

INTERNETWORKING BLUEPRINT

This Blueprint contains the subject matter content of this Skill Connect Assessment. This Blueprint does **NOT** contain the information one would need to fully prepare for a SkillsUSA Championships contest. Please refer to the *SkillsUSA Championships Technical Standards* CD-ROM for the current year or purchase and download the relevant "Contest Singles." Both are available through www.skillsusa.org > Shop > Educational Materials Catalog.

Standards and Competencies

Explain common networking concepts and terminology

- Identify the basic characteristics of LANs and WANs
- Explain the concept of bandwidth and throughput and factors that affect them
- List and describe the components necessary to create a small LAN using wire or wireless media
- Identify the roles of various network devices in a network (NICs, hubs, switches, routers, firewalls, AP)
- Explain the concept of latency and how it can be minimized
- Describe the advantages and disadvantages associated with implementing common physical topologies: star/extended star, ring and mesh
- Explain the importance of implementing basic security in computer networks

Install and troubleshoot basic hardware and software required to communicate in a simple network and test for connectivity

- Identify the pin-outs and construct a UTP (patch, console and crossover) cable for connectivity
- Specify the cable type required for the various Ethernet connections
- Configure a host with the appropriate addressing parameters to connect to a network
- Verify and troubleshoot basic connectivity using various testing tools, utilities and commands (cable testers, ping, trace, IP configuration, etc.)
- Document the physical and logical aspects of network topology
- Determine and install the appropriate network cabling and media required for connectivity between devices
- Configure, connect, verify and troubleshoot issues with the operation of an Ethernet NIC
- Determine the physical issues associated with cabling network equipment working over a WAN link

Compare and contrast various types of media used for networking

- Explain the characteristics and benefits of copper cable, fiber and wireless network media (air) in network applications, including data transmission speeds
- Identify the basic characteristics of UTP and fiber cables
- Identify Ethernet cabling issues that can cause degraded service
- Explain practical factors that cause attenuation of data signals over the different network media types (copper, fiber, air [radio frequency], and identify possible solutions to a media problem
- Identify basic concerns of implementing faster Ethernet

Explain the fundamental concepts associated with media access techniques (Ethernet operation, MAC, LLC, CSMA/CD)

- Describe the differences between full duplex and half duplex transmissions
 - Describe media access considerations of each
- Explain the function of auto negotiation of speed and duplex
- Describe the function of the Data Link Layer as it applies to Ethernet, including MAC and LLC sublayers

- Explain the concept of broadcast media and the addressing of a layer 2 broadcast on an Ethernet media
- Describe and discuss CSMA/CD, including the process, listen, send, collision, jam and back off

Optimize network design in regard to segmentation, collision domains and broadcast domains

- Describe basic operation of hubs and repeaters as they apply to Ethernet
- Explain how collisions are detected and managed in Ethernet networks
- Explain the concepts of collision domains and network segmentation
- Explain the benefits of using a switch versus using a hub in an Ethernet network
- Explain how collisions and excessive broadcasts occur in networks
 - Identify devices used to minimize collision and excessive broadcast effects

Implement and correct problems associated with basic IP addressing and sub netting schemes

- Explain the purpose of an IP address, subnet mask and a default gateway
 - Identify the appropriate address required for internetwork communication between hosts
- Categorize the different IP v4 address classes and their identifying features
- Explain the advantages and disadvantages of using public and private IP v4 addresses
- Determine whether an IP address is a network, broadcast, subnet, public or private IP v4 address
- Determine the appropriate subnet mask and IP addressing scheme required to meet network requirements for scalability and functionality
- Identify the methods for a node to obtain an IP address (include static and dynamic methods)
- Correct common problems associated with implementing basic IP addressing schemes in a network environment

Describe fundamental concepts of switching and routing

- Explain the major functions of a switch
- Explain the major functions of a router
- Explain the basic use of routed and routing protocols in network
- Describe the forwarding of frames and packets in switched and routed networks
- Describe the characteristics and functions of IP (connectionless and unreliable)
- Compare the basic concepts of static and dynamic routing
- Explain the OSI model and its functionality in computer networking

Define the Layers of the OSI model

- Explain the benefits of using the OSI model as a conceptual framework for network communication
- Explain the process of encapsulation and identify the protocol data units associated with each OSI Layer model
- Identify and describe the functions of network devices at each layer of the OSI model
- Explain ARP and when it is used
- Compare and contrast connection and connectionless delivery of packets in a network
- Describe the primary functions of the transport layer
- Compare and contrast characteristics of TCP and UDP
- Identify and describe the major TCP/IP protocols used at each layer of the OSI model
- Identify basic issues that occur at each layer using the OSI model
 - Identify the fields in the headers of protocol data units
 - Describe their role in propagating data in a network (MAC address, IP address, TCP port number)

