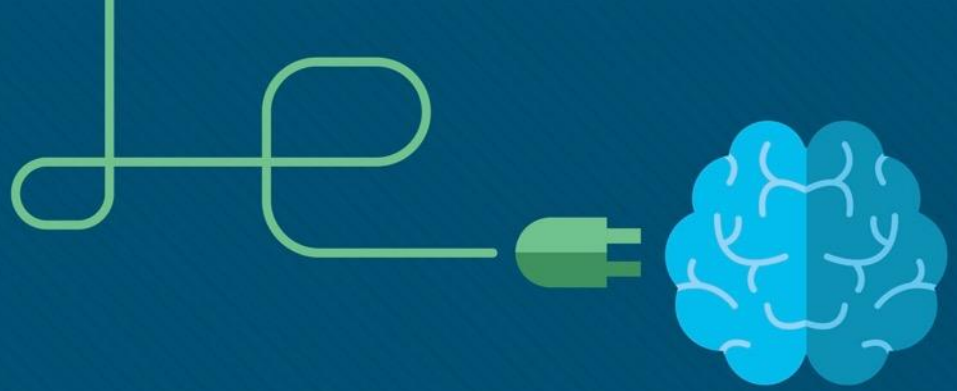
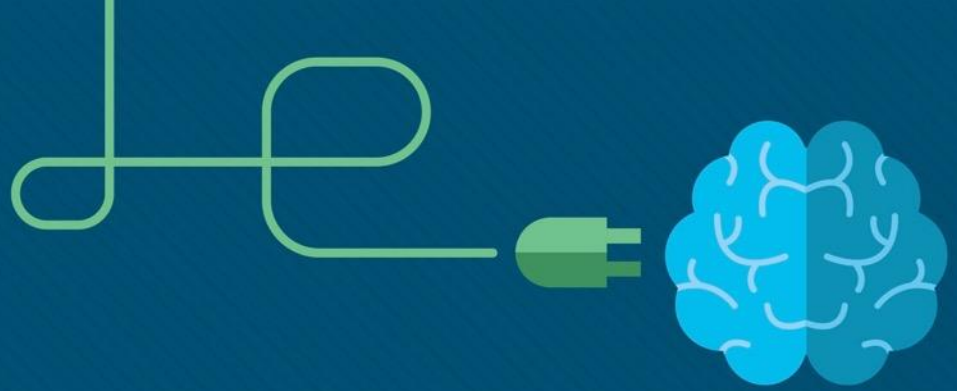


Module 15: Application Layer

Thomas Wyseur

Introduction to Networks v7.0
(ITN)



Module 15: Application Layer

Introduction to Networks v7.0
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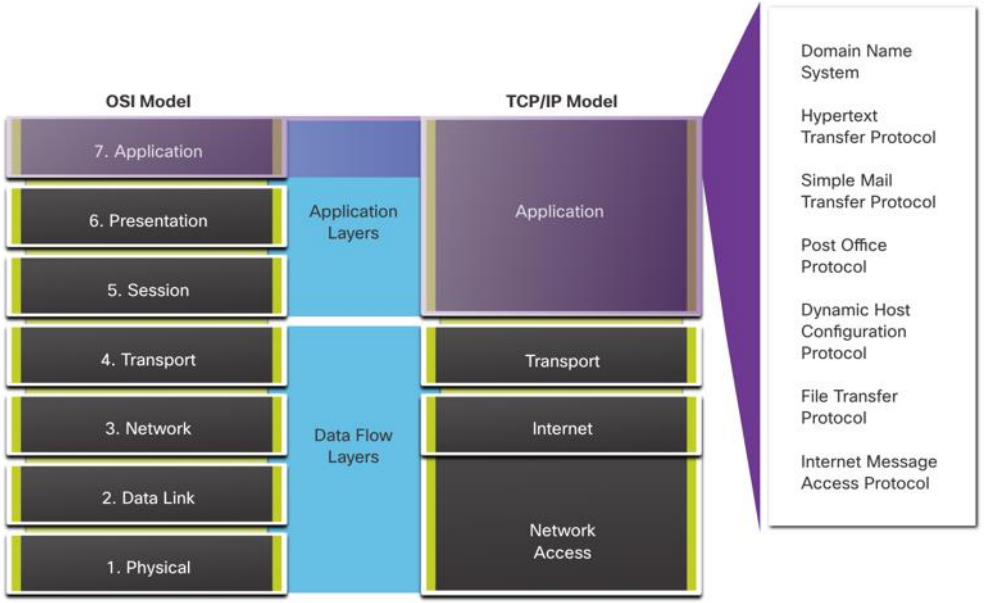
15.1 Application, Presentation, and Session

Application Layer

- The upper three layers of the OSI model (application, presentation, and session) define functions of the TCP/IP application layer.
- The application layer provides the interface between the applications used to communicate, and the underlying network over which messages are transmitted.
- Some of the most widely known application layer protocols include HTTP, FTP, TFTP, IMAP and DNS.



