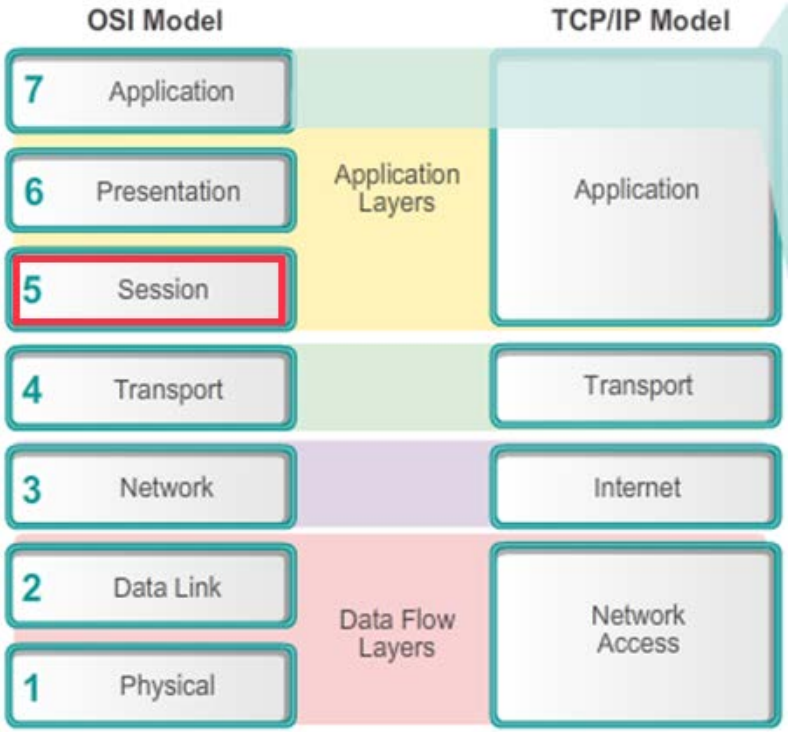
Chapter 10:
Application Layer

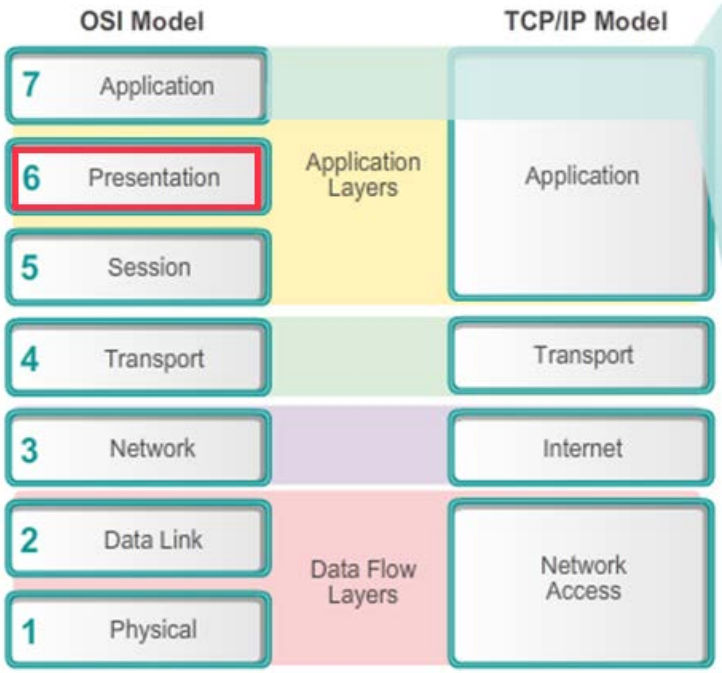
Presentation and Session Layers

- **Session layer**
  - Functions, creates, and maintains dialogs between source and destination applications
  - Handles the exchange of information between applications



