Introduction to Computer Networking
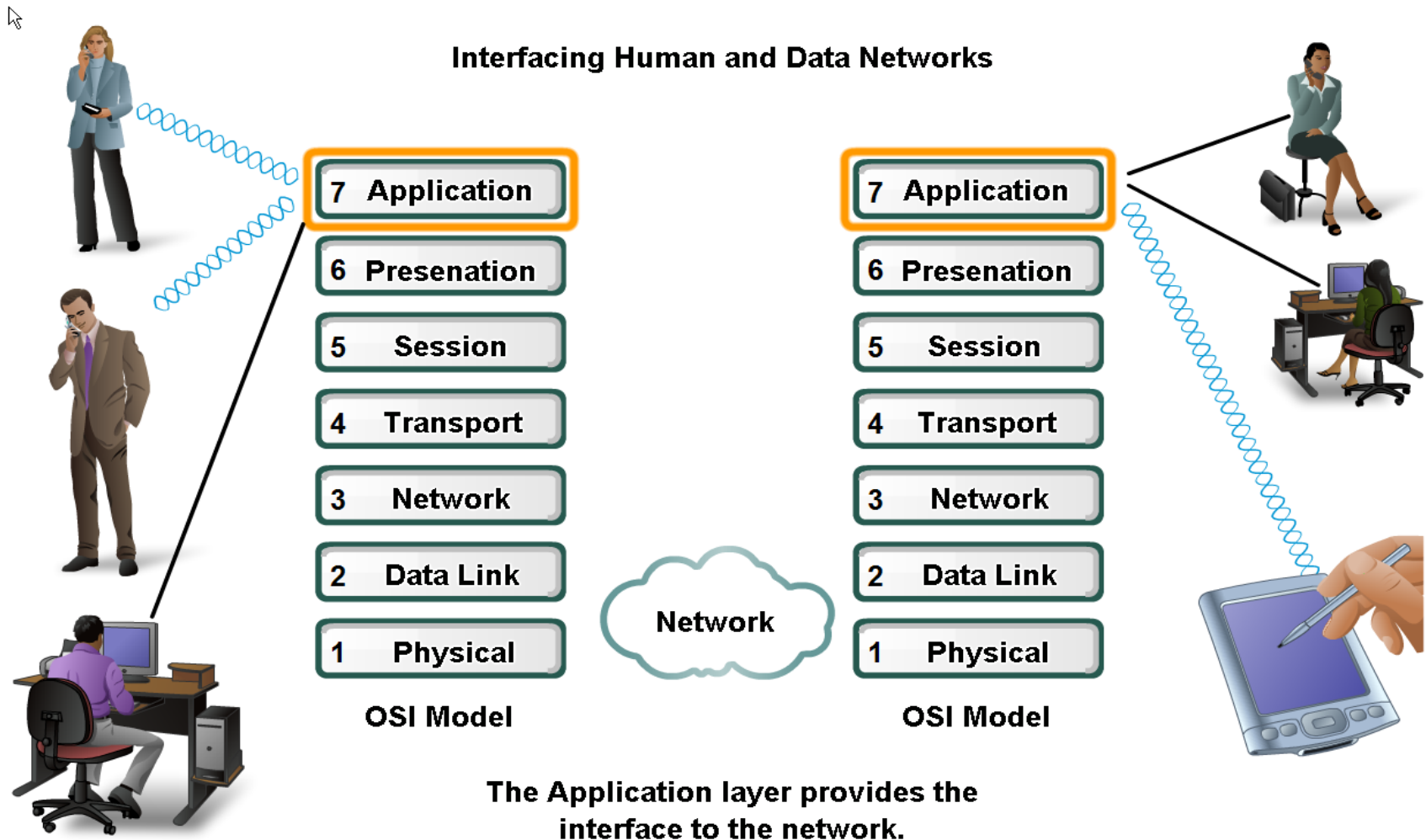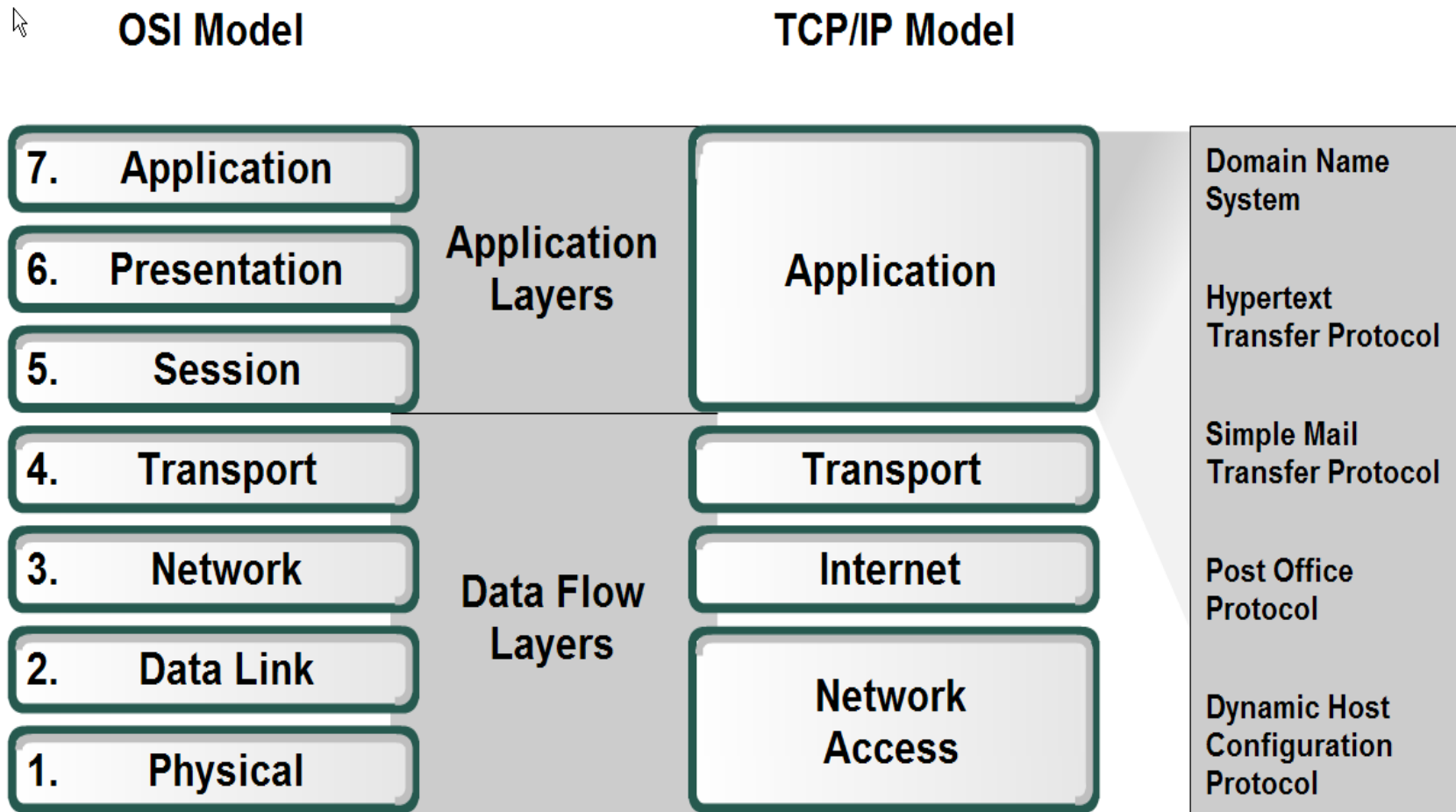
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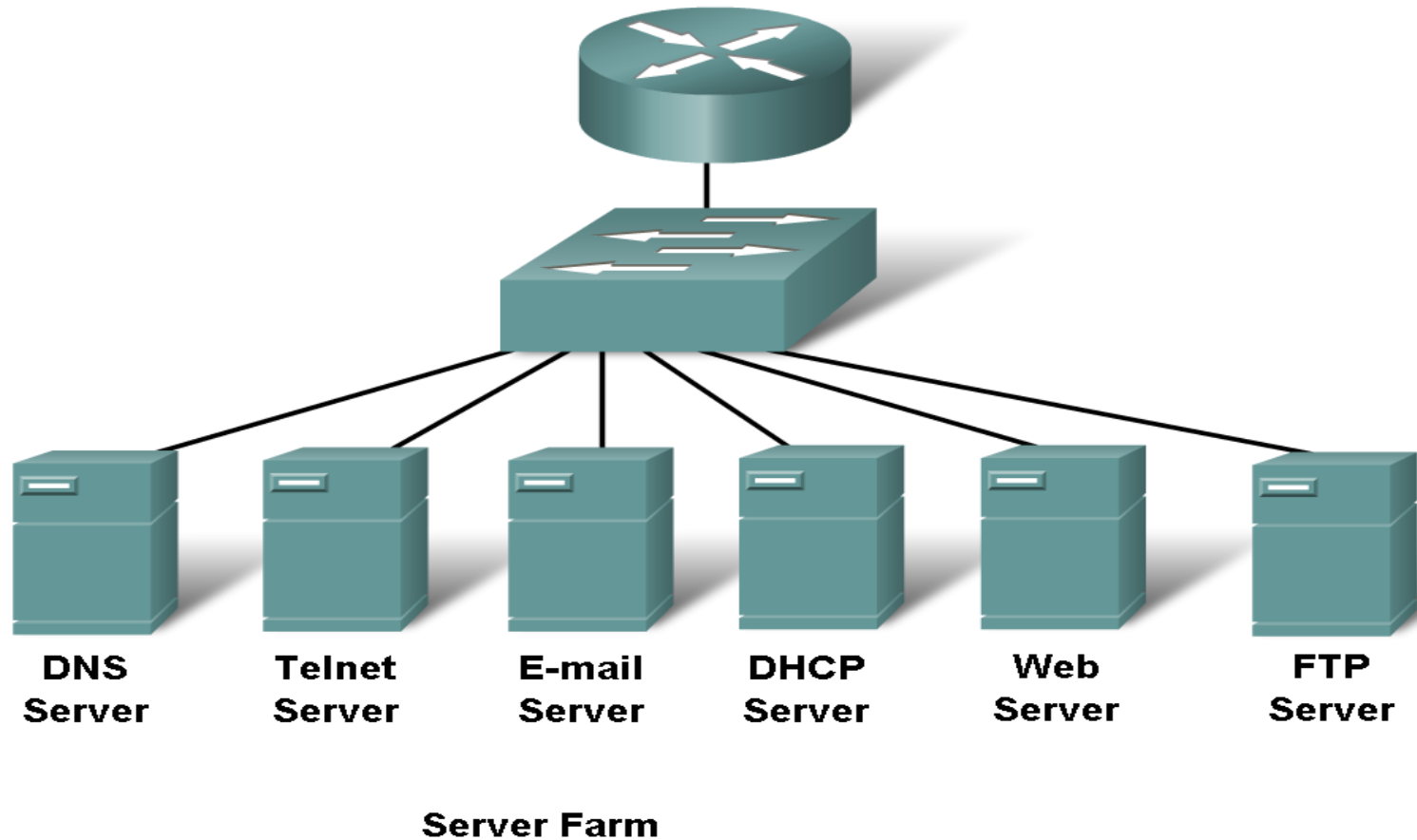
Applications Layer – allows user to interface with the network!

