C S 50B: ROUTING & SWITCHING ESSENTIALS (CCNA)

Foothill College Course Outline of Record

Heading	Value
Effective Term:	Summer 2021
Units:	4.5
Hours:	4 lecture, 2 laboratory per week (72 total per quarter)
Advisory:	C S 50A.
Degree & Credit Status:	Degree-Applicable Credit Course
Foothill GE:	Non-GE
Transferable:	CSU
Grade Type:	Letter Grade (Request for Pass/No Pass)
Repeatability:	Not Repeatable

Student Learning Outcomes

- The student will demonstrate the ability to configure the interior gateway routing protocols RIP, RIPv2, OSPF, and EIGRP.
- The student will demonstrate the process of selecting the appropriate routing protocol for specific network requirements.

Description

This course describes the architecture, components, and operations of routers and switches in a small network. Students learn how to configure a router and a switch for basic functionality. By the end of this course students will be able to configure and troubleshoot routers and switches and resolve common issues with RIPv1, RIPv2, single-area and multi-area OSPF, virtual LANs, and inter-VLAN routing in both IPv4 and IPv6 networks. This course is preparation for the CCENT and CCNA certification exams. This course describes the architecture, components, and operations of routers, and explains the principles of routing and routing protocols. Students will be given the opportunity to configure a router for basic and advanced functionality. Students will be able to configure and troubleshoot routers and resolve common issues with RIPv1, RIPv2, EIGRP, and OSPF in both IPv4 and IPv6 networks.

Course Objectives

The student will be able to:
A. Understand and describe basic switching concepts and the operation of Cisco switches.
B. Understand and describe the purpose, nature, and operations of a router, routing tables, and the route lookup process.
C. Understand and describe how VLANs create logically separate networks and how routing occurs between them.
D. Understand and describe dynamic routing protocols, distance vector routing protocols, and link-state routing protocols.
E. Configure and troubleshoot inter-VLAN routing.
F. Configure and troubleshoot static routing and default routing.
G. Configure and troubleshoot RIP and RIPng.
H. Configure and troubleshoot an Open Shortest Path First (OSPF) network.
I. Understand, configure, and troubleshoot access control lists (ACLs) for IPv4 and IPv6 networks.
J. Understand, configure, and troubleshoot Dynamic Host Configuration Protocol (DHCP) for IPv4 and IPv6 networks.
K. Understand, configure, and troubleshoot Network Address Translation (NAT) operations.

Course Content

A. Converged switched network and basic switching concepts
1. Converged networks
a. Growing complexity of networks
b. Elements of a converged network
c. Borderless network architecture
1) Hierarchical
2) Modular
3) Resiliency
4) Flexibility
d. Access, distribution and core layers
2. Switched networks
a. Role of switched networks
b. Switch form factors
c. Multilayer switching
d. Port density
e. Forwarding rates
f. Power over Ethernet
g. Frame forwarding
1) Forwarding based on the ingress port and the destination address
2) Dynamically populating a switch MAC address table
3) Switch forwarding methods
a) Store-and-forward
b) Cut-through
h. Collision domains
i. Broadcast domains
j. Reducing network congestion
1) High port density
2) Large frame buffers
3) Port speed
4) Fast internal switching
B. The purpose, nature, and operations of a router, routing tables, and the route lookup process
1. Routing concepts
a. The router is responsible for the routing of traffic between networks
b. Routers are specialized computers containing the following required components to operate
1) Central processing unit (CPU)
2) Operating system (OS) - Routers use Cisco IOS
3) Memory and storage (RAM, ROM, NVRAM, Flash)
c. Routers interconnect networks
d. Routers choose best paths
e. Packet forwarding methods
1) Process switching
2) Fast switching
3) Cisco Express Forwarding (CEF)
4) Default gateways
5) The routing table
a) Routing table entry sources
b) Routing table lookup
2. Initial configuration of a router
a. Name the device
b. Securing management access
c. Configure interfaces

