Transport Layer
and
Application Layer

Introduction to Networks v6.0

CISCO™

Chapter 10: Application Layer

Pertemuan ke 10

Kompetensi Khusus

- Mahasiswa mampu menerapkan beberapa skema pengalamatan, salah satunya dengan VLSM untuk memberikan konektivitas kepada pengguna akhir di jaringan berukuran kecil dan menengah agar memungkinkan jalur pengiriman paket data pada transport layer menuju tujuannya (C2)

- Mahasiswa dapat menunjukkan jenis-jenis protokol pada application layer sesuai dengan kegunaannya (C2)

Materi:

1. Transport Layer Protocols
2. TCP and UDP
3. Variable Length Subnet Mask (VLSM)
4. Application Layer Protocols
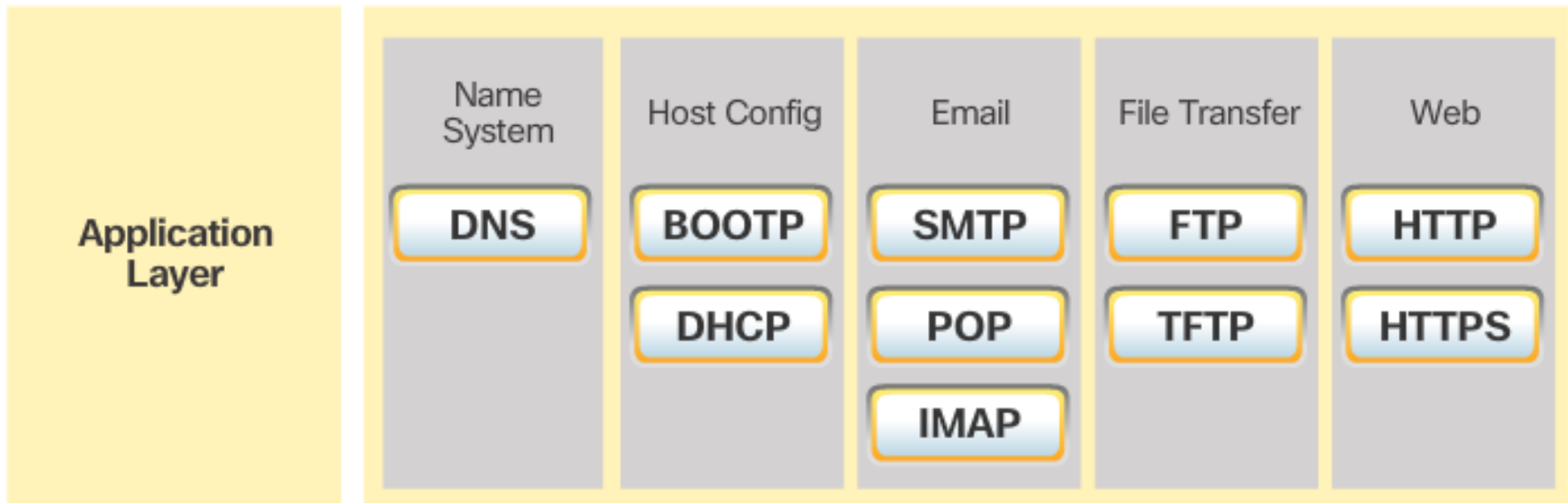5. Well-Known Application Layer Protocols and Services

1. Application Layer Protocols

1.1 Application, Presentation, Session

- Application Layer
  - Closest to the end user.
  - Application layer protocols help exchange data between programs running on the source and destination hosts.
  - The TCP/IP application layer performs the functions of the upper three layers of the OSI model.
  - Common application layer protocols include: HTTP, FTP, TFTP, DNS.

