Troubleshooting, Editing, Port #'s

show ip interface brief (display interface designations, IP address and status)
show ip route (display routing table)
show vlan brief (on switch - show what VLANs exist, names, ports assigned)
show controllers serial x/x/x (see if DCE or DTE connected and if clockrate is present)
show interface trunk (what ports are trunking, native vlan, allowed vlans)
show running-config (display the running configuration - active)
show startup-config (display the starup configuration)
show ip protocol (what routing protocol, which networks, passive interfaces, neighbors)
show cdp neighbors (see directly connected Cisco devices)
show cdp neighbors detail (includes IP address at other end)
show cdp interface (which interfaces are running CDP)
show interface serial x/x/x (what encapsulation, IP address, counters)
show interface fastethernet x/x switchport (configured mode and operating mode)
show version (which IOS, capability, memory, configuration-register)
show run | begin interface (will start listing at the first instance of 'interface')
show ip route connected (show routing table entries for directly connected networks)
show ip route static (show routing table entries for static routes)
show ip route ospf (show routing table entries learned through OSPF)
show ip route eigrp (show routing table entries learned through EIGRP)
show mac-address-table or **show mac address-table** (varies with different IOS)
show flash (display filenames and directories in Flash memory)
show clock (current date/time in this device)
show ipv6 ??? (does the IPv6 version of many IPv4 commands)
show processes (shows active processes running on router)
show process cpu (shows cpu statistics)
show memory (shows memory allocation)
show users (show who is telnetted into this device)
show standby (see if HSRP is active)
ping X.X.X.X (try to reach the destination host at X.X.X.X)
trace X.X.X.X (show the path taken to reach the destination host at X.X.X.X)
R1(config)# **do show ???** (execute show commands from configuration mode)
debug ??? (real-time reporting about processes related to almost any function)
debug all (very dangerous as the router can become consumed by reporting everything)
undebug all (turn off all debugging commands – handy if this is a busy router)

CCNA Commands Summary

Line editing commands

ctrl-a (go to the beginning of the current line)
ctrl-e (go to the end of the current line)
ctrl-p or up-arrow (repeat up to 10 previous commands in the current mode)
ctrl-n or dn-arrow (if you have gone back in command history, this moves forward)
backspace-key (erase the character to the left of the current cursor position)
ctrl-z or **end** (go out to privilege mode)
exit (move back one level in the hierarchical command structure)
ctrl-c (cancel current command or leave Setup mode if you accidentally get into it)
ctrl-shift-6 (stop ping or trace)
terminal length 0 [zero] (turn off paging – makes output without breaks)
terminal length 24 (normal page breaks in output)
wr (shortcut for 'copy running-config startup-config)

Common Port Numbers and Protocols

File Transfer Protocol (**FTP**)
    FTP Control=TCP port 21
    FTP Data = TCP Port 20
Secure Shell (**SSH**) - TCP Port 22
Telnet - TCP Port 23
Simple Mail Transfer Protocol (**SMTP**) - TCP Port 25
Domain Name System (**DNS**) - TCP/UDP Port 53
Dynamic Host Configuration Protocol (**DHCP**)
    BOOTPS=UDP Port 67 (DHCP request from client to server)
    BOOTPC=UDP Port 68 (DHCP reply from server to client)
Hypertext Transfer Protocol (**HTTP**) - TCP Port 80
Post Office Protocol – incoming mail (**POP**) - TCP Port 110
Network Time Protocol (**NTP**) - UDP Port 123
Simple Network Management Protocol (**SNMP**) - UDP Port 161
Secure Hypertext Transfer Protocol (**HTTPS**) - TCP Port 443

Basic Router / Switch Configuration

To Restore a Switch or Router to Default Configuration

S1# **delete vlan.dat** (hit 'enter' to accept defaults) [Note: Only do this on a switch]
S1# **erase startup-config** (hit 'enter' to accept defaults [Router or Switch])
S1# **reload** (answer 'no' if asked to save current config [Router or Switch])

Router / Switch Basic Configuration

R1# **configure terminal** (enter global configuration mode)
R1(config)# **hostname NAME** (configure the NAME of the Router or Switch)
R1(config)# **security passwords min-length 5** (set minimum password length)
R1(config)# **service password-encryption** (encrypt all passwords – except secret)
R1(config)# **login block-for 60 attempts 3 within 30** (wait 1 min if 3 bad attempts in 30 sec)
R1(config)# **enable secret PASSWORD** (make the privilege level password 'PASSWORD')
R1(config)# **no ip domain-lookup** (suppress DNS attempt when a command is mistyped)
R1(config)# **banner motd MESSAGE** (create a MESSAGE that will display when logging in)
R1(config)# **line console 0** [zero] (enter the console connection configuration mode)
R1(config-line)# **password PASSWORD** (make the user level password 'PASSWORD')
R1(config-line)# **login** (instruct the router that you want it to check for a password)
R1(config-line)# **logging synchronous** (assists by keeping command entry more orderly)
R1(config-line)# **exec-timeout 0 0** [zeroes] (no timeout while configuring the router)
R1(config)# **line vty 0 4** [zero 4] (configure the same options as line console above)
S1(config)# **line vty 0 15** [zero 15] (configure the same options in a switch)
R1# **copy running-configuration startup-configuration** (save config in NVRAM)
R1# **wr** (legacy command - Same as copy running-configuration startup-configuration)
R1(config)# ! (remark – makes no configuration changes)

For Switch Management Interface Configuration

S1(config)# **interface vlan 1** (create a virtual host on the switch)
S1(config-if)# **description Management interface for this switch** (optional description)
S1(config-if)# **ip address 192.168.100.50 255.255.255.0** (assign an IP address)
S1(config-if)# **no shut** (must turn it on)
S1(config-if)# **exit** (leave interface config and return to global config)

S1(config)# **ip default-gateway 192.168.100.1** (must be on same subnet as Mgt interface)
S1(config)# **enable secret class** (must have an enable password for remote config)
S1(config)# **line vty 0 15** (switches may have 16 VTY connections at once)
S1(config-line)# **password cisco** (must set a login password for telnet to be possible)
S1(config-line)# **login** (tell the VTY ports to ask for password from remote user)
S1(config-line)# **transport input telnet** (allows only telnet for remote config – default)

CCNA Commands Summary

Configuring IPv4 Router Interface

R1(config)# **interface INTERFACE-TYPE** (enter configuration mode for an interface)
R1(config-if)# **ip address ADDRESS SNM** (assign the IP Address and subnet mask)
R1(config-if)# **description WORDS** (document what this interface is used for)
R1(config-if)# **clock rate CLOCK** (on serial DCE interfaces, set the speed of the link)
R1(config-if)# **bandwidth VALUE** (used by the routing protocol for the speed of the link)
R1(config-if)# **no shutdown** (turn the interface on)
R1(config-if)# **shutdown** (turn the interface off)

Configuring IPv6 Router Interface

R1(config)# **ipv6 unicast-routing** (activate IPv6 routing – off by default)
R1(config)# **interface Gi1/1**
R1(config-if)# **ipv6 enable** (turn on ipv6 in this interface)
R1(config-if)# **ipv6 address 3ffe:b00:c18:1::3 /64** (manually enter complete address)
-or-
R1(config-if)# **ipv6 address 3ffe:b00:c18:1:: /64 eui-64** (auto configure host portion)
R1(config-if)# **ipv6 address fe80::4 link-local** (configure link-local address)

Layer-3 Switch Commands

S1(config)# **ip routing** (activate IPv4 routing within the switch)
S1(config)# **ipv6 routing** (activate IPv6 routing within the switch)
S1(config-if)# **no switchport** (used to designate that this is a router port, not a switchport)
S1(config-if)# **switchport trunk encapsulation dot1q** (to configure trunking for dot1Q)

