted), 'Interface Grouping', 'DSL Settings', 'Dynamic DNS', 'Advanced Routing', 'IPSec VPN', and 'IPTV'. The main content area is titled 'DHCP Server'. It contains the following settings: 'IP Version' set to 'IPv4'; 'MAC Address' as '60:E3:27:CF:EA:CB'; 'LAN IPv4' as '192.168.1.1'; 'Subnet Mask' as '255.255.255.0'; 'IGMP Snooping' checked; 'DHCP' checked; 'DHCP Server' selected over 'DHCP Relay'; 'IP Address Pool' from '192.168.1.100' to '192.168.1.199'; 'Address Lease Time' as '1440 minutes(1-2880)'; 'Default Gateway' as '192.168.1.1' (Optional); 'Default Domain' (Optional); 'Primary DNS' as '0.0.0.0' (Optional); and 'Secondary DNS' as '0.0.0.0' (Optional). A green 'Save' button is at the bottom right.

Screenshot courtesy of TP-Link

- Uses and disadvantages for static addressing
- Dynamic Host Configuration Protocol (DHCP)
- Automatic Private IP Addressing (APIPA)
 - 169.254.x.y

SOHO Router Address Configuration

- Router's LAN interface
 - Web management interface
- Administrator password
- Router's public/WAN interface
 - Static versus dynamic addressing
 - Line protocol settings and monitoring

The screenshot displays the TP-Link Archer VR900 web management interface. The top navigation bar includes the TP-Link logo, the model name 'Archer VR900', and tabs for 'Quick Setup', 'Basic', and 'Advanced'. The 'Advanced' tab is selected, and the left sidebar shows the 'Network' menu with sub-items like 'Internet', 'LAN Settings', 'Interface Grouping', 'DSL Settings', 'Dynamic DNS', 'Advanced Routing', 'IPSec VPN', and 'IPTV'. The main content area is titled 'WAN Interface' and features a table with columns for 'WAN Interface Name', 'VPI/VC1 or VID', 'Status', 'Operation', and 'Modify'. The table contains one entry: 'pppoe_ptm_101_0_d' with VPI/VC1 of 101 and a status of 'Connected'. Below the table is the 'Internet Connection Setup' section, which includes fields for 'DSL Modulation Type' (VDSL), 'VLAN ID' (101), 'Internet Connection Type' (PPPoE), 'Username' (broadband.user@btbroa), 'Password', 'Confirm password', and 'Connection Mode' (radio buttons for 'Always on', 'Connect on demand', and 'Connect manually').

WAN Interface Name	VPI/VC1 or VID	Status	Operation	Modify
pppoe_ptm_101_0_d	101	Connected	Disconnect	

Internet Connection Setup

DSL Modulation Type: VDSL

VLAN ID: 101

Internet Connection Type: PPPoE

Username: broadband.user@btbroa

Password:

Confirm password:

Connection Mode: ☒ Always on ☐ Connect on demand ☐ Connect manually

Screenshot courtesy of TP-Link

IPv6 Addressing

- IPv6 address format
 - Hex digits and canonical notation
- Network prefixes
 - Fixed-length 64-bit host identifier
 - Network prefix masks first 64 bits
- Global and link-local interface addresses
 - Global addressing (start with 2 or 3)
 - Link-local addressing (fe80::)
- Static address assignment versus Stateless Address Auto Configuration (SLAAC)
- Dual-stack hosts operate both IPv6 and IPv4 at the same time



Review Activity: Basic TCP/IP Concepts

- IPv4 Addressing
- Network Prefixes
- IPv4 Forwarding
- Public and Private Addressing
- IPv4 Host Address Configuration
- Static Versus Dynamic Host Address Configuration
- SOHO Router Configuration
- IPv6 Addressing

Lab Activity

- Assisted Lab: Configure a SOHO Router
 - Use the GNS3 network simulator to configure a home network

Lesson 5

Topic 5C

Compare Protocols and Ports

Protocols and Ports

- Transport layer
 - Identify each application protocol
 - Track sessions
- Protocol ports
 - Server port
 - Client port