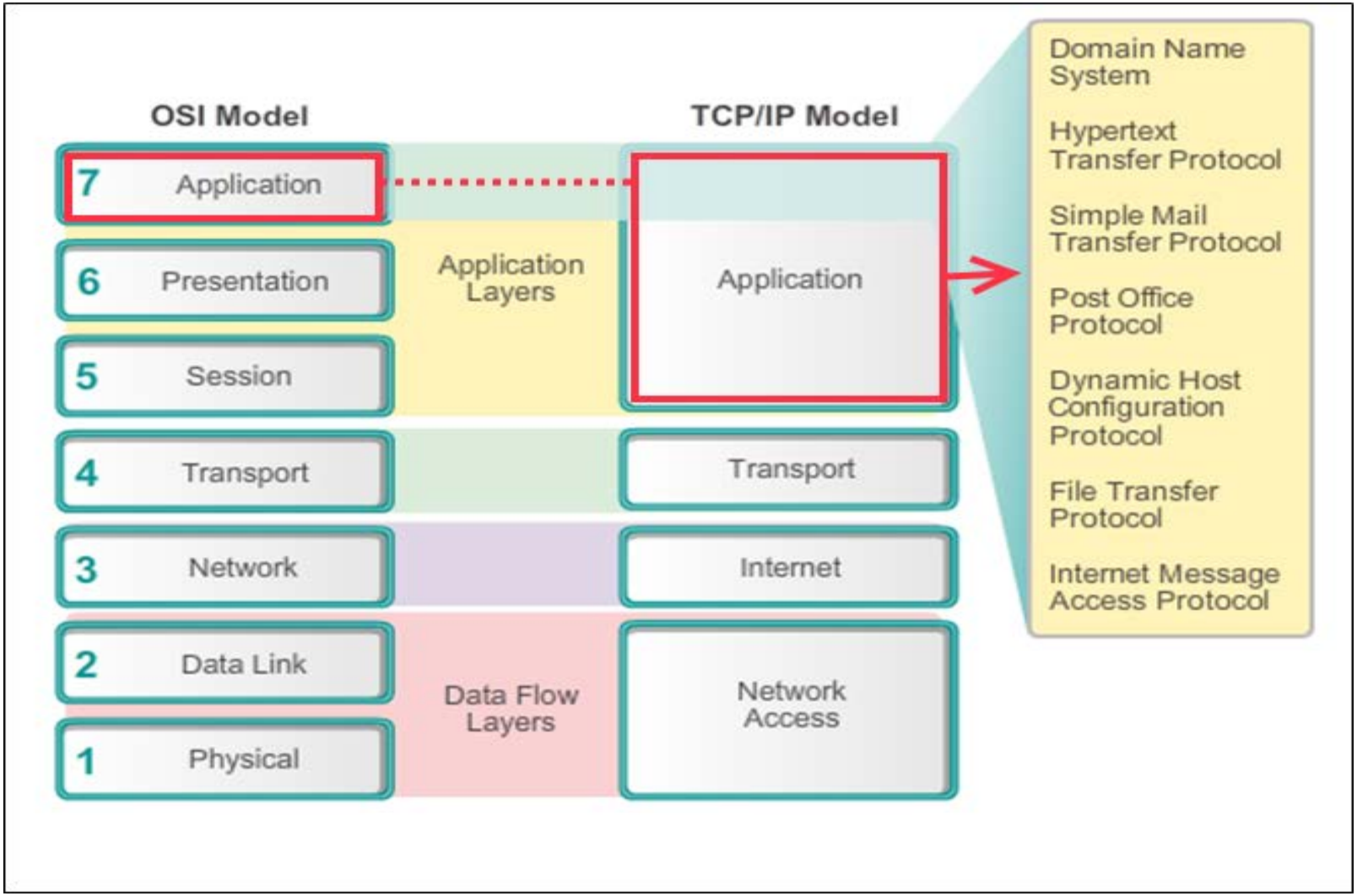
Presentation and Session Layers

- **Presentation layer**
  - Coding and conversion of application layer data
  - Data compression
  - Data encryption



Application Session and Presentation

Application Layer



TCP/IP Application Layer Protocols

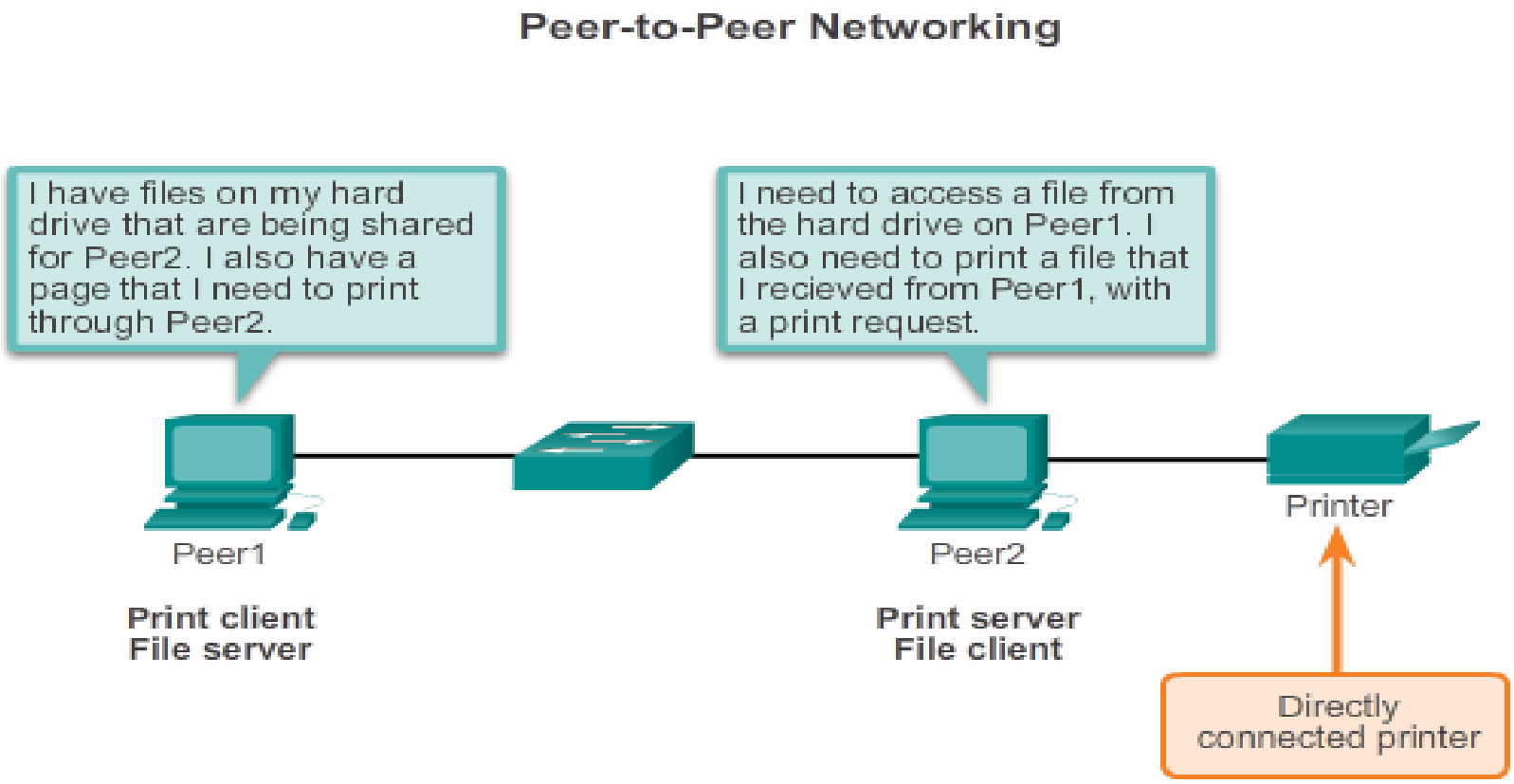
- **Domain Name Service Protocol (DNS)** – is used to resolve Internet names to IP addresses
- **Telnet** – a terminal emulation protocol used to provide remote access to servers and networking devices
- **Bootstrap Protocol (BOOTP)** – a network protocol used to obtain IP address information during bootup
- **Dynamic Host Control Protocol (DHCP)** – used to assign an IP address, subnet mask, default gateway and DNS server to a host
- **Hypertext Transfer Protocol (HTTP)** – used to transfer files that make up the Web pages of the World Wide Web

Application, Session and Presentation

TCP/IP Application Layer Protocols (cont.)