Interfacing Human and Data Networks

OSI Model
7 Application
6 Presenation
5 Session
4 Transport
3 Network
2 Data Link
1 Physical

Network

OSI Model
7 Application
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The Application layer provides the interface to the network.

Application Layer – Provides the interface between the applications on either end of the network.

OSI Model

TCP/IP Model

OSI Model		TCP/IP Model	
7. Application	Application Layers	Application	Domain Name System
6. Presentation			
5. Session			Hypertext Transfer Protocol
4. Transport	Data Flow Layers	Transport	Simple Mail Transfer Protocol
3. Network		Internet	Post Office Protocol
2. Data Link		Network Access	Dynamic Host Configuration Protocol
1. Physical			

Protocols and networks

DNS Server   Telnet Server   E-mail Server   DHCP Server   Web Server   FTP Server

Server Farm

Protocols

DNS – Matches domain names with IP addresses

HTTP – Used to transfer data between clients/servers using a web browser

SMTP & POP3 – used to send email messages from clients to servers over the internet

FTP – allows the download/upload of files between a client/server.

Telnet – allows users to login to a host from a remote location and take control as if they were sitting at the machine (virtual connection)

DHCP – assigns IP addresses, subnet masks, default gateways, DNS servers, etcs. To users as they login the network

Client/Server Model

Client –

device requesting information (initiates the data exchange), Can also UPLOAD data to the servers

Server – device responding to the request

How does it handle multiple request from multiple users and keep everything in order?

Relies on support from the lower layer functions to distinguish between services and conversations.

Server relies on a service called a server daemon – runs in the background and 'listens' for requests for that service. It can then exchange messages as appropriate & send requested data.

Examples:

E-mail Client on an employee computer issues a request to the e-mail server for any unread e-mail. The server responds by sending the e-mail to the client. Conversations can originate with either party.

Peer-to-Peer (P2P) Network Model

Two or more computers are connected and are able to share resources **without having a dedicated server**
Every end device can function as a client or server on a 'per request' basis.
Resources are decentralized (information can be located anywhere).

Difficult to enforce security and policies.
User accounts and access rights have to be set individually on each peer device.