VLANS, Trunks, Router-on-a-Stick, VTP

VLAN Creation and Port Assignment

S1(config)# **vlan 10** (create VLAN 10 in the VLAN.DAT database)
S1(config-vlan)# **name Management** (optionally name the VLAN)
S1(config)# **interface fa0/12** (select a port on the switch) --or--
S1(config)# **interface range fa0/12 – 20** (select a range of ports to be configured the same)
S1(config-if)# **switchport mode access** (set the port to Access mode)
S1(config-if)# **switchport access vlan 10** (assign this port(s) to VLAN 10)

Trunk Creation

S1(config)# **interface gi1/1** (select port for trunking)
S1(config-if)# **switchport trunk encapsulation dot1q** (NOTE: on Layer 3 switch only)
S1(config-if)# **switchport mode trunk** (set the port to be in trunk mode)
S1(config-if)# **switchport trunk native vlan 99** (set VLAN 99 to carry native traffic)
S1(config-if)# **switchport trunk allowed vlan 1,10,20,99** (optional – which VLANs are permitted to go across this trunk. Don't forget to include VLAN 1 and the native VLAN)

Router-on-a-Stick Configuration

R1(config)# **interface Fa0/0** (select the main interface)
R1(config-if)# **no ip address** (there should not be any IP Address on the main interface)
R1(config-if)# **interface Fa0/0.10** (create a sub-interface – the number can be anything)
R1(config-if)# **encapsulation dot1q 10** (use 802.1Q trunking; assign to this VLAN #)
R1(config-if)# **ip address 172.16.10.1 255.255.255.255** (define the default-gateway IP)
R1(config-if)# **interface Fa0/0.99** (create another sub-interface - this one for native traffic)
R1(config-if)# **encapsulation dot1q 99 native** (802.1Q trunking; VLAN #; and native)
(NOTE: No IP address unless workstations or management interfaces are on this VLAN)

R1(config)# **ip classless** (classless routing behavior – default in IOS 11.3+)
R1(config)# **no ip classless** (classful routing behavior)

VLAN Trunking Protocol (VTP) Configuration

S1(config)# **vtp mode server** (configure this switch to be in server mode) --or--
S1(config)# **vtp mode client** (configure this switch to be in client mode) ---or--

S1(config)# **vtp mode transparent** (configure this switch in transparent mode - Suggested)
S1(config)# **vtp domain NAME** (change the VTP domain name of this switch to NAME)
S1(config)# **vtp password PASSWORD** (change the VTP password for this switch)
S1(config)# **vtp pruning** (activate VTP pruning – Not supported in Packet Tracer)
S1(config)# **vtp version 2** (change the VTP version to 2)

S1# **show vtp status** (see VTP mode, revision, version, domain name, pruning mode, etc)
S1# **show vtp password** (only way to see the VTP password – does not show in status)

Etherchannel (PortChannel)

To configure a Layer 2 (trunking) Etherchannel:

S1(config)# **interface range fa0/1 – 4** (group of physical interfaces)
S1(config-if)# **switchport trunk encapsulation dot1q** (NOTE: on Layer 3 switch only)
S1(config-if)# **switchport mode trunk** (set to trunk mode)
S1(config-if)# **switchport trunk native vlan 777** (Set native VLAN)
S1(config-if)# **channel-protocol lacp** (set this interface to LACP portchannel) -or--
S1(config-if)# **channel-protocol pagp** (set this interface to PAgP portchannel)
S1(config-if)# **channel-group 3 mode** [see choices below]

passive	(enable LACP only if a LACP device is detected)
active	(enable LACP unconditionally)
auto	(enable PAgP only if a PAgP device is detected)
desirable	(enable PAgP unconditionally)
on	(enable Etherchannel)

S1(config)# **interface port-channel 3** (configure the virtual interface from 1 to 6)
S1(config-if)# **switchport mode trunk** (set to trunk mode)
S1(config-if)# **switchport trunk native vlan 777** (set native VLAN the same as the physical)
S1(config-if)# **no shutdown** (turn on the virtual interface)

To configure a Layer 3 Etherchannel:

SW1(config)# **interface range fa0/1 – 2**
SW1(config-if)# **no switchport**
SW1(config-if)# **channel-group 1 mode {active, passive, on}**
SW1(config)# **interface port-channel 1**
SW1(config-if)# **no switchport**
SW1(config-if)# **ip address x.x.x.x m.m.m.m**
(The other end is configured the same)

EtherChannel uses a load-balancing algorithm based on selected type or criteria:

- Source IP Address (src-ip)
- Destination IP Address (dst-ip)
- Both Source and Destination IP (src-dst-ip) – default L3 type
- Source MAC address (src-mac) – default L2 type
- Destination MAC address (dst-mac)
- Both Source and Destination MAC (src-dst-mac)
- Source TCP/UDP port number (src-port)
- Destination TCP/UDP port number (dst-port)
- Both Source and Destination port number (src-dst-port)

SW1(config)# **port-channel load-balance TYPE**

Spanning Tree Protocol (STP), HSRP

Spanning Tree

S1(config)# **spanning-tree mode pvst** (configure for PVST – Default)
S1(config)# **spanning-tree mode rapid-pvst** (configure this switch for rapid PVST)
S1(config)# **spanning-tree vlan 10,20 root primary** (make root bridge for these VLANs)
S1(config)# **spanning-tree vlan 10 root secondary** (make secondary root bridge for VLAN)
S1(config)# **spanning-tree vlan 10 priority 8192** (set the BID priority to 8192 in this VLAN)
S1(config)# **spanning-tree portfast default** (default Portfast on all interfaces in this switch)
S1(config)# **interface range fa0/10 – 20** (must be configured as Access ports for Portfast)
S1(config-if)# **spanning-tree portfast** (set interfaces for Portfast)
S1(config-if)# **spanning-tree bpduguard enable** (disables interface if it receives a BPDU)
S1(config)# **interface fa0/1** (select a port to set STP port priority)
S1(config-if)# **spanning-tree vlan 10 port-priority 16** (set port priority to 16; default is 128)

S1# **show spanning-tree** (see spanning-tree status on a VLAN-by-VLAN basis)
S1# **show spanning-tree vlan 10** (see detail spanning-tree information for VLAN 10)
S1# **show spanning-tree summary** (among other things, see if this is the root bridge)
S1# **show spanning-tree blockedports** (see which ports are in STP blocking status)
S1# **show spanning-tree root** (see which BID is root on a VLAN-by-VLAN basis)

Hot Standby Routing Protocol (HSRP) for IPv4

R1(config)# **interface fastethernet 0/1**
R1(config)# **standby version 2** (use the same version at each end)
R1(config-if)# **standby** [optional **group#**] **ip** [optional **IP-ADDRESS**] [optional **secondary**]
(The other end is configured the same)
R1(config-if)# **standby** [optional **group#**] **priority NUMBER** [optional **preempt**]
Set a higher priority (default 100) to make this router the primary in HSRP
Preempt will make this router the active one if it had been down and comes back up

Hot Standby Routing Protocol (HSRP) for IPv6

R1(config)# **interface fastethernet 0/1**

R1(config-if)# **standby version 2** (use the same version at each end)
R1(config-if)# **standby GROUP# ipv6 autoconfig** (create virtual IPv6 Link-Local address)
R1(config-if)# **standby GROUP# ipv6 2001:CAFE:ACAD:4::1/64** (set virtual shared IP)
(The other end is configured the same)
R1(config-if)# **standby GROUP# priority NUMBER** [optional **preempt**]
Set a higher priority (default 100) to make this router the primary in HSRP
Preempt will make this router the active one if it had been down and comes back up

R1# **show standby** (verify the configuration)