- **File Transfer Protocol (FTP)** - used for interactive file transfer between systems
- **Trivial File Transfer Protocol (TFTP)** - used for connectionless active file transfer
- **Simple Mail Transfer Protocol (SMTP)** - used for the transfer of mail messages and attachments
- **Post Office Protocol (POP)** - used by email clients to retrieve email from a remote server
- **Internet Message Access Protocol (IMAP)** – another protocol for email retrieval

Peer-to-Peer Networks



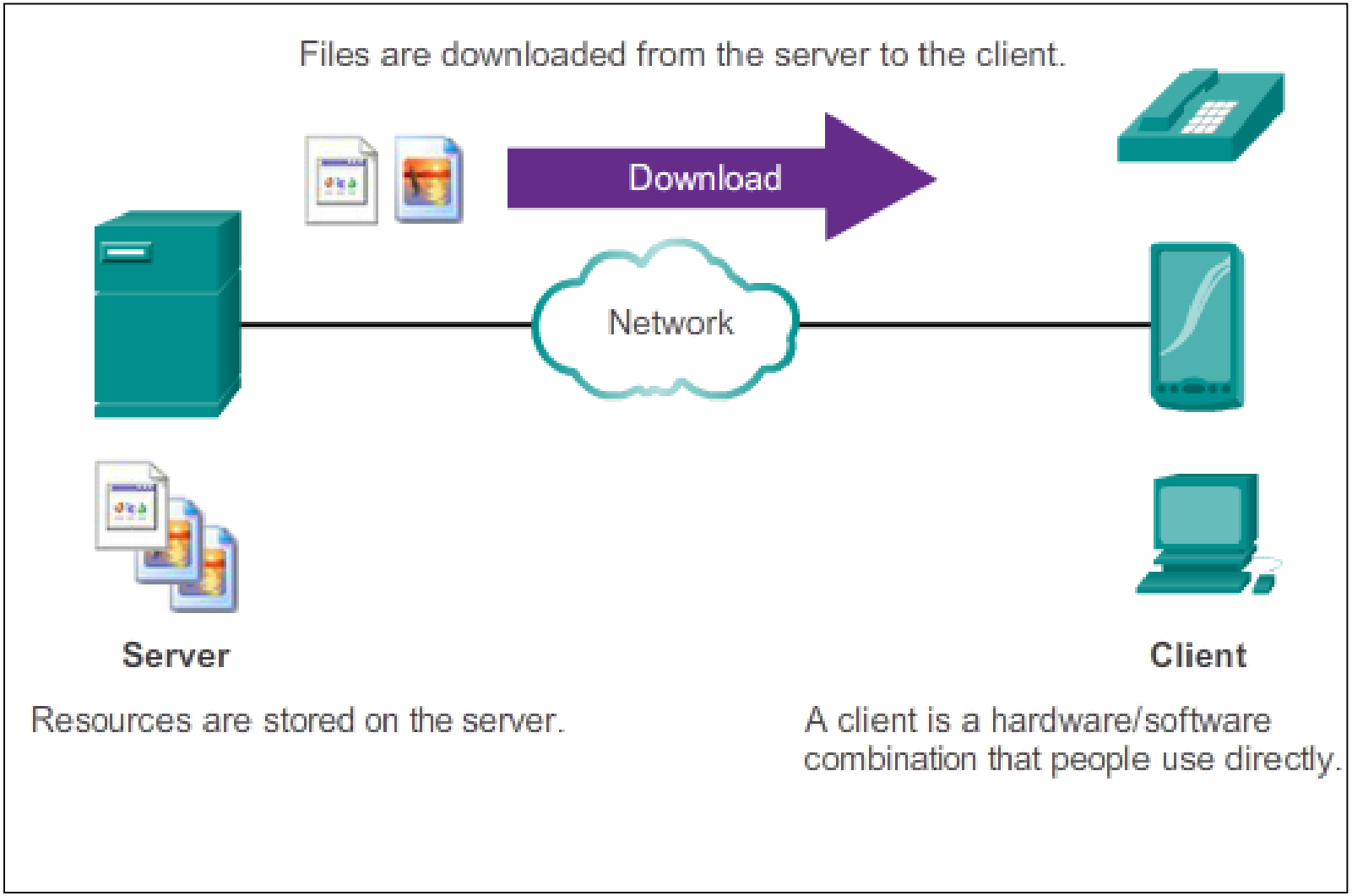
Both devices are considered equal in the communication.
The roles of client and server are set on a per request basis.

Common P2P Applications

- With P2P applications, each computer in the network running the application can act as a client or a server for the other computers in the network running the application.
- Common P2P applications include:
  - eDonkey
  - eMule
  - Shareaza
  - BitTorrent
  - Bitcoin
  - LionShare