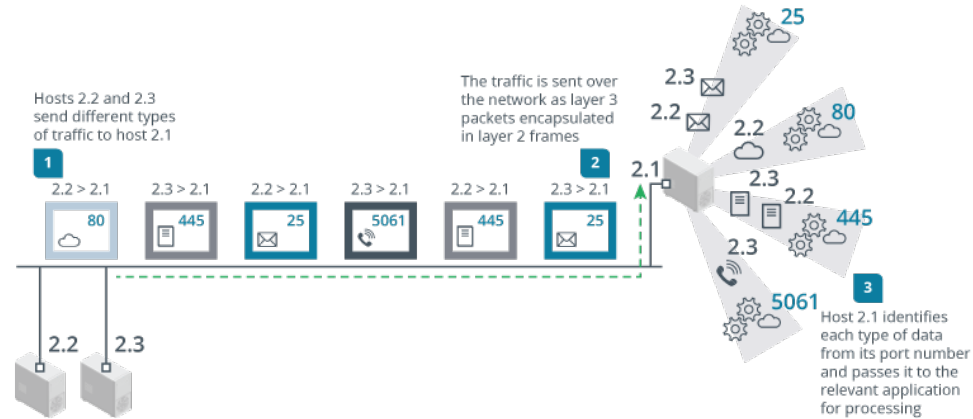
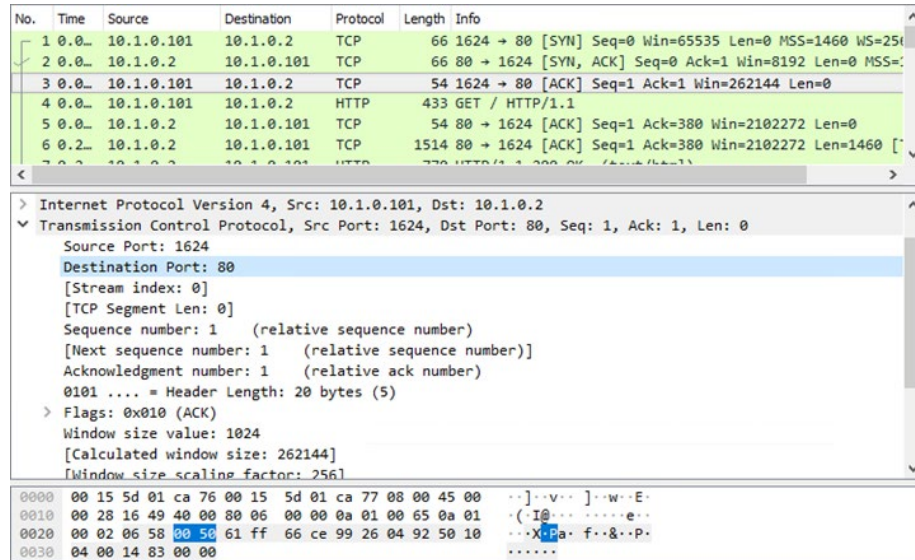


Image © 123RF.com

Transmission Control Protocol



The screenshot shows a Wireshark packet capture with the following details:

No.	Time	Source	Destination	Protocol	Length	Info
1	0.0...	10.1.0.101	10.1.0.2	TCP	66	1624 → 80 [SYN] Seq=0 Win=65535 Len=0 MSS=1460 WS=256
2	0.0...	10.1.0.2	10.1.0.101	TCP	66	80 → 1624 [SYN, ACK] Seq=0 Ack=1 Win=8192 Len=0 MSS=1460
3	0.0...	10.1.0.101	10.1.0.2	TCP	54	1624 → 80 [ACK] Seq=1 Ack=1 Win=262144 Len=0
4	0.0...	10.1.0.101	10.1.0.2	HTTP	433	GET / HTTP/1.1
5	0.0...	10.1.0.2	10.1.0.101	TCP	54	80 → 1624 [ACK] Seq=1 Ack=380 Win=2102272 Len=0
6	0.2...	10.1.0.2	10.1.0.101	TCP	1514	80 → 1624 [ACK] Seq=1 Ack=380 Win=2102272 Len=1460