Security Practices

R1(config)# **service password-encryption** (encrypt all passwords (except 'secret')
R1(config)# **security password min-length 8** (set minimum 8 character passwords)
R1(config)# **login block-for 120 attempts 3 within 60** (block for 2 minutes if more than 3 failed logins within 60 seconds)

SSH Configuration

Router(config)# **hostname R1** (must change the name of the device from the default)
R1(config)# **username Bob password Let-me-in!** (configure a local user and password)
R1(config)# **ip domain-name ANYTHING.COM** (must set for crypto-key generation)
R1(config)# **crypto key generate rsa** (make an encryption key - select 1024 bits)
R1(config)# **ip ssh version 2** (configure for SSH version 2)
R1(config)# **line vty 0 15** (change parameters for remote access)
R1(config-line)# **login local** (select to authenticate against usernames in this device)
R1(config-line)# **transport input ssh** (only allow SSH for remote management)

Port Security Configuration on a Switch

S1(config)# **interface fa0/1** or **interface range fa0/1 – 15, gi1/1**
S1(config-if)# **switchport mode access** (must change from dynamic to access mode)
S1(config-if)# **switchport port-security** (must do to activate port-security)
S1(config-if)# **switchport port-security maximum 25** (allow 25 MAC addresses)
S1(config-if)# **switchport port-security mac-address sticky** (memorize MAC addresses)
S1(config-if)# **switchport port-security violation restrict** (send SNMP message) --or--
S1(config-if)# **switchport port-security violation protect** (only stop excess MACs) –or--
S1(config-if)# **switchport port-security violation shutdown** (shutdown interface - default)
S1(config-if)# **switchport protected** (does not allow traffic to/from other protected ports)
S1(config-if)# **spanning-tree bpduguard enable** (disables interface if it receives a BPDU)
S1(config-if)# **shutdown** then **no shutdown** (restore individual interface if it has shutdown)
S1# **errdisable recovery cause psecure_violation** (restore shutdown interfaces in 5 min)

S1# **show port-security interface fa0/12** (show security configuration for an interface)

Enable/Disable Cisco Discovery Protocol (CDP)

R1(config)# **cdp run** (activate CDP globally in the router – on by default)
R1(config)# **no cdp run** (disable CDP within the entire router)
R1(config-if)# **no cdp enable** (stop CDP updates leaving through this specific interface)

IP DHCP Snooping

R1(config)# **ip dhcp snooping** (globally enable DHCP snooping)
R1(config-if)# **ip dhcp snooping trust** (interface with DHCP server)

Routing (Static, RIP, EIGRP, OSPF)

Configuring Static Routes

R1(config)# **ip route 0.0.0.0 0.0.0.0 serial0/0** (default-route goes out serial 0/0)
R1(config)# **ip route 0.0.0.0 0.0.0.0 50.77.4.13** (default-route goes to next-hop 50.77.4.13)
R1(config)# **ip route 0.0.0.0 0.0.0.0 serial0/0 150** (default-route goes out serial 0/0. An optional parameter is added to set the administrative distance to 150)
R1(config)# **ip route 47.151.2.0 255.255.255.0 172.24.2.11** (to get to network 47.151.2.0/24, go to next-hop address of 172.24.2.11)
R1(config)# **ip route 47.151.2.0 255.255.255.0 serial0/1** (to get to network 47.151.2.0/24, go out serial 0/1)
R1(config)# **ip route 47.151.2.0 255.255.255.0 192.168.12.2 fastethernet0/0** (to get to network 47.151.2.0/24, go to the next-hop 192.168.12.2 out Fastethernet0/0; on Ethernet both are needed)

Configuring RIP (IPv4)

R1(config)# **no router rip** (remove all RIP configurations and routing table entries)
R1(config)# **router rip** (enter rip configuration commands)
R1(config-router)# **network 192.168.10.0** (define which directly connected network(s) to include in RIP update processes. No subnet mask – always classful)
R1(config-router)# **passive-interface fastethernet0/0** (prevent RIP updates from broadcasting out this interface)
R1(config-router)# **default-information originate** (configure RIP to include default-routes in updates to other routers. This is disabled by default. Only on router with default-route)
R1(config-router)# **redistribute static** (configure RIP to include classful static routes in updates to other routers. This is disabled by default. Only needed if there are static routes)
R1# **debug ip rip** (examine RIP updates in real-time)

Additional Commands to configure RIP Version 2

R1(config-router)# **version 2** (configure RIP for RIPv2)
R1(config-router)# **no auto-summary** (turn off automatic classful summarization-suggested)

Configuring RIPng (for IPv6)

R1(config)# **ipv6 route ::/0 S0/0/1** (default route goes out S0/0/1)
R1(config)# **ipv6 router rip NAME** (start the RIPng instance)
R1(config)# **interface fa0/1**

R1(config-if)# **ipv6 rip NAME enable** (include this interface and subnet in routing)
R1(config-if)# **ipv6 rip NAME default-information originate** (send default route)

Configuring IPv4 EIGRP

R1(config)# **no router eigrp 100** (completely remove this instance of EIGRP in this router)
R1(config)# **router eigrp 100** (100=Process ID within this network – Cisco calls this Autonomous System)
R1(config)# **eigrp router-id 5.5.5.5** (use this ID when identifying EIGRP neighbors)
R1(config-router)# **no auto-summary** (the default is to summarize to classful boundaries)
R1(config-router)# **network 172.16.0.0** (no subnet or wildcard mask is needed if classful)
R1(config-router)# **network 172.16.25.0 0.0.0.255** (wildcard mask – this is inverse of /24)
R1(config-router)# **passive-interface default** (no routing updates out any interface)
R1(config-router)# **no passive-interface fastethernet 0/1** (allow certain interfaces)
R1(config-router)# **passive-interface fastethernet 0/0** (no routing updates out Fa0/0)
R1(config-router)# **redistribute static** (one statement redistributes static routes - including the default-route)
R1(config-if)# **maximum paths 2** (load balancing paths: default=4, no load balancing=1)
R1(config-router)# **metric weights 0 k1 k2 k3 k4 k5** (used to modify the metric multipliers)
R1(config-if)# **bandwidth 768** (indicate the serial line speed for the routing protocol – this example is 768-K)
R1(config-if)# **ip summary-address eigrp 100 172.16.24.0 255.255.252.0** (manually summarized network statement configured on outbound interface)
R1(config-if)# **ip bandwidth-percent eigrp 100 40** (in this example limit EIGRP AS=100 updates to a maximum of 40% of the link bandwidth)
R1(config-if)# **ip hello-interval eigrp 100 30** (in this example, set hello intervals on this interface to 30 seconds for EIGRP AS=100)
R1(config-if)# **ip hold-time eigrp 100 90** (in this example, set the hold-time on this interface to 90 seconds for EIGRP AS=100)
R1(config)# **key chain MYCHAIN** (name the key chain – done in global config)
R1(config-keychain)# **key 1** (must assign a number – same at both ends of link)
R1(config-keychain-key)# **key-string securetraffic** ('securetraffic' is the passphrase)
R1(config)# **interface serial 0/1** (interface to the other EIGRP router)
R1(config-subif)# **ip authentication mode eigrp 10 md5** (turn on authentication)
R1(config-subif)# **ip authentication key-chain eigrp 10 MYCHAIN** (use this key)

R1# **show ip eigrp neighbors** (see neighbor adjacencies)
R1# **show ip eigrp topology** (see the EIGRP topology table)

R1# **debug eigrp fsm** (see what DUAL does when a route is removed from the routing table)

Configuring IPv4 OSPF(v2)