P2P Applications

Running applications in hybrid mode allows for a centralized directory of files even though the files themselves may be on multiple machines.
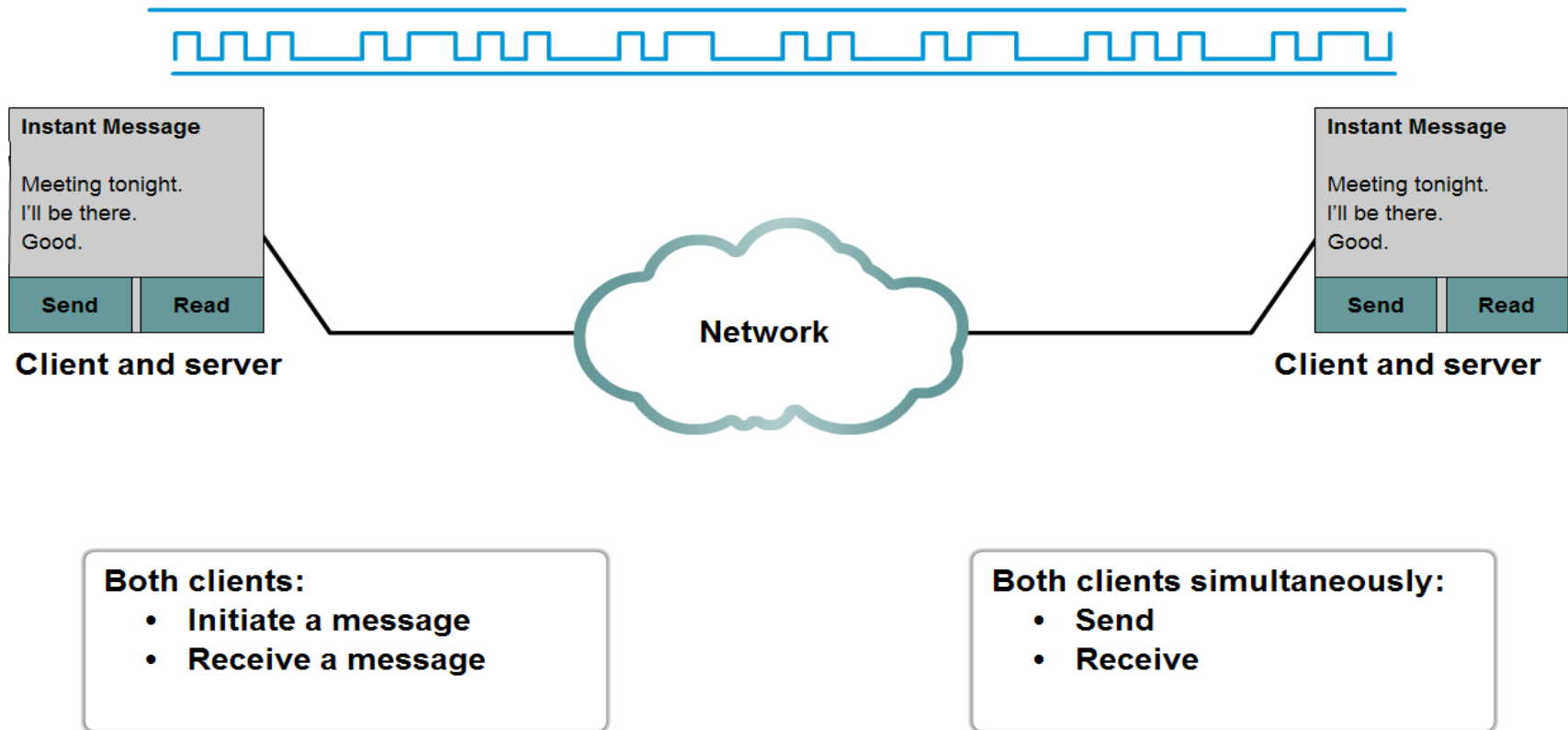Unlike P2P networks, a device can act as both the client and server within the same communication.

Each device must provide a user interface and run a background service.
Can be used on P2P networks, client/server networks and across the internet.

P2P Applications Example

Peer-to-Peer Applications

Client and server in the same communication

Instant Message

Meeting tonight.
I'll be there.
Good.

Send   Read

Client and server

Network

Instant Message

Meeting tonight.
I'll be there.
Good.

Send   Read

Client and server

Both clients:
- **Initiate a message**
- **Receive a message**

Both clients simultaneously:
- **Send**
- **Receive**

E-mail services and SMTP/POP protocols

E-mail is the most popular network service.
E-mail client (when people compose e-mail) is called Mail User Agent (MUA).
MUA allows messages to be sent/retrieved to and from your mailbox.
Requires several applications and services

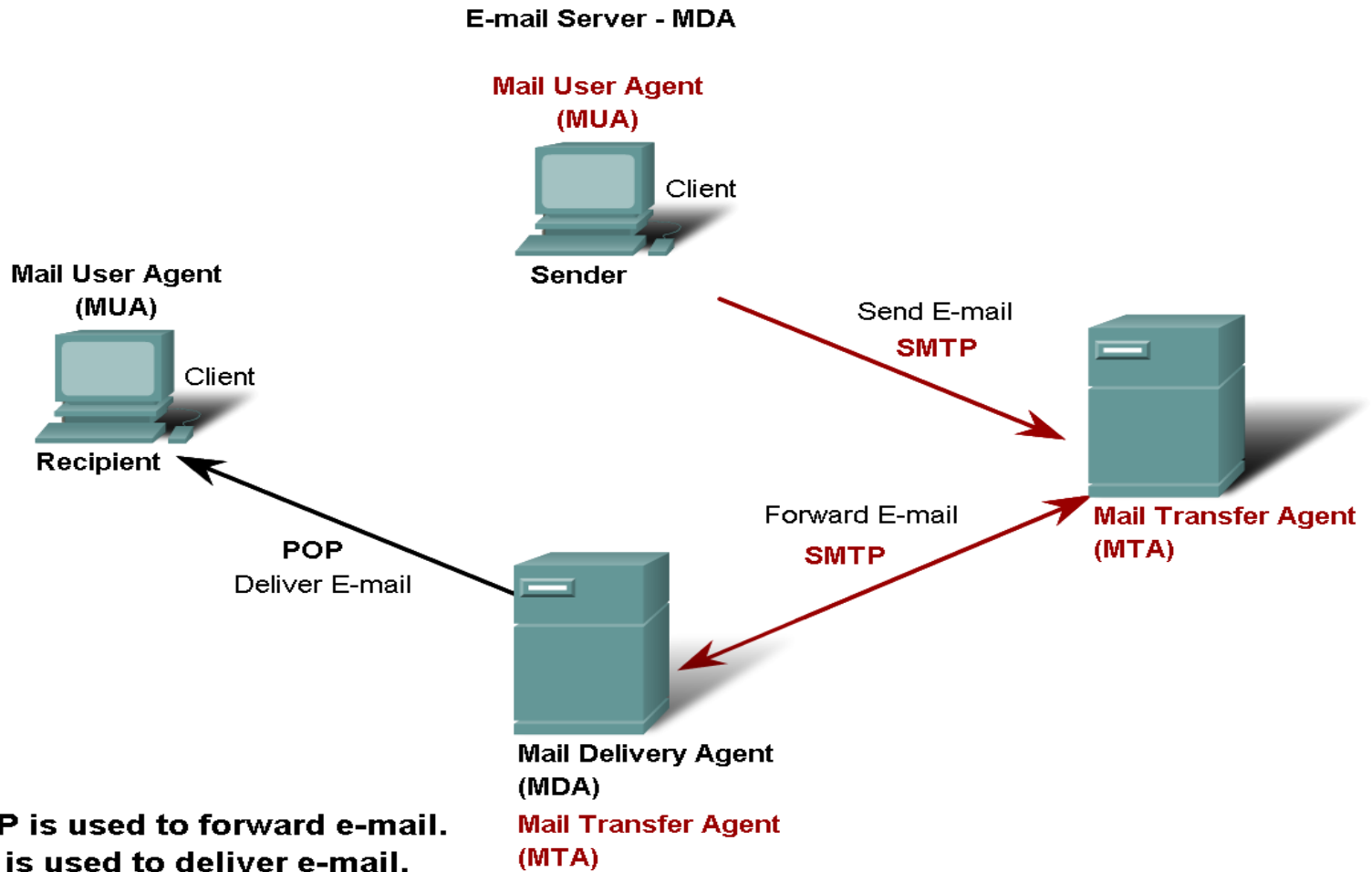 POP or POP3 – deliver email from server to client (incoming messages)
  SMTP – handles outbound messages from clients

E-mail services and SMTP/POP protocols

What do servers require?

1) Must be running SMTP!
2) Also operates
    1) Mail Transfer Agent (MTA) – used to forward email
        1) Receives email from the clients MUA
        2) Uses SMTP to route email between SERVERS!
        3) Passes email to the MDA for final delivery
    2) Mail Delivery Agent (MDA) – receives messages from MUA or from the MTA on another server
3) For two e-mail servers to talk – MUST run SMTP and MTA in order to transfer mail between the 2 servers!
4) Some clients run Lotus Notes, Groupwise, or MS Exchange. They have their own proprietary protocol for handling e-mail.

E-mail services and SMTP/POP protocols

E-mail Server - MDA

Mail User Agent (MUA)

Client

Sender

Send E-mail
SMTP

Mail User Agent (MUA)

Client

Recipient

POP
Deliver E-mail

Forward E-mail
SMTP

Mail Transfer Agent (MTA)

Mail Delivery Agent (MDA)

Mail Transfer Agent (MTA)

SMTP is used to forward e-mail.
POP is used to deliver e-mail.

