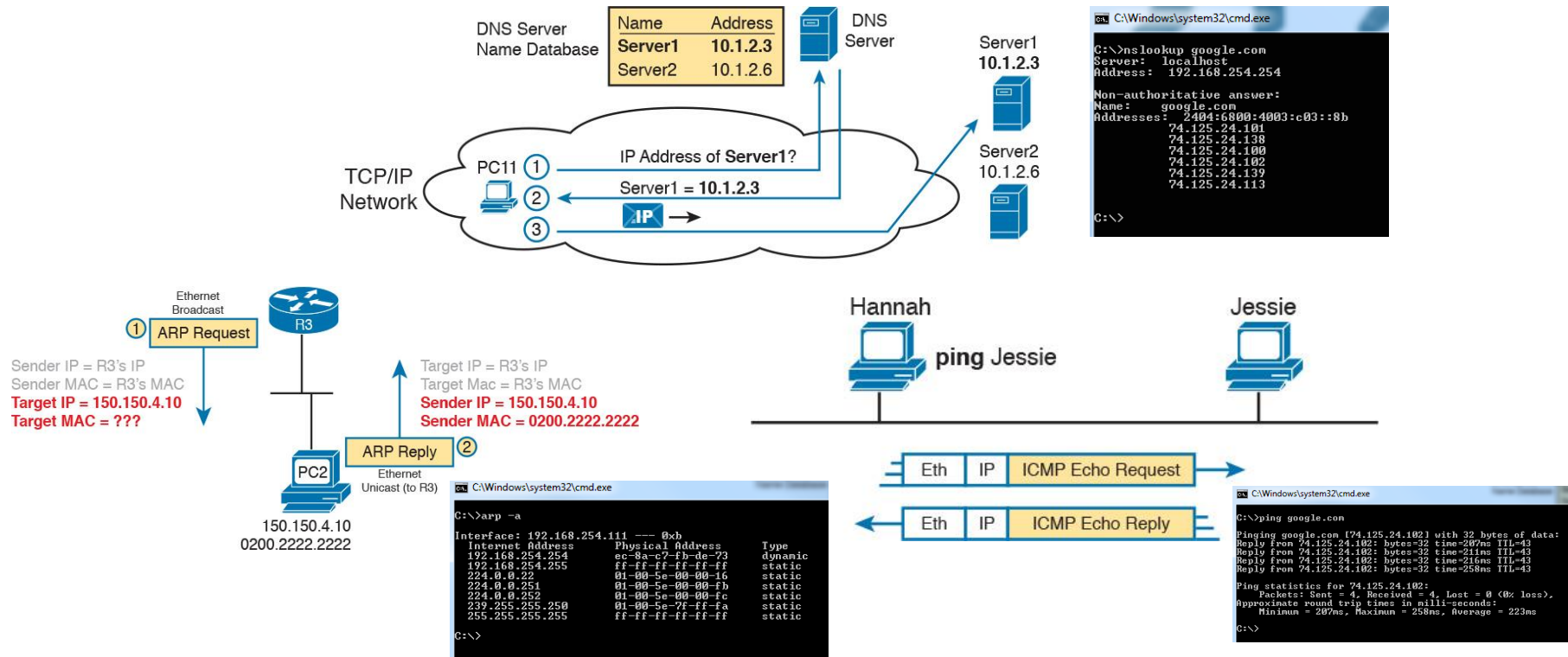


Internold Networks CCNA Live Webclass (INCLW)

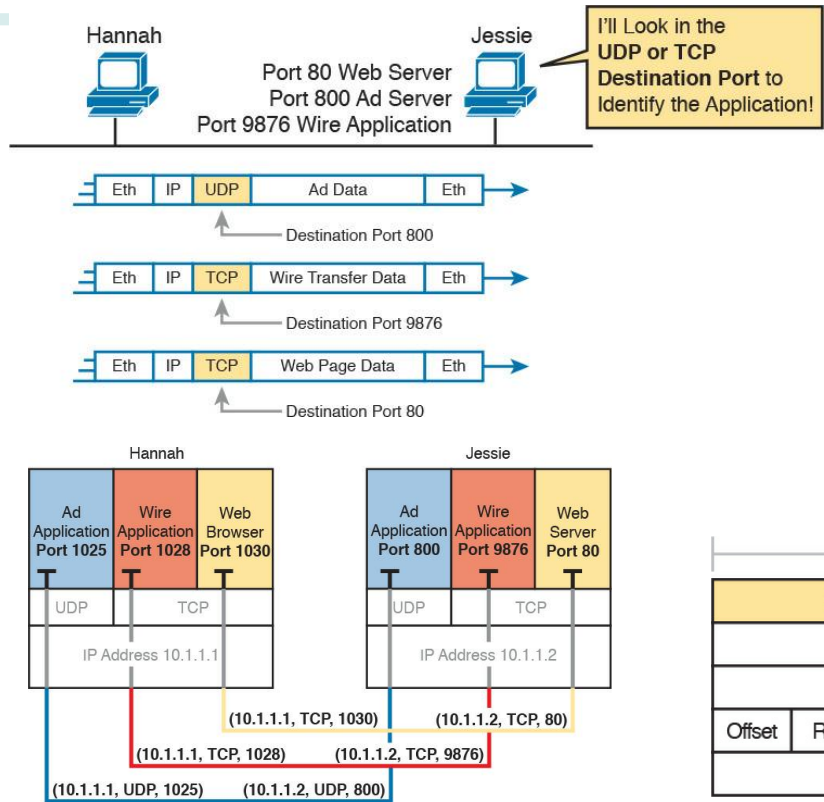
Week 3 of 8



Other Network Layer Features (DNS, ARP, Ping)

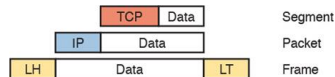
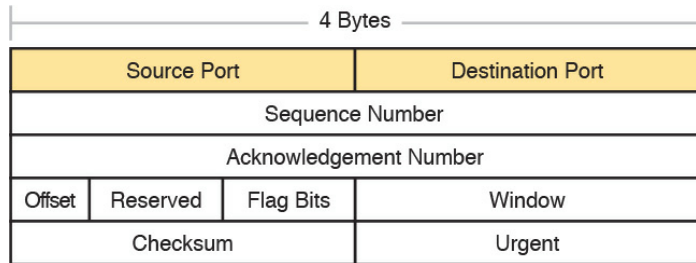


TCP/IP Layer 4 Protocols: TCP ... Multiplexing Using TCP Port Numbers



Port Number	Protocol	Application
20	TCP	FTP data
21	TCP	FTP control
22	TCP	SSH
23	TCP	Telnet
25	TCP	SMTP
53	UDP, TCP ¹	DNS
67	UDP	DHCP Server
68	UDP	DHCP Client
69	UDP	TFTP
80	TCP	HTTP (W/W)
110	TCP	POP3
161	UDP	SNMP
443	TCP	SSL
514	UDP	Syslog

¹ DNS uses both UDP and TCP in different instances. It uses port 53 for both TCP and UDP.



TCP/IP Layer 4 Protocols: TCP ::: Three-Way Handshake

Web Browser



Port
1027

SYN, DPORT=80, SPORT=1027

SYN, ACK, DPORT=1027, SPORT=80

ACK, DPORT=80, SPORT=1027

Web Server



Port
80

4 Bytes			
Source Port		Destination Port	
Sequence Number			
Acknowledgement Number			
Offset	Reserved	Flag Bits	Window
Checksum			Urgent

- **Connection-oriented protocol:** A protocol that requires an exchange of messages before data transfer begins, or that has a required pre-established correlation between two endpoints.
- **Connectionless protocol:** A protocol that does not require an exchange of messages and that does not require a pre-established correlation between two endpoints.

