Basic Networking Concepts

AS A NETWORK ADMINISTRATOR OR ENGINEER, you will be expected to understand how networking components work and how to talk about them with other professionals. The OSI model and TCP/IP model are two popular ways to visualize networks and communicate about them in an understandable manner. This unit introduces you to both models as well as common rules for TCP/IP.

Objective:

Summarize the OSI and TCP/IP models and layers in addition to common TCP/IP application protocols.

Key Terms:

application layer (OSI model)
application layer (TCP/IP model)
bit
computer network
data link layer
DNS
frames
FTP
FTPS
HTTP
HTTPS
IMAP4
Internet layer
Kerberos
LDAP
LDAPS
link layer
network
network devices
network layer
networking
networking concepts
NNTP
OSI model
packets
physical layer
POP3
presentation layer
protocol
protocol suite
RDP
session layer
segments
SMTP
SNMP
SSH
TCP/IP model
TELNET
transport layer (OSI model)
transport layer (TCP/IP model)

Understanding Basic Networking Concepts

A **network** is any connection of two or more computers that allows for the exchange of data. **Network devices** are the components used to connect devices together to share files or resources. A **computer network** is a set of computers and devices linked to each other with physical lines to communicate and exchange information as digital data. **Networking** is implementing tools and tasks for linking computers so they can share resources over the network. **Networking concepts** are the models, protocols, layers, and network interconnection.

OSI MODEL

Open Systems Interconnection is also known as OSI. The **OSI model** is a seven-layer system used to visualize networks—a product of the International Standards Organization (ISO). The model is used to group network functions and explain how data moves through a network. The OSI model is especially useful for development tasks and for problem solving and troubleshooting.

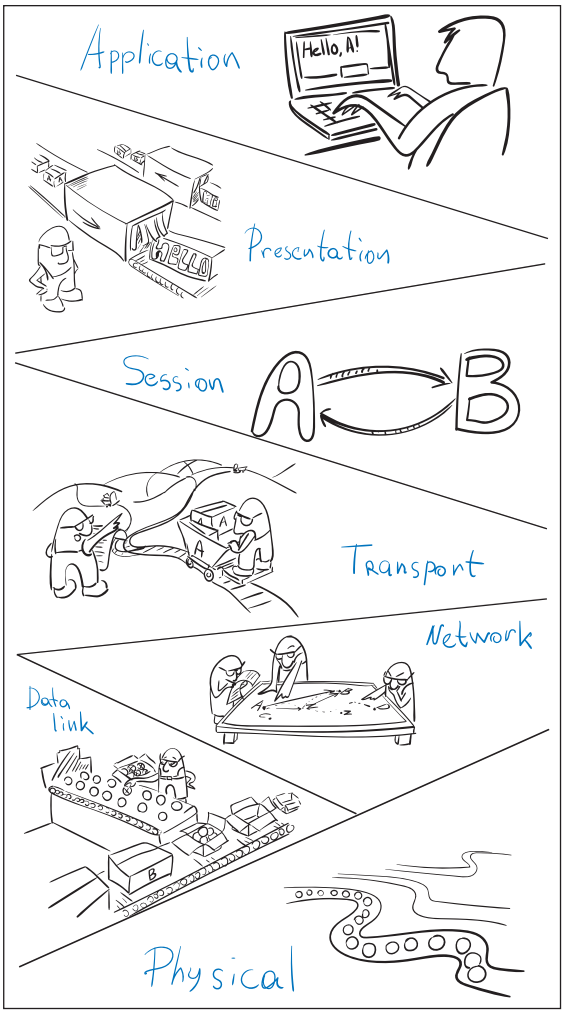

FIGURE 1. The Open Systems Interconnection (OSI) model is a seven-layer system used to visualize networks. The model is used to group network functions and to explain how data moves through a network.

Stack

In web development, a developer may refer to OSI as a "stack." A stack is the operating system on which the application runs, the database software, and the back-end software or programming language. Developers use the model (or the stack) to narrow down where the problem is located and the probable causes.