R1(config)# **interface loopback 10** (optionally create a virtual interface for OSPF router ID)
R1(config)# **router ospf 1** (configure an OSPF routing process)
R1(config-router)# **router-id 2.2.2.2** (optionally configure the OSPF Router ID - Suggested)
R1(config-router)# **network 172.16.45.0 0.0.0.255 area 0** (include directly connected networks that match this parameter)
R1(config-router)# **default-information originate** (propagate the quad-0 default route)
R1(config-router)# **redistribute static** (propagate classful static routes configured on this router to other OSPF routers)
R1(config-router)# **redistribute static subnets** (propagate classless static routes configured on this router to other OSPF routers)
R1(config-router)# **passive-interface default** (no routing updates out any interface)
R1(config-router)# **no passive-interface fastethernet 0/1** (allow certain interfaces)
R1(config-router)# **passive-interface fastethernet 0/1** (do not send OSPF routing updates out this interface)
R1(config-router)# **area 7 range 172.16.8.0 255.255.248.0** (on ABR summarize addresses)
R1(config-router)# **summary address 172.16.8.0 255.255.248.0** (On ASBR – to summarize non-OSPF routes imported into OSPF)
R1(config-router)# **auto-cost reference-bandwidth ???** (optionally change the reference bandwidth in terms of Mbits per second 1-4294967; must be the same on all routers)
R1(config-router)# **area AREA-ID authentication message-digest** (globally activate MD-5 authentication within an OSPF area)
R1(config-router)# **ip ospf message-digest-key 1 md5 PASSWORD** (authentication key)
R1(config-if)# **ip ospf message-digest-key 1 md5 PASSWORD** (on this interface, configure the OSPF authentication key – will not activate authentication)
R1(config-if)# **ip ospf authentication message-digest** (activate OSPF authentication)
R1(config-if)# **ip ospf cost 1562** (optionally configure an absolute OSPF cost for a link – this example same as bandwidth 64)
R1(config-if)# **ip ospf hello-interval seconds** (change hello timer from default 10 seconds)
R1(config-if)# **ip ospf dead-interval seconds** (change dead timer from default 40 seconds)
R1(config-if)# **ip ospf priority {0 - 255}** (for OSPF DR/BDR election, default=1, ineligible=0)

R1# **show ip ospf neighbor** (display OSPF neighbor adjacencies – State should be 'FULL' or '2WAY')
R1# **show ip protocols** (includes the OSPF Router ID of this router)
R1# **clear ip ospf process** (re-calculate OSPF Router ID based on current parameters)
R1# **show ip ospf** (display OSPF process and router IDs, as well as area information)
R1# **show ip ospf interface serial 0/0/0** (see DR/BDR information, hello and dead intervals)

Configure IPv6 OSPF(v3)

R1(config)# **ipv6 unicast-routing** (turn on ipv6 routing)
R1(config)# **no ipv6 router ospf 55** (remove this instance of OSPF in this router)
R1(config)# **ipv6 router ospf 100** (create the OSPF process in this router)
R1(config-rtr)# **router-id 5.5.5.5** (must have router id)
R1(config-rtr)# **default-information originate** (redistribute default route to other routers)
R1(config-rtr)# **redistribute static** (redistribute classful static routes, including default)
R1(config-rtr)# **redistribute static subnets** (redistribute classless static routes)
R1(config-rtr)# **passive-interface default** (no routing updates out any interface)
R1(config-rtr)# **no passive-interface gi 1/0** (allow updates out this interface)
R1(config-rtr)# **passive-interface gi 1/1** (no routing updates out gi 1/1)
R1(config-rtr)# **no shutdown** (turn it on)
R1(config)# **interface gi 1/1** (networks are assigned through the interface)
R1(config-if)# **ipv6 enable** (allow IPv6 on this interface)
R1(config-if)# **ipv6 ospf 100 area 0** (associate this interface with IPv6 OSPF 55, area 0)

Configure IPv6 EIGRP

R1(config)# **ipv6 unicast-routing** (turn on ipv6 routing)
R1(config)# **no ipv6 router eigrp 100** (remove this instance of EIGRP in this router)
R1(config)# **ipv6 router eigrp 100** (create the EIGRP process)
R1(config-rtr)# **eigrp router-id 5.5.5.5** (must have a router id)
R1(config-rtr)# **redistribute static** (redistribute static and default routes to other routers)
R1(config-rtr)# **passive-interface default** (no routing updates out any interface)
R1(config-rtr)# **no passive-interface gi 1/0** (allow updates out this interface)
R1(config-rtr)# **passive-interface gi 1/1** (no routing updates out gi 1/1)
R1(config-rtr)# **no shutdown** (must turn on EIGRP in this router)
R1(config)# **interface gi 1/1** (networks are assigned through the interface)
R1(config-if)# **ipv6 enable** (allow IPv6 on this interface)
R1(config-if)# **ipv6 eigrp 100** (associate this interface with IPv6 EIGRP process 100)
R1(config-if)# **ipv6 summary-address eigrp 100 2001:123A:AAA0::/60** (EIGRP summary address)
R1(config-if)# **ipv6 bandwidth-percent eigrp 100 40** (in this example limit EIGRP AS=100 updates to a maximum of 40% of the link bandwidth)
R1(config)# **key chain MYCHAIN** (name the key chain – done in global config)
R1(config-keychain)# **key 1** (must assign a number – same at both ends of link)
R1(config-keychain-key)# **key-string securetraffic** ('securetraffic' is the passphrase)
R1(config)# **interface serial 0/1** (interface to the other EIGRP router)
R1(config-subif)# **ipv6 authentication mode eigrp 10 md5** (turn on authentication)

R1(config-subif)# **ipv6 authentication key-chain eigrp 10 MYCHAIN** (use this key)

PPP and Frame-Relay

Configuring PPP with Authentication

R1(config)# **username R-2 password PASSWORD** (configure for PAP / CHAP)

- If **PAP**, the username and password must match the sent-username and password from other router.
- If **CHAP**, the username must be the hostname of the other router and the passwords must be the same in each routers username configuration.

R1(config)# **interface serial 0/0/0** (select the interface for ppp configuration)
R1(config-if)# **encapsulation ppp** (set interface to PPP)
R1(config-if)# **compress [predictor / stac]** (optional-configure data compression)
R1(config-if)# **ppp quality [percentage]** (optional-set a threshold of throughput before the ppp link will reset)
R1(config-if)# **ppp authentication pap** (optional-configure for PAP authentication)
R1(config-if)# **ppp pap sent-username R-1 password PASSWORD** (if PAP is used, this must be configured)
R1(config-if)# **ppp authentication chap** (optional-configure for CHAP authentication)
R1(config-if)# **ppp multilink** (optional-combine multiple PPP links for more bandwidth)
R1(config-if)# **encapsulation hdlc** (reset the interface to the default value of HDLC)

Frame-Relay Commands

-There are two basic types of Frame-Relay configuration: Point-to-Point and Multi-Point.
-A Point-to-Point link involves a single IP subnet and one DLCI. It may be configured directly on the physical interface or may be done as a sub-interface.

****FR Point-to-Point no sub-interface; Sample Configuration 1:**

R1(config)# **interface serial 0/0/0**
R1(config-if)# **ip address 192.168.5.1 255.255.255.252** (typically /30)
R1(config-if)# **encapsulation frame-relay [ietf, cisco]** PVC=IEFT is optional, cisco=default)
R1(config-if)# **frame-relay lmi-type [ansi, q933a, cisco]** (optional, cisco=default)
R1(config-if)# **frame-relay map ip 192.168.5.1 752** (to allow local ping- 192.168.5.1 is the local interface IP, DLCI=752 is a valid DLCI for this interface)
R1(config-if)# **frame-relay map ip 192.168.5.2 752 broadcast** [**ietf, cisco]** (192.168.5.2 is next hop, DLCI=752, broadcast is optional, PVC=IEFT is optional – cisco is default)

****FR Point-to-Point with sub-interface; Sample Configuration 2:**

R1(config)# **interface serial 0/0/0**
R1(config-if)# **no ip address** (no IP address on the main interface)
R1(config-if)# **encapsulation frame-relay [ietf, cisco]** PVC=IEFT is optional, cisco=default)
R1(config-if)# **frame-relay lmi-type [ansi, q933a, cisco]** (optional, cisco=default)

R1(config-if)# **interface serial 0/0/0.752 point-to-point** (sub-int # is customarily DLCI #)
R1(config-subif)# **ip address 192.168.5.1 255.255.255.252** (typically /30)
R1(config-subif)# **frame-relay interface-dlci 752** (DLCI=752, next hop and broadcast are dynamically assigned)

-Multi-point configurations are when there is one IP subnet with multiple connections (DLCIs). It may be configured directly on the physical interface or may be done as a sub-interface.

