

Instructor Guide

Computer Networking Fundamentals

LESSON: OSI Model

Before you Begin

This is the second module of the Computer Networking Fundamentals course in the extended program. Keep in mind that learners will need additional guidance and reminders about the requirements of this course. For this lesson and upcoming lessons, instructors are required to ensure the following activities are completed:

- Review the “Lesson Opener” and “Real World Scenario” with the learners prior to starting the module.
- Throughout the module, you will find “Consider the Real World Scenario” slides. Review the questions found on these slides, tie the concepts back to the scenario discussed at the start of the lesson as well as content you are presenting, and encourage the learners to share their thoughts.
- Ensure learners are given opportunities for breaks throughout the lesson. The pacing guide below provides recommended breaks. However, there are additional breaks added in the slide deck, please use them if needed.
- For each lesson, you will find a “Pulse Check” slide which is the opportunity for instructors to open a poll to gather feedback from the learners. Leave the poll open for about 1 minute and after you close the poll, share the results with the learners. Encourage the learners to share their thoughts. This information will help the instructors as well as the learners better understand where they are with regards to the lesson.
- Labs are to be demonstrated live for each module. The demonstration of labs is the top priority for the lead instructor. While demonstrating each lab, encourage students to participate and explore.
- At the end of each lesson, it is important to take a few minutes to review the key concepts for the lesson, provide guidance on what the learners can do to prepare for the next lesson, and wrap up with Q&A.

Summary

In this lesson, learners will explore both the OSI model as well as the TCP/IP model, consisting of various logical layers, and its role in computer network architecture. You will notice that the emphasis is on the OSI model. The goal is to help learners understand how network traffic is generated, encapsulated, and transmitted through the layers, and how it is received and

decapsulated in the reverse direction. Each layer's responsibilities, protocols, and associated devices will be covered, highlighting the physical layer's management of the physical medium, the transport layer's provision of reliable communication, and the application layer's services to applications. Additionally, learners will differentiate between TCP and UDP protocols, understand the concept of logical ports, and grasp the advantages of the OSI model in terms of modularity, functional separation, and educational use.

Objectives

- Analyze the function of each layer of the OSI model in the network communication process and its importance in enabling communication between devices.
- Compare and contrast the seven layers of the OSI model and their respective protocols.
- Explain the role of different devices used at each layer of the OSI model in facilitating network communication.
- Illustrate how the layered approach of the OSI model helps users understand and troubleshoot network communication issues by identifying the devices used at each layer.
- Compare and contrast TCP and UDP transport protocols.
- Define logical ports.
- Describe the three main logical port groups.
- Describe the key differences between the OSI model and the TCP/IP model.
- Compare and contrast the advantages and disadvantages of the OSI model and the TCP/IP model.

Lesson Activities and Teaching Strategies

Estimated Time	Lesson Portion	Directions
5 min	Lesson Opener: OSI Model	<ul style="list-style-type: none"> ● Introduce learners to the importance of the OSI Model and the reason why it is imperative to understand the OSI model in order to comprehend computer networking.
5 min	Real World Scenario: OSI Model	<ul style="list-style-type: none"> ● Review the real world scenario challenge and inform learners that you will be constantly coming back to this scenario throughout the lesson to discover how to solve and apply concepts to this real situation.
20 min	Cyber Uncovered: OSI Model Overview	<ul style="list-style-type: none"> ● Introduce the OSI model and its purpose as a networking framework for implementing protocols in layers. Explain that it was developed by the International Organization for Standardization (ISO) in 1974.

