Networking Academy

Industrial Networking Essentials v1.0

Scope and Sequence

Version 1.0

Contents

Target Audience

The Cisco Networking Academy "Industrial Networking Essentials" course is designed for students in secondary and post-secondary educational institutions, as well as any learner interested in learning the basics of technologies and protocols used in modern industrial network infrastructures.

Prerequisites

Learners should have basic computer skills, including familiarity with operating systems and internet usage. It is also recommended to have a basic understanding of industrial components such as sensors, actuators, programmable logic controllers (PLC), and remote terminal units (RTU).

Course Description

Industrial Networking Essentials offers a comprehensive introduction to networking concepts crucial for modern industrial infrastructures. The course emphasizes the integration of Information Technology (IT) and Operational Technology (OT), particularly exploring reference topologies specific to two verticals: manufacturing and power energy.

A key feature of this course is the practical application of industrial skills using Cisco Packet Tracer. Learners will have the opportunity to practice configuring and test industrial network scenarios on their personal computers, gaining practical experience in a virtual environment.

The course design includes:

- 17 modules focusing on essential networking concepts tailored to industrial contexts.
- A per-module Glossary of Terms is provided to enhance the learning experience.
- Emphasis on applied skills with 3 labs and 22 Cisco Packet Tracer activities to simulate real-world industrial scenarios.
- Videos and quizzes to enhance learning experiences and knowledge retention.
- 1 final exam that, upon successful completion, awards a Digital Badge,

The estimated time commitment for the course is 35 hours, offering flexibility to accommodate different learning paces and schedules.

Course Objectives

The course aims to develop a foundational understanding of networking within the context of industrial settings. Key objectives include:

- Explain the components of a hierarchical network design and its significance in industrial settings.
- Identify and describe network types, components, media and connections
- Explain wireless communication techniques within integrated IT and OT environments.
- Highlight the importance of standards and protocols in ensuring reliable and interoperable network communications.
- Explain how communication occurs on Ethernet networks

- Explain the features and structure of IP address
- Configure routers to enable connectivity between different networks
- Explain how clients access network services and understand the function of common application layer services.
- Discuss how application layer protocols function within the Industrial Internet of Things (IIoT).
- Build a simple, simulated Industrial Automation and Control Systems (IACS) network using Cisco devices.

Equipment Requirements

For the best learning experience, we recommend using a personal computer (Windows, Mac, or Ubuntu) that supports Cisco Packet Tracer 9.0.0 or higher.

Course Outline

The " Industrial Networking Essentials " course is structured into 17 modules that cover specific competencies.

The table below details the modules and their associated competencies. Each module is an integrated unit of learning that consists of content, activities, and assessments that target a specific set of competencies. The size of the module depends on the depth of knowledge and skill needed to master the competency.

Module Title and Objective

Module Title/Topic Title	Objective
Module 1: Networking Concepts for Operations and Technologies	**Explain components of a hierarchical network design.**
1.1: IT and OT	Explain the need for a synthesis of the Information Technologies and Operational Technologies functions in the Industrial Internet of Things.
1.2: Industrial Networking	Explain the features of IIoT implementations.
Module 2: Network Components, Types, and Connections	**Explain network types, components, and connections.**
2.1: Clients, Servers, and Peers	Explain the roles of clients and servers in a network.
2.2: Network Components	Explain the roles of network infrastructure devices.
2.3: Network Types	Explain the use of different network types in IT and OT networks.
Module 3: Network Media	**Describe common network media.**
3.1: Network Media Types	Describe common types of network cables.
Module 4: Wireless Networks in Integrated IT and OT Systems	**Configure wireless communication in an integrated IT - OT environment.**
4.1: Wireless Networks	Describe the different types of networks used by cell phones and mobile devices.
4.2: Learning with Cisco Packet Tracer	Use Cisco Packet Tracer to configure a wireless network.
4.3: Wireless Protocols in IT and OT networks	Describe wireless network protocols that are common in IT and OT networks.