TCP/IP Layer 4 Protocols: TCP ::: Reliability and Error Recovery

Web Browser



1000 Bytes of Data, Sequence = 1000
1000 Bytes of Data, Sequence = 2000
1000 Bytes of Data, Sequence = 3000

Web Server



1 Got All 3000 Bytes.
Send ACK

No Data, Acknowledgment = 4000

4 Bytes			
Source Port		Destination Port	
Sequence Number			
Acknowledgement Number			
Offset	Reserved	Flag Bits	Window
Checksum			Urgent

Web Browser



1000 Bytes of Data, Sequence = 1000
1000 Bytes of Data, Sequence = 2000
1000 Bytes of Data, Sequence = 3000

Web Server



1 I Received 1000 - 1999.
I Received 3000 - 3999.
Ask for 2000 Next!

No Data, Acknowledgment = 2000

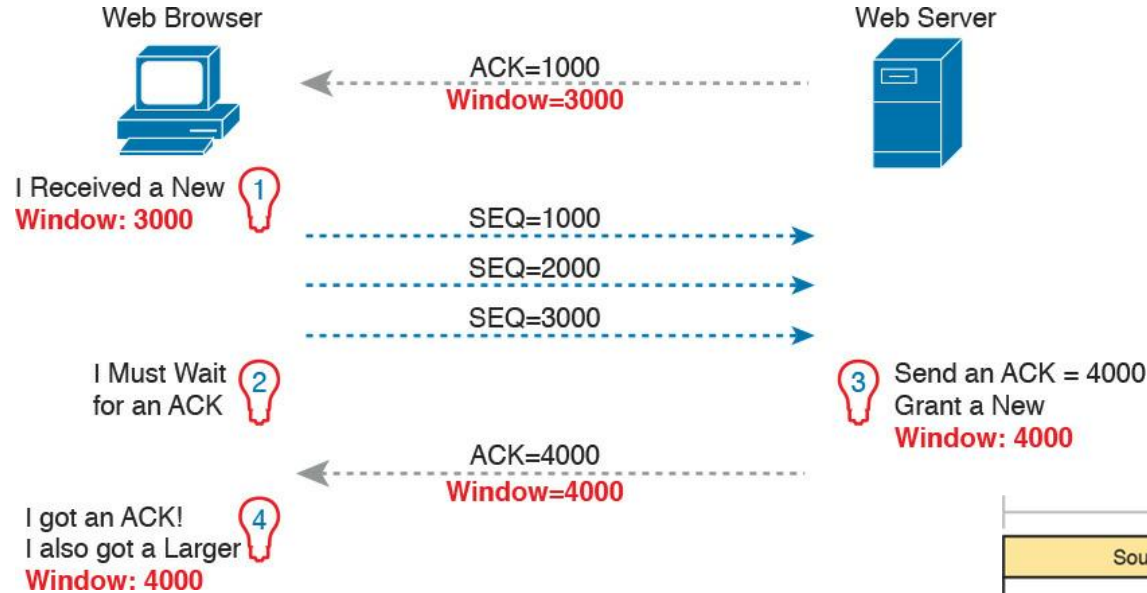
He Lost Segment with
SEQ = 2000. 2
Resend it!

1000 Bytes of Data, Sequence = 2000

3 I Received 2000 - 2999.
Already Have 3000 - 3999.
Ask for 4000 Next!

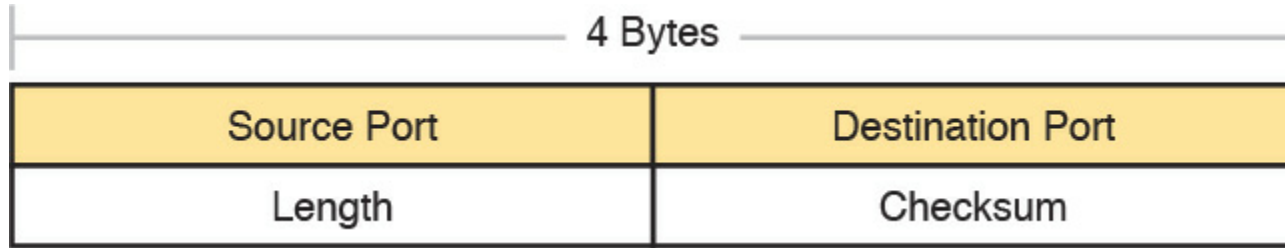
No Data, Acknowledgment = 4000

TCP/IP Layer 4 Protocols: TCP :: Flow Control Using Windowing

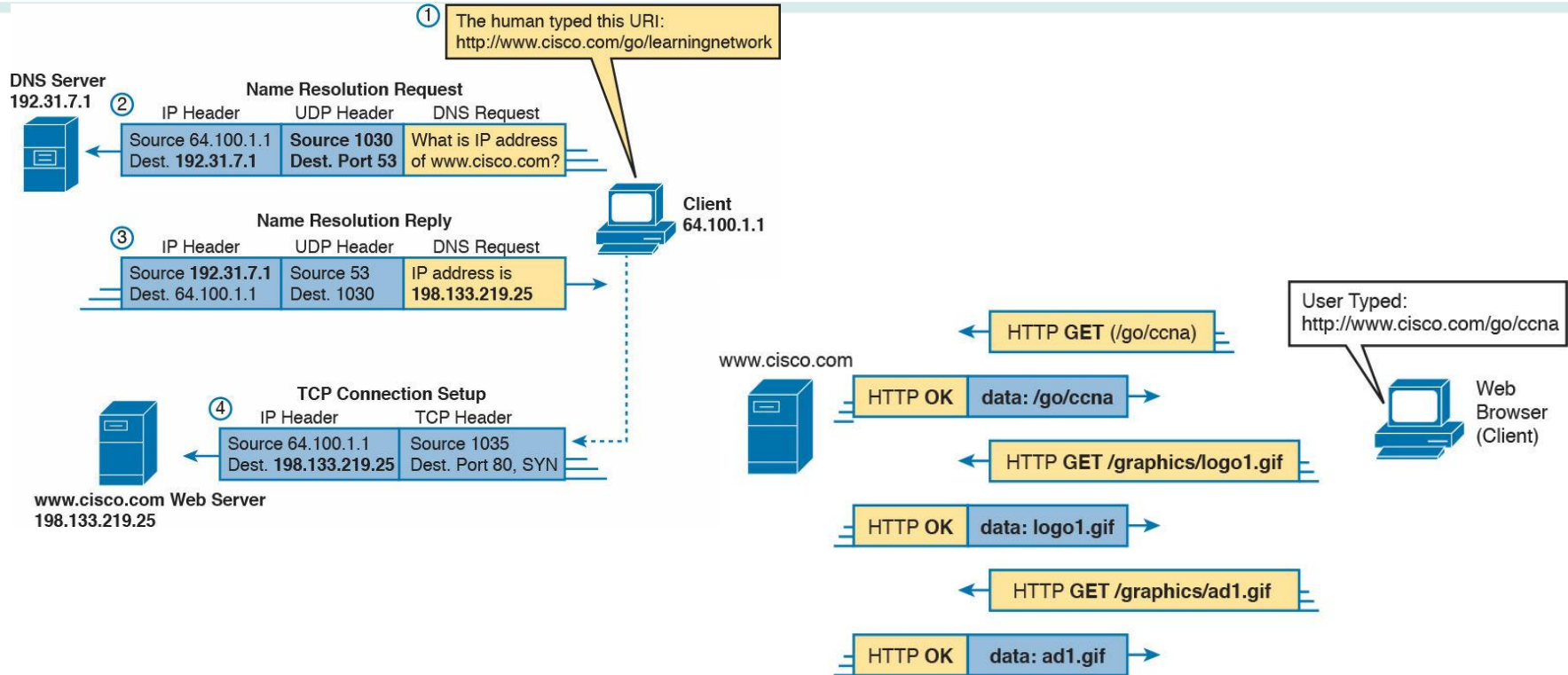


4 Bytes			
Source Port		Destination Port	
Sequence Number			
Acknowledgement Number			
Offset	Reserved	Flag Bits	Window
Checksum			Urgent

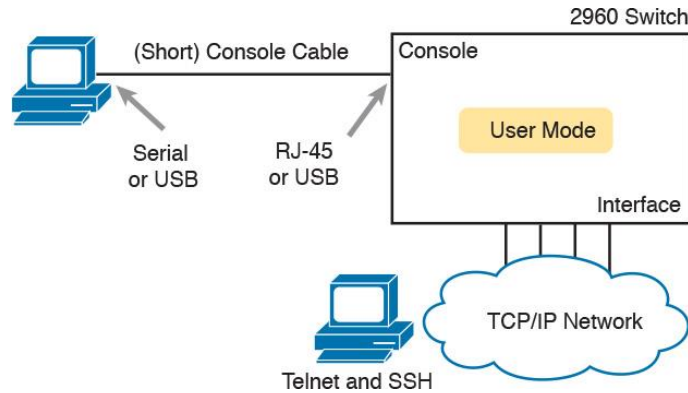
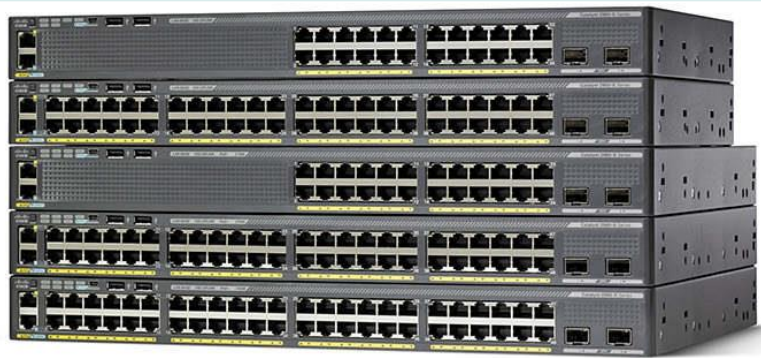
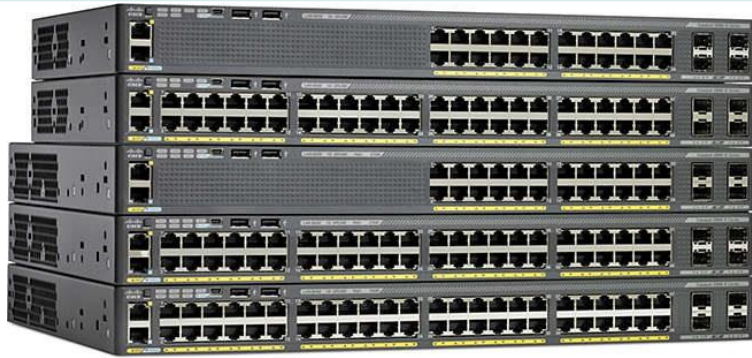
TCP/IP Layer 4 Protocols: UDP