Networking Problem

In networking, an engineer or technician may discover a networking problem and use the model to figure out where the problem is originating. For example, if a client computer is unable to access a specific website, the IT professional may suspect the obvious—as the problem is limited to one computer—that the problem is in the OSI application level. After testing, the problem may still exist. If switching web browsers did not solve the problem, the problem was not in the application level. Next, the model moves to the presentation level, and the IT professional suspects a

faulty setting. The client entered some DNS settings incorrectly. The problem is in the presentation layer.

Increment Movement

The model moves incrementally from the hardware (physical, layer one) to data input (application, layer seven) to the human operator. (NOTE: Usually, the OSI model is shown with layer 7 at the top, which is why this lesson starts with layer 7.)

OSI Model Layers

You need to know the roles of the various layers involved.

Layer 7

The **application layer** is the location closest to the user and communicates with the user and the network. Typically, it is the software run from the local machine. User applications are part of the application layer. Gateways work in this layer. Services exist for email and file transfer. An example is an Internet browser, an FTP client, Microsoft, or Apple.

Layer 6

The **presentation layer** is the location of the operating system—Windows, OS X, etc. This layer translates data coming from the application layer. It also encrypts and decrypts.

Layer 5

The **session layer** is the location that creates, maintains, and manages connections between third-party computers and between the operating system on the presentation layer. Each connection made is called a session.

- A user browses the Internet (interacts with the application layer).
- The application layer is interacting with the presentation layer.
- The operating system is interacting with the web server.

Layer 4

The **transport layer** is the location with the responsibility for the logistics of the session.

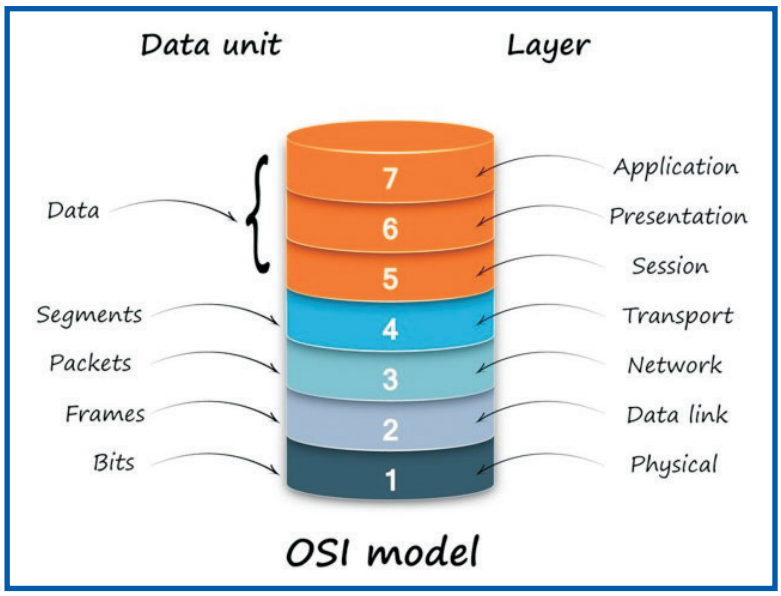

FIGURE 2. The OSI model is a seven-layer system used to visualize networks—data units and layer functions. The model is especially useful for development tasks and for problem solving and troubleshooting.

Transport makes sure that data is sent and received without errors, usually using TCP/IP. **Segments** are chunks of data in the transport layer.

Layer 3

The **network layer** is the location in which routers operate. Routers (part of the network layer) forward packets of information between network computers. This layer decides which route through the physical layer packets will take. **Packets** are chunks of data created by software and used in the network layer. Routers work at the network layer using IP addresses.

