Changing switch hostname	
Switch(config)#hostname **SW1**	
Configuring passwords	
SW1(config)#enable secret **cisco**	MD5 hash.
SW1(config)#enable password **notcisco**	Clear text.
Securing console port	
SW1(config)#line con 0 SW1(config-line)#password **cisco** SW1(config-line)#login	
Securing terminal lines	
SW1(config)#line vty 0 4 SW1(config-line)#password **cisco** SW1(config-line)#login	
Encrypting passwords	
SW1(config)#service password-encryption	
Configuring banners	
SW1(config)#banner motd $ **-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-** **UNAUTHORIZED ACCESS IS PROHIBITED** **-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-** $	
Giving the switch an IP address	
SW1(config)#interface vlan 1 SW1(config-if)#ip address **172.16.1.11 255.255.255.0** (or **dhcp)** SW1(config-if)#shutdown	
Setting the default gateway	
SW1(config)#ip default-gateway **172.16.1.1**	
Saving configuration	
SW1#copy running-config startup-config Destination filename [startup-config]? Building configuration… [OK]	Press enter to confirm file name.
SW1#wr Building configuration… [OK]	Short for write memory.
Working environment (name lookup, history, exec-timeout and logging behavior)	
SW1(config)#no ip domain-lookup SW1(config)#line vty 0 4 SW1(config-line)#history size **15** SW1(config-line)# exec-timeout **10 30** SW1(config-line)#logging synchronous	Also valid for line con 0.
Configuring switch to use SSH	
• **Configure DNS domain name:** SW1(config)#ip domain-name **example.com** • **Configure a username and password:** SW1(config)#username **admin** password **cisco** • **Generate encryption keys:** SW1(config)#crypto key generate rsa How many bits in the modulus [512]: **1024** • **Define SSH version to use:** SW1(config)#ip ssh version 2 • **Enable vty lines to use SSH:** SW1(config)#line vty 0 4 SW1(config-line)#login local SW1(config-line)#transport input telnet ssh	The size of the key modulus in the range of 360 to 2048. You can set vty lines to use only telnet or only ssh or both as in the example.

Aliases	
SW1(config)#alias exec **c** configure terminal SW1(config)#alias exec **s** show ip interface brief SW1(config)#alias exec **sr** show running-config	Used to create shortcuts for long commands.

Description, speed and duplex	
SW1(config)#interface fastEthernet 0/1 SW1(config-if)#description **LINK TO INTERNET ROUTER** SW1(config-if)#speed 100 **(options: 10, 100, auto)** SW1(config)#interface range fastEthernet 0/5 – 10 SW1(config-if-range)#duplex full **(options: half, full, auto)**	The **range** keyword used to set a group of interfaces at once.

Verify Basic Configuration	
SW1#show version	Shows information about the switch and its interfaces, RAM, NVRAM, flash, IOS, etc.
SW1#show running-config	Shows the current configuration file stored in DRAM.
SW1#show startup-config	Shows the configuration file stored in NVRAM which is used at first boot process.
SW1#show history	Lists the commands currently held in the history buffer.
SW1#show ip interface brief	Shows an overview of all interfaces, their physical status, protocol status and ip address if assigned.
SW1#show interface vlan 1	Shows detailed information about the specified interface, its status, protocol, duplex, speed, encapsulation, last 5 min traffic.
SW1#show interfaces description	Shows the description of all interfaces
SW1#show interfaces status	Shows the status of all interfaces like connected or not, speed, duplex, trunk or access vlan.
SW1#show crypto key mypubkey rsa	Shows the public encryption key used for SSH.
SW1#show dhcp lease	Shows information about the leased IP address (when an interface is configured to get IP address via a dhcp server)

Configuring port security	
• **Make the switch interface as access port:** SW1(config-if)#switchport mode access • **Enable port security on the interface:** SW1(config-if)#switchport port-security • **Specify the maximum number of allowed MAC addresses:** SW1(config-if)#switchport port-security maximum 1 • **Define the action to take when violation occurs:** SW1(config-if)#switchport port-security violation shutdown **(options: shutdown, protect, restrict)** • **Specify the allowed MAC addresses:** SW1(config-if)#switchport port-security mac-address **68b5.9965.1195** **(options: H.H.H, sticky)**	The **sticky** keyword is used to let the interface dynamically learns and configures the MAC addresses of the currently connected hosts.