- Presentation and Session Layer
  - Format data, compress and encrypt data
  - Common standards for video include QuickTime and Motion Picture Experts Group (MPEG).
  - Common graphic image formats are: GIF, JPEG and PNG
  - The session layer creates and maintains dialogs between source and destination applications.
  - The session layer handles the exchange of information to initiate dialogs, keep them active, and to restart sessions that are disrupted or idle.
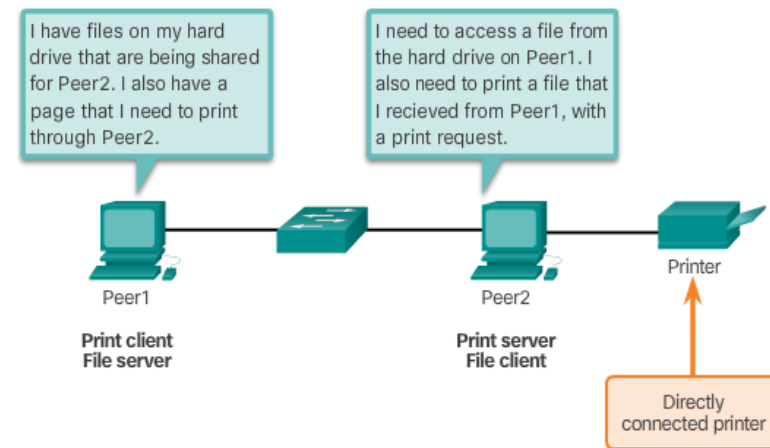
1.1 Application, Presentation, Session

- TCP/IP Application Layer Protocols
  - TCP/IP application protocols specify the format and control information necessary for common Internet functions.
  - Application layer protocols must be implemented in both the source and destination devices.
  - Application layer protocols implemented on the source and destination host must be compatible to allow communication.

Application Layer	Name System	Host Config	Email	File Transfer	Web
	DNS	BOOTP	SMTP	FTP	HTTP
		DHCP	POP	TFTP	HTTPS
			IMAP		

1.2 How Application Protocols Interact with End-User Applications

- Client-Server Model
  - Clients request information while servers provide it.
  - Client and server processes are considered to be in the application layer.
  - The contents of the data exchange will depend of the application in use.
  - Email is an example of a Client-Server interaction.

- Peer-to-Peer Networks
  - Data is accessed without the use of a dedicated server.
  - Two or more computers can be connected to a P2P network to share resources.
  - Every connected end device (a peer) can function as both a server and a client.
  - The roles of client and server are set on a per-request basis.

I have files on my hard drive that are being shared for Peer2. I also have a page that I need to print through Peer2.

I need to access a file from the hard drive on Peer1. I also need to print a file that I recieved from Peer1, with a print request.

Peer1

Print client
File server

Peer2

Print server
File client

Printer

Directly connected printer

1.2 How Application Protocols Interact with End-User Applications

- Peer-to-Peer Applications
  - Some P2P applications use a hybrid system, where resource sharing is decentralized.
  - Indexes that point to resource locations are stored in a centralized directory.
  - In a hybrid system, each peer accesses an index server to get the location of a resource stored on another peer.

- Common P2P Applications
  - Common P2P networks include: eDonkey, G2, BitTorrent.
  - Many P2P applications allow users to share pieces of many files with each other at the same time.
  - A small torrent file contains information about the location of other users and tracker computers.
  - Trackers are computers keeping track of the files hosted by users.
  - This technology is called BitTorrent. There are many BitTorrent clients, including BitTorrent, uTorrent, Frostwire, and qBittorrent.

2. Well-Known Application Layer Protocols and Services

2.1 Web and Email Protocols

- Hypertext transfer Protocol and Hypertext Markup Language
    - A URL is a reference to a web server.
    - URLs and URIs are the names most people associate with web addresses.
    - URLs contain the protocol, the server name and the requested filename.
    - Using DNS, the server name portion of the URL is then translated to the associated IP address before the server can be contacted.

- HTTP and HTTPS
    - The browser sends a GET request to the server's IP address and asks for the index.html file.
    - The server sends the requested file to the client.
    - The index.html was specified in the URL and contains the HTML code for this web page.
    - The browser processes the HTML code and formats the page for the browser window based on the code in the file.
    - HTTP Is not secure. Messages can be intercepted.
    - HTTPS uses authentication and encryption to secure data.

2.1 Web and Email Protocols

- Email Protocols
  - Email is a store-and-forward method of sending, storing, and retrieving electronic messages.
  - Email messages are stored on mail servers.
  - Email clients communicate with mail servers to send and receive email.
  - Mail servers communicate with other mail servers to transport messages from one domain to another.
  - Email relies on three separate protocols for operation: SMTP,POP and IMAP.

- SMTP Operation
  - SMTP message formats require a message header and body.
  - The header must have a properly formatted recipient email address and a sender address.
  - An SMTP client sends an email by connecting to a SMTP server on port 25.
  - The server receives the message and stores it in a local mailbox or relays the message to another mail server.
 - Users use email clients to retrieve messages stored on the server.