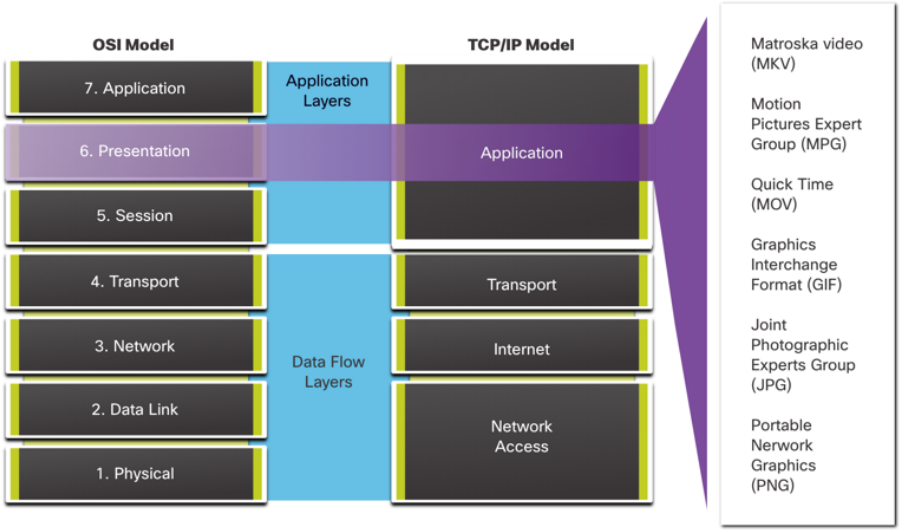
Presentation and Session Layer

The presentation layer has three primary functions:

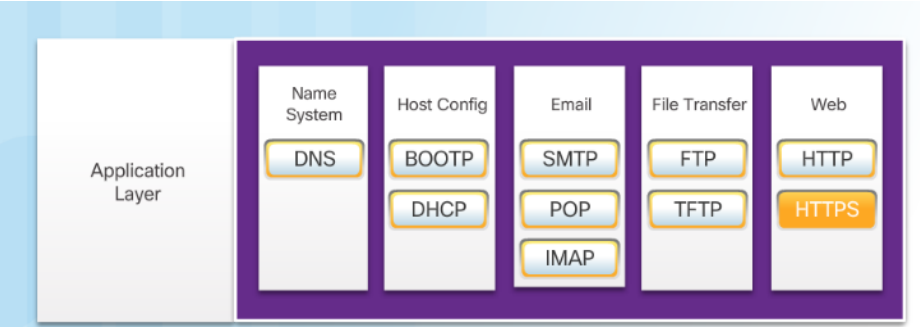
- Formatting, or presenting, data at the source device into a compatible format for receipt by the destination device
- Compressing data in a way that can be decompressed by the destination device
- Encrypting data for transmission and decrypting data upon receipt

The session layer functions:

- It creates and maintains dialogs between source and destination applications.
- It handles the exchange of information to initiate dialogs, keep them active, and to restart sessions that are disrupted or idle for a long period of time.



TCP/IP Application Layer Protocols

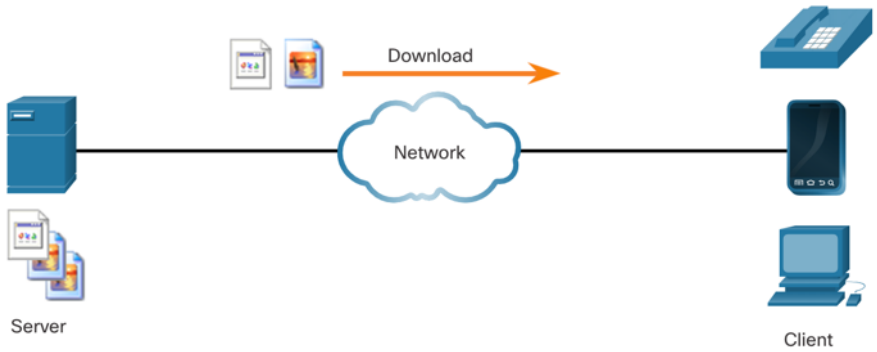


- Domain Name Server (DNS) TCP,UDP 53 - Translates domain names, such as cisco.com, into IP addresses.
- (BOOTP) – Bootstrap Protocol - BOOTP is being superseded by DHCP.
- Dynamic Host Configuration Protocol (DHCP) UDP client 68, server 67 – Dynamically assigns IP addresses to client stations at start-up.
- Simple Mail Transport Protocol (SMTP) TCP 25 - Enables clients to send email to a mail server.
- Post Office Protocol (POP) TCP 110 - Enables clients to retrieve email from a mail server.
- Internet Message Access Protocol (IMAP) TCP 143 - Enables clients to retrieve email from a mail server, maintains email on server.
- File Transfer Protocol (FTP) TCP 20 and 21 - Reliable, connection-oriented, and acknowledged file delivery protocol.
- Trivial File Transfer Protocol (TFTP) UDP 69 – simple connectionless file transfer protocol.
- Hypertext Transfer Protocol (HTTP) TCP 80, 8080 - Set of rules for exchanging text, graphic images, etc. on the World Wide Web.
- Hypertext Transfer Protocol Secure (HTTPS) TCP, UDP 443 – Uses encryption and authentication to secure communication.

15.2 Peer-to-Peer

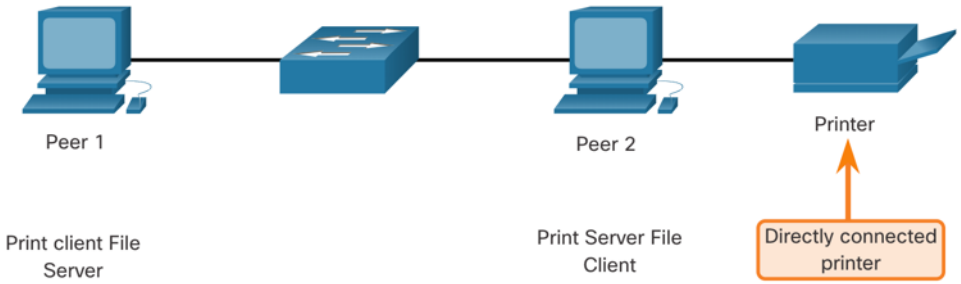
Client-Server Model

- Client and server processes are considered to be in the application layer.
- In the client/server model, the device requesting the information is called a client and the device responding to the request is called a server.
- Application layer protocols describe the format of the requests and responses between clients and servers.