Verify and troubleshoot port security	
SW1#show mac-address-table	Shows the entries of the mac address table
SW1#show port-security	overview of port security of all interfaces
SW1#show port-security interface fa0/5	Shows detailed information about port security on the specified interface

Configuring VLANs

• **Create a new VLAN and give it a name:** SW1(config)#vlan 10 SW1(config-vlan)#name SALES • **Assign an access interface to access a specific VLAN:** SW1(config)#interface fastEthernet 0/5 SW1(config-if)#switchport mode access SW1(config-if)#switchport access vlan 10	
Configuring an auxiliary VLAN for cisco IP phones	
SW1(config)#interface fastEthernet 0/5 SW1(config-if)#switchport access vlan 10 SW1(config-if)#switchport voice vlan 12	accessing vlan 10 (data) and 12 (VoIP)
Configuring Trunks	
SW1(config)#interface fastEthernet 0/1 SW1(config-if)#switchport mode trunk **(options: access, trunk, dynamic auto, dynamic desirable)** SW1(config-if)#switchport trunk allowed vlan add **10** **(options: add, remove, all, except)**	
Securing VLANS and Trunking	
• **Administratively disable unused interfaces:** SW1(config-if)#shutdown • **Prevent trunking by disabling auto negotiation on the interface:** SW1(config-if)#nonegotiate (or hardcode the port as an access port) SW1(config-if)#switchport mode access • **Assign the port to an unused VLAN:** SW1(config-if)#switchport access vlan 222	
Configuring VTP	
• **Configure VTP mode:** SW1(config)#vtp mode server **(options: server, client, transparent)** • **Configure VTP domain name:** SW1(config)#vtp domain **EXAMPLE (case-sensitive)** • **Configure VTP password: (optional)** SW1(config)#vtp password **cisco (case-sensitive)** • **Configure VTP pruning: (optional)** SW1(config)#vtp pruning **(only works on VTP servers)** • **Enable VTP version 2: (optional)** SW1(config)#vtp version 2 • **Bring up trunks between the switches**	The **transparent** VTP mode is used when an engineer wants to deactivate VTP on a particular switch
Verify and troubleshoot VLANS and VTP	
SW1#show interfaces *if* switchport	Lists information about administrative setting and operation status of interface
SW1#show interfaces trunk	Lists all the trunk ports on a switch including the trunk allowed VLANS
SW1#show vlan {brief| id| name| summary}	Lists information about the VLANs
SW1#show vtp status	Lists VTP configuration (mode, domain name, version, etc) and **revision** number
SW1#show vtp password	Shows the VTP password
STP optimization	

- **Hard coding the root bridge** (changing bridge priority):

```
SW1(config)#spanning-tree vlan 1 root primary
SW1(config)#spanning-tree vlan 1 root secondary
SW1(config)#spanning-tree [vlan 1] priority 8192
```

- **Changing the STP mode:**

```
SW1(config)#spanning-tree mode rapid-pvst
```

(options: mst, pvst, rapid-pvst)

- **Enabling portfast and BPDU guard on an interface:**

```
SW1(config-if)#spanning-tree portfast
SW1(config-if)#spanning-tree bpduguard enable
```

- **Changing port cost**:

```
SW1(config-if)#spanning-tree [vlan 1] cost 25
```

- **Bundling interfaces into an etherchannel:**

```
SW1(config-if)#channel-group 1 mode on
```

(options: auto, desirable, on)

Priority must be a multiply of 4096

Portfast and BPDU guard are enabled only on interfaces connected to end user hosts

STP verification and troubleshooting

SW1#show spanning-tree	Shows detailed info about STP state
SW1#show spanning-tree interface fa0/2	Shows STP info only on a specific port
SW1#show spanning-tree vlan 1	Shows STP info only for a specific VLAN
SW1#show spanning-tree [vlan1] root	Shows info about the root switch
SW1#show spanning-tree [vlan1] bridge	Shows info about the local switch
SW1#show etherchannel 1	Show the state of the etherchannels
SW1#debug spanning-tree events	Provides informational messages about the changes in the STP topology