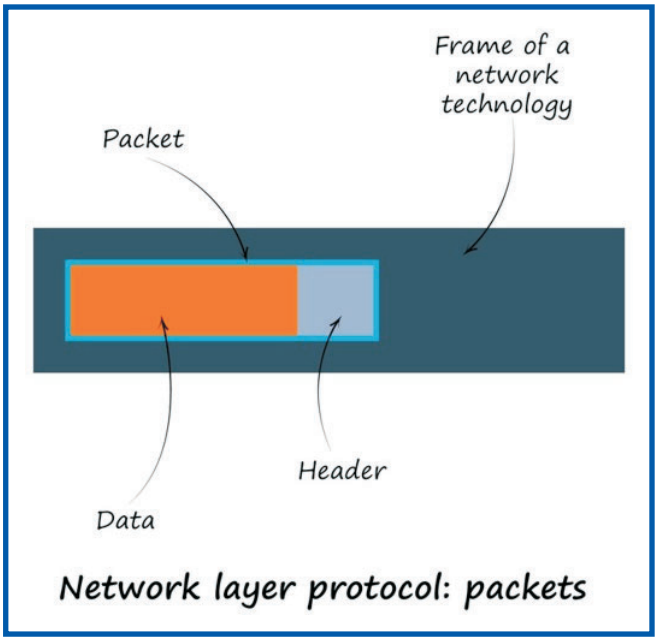

FIGURE 3. Packets are chunks of data created by software and used in the network layer. Routers are part of the network layer. Routers work at the network layer using IP addresses.

Layer 2

The **data link layer** is the location where switches operate and link between two directly connected nodes. This layer sends frames using the physical layer. **Frames** are chunks of data created by network hardware. The switch, bridge, and WAP are part of the data link. NICs and switches work at the data link layer by working with MAC addresses.

Layer 1

The **physical layer** is the physical hardware that makes up the network. It is concerned with the transmission of bits of data using cables and hubs. A **bit** is a unit of information that is either a zero or a one. It is the smallest unit of computer data. Hubs and repeaters work at this layer.

TCP/IP MODEL

The transmission control protocol/Internet protocol is also known as the TCP/IP. A **TCP/IP model** is a combination of two networking models' rules about how data is sent, addressed, and received: TCP and IP. TCP/IP is different from the OSI model. For instance, some OSI layers are combined, and some are not used in the TC/IP model. They are related but separate models.

Department of Defense (DoD)

TCP and IP were originally Department of Defense (DoD) research projects. The DoD was attempting to connect networks of different types to create a network of networks (the Internet). This model is sometimes called the DoD model. A **protocol** is a rule or guideline

that computers use to "talk" to each other. Several other networking protocols exist. However, TCP/IP is by far the most popular choice due to its integrated addressing and ability to work well with routers.

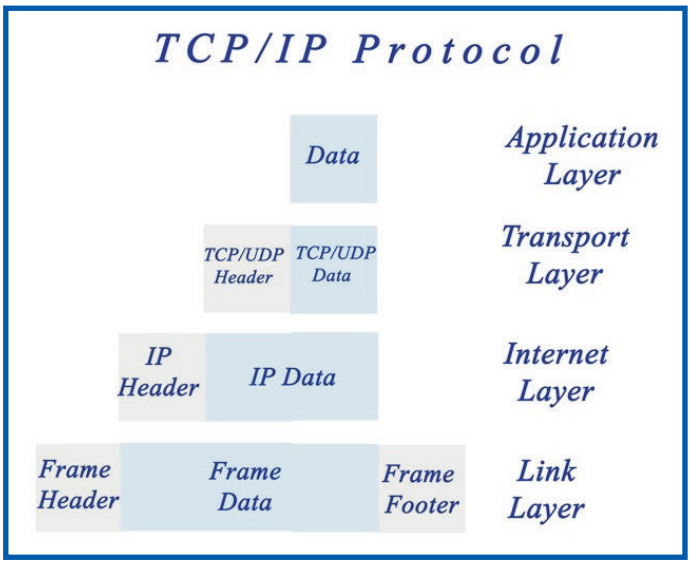

FIGURE 4. TCP/IP is a combination of two networking models with rules about how data is sent, addressed, and received. TCP/IP is different from the OSI model. This diagram illustrates the four layers of the TCP/IP model.

