Module 12: Application Layer Services

Networking Essentials (NETESS)

Module Objectives

Module Title: Application Layer Services
Module Objective: Explain the function of common application layer services.

Topic Title	Topic Objective
Network Application Services	Describe common network applications.
Domain Name System	Describe DNS.
Web Clients and Servers	Describe HTTP and HTML.
FTP Clients and Servers	Describe FTP.
Virtual Terminals	Describe Telnet and SSH.
Email and Messaging	Describe email protocols.

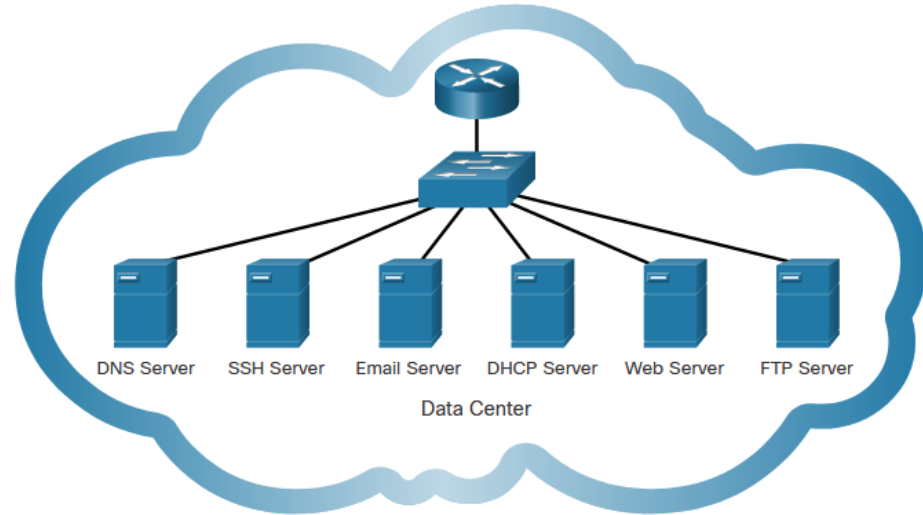# 12.1 Network Application Services

Common Network Application Services

What are the most common internet services that you use on a regular basis?

For most people, the list includes services such as internet searches, social media sites, video and audio streaming, on-line shopping sites, email and messaging.

- Each of these services relies on protocols from the TCP/IP protocol suite to reliably communicate the information between the clients and the servers.

Some of the most common servers that provide these services are shown.

DNS Server   SSH Server   Email Server   DHCP Server   Web Server   FTP Server

Data Center

Common Network Application Services (Cont.)

Protocol	Description
Domain Name System (DNS)	Resolves internet names to IP addresses.
Secure Shell (SSH)	Used to provide remote access to servers and networking devices.
Simple Mail Transfer Protocol (SMTP)	Sends email messages and attachments from clients to servers and from servers to other email servers.
Post Office Protocol (POP)	Used by email clients to retrieve email and attachments from a remote server.
Internet Message Access Protocol (IMAP)	Used by email clients to retrieve email and attachments from a remote server.
Dynamic Host Configuration Protocol (DHCP)	Used to automatically configure devices with IP addressing and other necessary information to enable them to communicate over the internet.
Hypertext Transfer Protocol (HTTP)	Used by web browsers to request web pages and web servers to transfers the files that make up web pages of the World Wide Web.
File Transfer Protocol (FTP)	Used for interactive file transfer between systems.