****Multi-Point no sub-interface; Sample Configuration 3:**

R1(config)# **interface serial 0/0/0**
R1(config-if)# **ip address 192.168.5.1 255.255.255.248** (not /30)
R1(config-if)# **encapsulation frame-relay**
R1(config-if)# **frame-relay lmi-type [ansi, q933a, cisco]** (optional, cisco=default)
R1(config-if)# **frame-relay map ip 192.168.5.1 752** (to allow local ping- 192.168.5.1 is the local interface IP, DLCI=752 is a valid DLCI for this interface)
R1(config-if)# **frame-relay map ip 192.168.5.2 752 broadcast** [**ietf, cisco]** (192.168.5.2 is next hop, DLCI=752, broadcast is optional, PVC=IEFT is optional – cisco is default)
R1(config-if)# **frame-relay map ip 192.168.5.3 339 broadcast** [**ietf, cisco]** (192.168.5.3 is next hop, DLCI=339, broadcast is optional, PVC=IEFT is optional – cisco is default)

****Multi-Point with sub-interface; Sample Configuration 4:**

R1(config)# **interface serial 0/0/0**
R1(config-if)# **no ip address** (no IP address on the main interface)
R1(config-if)# **encapsulation frame-relay** (not configured on sub-interface)
R1(config-if)# **frame-relay lmi-type [ansi, q933a, cisco]** (optional, cisco=default)
R1(config-if)# **interface serial 0/0/0.752 multipoint** (sub-interface # is customarily DLCI #)
R1(config-subif)# **ip address 192.168.5.1 255.255.255.248** (not /30)
R1(config-subif)# **frame-relay map ip 192.168.5.1 752** (to allow local ping- 192.168.5.1 is the local interface IP, DLCI=752 is a valid DLCI for this interface)
R1(config-subif)# **frame-relay map ip 192.168.5.2 752 broadcast** [**ietf, cisco]** (192.168.5.2 is next hop, DLCI=752, broadcast is optional, PVC=IEFT is optional – cisco is default)
R1(config-subif)# **frame-relay map ip 192.168.5.3 339 broadcast** [**ietf, cisco]** (192.168.5.3 is next hop, DLCI=339, broadcast is optional, PVC=IEFT is optional – cisco is default)

R1# **show frame-relay map** (display mapping of IPs and DLCIs)
Static: Map entry was from a 'frame-relay map' statement.
Dynamic: Map entry was created through inverse-ARP.

R1# **show frame-relay lmi** (see status of local link to Frame-Relay cloud)

R1# **show frame-relay pvc** (see which links are actually up end-to-end)

Active: PVC is fully connected and functional.

Inactive: Connected to FR switch, but other side isn't seen.

Delete: Not talking to the FR switch.

Access Control Lists

Standard Access Lists

-Standard access lists only evaluate the source IP field. They can use the 'host' and 'any' keywords, or apply wildcard masks. They do not use port numbers.

**Named Standard Access List :

R-1(config)# **ip access-list standard NAME** (name the list)

R-1(config-std-nacl)# **deny host 192.168.20.5 log** (deny a specific host / log matches)

R-1(config-std-nacl)# **permit 192.168.20.0 0.0.0.255** (permit subnet 192.168.20.0)

R-1(config-std-nacl)# **deny any** (deny all other IP addresses)

**Numbered IP Standard Access List:

R-1(config)# **access-list 25 deny host 192.168.20.5** (deny specific host)

R-1(config)# **access-list 25 permit 192.168.20.0 0.0.0.255** (permit entire subnet)

R-1(config)# **access-list 25 deny any** (deny all other IP addresses)

Extended Access Lists

Action (required)	Protocol (required)	Source IP (required)	Compare (optional)	Port/Protocol (optional)	Dest IP (required)	Compare (optional)	Port/Protocol (optional)
permit	IP	IP address & Wildcard mask	eq	23 – telnet	IP address & Wildcard mask	eq	23 – telnet
deny	TCP		gt	80 – http		gt	80 – http
remark	UDP	any	lt	443 – https	any	lt	443 – https
	ICMP	host X.X.X.X	neq	echo (ping)	host X.X.X.X	neq	echo (ping)
	OSPF		range	echo-reply		range	echo-reply
	EIGRP						
	Etc…						

There can be additional optional commands (log, time-of-day, established, etc)

on the end of most statements. The protocol field must match the destination port / protocol - if they are used (example: TCP=Telnet, ICMP=Ping, UDP=DNS).

**Named Extended Access List:

R-1(config)# **ip access-list extended NAME** (name the list)

Example: Deny an individual host to an entire subnet for Telnet and also log matches:

R-1(config-ext-nacl)# **deny tcp host 192.168.20.10 172.16.0.0 0.0.255.255 eq 23 log**

Example: Permit an entire subnet to go anywhere:

R-1(config-ext-nacl)# **permit ip 192.168.20.0 0.0.0.255 any**

Example: Deny everything:

R-1(config-ext-nacl)# **deny ip any any** (this is applied by default if not configured)

Applying Access Lists

R-1(config)# **interface fastethernet 0/0**

R-1(config-if)# **ip access-group NAME in** (evaluate packets coming in to the router)

R-1(config-if)# **ip access-group NAME out** (evaluate packets leaving the router)

R-1(config)# **line vty 0 4**
R-1(config-line)# **access-class NAME in** (evaluate packets for telnet or SSH)

Dynamic Access List (Stateful-Firewall)

R1(config)# **ip access-list extended OUTBOUND-TRAFFIC**
R1(config-ext-nacl)# **permit tcp any any reflect TCP-TRAFFIC**
R1(config-ext-nacl)# **permit udp any any reflect UDP-TRAFFIC**
R1(config-ext-nacl)# **permit icmp any any reflect ICMP-TRAFFIC**
R1(config-ext-nacl)# **deny ip any any**
R1(config)# **ip access-list extended EVALUATE-INBOUND**
R1(config-ext-nacl)# **evaluate TCP-TRAFFIC**
R1(config-ext-nacl)# **evaluate UDP-TRAFFIC**
R1(config-ext-nacl)# **evaluate ICMP-TRAFFIC**
R1(config)# **interface serial 0/0/0**
R1(config-if)# **ip access-group OUTBOUND-TRAFFIC out**
R1(config-if)# **ip access-group EVALUATE-INBOUND in**

Time-Based ACL

R-1(config)# **time-range MON-WED-FRI**
R-1(config-time-range)# **periodic Monday Wednesday Friday 8:00 to 17:00**
R-1(config)# **access-list 133 permit tcp 192.168.20.0 0.0.0.255 any eq telnet time-range MON-WED-FRI**

R-1# **show access-list** (see access lists on this router and # of 'matches' per line)
R-1# **show access-list NAME** (see a specific access list and # of 'matches' per line)