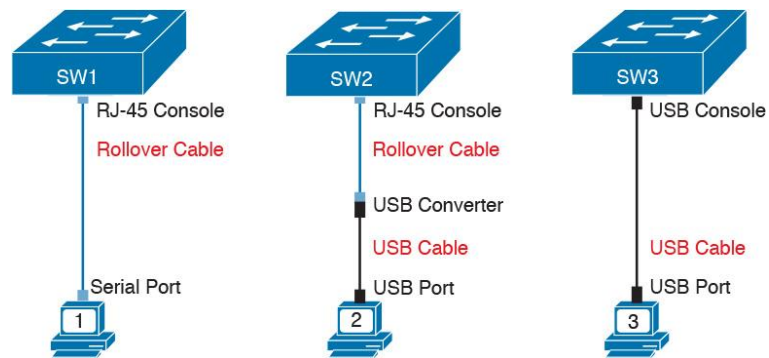
TCP/IP Applications ... Finding the Web Server using DNS / HTTP



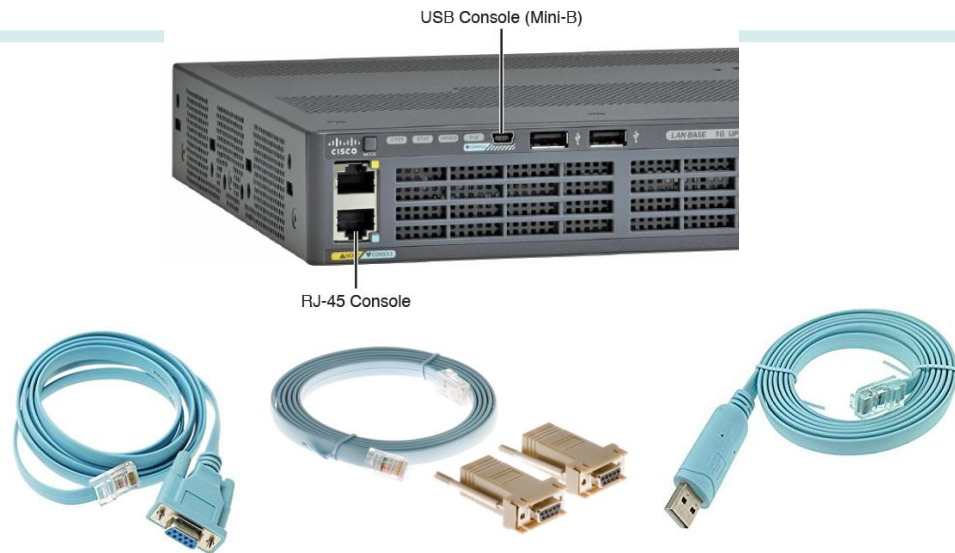
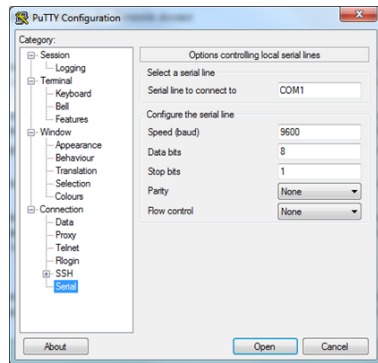
Accessing the Cisco Catalyst Switch CLI



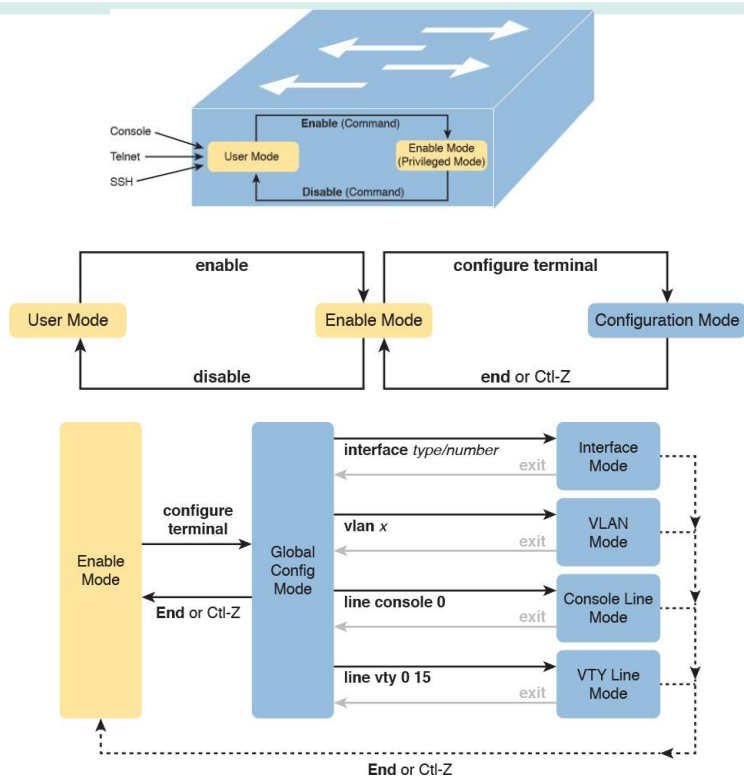
Accessing the Cisco Catalyst Switch CLI :: Cabling the Console



- 9600 bits/second
- No hardware flow control
- 8-bit ASCII
- No parity bits
- 1 stop bit



Accessing the Cisco Catalyst Switch CLI ... CLI Modes and Help Features



What You Enter	What Help You Get
<code>?</code>	Help for all commands available in this mode.
<code>command ?</code>	With a space between the command and the <code>?</code> , the switch lists text to describe all the first parameter options for the command.
<code>com?</code>	A list of commands that start with <code>com</code> .
<code>command parm?</code>	Lists all parameters beginning with the parameter typed so far. (Notice that there is no space between <code>parm</code> and the <code>?</code> .)
<code>command parm<Tab></code>	Pressing the Tab key causes IOS to spell out the rest of the word, assuming that you have typed enough of the word so there is only one option that begins with that string of characters.
<code>command parm1 ?</code>	If a space is inserted before the question mark, the CLI lists all the next parameters and gives a brief explanation of each.

Keyboard Command	What Happens
Up arrow or Ctrl+P	This displays the most recently used command. If you press it again, the next most recent command appears, until the history buffer is exhausted. (The <i>P</i> stands for previous.)
Down arrow or Ctrl+N	If you have gone too far back into the history buffer, these keys take you forward to the more recently entered commands. (The <i>N</i> stands for next.)
Left arrow or Ctrl+B	This moves the cursor backward in the currently displayed command without deleting characters. (The <i>B</i> stands for back.)
Right arrow or Ctrl+F	This moves the cursor forward in the currently displayed command without deleting characters. (The <i>F</i> stands for forward.)
Backspace	This moves the cursor backward in the currently displayed command, deleting characters.

Prompt	Name of Mode	Context-Setting Command(s) to Reach This Mode
hostname(config)#	Global	None—first mode after configure terminal
hostname(config-line)#	Line	line console 0 line vty 0 15
hostname(config-if)#	Interface	interface type number
hostname(vlan)#	VLAN	vlan number

Configuring Cisco IOS Software ::: Memory Types

RAM
(Working
Memory and
Running
Configuration)

Flash
(Cisco IOS
Software)

ROM
(Bootstrap
Program)

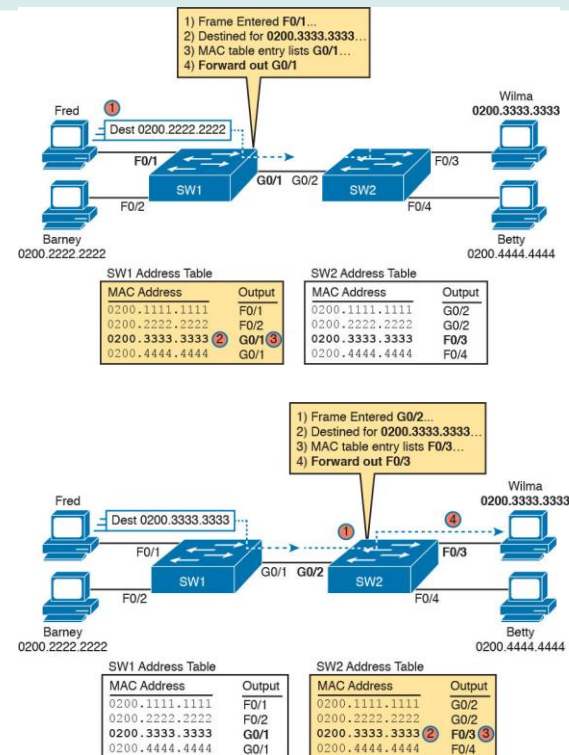
NVRAM
(Startup
Configuration)