Decomposition

The IP portion of the model is concerned with decomposition of the initial information and getting it into a packet, and then routing a packet through networks to its destination identified by the IP address.

Reliability

The TCP portion of the model is concerned with reliability of packet transmission, error checks, and assurance that data is received in the correct order.

Packets

Data is sent in packets with TCP/IP. Each packet contains a header with identification and address information for the data contained within.

TCP/IP Layers

Communication between networked computers occurs through protocol suites. A **protocol suite** is a layered architecture where each layer depicts some functionality that can be carried out by a protocol. TCP/IP is the most widely used and available protocol suite. Layers usually have more than one protocol available—options to carry out a responsibility. TCP/IP is a four-layer model: application, transport, network, and data link.

Application Layer

The **application layer** is the functionality that packages data from applications and prepares it for transport through lower layers. The application layer is at the top of the model. (NOTE: The TCP/IP application layer is equivalent to the application, session, and presentation layers in OSI.) Popular application layer protocols that communicate with the transport layer are HTTP, FTP, SMTP, and SNTP.

Transport Layer

The **transport layer** is the location that ensures data arrives in order and without error from the application layer. (NOTE: The TCP/IP transport layer is equivalent to the transport

layer in the OSI model.) Common application layer protocols that communicate on the transport layer are:

- TCP divides the data into proper sized chunks and then passes the chunks onto the network.
- User datagram protocol (UDP) sends packets from one host to another and is a simpler but more unreliable service than TCP.

Internet Layer

The **Internet layer** (network layer) is an area that receives, organizes, and sends packets to the network—routing data over the network. (NOTE: The TCP/IP Internet layer is equivalent to the network layer in OSI.) The main protocol used at this layer is IP. Popular application layer protocols that communicate with the Internet layer are Internet control message protocol (ICMP) and Internet group management protocol (IGMP).

Link Layer

The **link layer** (network interface layer) is an area that identifies what type of packet is being transported. In this case, it is identifying that the packet is TCP/IP. This layer consists of device drivers in the OS and the network interface card attached to the system. (The TCP/IP link layer is equivalent to the data link layer and the physical layer combined in the OSI model.) Common link layer protocols include address resolution protocol (ARP) and point-to-point protocol (PPP).

COMMON TCP/IP PROTOCOLS

The TCP protocol resides in the transport layer of the OSI and TCP/IP models. The IP protocol resides at the network layer of the OSI model and the Internet layer of the TCP/IP model. At the "top" of both models is the application layer that contains many application protocol options. These protocols determine the functionality of different applications and services. Data enters following the IP protocol, follows the TCP protocol, and finally uses one of many application protocols (depending on the type of data).

Hypertext Transfer Protocol (HTTP)

Hypertext transfer protocol or **HTTP** is a protocol that makes use of hyperlinks in text and is the foundation of the Internet as it currently exists. **HTTPS** is HTTP with an added security feature.

TELNET

TELNET is a protocol that allows for remote access to computers via the Internet.

File Transfer Protocol (FTP)

File transfer protocol or **FTP** is a protocol used to move files. FTP sites do not look like normal websites. They are simply a list of files available for download. **FTPS** is a protocol used to move files or FTP with security.