Enabling or disabling CDP

- **Enabling CDP globally on a switch:**

```
SW1(config)#cdp run
```

- **Disabling CDP on a given interface:**

```
SW1(config-if)#no cdp enable
```

Using CDP for network verification and troubleshooting

SW1#show cdp	Shows global information about CDP itself
SW1#show cdp interface fa0/2	Shows information about CDP on a specific interface
SW1#show cdp neighbors	Shows information about the directly connected cisco devices including interfaces names capabilities
SW1#show cdp neighbors detail	Shows detailed information about the neighboring cisco devices including device address and version of IOS they run
SW1#show cdp entry *	Same as show cdp neighbor detail
SW1#show cdp entry SW2	Shows detailed information about the specified entry only

Router basic configuration

```
Router(config)#hostname R1
R1(config)#enable secret cisco
R1(config)#line con 0
R1(config-line)#password cisco
R1(config-line)#login
R1(config-line)#logging synchronous
R1(config-line)#exec-timeout 30 0
R1(config-line)#exit
R1(config)#line vty 0 4
R1(config-line)#password cisco
R1(config-line)#login
R1(config-line)#logging synchronous
R1(config-line)#exec-timeout 30 0
R1(config-line)#exit
R1(config)#line aux 0
R1(config-line)#password cisco
R1(config-line)#login
R1(config-line)#logging synchronous
R1(config-line)#exec-timeout 30 0
R1(config-line)#exit
R1(config)#banner motd $
-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-
UNAUTHORIZED ACCESS IS PROHIBITED
-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-
$
R1(config)#alias exec c configure terminal
R1(config)#alias exec s show ip interface brief
R1(config)#alias exec sr show running-config
R1(config)#no ip domain-lookup
R1(config)#service password-encryption
R1(config)#ip domain-name example.com
R1(config)#username admin password cisco
R1(config)#crypto key generate rsa
How many bits in the modulus [512]: 1024
R1(config)#ip ssh version 2
R1(config)#line vty 0 4
R1(config-line)#login local
R1(config-line)#transport input telnet ssh
```

This section includes IOS commands that are absolutely identical on both routers and switches, except the part of line aux 0 which is configured only on router because switches do not have an auxiliary port.

Configuring router interfaces

```
R1(config)#interface fastEthernet 0/0
R1(config-if)#description LINK_TO_LOCAL_LAN_THROUGH_SW1
R1(config-if)#ip address 172.16.1.1 255.255.255.0
R1(config-if)#no shutdown
R1(config-if)#exit
R1(config)#interface serial 0/1/0
R1(config-if)#description WAN_CONNECTION_TO_R2
R1(config-if)#ip address 10.1.1.1 255.255.255.252
R1(config-if)#clock rate 128000
R1(config-if)#no shutdown
```

Clock rate is set only on the DCE side, typically the ISP side. On your router which is DTE you don't need to set clocking.

Configuring Router-On-Stick for vlan routing

```
R1(config)#interface fastEthernet 0/0
R1(config-if)#no shutdown
R1(config)# interface fastEthernet 0/0.10
R1(config-subif)# encapsulation dot1q 10
R1(config-subif)#ip address 192.168.10.1 255.255.255.0
R1(config-subif)# interface fastEthernet 0/0.20
R1(config-subif)# encapsulation dot1q 20
R1(config-subif)#ip address 192.168.20.1 255.255.255.0
```

Static routes	
R1(config)#ip route **10.1.2.0 255.255.255.0 10.1.128.1**	Using next hop
R1(config)#ip route **10.1.2.0 255.255.255.0 Serial 0/0** ***Note:** Exit interface can be used in point-to-point serial links.	Using exit interface
Default Route	
R1(config)#ip route **0.0.0.0 0.0.0.0 199.1.1.1**	
RIPv2 Configuration	

R1(config)#router rip
R1(config-router)#version 2
R1(config-router)#network **10.0.0.0** (written as an original class A)	