Configuration Filename	Purpose	Where It Is Stored
startup-config	Stores the initial configuration used anytime the switch reloads Cisco IOS.	NVRAM
running-config	Stores the currently used configuration commands. This file changes dynamically when someone enters commands in configuration mode.	RAM

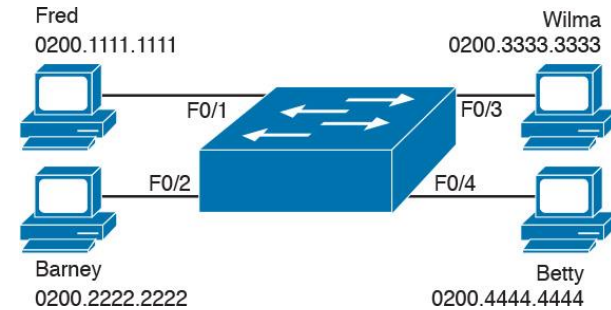
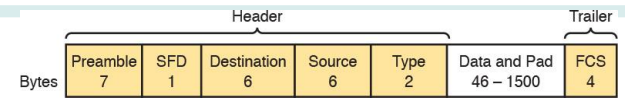
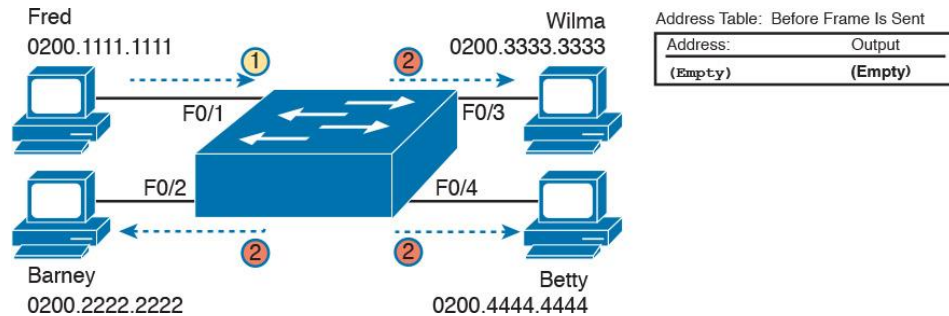
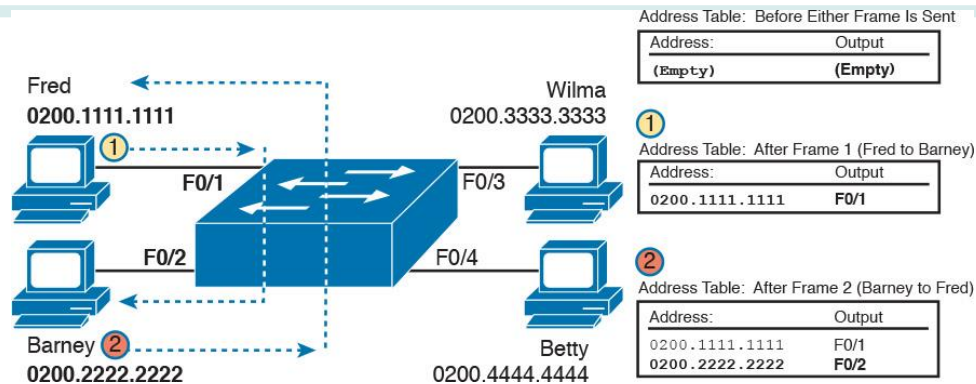
Configuring Cisco IOS Software ::: Command Reference

Command	Mode and Purpose
line console 0	Global command that changes the context to console configuration mode.
login	Line (console and vty) configuration mode. Tells IOS to prompt for a password (no username).
password <i>pass-value</i>	Line (console and vty) configuration mode. Sets the password required on that line for login if the login command (with no other parameters) is also configured.
interface <i>type port-number</i>	Global command that changes the context to interface mode—for example, interface FastEthernet 0/1.
hostname <i>name</i>	Global command that sets this switch's hostname, which is also used as the first part of the switch's command prompt.
exit	Moves back to the next higher mode in configuration mode.
end	Exits configuration mode and goes back to enable mode from any of the configuration submodes.
Ctrl+Z	This is not a command, but rather a two-key combination (pressing the Ctrl key and the letter Z) that together do the same thing as the end command.

Command	Purpose
no debug all	Enable mode EXEC command to disable all currently enabled debugs.
undebug all	
reload	Enable mode EXEC command that reboots the switch or router.
copy running-config startup-config	Enable mode EXEC command that saves the active config, replacing the startup-config file used when the switch initializes.
copy startup-config running-config	Enable mode EXEC command that merges the startup-config file with the currently active config file in RAM.
show running-config	Lists the contents of the running-config file.
write erase erase startup-config erase nvram:	These enable mode EXEC commands erase the startup-config file.
quit	EXEC command that disconnects the user from the CLI session.
show startup-config	Lists the contents of the startup-config (initial config) file.
enable	Moves the user from user mode to enable (privileged) mode and prompts for a password if one is configured.
disable	Moves the user from enable mode to user mode.
configure terminal	Enable mode command that moves the user into configuration mode.



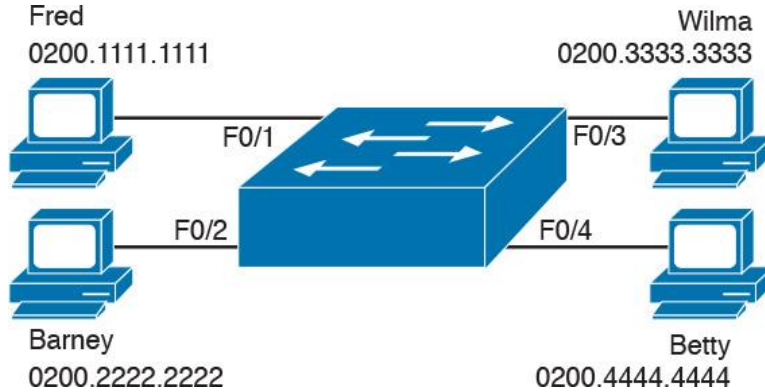
LAN Switching Concepts ::: Learning MAC Address



```
SW1# show mac address-table dynamic
Mac Address Table
```

```
-----
Vlan    Mac Address      Type      Ports
-----
1       0200.1111.1111   DYNAMIC   Fa0/1
1       0200.2222.2222   DYNAMIC   Fa0/2
1       0200.3333.3333   DYNAMIC   Fa0/3
1       0200.4444.4444   DYNAMIC   Fa0/4
Total Mac Addresses for this criterion: 4
SW1#
```

Verifying and Analyzing Ethernet Switching ... MAC Table and Interfaces



```
SW1# show mac address-table dynamic
```

Mac Address Table

Vlan	Mac Address	Type	Ports
1	0200.1111.1111	DYNAMIC	Fa0/1
1	0200.2222.2222	DYNAMIC	Fa0/2
1	0200.3333.3333	DYNAMIC	Fa0/3
1	0200.4444.4444	DYNAMIC	Fa0/4

Total Mac Addresses for this criterion: 4

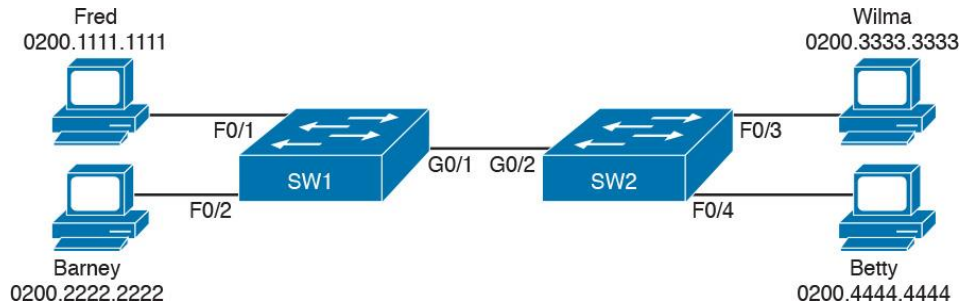
SW1#

```
SW1# show interfaces status
```