The packet details pane for the selected packet (No. 4) shows:

- Internet Protocol Version 4, Src: 10.1.0.101, Dst: 10.1.0.2
- Transmission Control Protocol, Src Port: 1624, Dst Port: 80, Seq: 1, Ack: 1, Len: 0
 - Source Port: 1624
 - Destination Port: 80
 - [Stream index: 0]
 - [TCP Segment Len: 0]
 - Sequence number: 1 (relative sequence number)
 - [Next sequence number: 1 (relative sequence number)]
 - Acknowledgment number: 1 (relative ack number)
 - 0101 ... = Header Length: 20 bytes (5)
- Flags: 0x010 (ACK)
- Window size value: 1024
- [Calculated window size: 262144]
- [Window size scaling factor: 256]

The packet bytes pane shows the raw data in hexadecimal and ASCII:

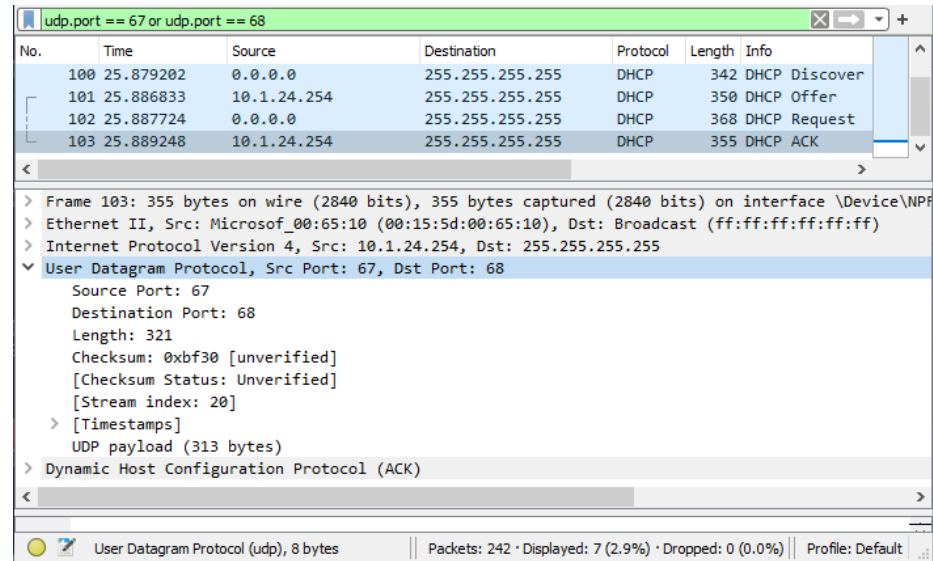
```
0000 00 15 5d 01 ca 76 00 15 5d 01 ca 77 08 00 45 00  ..]..v...].w..E.
0010 00 28 16 49 40 00 80 06 00 00 0a 01 00 65 0a 01  .(I@.....e..
0020 00 02 06 58 00 50 61 ff 66 ce 99 26 04 92 50 10  ...X.Pa.f...&..P.
0030 04 00 14 83 00 00  ....
```

Screenshot courtesy of Wireshark

- Connection-oriented transport protocol
 - Establish connection
 - Assign each packet sequence number
 - Allow the receiver to acknowledge (ACK)
 - Allow the receiver to send a negative acknowledgement (NACK)
 - Allow the graceful termination of a session
- TCP-based application protocols
 - HyperText Transfer Protocol Secure (HTTPS)
 - Secure Shell (SSH)

User Datagram Protocol

- Connectionless, unreliable delivery
- Smaller header
- UDP-based application protocols
 - Dynamic Host Configuration Protocol (DHCP)
 - Trivial File Transfer Protocol (TFTP)



No.	Time	Source	Destination	Protocol	Length	Info
100	25.879202	0.0.0.0	255.255.255.255	DHCP	342	DHCP Discover
101	25.886833	10.1.24.254	255.255.255.255	DHCP	350	DHCP Offer
102	25.887724	0.0.0.0	255.255.255.255	DHCP	368	DHCP Request
103	25.889248	10.1.24.254	255.255.255.255	DHCP	355	DHCP ACK

> Frame 103: 355 bytes on wire (2840 bits), 355 bytes captured (2840 bits) on interface \Device\NPF...

