



CISCO® CCIE
Routing and Switching
Lab Guide

1ST EDITION

John Kaberna
(CCIE# 7146)

Raymond Fung
(CCIE# 6832)

Table of Contents

SECTION I: LAYER 2 TECHNOLOGIES'

CHAPTER 1: FRAME RELAY

- INTERFACE TYPES 7
- INVERSE ARP
- FRAME MAPS
- INTERFACE DLCI
- SPLIT HORIZON
- LMI TYPES
- FRAME SWITCHING
- TYPICAL GOTCHAS!

CHAPTER 2: ATM

- TERMS
- RFC 2684 VERSUS RFC 2225
- VCD, VPI, AND VCI
- SVC CONFIGURATION
- TYPICAL GOTCHAS!

CHAPTER 3: ISDN

- MINIMUM CONFIGURATION
- ADVANCED CONFIGURATIONS
- DIALER-MAP
- DIALER PROFILES
- ISDN AND ROUTING PROTOCOLS
- TYPICAL GOTCHAS!

CHAPTER 4: BRIDGING

- TRANSPARENT BRIDGING (TB)
- INTEGRATED ROUTING AND BRIDGING (IRB)
- CONCURRENT ROUTING AND BRIDGING (CRB)
- TYPICAL GOTCHAS!

CHAPTER 5: CATALYST 3550 SWITCHING

- SPANNING TREE (STA)
- VIRTUAL LAN'S (VLAN)
- TRUNKING
- TRUNK ENCAPSULATION
- VLAN RESTRICTIONS
- ETHERCHANNEL
- LAYER 2 CHANNELS
- LAYER 3 CHANNELS
- LOAD BALANCING
- ROUTER PORT CHANNEL
- VLAN TRUNKING PROTOCOL (VTP)
- TYPICAL GOTCHAS!

SECTION II: LAYER 3 ROUTING PROTOCOLS

CHAPTER 6: GENERAL ROUTING

- NETWORK COMMAND
- PASSIVE INTERFACE
- SPLIT HORIZON
- DISTANCE
- TYPICAL GOTCHAS!

CHAPTER 7: OSPF

- OSPF AREAS TYPES
- PEER RELATIONSHIPS
- AREA 0
- BASIC OSPF CONFIGURATION
- FRAME-RELAY AND OSPF
- DESIGNATED AND BACKUP DESIGNATED ROUTER ELECTIONS
- LOOPBACKS
- ROUTER ID
- VIRTUAL LINKS
- OSPF AUTHENTICATION
- TYPICAL GOTCHAS

CHAPTER 8: BGP

- BGP PEERS⁹
- BASIC BGP CONFIGURATION¹⁰
- SYNCHRONIZATION
- NEXT-HOP-SELF
- TRANSIT AS
- MD5 AUTHENTICATION
- EBGP MULTIHOP
- BGP PATH SELECTION
- ROUTE AGGREGATION AND AUTO SUMMARY
- ROUTE REFLECTORS
- CONFEDERATIONS
- BGP PEER GROUPS
- ROUTE DAMPENING
- SOFT RECONFIGURATION
- TYPICAL GOTCHAS!

CHAPTER 9: EIGRP

- FEATURES OF EIGRP
- TYPES OF SUCCESSORS
- TABLES
- NEIGHBOR TABLE – THE CURRENT STATE OF ALL THE ROUTER'S IMMEDIATELY ADJACENT NEIGHBORS
- BASIC EIGRP CONFIGURATION
- MANIPULATING ROUTES
- STATIC NEIGHBORS
- EIGRP TIMERS
- TYPICAL GOTCHAS!

CHAPTER 10: RIP

- BASIC RIP CONFIGURATION
- ADJUSTING RIP TIMERS
- UNICAST UPDATES
- OFFSET LIST
- SOURCE IP ADDRESS VALIDATION
- INTERPACKET DELAY
- TYPICAL GOTCHAS!

CHAPTER 11: RIP VERSION 2

- BASIC RIP VERSION 2 CONFIGURATION
- AUTHENTICATION
- ROUTE SUMMARIZATION
- DEMAND CIRCUIT
- TYPICAL GOTCHAS!

CHAPTER 12: REDISTRIBUTION

- REDISTRIBUTION ISSUES
- BASIC REDISTRIBUTION
- ADMINISTRATIVE DISTANCE ISSUE
- ROUTING LOOP ISSUE
- ROUTE MAPS
- DISTRIBUTE LISTS
- VLSM TO FLSM ISSUE
- TYPICAL GOTCHAS!