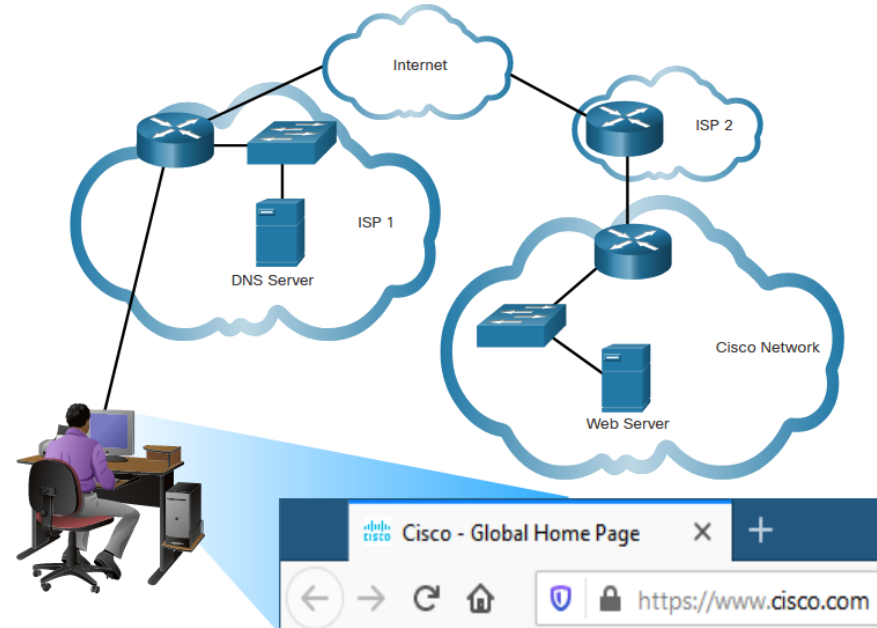# 12.2 Domain Name System

Domain Name Translation

It would be impossible to remember the IP addresses for all of the servers hosting services on the internet.

Instead, there is an easier way to locate servers by associating a name with an IP address:
The Domain Name System (DNS) provides a way for hosts to use this name to request the IP address of a specific server.

- DNS names are registered and organized on the internet within specific high-level groups, or domains.
    - Some of the most common high-level domains on the internet are .com, .edu, and .net.

Video - DNS Servers

DNS Servers

A DNS server contains a table that associates hostnames in a domain with corresponding IP addresses.

When a client has the name of server, such as a web server, but needs to find the IP address, it sends a request to the DNS server on port 53.

When the DNS server receives the request, it checks its table to determine the IP address associated with that web server.

If the local DNS server does not have an entry for the requested name, it queries another DNS server within the domain.

I found the IP address of www.cisco.com.

ISP 1

DNS Server

Name www.cisco.com
Address 198.133.219.25
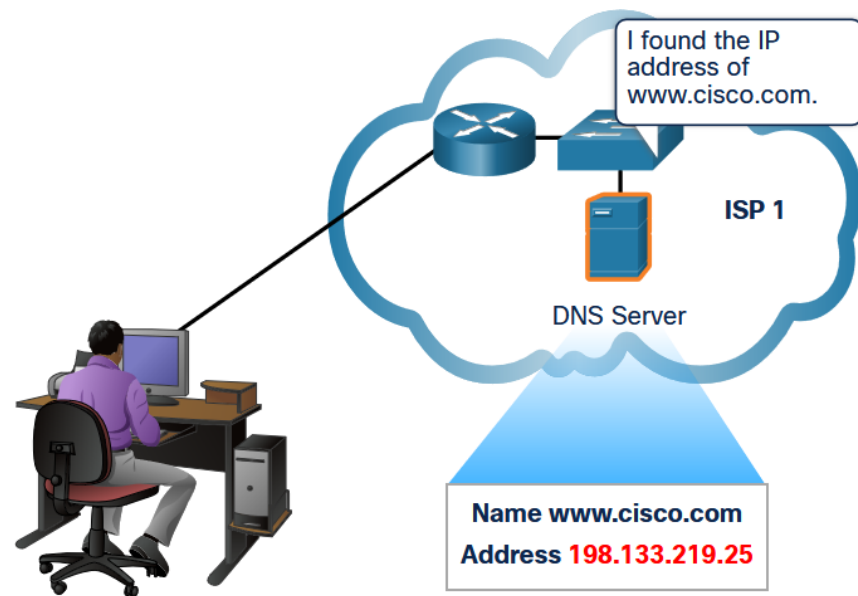
Lab - Observe DNS Name Resolution

In this lab, you will complete the following objectives:

- Observe the conversion of a URL to an IP address.