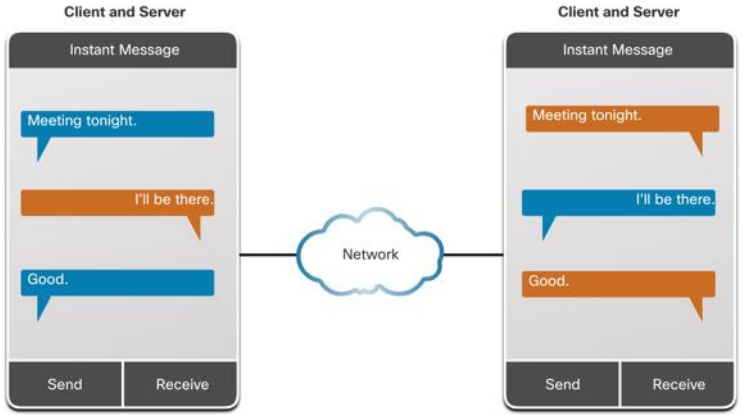
Peer-to-Peer Networks

- In a peer-to-peer (P2P) network, two or more computers are connected via a network and can share resources (such as printers and files) without having a dedicated server.
- Every connected end device (known as a peer) can function as both a server and a client.
- One computer might assume the role of server for one transaction while simultaneously serving as a client for another. The roles of client and server are set on a per request basis.



Peer-to-Peer Applications

- A P2P application allows a device to act as both a client and a server within the same communication.
- Some P2P applications use a hybrid system where each peer accesses an index server to get the location of a resource stored on another peer.

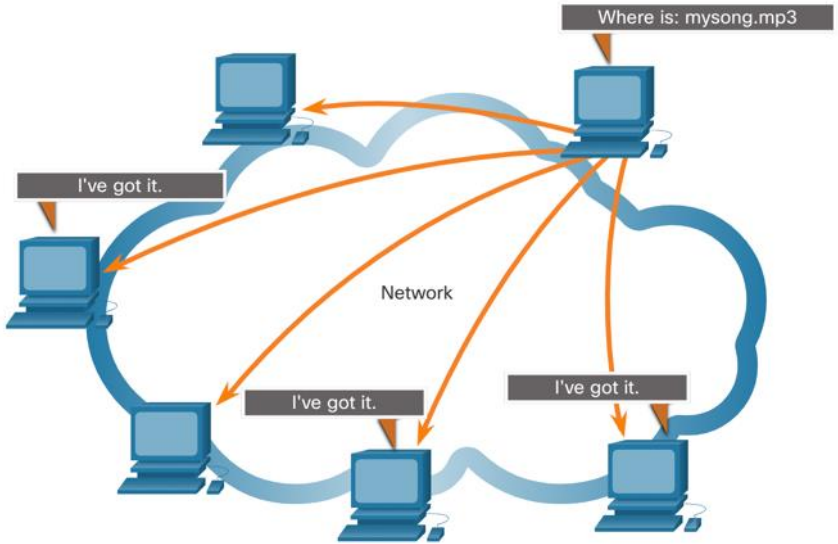


Common P2P Applications

With P2P applications, each computer in the network that is running the application can act as a client or a server for the other computers in the network that are also running the application.

Common P2P networks include the following:

- BitTorrent
- Direct Connect
- eDonkey
- Freenet



15.3 Web and Email Protocols

Hypertext Transfer Protocol and Hypertext Markup Language

When a web address or Uniform Resource Locator (URL) is typed into a web browser, the web browser establishes a connection to the web service. The web service is running on the server that is using the HTTP protocol.

To better understand how the web browser and web server interact, examine how a web page is opened in a browser.

Step 1

The browser interprets the three parts of the URL:

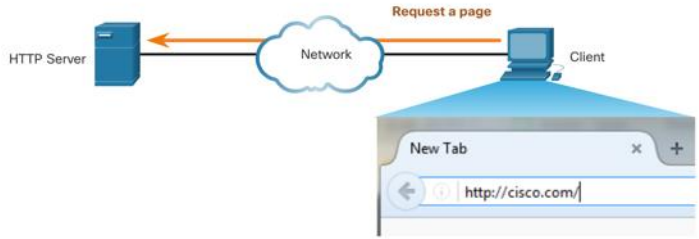
- http (the protocol or scheme)
- www.cisco.com (the server name)
- index.html (the specific filename requested)

Hypertext Transfer Protocol and Hypertext Markup Language (Cont.)

Step 2

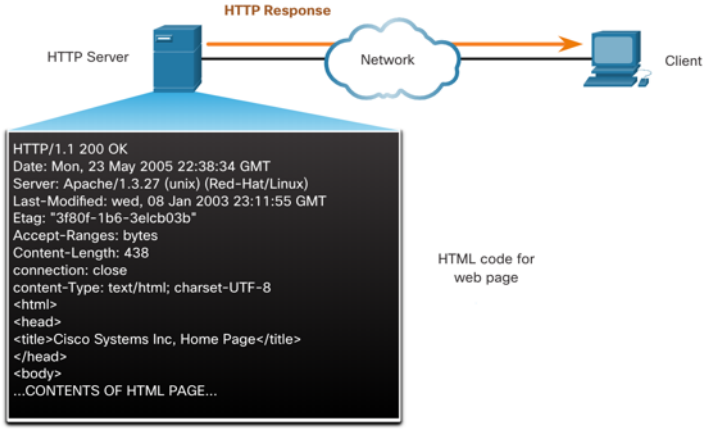
The browser then checks with a name server to convert www.cisco.com into a numeric IP address, which it uses to connect to the server.