> Ethernet II, Src: Microsof_00:65:10 (00:15:5d:00:65:10), Dst: Broadcast (ff:ff:ff:ff:ff:ff)

> Internet Protocol Version 4, Src: 10.1.24.254, Dst: 255.255.255.255

▼ User Datagram Protocol, Src Port: 67, Dst Port: 68

- Source Port: 67
- Destination Port: 68
- Length: 321
- Checksum: 0xbf30 [unverified]
[Checksum Status: Unverified]
- [Stream index: 20]
- > [Timestamps]
- UDP payload (313 bytes)
- > Dynamic Host Configuration Protocol (ACK)

User Datagram Protocol (udp), 8 bytes | Packets: 242 · Displayed: 7 (2.9%) · Dropped: 0 (0.0%) | Profile: Default

Screenshot courtesy of Wireshark.

Well-known Ports

Networking	DNS UDP/53 TCP/53	DHCP UDP/67 UDP/68	NBT UDP/TCP 137-139	SNMP UDP/161 UDP/162	LDAP TCP/389
Remote access	SSH TCP/22	Telnet TCP/23	RDP TCP/3389		
File transfer	FTP TCP/20 TCP/21	HTTP TCP/80	HTTPS TCP/443	SMB TCP/445	
Email	SMTP TCP/25	POP3 TCP/110	IMAP TCP/143		

Review Activity: Protocols and Ports

- Protocols and Ports
- Transmission Control Protocol
- User Datagram Protocol
- Well-known Ports

Lesson 5

Topic 5D

Compare Network Configuration Concepts

Dynamic Host Configuration Protocol

- DHCP scope
 - Range of addresses in a subnet offered by the server as leases
- DHCP leases
 - Discover, Offer, Request, Acknowledge (DORA)
 - UDP/67 server port and UDP/68 client port
- DHCP reservations
 - Lease the same IP address based on client's MAC address or other interface identifier