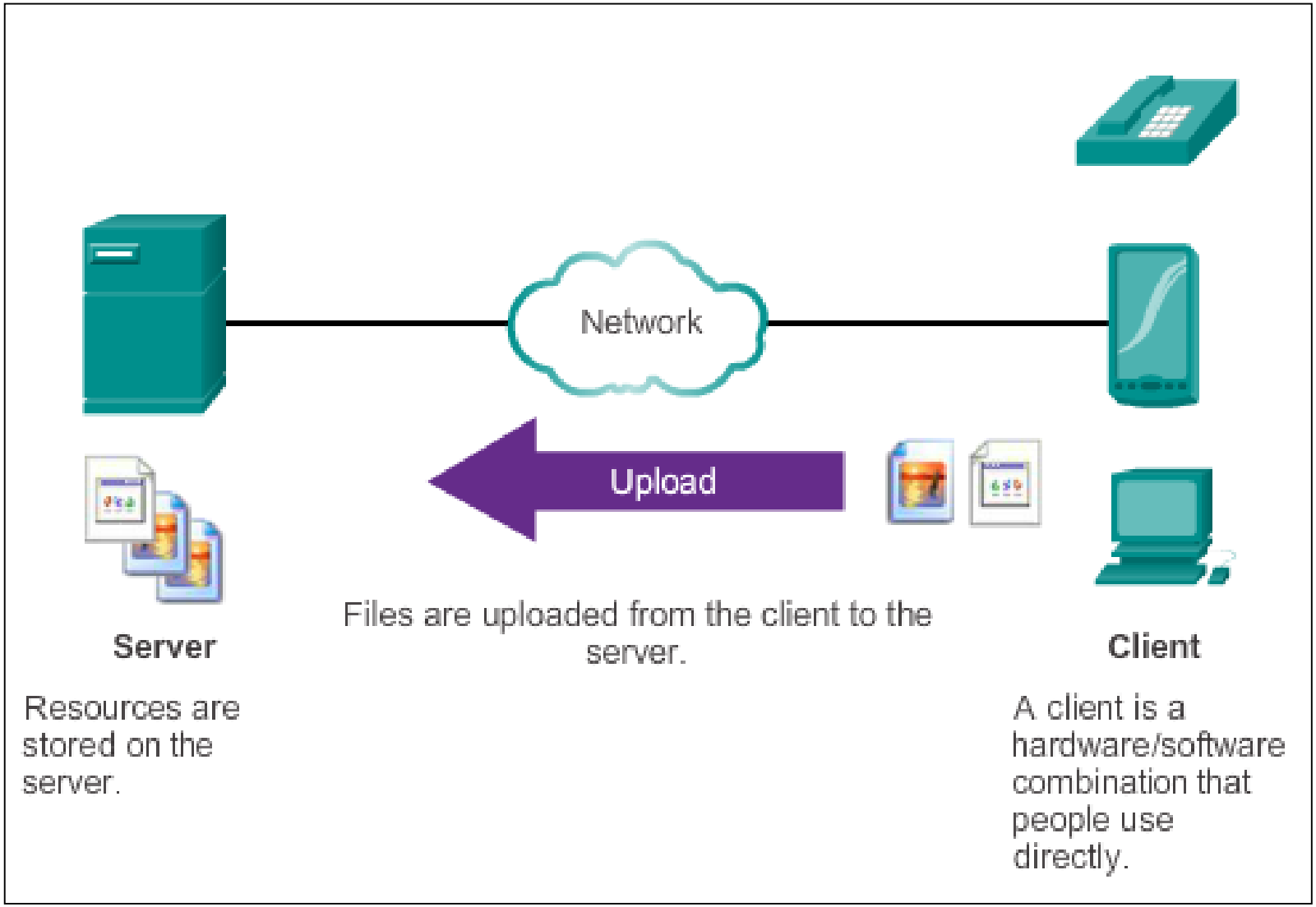
How Application Protocols Interact with End-User Applications

Client-Server Model



How Application Protocols Interact with End-User Applications

Client-Server Model



Hypertext Transfer Protocol and Hypertext Markup Language

Example URL: http://www.cisco.com/index.html

1. First, the browser interprets the three parts of the URL:
   - **http** (the protocol or scheme)
   - **www.cisco.com** (the server name)
   - **index.html** (the specific file name requested)
2. Browser checks with a name server to convert **www.cisco.com** into a numeric address
3. Using the HTTP protocol requirements sends a GET request to the server and asks for the file **index.html**
4. Server sends the HTML code for this web page
5. Browser deciphers the HTML code and formats the page

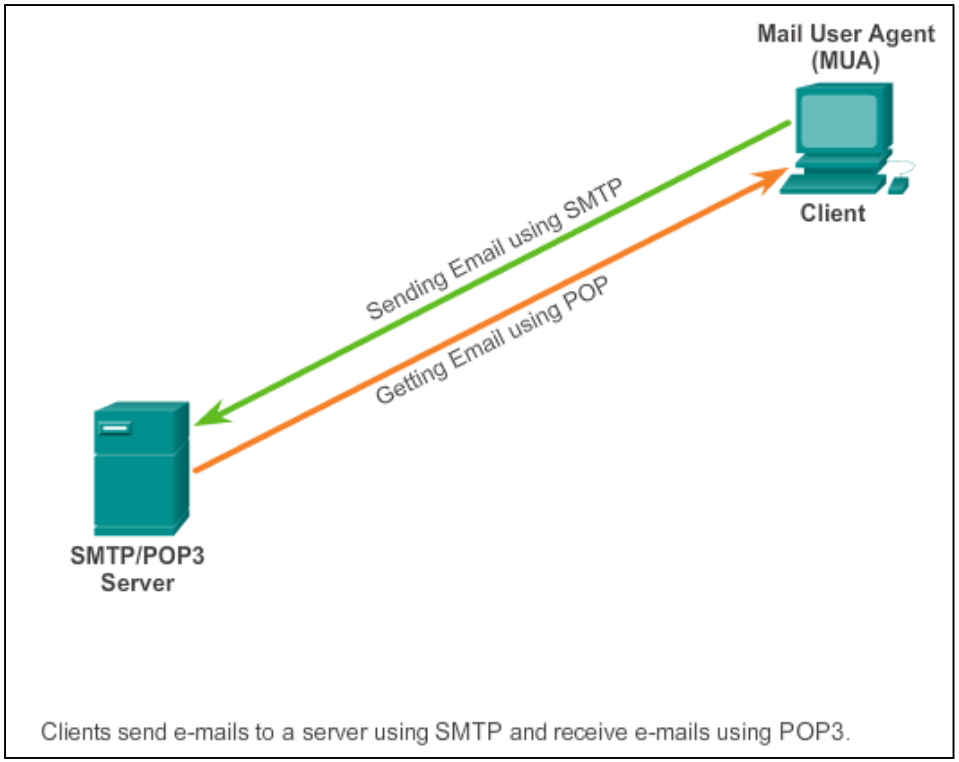
HTTP and HTTPS

- Developed to publish and retrieve HTML pages
- Used for data transfer
- Specifies a request/response protocol
- Three common message types are GET, POST, and PUT
- GET is a client request for data
- POST and PUT are used to send messages that upload data to the web server