R1(config-router)#no autosummary	
R1(config-router)#passive-interface serial 0/0	
RIPv2 Verification	
R1#show ip protocols	Shows information about the running routing protocol process
R1#show ip route	Shows the entire routing table
R1#show ip route rip	Shows routes learned via RIP only
R1#show ip route 10.1.1.1	Shows detailed information about the route to the specified destination network
OSPF Configuration	
• **Enter OSPF router configuration mode:** R1(config)#router ospf **10** (process ID) • **Configure one or more network commands to identify which interfaces will run OSPF:** R1(config-router)#network **10.0.0.0 0.255.255.255** area **0** R1(config-router)#network **172.16.8.0 0.0.7.255** area **0** R1(config-router)#network **192.168.1.254 0.0.0.0** area **1**	
• **Configure router ID either by: (Optional)** o Using router-id ospf subcommand: R1(config-router)#router-id **1.1.1.1** o Configuring an IP address on a loopback interface: R1(config)#interface **loopback 0** R1(config-if)#ip address **1.1.1.1 255.255.255.255**	
• **Change Hello and Dead intervals per interface: (Optional)** R1(config-if)#ip ospf hello-interval **2** R1(config-if)#ip ospf dead-interval **6**	
• **Impact routing choices by tuning interface cost using one of the following ways: (Optional)** o Changing interface cost: R1(config-if)#ip ospf cost **55** o Changing interface bandwidth: R1(config-if)#bandwidth **128** (Kbps) o Changing the reference bandwidth that used by OSPF to calculate the cost: R1(config-router)#auto-cost reference-bandwidth **1000** (Mbps)	
• **Disabling OSPF on a certain interface: (Optional)** R1(config-router)#passive-interface **serial 0/0**	
• **Configuring OSPF authentication: (Optional)** o Type 0 authentication (none): R1(config-if)#ip ospf authentication null o Type 1 authentication (clear text): R1(config-if)#ip ospf authentication R1(config-if)#ip ospf authentication-key **cisco** o Type 2 authentication (md5): R1(config-if)#ip ospf authentication message-digest R1(config-if)#ip ospf message-digest-key **1** md5 **cisco**	
• **Configure maximum equal-cost paths: (Optional)** R1(config-router)#maximum paths **6**	

OSPF verification	
R1#show ip protocols	Shows information about the running routing protocol process
R1#show ip route	Shows the entire routing table
R1#show ip route ospf	Shows routes learned via OSPF only
R1#show ip ospf neighbors	Shows all neighboring routers along with their respective adjacency state
R1#show ip ospf database	Shows all the information contained in the LSDB
R1#show ip ospf interfaces serial 0/0	Shows detailed information about OSPF running on a specific interface

EIGRP Configuration	
• **Enter EIGRP configuration mode and define AS number:** R1(config)#router eigrp **121** (AS number) • **Configure one or more network commands to enable EIGRP on the specified interfaces:** R1(config-router)#network **10.0.0.0** R1(config-router)#network **172.16.0.0 0.0.3.255** R1(config-router)#network **192.168.1.1 0.0.0.0** R1(config-router)#network **0.0.0.0 255.255.255.255**	
• **Disable auto summarization: (Optional)** R1(config-router)#no autosummary	
• **Disable EIGRP on a specific interface: (Optional)** R1(config-router)#passive-interface **serial 0/0**	
• **Configure load balancing parameters: (Optional)** R1(config-router)#maximum-paths **6** R1(config-router)#variance **4**	
• **Change interface Hello and Hold timers: (Optional)** R1(config-if)#ip hello-interval eigrp **121 3** R1(config-if)#ip hold-time eigrp **121 10**	

• **Impacting metric calculations by tuning BW and delay of the interface: (Optional)**
R1(config-if)#bandwidth **265** (kbps)
R1(config-if)#delay **120** (tens of microseconds)	

EIGRP Authentication	
• **Create an authentication key chain as follows:** ○ Create a key chain and give it a name: R1(config)#key chain **MY_KEYS** ○ Create one or more keys giving them numbers: R1(config-keychain)#key **1** ○ Define the key value: R1(config-keychain-key)#key-string **1stKEY** ○ Define the life time of the keys (optional): R1(config-keychain-key)#send-lifetime **[start time] [end time]** R1(config-keychain-key)#accept-lifetime **[start time] [end time]** • **Enable md5 authentication mode for EIGRP on the interface:** R1(config-if)#ip authentication mode eigrp **121** md5 • **Refer to the correct key chain to be used on the interface:** R1(config-if)#ip authentication key-chain eigrp **121 MY_KEYS**	The key-string value and the mode must be the same on both routers. Lifetime options of the keys requires the clock of the routers to be set correctly, better use NTP, or it can cause problems