Port	Name	Status	Vlan	Duplex	Speed	Type
Fa0/1		connected	1	a-full	a-100	10/100BaseTX
Fa0/2		connected	1	a-full	a-100	10/100BaseTX
Fa0/3		connected	1	a-full	a-100	10/100BaseTX
Fa0/4		connected	1	a-full	a-100	10/100BaseTX
Fa0/5		notconnect	1	auto	auto	10/100BaseTX
Fa0/6		notconnect	1	auto	auto	10/100BaseTX
Fa0/7		notconnect	1	auto	auto	10/100BaseTX
Fa0/8		notconnect	1	auto	auto	10/100BaseTX
Fa0/9		notconnect	1	auto	auto	10/100BaseTX
Fa0/10		notconnect	1	auto	auto	10/100BaseTX
Fa0/11		notconnect	1	auto	auto	10/100BaseTX
Fa0/12		notconnect	1	auto	auto	10/100BaseTX
Fa0/13		notconnect	1	auto	auto	10/100BaseTX
Fa0/14		notconnect	1	auto	auto	10/100BaseTX
Fa0/15		notconnect	1	auto	auto	10/100BaseTX
Fa0/16		notconnect	1	auto	auto	10/100BaseTX
Fa0/17		notconnect	1	auto	auto	10/100BaseTX
Fa0/18		notconnect	1	auto	auto	10/100BaseTX
Fa0/19		notconnect	1	auto	auto	10/100BaseTX
Fa0/20		notconnect	1	auto	auto	10/100BaseTX
Fa0/21		notconnect	1	auto	auto	10/100BaseTX
Fa0/22		notconnect	1	auto	auto	10/100BaseTX
Fa0/23		notconnect	1	auto	auto	10/100BaseTX
Fa0/24		notconnect	1	auto	auto	10/100BaseTX
Gi0/1		notconnect	1	auto	auto	10/100/1000BaseTX
Gi0/2		notconnect	1	auto	auto	10/100/1000BaseTX

SW1#

Verifying and Analyzing Ethernet Switching :: Multiple Switches



```
SW1# show mac address-table dynamic
      Mac Address Table
```

Vlan	Mac Address	Type	Ports
1	0200.1111.1111	DYNAMIC	Fa0/1
1	0200.2222.2222	DYNAMIC	Fa0/2
1	0200.3333.3333	DYNAMIC	Gi0/1
1	0200.4444.4444	DYNAMIC	Gi0/1

```
Total Mac Addresses for this criterion: 4
```

! The next output is from switch SW2

```
SW2# show mac address-table dynamic
```

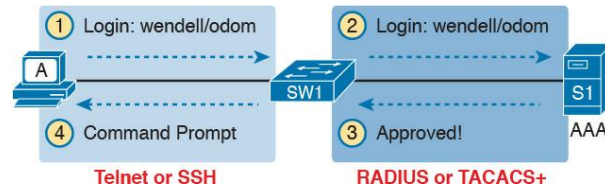
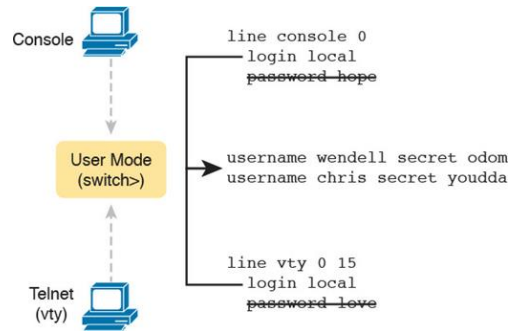
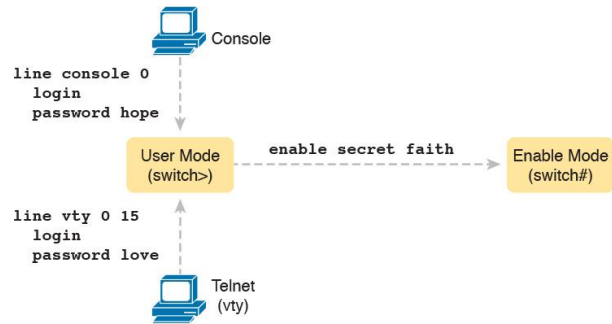
1	0200.1111.1111	DYNAMIC	Gi0/2
1	0200.2222.2222	DYNAMIC	Gi0/2
1	0200.3333.3333	DYNAMIC	Fa0/3
1	0200.4444.4444	DYNAMIC	Fa0/4

```
Total Mac Addresses for this criterion: 4
```

Verifying and Analyzing Ethernet Switching ... Command Reference

Command	Mode/Purpose/Description
<code>show mac address-table</code>	Shows all MAC table entries of all types
<code>show mac address-table dynamic</code>	Shows all dynamically learned MAC table entries
<code>show mac address-table dynamic vlan <i>vlan-id</i></code>	Shows all dynamically learned MAC table entries in that VLAN
<code>show mac address-table dynamic address <i>MAC-address</i></code>	Shows the dynamically learned MAC table entries with that MAC address
<code>show mac address-table dynamic interface <i>interface-id</i></code>	Shows all dynamically learned MAC table entries associated with that interface
<code>show mac address-table count</code>	Shows the number of entries in the MAC table, and the total number of remaining empty slots in the MAC table
<code>show mac address-table aging-time</code>	Shows the global and per-VLAN aging timeout for inactive MAC table entries
<code>clear mac address-table dynamic</code>	Empties the MAC table of all dynamic entries
<code>show interfaces status</code>	Lists one line per interface on the switch, with basic status and operating information for each

Securing the Switch CLI

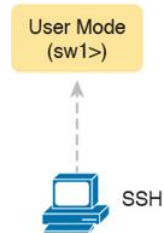


SSH-Specific Configuration

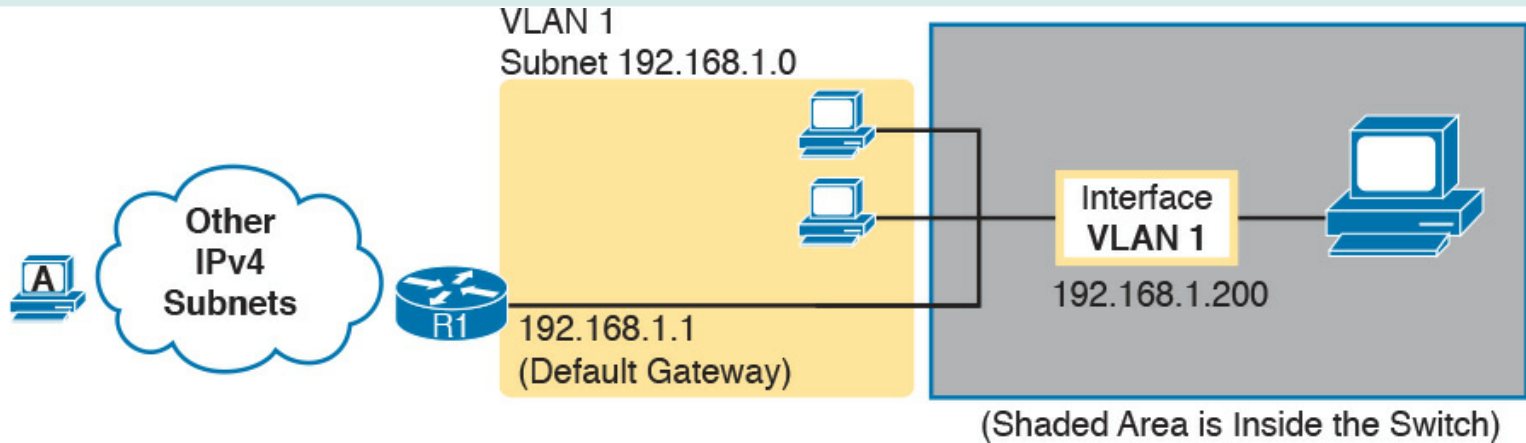
```
hostname sw1
ip domain-name example.com
! Next Command Uses FQDN "sw1.example.com"
crypto key generate rsa
```

Local Username Configuration (Like Telnet)

```
username wendell secret odom
username chris secret youdda
!
line vty 0 15
login local
```



Enabling IPv4 for Remote Access



```
Emma# configure terminal
Emma(config)# interface vlan 1
Emma(config-if)# ip address 192.168.1.200 255.255.255.0
Emma(config-if)# no shutdown
00:25:07: %LINK-3-UPDOWN: Interface Vlan1, changed state to up
00:25:08: %LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan1, changed
state to up
Emma(config-if)# exit
Emma(config)# ip default-gateway 192.168.1.1
```

Command Reference

Command	Mode/Purpose/Description
line console 0	Changes the context to console configuration mode.
line vty <i>1st-vty last-vty</i>	Changes the context to vty configuration mode for the range of vty lines listed in the command.
login	Console and vty configuration mode. Tells IOS to prompt for a password.
password <i>pass-value</i>	Console and vty configuration mode. Lists the password required if the login command (with no other parameters) is configured.
login local	Console and vty configuration mode. Tells IOS to prompt for a username and password, to be checked against locally configured username global configuration commands on this switch or router.
username <i>name</i> secret <i>pass-value</i>	Global command. Defines one of possibly multiple usernames and associated passwords, used for user authentication. Used when the login local line configuration command has been used.
crypto key generate rsa [modulus <i>360..2048</i>]	Global command. Creates and stores (in a hidden location in flash memory) the keys required by SSH.
transport input { telnet ssh all none }	vty line configuration mode. Defines whether Telnet/SSH access is allowed into this switch. Both values can be configured on one command to allow both Telnet and SSH access (the default).