Common Application Layer Protocols

SMTP, POP, and IMAP

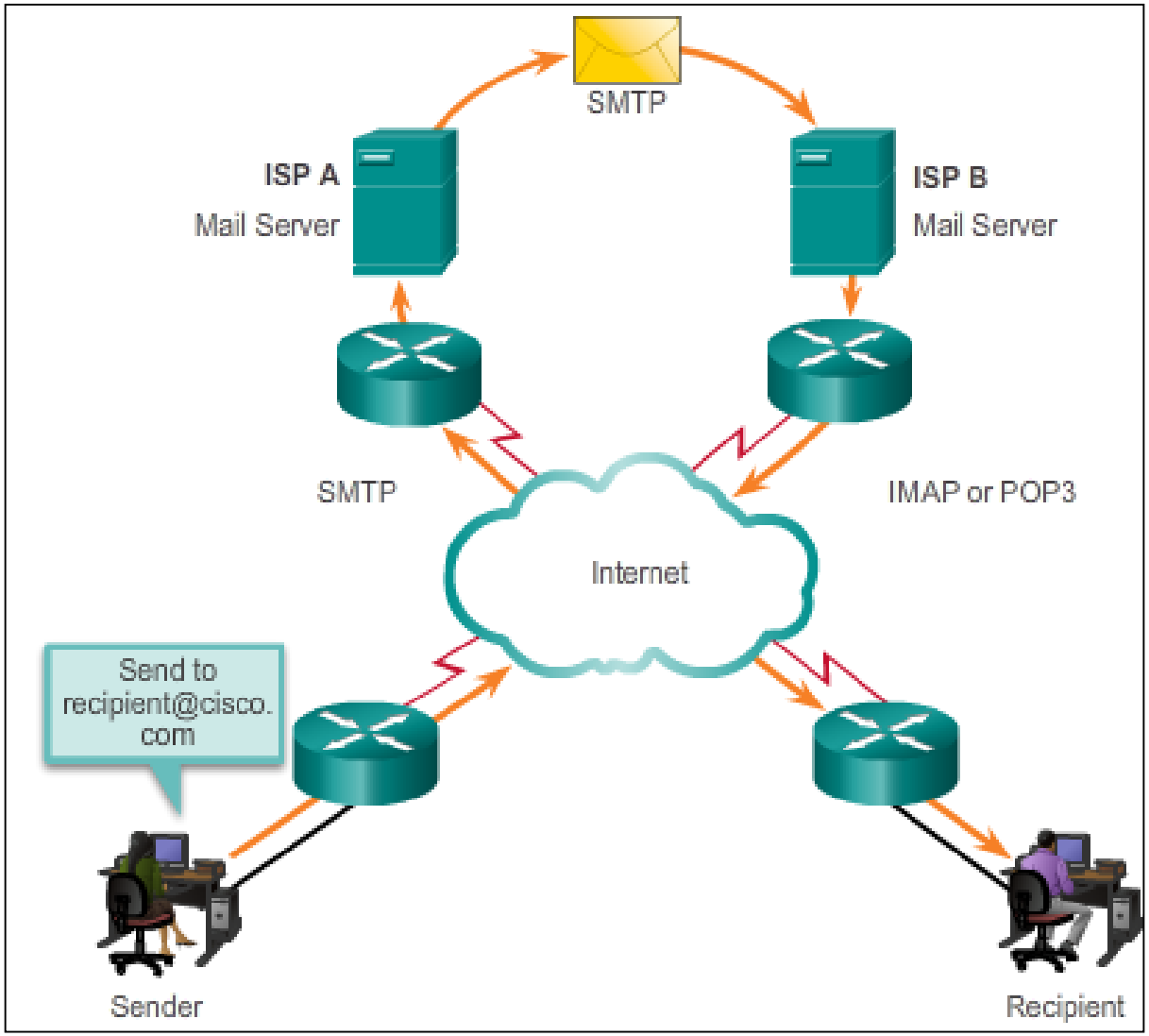
- Uses an application called a Mail User Agent (email client)
- Allows messages to be sent
- Places received messages into the client's mailbox
- SMTP - Send email from either a client or a server
- POP - Receive email messages from an email server
- IMAP - Internet Message Access Protocol
- Email client provides the functionality of both protocols within one application



Clients send e-mails to a server using SMTP and receive e-mails using POP3.

Common Application Layer Protocols

SMTP, POP, and IMAP (cont.)



SMTP, POP, and IMAP (cont.)

Simple Mail Transfer Protocol (SMTP)

- transfers mail
- message must be formatted properly
- SMTP processes must be running on both the client and server
- message header must have a properly formatted recipient email address and a sender
- uses port 25

SMTP, POP, and IMAP (cont.)

Post Office Protocol (POP)

- enables a workstation to retrieve mail from a mail server
- mail is downloaded from the server to the client and then deleted on the server
- uses port 110
- POP does not store messages
- POP3 is desirable for an ISP, because it alleviates their responsibility for managing large amounts of storage for their email servers

Everyday Application Layer Protocols

SMTP, POP, and IMAP (cont.)

MDA – Mail Delivery Agent

- MDA accepts a piece of email from MTA and performs the actual delivery.
- MDA receives all the inbound mail from the MTA and places it into mailboxes.
- MDA can also resolve final delivery issues, such as virus scanning, spam filtering, and return-receipt handling.

(MTA – Mail Transfer Agent)

Common Application Layer Protocols

SMTP, POP, and IMAP (cont.)

Simple Mail Transfer Protocol (SMTP)

- Transfers mail reliably and efficiently

Post Office Protocol (POP)

- Enables a workstation to retrieve mail from a mail server
- With POP, mail is downloaded from the server to the client and then deleted on the server

SMTP, POP, and IMAP (cont.)