The client initiates an HTTP request to a server by sending a GET request to the server and asks for the index.html file.



Step 3

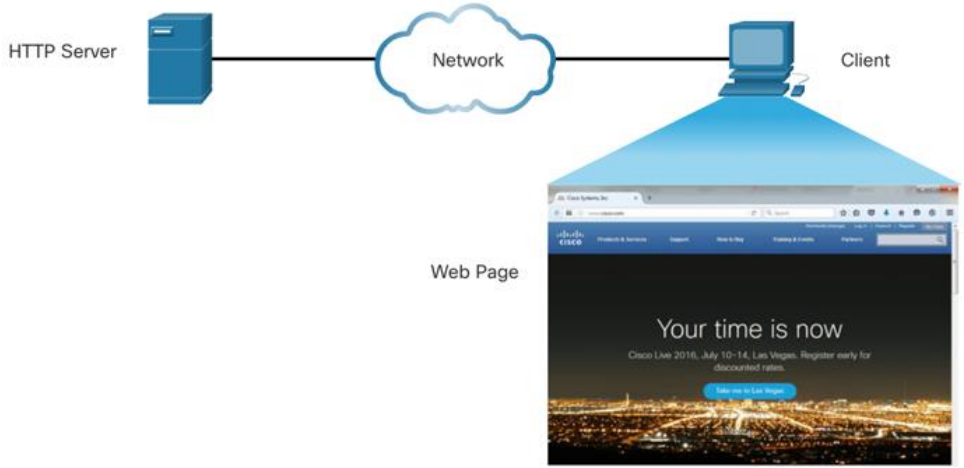
In response to the request, the server sends the HTML code for this web page to the browser.



Hypertext Transfer Protocol and Hypertext Markup Language (Cont.)

Step 4

The browser deciphers the HTML code and formats the page for the browser window.

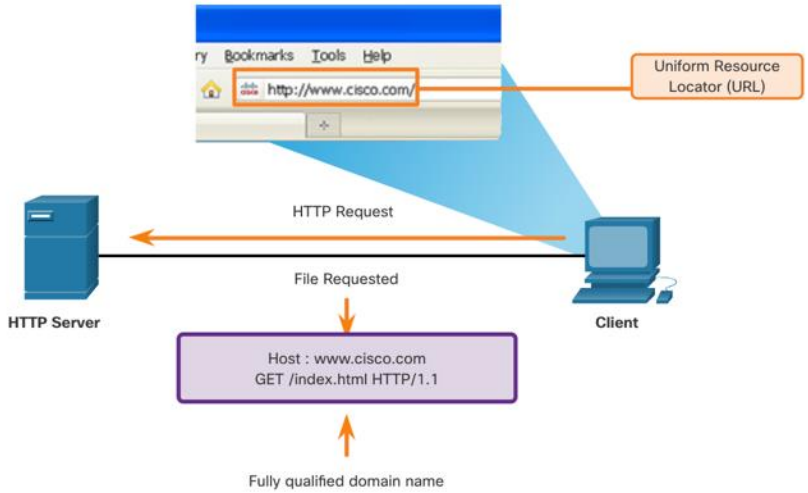


HTTP and HTTPS

HTTP is a request/response protocol that specifies the message types used for that communication.

The three common message types are GET, POST, and PUT:

- **GET** - This is a client request for data. A client (web browser) sends the GET message to the web server to request HTML pages.
- **POST** - This uploads data files to the web server, such as form data.
- **PUT** - This uploads resources or content to the web server, such as an image.



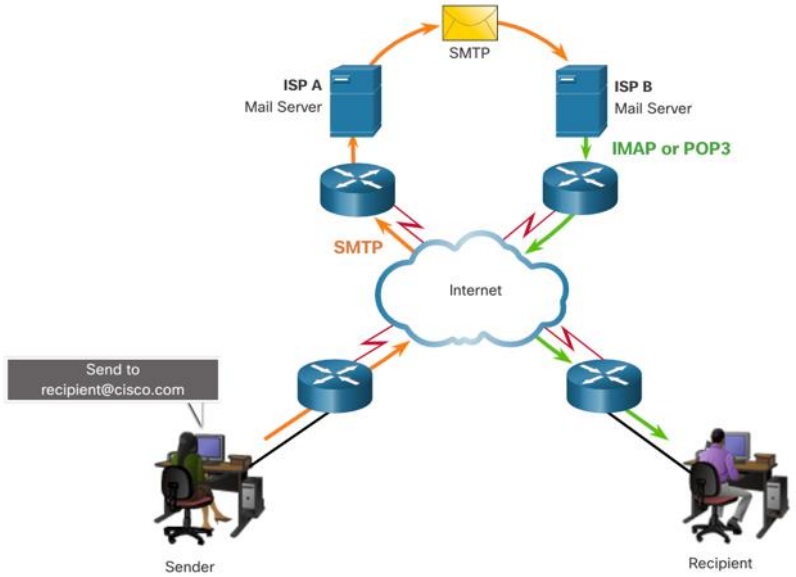
Note: HTTP is not a secure protocol. For secure communications sent across the internet, HTTPS should be used.

Email Protocols

Email is a store-and-forward method of sending, storing, and retrieving electronic messages across a network. Email messages are stored in databases on mail servers. Email clients communicate with mail servers to send and receive email.

