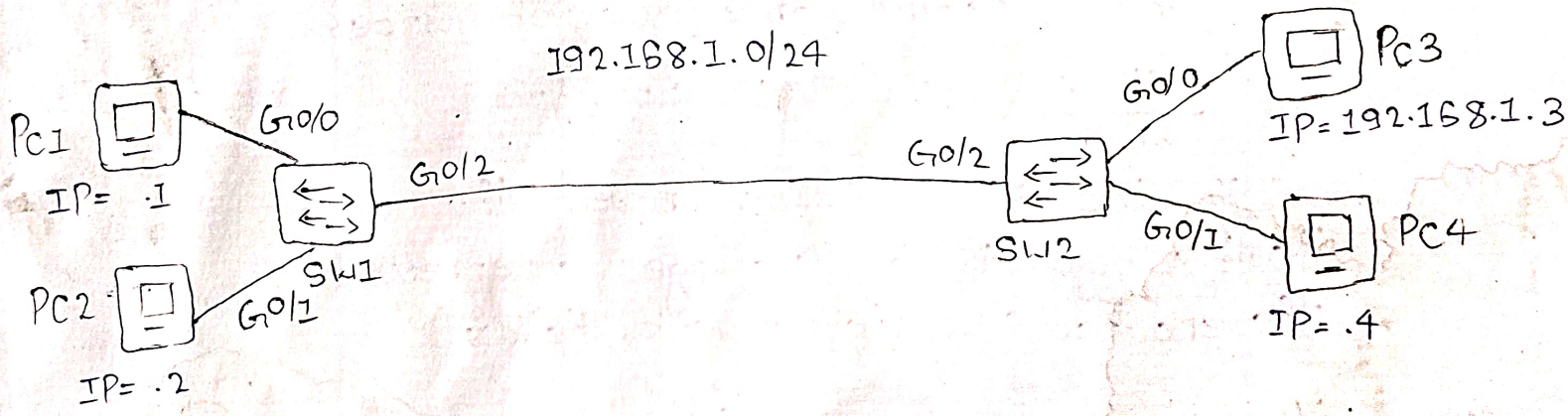
IPv4 Addresing

Layer 3 (Network layer) — How data is transfer b/w LAN.

- Provides connectivity b/w end hosts on different network (i.e outside of the LAN)
- Provide logical addressing (IP Addresses) ⟶ Today focus
- Provide path selection b/w source & Destination
- Routers operate at layer 3.

Routing



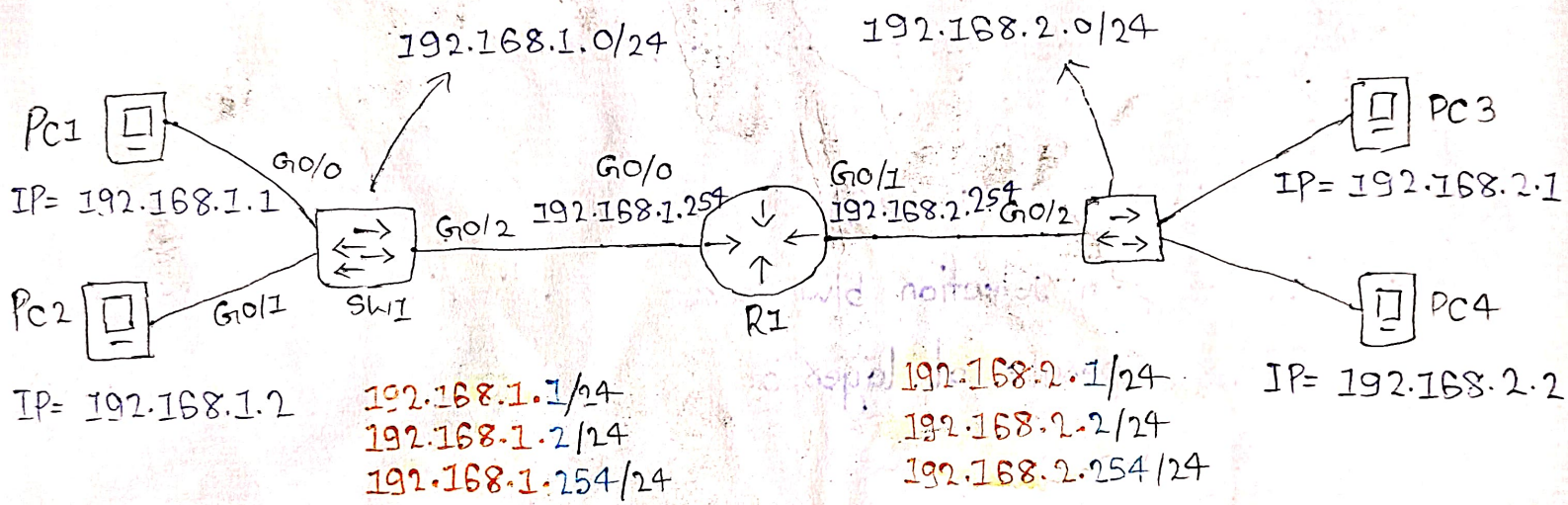
STEP-1: If PC1 send broadcast frame with a Destination MAC add. all (F)

