



## INTERNETWORKING

SkillsUSA Championships Technical Standards



### PURPOSE

To evaluate each competitor's preparation for employment and to recognize outstanding students for excellence and professionalism in the field of internetworking.

### ELIGIBILITY

Open to active SkillsUSA members currently enrolled in programs with internetworking as an occupational objective. Each state may send one high school and one college/postsecondary competitor.

### CLOTHING REQUIREMENTS

#### **Class E: Competition Specific — Business Casual**

- Official SkillsUSA white polo shirt
- Black dress slacks or black dress skirt (knee-length minimum)
- Black closed-toe dress shoes

**Note:** Wearing socks or hose is no longer required. If worn, socks must be black dress socks and hose must be either black or skin-tone and seamless/nonpattern.

These regulations refer to clothing items that are pictured and described at [www.skillsusastore.org](http://www.skillsusastore.org). If you have questions about clothing or other logo items, call 1-888-501-2183.

**Note:** Competitors must wear their official competition clothing to the competition orientation meeting.

## EQUIPMENT AND MATERIALS

1. Supplied by the technical committee:
  - a. Computer workstation (if available)
  - b. Cisco routers, switches, and equipment not listed as supplied by the competitor
2. Supplied by competitor:
  - a. Laptop computer with wireless, Ethernet connection and COM port (USB with adapter)
  - b. Tools necessary to connect to a router or switch via an RS232 console connection (USB to serial adapter and console cable)
  - c. One - 6' multiple-outlet power strip
  - d. All competitors must create a one-page resume. See “Resume Requirement” below for guidelines.

### RESUME REQUIREMENT

Competitors must create a one-page resume to submit online. SkillsUSA South Carolina competitors should submit their resume by the deadline published on the competition updates page of our website. Failure to submit a resume will result in a 10-point penalty.

Your resume must be saved as a PDF file type using file name format of “Last Name\_First Name.” For example, “Amanda Smith” would save her resume as Smith\_Amanda. If you need assistance with saving your file as a PDF, visit the Adobe website for more information.

Note: Check the Competition Guidelines and/or the updates page on the state website.

### PROHIBITED DEVICES

Cellphones, electronic watches and/or other electronic devices not approved by a competition’s national technical committee are **NOT** allowed in the competition area. Please follow the guidelines in each technical standard for approved exceptions. Technical committee members may also approve exceptions onsite during the SkillsUSA Championships if deemed appropriate.

### Penalties for Prohibited Devices

If a competitor’s electronic device makes noise or if the competitor is seen using it at any time during the competition, an official report will be documented for review by the Director of the SkillsUSA Championships. If confirmed that the competitor used the device in a manner which compromised the integrity of the competition, the competitor’s scores may be removed.

## **SCOPE OF THE COMPETITION**

The competition is defined by current industry technical standards and will consist of five parts: An end-to-end network configuration, a troubleshooting exercise, a simulation TAC call, a written exam, and a design project.

### **KNOWLEDGE PERFORMANCE**

The competition will include a written exam assessing knowledge of general networking concepts.

### **SKILL PERFORMANCE**

The competition may include but is not limited to the following assessments.

### **DESIGN PROBLEM**

Competitors will be evaluated on their ability to design a network that meets specific requirements. The design problem will be posted by Thursday prior to the competition's start. Competitors are expected to complete the design before arriving at the competition. Competitors will present their design proposal during the competition.

### **END-TO-END NETWORKING**

Given a set of networking equipment (cable, fiber, hubs/switches routers, etc.) the student must, in a specified amount of time, install, or repair a network and demonstrate that the installation properly runs internet applications.

Given a logical topology and network requirements, the students will be able to develop a usable network that meets or exceeds the documentation provided. The vision and context are that client companies would request a demonstration booth that runs a particular internet application, and the student, given equipment and tools, would provide the appropriate connectivity for the application to run successfully.

### **TECHNICAL ASSISTANCE CALL**

The student must solve a networking problem while on the phone with a customer. This is a simulation of working in a Technical Assistance Center. This station not only assesses technical skill, but also communication and customer service.

### **WRITTEN EXAM**

The student must answer questions related to CCNA-level networking.

### **TROUBLESHOOTING**

Competitors will be evaluated on their ability to troubleshoot and correct issues in an already existing network.

## **WIRESHARK ANALYSIS**

Competitors will be evaluated on their ability to capture and analyze network traffic utilizing Wireshark.

## **ADDITIONAL INFORMATION AND COMPETITION UPDATES**

- For any competition updates, please reference the competition updates page on the SkillsUSA website.