d. Configure a banner
3. Routing decisions
4. Routing operation
C. VLANs
1. Overview of VLANs
a. Characteristics of a VLAN
1) A logical partition of a Layer 2 network
a) Multiple partitions can be created, allowing for multiple VLANs to co-exist
b) VLANs are mutually isolated and packets can only pass between them via a router
c) The partitioning of the Layer 2 network takes place inside a Layer 2 device, usually via a switch
2) Each VLAN is a broadcast domain, usually with its own IP network
3) Benefits of VLANs
2. Types of VLANs
3. VLAN trunks
a. Tagging Ethernet frames for VLAN identification
b. Native VLANs and 802.1Q tagging
c. Voice VLAN tagging
d. Configuring IEEE 802.1q trunk links
e. Resetting the trunk To default state
4. VLAN assignments
a. VLAN ranges on catalyst switches
b. Creating a VLAN
c. Assigning ports to VLANs
d. Changing VLAN port membership
e. Deleting VLANs
5. Dynamic Trunking Protocol (DTP)
a. Permits ports to negotiate to become trunks
b. Negotiated interface modes
6. Troubleshooting VLAN and trunk problems
D. Dynamic routing protocols
1. Purpose of dynamic routing protocols
a. Discovery of remote networks
b. Maintaining up-to-date routing information
c. Choosing the best path to destination networks
d. Ability to find a new best path if the current path is no longer available
2. Distance vector dynamic routing
a. Distance vector protocols use routers as sign posts along the path to the final destination
b. Share updates between neighbors
c. Not aware of the network topology
d. Some send periodic updates to broadcast IP 255.255.255.255 even if topology has not changed
e. Updates consume bandwidth and network device CPU resources
f. RIPv2 and EIGRP use multicast addresses
g. EIGRP will only send an update when topology has changed
1) Large networks networks
2) Fast convergence
E. Inter-VLAN routing
1. Inter-VLAN routing operation
a. Inter-VLAN touting is a process for forwarding network traffic from one VLAN to another, using a router
b. Legacy Inter-VLAN routing
c. Router-on-a-stick Inter-VLAN routing
d. Multilayer switch Inter-VLAN routing
2. Configure legacy Inter-VLAN routing
3. Configure router-on-a-stick
4. Configure layer 3 switching
a. Layer 3 switches usually have packet-switching throughputs in the millions of packets per second (pps)
b. All Catalyst multilayer switches support the following types of layer 3 interfaces
1) Routed port
2) Switch Virtual Interface (SVI)
c. High-performance switches, such as the Catalyst 6500 and Catalyst 4500, are able to perform most of the router's functions
d. Several models of Catalyst switches require enhanced software for specific routing protocol features
e. Layer 3 switching operation and configuration
f. Inter-VLAN routing with Switch Virtual Interfaces
g. Inter-VLAN routing with routed ports
h. Configuring static routes on a Catalyst 2960
F. Static routing for IPv4 and IPv6
1. Reach remote networks
a. Manually learn routes
b. Dynamically learn routes
c. Advantages of static routes
1) Static routes are not advertised over the network, resulting in better security
2) Static routes use less bandwidth than dynamic routing protocols, no CPU cycles are used to calculate and communicate routes
3) The path a static route uses to send data is known
d. Disadvantages of static routes
1) Initial configuration and maintenance is time-consuming
2) Configuration is error-prone, especially in large networks
3) Administrator intervention is required to maintain changing route information
4) Does not scale well with growing networks; maintenance becomes cumbersome
5) Requires complete knowledge of the whole network for proper implementation
e. Configuring a static route
f. Verifying a static route
g. Configuring a default static route
h. Classful and classless routing
i. Route summarization
j. Subnetting
1) FLSM
2) VLSM
k. Floating static routes
G. Configuring Routing Information Protocols (RIP) for IPv4 and IPv6
1. Differences between the two protocols RIPv2 and RIPv2
a. The classful network statement for RIP
b. The interface command for RIPng
c. Split horizon
d. Poison reverse and route poisoning
H. OSPFv2 and OSPFv3
1. The process number and router-ID
2. Establishing neighbor relationships
3. DRs and DBRs on multi-access networks
4. OSPF packet types and their uses
5. OSPF LSA types and their uses
6. Single area OSPF
7. Multi-area OSPF
a. Area numbers
b. Stub areas
c. Not so stubby areas (NSSA)
d. Totally stubby areas (TSSA)
I. ACLs for IPv4 and IPv6
1. IP ACL operation
a. Packet filtering
b. Inbound or outbound filtering

c. Wildcard masks
2. Configuring, monitoring and troubleshooting ACLs
a. Standard IPv4 ACLs
b. Named or numbered
c. Extended IPv4 ACLs
d. ACL best practices
e. Where to place ACLs
f. Applying ACLs to an interface
g. Applying ACLs to a VTY port
h. Editing ACLs
i. Verifying ACL
j. Verifying ACLs
k. ACL sequence numbers
l. Limiting debug output with ACLs
3. Troubleshoot ACLs
a. SHOW ACL
J. Dynamic Host Configuration Protocol (DHCP)
1. DHCP features
2. BootP and DHCP differences
3. DHCP protocol
4. DHCP configuration
5. Verifying DHCP operation
6. Troubleshooting DHCP operation
K. Network address translation
1. Private IP addresses vs. public IP addresses
2. Which addresses are translated
3. Where does the translation occur
4. Configuration of NAT
a. Configure static NAT using the CLI
b. Configure dynamic NAT using the CLI
c. Configure PAT using the CLI
d. Configure port forwarding using the CLI
e. Configure NAT64
f. Use show commands to verify NAT operation
5. NAT vs. PAT
6. NAT for IPv6
7. Troubleshooting NAT
a. Show commands
b. Debug commands