- Observe DNS lookup using the **nslookup** command.

12.3 Web Clients and Servers

Video - HTTP and HTML

HTTP and HTML

When a web client receives the IP address of a web server, the client browser uses that IP address and port 80 to request web services.

- This request is sent to the server using the Hypertext Transfer Protocol (HTTP).
- Requests for secure HTTP are sent to port 443.

When the server receives a port 80 request, the server responds to the client request and sends the web page to the client.

- The information content of a web page is encoded using specialized 'mark-up' languages.
  - The HyperText Markup Language (HTML) coding tells the browser how to format the we page and what graphics and fonts to use.
  - HTML is the most commonly used language.

Client sends an HTTP request to destination port 80 for HTML web page.
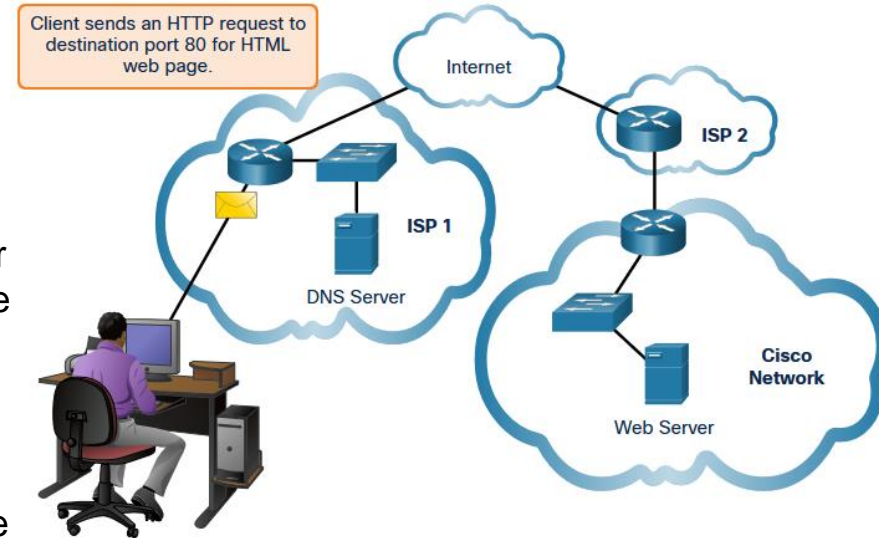
Packet Tracer – Observe Web Requests

In this activity, you will observe web requests when a client browser requests web pages from a server.

12.4 FTP Clients and Servers

File Transfer Protocol

The File Transfer Protocol (FTP) provides an easy method to transfer files from one computer to another.

A host running FTP client software can access an FTP server to perform various file management functions, including file uploads and downloads.

The FTP server enables a client to exchange files between devices. It also enables clients to manage files remotely by sending file management commands such as delete or rename.

The FTP service uses two different ports to communicate between client and server.

- To begin an FTP session, control connection requests are sent to the server using destination TCP port 21.
- When the session is opened, the server uses TCP port 20 to transfer the data files.

Server

Network

Client

1. Control Connection:
Client opens first connection to the server for control traffic.

2. Data Connection:
Client opens second connection for data traffic.

Get Data

3. Data Transfer:
Server transfers data to the client.

Video - FTP Client Software

FTP Client Software

Most client operating systems such as Windows, Mac OS, and Linux include a command-line interface for FTP.

There is also GUI-based FTP client software that provides a simple drag-and-drop interface for FTP.