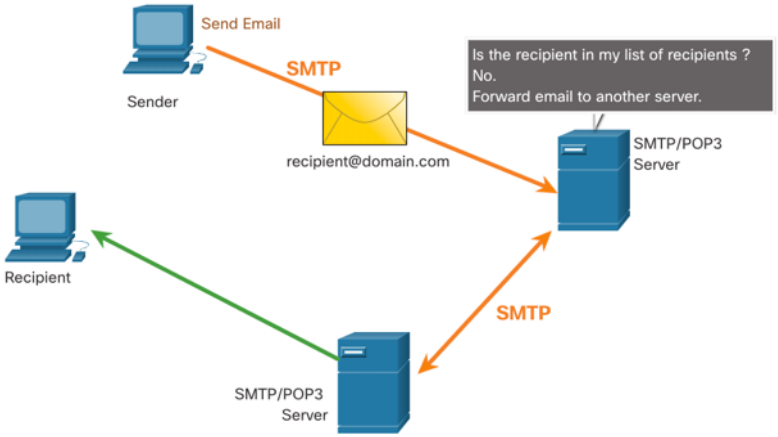
The email protocols used for operation are:

- Simple Mail Transfer Protocol (SMTP) – used to send mail.
- Post Office Protocol (POP) & IMAP – used for clients to receive mail.



SMTP, POP and IMAP

- When a client sends email, the client SMTP process connects with a server SMTP process on well-known port 25.
- After the connection is made, the client attempts to send the email to the server across the connection.
- When the server receives the message, it either places the message in a local account, if the recipient is local, or forwards the message to another mail server for delivery.
- The destination email server may not be online or may be busy. If so, SMTP spools messages to be sent at a later time.

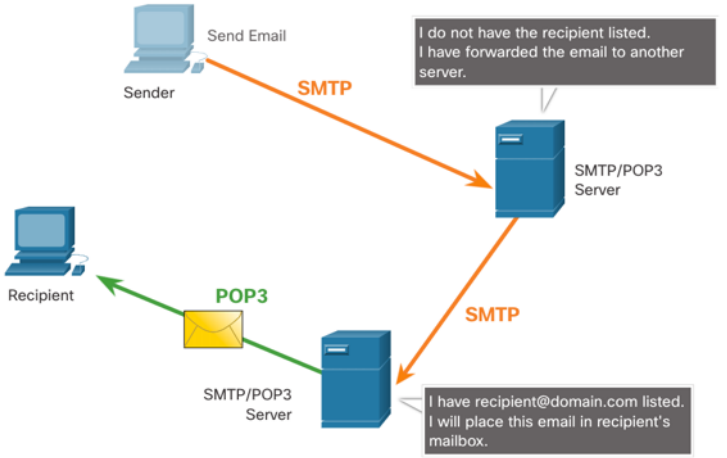


Note: SMTP message formats require a message header (recipient email address & sender email address) and a message body.

SMTP, POP and IMAP (Cont.)

POP is used by an application to retrieve mail from a mail server. When mail is downloaded from the server to the client using POP the messages are then deleted on the server.

- The server starts the POP service by passively listening on TCP port 110 for client connection requests.
- When a client wants to make use of the service, it sends a request to establish a TCP connection with the server.
- When the connection is established, the POP server sends a greeting.
- The client and POP server then exchange commands and responses until the connection is closed or aborted.

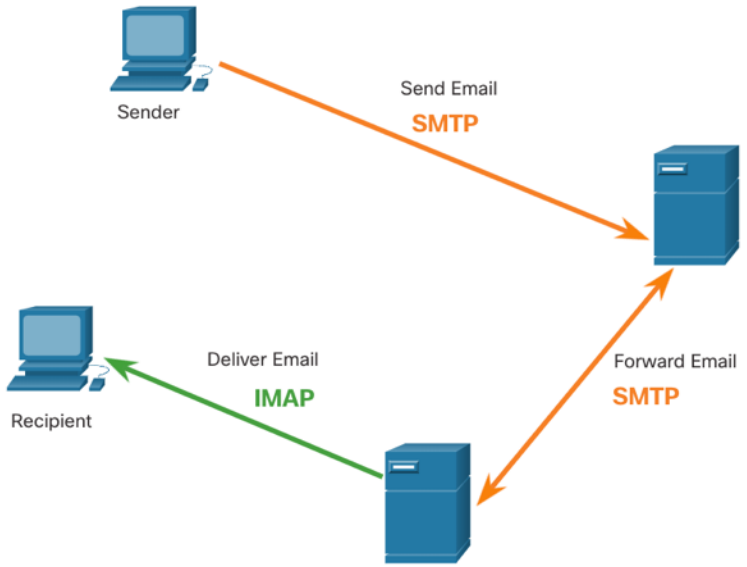


Note: Since POP does not store messages, it is not recommended for small businesses that need a centralized backup solution.

SMTP, POP and IMAP (Cont.)

IMAP is another protocol that describes a method to retrieve email messages.