Command	Mode/Purpose/Description
interface vlan <i>number</i>	Changes the context to VLAN interface mode. For VLAN 1, allows the configuration of the switch's IP address.
ip address <i>ip-address subnet-mask</i>	VLAN interface mode. Statically configures the switch's IP address and mask.
ip address dhcp	VLAN interface mode. Configures the switch as a DHCP client to discover its IPv4 address, mask, and default gateway.
ip default-gateway <i>address</i>	Global command. Configures the switch's default gateway IPv4 address. Not required if the switch uses DHCP.
ip name-server <i>server-ip-1 server-ip-2 ...</i>	Global command. Configures the IPv4 addresses of DNS servers, so any commands when logged in to the switch will use the DNS for name resolution.

Command Reference

Command	Mode/Purpose/Description
hostname <i>name</i>	Global command. Sets this switch's hostname, which is also used as the first part of the switch's command prompt.
enable secret <i>pass-value</i>	Global command. Sets this switch's password that is required for any user to reach enable mode.
history size <i>length</i>	Line config mode. Defines the number of commands held in the history buffer, for later recall, for users of those lines.
logging synchronous	Console or vty mode. Tells IOS to send log messages to the user at natural break points between commands rather than in the middle of a line of output.
[no] logging console	Global command that disables or enables the display of log messages to the console.
exec-timeout <i>minutes</i> <i>seconds</i>	Console or vty mode. Sets the inactivity timeout, so that after the defined period of no action, IOS closes the current user login session.

Command	Purpose
show running-config	Lists the currently used configuration
show running-config begin <i>line</i> vtty	Pipes (sends) the command output to the begin command, which only lists output beginning with the first line that contains the text "line vty"
show dhcp lease	Lists any information the switch acquires as a DHCP client. This includes IP address, subnet mask, and default gateway information
show crypto key mypubkey rsa	Lists the public and shared key created for use with SSH using the crypto key generate rsa global configuration command
show ip ssh	Lists status information for the SSH server, including the SSH version
show ssh	Lists status information for current SSH connections into and out of the local switch
show interfaces <i>vlan number</i>	Lists the interface status, the switch's IPv4 address and mask, and much more
show ip default-gateway	Lists the switch's setting for its IPv4 default gateway
terminal history size <i>x</i>	Changes the length of the history buffer for the current user only, only for the current login to the switch
show history	Lists the commands in the current history buffer

Configuring speed, duplex, and description

```
Emma# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Emma(config)# interface FastEthernet 0/1
Emma(config-if)# duplex full
Emma(config-if)# speed 100
Emma(config-if)# description Printer on 3rd floor, Preset to 100/full is connected
here
Emma(config-if)# exit
Emma(config)# interface range FastEthernet 0/11 - 20
Emma(config-if-range)# description end-users connect here
Emma(config-if-range)# ^Z
Emma#
```

Displaying Interface Status | Administratively Disabling an Interface

```
Emma# show interfaces status
```

Port	Name	Status	Vlan	Duplex	Speed	Type
Fa0/1	Printer on 3rd floor	notconnect	1	full	100	10/100BaseTX
Fa0/2		notconnect	1	auto	auto	10/100BaseTX
Fa0/3		notconnect	1	auto	auto	10/100BaseTX
Fa0/4		connected	1	a-full	a-100	10/100BaseTX
Fa0/5		notconnect	1	auto	auto	10/100BaseTX
Fa0/6		connected	1	a-full	a-100	10/100BaseTX
Fa0/7		notconnect	1	auto	auto	10/100BaseTX
Fa0/8		notconnect	1	auto	auto	10/100BaseTX
Fa0/9		notconnect	1	auto	auto	10/100BaseTX

```
SW1# configure terminal
```

```
Enter configuration commands, one per line. End with CNTL/Z.
```

```
SW1(config)# interface fastEthernet 0/1
```

```
SW1(config-if)# shutdown
```

```
SW1(config-if)#
```

```
*Mar  2 03:02:19.701: %LINK-5-CHANGED: Interface FastEthernet0/1, changed state to  
administratively down
```

```
*Mar  2 03:02:20.708: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1,  
changed state to down
```

Removing Configuration with the no Command

```
SW1# show running-config interface f0/2
Building configuration...

Current configuration : 95 bytes
!
interface FastEthernet0/2
  description link to 2901-2
  shutdown
  speed 100
  duplex half
end

SW1# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
SW1(config)# interface fastEthernet 0/2
SW1(config-if)# no speed
SW1(config-if)# no duplex
SW1(config-if)# no description
SW1(config-if)# no shutdown
SW1(config-if)# ^Z
SW1#
SW1# show running-config interface f0/2
Building configuration...
Current configuration : 33 bytes
```



Classful Network Concepts :: IP Address

32-bits

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	---	---	---	---	---	---	---	---	---	---

4-octets

1 st Octet								2 nd Octet								3 rd Octet								4 th Octet							
-----------------------	--	--	--	--	--	--	--	-----------------------	--	--	--	--	--	--	--	-----------------------	--	--	--	--	--	--	--	-----------------------	--	--	--	--	--	--	--

1-octet =
8-bits = 1-byte

7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Dotted-Decimal
Notation

0-255								0-255								0-255								0-255							
-------	--	--	--	--	--	--	--	-------	--	--	--	--	--	--	--	-------	--	--	--	--	--	--	--	-------	--	--	--	--	--	--	--

Binary-Decimal
Conversion

128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1
-----	----	----	----	---	---	---	---	-----	----	----	----	---	---	---	---	-----	----	----	----	---	---	---	---	-----	----	----	----	---	---	---	---

1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Decimal-Binary
Conversion

255								0								1								129							
-----	--	--	--	--	--	--	--	---	--	--	--	--	--	--	--	---	--	--	--	--	--	--	--	-----	--	--	--	--	--	--	--

127								63								224								17							
-----	--	--	--	--	--	--	--	----	--	--	--	--	--	--	--	-----	--	--	--	--	--	--	--	----	--	--	--	--	--	--	--

0	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	1	0	0	0	1
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---



Classful Network Concepts :: IP Address

32-bits

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	---	---	---	---	---	---	---	---	---	---

4-octets

1 st Octet								2 nd Octet								3 rd Octet								4 th Octet							
-----------------------	--	--	--	--	--	--	--	-----------------------	--	--	--	--	--	--	--	-----------------------	--	--	--	--	--	--	--	-----------------------	--	--	--	--	--	--	--

1-octet =
8-bits = 1-byte

7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Dotted-Decimal
Notation

0-255								0-255								0-255								0-255							
-------	--	--	--	--	--	--	--	-------	--	--	--	--	--	--	--	-------	--	--	--	--	--	--	--	-------	--	--	--	--	--	--	--

128	64	32	16	8	4	2	1
-----	----	----	----	---	---	---	---

Class A

0	X	X	X	X	X	X	X
---	---	---	---	---	---	---	---

X=0 results to 0

X=1 results to 127

7 usable bits

Class B

1	0	X	X	X	X	X	X
---	---	---	---	---	---	---	---

X=0 results to 128

X=1 results to 191

6 usable bits

Class C

1	1	0	X	X	X	X	X
---	---	---	---	---	---	---	---

X=0 results to 192

X=1 results to 223

5 usable bits



Classful Network Concepts :: IP Address

32-bits

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	---	---	---	---	---	---	---	---	---	---

4-octets

1 st Octet								2 nd Octet								3 rd Octet								4 th Octet							
-----------------------	--	--	--	--	--	--	--	-----------------------	--	--	--	--	--	--	--	-----------------------	--	--	--	--	--	--	--	-----------------------	--	--	--	--	--	--	--

1-octet =
8-bits = 1-byte

7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Dotted-Decimal
Notation

0-255								0-255								0-255								0-255							
-------	--	--	--	--	--	--	--	-------	--	--	--	--	--	--	--	-------	--	--	--	--	--	--	--	-------	--	--	--	--	--	--	--

128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1
-----	----	----	----	---	---	---	---	-----	----	----	----	---	---	---	---	-----	----	----	----	---	---	---	---	-----	----	----	----	---	---	---	---

Class A

Network (8>7)								Host (8)								Host (8)								Host (8)							
---------------	--	--	--	--	--	--	--	----------	--	--	--	--	--	--	--	----------	--	--	--	--	--	--	--	----------	--	--	--	--	--	--	--

7N 24H

Class B

Network (8>6)								Network (8)								Host (8)								Host (8)							
---------------	--	--	--	--	--	--	--	-------------	--	--	--	--	--	--	--	----------	--	--	--	--	--	--	--	----------	--	--	--	--	--	--	--