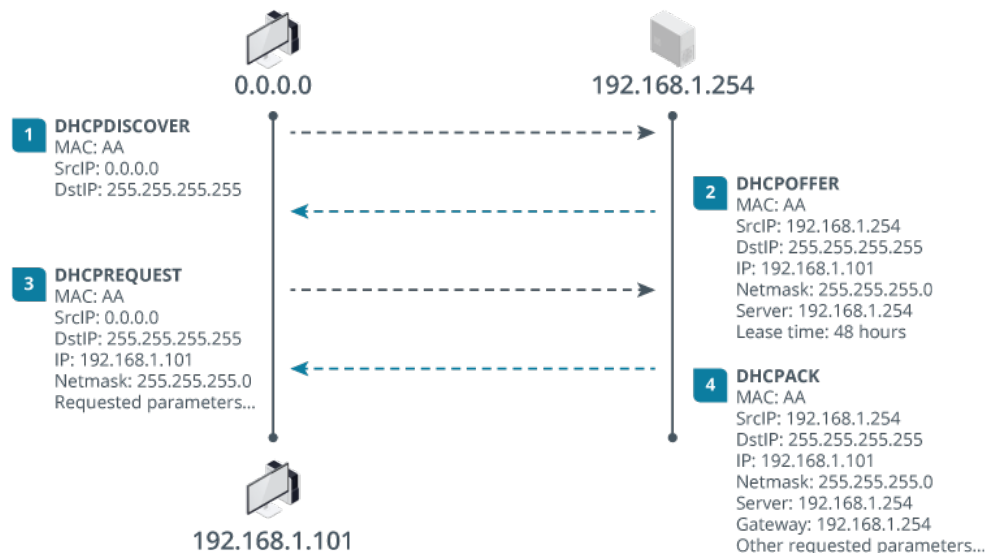


Image © 123RF.com

Domain Name System

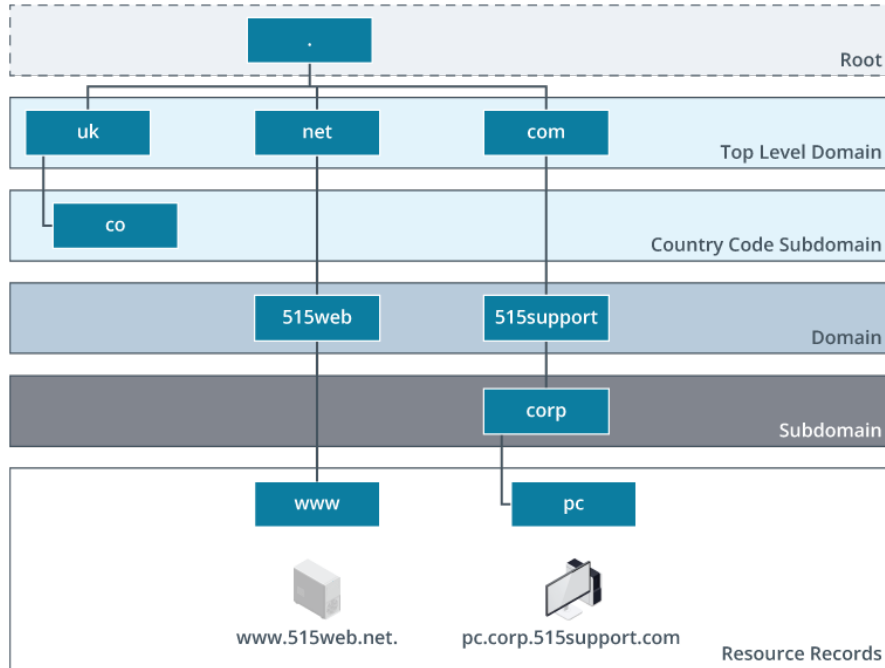
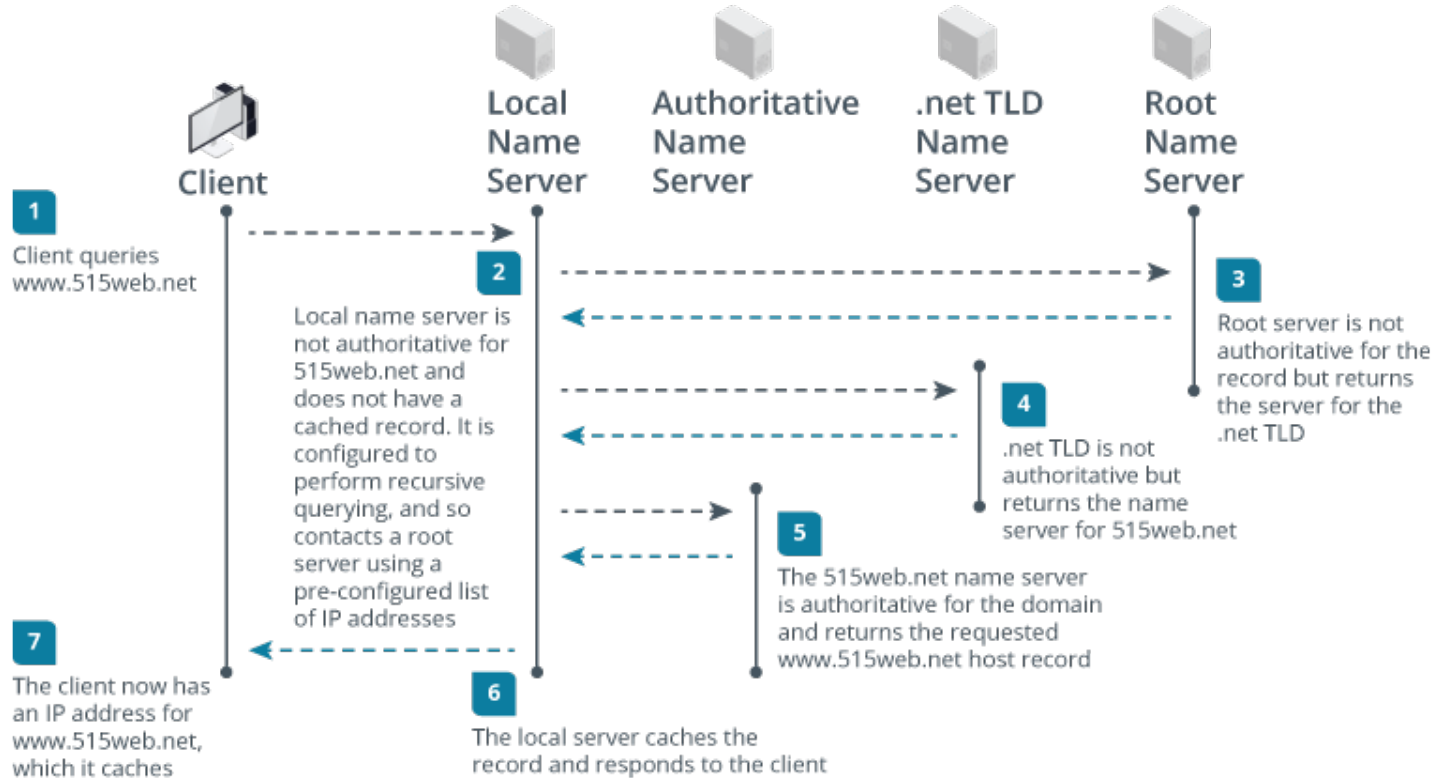