STEP-2: After SW1 recives the frame broadcasted with its all interfaces except one that recive from so that mean Gi0/1 & Gi0/2.

STEP-3: SW2 To same broadcasting with all interfaces except one that recived on which means G0/0 & G0/1

As, you see all other PCs in the network have recived the frame. Now, what if I Put a router b/w SW1 & SW2?

Now I've put R1 in b/w the two switches., Now instead of one network, the PCs have been split intwo two network.



NOTE:- You may have noticed that, in these network IP Addresses, the first three groups of numbers

192.168.1.0/24 192.168.2.0/24

192.168.1 & 192.168.2 represent the network itself & only this last 0 changes to represent the end hosts on the network, the PCs

You may also have, what these /24 means at the end. Actually, they are used to tell what part of the address represent the network & which parts represent the endhots, the PCs.

The routers needs an IP Address, not just one IP Address for each network its connected to So Let's give R1's G0/0 interface an IP address of 192.168.1.254 & its G0/1 interface an IP address of 192.168.2.254

STEP-1: If PC1 sends a frame to the broadcast MAC add. of all(F) SW1 will recived the frame & it will forwasd it out of all interface except the one the frame was received on.

STEP-2: It send the frame out G0/1 & G0/2 & PC2 & R1 receive the frame However that's where it ends

Note: The broadcast is limited to the local network it doesn't cross the routes & go to SW2, PC3, and PC4. I will go more into detail about routing & layer 3 forwasding but today i will focus on IP addresses themselves.

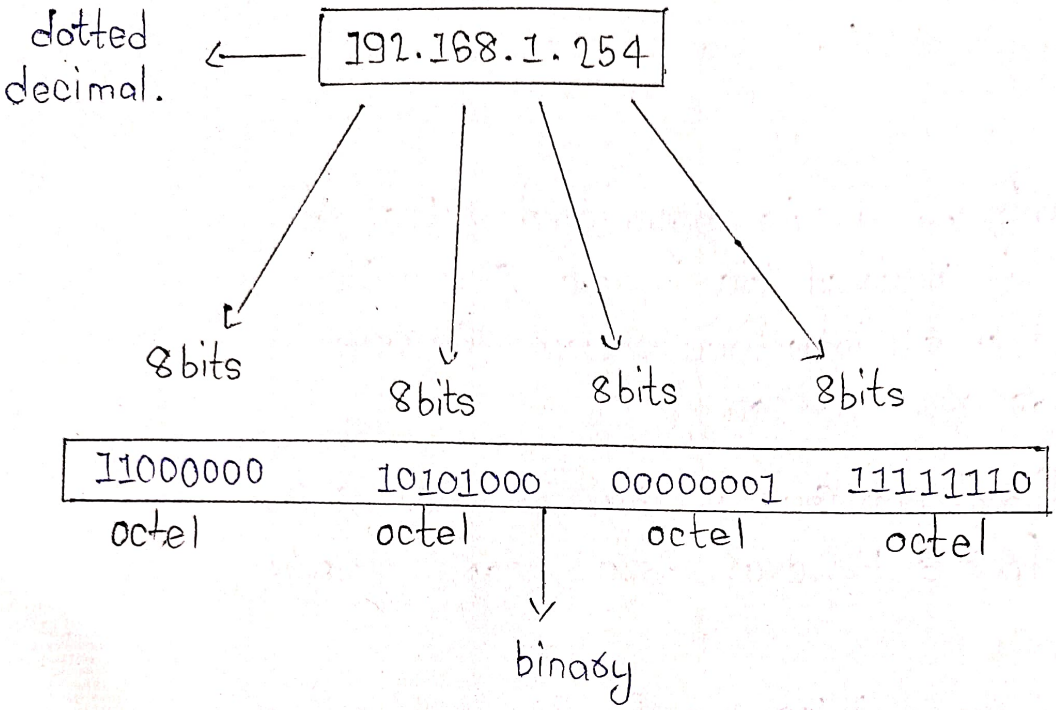
IPV4 Header

We talk about more IPV4 Header. so today let's look at these two fields the -> Source IP Address
-> Destination IP Address.