SECTION III: DESKTOP PROTOCOLS, NETWORK MANAGEMENT AND SECURITY

CHAPTER 13: DLSW+

- BASIC DLSW SETUP
- LOCAL PEER
- REMOTE PEER
- TCP ENCAPSULATION
- MAPPING DLSW+ TO A LOCAL DATA-LINK CONTROL
- SCALABILITY
- ACCESS CONTROL
- TYPICAL GOTCHAS!

CHAPTER 14: NETWORK MANAGEMENT

- SIMPLE NETWORK MANAGEMENT PROTOCOL (SNMP)
- NETWORK TIME PROTOCOL (NTP)
- SECURE SHELL (SSH)
- TYPICAL GOTCHAS!

CHAPTER 15: CISCO ROUTER SECURITY

- CISCO ROUTER SECURITY RECOMMENDATIONS
- DISABLE UNNECESSARY SERVICES
- PREVENTING MOST DENIAL OF SERVICE ATTACKS
- ROUTER SELF PROTECTION
- TYPICAL GOTCHAS!

CHAPTER 16: AAA

LOCAL AAA
PRIVILEGE LEVELS
TYPICAL GOTCHAS!

CHAPTER 17: GRE TUNNELS

GRE OVERVIEW
BASIC GRE CONFIGURATION
GRE AND ROUTING PROTOCOLS
TYPICAL GOTCHAS!

CHAPTER 18: NETWORK ADDRESS TRANSLATION

NAT
TYPICAL GOTCHAS!

SECTION IV: VOICE AND QOS

CHAPTER 19: VOICE

BASIC VOIP CONFIGURATION
NUMBER EXPRESSIONS
MULTIPLE NUMBERS
IP PRECEDENCE
VOICE ACTIVITY DETECTION
PLAR
VOICE OVER FRAME RELAY
ADDITIONAL VOICE OVER FRAME RELAY COMMANDS
VOICE OVER ATM
TYPICAL GOTCHAS!

CHAPTER 20: QOS

PRIORITY QUEUEING
CUSTOM QUEUEING
FAIR QUEUEING AND ITS COUSINS
RANDOM EARLY DETECT (RED) AND WEIGHTED RANDOM EARLY DETECT (WRED)
COMMITTED ACCESS RATE (CAR)
TYPICAL GOTCHAS!

SECTION V: MISCELLANEOUS

CHAPTER 21: HOT STANDBY ROUTING PROTOCOL

DEFAULT GATEWAY REDUNDANCY - HSRP AND IRDP
IRDP (ICMP ROUTER DISCOVERY PROTOCOL)
TYPICAL GOTCHAS!

CHAPTER 22: DYNAMIC HOST CONFIGURATION PROTOCOL.....

DHCP (SERVER AND CLIENT)
TYPICAL GOTCHAS!

CHAPTER 23: NEXT HOP RESOLUTION PROTOCOL

CONFIGURING BASIC NHRP
TUNING NHRP

TYPICAL GOTCHAS!

CHAPTER 24: MOBILE IP

LOCAL AREA MOBILITY (LAM) AND MOBILE-IP
MOBILE IP (RFC 2002)
TYPICAL GOTCHAS!

CHAPTER 25: MULTICAST

INTERIOR GATEWAY MANAGEMENT PROTOCOL (IGMP)
DISTANCE VECTOR MULTICAST ROUTING PROTOCOL (DVMRP)
PROTOCOL-INDEPENDENT MULTICAST (PIM)
TYPICAL GOTCHAS!