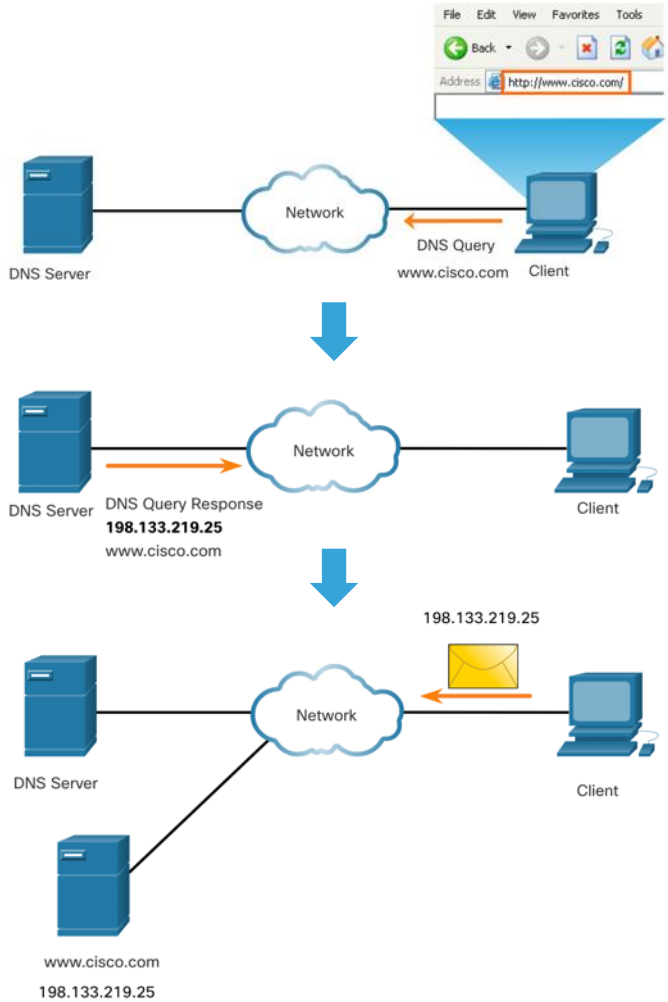
- Unlike POP, when a user connects to an IMAP server, copies of the messages are downloaded to the client application. The original messages are kept on the server until manually deleted.
- When a user decides to delete a message, the server synchronizes that action and deletes the message from the server.



15.4 IP Addressing Services

Domain Name Service

- Domain names were created to convert the numeric IP addresses into a simple, recognizable name.
- Fully-qualified domain names (FQDNs), such as http://www.cisco.com, are much easier for people to remember than 198.133.219.25.
- The DNS protocol defines an automated service that matches resource names with the required numeric network address. It includes the format for queries, responses, and data.



DNS Message Format

The DNS server stores different types of resource records that are used to resolve names. These records contain the name, address, and type of record.

Some of these record types are as follows:

- **A** - An end device IPv4 address
- **NS** - An authoritative name server
- **AAAA** - An end device IPv6 address (pronounced quad-A)
- **MX** - A mail exchange record

When a client makes a query, the server DNS process first looks at its own records to resolve the name. If it is unable to resolve the name by using its stored records, it contacts other servers to resolve the name.

After a match is found and returned to the original requesting server, the server temporarily stores the numbered address in the event that the same name is requested again.

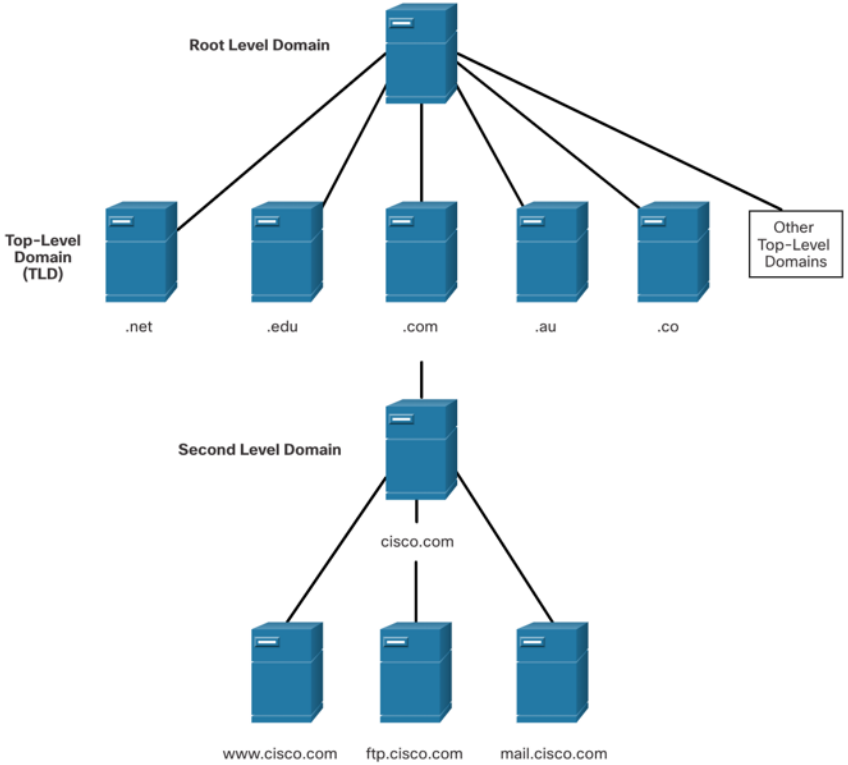
DNS Message Format (Cont.)

DNS uses the same message format between servers, consisting of a question, answer, authority, and additional information for all types of client queries and server responses, error messages, and transfer of resource record information.