After logging into the FTP server with a username and password, the user drags files between the local host window and the remote site (FTP server) window to transfer files.
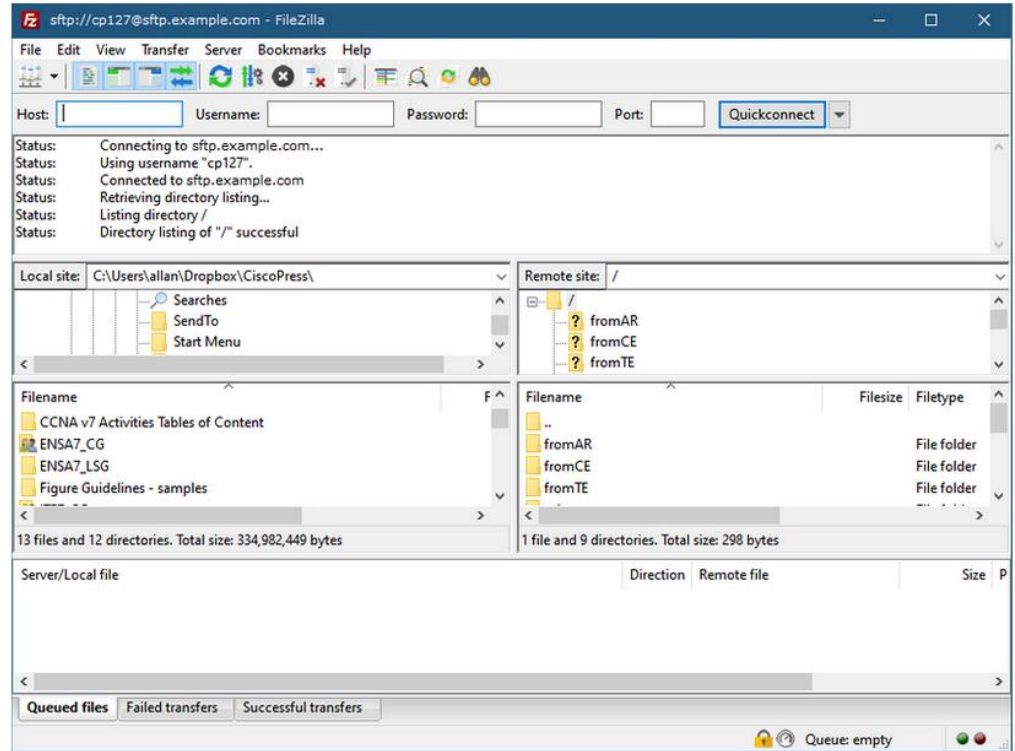
FT Packet Tracer – Use FTP Services

In this activity, you will put a file on an FTP server and get a file from an FTP server.

12.5 Virtual Terminals

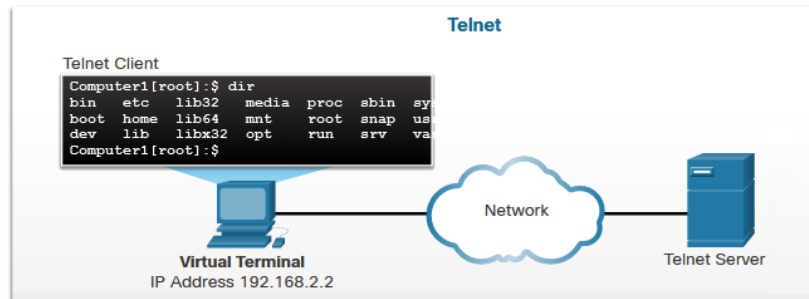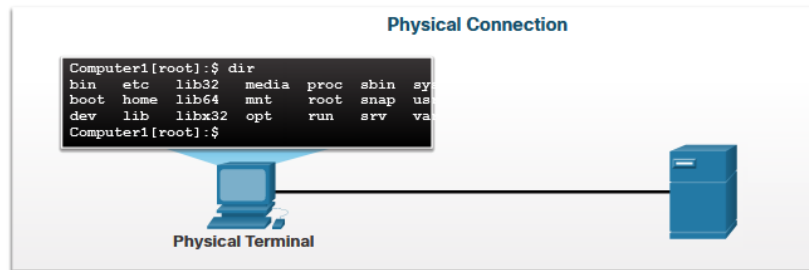# Video - Remote Access with Telnet or SSH

Telnet

Telnet provides a standard method of emulating text-based terminal devices over the data network.

Telnet servers listen for client requests on TCP port 23.