DHCP

Dynamic Host Configuration Protocol – enables devices to obtain IP addresses, subnet masks, gateways, DNS server information, etc. from a DHCP server.
An IP address that is not being used is assigned from a range of available addresses
Not permanently assigned – only leased for a specific period of time (usually 24 hours – 7 days)
If the host logs off or the power is lost, the IP address they were using is returned to the pool to be re-assigned to another host when needed.
This is how you are able to use Wi-Fi at various places in the world!
Don't use DHCP for devices such as servers, printers, routers, switches, etc. These should be statically assigned.

Telnet

Developed in the early 1970's – among the oldest of the application layer protocols and services in the TCP/IP protocol suite.

Allows users to emulate text-based terminal devices over the network using software.

A connection is known as a 'virtual terminal (vty)' session.

Can be run from the command prompt on a PC.

You can use the device as if you were sitting there with all the rights and priorities that you username will offer you.
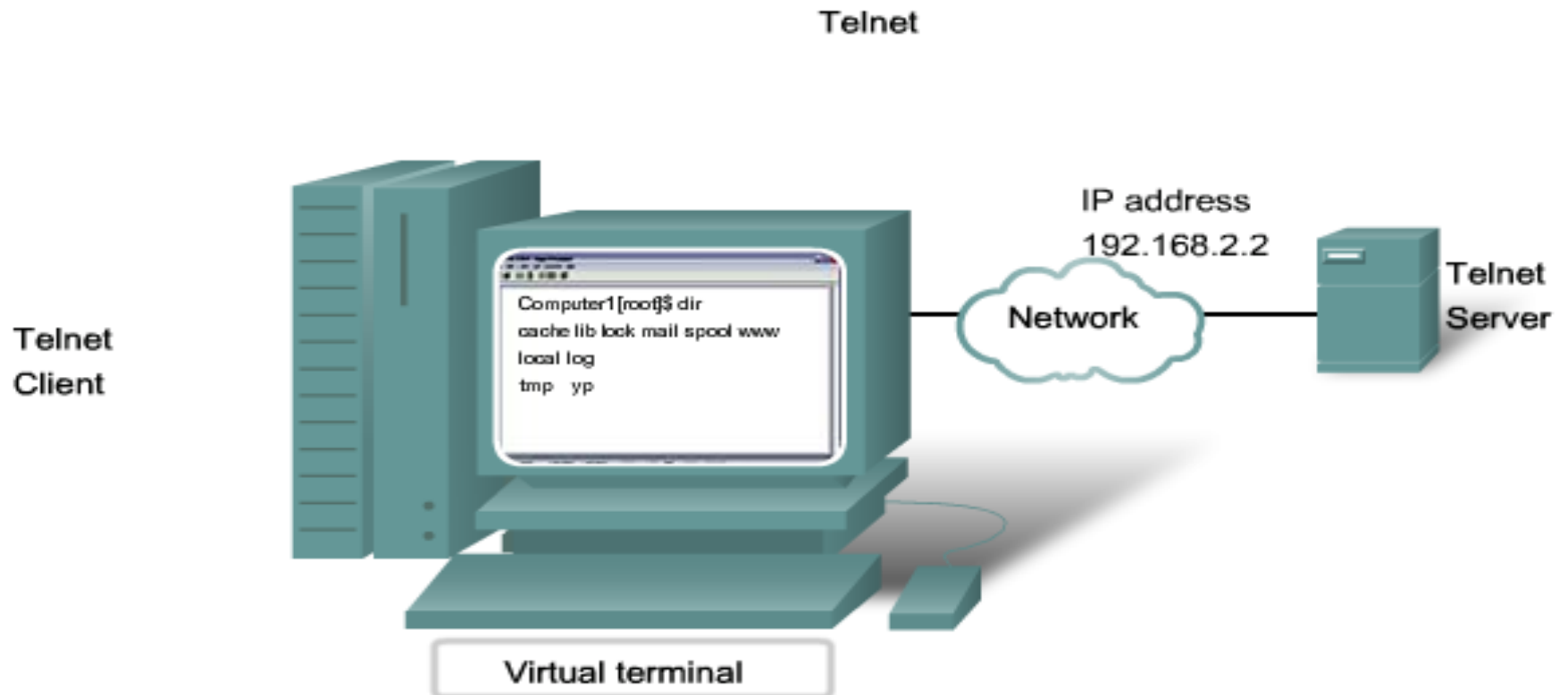
Disadvantages: Doesn't support encryption like SSH. All data is transferred as plain text. It can be easily intercepted and understood.

If security is a concern, you should use Secure Shell (SSH) protocol.

Provides for remote logins with stronger authentication than telnet.

Network Professionals should always use SSH whenever possible.

Telnet

Telnet

Telnet Client

```
Computer1 [root]$ dir
cache lib lock mail spool www
local log
tmp   yp
```

IP address
192.168.2.2

Network

Telnet Server

Virtual terminal

Telnet provides a way to use a computer, connected via the network, to access a network device as if the keyboard and monitor were directly connected to the device.

TELNET

It is client/server application program. TELNET is an abbreviation for *TErminaL NETwork.*

TELNET enables the establishment of a connection to a remote system in such a way that the local terminal appears to be a terminal at the remote system.

Timesharing Environment

A large computer supports multiple users. The interaction between a user and the computer occurs through a terminal, which is usually a combination of keyboard, monitor, and mouse.
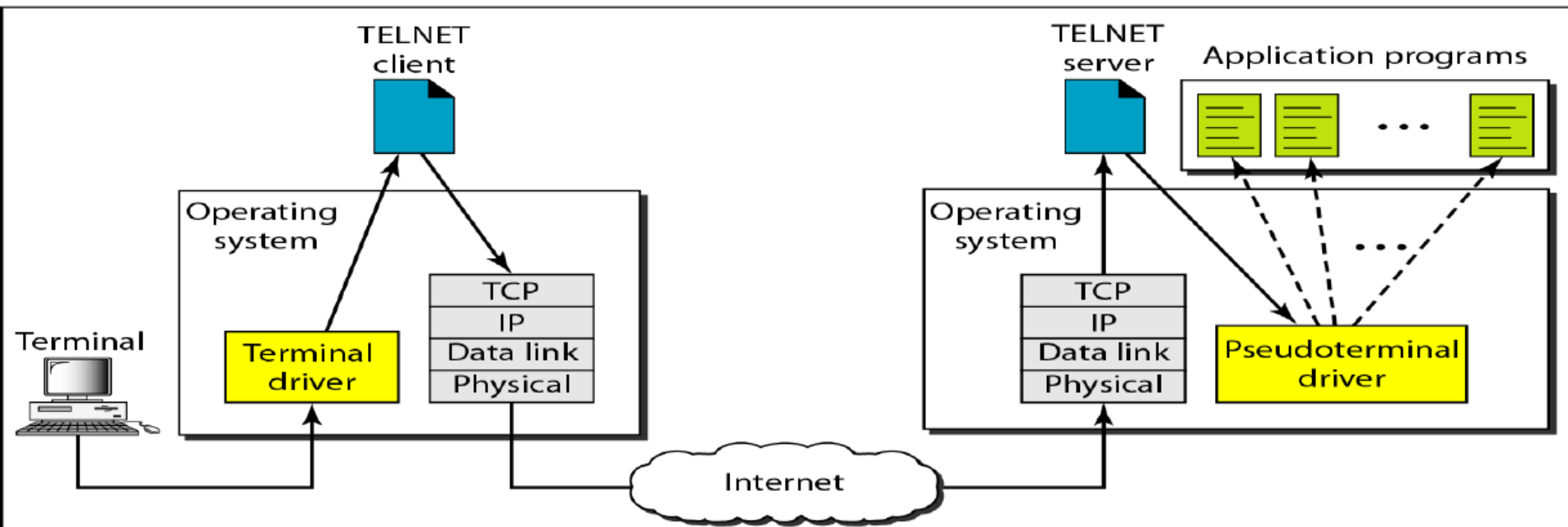
Logging

To access the system, the user logs into the system with a user id or log-in name. The system also includes password checking to prevent an unauthorized user from accessing the resources.