Lab Content

A. Basic Router Configuration
1. Subnet an address space given requirements
2. Assign appropriate addresses to interfaces and document
3. Cable a network according to the topology diagram
4. Erase the startup configuration and reload a router to the default state
5. Perform basic configuration tasks on a router
6. Configure and activate Serial and Ethernet interfaces
7. Test and verify configurations
8. Reflect upon and document the network implementation
B. Basic Static Route Configuration
1. Cable a network according to the topology diagram
2. Erase the startup configuration and reload a router to the default state
3. Perform basic configuration tasks on a router
4. Interpret debug ip routing output
5. Configure and activate Serial and Ethernet interfaces
6. Test connectivity
7. Gather information to discover causes for lack of connectivity between devices
8. Configure a static route using an intermediate address
9. Configure a static route using an exit interface
10. Compare a static route with intermediate address to a static route with exit interface
11. Configure a default static route
12. Configure a summary static route
13. Document the network implementation
C. Routing Table Interpretation Lab
1. Interpret router outputs
2. Identify the IP addresses for each router
3. Draw a diagram of the network topology
4. Cable and configure a network based on the topology diagram
5. Test and verify full connectivity
D. RIP Troubleshooting
1. Cable a network according to the topology diagram
2. Erase the startup configuration and reload a router to the default state
3. Load the routers with supplied scripts
4. Discover where convergence is not complete
5. Gather information about the non-converged portion of the network along with any other errors
6. Analyze information to determine why convergence is not complete
7. Propose solutions to network errors
8. Implement solutions to network errors
9. Document the corrected network
E. Configure VLANs, VTP and Inter-VLAN Routing on Switches and Routers
F. Configure and Test Switchport Security
G. Describe the Benefits of Virtual LANs and Demonstrate their Configuration and Operation
H. Investigating the Routing Table Lookup Process
1. Cable a network according to the topology diagram
2. Erase the startup configuration and reload a router to the default state
3. Perform basic configuration tasks on a router
4. Determine level 1 and level 2 routes
5. Modify the configuration to reflect static and default routing
6. Enable classful routing and investigate classful routing behavior
7. Enable classless routing and investigate classless routing behavior
I. Basic OSPF Configuration Lab
1. Cable a network according to the topology diagram
2. Erase the startup configuration and reload a router to the default state
3. Perform basic configuration tasks on a router
4. Configure and activate interfaces
5. Configure OSPF routing on all routers
6. Configure OSPF router IDs
7. Verify OSPF routing using show commands
8. Configure a static default route
9. Propagate default route to OSPF neighbors
10. Configure OSPF hello and dead timers
11. Configure OSPF on a multi-access network
12. Configure OSPF priority
13. Understand the OSPF election process
14. Document the OSPF configuration
J. Analyze the Advantages of LAN Segmentation, and LAN Segmentation using Bridges, Switches, and Routers

Special Facilities and/or Equipment

A. Access to a network laboratory with current Cisco network equipment host computers required to support the class.
B. A website or course management system with an assignment posting component (through which all lab assignments are to be submitted) and a forum component (where students can discuss course material and receive help from the instructor). This applies to all sections, including on-campus (i.e., face-to-face) offerings.

C. When taught via Foothill Global Access on the Internet, the college will provide a fully functional and maintained course management system through which the instructor and students can interact.
D. When taught via Foothill Global Access on the Internet, students must have currently existing email accounts and ongoing access to computers with internet capabilities.

Method(s) of Evaluation

Methods of Evaluation may include but are not limited to the following:

Tests and quizzes
Written laboratory assignments
Final examination

Method(s) of Instruction

Methods of Instruction may include but are not limited to the following:

Lectures which include motivation for the architecture of the specific topics being discussed
In-person or online labs (for all sections, including those meeting face-to-face/on-campus), consisting of:
1. An assignment webpage located on a college-hosted course management system or other department-approved internet environment. Here, the students will review the specification of each assignment and submit their completed lab work
2. A discussion webpage located on a college-hosted course management system or other department-approved internet environment. Here, students can request assistance from the instructor and interact publicly with other class members
Detailed review of laboratory assignments which includes model solutions and specific comments on the student submissions
In person or online discussion which engages students and instructor in an ongoing dialog pertaining to all aspects of designing, implementing and analyzing programs
When course is taught fully online:
1. Instructor-authored lecture materials, handouts, syllabus, assignments, tests, and other relevant course material will be delivered through a college-hosted course management system or other department-approved internet environment
2. Additional instructional guidelines for this course are listed in the attached addendum of CS department online practices

Representative Text(s) and Other Materials

Odom, Wendall. CCNA 200-301 Official Cert Guide, Volume 1. 2019.

Types and/or Examples of Required Reading, Writing, and Outside of Class Assignments

A. Reading
1. Textbook assigned reading averaging 30 pages per week.
2. Online curriculum averaging 20 pages per week.
3. Online resources as directed by instructor though links pertinent to networking.
4. Library and reference material directed by instructor through course handouts.
B. Writing
1. Technical prose documentation that supports and describes the laboratory exercises that are submitted for grades.

Discipline(s)

Computer Science