A connection using Telnet is called a virtual terminal (vty) session, or connection.
- Rather than using a physical device to connect to the server, Telnet uses software to create a virtual device that provides the same features of a terminal session with access to the server's command line interface (CLI).

The client is able to execute commands as if it were locally (physically) connected to the server.

Physical Connection

```
Computer1[root]:$ dir
bin   etc   lib32   media   proc   sbin   sy
boot  home  lib64   mnt     root   snap   us
dev   lib   libx32  opt     run    srv    va
Computer1[root]:$
```

Physical Terminal

Telnet

Telnet Client

```
Computer1[root]:$ dir
bin   etc   lib32   media   proc   sbin   sy
boot  home  lib64   mnt     root   snap   us
dev   lib   libx32  opt     run    srv    va
Computer1[root]:$
```

Virtual Terminal
IP Address 192.168.2.2

Network

Telnet Server

Security Issues with Telnet

After a Telnet connection is established, users can perform any authorized function on the server, just as if they were using a command line session on the server itself.

Although the Telnet protocol can require a user to login, it does not support transporting encrypted data.
- All data exchanged during Telnet sessions is transported as plaintext across the network.

The Secure Shell (SSH) protocol offers an alternate and secure method for server access.
SSH provides the structure for secure remote login and other secure network services.
- SSH provides stronger authentication than Telnet and supports transporting session data using encryption.
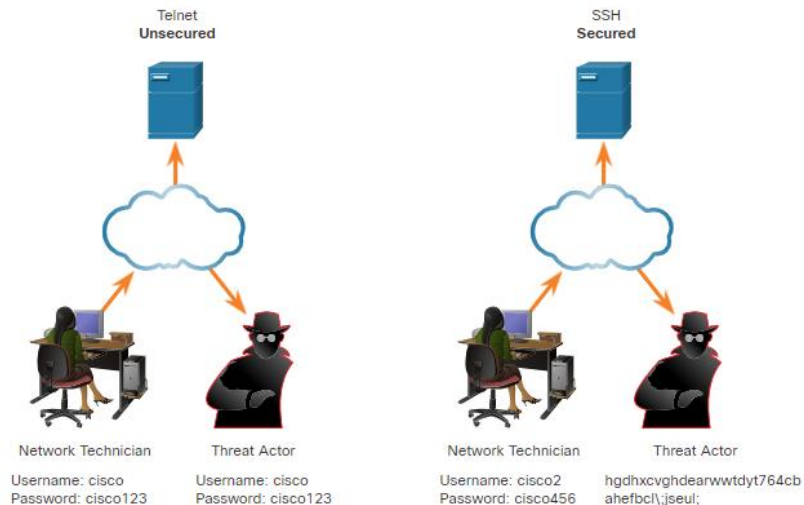
Packet Tracer – Use Telnet and SSH

In this activity, you will establish remote session to a router using Telnet and SSH.
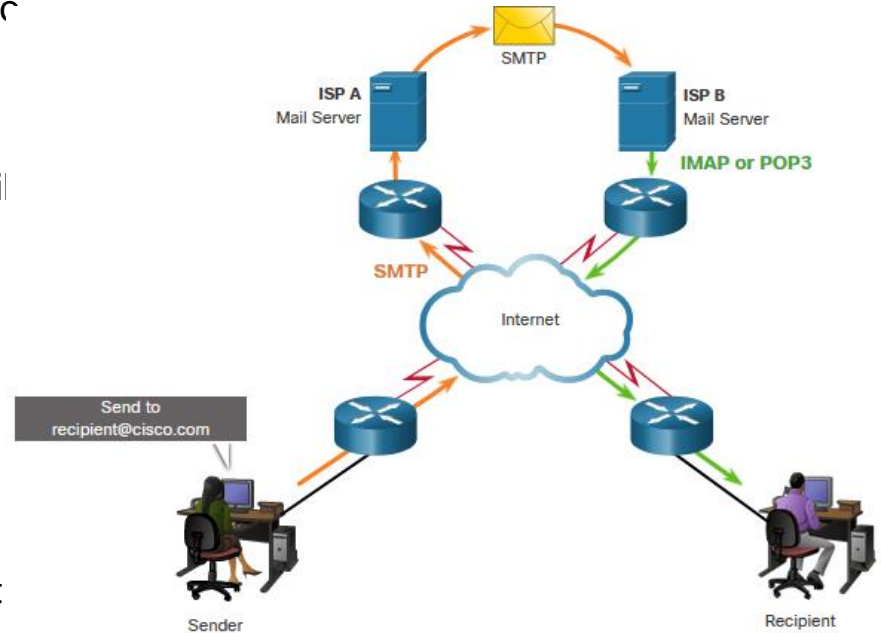
12.6 Email and Messaging