Image © 123RF.com

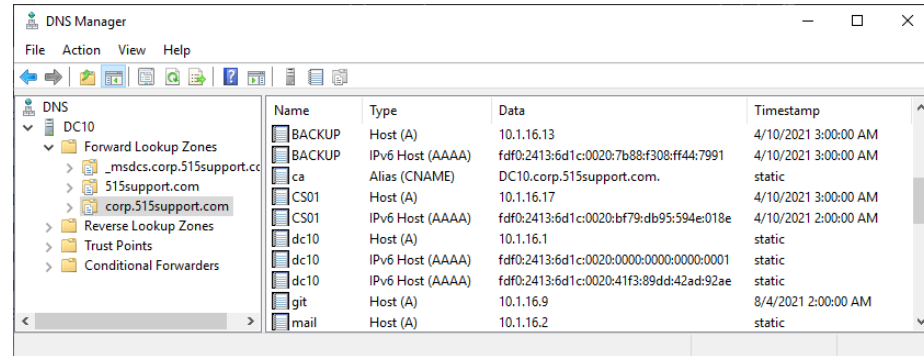
- Resolve “friendly” names assigned to hosts to IP addresses
 - Host name
 - Fully Qualified Domain Name (FQDN)
- DNS hierarchy
 - Root servers
 - Top Level Domains (TLDs)
 - Domain names

DNS Queries



DNS Record Types

- Address records
 - A records resolve to an IPv4 address
 - AAAA records resolve to an IPv6 address
- Mail Exchanger (MX) records
 - Identify address record providing mail services
 - Can create multiple records with priority values (lowest numbered is highest priority)



The screenshot shows the Windows DNS Manager application. The left pane displays the hierarchy: DNS > DC10 > Forward Lookup Zones > corp.515support.com. The right pane shows a list of DNS records for this zone.