Local login

Remote login

Application programs

Terminal

Terminal driver

Operating system

a. Local log-in

TELNET client

Operating system

Terminal

Terminal driver

TCP
IP
Data link
Physical

Internet

TELNET server

Application programs

Operating system
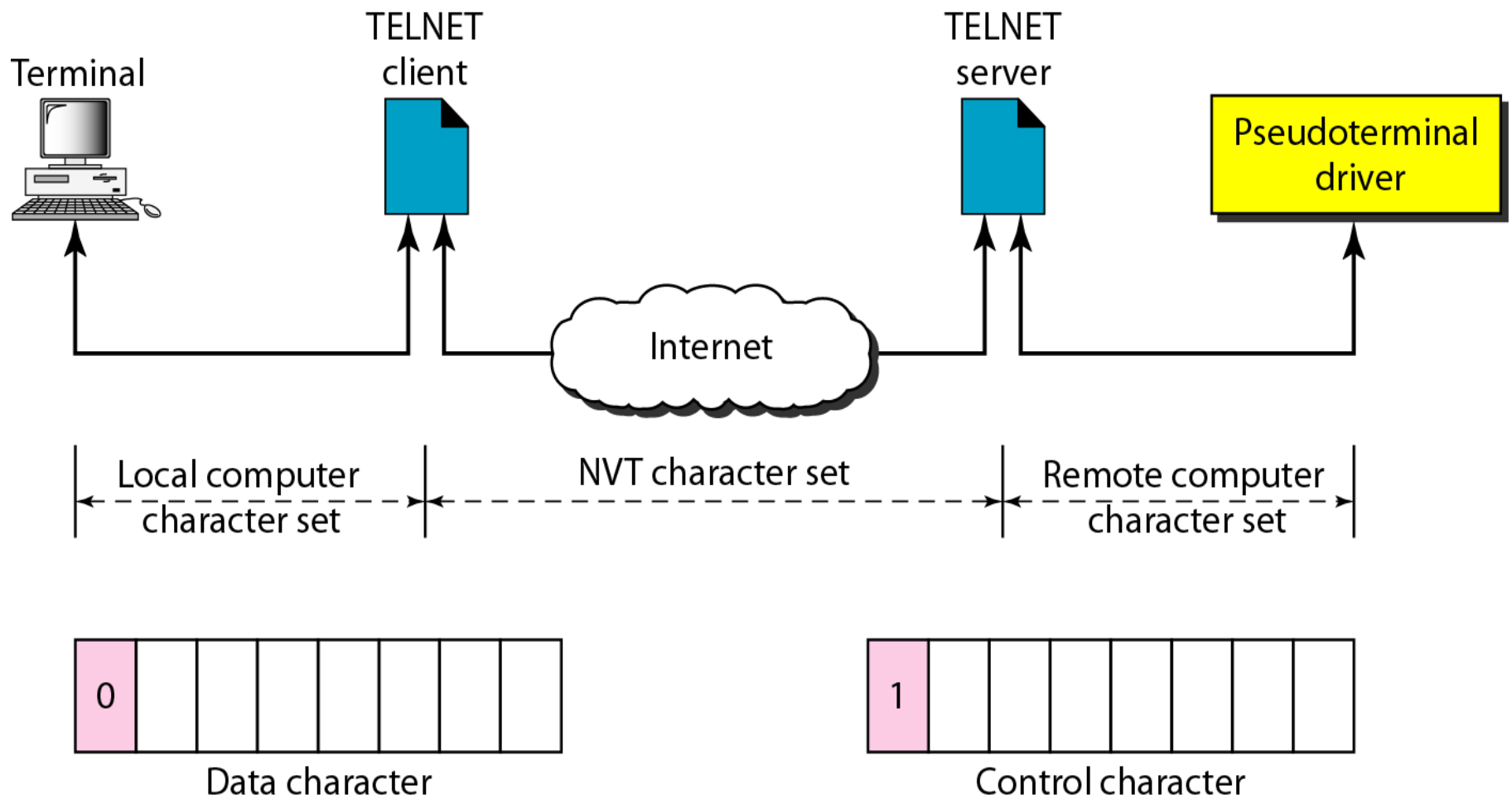
TCP
IP
Data link
Physical
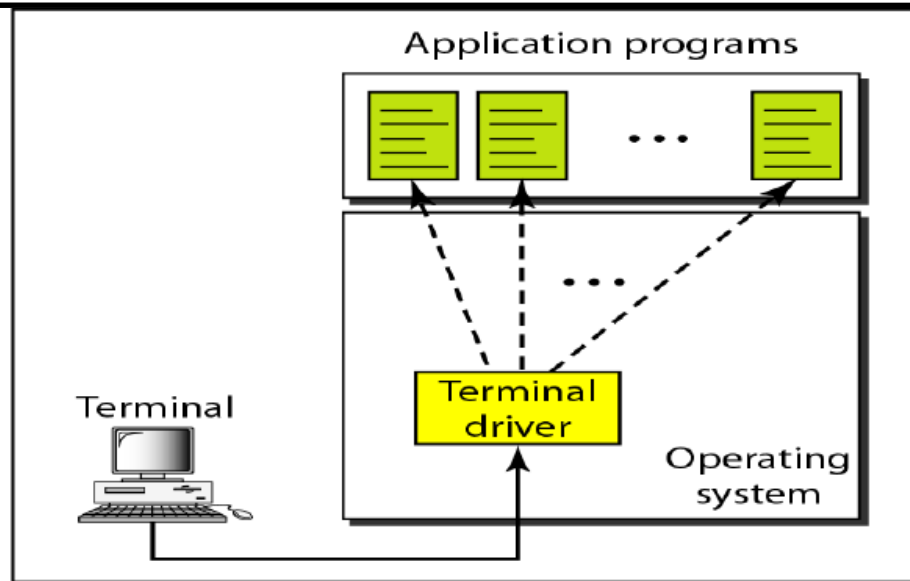
Pseudoterminal driver

b. Remote log-in

TELNET

When a user logs into a local timesharing system, it is called **local log-in.** As a user types at a terminal or at a workstation running a terminal emulator, the keystrokes are accepted by the terminal driver. The terminal driver passes the characters to the perating system. The operating system, in turn, interprets the combination of characters and invokes the desired application program or utility. When a user wants to access an application program or utility located on a remote Machine, it is called **remote log-in.**

Here the TELNET client and server programs come into use. The user sends the keystrokes to the terminal driver, where the local operating system accepts the characters but does not interpret them. The characters are sent to the TELNET client, which transforms the characters to a universal character set called *network virtual terminal (NVT) characters and delivers them to the local TCP/IP* protocol stack.

Terminal   TELNET client   TELNET server   Pseudoterminal driver

Internet

Local computer character set   NVT character set   Remote computer character set

0							

Data character

1							

Control character

FTP

Commonly used application layer protocol
Allows for the transfer of files between clients/servers.
Requires 2 connections to the server

1) Commands – uses TCP port 21
2) Actual data – uses TCP port 20

File Sharing Services and SMB protocol

Server Message Block

SMB has become a mainstay of Microsoft networking, even more so since the introduction of Windows 2000 software.