Email Clients and Servers

Email servers run server software that enables them to interact with clients and with other email servers over the network.

Various application protocols used in processing email include SMTP, POP3, and IMAP4.

Each mail server receives and stores mail for users who have mailboxes configured on the mail server.

- Mailboxes are identified by the format:
  user@company.domain

- Each user with a mailbox must use an email client to access the mail server and read these messages.

Email Protocols

**Simple Mail Transfer Protocol (SMTP)**
SMTP uses port 25 and is used by an email client to send messages to its local email server. The local server then decides if the message is destined for a local mailbox or if the message is addressed to a mailbox on another server.

Post Office Protocol (POP3)
A server that supports POP clients receives and stores messages addressed to its users. When the client connects to the email server, the messages are downloaded to the client. By default, messages are not kept on the server after they have been accessed by the client. Clients contact POP3 servers on port 110.

Internet Message Access Protocol (IMAP4)
A server that supports IMAP clients receives and stores messages addressed to its users. IMAP keeps the messages in the mailboxes on the server, unless they are deleted by the user. IMAP4 listens for client requests on port 143.

ISP A
Mail Server

SMTP Port 25

Internet

Sender
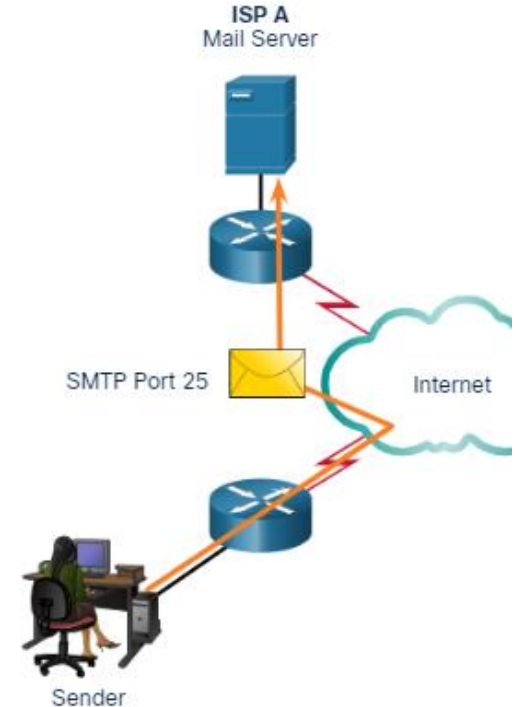
Text Messaging

- Enables users to communicate or chat over the internet in real-time
- May also be called instant messages, direct messages, private messages, and chat messages.
- Text messaging software is built into many online applications, smart phone apps, and social media sites.

Text messaging services on a computer are usually accessed through a web-based client that is integrated into a social media or information sharing site.