## **STANDARDS AND COMPETENCIES**

### **WORK 1.0 — Network Fundamentals**

- 1.1. Explain the role and function of network components.
  - 1.1.1. Routers
  - 1.1.2. L2 and L3 switches
  - 1.1.3. Next-generation firewalls and IPS
  - 1.1.4. Access points
  - 1.1.5. Controllers (Cisco DNA Center and WLC)
  - 1.1.6. Endpoints
  - 1.1.7. Servers
  - 1.1.8. PoE
- 1.2. Describe characteristics of network topology architectures.
  - 1.2.1. 2 tier
  - 1.2.2. 3 tier
  - 1.2.3. Spine-leaf
  - 1.2.4. WAN
  - 1.2.5. Small office/home office (SOHO)
  - 1.2.6. On-premises and cloud
- 1.3. Compare physical interface and cabling types.
  - 1.3.1. Single-mode fiber, multimode fiber, copper
  - 1.3.2. Connections (Ethernet shared media and point-to-point)
  - 1.3.3. Concepts of PoE
- 1.4. Identify interface and cable issues (collisions, errors, mismatch duplex, and/or speed).
- 1.5. Compare TCP to UDP.
- 1.6. Configure and verify IPv4 addressing and subnetting.
- 1.7. Describe the need for private IPv4 addressing.
- 1.8. Configure and verify IPv6 addressing and prefix.
- 1.9. Compare IPv6 address types.
  - 1.9.1. Global unicast
  - 1.9.2. Unique local
  - 1.9.3. Link local
  - 1.9.4. Anycast
  - 1.9.5. Multicast
  - 1.9.6. Modified EUI 64
- 1.10. Verify IP parameters for Client OS (Windows, Mac OS, Linux).
- 1.11. Describe wireless principles.

- 1.11.1. Nonoverlapping Wi-Fi channels
- 1.11.2. SSID
- 1.11.3. RF
- 1.11.4. Encryption
- 1.12. Explain virtualization fundamentals (virtual machines).
- 1.13. Describe switching concepts
  - 1.13.1. MAC learning and aging
  - 1.13.2. Frame switching
  - 1.13.3. Frame flooding
  - 1.13.4. MAC address table

## **WORK 2.0 — Network Access**

- 2.1. Configure and verify VLANs (normal range) spanning multiple switches.
  - 2.1.1. Access ports (data and voice)
  - 2.1.2. Default VLAN
  - 2.1.3. Connectivity
- 2.2. Configure and verify interswitch connectivity.
  - 2.2.1. Trunk ports
  - 2.2.2. 802.1Q
  - 2.2.3. Native VLAN
- 2.3. Configure and verify Layer 2 discovery protocols (Cisco Discovery Protocol and LLDP).
- 2.4. Configure and verify (Layer 2/Layer 3) EtherChannel (LACP).
- 2.5. Describe the need for and basic operations of Rapid PVST+ Spanning Tree Protocol and identify basic operations.
  - 2.5.1. Root port, root bridge (primary/secondary), and other port names
  - 2.5.2. Port states (forwarding/blocking)
  - 2.5.3. PortFast benefits
- 2.6. Compare Cisco Wireless Architectures and AP modes.
- 2.7. Describe physical infrastructure connections of WLAN components (AP,WLC, access/trunk ports, and LAG).
- 2.8. Describe AP and WLC management access connections (Telnet, SSH, HTTP,HTTPS, console, and TACACS+/RADIUS).
- 2.9. Configure the components of a wireless LAN access for client connectivity using GUI only such as WLAN creation, security settings, QoS profiles, and advanced WLAN settings.

## **WORK 3.0 — IP Connectivity**

- 3.1. Interpret the components of routing table.
  - 3.1.1. Routing protocol code
  - 3.1.2. Prefix
  - 3.1.3. Network mask
  - 3.1.4. Next hop
  - 3.1.5. Administrative distance
  - 3.1.6. Metric
  - 3.1.7. Gateway of last resort
- 3.2. Determine how a router makes a forwarding decision by default.
  - 3.2.1. Longest match

- 3.2.2. Administrative distance
- 3.2.3. Routing protocol metric
- 3.3. Configure and verify IPv4 and IPv6 static routing.
  - 3.3.1. Default route
  - 3.3.2. Network route
  - 3.3.3. Host route
  - 3.3.4. Floating static
- 3.4. Configure and verify single area OSPFv2.
  - 3.4.1. Neighbor adjacencies
  - 3.4.2. Point-to-point
  - 3.4.3. Broadcast (DR/BDR selection)
  - 3.4.4. Router ID
- 3.5. Describe the purpose of first hop redundancy protocol.