EIGRP Verification	
R1#show ip route eigrp	Shows routes learned via EIGRP only
R1#show ip eigrp neighbors	Shows EIGRP neighbors and status
R1#show ip eigrp topology	Shows EIGRP topology table, including successor and feasible successor
R1#show ip eigrp interfaces	Shows interfaces that run EIGRP
R1#show ip eigrp traffic	Lists statistics on numbers of EIGRP messages sent and received by the router

Access Control Lists (ACLs)

Standard ACL

- **Plane the location (router and interface) and direction (in or out) on that interface:**
  - Standard ACL should be placed as close as possible to the destination of the packet.
  - Identify the source IP addresses of packets as they go in the direction that the ACL is examining.
- **Use a remark to describe the ACL: (Optional):**

```
R1(config)#access-list 1 remark ACL TO DENY ACCESS FROM SALES VLAN
```

- **Create the ACL, keeping the following in mind:**
  - ACL uses first-match logic.
  - There is an implicit *deny any* at the end of the ACL.

```
R1(config)#access-list 2 deny 192.168.1.77
R1(config)#access-list 2 deny 192.168.1.64 0.0.0.31
R1(config)#access-list 2 permit 10.1.0.0 0.0.255.255
R1(config)#access-list 2 deny 10.0.0.0 0.255.255.255
R1(config)#access-list 2 permit any
```

- **Enable the ACL on the chosen router interface in the correct direction (in or out):**

```
R1(config-if)#ip access-group 2 out
```

Standard ACL number ranges: 1 – 99 and 1300 – 1999.

- **Using standard ACL to limit telnet and SSH access to a router:**
  - Create the ACL that defines the permitted telnet clients:

```
R1(config)#access-list 99 remark ALLOWED TELNET CLIENTS
R1(config)#access-list 99 permit 192.168.1.128 0.0.0.15
```

  - apply the ACL inbound the vty lines

```
R1(config)#line vty 0 4
R1(config-line)#access-class 99 in
```

Extended ACL

- **Note:**
  - Extended ACL should be placed as close as possible to the source of the packet.
  - Extended ACL matches packets based on source & des. IP addresses, protocol, source & des. Port numbers and other criteria as well.

```
R1(config)#access-list 101 remark MY_ACCESS_LIST
R1(config)#access-list 101 deny ip host 10.1.1.1 host 10.2.2.2
R1(config)#access-list 101 deny tcp 10.1.1.0 0.0.0.255 any eq 23
R1(config)#access-list 101 deny icmp 10.1.1.1 0.0.0.0 any
R1(config)#access-list 101 deny tcp host 10.1.1.0 host 10.0.0.1 eq 80
R1(config)#access-list 101 deny udp host 10.1.1.7 eq 53 any
R1(config)#access-list 101 permit ip any any
R1(config)#interface fastEthernet 0/0
R1(config-if)#ip access-group 101 in
```

Extended ACL number ranges: 100 – 199 and 2000 – 2699.

Named ACL

- **Note:**
  - Named ACLs use names to identify ACLs rather than numbers, and commands that permit or deny traffic are written in a sub mode called named ACL mode (nacl).
  - Named ACL enables the editing of the ACL (deleting or inserting statements) by sequencing statements of the ACL.
- **Named standard ACL:**

```
R1(config)#ip access-list standard MY_STANDARD_ACL
R1(config-std-nacl)#permit 10.1.1.0 0.0.0.255
R1(config-std-nacl)#deny 10.2.2.2
R1(config-std-nacl)#permit any
R1(config)#interface fastEthernet 0/1
R1(config-if)#ip access-group MY_STANDARD_ACL out
```

- **Named extended ACL:**

```
R1(config)#ip access-list extended MY_EXTENDED_ACL
R1(config-ext-nacl)#deny icmp 10.1.1.1 0.0.0.0 any
R1(config-ext-nacl)#deny tcp host 10.1.1.0 host 10.0.0.1 eq 80
R1(config-ext-nacl)# permit ip any any
R1(config)#interface fastEthernet 0/1
R1(config-if)#ip access-group MY_EXTENDED_ACL in
```

- **Editing ACL using sequence numbers:**

```
R1(config)#ip access-list extended MY_EXTENDED_ACL
R1(config-ext-nacl)#no 20 (deletes the statement of sequence number 20)
R1(config)#ip access-list standard 99
R1(config-std-nacl)#5 deny 1.1.1.1 (inserts a statement with sequence 5)
```

You can edit numbered ACLs using the configuration style of the named ACLs in as shown in the last example.