There are also a number of standalone text message clients such as Cisco Webex Teams, Microsoft Teams, WhatsApp, Facebook Messenger, and many others that support the transfer of documents, video, music, and audio files.
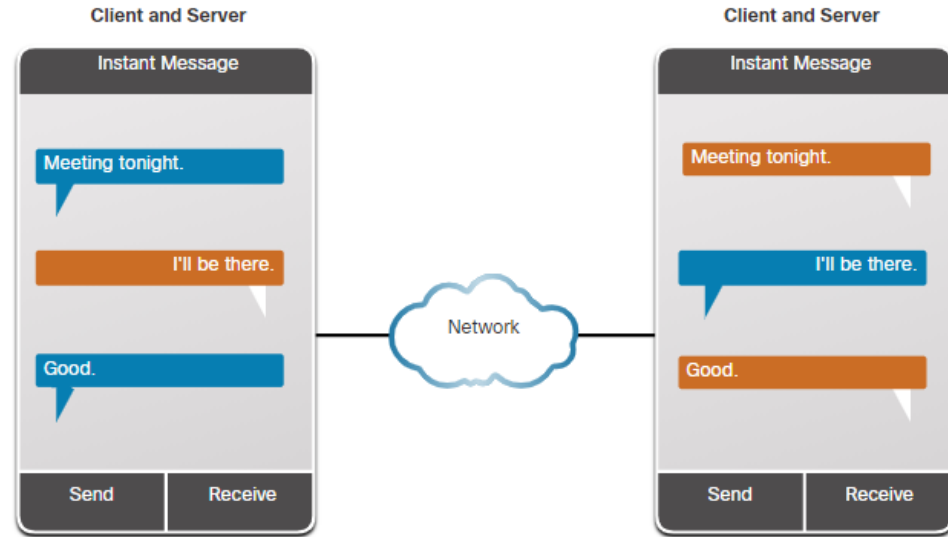
Internet Phone Calls

An internet telephony client uses peer-to-peer technology similar to that used by instant messaging.
- Protocols and destination ports used by internet telephony applications can vary.

IP telephony makes use of Voice over IP (VoIP) technology, which converts analog voice signals into digital data.
- Voice data is encapsulated into IP packets which carry the phone call through the network.

When the IP phone software has been installed, the user selects a unique name.
- A unique name allows calls to be received from other users.
- Calls are made to other users of the same service by selecting the username from a list.

A call to a regular telephone (landline or cell phone) requires using a gateway to access the Public Switched Telephone Network (PSTN) and depending on the service, there may be charges associated with this type of call.

12.7 Application Layer Services Summary

What Did I Learn in this Module?

The most common internet services such as internet searches, social media sites, video and audio streaming, on-line shopping sites, email and messaging rely on protocols from the TCP/IP protocol suite to reliably communicate the information between the clients and the servers.
- DNS, SSH, SMTP, POP, IMAP, DHCP, HTTP, & FTP

- Domain Name System (DNS) provides a way for hosts to use this name to request the IP address of a specific server.
    - DNS names are registered and organized on the internet within specific high level groups, or domains. Some of the most common high level domains on the internet are .com, .edu, and .net.
    - When a client has the name of server, such as a web server, but needs to find the IP address, it sends a request to the DNS server on port 53.

- When a web client receives the IP address of a web server, the client browser uses that IP address and port 80 to request web services.
    - This request is sent to the server using the Hypertext Transfer Protocol (HTTP).

What Did I Learn in this Module? (Cont.)

Requests for secure HTTP are sent to port 443 and they use **https** in the site address.

File Transfer Protocol (FTP) provides an easy method to transfer files from one computer to another.
- Control connection requests are sent to the server using destination TCP port 21.
- The server uses TCP port 20 to transfer the data files.

Telnet provides a standard method of emulating text-based terminal devices over the data network.
- Both the protocol itself and the client software that implements the protocol are commonly referred to as Telnet.
- Telnet servers listen for client requests on TCP port 23.
- Secure Shell (SSH) protocol offers an alternate and secure method for server access

Email servers run server software that enables them to interact with clients and with other email servers over the network.
- Various application protocols used in processing email include SMTP, POP3, and IMAP4.

Module 12 – New Terms and Commands

- DNS
- SSH
- SMTP
- POP
- IMAP
- DHCP
- HTTP
- FTP
- HTTP
- HTTPS

- HTML
- FTP
- Telnet
- VTY
- CLI
- SMTP
- POP3
- IMAP4
- VoIP
- PSTN