Describe the importance of a router in a WAN configuration

- Compare WAN connections to LAN connections
- Identify the role of a router in a WAN
- Describe the importance of a WAN router
- Describe router physical characteristics

- Connect all router external connections, management, LAN and WAN

Configure a router to multiple networks by using the IOS software

- Identify the workings of an operating system works with the router
- Determine the state of the router interfaces using the LED indicators
- Identify the features of the IOS for services that will be delivered on the network

Log in to a router, record the IOS and running configuration and use troubleshooting commands

- Describe the boot process
- Log in and navigate throughout the router IOS
- Fix errors by utilizing troubleshooting command line errors
- View the image names and memory of the router by using the show version command 6

Configure a router by utilizing the CLI

- Utilize CLI command modes
- Configure a router name
- Configure router passwords
- Utilize the show commands
- Configure a serial interface and Ethernet interface
- Change configurations
- Configure interface descriptions
- Configure interface description
- Configure login banners and MOTD
- Configure host tables
- Back up the configuration file by using the copy command to back up the configuration file

Discover other devices on the network using the router

- Document neighboring routers and Cisco devices by using Cisco Discovery Protocol (CDP) commands
- Monitor CDP
- Disable CDP
- Troubleshoot CDP
- Gather information about remote devices by using Telnet
- Establish and verify a Telnet connection
- Disconnect and suspend Telnet sessions
- Use advanced Telnet operation
- Troubleshoot IP address issues

Manage the IOS software

- Identify where a Cisco device locates and loads IOS
- Utilize the boot system command
- Configure the register
- Troubleshoot IOS boot failure
- Manage the Cisco file system
- Identify IOS naming conventions
- Utilize TFTP to manage and copy

Configure routing protocols

- Identify the workings of a static route
- Configure static routes
- Configure default route forwarding
- Verify static route configuration
- Troubleshoot static route configuration
- Identify the purpose of a routing protocol and autonomous system

- Identify the classes of routing protocols
- Identify distance vector routing protocol features and examples
- Discuss link-state routing protocol features and examples
- Describe path determination
- Configure RIP and OSPF single area

Identify and utilize distance vector routing protocols

- View distance vector routing updates, hold-down timers, and RIP processes
- Eliminate routing loops through split horizon, route poisoning, triggered updates
- Utilize RIP as the routing protocol
- Configure RIP
- Utilize the IP classless command
- Verify RIP configuration
- Troubleshoot RIP update issues
- Load balance using RIP
- Load balance across multiple paths
- Integrate static routes with RIP

Use TCP/IP suite error and control messages to troubleshoot a router

- Identify TCP/IP error message
- Utilize ICMP
- Utilize ICMP message delivery
- Discover unreachable networks
- Utilize ping to test destination reach ability
- Define echo messages
- Utilize the TCP/IP suite control messages
- Utilize ICMP redirect/change request
- Utilize requests and reply message formats
- Utilize congestion and flow control message

Use basic show commands to troubleshoot the router

- Utilize the show IP route command to determine the gateway of last resort, route source and destination, L2 and L3 addresses, administrative distance, route metric, the route next hop, last route update and multiple paths to destination
- Identify OSI layers
- Troubleshoot Layer 1 using show interface
- Troubleshoot Layer 2 using show interface
- Troubleshoot using show CDP
- Troubleshoot using trace route
- Troubleshoot routing issues
- Troubleshoot using show controllers serial
- Utilize the debug command

Identify the intermediate TCP/IP operations and porting

- Identify synchronization process or three-way handshake
- Define a denial-of-service attack
- Identify how windowing, sequencing numbers and positive ACK work together to deliver data packets
- Compare UDP with TCP
- Observe transport layer ports
- Test multiple conversations between hosts
- Define ports for services, clients and numbering and well known port numbers
- Compare and contrast MAC addresses, IP addresses and port numbers

Identify and utilize access control lists (ACLs) to add security to the network

- Describe access control list fundamentals

- Create ACLs
- Discuss the function of a wildcard mask
- Utilize an ACL by Verify
- Compare standard, extended ACLs and named ACLs
- Place an ACL to create the requested security inside a firewall

Define and use variable length subnet masking (VLSM)