Module Title/Topic Title	Objective
Module 5: Communication Principles	**Explain the importance of standards and protocols in network communications.**
5.1: Communication Protocols	Describe network communication protocols.
5.2: Communication Standards	Describe network communication standards.
5.3: Network Communication Models	Compare network protocol models.
5.4: IACS Protocols	Describe important IACS protocols.
Module 6: Network Design	**Explain components of a hierarchical network design.**
6.1: Reliable Networks	Describe the four basic requirements of a reliable network.
6.2: Hierarchical Network Design	Explain the function at each layer of the 3-layer network design model.
Module 7: The Access Layer	**Explain how communication occurs on Ethernet networks.**
7.1: Ethernet MAC Address	Explain the types of Ethernet MAC addresses.
7.2: Encapsulation and the Ethernet Frame	Explain the process of encapsulation and Ethernet framing.
7.3: Access Layer Network Communications	Explain how to improve network communication at the access layer.
7.4: The MAC Address Table	Explain how a switch builds its MAC address table and forwards frames.
7.5: Access Control with Ethernet Switches	Explain how Ethernet switches can be configured to segment networks.
Module 8: Configuring Network Devices	**Use a command line interface to configure network devices.**
8.1: IOS Navigation	Use correct commands to navigate device configuration modes.
8.2: The Command Structure	Explain how to configure network devices.
8.3: View Device Information	Use show commands to monitor device operations.
8.4: Basic Switch Configuration	Configure initial settings on a network switch.
8.5: Configure VLANs and Trunking	Configure a switch with VLANs and trunking based on requirements.
Module 9: The Internet Protocol	**Explain the features of an IP address.**
9.1: Purpose of an IPv4 Address	Explain the purpose of an IPv4 address.
9.2: The IPv4 Address Structure	Explain how IPv4 addresses and subnets are used together.
Module 10: IPv4 Addressing	**Explain how IPv4 addresses are used in network communication and segmentation.**
10.1: Network Segmentation	Explain how subnetting segments a network to enable better communication.
10.2: IPv4 Unicast, Broadcast, and Multicast	Compare the characteristics and uses of the unicast, broadcast and multicast IPv4 addresses.
10.3: Types of IPv4 Addresses	Explain public, private, and reserved IPv4 addresses.
10.4: IPv4 Address Structure - Segmentation with Addresses	Describe the structure of an IPv4 address including the network portion, the host portion, and the subnet mask.
10.5: Subnet an IPv4 Network	Calculate IPv4 subnets for a /24 prefix.
Module 11: Gateways to Other Networks	**Configure routers to interconnect networks.**
11.1: Basic Router Configuration	Configure initial settings on a router.
11.2: Configure the Default Gateway	Configure devices to use the default gateway.
11.3: Network Boundaries	Describe network (IT/OT) boundaries.
11.4: Network Address Translation	Explain the purpose of Network Address Translation in small networks.

Module Title/Topic Title	Objective
Module 12: Routing Between Networks	**Create a fully connected LAN.**
12.1: The Need for Routing	Explain the need for routing.
12.2: The Routing Table	Explain how routers use routing tables to make forwarding decisions.
12.3: Create a LAN	Build a fully connected network.
Module 13: Transport Layer	**Explain how clients access services**
13.1: TCP and UDP	Compare TCP and UDP transport layer functions.
13.2: Port Numbers	Explain how TCP and UDP use port numbers.
Module 14: Application Layer Services	**Explain the function of common application layer services.**
14.1: The Client Server Relationship	Explain client and server interaction.
14.2: Network Application Services	Describe common network applications.
14.3: Web Clients and Servers	Describe HTTP and HTML.
14.4: Virtual Terminals	Describe Telnet and SSH.
14.5: Authentication, Authorization, and Accounting (AAA)	Describe AAA services.
Module 15: Application Layer Implementations in IACS and the Industrial Internet of Things	**Explain how application layer protocols function in the IIoT.**
15.1: Common OT Data and Messaging Protocols	Explain how IIoT messaging protocols function.
15.2: Special Use Application Layer Protocols	Explain how special use protocols function in different industrial verticals.
Module 16: Build a Small IACS Network	**Build a simple IACS (Industrial Automation and Control Systems) network using Cisco devices.**
16.1: IACS Network Basics	Describe the components required to build a basic IACS network.
16.2: Harden Network Devices	Configure device hardening features to mitigate security threats.
16.3: Configure a Small IACS Network	Configure a simple IACS network using Cisco devices.
Module 17: Build a Simple Digital Substation Network (OPTIONAL Module)	**Connect IACS and Substation networks.**
17.1: Digital Substation Network Basics	Describe digital substation network technologies.
17.2: Set Up Devices	Connect network devices for Substation communications.