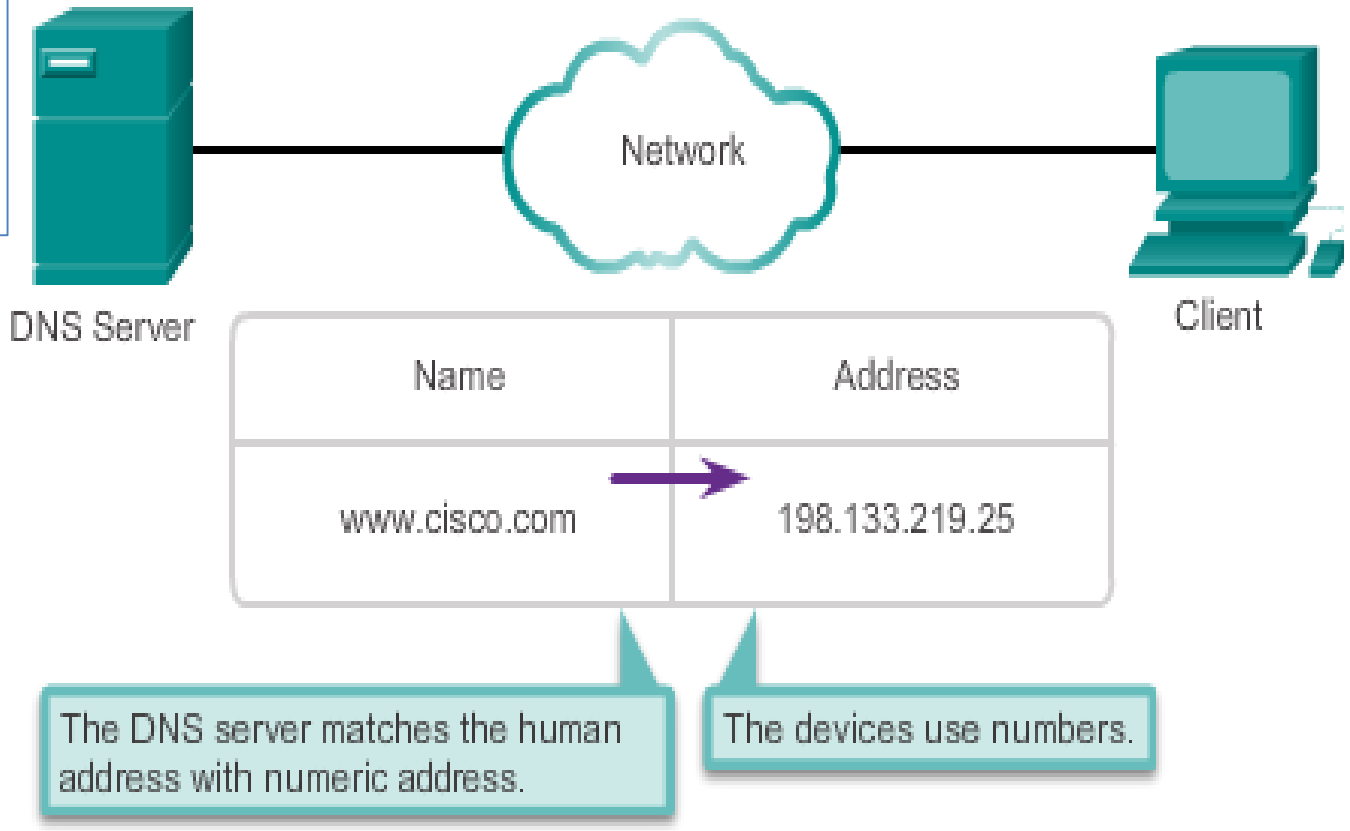
Internet Message Access Protocol (IMAP)

- Another protocol that to retrieves email messages
- Unlike POP, when the user connects to an IMAP-capable server, copies of the messages are downloaded to the client application
- Original messages are kept on the server until manually deleted

Providing IP Addressing Services

Domain Name Service

A human legible name is resolved to its numeric network device address by the DNS protocol.



DNS (Domain Name Service) Message Format

- DNS server stores different types of resource records used to resolve names
- It contains the name, address, and type of record.
- Record types are:
  - **A** – An end device address
  - **NS** – An authoritative name server
  - **CNAME** – The canonical name for an alias; used when multiple services have the single network address, but each service has its own entry in DNS
  - **MX** – Mail exchange record; maps a domain name to a list of mail exchange servers
- If it is not able to resolve the name using its stored records, it contacts other servers.
- Server temporarily stores the numbered address that matches the name in cache memory.
- Windows **ipconfig /displaydns** displays all cached DNS.

Providing IP Addressing Services

DNS Hierarchy

Examples top-level domains:

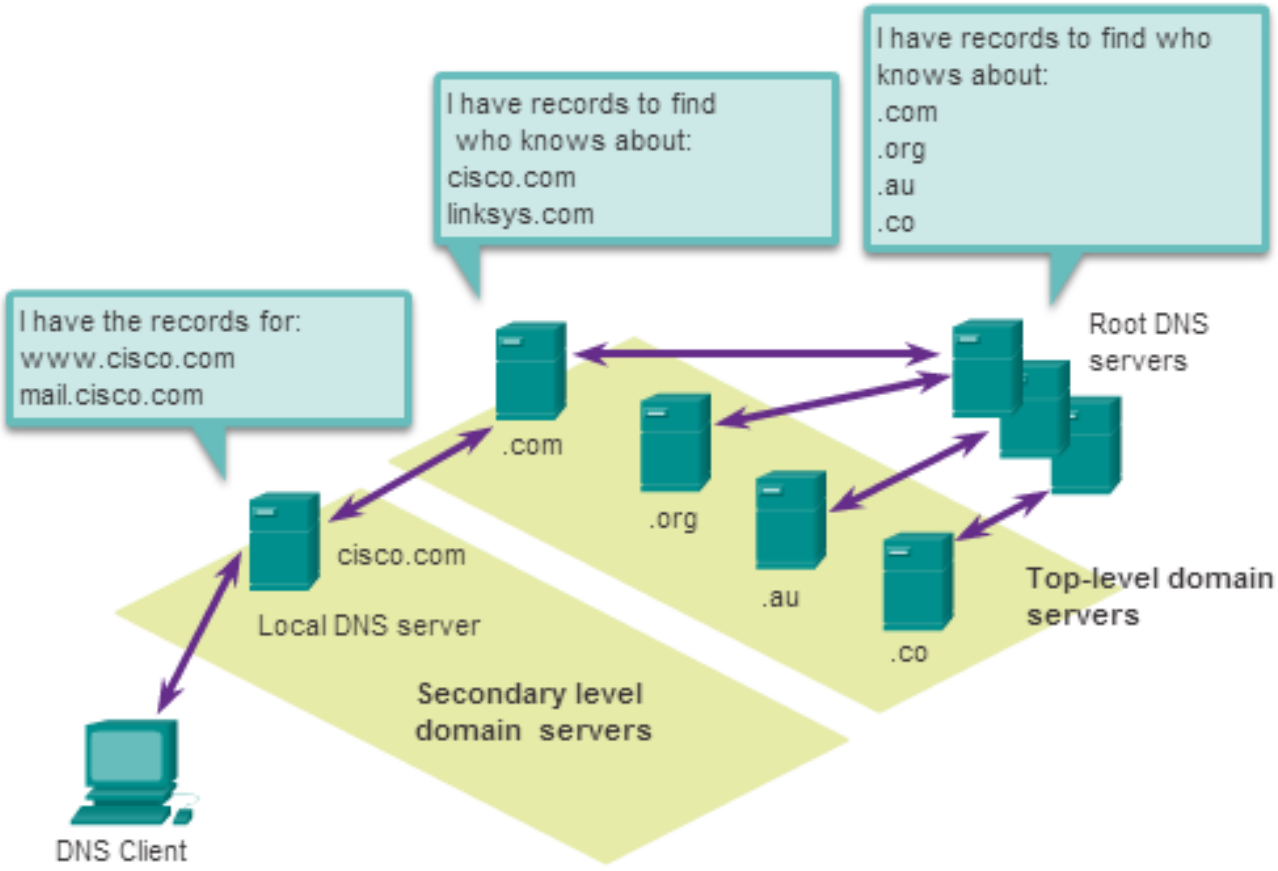
.au - Australia

.co - Colombia

.com - business or industry

.jp - Japan

.org - non-profit organization

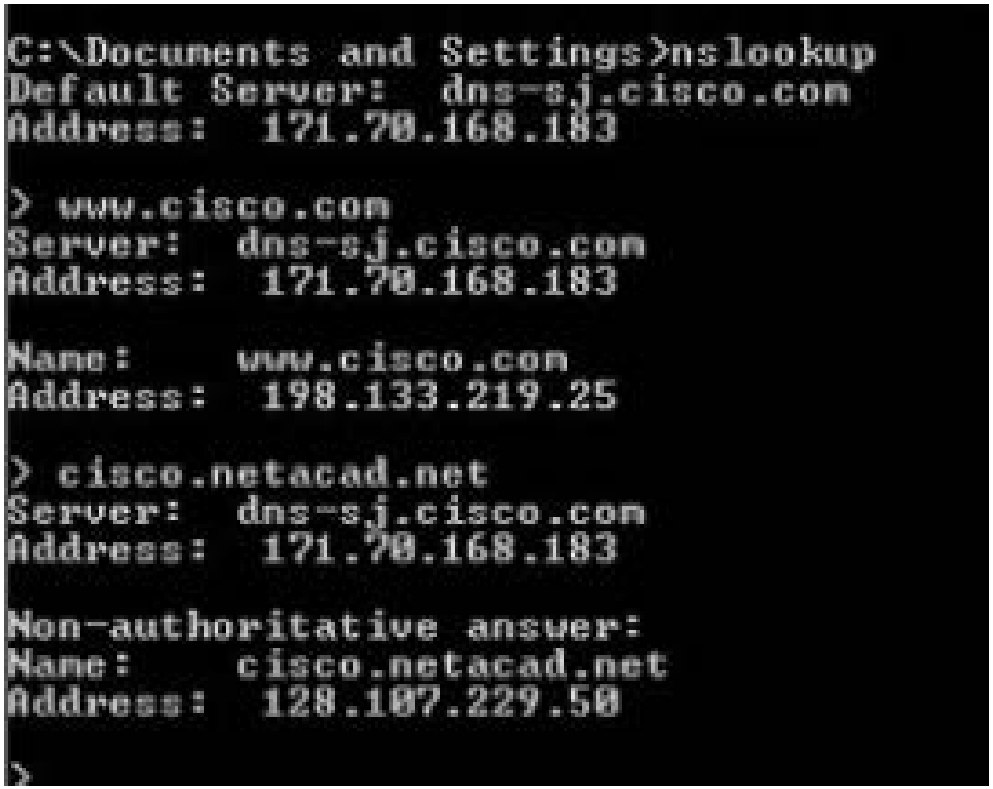


A hierarchy of DNS servers contains the resource records that match names with addresses.

Providing IP Addressing Services

nslookup (CLI command)

- Operating system utility ‘nslookup’ allows user to manually query the name servers to resolve a given host name
- Utility can be used to troubleshoot name resolution issues and to verify the current status of the name servers



Dynamic Host Configuration Protocol (DHCP)

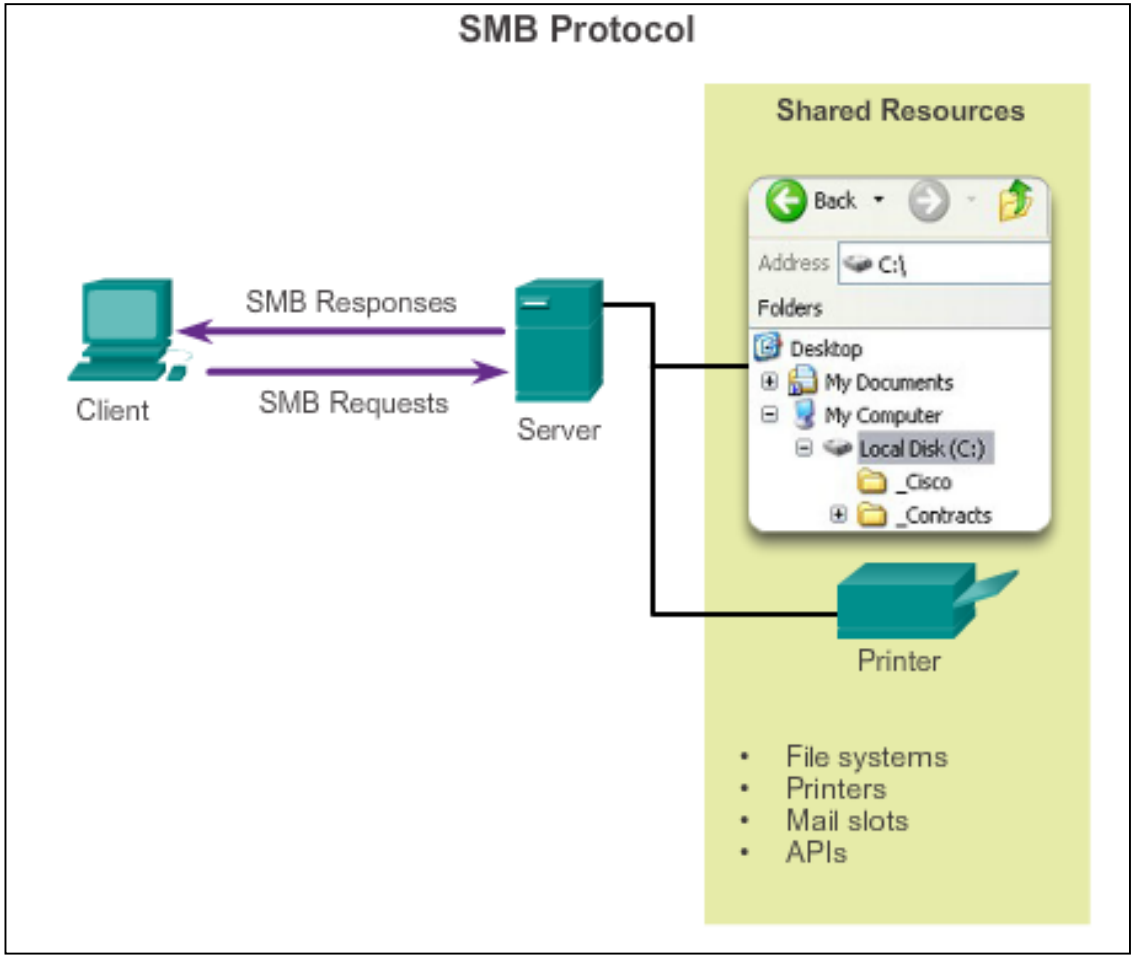
- DHCP allows a host to obtain an IP address dynamically.
- DHCP server is contacted and address requested
- DHCP is used for general purpose hosts such as end user devices,
- static addressing is used for network devices such as gateways, switches, servers and printers.