DNS message section	Description
Question	The question for the name server
Answer	Resource Records answering the question
Authority	Resource Records pointing toward an authority
Additional	Resource Records holding additional information

DNS Hierarchy

- DNS uses a hierarchical system to create a database to provide name resolution.
- Each DNS server maintains a specific database file and is only responsible for managing name-to-IP mappings for that small portion of the entire DNS structure.
- When a DNS server receives a request for a name translation that is not within its DNS zone, the DNS server forwards the request to another DNS server within the proper zone for translation.
- Examples of top-level domains:
  - **.com** - a business or industry
  - **.org** - a non-profit organization
  - **.au** - Australia



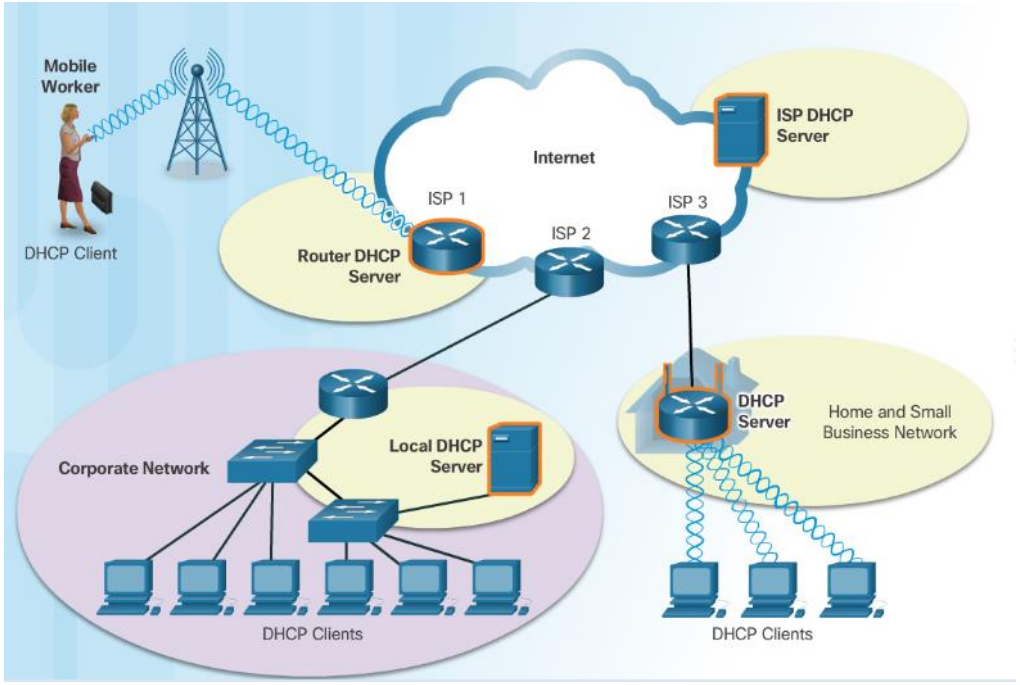
The nslookup Command

- Nslookup is a computer operating system utility that allows a user to manually query the DNS servers configured on the device to resolve a given host name.
- This utility can also be used to troubleshoot name resolution issues and to verify the current status of the name servers.
- When the **nslookup** command is issued, the default DNS server configured for your host is displayed.
- The name of a host or domain can be entered at the **nslookup** prompt.

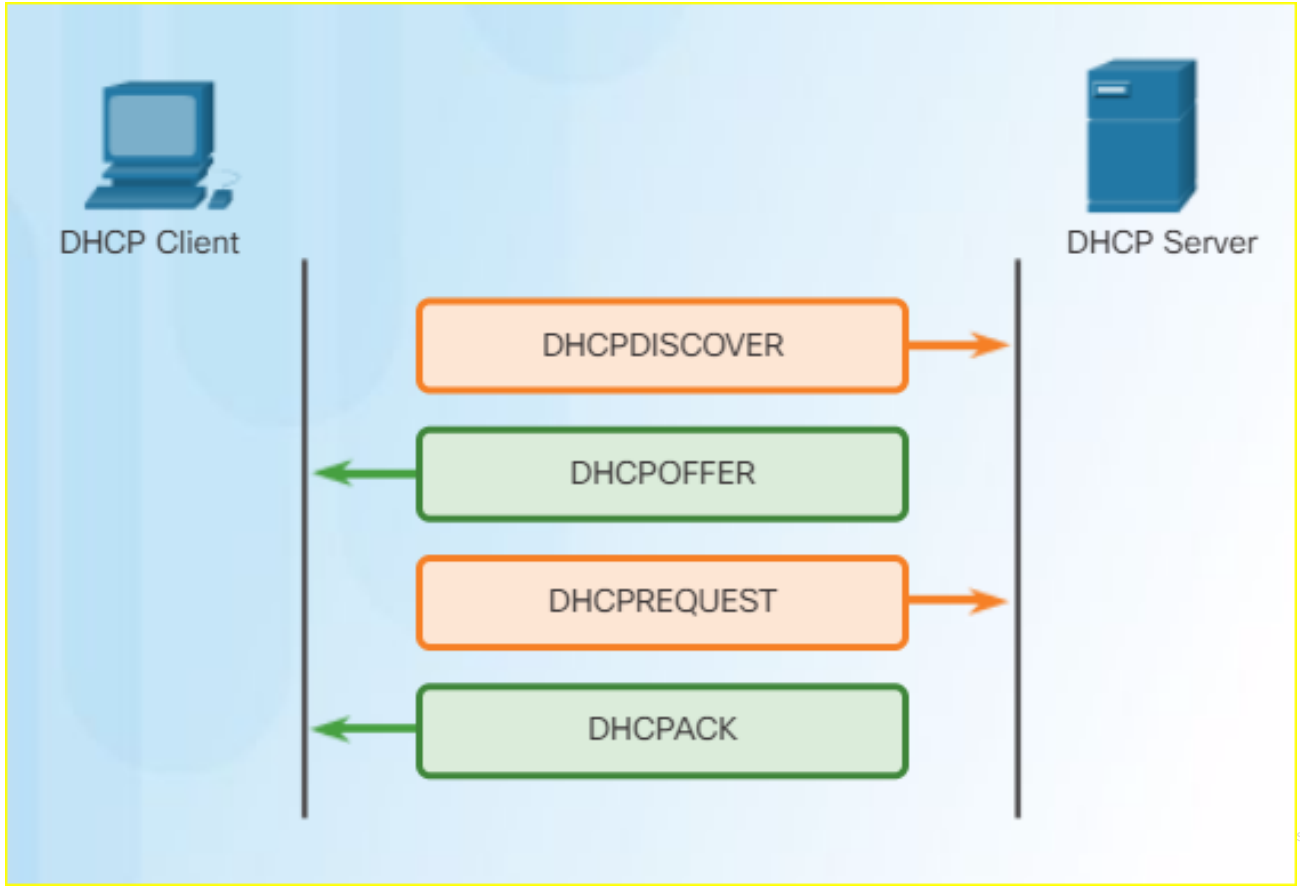
```
C:\Users> nslookup
Default Server:  dns-sj.cisco.com
Address:  171.70.168.183
> www.cisco.com
Server:  dns-sj.cisco.com
Address:  171.70.168.183
Name:    origin-www.cisco.com
Addresses:  2001:420:1101:1::a
          173.37.145.84
Aliases:  www.cisco.com
> cisco.netacad.net
Server:  dns-sj.cisco.com
Address:  171.70.168.183
Name:    cisco.netacad.net
Address:  72.163.6.223
>
```