DHCP and NAT

Configuring DHCP for IPv4

R-1(config)# **ip dhcp excluded 172.16.2.1 172.16.2.7** (excluded IP range)
R-1(config)# **ip dhcp pool LAN-2** (name this DHCP pool)
R-1(config-dhcp)# **network 172.16.2.0 255.255.255.128** (entire network range)
R-1(config-dhcp)# **default-router 172.16.2.1** (address on router port)
R-1(config-dhcp)# **dns-server 140.198.8.14** (DNS server – can have up to 4)
R-1(config-dhcp)# **domain-name MCC.COM** (optional domain name)
R-1(config-dhcp)# **lease-time 5** (optional - change to 5 day lease, 1 day is default)
!
R-3(config)# **interface fastethernet 0/1** (interface for network with DHCP clients)
R-3(config-if)# **ip helper-address 192.168.15.2** (address where DHCP server is)
!
R-1# **show ip dhcp binding** (see what IP addresses are assigned & MAC addresses)
DOS-PROMPT>**ipconfig /release** (remove dynamically assigned IP information on PC)
DOS-PROMPT>**ipconfig /renew** (get new IP address from DHCP server)

Configuring DHCP for IPv6 Stateless Address Auto-Configuration (SLAAC)

R1(config)# **ipv6 unicast routing** (make sure IPv6 is activated)
R1(config)# **ipv6 dhcp pool LAN-10-STATELESS** (create pool for addresses and DNS)
R1(config-dhcpv6)# **dns-server 2001:345:ACAD:F::5** (IPv6 DNS server address)
R1(config-dhcpv6)# **domain-name cisco.com** (optional domain name)
R1(config)# **interface g1/1**
R1(config-if)# **ipv6 address 2001:A1B5:C13:10::1/64** (configure IPv6 address)
R1(config-if)# **ipv6 dhcp server LAN-10-STATELESS** (look to this DHCP pool)
R1(config-if)# **ipv6 nd other-config-flag** (enable IPv6 Neighbor Discovery)

Configuring DHCP for IPv6 Stateful Address Auto-configuration

R1(config)# **ipv6 unicast routing** (make sure IPv6 is activated)
R1(config)# **ipv6 dhcp pool LAN-10-STATEFUL** (create pool for addresses and DNS)
R1(config-dhcpv6)# **address prefix 2001:D7B:CAFÉ:10::/64 lifetime infinite infinite**
R1(config-dhcpv6)# **dns-server 2001:345:ACAD:F::5** (IPv6 DNS server address)
R1(config-dhcpv6)# **domain-name cisco.com** (optional domain name)
R1(config)# **interface g1/1**
R1(config-if)# **ipv6 address 2001:D7B:CAFE:10::1/64** (configure IPv6 address)
R1(config-if)# **ipv6 dhcp server LAN-10-STATEFUL** (look to this DHCP pool)
R1(config-if)# **ipv6 nd managed-config-flag** (enable IPv6 Neighbor Discovery)
R-3(config)# **interface fastethernet 0/1** (interface for network with DHCP clients)

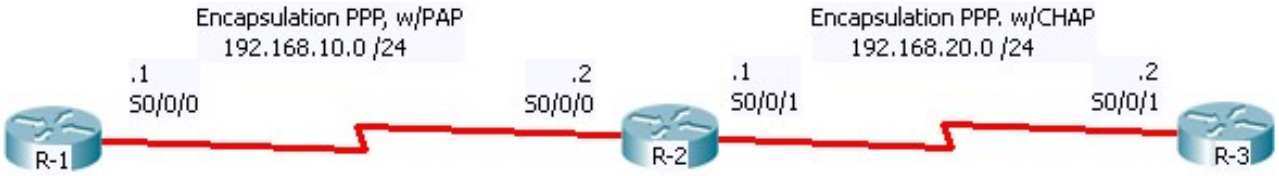
R-3(config-if)# **ip dhcp relay destination 2001:A123:7CA1::15** (IPv6 DHCP server address)
R1# **show ipv6 dhcp pool**
R1# **show ipv6 dhcp binding**

Configure NAT for IPv4

-For both static and dynamic NAT, designate interfaces as inside or outside:
R-1(config)# **interface fa0/0** (typically designate all interfaces except the outside one)
R-1(config-if)# **ip nat inside** (designate this as an inside interface)
R-1(config)# **interface serial 0/0/0** (typically there is only one outside interface)
R-1(config-if)# **ip nat outside** (designate this as an outside interface)
!
-Static NAT requires only one statement. The IP addresses are inside / outside:
R-1(config)# **ip nat inside source static 192.168.10.22 73.2.34.137**
!
-Dynamic NAT may use a pool of 'outside addresses'. If you do not use a pool, you will have to use the address on the outside interface. You can use 'netmask':
R-1(config)# **ip nat pool POOL-NAME 73.2.34.138 73.2.34.143 netmask 255.255.255.248**
-or- You may choose to use 'prefix-length':
R-1(config)# **ip nat pool POOL-NAME 73.2.34.138 73.2.34.143 prefix-length 29**
!
-Dynamic NAT requires an ACL to define which internal addresses can be NATted:
R-1(config)# **ip access-list standard NAT-ELIGIBLE**
R-1(config-std-nacl)# **permit 192.168.10.0 0.0.0.255** (include all subnets)
R-1(config-std-nacl)# **deny any**
!
-Dynamic NAT can use the pool for outside addresses:
R-1(config)# **ip nat inside source list NAT-ELIGIBLE pool POOL-NAME**
-or- Dynamic NAT can use the pool with overload to share outside addresses:
R-1(config)# **ip nat inside source list NAT-ELIGIBLE pool POOL-NAME overload**
-or- Dynamic NAT can use the exit interface – almost always will use overload:
R-1(config)# **ip nat inside source list NAT-ELIGIBLE interface serial 0/0/0 overload**

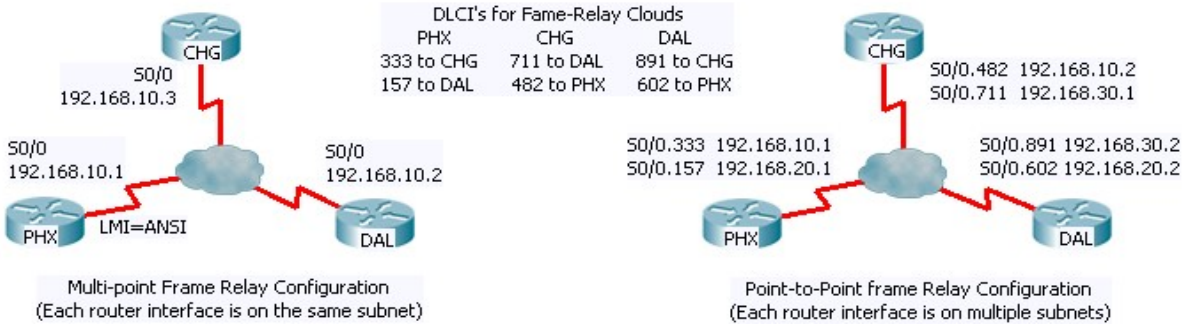
R-1# **show ip nat translations** (current translations- dynamic and static)
R-1# **show ip nat statistics** (see # of active translations, role of interfaces, etc)

PPP Protocol – PAP & CHAP Authentication:



R-1	R-2	R-3
username FROM-R2 password R2-Pass ! interface Serial0/0/0 description PPP Link to R-2, auth PAP ip address 192.168.10.1 255.255.255.0 encapsulation ppp ppp authentication pap ppp pap sent-username FROM-R1 password CCNA-4 **For PPP-PAP to work, the sent-username and password from one router must exist in the username table of the other router.**	username R-3 password Cisco-X username FROM-R1 password CCNA-4 ! interface Serial0/0/0 description PPP link to R-1, auth PAP ip address 192.168.10.2 255.255.255.0 encapsulation ppp ppp authentication pap ppp pap sent-username FROM-R2 password R2-Pass ! interface Serial0/0/1 description PPP link to R-3, auth CHAP ip address 192.168.20.1 255.255.255.0 encapsulation ppp ppp authentication chap	username R-2 password Cisco-X ! interface Serial0/0/1 description PPP link to R-2, auth CHAP ip address 192.168.20.2 255.255.255.0 encapsulation ppp ppp authentication chap **For PPP-CHAP to work, the name of the peer router must be in each routers username table and the passwords must be the same in each table.**