Note: Module 17 is optional and intended for those interested in exploring the fundamentals of a Digital Substation network (Power Energy). The content of this module is not assessed in the course final exam.

This course features a range of Cisco Packet Tracer Activities specifically tailored to the manufacturing and power energy sectors. These activities offer dedicated lab exercises for certain topics, uniquely designed for each industry vertical, providing targeted and relevant learning experiences

Below is the list of suggested lab activities for those interested in exploring the Power Energy Vertical:

Lab ID	Title
4.2.11	Packet Tracer - Create a Simple Network
6.2.2	Lab - View Wireless and Wired NIC Information
7.4.8	Lab - Use Wireshark to View CIP Traffic
7.4.9	Lab – Ethernet/IP Packet Analysis using Wireshark
8.2.6	Packet Tracer - Navigate the IOS
8.3.3	Packet Tracer - Use Cisco IOS Show Commands
8.4.4	Packet Tracer - Implement Basic Connectivity
8.5.5	Packet Tracer - VLAN Configuration
8.5.7	Packet Tracer - Configure Trunks
9.1.4	Packet Tracer - Connect to a Web Server
10.5.5	Packet Tracer - Subnet an IPv4 Network
11.1.4	Packet Tracer - Configure Initial Router Settings
11.2.4	Packet Tracer Tutorial Activity - Build a Switch and Router Network
11.2.5	Packet Tracer - Troubleshoot Default Gateway Issues
11.4.5	Packet Tracer - Examine NAT
12.3.3	Packet Tracer - Create a LAN (Energy)
12.3.4	Packet Tracer - Observe Traffic Flow in a Routed Network (Energy)
14.1.5	Packet Tracer - The Client Interaction (Energy)
14.3.3	Packet Tracer - Observe Web Requests (Energy)
14.4.4	Packet Tracer - Use Telnet and SSH (Energy)
16.2.11	Packet Tracer - Configure SSH
16.3.2	Packet Tracer - Configure the IDMZ Firewall
16.3.3	Packet Tracer - Configure Devices in the Industrial Zone (Energy)
17.2.1	Packet Tracer - Configure a Simple Substation Network
17.2.2	Packet Tracer - Configure a Simple IACS Network

Below is the list of suggested lab activities for those interested in exploring the Manufacturing vertical:

Lab ID	Title
4.2.11	Packet Tracer - Create a Simple Network
6.2.2	Lab - View Wireless and Wired NIC Information
7.4.8	Lab - Use Wireshark to View CIP Traffic
7.4.9	Lab – Ethernet/IP Packet Analysis using Wireshark
8.2.6	Packet Tracer - Navigate the IOS
8.3.3	Packet Tracer - Use Cisco IOS Show Commands
8.4.4	Packet Tracer - Implement Basic Connectivity
8.5.5	Packet Tracer - VLAN Configuration
8.5.7	Packet Tracer - Configure Trunks
9.1.4	Packet Tracer - Connect to a Web Server
10.5.5	Packet Tracer - Subnet an IPv4 Network
11.1.4	Packet Tracer - Configure Initial Router Settings
11.2.4	Packet Tracer Tutorial Activity - Build a Switch and Router Network
11.2.5	Packet Tracer - Troubleshoot Default Gateway Issues
11.4.5	Packet Tracer - Examine NAT
12.3.3	Packet Tracer - Create a LAN (Manufacturing)
12.3.4	Packet Tracer - Observe Traffic Flow in a Routed Network (Manufacturing)
14.1.5	Packet Tracer - The Client Interaction (Manufacturing)
14.3.3	Packet Tracer - Observe Web Requests (Manufacturing)
14.4.4	Packet Tracer - Use Telnet and SSH (Manufacturing)
16.2.11	Packet Tracer - Configure SSH
16.3.2	Packet Tracer - Configure the IDMZ Firewall
16.3.3	Packet Tracer - Configure Devices in the Industrial Zone (Manufacturing)
17.2.1	Packet Tracer - Configure a Simple Substation Network
17.2.2	Packet Tracer - Configure a Simple IACS Network