Allows servers to share their resources with clients

Linux and Unix also share with Microsoft networks using a version of SMB called SAMBA.

Apple also supports sharing resources using an SMB protocol

What can SMB do?

     Start, authenticate, and terminate sessions

     Control file and printer access

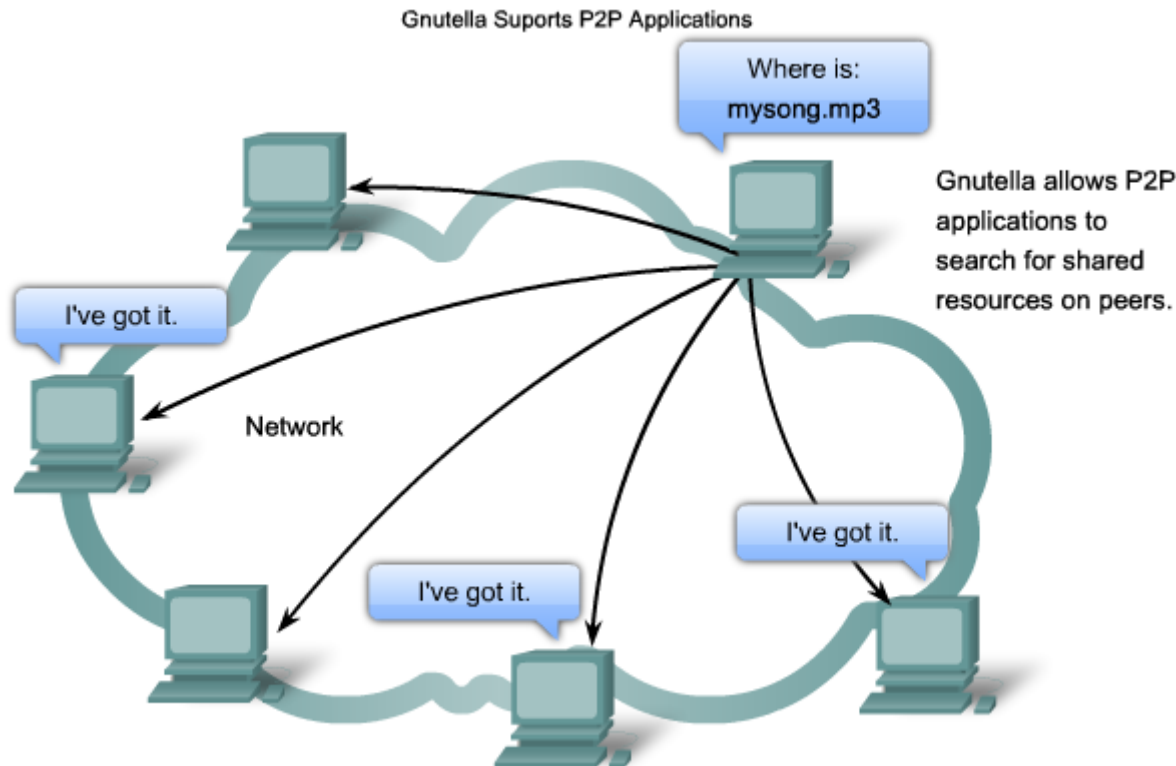   Allow applications to send/receive messages to/from another device

File sharing services and SMB

File Sharing Using the SMB Protocol

Shared Resources

Back

Address C:\

Folders

Desktop
My Documents
My Computer
Local Disk (C:)
_Cisco
_Contracts

- File systems
- Printers
- Mail slots
- APIs

SMB Responses

SMB Requests

Client

Server

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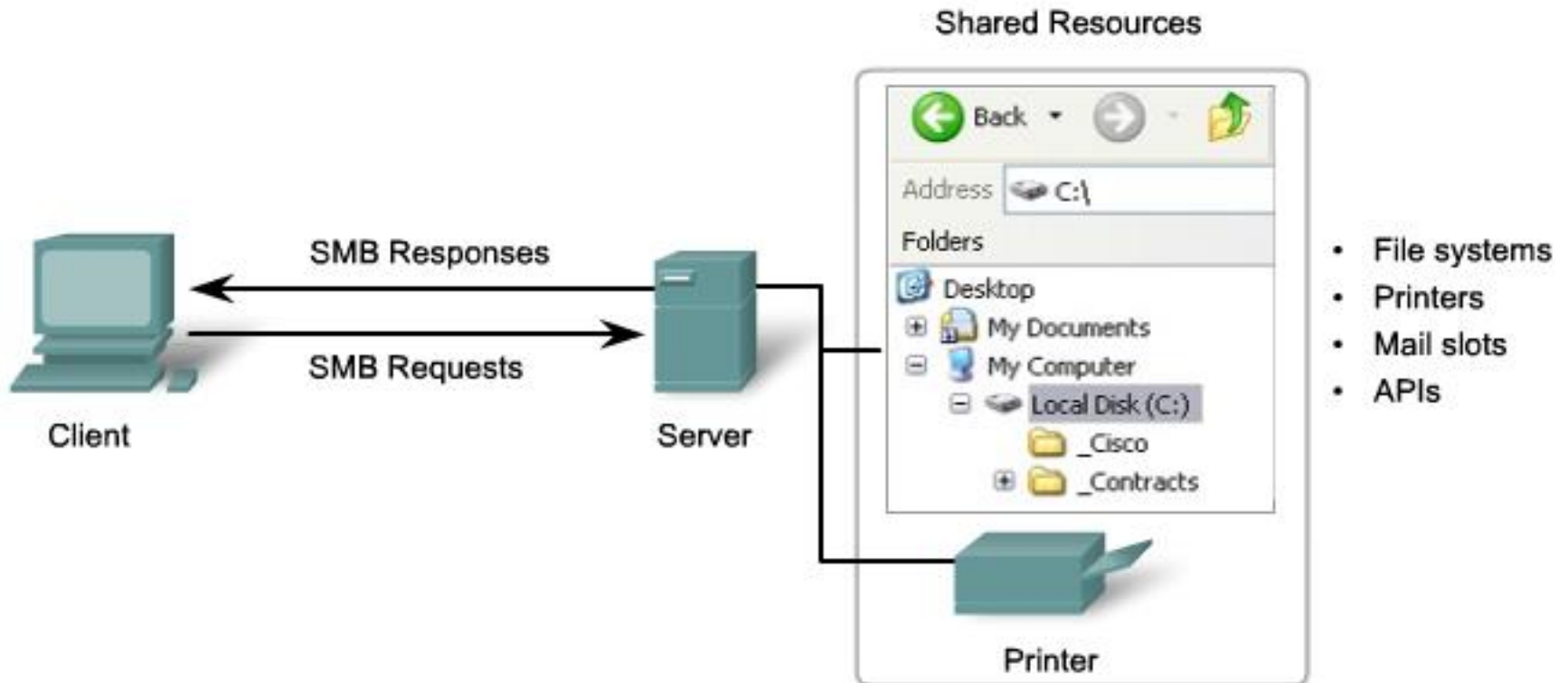
SMB is a client-server, request-response protocol. Servers can make their resources available to clients on the network.

Gnutella protocol

Gnutella Suports P2P Applications

Where is:
mysong.mp3

Gnutella allows P2P applications to search for shared resources on peers.

I've got it.

Network

I've got it.

I've got it.

People can make files on their hard disks available to other users to download.

Relies heavily on HTTP services.

Client applications that use Gnutella are BearShare, LimeWire, Morpheus, WinMX, Gnucleus, etc.