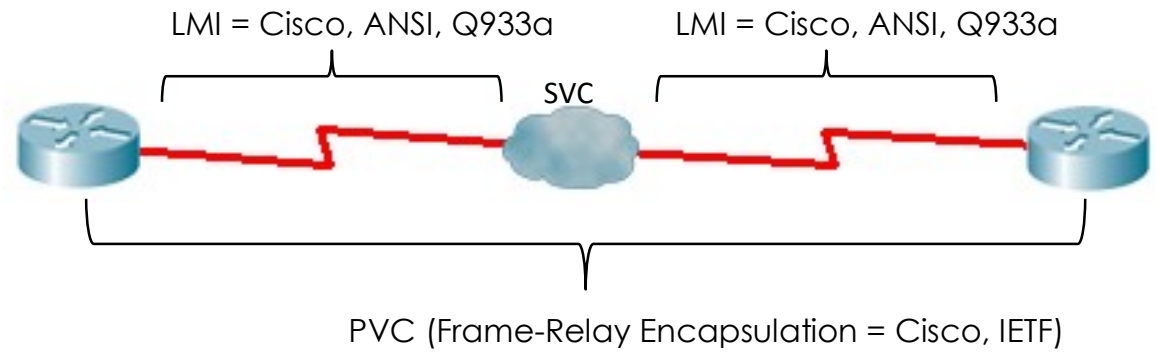
Frame-Relay Configurations: Multipoint and Point-to-Point



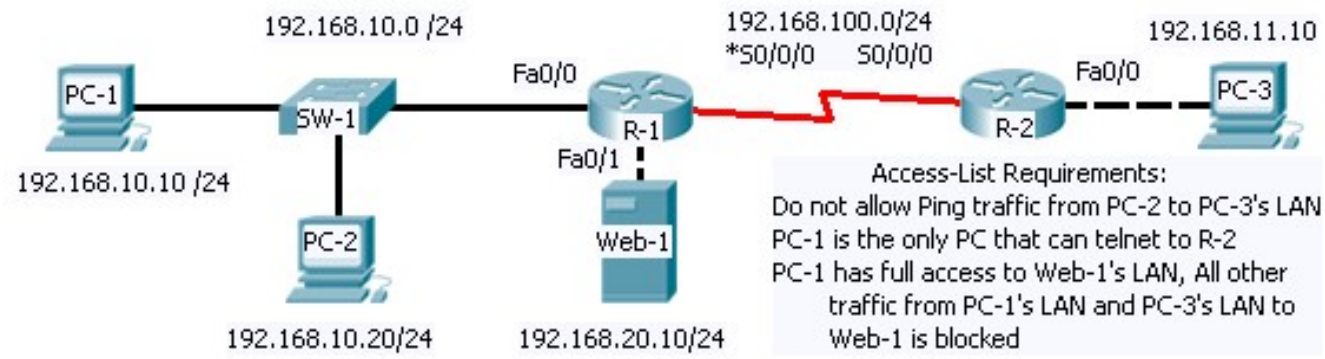
Frame-Relay Multipoint (all three router interfaces are on the same IP subnet)	**Frame-Relay Point-to-Point** (all three router interfaces are on different IP subnets)
! !PHX Router ! interface Serial0/0 ip address 192.168.10.1 255.255.255.0 encapsulation frame-relay frame-relay map ip 192.168.10.2 157 broadcast	! !PHX Router ! interface Serial0/0 no ip address encapsulation frame-relay !

frame-relay map ip 192.168.10.3 333 broadcast frame-relay map ip 192.168.10.1 157 frame-relay lmi-type ansi ! !CHG and DAL are similar except for different IP ! Addresses on S0/0, different IPs and DLCIs in the ! Frame-Relay map statements, and PHX is LMI=Ansi.	interface Serial0/0.157 point-to-point ip address 192.168.20.1 255.255.255.0 frame-relay interface-dlci 157 ! interface Serial0/0.333 point-to-point ip address 192.168.10.1 255.255.255.0 frame-relay interface-dlci 333

Frame-Relay Logical Diagram – LMI, SVC and PVC:



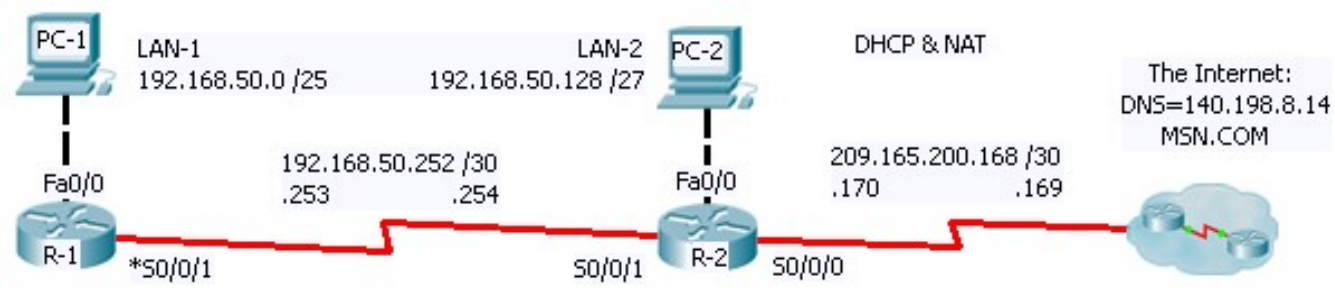
ACLs – (Access Control Lists):



R1	R2
! interface FastEthernet 0/0 ip access-group NO-PING-PC2-TO-PC3-LAN in ! ip access-list extended NO-PING-PC2-TO-PC3-LAN remark Deny Ping from PC-2 to PC-3's LAN deny icmp host 192.168.10.20 192.168.11.0 0.0.0.255 echo remark Permit all other traffic permit ip any any ! ! interface FastEthernet 0/1	! access-list 10 remark Only allow PC-1 access-list 10 permit host 192.168.10.10 access-list 10 remark Deny all others access-list 10 deny any ! line vty 0-4 access-class 10 in !

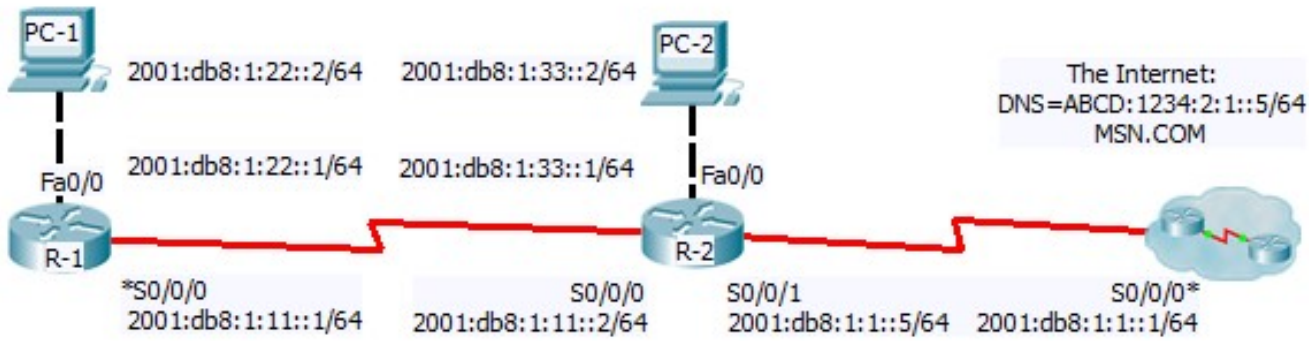
ip access-group RESTRICT-WEB1-TRAFFIC out ! ip access-list standard RESTRICT-WEB1-TRAFFIC remark Permit PC-1 permit host 192.168.10.10 remark Deny all PC-1 and PC-3 LAN traffic deny 192.168.10.0 0.0.1.255 remark Allow all other traffic permit any !	