#### **WORK 4.0 — IP Services**

- 4.1. Configure and verify inside source NAT using static and pools.
- 4.2. Configure and verify NTP operating in a client and server mode.
- 4.3. Explain the role of DHCP and DNS within the network.
- 4.4. Explain the function of SNMP in network operations.
- 4.5. Describe the use of syslog features including facilities and levels.
- 4.6. Configure and verify DHCP client and relay.
- 4.7. Explain the forwarding per-hop behavior (PHB) for QoS such as classification, marking, queuing, congestion, policing, shaping.
- 4.8. Configure network devices for remote access using SSH.
- 4.9. Describe the capabilities and function of TFTP/FTP in the network.

#### **WORK 5.0 — Security Fundamentals**

- 5.1. Define key security concepts (threats, vulnerabilities, exploits, and mitigation techniques).
- 5.2. Describe security program elements (user awareness, training, and physical access control).
- 5.3. Configure device access control using local passwords.
- 5.4. Describe security password policies elements, such as management, complexity, and password alternatives (multifactor authentication, certificates, and biometrics).
- 5.5. Describe remote access and site-to-site VPNs.
- 5.6. Configure and verify access control lists.
- 5.7. Configure Layer 2 security features (DHCP snooping, dynamic ARP inspection, and port security).
- 5.8. Differentiate authentication, authorization, and accounting concepts.
- 5.9. Describe wireless security protocols (WPA, WPA2, and WPA3).
- 5.10. Configure WLAN using WPA2 PSK using the GUI

#### **WORK 6.0 — Automation and Programmability**

- 6.1. Explain how automation impacts network management.
- 6.2. Compare traditional networks with controller-based networking.
- 6.3. Describe controller-based and software defined architectures (overlay, underlay, and fabric).

- 6.3.1. Separation of control plane and data plane
- 6.3.2. North-bound and south-bound APIs
- 6.4. Compare traditional campus device management with Cisco DNA Center enabled device management.
- 6.5. Describe characteristics of REST-based APIs (CRUD, HTTP verbs, and data encoding).
- 6.6. Recognize the capabilities of configuration management mechanisms Puppet, Chef and Ansible.
- 6.7. Interpret JSON encoded data.

### **WORK 7.0 — Important Topics Outside the CCNA's Scope**

- 7.1. Configure and troubleshoot the following Routing Protocols.
  - 7.1.1. RIP (v1 and 2)
  - 7.1.2. OSPFv2
  - 7.1.3. EIGRP
  - 7.1.4. BGP
  - 7.1.5. Static Routing
- 7.2. Configure and Troubleshoot Spanning-Tree Protocol (Rapid and regular).
- 7.3. Configure and Troubleshoot VLAN Trunking.
- 7.4. Configure and Troubleshoot Windows System administration.
  - 7.4.1. DNS
  - 7.4.2. Active Directory Users, Computers, and Groups
  - 7.4.3. DHCP
  - 7.4.4. NTP
  - 7.4.5. IP Settings
- 7.5. Configure and Troubleshoot Linux System administration.
  - 7.5.1. DNS
  - 7.5.2. Users and Groups
  - 7.5.3. DHCP
  - 7.5.4. NTP
  - 7.5.5. IP Settings
  - 7.5.6. Services
- 7.6. Perform Password Recovery on Network Devices.
- 7.7. Explain L2 and L3 headers.
- 7.8. Collect and Interpret packet captures.

### **WORK 8.0 — SkillsUSA Framework**

The SkillsUSA Framework is used to pinpoint the Essential Elements found in Personal Skills, Workplace Skills and Technical Skills Grounded in Academics. Students will be expected to display or explain how they used some of these Essential Elements. Please reference the graphic, as you may be scored on specific elements applied to your project. For more, visit: [www.skillsusa.org/who-we-are/skillsusa-framework/](http://www.skillsusa.org/who-we-are/skillsusa-framework/).



## **COMMITTEE IDENTIFIED ACADEMIC SKILLS**

The technical committee has identified that the following academic skills are embedded in this competition.

### **Math Skills**

- Use proportions and ratios to solve practical problems
- Solve problems using proportions, formulas and functions
- Binary number systems
- Bitwise shifting binary numbers
- Boolean logic functions

### **Science Skills**

- Plan and conduct a scientific investigation
- Use knowledge of mechanical, chemical and electrical energy
- Use knowledge of heat, light and sound energy
- 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 such verbal communication skills as word choice, pitch, feeling, tone and voice
- Demonstrate use of such nonverbal communication skills 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. For more information, visit: [www.nctm.org](http://www.nctm.org).*

### **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: [www2.mcrel.org/compendium/](http://www2.mcrel.org/compendium/).*

### **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.ncte.org/standards](http://www.ncte.org/standards).*