2.1 Web and Email Protocols

- POP Operation
    - Messages are downloaded from the server to the client.
    - Email clients direct their POP requests to mail servers on port TCP 110.
    - POP allows for email messages to be downloaded to the client's device (computer or phone) and removed from the server.
    - A downloaded message resides on the device that triggered the download.

- IMAP Protocols
    - IMAP is another protocol used to retrieve email messages.
    - Allows for messages to be displayed to the user rather than downloaded.
    - The original messages reside on the server until manually deleted by the user.
    - Users view copies of the messages in their email client software.
    - Support folder hierarchy to organize and store mail.
    - When a user decides to delete a message, the server synchronizes that action and deletes the message from the server.
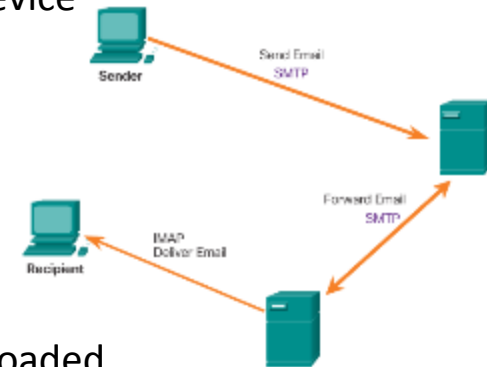
2.2 IP Addressing Services

- Domain Name Service
  - IP addresses are not easy to memorize.
  - Domain names make server addresses more user-friendly.
  - Computers still need the actual numeric address before they can communicate.
  - The DNS protocol allows for the dynamic translation of a domain name into the associated IP address.

- DNS Message Format
  - Common DNS records are A, NS, AAAA and MX.
  - DNS servers search its own records first, relaying the client's request to other servers if it can't resolve the request.
  - The response is then forwarded to the client.
  - The client often stores previous name resolutions. Use the **ipconfig /displaydns** to list cached DNS entries on Windows.

DNS uses the same message format for:
- all types of client queries and server responses
- error messages
- the transfer of resource record information between servers

Header	
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

2.2 IP Addressing Services

- DNS Hierarchy
  - The DNS protocol uses a hierarchical system.
  - The naming structure is broken down into small, manageable zones.
  - Each DNS server is only responsible for managing name-to-IP mappings for a small portion of the DNS structure.
  - Requests for zones not stored in a specific DNS server are forwarded to other servers for translation.
  - Top-level domains represent either the type of domain or the country of origin.
    Examples of top-level domains are **.com**, **.org**, **.au** and **.co**

- The nslookup Command
  - Use **nslookup** to place DNS queries.
  - Useful for DNS troubleshooting.
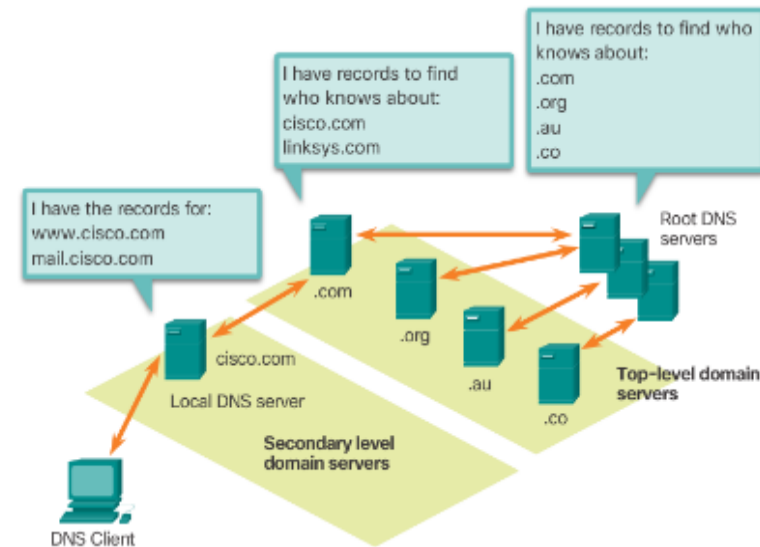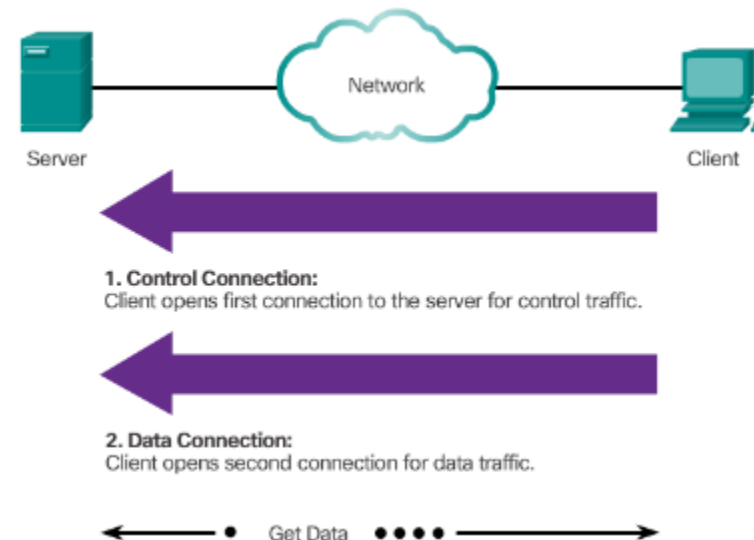
2.2 IP Addressing Services