- Define VLSM and why is it used
- Recognize when to use VLSM
- Calculate subnets with VLSM
- Recognize route aggregation with VLSM
- Configure VLSM on a multi-router network

Describe how RIP Version 2 is incorporated in a routed network

- Compare RIP v1 and v2
- Configure RIP v2
- Verify RIP v2
- Troubleshoot RIP v2

Understand how to design and implement single-area OSPF

- Recognize link-state routing protocol
- Compare the advantages and disadvantages of link-state routing
- Compare and contrast distance vector and link-state routing
- Compare OSPF with distance vector routing protocols
- Observe single area OSPF configuration
- Configure the OSPF routing process
- Configure OSPF loopback address and router priority
- Modify OSPF cost metric
- Configure OSPF authentication
- Configure OSPF timers
- Verify the OSPF configuration
- Troubleshoot OSPF configuration

Describe and implement EIGRP routing protocol

- Recognize EIGRP concepts
- Describe EIGRP concepts and terminology
- Configure EIGRP
- Configure EIGRP summarization
- Verify basic EIGRP
- Troubleshoot EIGRP configuration

Understand how switching operates switching concepts

- Recognize Ethernet/802.3 LAN technologies
- Recognize factors that impact network performance
- Recognize network segmentation using hardware devices
- Recognize basic operations of a switch
- Compare Layer 2 and Layer 3 switching
- Compare symmetric and asymmetric switching
- Recognize micro segmentation implementation
- Recognize the effects switches have on a collision domain

Understand the use of the access, distribution and core layers in switching and routing

- Describe LAN design goals
- Utilize a 1,2,3 layered model in the switch design

Understand how to do a complete switch configuration

- Verify port LEDs during switch POST
- View initial boot output from the switch
- Examine keyboard help in the switch CLI
- Recognize switch modes
- Configure the switch
- Verify the catalyst switch default configuration
- Configure the catalyst switch
- Manage the MAC address table
- Configure static MAC addresses
- Configure port security
- Execute a plan for adds, moves and changes
- Manage switch operating system
- Define password recover
- Recognize firmware upgrade

Understand how spanning tree protocol has an effect on network design and setup

- Describe redundant topologies
- Describe a broadcast storm
- Recognize redundant topology and spanning tree
- Describe spanning tree operations
- Design the configuration to select a root bridge
- Select the stages of spanning tree port states
- Describe spanning tree recalculation and its effects on the network

Describe how virtual LANs help to control broadcast domains and how this benefits the LAN network

- Recognize VLAN concepts
- Demonstrate the relationship between broadcast domains with VLANs and routers
- Describe VLAN types

Configure a VLAN-using network design concept

- Define geographic VLANs
- Configure static VLANs
- Verify VLAN configuration
- Save VLAN configuration
- Delete VLANs
- Troubleshoot VLANs

Utilize virtual trunking protocol to set up multiple ports on a router and switch

- Describe Trunking concepts
- Describe Trunking operation
- Describe VTP concepts and how to configure and implement them in a physical and logical network design
- Divide physical interfaces into sub-interfaces
- Configure inter-VLAN routing

Demonstrate how to use NAT and PAT to scale IP addresses over a multi-network configuration

- Name the private address spaces
- Identify the features of NAT and PAT
- Configure NAT and PAT
- Verify PAT configuration
- Troubleshoot NAT and PAT configurations
- Identify and utilize DHCP in a router configuration

- Verify DHCP operation
- Troubleshoot DHCP

Recognize the use of WAN technologies in the configuration of a router and the delivery of data

- Name the WAN devices
- Identify WAN standards and encapsulation types
- Compare packet and circuit switching
- Name the WAN link options and technology related to them
- Incorporate WAN design into the network scheme
- Know how to identify and select networking capabilities
- Use a three-layer design model

Understand and configure a secure PPP serial connection

- Define a serial point-to-point links
- Define time-division multiplexing
- Use demarcation point as a reference for security
- Define DTE-DCE
- Compare HDLC encapsulation to PPP
- Configure PPP authentication
- Compare password authentication Protocol (PAP) to challenge handshake authentication protocol
- Configure PPP
- Verify the serial PPP encapsulation configuration
- Troubleshoot the serial PPP encapsulation configuration

Illustrate ISDN and DDR concepts

- Discuss ISDN standards and access methods
- Name the ISDN switch types
- Configure ISDN BRI/PRI ports
- Verify ISDN configuration
- Troubleshoot the ISDN configuration
- Configure legacy DDR
- Define static routes for DDR
- Configure DDR dialer information
- Set up a dialer profile
- Configure dialer profiles
- Verify DDR configuration
- Troubleshoot the DDR configuration