Verifying ACLs

R1#show access-lists	Shows all ACLs configured on a router with counters at the end of each statement
R1#show ip access-list	Same as the previous command
R1#show ip access-list 101	Shows only the specified ACL
R1#show ip interface f0/0	Includes a reference to the ACLs enabled on that interface either in or out.

DHCP Server

- **Define a DHCP pool and give it a name:**

```
R1(config)#ip dhcp pool MY_POOL
```

- **Define network and mask to use in this pool and the default gateway:**

```
R1(dhcp-config)#network 192.168.1.0 255.255.255.0
R1(dhcp-config)#default-router 192.168.1.1
```

- **Define one or more DNS server (OPTIONAL):**

```
R1(dhcp-config)#dns-server 213.131.65.20 8.8.8.8
```

- **Confine the lease time (OPTIONAL):**

```
R1(dhcp-config)lease 2 (days)
```

- **Define one or more scopes of excluded (reserved) addresses (OPTIONAL):**

```
R1(config)#ip dhcp excluded-address 192.168.1.1 192.168.1.100
R1(config)#ip dhcp excluded-address 192.168.1.200 192.168.1.254
```

DHCP Verification and Troubleshooting

R1#show ip dhcp pool POOL_1	shows the status of the specified pool and the leased addresses from that pool
R1#show ip dhcp binding	Shows all the leased ip addresses from all configured DHCP pools
R1#show ip dhcp conflict	Shows any conflicts that occurred

PPP Configuration

```
R1(config)#interface serial 0/0
R1(config-if)#encapsulation ppp
```

PPP Authentication

CHAP

- **Configure the hostname:**

```
R1(config)#hostname ALPHA
```

- **Configure the name of the other end router and the shared password:**

```
ALPHA(config)#username BETA password XYZ
```

- **Enable CHAP authentication on the interface:**

```
ALPHA(config)#interface serial 0/0
ALPHA(config-if)#ppp authentication chap
```

The password used is shared password, that means it must be the same on both routers

PAP

- **Configure the hostname:**

```
R1(config)#hostname ALPHA
```

- **Configure the name of the other end router and the shared password:**

```
ALPHA(config)#username BETA password XYZ
```

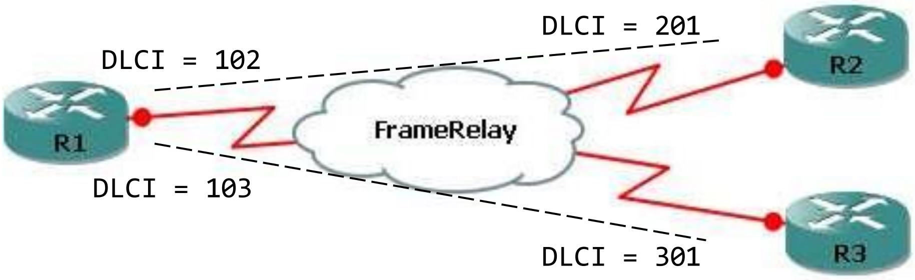
- **Enable PAP authentication on the interface and define the username and password to be sent by PAP:**

```
ALPHA(config)#interface serial 0/0
ALPHA(config-if)#ppp authentication pap
ALPHA(config-if)#ppp pap sent-username ALPHA password XYZ
```

PPP Verification and troubleshoot

R1#show interface s0/0	Shows the encapsulation type and the control protocols of PPP
R1#show run	Useful for viewing the configuration of usernames and passwords used to authenticate ppp
R1#debug ppp authentication	Displays the authentication process of ppp in real time

Frame Relay



Multipoint (one subnet)

- **Give the interface an ip address and enable Frame Relay encapsulation:**

```
R1(config)#interface serial 0/0
R1(config-if)#ip address 1.1.1.1 255.255.255.0
R1(config-if)#encapsulation frame-relay (ietf)
```