PRACTICE LABS

CCIE RS CLASS GUIDE PRACTICE LAB 1

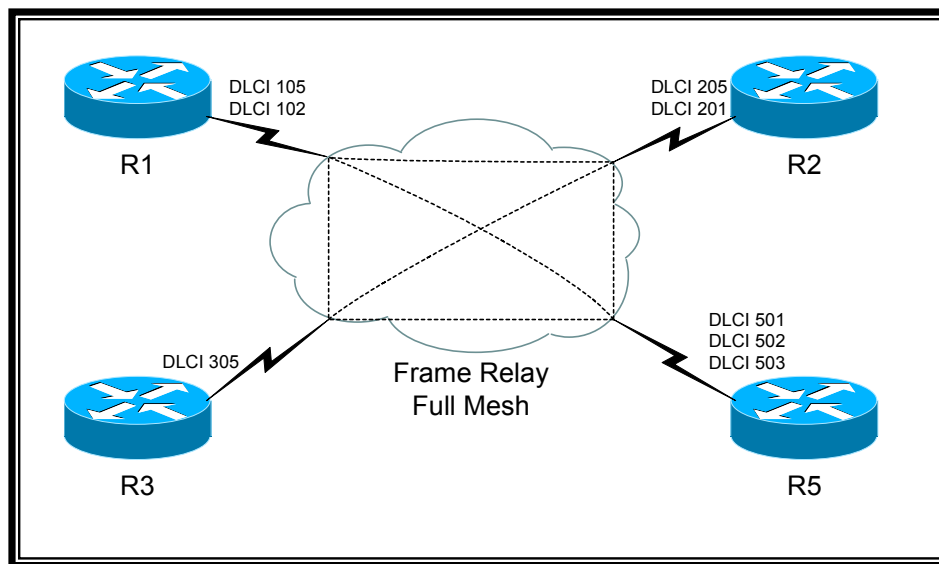
CCIE RS CLASS GUIDE PRACTICE LAB 2

FRAME-RELAY

INTERFACE TYPES

Prior to configuring any frame-relay network, you'll need to identify the physical interfaces to be used and their corresponding DLCI's. Figure 1.1 illustrates the topology discussed in the upcoming sections.

Figure 1.1. *Frame Relay full mesh topology*



PHYSICAL INTERFACES

Physical interfaces do not use point-to-point or point-to-multipoint subinterfaces. Physical interfaces receive all DLCI's advertised by the switch. If you create a subinterface, you need to tell that subinterface which DLCI it should use. To verify which DLCI's a physical interface receives use the `show frame pvc` command.

If your PVC is configured properly, the DLCI USAGE field should be LOCAL and PVC STATUS should be ACTIVE. Remember that both ends of the PVC need to be configured properly in order for the PVC to be active. If you have not yet configured an IP address, your DLCI USAGE should be UNUSED.

```
r5# show frame pvc

PVC Statistics for interface Serial1 (Frame Relay DTE)

DLCI = 501, DLCI USAGE = LOCAL, PVC STATUS = ACTIVE, INTERFACE
input pkts 1          output pkts 1          in bytes 30
  out bytes 30        dropped pkts 0          in FECN pkts 0
  in BECN pkts 0    out FECN pkts 0          out BECN pkts 0
  in DE pkts 0       out DE pkts 0
  out bcast pkts 1  out bcast bytes 30
  pvc create time 00:05:51, last time pvc status changed 00:05:52

DLCI = 502, DLCI USAGE = UNUSED, PVC STATUS = ACTIVE, INTERFACE = Serial1

  input pkts 0          output pkts 4          in bytes 0
  out bytes 120        dropped pkts 0          in FECN pkts 0
  in BECN pkts 0    out FECN pkts 0          out BECN pkts 0
  in DE pkts 0       out DE pkts 0
  out bcast pkts 4  out bcast bytes 120    Num Pkts Switched 0
  pvc create time 00:08:53, last time pvc status changed 00:02:43
```

You should also check your PVC status. Active means the PVC is active and information can be exchanged. Inactive means the router's local connection to the switch is working to the frame switch, but there is a problem on the remote end. Both ends of a PVC must be up for it to be active. Deleted means the router is not receiving LMI from the frame switch or there is a layer 1 problem.

BORDER GATEWAY PROTOCOL

BGP is used to route between Autonomous Systems and is the routing protocol for the Internet. Configuration of BGP can be quite complicated and there are many options. We will try to cover most of the BGP topics that may be on the lab exam.

BGP PEERS

BGP requires that routers establish a peer relationship. Unlike OSPF, this neighbor (peer) relationship must be manually configured. Routers are considered peers or neighbors whenever they open up a TCP session to exchange routing information. When routers communicate for the first time, they exchange their entire routing table. From then on, they send only incremental updates. BGP uses TCP as its transport protocol, via port 179.

INTERNAL BGP (IBGP)

Exchanges routing information within the same AS between routers.
IBGP routers must be fully meshed
All IBGP routers must have the same BGP routing table (only EBGP links can adjust or filter BGP routes)

EXTERNAL BGP (EBGP)

Used when routers belong to different AS's and exchange BGP updates.
BGP must be synchronized with the IGP (IGP's include such routing protocols as OSPF, RIP, EIGRP, etc.) if the AS provides transit service for other AS's. Synchronization helps prevent BGP from advertising an internal route that is no longer available via the IGP.