Configure a point-to-point and multi-point Frame Relay circuit

- Describe frame relay concepts
- Define frame relay terminology
- Configure a basic frame relay
- Configure a static frame relay map
- Configure frame relay sub-interfaces
- Verify the frame relay configuration
- Troubleshoot the frame relay configuration

Demonstrate best practices of network administration

- Define and compare workstations and servers
- Define NOS
- Use popular network operating systems Microsoft XP, 2000, NET, UNIX Sun, HP and LINUX versions as they relate to a network
- Describe SNMP and CMIP standards
- Configure SNMP and use syslogs to monitor networks

Provide customer support

- Converse effectively and correctly with a customer
- Speak clearly and to the point when conversing about products and solutions for the customer
- Repeat name, location and phone number back to the customer during technical support conversations
- Record all conversations with customers as either information, need to know or solution delivered
- Make good comparisons that the customer can relate to when troubleshooting a problem
- Take the needed actions to fix the customer's problem
- Close the conversation with a positive, reassuring attitude

Demonstrate professional development skills in a simulated customer-service or employment situation. Examples may include:

- Job interview
- Customer service scenario
- Communications
- Decision making, problem solving and/or critical thinking

Committee Identified Academic Skills

The SkillsUSA national technical committee has identified that the following academic skills are embedded in the internetworking training program and assessment:

Math Skills

- Use fractions to solve practical problems
- Use proportions and ratios to solve practical problems
- Use scientific notation
- Solve practical problems involving percents
- Solve single variable algebraic expressions
- Measure angles
- Find surface area and perimeter of two-dimensional objects
- Find volume and surface area of three-dimensional objects
- Make predictions using knowledge of probability
- Make comparisons, predictions, and inferences using graphs and charts
- Organize and describe data using matrixes
- Solve problems using proportions, formulas and functions
- Binary number systems
- Boolean logic functions

Science Skills

- Plan and conduct a scientific investigation
- Describe characteristics of types of matter based on physical and chemical properties
- Use knowledge of physical properties (shape, density, solubility, odor, melting point, boiling point and color)
- Understand the modern model of atomic structure
- Use knowledge of classification of elements as metals, metalloids and nonmetals
- Describe phases of matter
- Use knowledge of potential and kinetic energy
- Use knowledge of mechanical, chemical and electrical energy
- Use knowledge of heat, light and sound energy
- Use knowledge of sound and technological applications of sound waves
- Use knowledge of the nature and technological applications of light
- Use knowledge of principles of electricity and magnetism
- Use knowledge of static electricity, current electricity and circuits

Language Arts Skills

- Provide information in oral presentations
- Demonstrate use of verbal communication skills, such as word choice, pitch, feeling, tone and voice
- Demonstrate use of nonverbal communication skills, such as eye contact, posture and gestures using interviewing techniques to gain information
- Demonstrate comprehension of a variety of informational texts
- Understand source, viewpoint and purpose of texts
- Demonstrate knowledge of appropriate reference materials
- Use print, electronic databases and online resources to access information in books and articles
- Demonstrate informational writing

Connections to National Standards

State-level academic curriculum specialists identified the following connections to national academic standards.

Math Standards

- Numbers and operations
- Problem solving
- Reasoning and proof
- Communication
- Connections
- Representation

Source: NCTM Principles and Standards for School Mathematics. To view high school standards, visit: standards.nctm.org/document/chapter7/index.htm. Select “Standards” from menu.

Science Standards

- Understands the sources and properties of energy
- Understands forces and motion
- Understands the nature of scientific inquiry

Source: McREL compendium of national science standards. To view and search the compendium, visit: www.mcrel.org/standards-benchmarks/.

Language Arts Standards

- Students apply a wide range of strategies to comprehend, interpret, evaluate and appreciate texts. They draw on their prior experience, their interactions with other readers and writers, their knowledge of word meaning and of other texts, their word identification strategies and their understanding of textual features (e.g., sound-letter correspondence, sentence structure, context, graphics)
- Students adjust their use of spoken, written and visual language (e.g., conventions, style, vocabulary) to communicate effectively with a variety of audiences and for different purposes
- Students employ a wide range of strategies as they write and use different writing process elements appropriately to communicate with different audiences for a variety of purposes
- Students use spoken, written and visual language to accomplish their own purposes (e.g., for learning, enjoyment, persuasion and the exchange of information)

Source: IRA/NCTE Standards for the English Language Arts. To view the standards, visit: www.readwritethink.org/standards/index.html.