		<ul style="list-style-type: none"> ● Present the seven layers of the OSI model: Application, Presentation, Session, Transport, Network, Data Link, and Physical. Emphasize that network traffic is assembled (encapsulated) from the top layer to the bottom layer when generated and goes through the model in the reverse direction when received. ● Discuss the upper layers of the OSI model, including Layer 7 (Application) where users interact directly with applications, Layer 6 (Presentation) responsible for data format translation, and Layer 5 (Session) responsible for creating and managing sessions between devices. ● Explain the Transport Layer (Layer 4) in detail, covering its role in coordinating data transfers, ensuring data integrity, and providing flow control and reliability. Discuss protocols such as TCP and UDP in this layer. ● Explore the Network Layer (Layer 3) and its function in organizing data into IP datagrams with logical source and destination addresses. Discuss the role of routers in this layer and mention diagnostic tools like ping and tracert. ● Describe the lower layers of the OSI model, including Layer 2 (Data Link) responsible for node-to-node data transfer and error detection, and Layer 1 (Physical) defining how data is physically sent through the network. Mention the sub-layers of the Data Link layer (MAC and LLC). Discuss the role of switches in the Data Link layer and hubs in the Physical layer. ● Be prepared to discuss the implication of the real world scenario presented at the beginning of class. Engage the learners by asking the questions found on the slide and encourage discussion in class.
20 min	Cyber Uncovered: Devices Per layer	<ul style="list-style-type: none"> ● Introduce the concept of upper layer devices and their role in providing specific network services to applications and end-users. Explain the use of application protocols such as DNS, DHCP, HTTP, and HTTPS in the Application layer. ● Discuss the functions of the Presentation layer, emphasizing data translation, encryption, and decryption to ensure compatibility between different applications. ● Explore the Session layer devices and their responsibilities in establishing, managing, and terminating communication sessions between applications. Emphasize their role in providing connectivity between different types of networks. ● Focus on Transport layer devices and their role in providing reliable end-to-end communication between applications. Discuss the use of transport protocols like TCP and UDP to

		<p>establish and manage communication sessions, ensure data integrity, and provide flow control.</p> <ul style="list-style-type: none"> ● Discuss the functions of Network layer devices in routing packets between different networks. Explain how devices such as routers use logical IP addresses to make routing decisions based on these addresses. ● Describe the role of Data Link layer devices in ensuring error-free data transmission between adjacent network nodes. Highlight the use of MAC addresses for device identification on the local network and mention devices like switches and network interface cards. ● Be prepared to discuss the implication of the real world scenario presented at the beginning of class. Engage the learners by asking the questions found on the slide and encourage discussion in class.
5 min	Break	<ul style="list-style-type: none"> ● Share a timer on the screen so there is clarity as to when class will resume. Ensure cameras and microphones are disabled during the break.
20 min	Cyber Uncovered: Network Protocols Per Level	<ul style="list-style-type: none"> ● Discuss the importance of protocols found within the application layer emphasizing secure vs non-secure protocols and examples of how each of these protocols are used to transfer data between hosts. Emphasize the need for secure protocols to protect sensitive information and prevent unauthorized access. ● Be prepared to discuss the implication of the real world scenario presented at the beginning of class. Engage the learners by asking the questions found on the slide and encourage discussion in class.
20 min	Cyber Uncovered: Transport Protocols	<ul style="list-style-type: none"> ● Introduce TCP and UDP as protocols used to transmit data over the network. Emphasize that TCP and UDP operate at Layer 4 (transport layer) of the OSI model. ● Discuss TCP in detail, highlighting its reliability and widespread usage compared to UDP. Explain the three-way handshake process used by TCP to establish a connection and the importance of packet marking and correct ordering. Mention the relevant RFC (RFC 793) for further reading. ● Explore UDP and its focus on speed and low overhead. Explain that UDP sends packets without checking data integrity and is suitable for applications like streaming audio. Discuss the RFC (RFC 768) that describes UDP in detail. ● Be prepared to discuss the implication of the real world scenario presented at the beginning of class. Engage the

		learners by asking the questions found on the slide and encourage discussion in class.
5 min	Pulse Check	<ul style="list-style-type: none"> After the poll is concluded, review the results with the learners. Encourage those in the red zone to attend office hours and/or to reach out to the instructors for assistance.
5 min	Break	<ul style="list-style-type: none"> Share a timer on the screen so there is clarity as to when class will resume. Ensure cameras and microphones are disabled during the break.
20 min	Cyber Uncovered: Logical Ports	<ul style="list-style-type: none"> Discuss logical ports and their significance in network communication. Explain that logical ports represent services or protocols on the end devices and enable communication between different processes. Use the analogy of street addresses and apartment numbers to clarify the concept. Explain the three main groups of logical ports: well-known ports, registered ports, and dynamic or private ports. Discuss the purpose and examples of each group. Also, mention the common protocol ports used in network communication. Potentially demonstrate how netstat can be used as a discovery and/or troubleshooting tool. Be prepared to discuss the implication of the real world scenario presented at the beginning of class to network types and devices. There are specific prompts that you should ask learners to reflect on to apply this concept to the real world scenario.
25 min	Cyber Uncovered: Data Encapsulation	<ul style="list-style-type: none"> Emphasize that encapsulation involves structuring data in a specific format for successful delivery from source to destination. Mention that the opposite process of encapsulation is called decapsulation, which occurs when the host receives the message. Describe how encapsulation is a fundamental process in both OSI and TCP/IP models. Outline the steps involved in data encapsulation from the user's click on a link to data transmission. Discuss the role of each layer (application, presentation, session, transport, network, data) in the encapsulation process. Be prepared to discuss the implication of the real world scenario presented at the beginning of class to network types and devices. There are specific prompts that you should ask learners to reflect on to apply this concept to the real world scenario.