14N 16H

Class C

Network (8>5)								Network (8)								Network (8)								Host (8)							
---------------	--	--	--	--	--	--	--	-------------	--	--	--	--	--	--	--	-------------	--	--	--	--	--	--	--	----------	--	--	--	--	--	--	--

21N 8H



Classful Network Concepts :: IP Address

Class A	Network (8>7)	Host (8)	Host (8)	Host (8)	7N 24H
Class B	Network (8>6)	Network (8)	Host (8)	Host (8)	14N 16H
Class C	Network (8>5)	Network (8)	Network (8)	Host (8)	21N 8H

Class	Networks	Hosts/Network
A	 126	 16,777,214
B	 16,384	 65,534
C	 2,097,152	 254

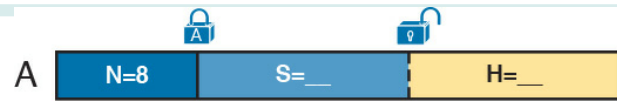
	Class A	Class B	Class C
First octet range	1 – 126	128 – 191	192 – 223
Valid network numbers	1.0.0.0 – 126.0.0.0	128.0.0.0 – 191.255.0.0	192.0.0.0 – 223.255.255.0
Total networks	$2^7 - 2 = 126$	$2^{14} = 16,384$	$2^{21} = 2,097,152$
Hosts per network	$2^{24} - 2$	$2^{16} - 2$	$2^8 - 2$
Octets (bits) in network part	1 (8)	2 (16)	3 (24)
Octets (bits) in host part	3 (24)	2 (16)	1 (8)
Default mask	255.0.0.0	255.255.0.0	255.255.255.0

Class of Networks	Private IP Networks	Number of Networks
A	10.0.0.0	1
B	172.16.0.0 through 172.31.0.0	16
C	192.168.0.0 through 192.168.255.0	256

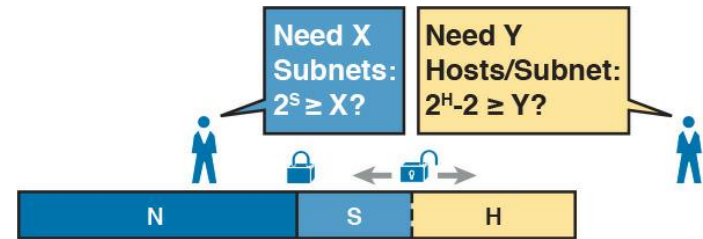
Subnetting: Borrowing Host Bits to Create Subnet Bits



X	2 ^X	X	2 ^X
1	2	17	131,072
2	4	18	262,144
3	8	19	524,288
4	16	20	1,048,576
5	32	21	2,097,152
6	64	22	4,194,304
7	128	23	8,388,608
8	256	24	16,777,216
9	512	25	33,554,432
10	1024	26	67,108,864
11	2048	27	134,217,728
12	4096	28	268,435,456
13	8192	29	536,870,912
14	16,384	30	1,073,741,824
15	32,768	31	2,147,483,648
16	65,536	32	4,294,967,296



N + S + H = 32

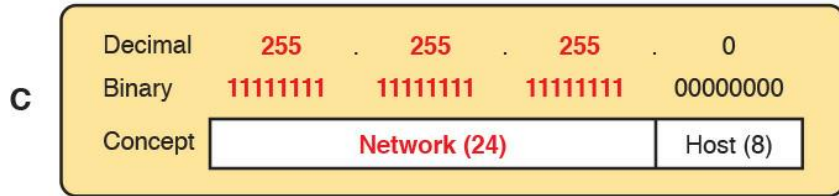
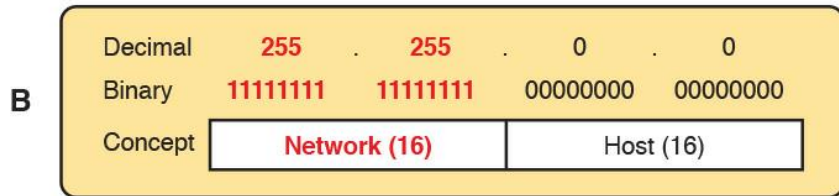
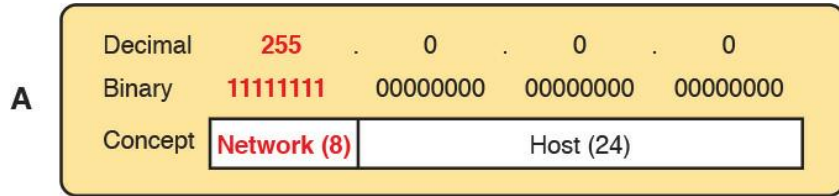


Subnetting: Classful/Default Subnet Masks



Class of Networks	Private IP Networks	Number of Networks
A	10.0.0.0	1
B	172.16.0.0 through 172.31.0.0	16
C	192.168.0.0 through 192.168.255.0	256

CIDR: Classless Inter-Domain Routing
VLSM: Variable Length Subnet Mask



Deriving the Network ID and Related Numbers :: Classful

Example: 10.17.18.21/8

Class	Subnet Mask	Network ID	1st Usable Address	Last Usable Address	Broadcast Address
A	255.0.0.0	10.0.0.0	10.0.0.1	10.255.255.254	10.255.255.255

Example: 172.16.8.9/16

Class	Subnet Mask	Network ID	1st Usable Address	Last Usable Address	Broadcast Address
B	255.255.0.0	172.16.0.0	172.16.0.1	172.16.255.254	172.16.255.255

Example: 192.168.100.3/24

Class	Subnet Mask	Network ID	1st Usable Address	Last Usable Address	Broadcast Address
C	255.255.255.0	192.168.100.0	192.168.100.1	192.168.100.254	192.168.100.255

Deriving the Network ID and Related Numbers :: Classless

Main Network: 192.168.100.0/24

Create 4 subnets with 60 hosts each.

192.168.100.0

128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	H	H	H	H	H	H	H	
192								168								100								0							
1	1	0	0	0	0	0	0	1	1	0	0	1	0	0	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	

4 = 2² :: thus borrow 2 H bits

60 ~ 2⁶ (64-2) :: thus 6 H bits remains

192.168.100.0

N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	H	H	H	H	H	H
1	1	0	0	0	0	0	0	1	1	0	0	1	0	0	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1
255								255								255								192							

Magic Number

/26

N=1, H=0

Deriving the Network ID and Related Numbers :: Classless

Main Network: 192.168.100.0/24

Create 4 subnets with 60 hosts each.

	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	H	H	H	H	H	H
192.168.100.0	1	1	0	0	0	0	0	0	1	1	0	0	1	0	0	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	Subnet 1 of 4
	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	
192.168.100.0	192								168								100								0								Subnet 1 of 4
192.168.100.64	192								168								100								64								+ Magic Number: 64 Subnet 2 of 4
192.168.100.128	192								168								100								128								+ Magic Number: 64 Subnet 3 of 4
192.168.100.192	192								168								100								192								+ Magic Number: 64 Subnet 4 of 4



Deriving the Network ID and Related Numbers :: Classless

Main Network: 192.168.100.0/24

Create 4 subnets with 60 hosts each.

Solution:

	Class	Subnet Mask	Subnet ID	1st Usable Address	Last Usable Address	Broadcast Address
192.168.100.0/26	n/a	255.255.255.192	192.168.100.0	192.168.100.1	192.168.100.62	192.168.100.63
192.168.100.64/26	n/a	255.255.255.192	192.168.100.64	192.168.100.65	192.168.100.126	192.168.100.127
192.168.100.128/26	n/a	255.255.255.192	192.168.100.128	192.168.100.129	192.168.100.190	192.168.100.191
192.168.100.192/26	n/a	255.255.255.192	192.168.100.192	192.168.100.193	192.168.100.254	192.168.100.255

Deriving the Network ID and Related Numbers :: Classless

Main Network: 172.16.8.0/25

Create 8 subnets with 10 hosts each.

172.16.8.0

128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	H	H	H	H	H	H	H
172								16								8								0							
1	0	1	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0

8 = 2³ :: thus borrow 3 H bits

10 ~ 2⁴ (16-2) :: thus 4 H bits remains

172.16.8.0

N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	H	H	H	H
1	0	1	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1
255								255								255								240							

Magic Number

/28

N=1, H=0

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Deriving the Network ID and Related Numbers :: Classless

Main Network: 172.16.8.0/25

Create 8 subnets with 10 hosts each.