WWW and HTTP

The WWW today is a distributed client/server service, in which a client using a browser can access a service using a server. However, the service provided is distributed over many locations called sites as shown in fig.
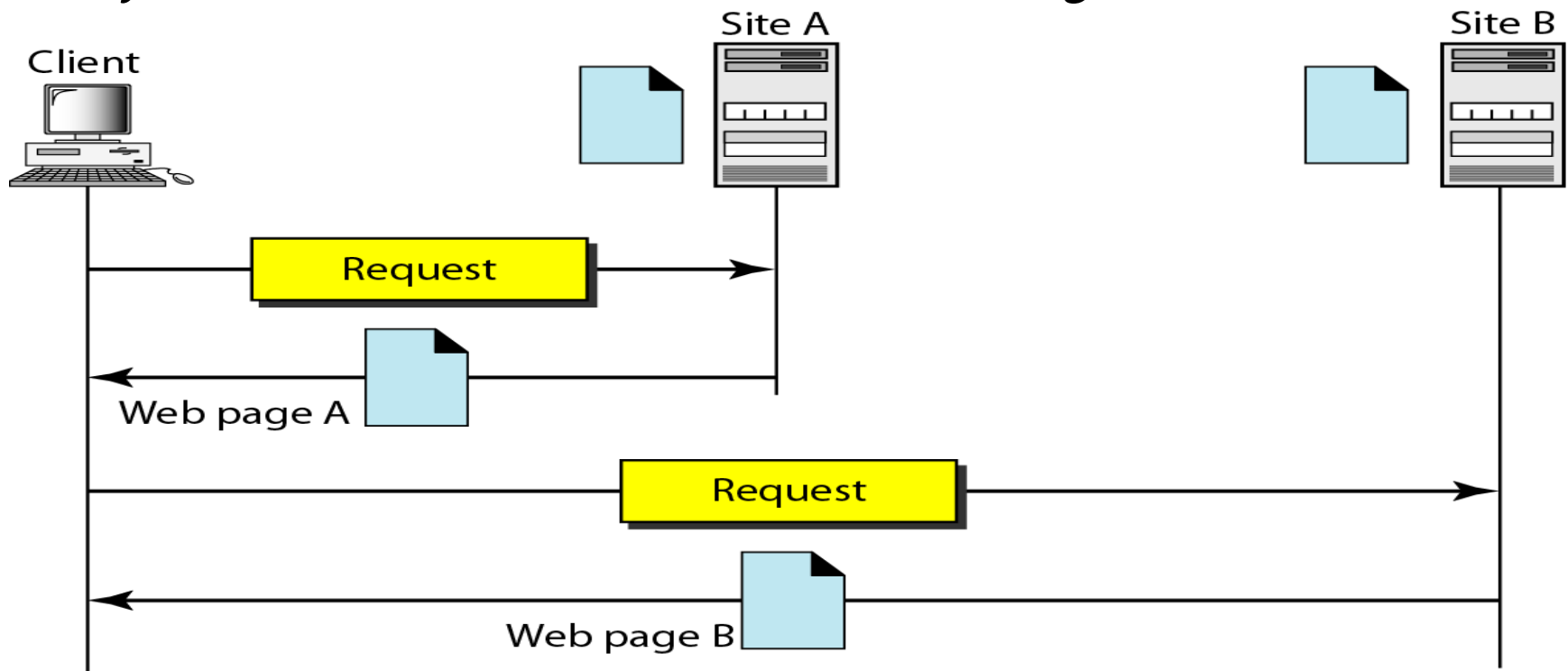
WWW Service and HTTP

Steps:

1) URL is typed in the address bar.
2) Browser checks with DNS server to convert it to an IP address
3) Connects to the server requested
4) Using **HTTP** or **HTTPS** protocol requirements, the browser sends a GET request to the server to ask for the desired html document (usually index.html)
5) The server sends the HTML code for the web page to the browser.
6) The browser interprets the HTML code and formats the page to fit the browser window.
7) See the next slide for an example.

WWW Service and HTTP

HTTP Protocol

Network

HTTP Server

Request a page

Client

Bookmarks   Tools   Help

http://www.cisco.com/

HTTP/HTTPS are some of the MOST used application protocols!

Client (Browser)

A variety of vendors offer commercial browsers that interpret and display a Web document,and all use nearly the same architecture.

Each browser usually consists of three parts: a controller, client protocol, and interpreters.

The controller receives input from the keyboard or the mouse and uses the client programs to access the document.

After the document has been accessed, the controller uses one of the interpreters to display the document on the screen.

The interpreter can be HTML, Java, or JavaScript, depending on the type of document

The client protocol can be one of the protocols described previously such as FTP or HTTP.

Client (Browser)

Browser

Controller

HTTP   FTP   TELNET   SMTP   • • •

HTML

JavaScript

Java

Interpreters
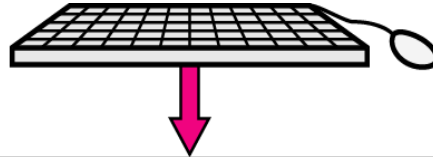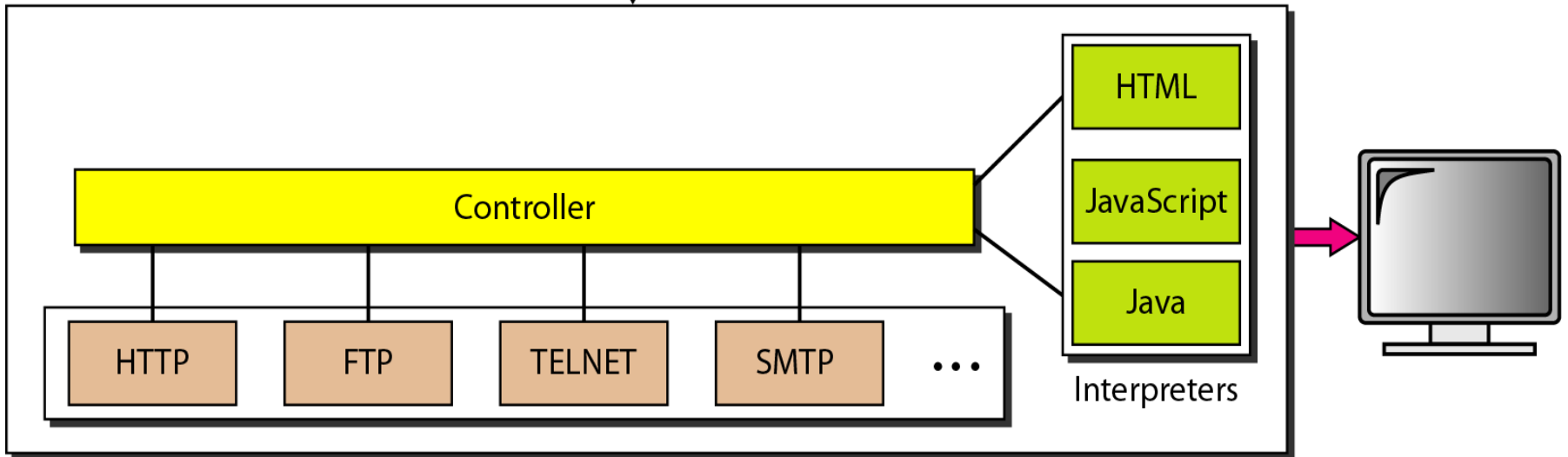
Server

The Web page is stored at the server.

Each time a client request arrives, the corresponding document is sent to the client.

To improve efficiency, servers normally store requested files in a cache in memory; memory is faster to access than disk.

A server can also become more efficient through multithreading or multiprocessing.

In this case, a server can answer more than one request at a time.

Uniform Resource Locator

The URL defines four things: protocol, host computer, port, and path.

The *protocol is the client/server program used to retrieve the document. Many* different protocols can retrieve a document; among them are FTP or HTTP. The most common today is HTTP.