- Dynamic Host Configuration Protocol
  - Computers need network IP information to communicate over a network.
  - IP information include host and gateway addresses, mask, and DNS server.
  - DHCP allows for automated and scalable distribution of IP information.
  - DHCP-distributed addresses are leased for a set period of time.
  - Addresses are returned to the pool for reuse when no longer in use.
  - DHCP supports IPv4 and DHCPv6 supports IPv6.

- DHCP Operation
  - The client broadcasts a DHCPDISCOVER.
  - A DHCP server replies with DHCPOFFER.
  - The client sends a DHCPREQUEST message to the server it wants to use (in case of multiple offers).
  - A client may also request an address previously been allocated by the server.
  - The server returns a DHCPACK to confirm the lease has been finalized.

2.3 File Sharing Services

- File Transfer Protocol
  - FTP was developed to allow the transfer of files over the network.
  - An FTP client is an application that runs on a client computer used to push and pull data from an FTP server.
  - FTP requires two connections between the client and the server: one connection for commands and replies and another connection for the actual file transfer.
  - The client initiates and establishes the first connection to the server for control traffic on TCP port 21.
  - The client then establishes the second connection to the server for the actual data transfer on TCP port 20.
  - The client can download (pull) data from the server or upload (push) data to the server.

Network

Server   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

2.3 File Sharing Services

- Server Message Block
  - SMB is a client/server file sharing protocol.
  - All SMB messages share a common format.
  - SMB file-sharing and print services have become the mainstay of Windows networking.
  - Microsoft products now support TCP/IP protocols to directly support SMB resource sharing.
  - After the connection is established, the user of the client can access the resources on the server as if the resource is local to the client host.
  - The Mac, LINUX, and UNIX operating systems have their own implementation of SMB.
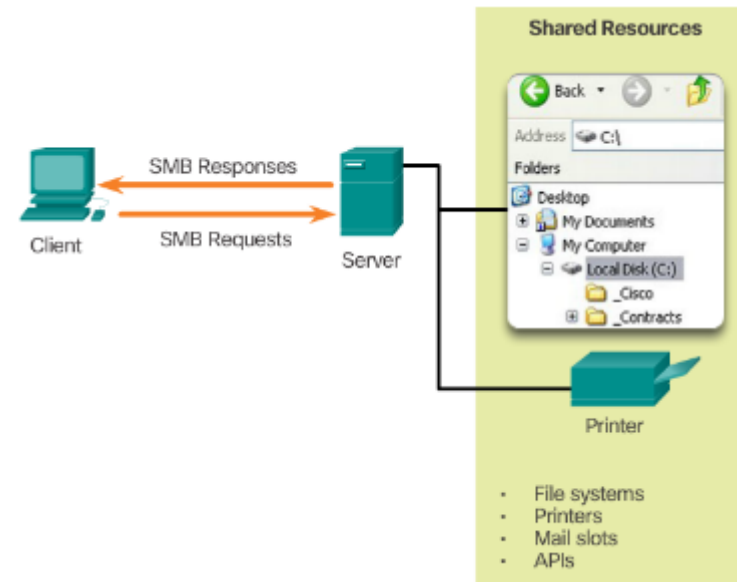
Chapter Summary

Summary

- Explain the operation of the application layer in providing support to end-user applications.

- Explain how well-known TCP/IP application layer protocols and services operate.

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