Name	Type	Data	Timestamp
BACKUP	Host (A)	10.1.16.13	4/10/2021 3:00:00 AM
BACKUP	IPv6 Host (AAAA)	fdf0:2413:6d1c:0020:7b88:f308:ff44:7991	4/10/2021 3:00:00 AM
ca	Alias (CNAME)	DC10.corp.515support.com.	static
CS01	Host (A)	10.1.16.17	4/10/2021 3:00:00 AM
CS01	IPv6 Host (AAAA)	fdf0:2413:6d1c:0020:bf79:db95:594e:018e	4/10/2021 2:00:00 AM
dc10	Host (A)	10.1.16.1	static
dc10	IPv6 Host (AAAA)	fdf0:2413:6d1c:0020:0000:0000:0000:0001	static
dc10	IPv6 Host (AAAA)	fdf0:2413:6d1c:0020:41f3:89dd:42ad:92ae	static
git	Host (A)	10.1.16.9	8/4/2021 2:00:00 AM
mail	Host (A)	10.1.16.2	static

Screenshot courtesy of Microsoft

DNS Spam Management Records

- Text (TXT) records store free form text to support services
- DNS can record authentication data for the domain's mail servers
- Recipients can check these records to block unwanted and spoofed messages (spam management)
- Sender Policy Framework (SPF)
 - Identifies hosts authorized to send mail
- DomainKeys Identified Mail (DKIM)
 - Uses cryptography to allow validation of mail source
- Domain-based Message Authentication, Reporting, and Conformance (DMARC)
 - Framework to ensure that SPF and DKIM are being utilized effectively

Virtual LANs

```
interface swp5
  bridge-access 100

interface swp6
  bridge-access 100

interface swp7
  bridge-access 100

interface swp8
  bridge-access 100

interface swp9
  bridge-access 200

interface swp10
  bridge-access 200

interface swp11
  bridge-access 200

interface swp12
  bridge-access 200

interface bridge
  bridge-ports swp5 swp6 swp7 swp8 swp9 swp10 swp11 swp12
  bridge-vids 10 100 200
  bridge-vlan-aware yes
```

- Divide local network into separate broadcast domains
- Configured on managed switches
 - Each switch port can be configured with a VLAN ID from 2 to 4094
 - Switch ports with same ID are in the same VLAN and broadcast domain
 - Unconfigured switch ports default to VLAN ID #1
- Traffic between VLANs must be sent via routers

Virtual Private Networks

- Join a local network from a remote location
- Local network traffic is tunneled over a public/untrusted network
- Uses authentication and encryption to prevent unauthorized access

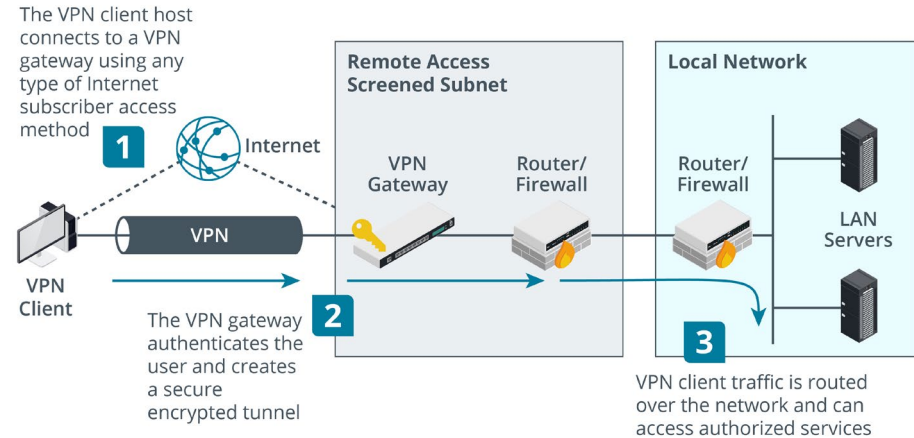


Image © 123RF.com

Review Activity: Network Configuration Concepts

- Dynamic Host Configuration Protocol
- Domain Name System
- DNS Queries
- DNS Record Types and Spam Management Records
- Virtual LANs
- Virtual Private Networks

CompTIA A+ Core 1 Exam 220-1101

Lesson 5



Summary