The host is the computer on which the information is located. The URL can optionally contain the port number of the server. If the *port is* included, it is inserted between the host and the path, and it is separated from the host by a colon. Path is the pathname of the file where the information is located.

| Protocol | :// | Host | : | Port | / | Path |

WEB DOCUMENTS

The documents in the WWW can be grouped into three broad categories: static, dynamic, and active.
Static documents are fixed-content documents that are created and stored in a server. The client can get only a copy of the document. When a client accesses the document, a copy of the document is sent. The user can then use a browsing program to display the document.

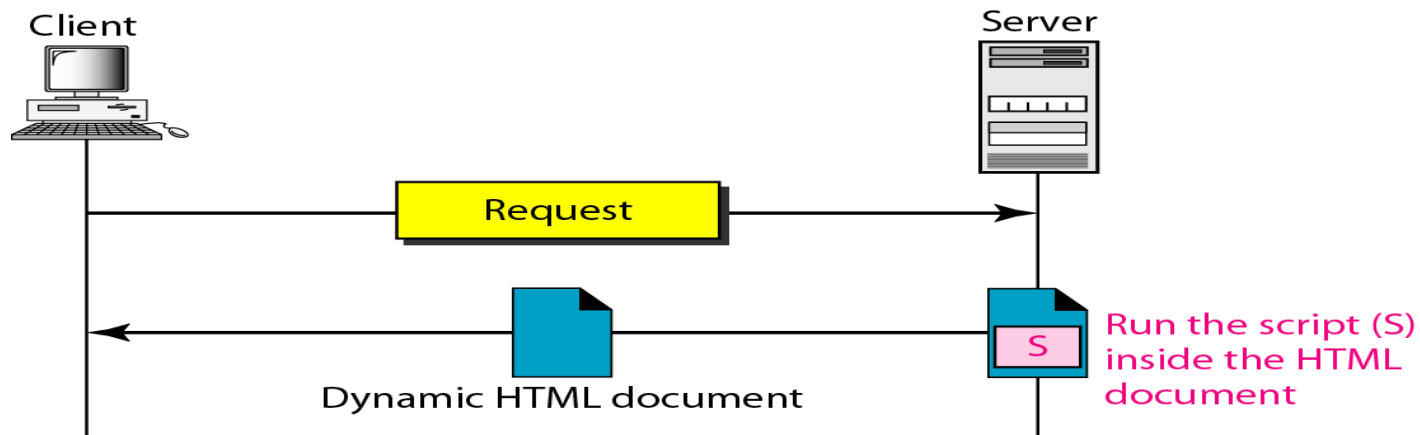Client

Server

Request

Static HTML document
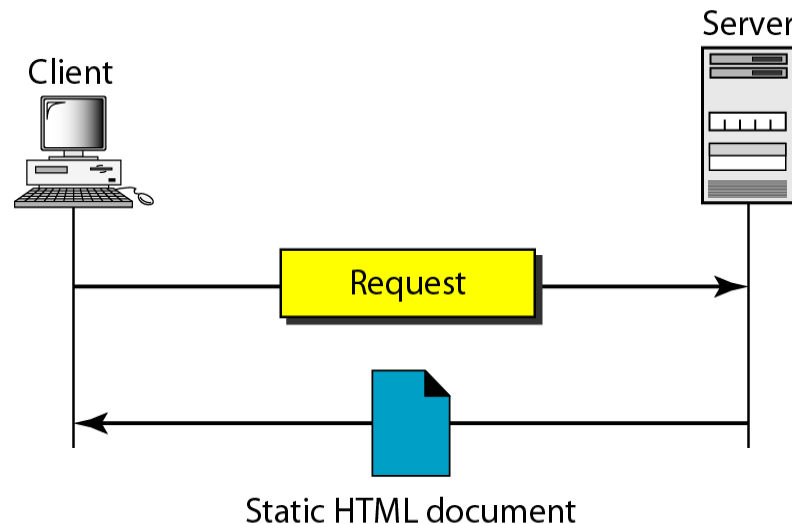
WEB DOCUMENTS

A dynamic document is created by a Web server whenever a browser requests the document. When a request arrives, the Web server runs an application program or a script that creates the dynamic document. The server returns the output of the program or script as a response to the browser that requested the document.
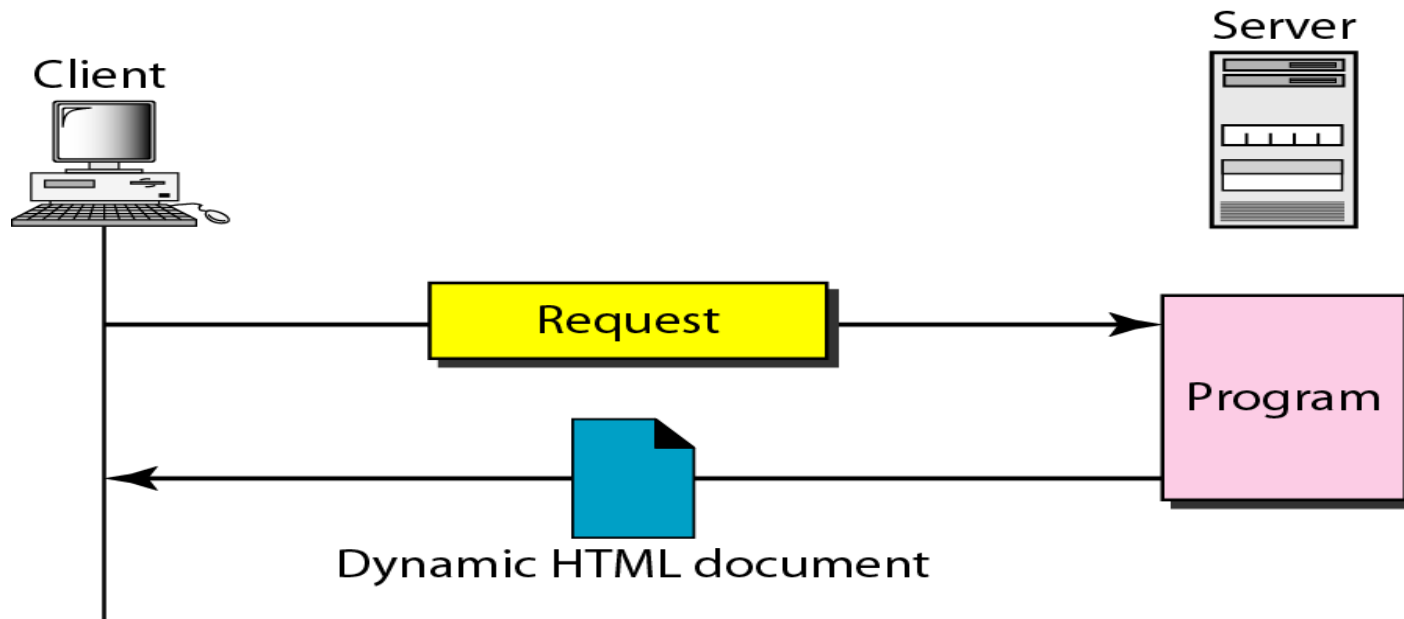
WEB DOCUMENTS

The Common Gateway Interface (CGI) is a technology that creates and handles dynamic documents.
Hypertext Preprocessor (PHP), which uses the Perl language; Java Server Pages (JSP), which uses the Java language for scripting; Active Server Pages (ASP), a Microsoft product which uses Visual Basic language for scripting; and ColdFusion, which embeds SQL database queries in the HTML document.

Client

Server

Request

Dynamic HTML document

S

Run the script (S) inside the HTML document

WEB DOCUMENTS

Active Documents

For many applications, we need a program or a script to be run at the client site. These are called active documents

Client

Server

Request

JS

Run the JavaScript (JS) to get the result

Result