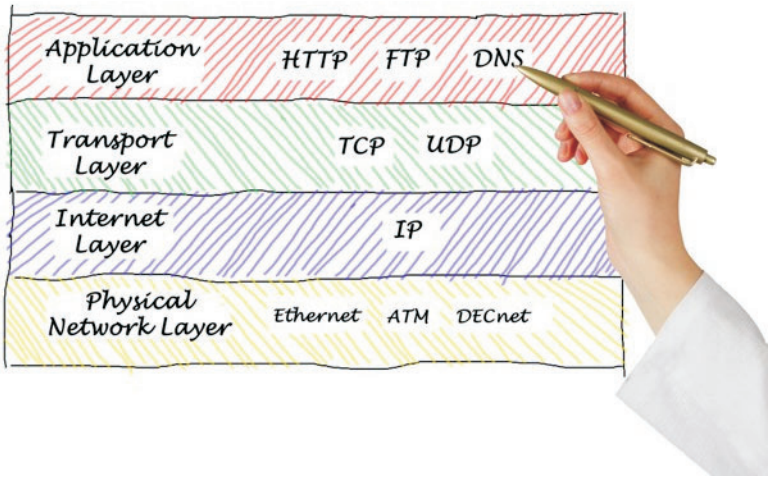

FIGURE 5. This illustration shows some of the Internet protocols by TCP/IP layer. [NOTE: In this illustration, the physical network layer = the link layer in this material.]

Simple Network Management Protocol (SNMP)

Simple network management protocol or **SNMP** is a protocol used for network management and monitoring. It helps organize the devices on a network.

Secure Shell (SSH)

Secure shell or **SSH** is a protocol that transfers data securely using cryptography. (NOTE: SSH is a replacement for TELNET that was not as secure for remote connections.)

Simple Mail Transfer Protocol (SMTP)

Simple mail transfer protocol or **SMTP** is a protocol used to send email.

Domain Name System (DNS)

Domain name system or **DNS** is the protocol used to name a website (e.g., Google.com) tied to a particular IP address.

Kerberos

Kerberos is a strong network authentication protocol for servers. It uses cryptography.

Network News Transfer Protocol (NNTP)

Network news transfer protocol or **NNTP** is a protocol used to send news articles between servers.

Internet Message Access Protocol (IMAP4)

Internet message access protocol or **IMAP4** is an email retrieval process that contains the ability to manage and access email on multiple devices. Post office protocol or **POP3** is an email retrieval protocol made somewhat obsolete by the more advanced IMAP.

FURTHER EXPLORATION...

ONLINE CONNECTION: Additional TCP/IP Protocols

TCP/IP has several protocols not listed in this unit. What are they? What is their use? How do they function within a network? What is going to happen with TCP/IP in the future? Will new protocols be added as technology changes? There is a move to switch to a different system called "Named Data Networking (NDN)." Research this system.

Then research Internet 2 to determine how it is different from our current Internet model. Who is using Internet 2 today? What would explain its use? Check out the links below for some research leads. If time allows, search protocols at different networking layers. The future of networking is constantly changing. To work in this field, you will be expected to continually learn about new ideas and technologies.

http://www.protocols.com/pbook/tcpip1/
http://www.internet2.edu/products-services/advanced-networking/

Lightweight Directory Access Protocol (LDAP)

Lightweight directory access protocol or **LDAP** is a method used to manage directories. **LDAPS** is LDAP with security.

Remote Desktop Protocol (RDP)

Remote desktop protocol or **RDP** is a method that allows users to access another computer over a network and is commonly used by employees who need to access their work computers from home. (NOTE: Microsoft owns RDP.)

Summary:

Networking can be a confusing topic without a framework in which to place all of the components and their functionalities. The OSI model allows a way to categorize the overall networking task. The TCP/IP model is more specific and is intended to categorize networking that uses the TCP/IP protocols. Understanding the layers of each grants you a deeper understanding of how each piece of the networking puzzle fits together. Remember that the OSI model is popular and covers networking for all protocols.

Checking Your Knowledge:

1. Explain the differences between FTP and HTTP.
2. What is the OSI model, and how is it useful to networking professionals?

3. What is the difference between LDAP and LDAPS?
4. What is a bit?
5. What is the TCP/IP model? List six application protocols used in TCP/IP.

Expanding Your Knowledge:

Connect two computers together using TCP/IP configuration settings (with your teacher's permission). See the Web Links for details.

Web Links:

How TCP/IP Works
http://www.hardwaresecrets.com/how-tcp-ip-protocol-works-part-1/

The OSI Model's Layers Defined and Functions Explained
https://support.microsoft.com/en-us/kb/103884

Two-Computer Simple Network: Windows
http://www.networking.windowsreinstall.com/directconnectionnetwork/