File Transfer Protocol (FTP)

- FTP allow data transfers between a client and a server.
- runs on a computer that is used to push and pull data from a server running an FTP daemon.
- FTP requires two connections between the client and the server,
  - one for commands and replies,
  - the other for the actual file transfer.

Server Message Block (SMB)

- Clients establish a long term connection to servers.
- Once connection is established, the user can access the resources on the server.

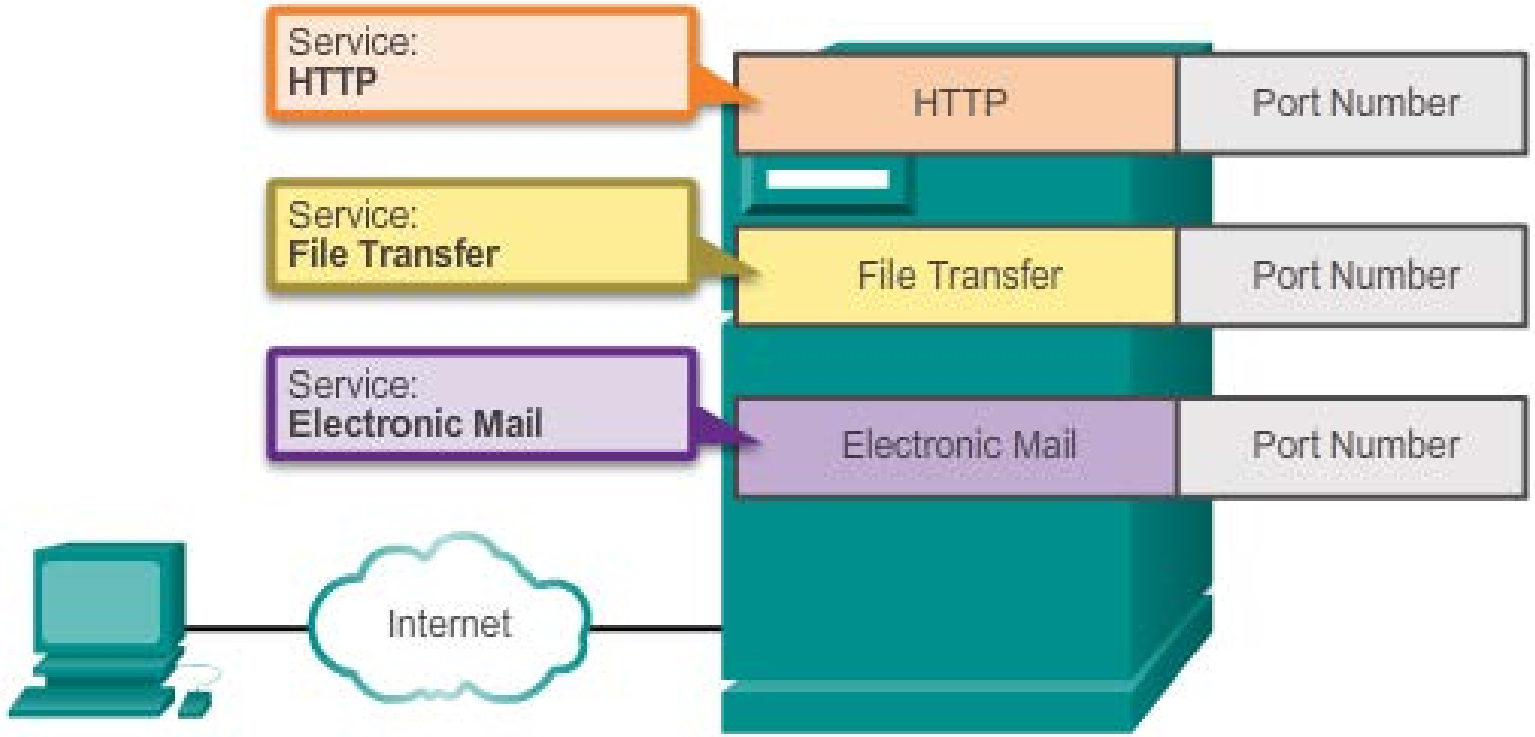


SMB is a client-server, request-response protocol. Servers can make their resources available to clients on the network.

Server Message Block (cont.)

A file may be copied from PC to PC with Windows Explorer using the SMB protocol.

Getting the Data to the Right Application



At the end device, the service port number directs the data to the correct conversation.