5 min	Break	<ul style="list-style-type: none"> ● Share a timer on the screen so there is clarity as to when class will resume. Ensure cameras and microphones are disabled during the break.
20 min	Cyber Uncovered: TCP/IP Model	<ul style="list-style-type: none"> ● Highlight the similarities and differences between OSI and TCP/IP models. ● Introduce the TCP/IP model as a suite of communication protocols used for interconnecting network devices on the internet. Discuss its purpose in describing how data is exchanged, addressing, routing, and recovering from network failures. Mention that TCP/IP was developed by DARPA in 1982. ● Explain the layers in the TCP/IP model, highlighting that they are similar to OSI except for the top three layers. Emphasize the client-server model of communication and the stateless nature of TCP/IP protocols. ● Discuss the Application Layer, explaining its role in defining TCP/IP application protocols and how host programs interface with transport layer services. Provide examples of higher-level protocols such as DNS, HTTP, Telnet, SSH, FTP, and others. Mention that the TCP/IP top layer combines the three top layers of OSI. ● Cover the Transport Layer, focusing on its coordination of data transfers between end systems and hosts. Discuss its responsibilities in verifying data integrity, recovering from errors, and organizing data into segments. Explain the concepts of flow control, multiplexing, and reliability. Highlight the correspondence between the transport layer in TCP/IP and OSI. ● Explore the Internet Layer, describing its function in organizing data into IP datagrams with logical source and destination addresses. Discuss the role of routers in this layer and their responsibility for delivering packets across multiple paths. Draw a comparison between the internet layer in TCP/IP and the network layer in OSI. ● Discuss the Network Access Layer, the lowest layer of the TCP/IP model, responsible for delivering packets within the physical network. Explain the organization of data into frames, the use of protocols for delivering data to directly connected devices, and the transmission of data on different media. Relate the network access layer in TCP/IP to the data link and physical layers in OSI. ● Be prepared to discuss the implication of the real world scenario presented at the beginning of class. Engage the

		learners by asking the questions found on the slide and encourage discussion in class.
20 min	Lab: Understanding Network Models	<ul style="list-style-type: none"> • The instructor will demonstrate the lab and encourage learners to participate during the live session • Remind learners to use this lab to practice and apply the concepts they have learned. • Learners will receive direct feedback on their lab in order to properly assess their knowledge and determine where they might need additional assistance.
5 min	Discussion Board	<ul style="list-style-type: none"> • Allocate a few minutes on the Review Discussion Board Slides reviewing requirements and impact on final grade.
5 min	Lesson Closure	<ul style="list-style-type: none"> • Spend just a few minutes reminding the learners what the key "take-aways" were from the lesson and what they should do to prepare for the next module. The take-aways discussion should include key concepts such as encapsulation and decapsulation. Learners should spend more time learning and understanding how the various layers support the processes of ensuring the payload is prepared for network communication. • You will be able to use the data collected in the pulse check to help with the lesson closure. Remind those learners that reported being in the "red zone" to take advantage of office-hours. • Recommend that the learners ensure they submit all of the assignments on-time to ensure the appropriate credit is provided to them. • Q&A
	Additional Time Filler (if needed)	<ul style="list-style-type: none"> • Kahoot • Discuss interview prep and questioning • Use breakout rooms for additional lab practice • Continue Real World Scenario Conversation

Share Your Experience

Cybersecurity is a challenging field and learners need to stay motivated and engaged. To learners, you are not only a subject matter expert but also a role model and an inspiration.

Consider sharing your personal experience in these areas:

- Can you share a personal experience where you faced a cybersecurity challenge that required motivation and perseverance to overcome? How did you stay engaged and motivated throughout the process?
- As a cybersecurity professional, what inspired you to pursue this field and continue to stay passionate about it? Was there a specific event or realization that sparked your interest?

- Can you share a personal experience where you applied the OSI model to troubleshoot a network communication issue? How did the layered approach of the model help you identify and resolve the problem effectively?
- Have you ever encountered a situation where understanding the OSI model was crucial for securing a network or mitigating a cybersecurity threat? How did the model's clear separation of functions assist you in implementing appropriate security measures?