- **Configure LMI signaling type: (Optional as discussed with ISP)**

```
R1(config-if)#frame-relay lmi-type ansi
(options: ansi, cisco, q933a)
```

- **Configure Frame Relay mapping:**

```
R1(config-if)# frame-relay map ip 1.1.1.2 102 broadcast (ietf)
R1(config-if)# frame-relay map ip 1.1.1.3 103 broadcast
```

```
R2(config)#interface serial 0/0
R2(config-if)#ip address 1.1.1.2 255.255.255.0
R2(config-if)#encapsulation frame-relay
R2(config-if)# frame-relay map ip 1.1.1.1 201 broadcast
R2(config-if)# frame-relay map ip 1.1.1.3 201 broadcast
```

```
R3(config)#interface serial 0/0
R3(config-if)#ip address 1.1.1.3 255.255.255.0
R3(config-if)#encapsulation frame-relay
R3(config-if)# frame-relay map ip 1.1.1.1 301 broadcast
R3(config-if)# frame-relay map ip 1.1.1.2 301 broadcast
```

Point-to-point (different subnets; one subnet per subinterface)

- **Enable Frame Relay encapsulation:**

```
R1(config)#interface serial 0/0
R1(config-if)#encapsulation frame-relay
```

- **Give an ip address to a subinterface and configure its DLCI:**

```
R1(config)#interface serial 0/0.102 point-to-point
R1(config-subif)#ip address 1.1.1.1 255.255.255.0
R1(config-subif)#frame-relay interface-dlci 102
R1(config)#interface serial 0/0.103 point-to-point
R1(config-subif)#ip address 2.2.2.1 255.255.255.0
R1(config-subif)#frame-relay interface-dlci 103
```

```
R2(config)#interface serial 0/0
R2(config-if)#encapsulation frame-relay
R2(config)#interface serial 0/0.201 point-to-point
R2(config-subif)#ip address 1.1.1.2 255.255.255.0
R2(config-subif)#frame-relay interface-dlci 201
```

```
R3(config)#interface serial 0/0
R3(config-if)#encapsulation frame-relay
R3(config)#interface serial 0/0.301 point-to-point
R3(config-subif)#ip address 2.2.2.2 255.255.255.0
R3(config-subif)#frame-relay interface-dlci 301
```

Frame Relay Verification and troubleshoot

R1#show interfaces serial 0/0	Shows the encapsulation type
R1#show frame-relay PVC	Lists PVC status information
R1#show frame-relay map	Lists DLCI to IP mapping
R1#show frame-relay lmi	Lists LMI status information
R1#debug frame-relay lmi	Displays the content of LMI messages
R1#debug frame-relay events	Lists messages about certain Frame Relay events, including Inverse ARP messaeges

Network Address Translation (NAT)

Static NAT

- **Define the outside and inside interfaces:**

```
R1(config)#interface serial 0/0
R1(config-if)#ip nat outside
R1(config)#interface FastEthernet 1/1
R1(config-if)#ip nat inside
```

- **Configure static NAT statement:**

```
R1(config)#ip nat inside source static 192.168.1.10 200.1.1.1
```

Dynamic NAT

- **Define the outside and inside interfaces:**
- **Create an ACL that determines the IP addresses that are allowed to be translated:**

```
R1(config)#access-list 3 permit 192.168.1.0 0.0.0.255
```

- **Create a pool of public IP addresses:**

```
R1(config)#ip nat pool PUB 200.1.1.1 200.1.1.6 netmask 255.255.255.248
```

- **Configure NAT statement:**

```
R1(config)#ip nat inside source list 3 pool PUB
```

NAT Overload (PAT)	
• **The same as dynamic NAT with the use of the overload keyword at the end of NAT statement:** R1(config)#ip nat inside source list **3** pool **PUB** overload	

NAT verification and troubleshoot	
R1#show run	Useful in viewing the configuration of NAT pool and the inside and outside interfaces
R1#show access-lists	Displays access lists, including the one used for NAT
R1#show ip nat stasitics	Shows counters for packets and NAT table entries, as well as basic configuration information
R1#show ip nat translations	Displays the NAT table
R1#clear ip nat translations *	Clears all the dynamic entries in the NAT table
R1#debug ip nat	Issues a log message describing each packet whose ip address is translated with NAT