Solution:

	Class	Subnet Mask	Subnet ID	1st Usable Address	Last Usable Address	Broadcast Address
172.16.8.0/28	n/a	255.255.255.240	172.16.8.0	172.16.8.1	172.16.8.14	172.16.8.15
172.16.8.16/28	n/a	255.255.255.240	172.16.8.16	172.16.8.17	172.16.8.30	172.16.8.31
172.16.8.32/28	n/a	255.255.255.240	172.16.8.32	172.16.8.33	172.16.8.46	172.16.8.47
172.16.8.48/28	n/a	255.255.255.240	172.16.8.48	172.16.8.49	172.16.8.62	172.16.8.63
172.16.8.64/28	n/a	255.255.255.240	172.16.8.64	172.16.8.65	172.16.8.78	172.16.8.79
172.16.8.80/28	n/a	255.255.255.240	172.16.8.80	172.16.8.81	172.16.8.94	172.16.8.95
172.16.8.96/28	n/a	255.255.255.240	172.16.8.96	172.16.8.97	172.16.8.110	172.16.8.111
172.16.8.112/28	n/a	255.255.255.240	172.16.8.112	172.16.8.113	172.16.8.126	172.16.8.127

Lab Topology and Addressing

Main Network:
172.16.8.0/25

S1: 172.16.8.0/28

S2: 172.16.8.16/28

S3: 172.16.8.32/28

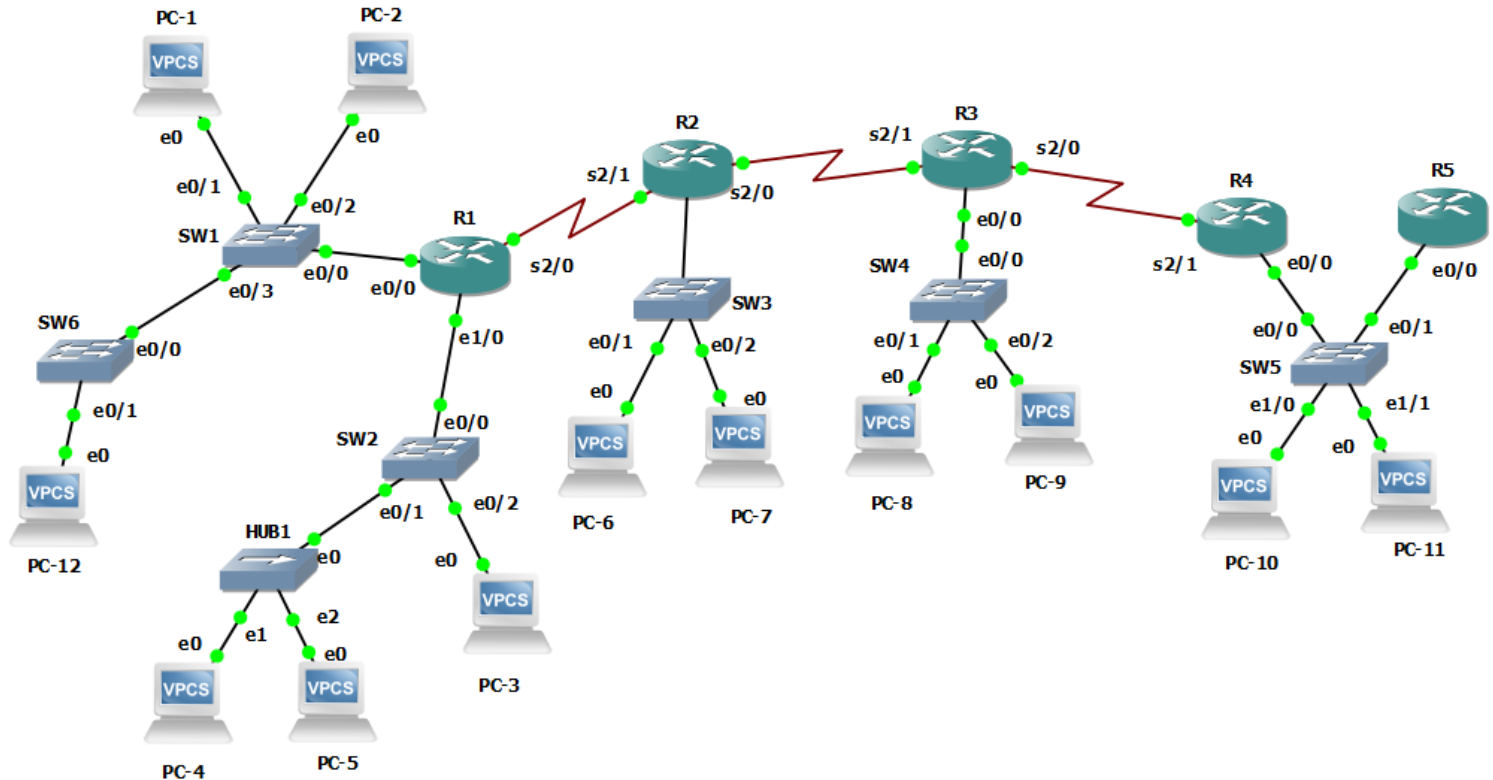
S4: 172.16.8.48/28

S5: 172.16.8.64/28

S6: 172.16.8.80/28

S7: 172.16.8.96/28

S8: 172.16.8.112/28



Live Configuration

Main Network:
172.16.8.0/25

S1: 172.16.8.0/28

S2: 172.16.8.16/28

S3: 172.16.8.32/28

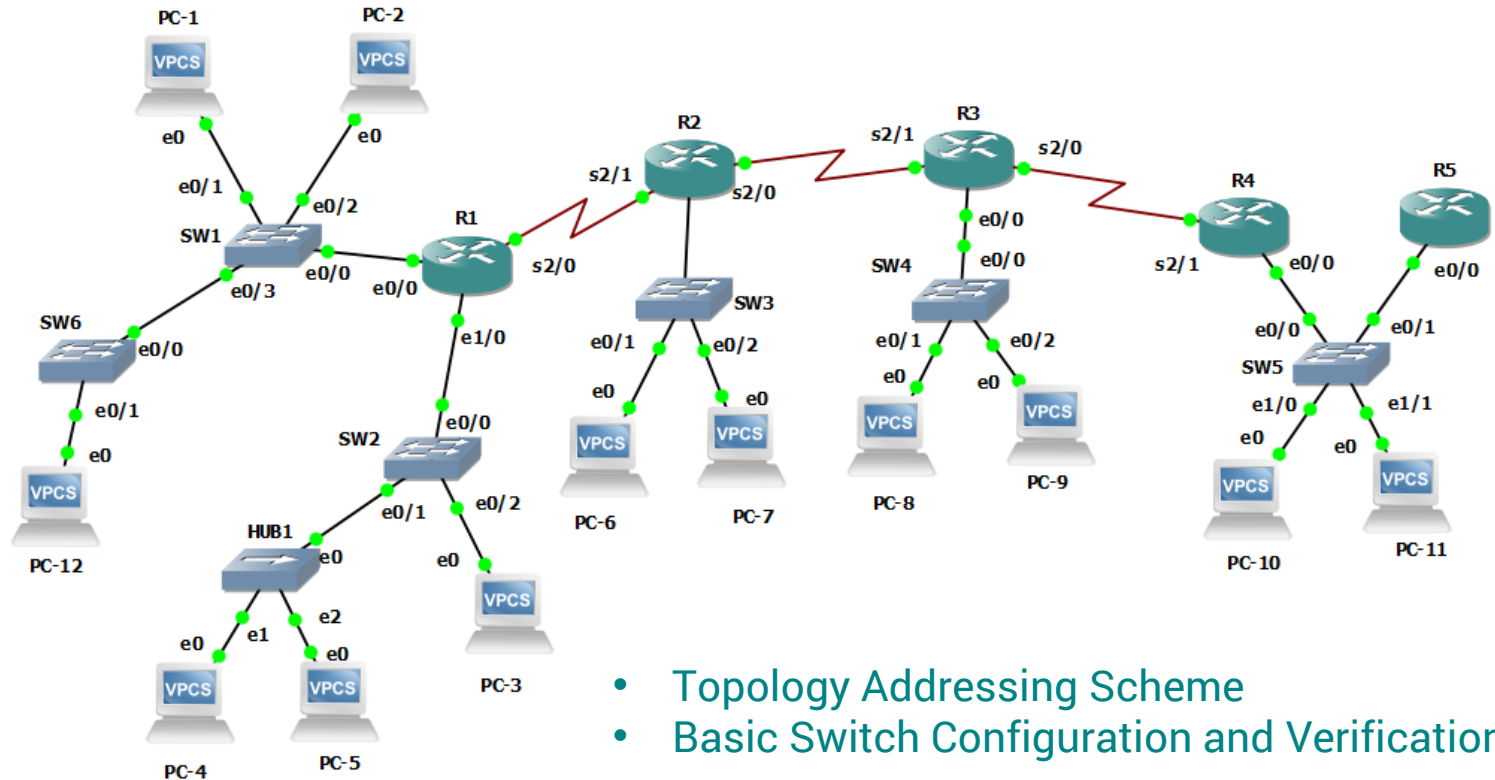
S4: 172.16.8.48/28

S5: 172.16.8.64/28

S6: 172.16.8.80/28

S7: 172.16.8.96/28

S8: 172.16.8.112/28



- Topology Addressing Scheme
- Basic Switch Configuration and Verification

Thank You

... for the opportunity to share.