DHCP & NAT Configuration:



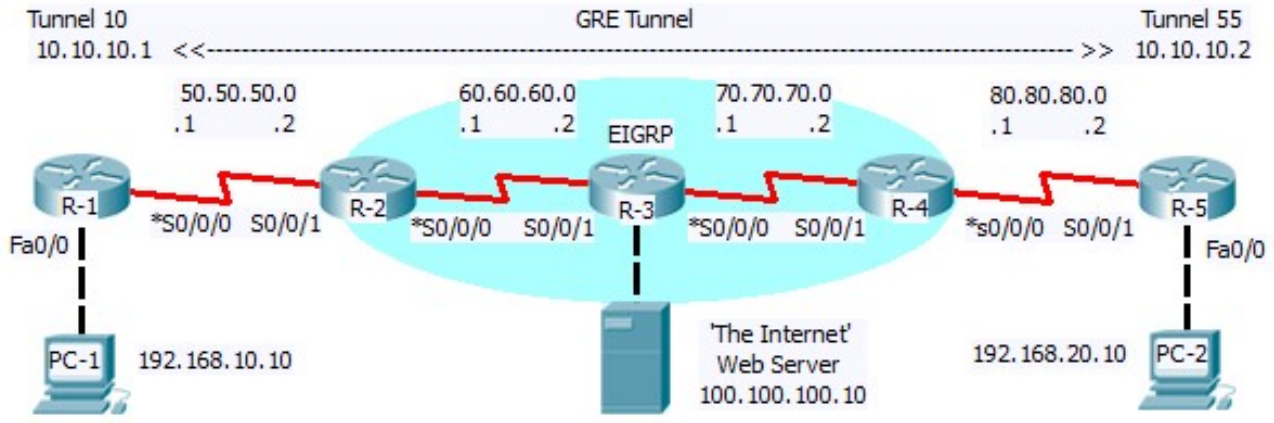
R-1	R-2
! ip dhcp excluded-address 192.168.50.1 192.168.50.7 ip dhcp excluded-address 192.168.50.129 192.168.50.131 ! ip dhcp pool LAN-1 network 192.168.50.0 255.255.255.128 default-router 192.168.50.1 dns-server 140.198.8.14 ! ip dhcp pool LAN-2 network 192.168.50.128 255.255.255.224 default-router 192.168.50.129 dns-server 140.198.8.14	! interface FastEthernet0/0 ip address 192.168.50.129 255.255.255.224 ip helper-address 192.168.50.253 ip nat inside ! interface Serial0/0/0 ip address 209.165.200.170 255.255.255.252 ip nat outside ! interface Serial0/0/1 ip address 192.168.50.254 255.255.255.252 ip nat inside ! ip nat inside source list INSIDE-ADDRESSES interface Serial0/0/0 overload ip route 0.0.0.0 0.0.0.0 Serial0/0/0 ! ip access-list standard INSIDE-ADDRESSES permit 192.168.50.0 0.0.0.127 permit 192.168.50.128 0.0.0.31 permit 192.168.50.252 0.0.0.3 deny any

IPv6 Configuration with EIGRP, AS=200:



R-1	R-2	ISP
! ipv6 unicast-routing ! interface FastEthernet0/0 no ip address ipv6 address FE80::1 link-local ipv6 address 2001:DB8:1:22::1/64 ipv6 eigrp 200 ! interface Serial0/0/0 no ip address ipv6 address FE80::1 link-local ipv6 address 2001:DB8:1:11::1/64 ipv6 eigrp 200 clock rate 2000000 ! ipv6 router eigrp 200 router id 1.1.1.1 no shutdown	! ipv6 unicast-routing ! interface FastEthernet0/0 no ip address ipv6 address FE80::2 link-local ipv6 address 2001:DB8:1:33::1/64 ipv6 eigrp 200 ! interface Serial0/0/0 no ip address ipv6 address FE80::2 link-local ipv6 address 2001:DB8:1:11::2/64 ipv6 eigrp 200 ! interface Serial0/0/1 no ip address ipv6 address FE80::2 link-local ipv6 address 2001:DB8:1:1::5/64 ! ipv6 router eigrp 200 router id 2.2.2.2 no shutdown redistribute static ! ipv6 route ::/0 Serial0/0/1	! interface FastEthernet0/0 desc Simulated Internet Web server no ip address ipv6 address FE80::3 link-local ipv6 address 2222:1111:5:1::1/64 ! interface FastEthernet0/1 desc Simulate ISP provided DNS function no ip address ipv6 address FE80::3 link-local ipv6 address ABCD:1234:2:1::1/64 ! interface Serial0/0/0 desc Link from ISP to our network no ip address ipv6 address FE80::3 link-local ipv6 address 2001:DB8:1:1::1/64 clock rate 800000 ! ipv6 route 2001:DB8:1::/48 Serial0/0/0

VPN GRE Tunnel:



R-1 ! interface Tunnel10 ip address 10.10.10.1 255.255.255.252 tunnel source Serial0/0/0 tunnel destination 80.80.80.2 ! interface FastEthernet0/0 ip address 192.168.10.1 255.255.255.0 ip nat inside ! interface Serial0/0/0 ip address 50.50.50.1 255.255.255.0 ip nat outside ! router rip version 2 passive-interface Serial0/0/0 network 10.0.0.0 network 192.168.10.0 no auto-summary ! ip nat inside source list 1 interface Serial0/0/0 overload ! ip route 0.0.0.0 0.0.0.0 Serial0/0/0 ! access-list 1 permit 192.168.10.0 0.0.0.255 access-list 1 deny any R-1#sh ip route *some output omitted* Gateway of last resort is 0.0.0.0 to network 0.0.0.0 C 10.10.10.0 is directly connected, Tunnel10 C 50.50.50.0 is directly connected,	R-5 ! interface Tunnel55 ip address 10.10.10.2 255.255.255.252 tunnel source Serial0/0/1 tunnel destination 50.50.50.1 ! interface FastEthernet0/0 ip address 192.168.20.1 255.255.255.0 ip nat inside ! interface Serial0/0/1 ip address 80.80.80.2 255.255.255.0 ip nat outside ! router rip version 2 passive-interface Serial0/0/1 network 10.0.0.0 network 192.168.20.0 no auto-summary ! ip nat inside source list NAT interface Serial0/0/1 overload ! ip route 0.0.0.0 0.0.0.0 Serial0/0/1 ! ip access-list standard NAT permit 192.168.20.0 0.0.0.255 deny any Gateway of last resort is 0.0.0.0 to network 0.0.0.0 C 10.10.10.0 is directly connected, Tunnel55 C 80.80.80.0 is directly connected, Serial0/0/1 R 192.168.10.0/24 [120/1] via 10.10.10.1, Tunnel55

Serial0/0/0 C 192.168.10.0/24 is directly connected, Fa0/0 R 192.168.20.0/24 [120/1] via 10.10.10.2, Tunnel10 S* 0.0.0.0/0 is directly connected, S0/0/0	C 192.168.20.0/24 is directly connected, Fa0/0 S* 0.0.0.0/0 is directly connected, Serial0/0/1