Dynamic Host Configuration Protocol

- The Dynamic Host Configuration Protocol (DHCP) for IPv4 automates the assignment of IPv4 addresses, subnet masks, gateways, and other parameters.
- DHCP-distributed addresses are leased for a set period of time, then returned to pool for reuse.
- DHCP is usually employed for end user devices. Static addressing is used for network devices, such as gateways, switches, servers, and printers.
- DHCPv6 (DHCP for IPv6) provides similar services for IPv6 clients.



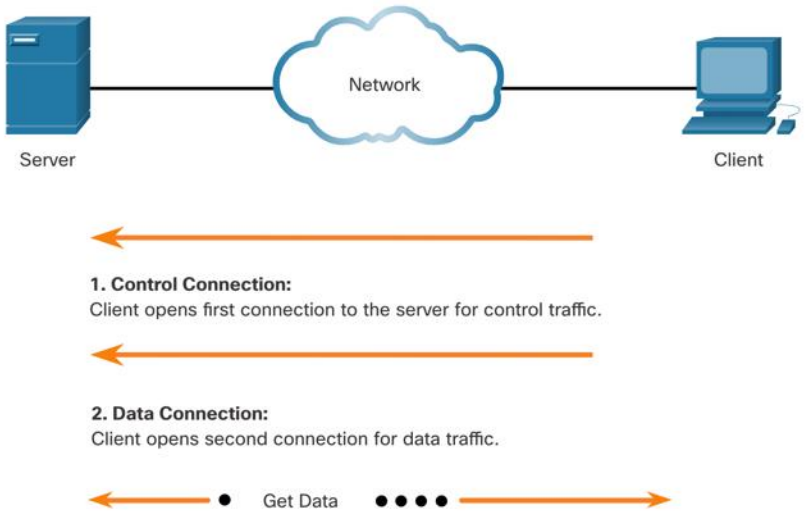
DHCP Operation



15.5 File Sharing Services

File Transfer Protocol

FTP was developed to allow for data transfers between a client and a server. An FTP client is an application which runs on a computer that is being used to push and pull data from an FTP server.



Step 1 - The client establishes the first connection to the server for control traffic using TCP port 21. The traffic consists of client commands and server replies.

Step 2 - The client establishes the second connection to the server for the actual data transfer using TCP port 20. This connection is created every time there is data to be transferred.

Step 3 - The data transfer can happen in either direction. The client can download (pull) data from the server, or the client can upload (push) data to the server.

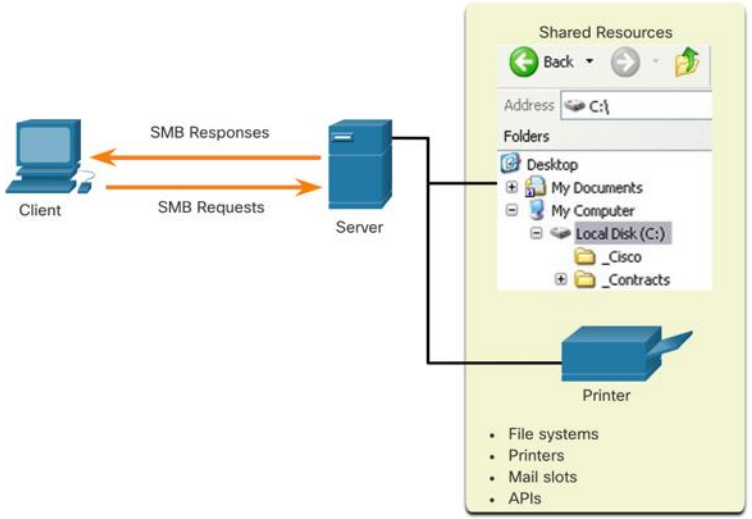
Server Message Block

The Server Message Block (SMB) is a client/server, request-response file sharing protocol. Servers can make their own resources available to clients on the network.

Three functions of SMB messages:

- Start, authenticate, and terminate sessions
- Control file and printer access
- Allow an application to send or receive messages to or from another device

Unlike the file sharing supported by FTP, clients establish a long-term connection to servers. After the connection is established, the user of the client can access the resources on the server as though the resource is local to the client host.

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