When to disable synchronization:
Your AS does not transfer traffic from one AS to another (transit AS)
All the transit routers on your AS are running BGP

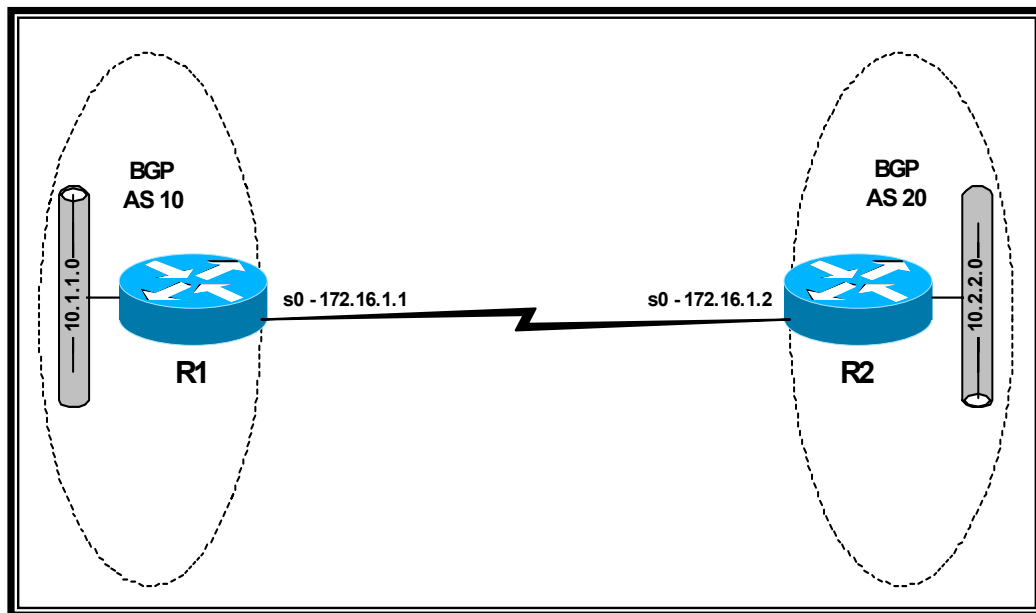
BASIC BGP CONFIGURATION

Enable BGP using a local BGP AS number assigned by InterNIC (for a production environment). During the lab exam, you will use AS numbers assigned by the exam instructions.

There are a few rules when configuring BGP. Neighbors must be configured on both sides. Also, neighbors must be directly connected or have a specific route (a default route will not work) to the neighbor. Multihop must be configured if the neighbors are not directly connected. Networks configured must have a match in the routing table in order for BGP to advertise the route

To configure BGP, first start the BGP routing process. Then advertise networks in to BGP (if applicable). Finally, configure your BGP peers.

Figure 8.1 Basic BGP topology



```
r1(config)# router bgp 10
```

```
r2(config)# router bgp 20
```

Configure the networks you want to advertise.

```
r1(config-router)# network 10.1.1.0 mask 255.255.255.0
```

```
r2(config-router)# network 10.2.2.0 mask 255.255.255.0
```

Specify BGP neighbors and IP address.

```
r1(config-router)# neighbor 172.16.1.2 remote-as 20
```

```
r2(config-router)# neighbor 172.16.1.1 remote-as 10
```

Note Once you have configured basic BGP, you'll typically need to clear the BGP session for any new changes to take effect by entering the `clear ip bgp*` command.

****WARNING**** While we recommend using the command `clear ip bgp *` in a lab environment, we highly suggest avoiding this command in a production environment!

BGP NEIGHBOR VERIFICATION

Once neighbors are configured, verify that you have a valid TCP and BGP connection.

```
r1# show ip bgp neighbors
BGP neighbor is 172.16.1.2, remote AS 20, external link
  BGP version 4, remote router ID 10.2.2.22
  BGP state = Established, up for 00:01:20
  Last read 00:00:19, hold time is 180, keepalive interval is 60 seconds
  Neighbor capabilities:
    Route refresh: advertised and received(new)
    Address family IPv4 Unicast: advertised and received
  Received 11 messages, 0 notifications, 0 in queue
  Sent 8 messages, 0 notifications, 0 in queue
  Route refresh request: received 0, sent 0
  Default minimum time between advertisement runs is 30 seconds

For address family: IPv4 Unicast
  BGP table version 3, neighbor version 3
  Index 1, Offset 0, Mask 0x2
  1 accepted prefixes consume 36 bytes
  Prefix advertised 1, suppressed 0, withdrawn 0
  Number of NLRI in the update sent: max 1, min 0
  Connections established 2; dropped 1
  Last reset 00:01:59, due to User reset
  Connection state is ESTAB, I/O status: 1, unread input bytes: 0
  Local host: 172.16.1.1, Local port: 11000
  Foreign host: 172.16.1.2, Foreign port: 179
```