↓

These field are both 32-bits in length So, IP Address are 32 bits, or 4 bytes

IPv4 Addresses



Decimal & Hexadecimal

Decimal (base 10)	3	2	9	4
	$3*1000$	$2*100$	$9*10$	$4*1$

Hexadecimal (base 16)	C	D	E
	$C*256$	$D*16$	$E*1$
	(C = 12)	(D = 13)	(E = 14)

$3072 + 208 + 14 = 3294$

Binary → Decimal

128	64	32	16	8	4	2	1
1	0	0	0	1	1	1	1

128 + 8 + 4 + 2 + 1 = 143

128	64	32	16	8	4	2	1
0	1	1	1	0	1	1	0

64 + 32 + 16 + 4 + 2 = 118

Decimal → Binary

221 → 11011100

128	64	32	16	8	4	2	1
1	1	0	1	1	1	0	0

221	93	38	28	12	4
-128	-64	-32	-16	-8	-4
93	28	-1	12	4	0

↓ Negative aaye to 0

207 → 1100111

128	64	32	16	8	4	2	1
1	1	0	0	1	1	1	1

207	79		15	7	3	1
-128	-64	-8	-8	-4	-2	-1
79	15	-1	7	3	1	0

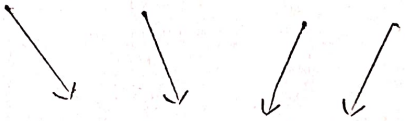
IPv4 Addresses

11000000101010000000000111111110

An IPv4 address is really a series of 32 bits it is split up into 4 octels

11000000 10101000 00000001 11111110

And then written in Dotted decimal formate to make it simpler for us humans to read & understand.



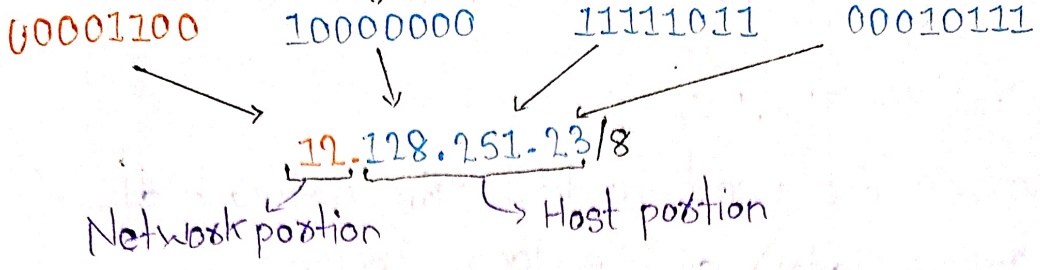
192.168.1.254/24

You May remember there was a this /24 that I said was used to identify which Part of IP Addresse represent the network & which represent the end host, Since An IP Address is 32 bits.

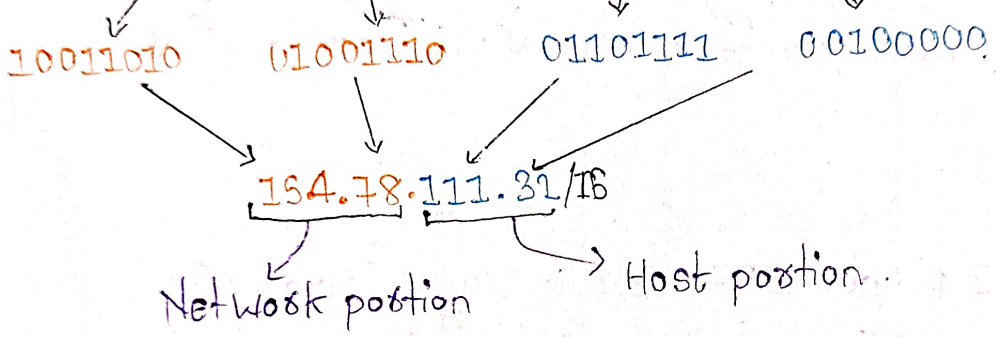
/24 means that the first 24 bits of this IP add. represent the network portion of the address & the remaining 8 represent the end host.

So, the first 24 bit is equal to the first 3 octels because 8+8+8 equal 24 So, 192.168.1.254 is the network portion of the address & 254 is the host portion

⊙ 00001100100000001111101100010111



⊙ 10011010010011100111011110010000



Class	First octel	First octel numeric range	
A	0xxxxxxx	1 ~~0~~ - ~~127~~ 126	→ 0 & 127 is reserved
B	10xxxxxx	128 - 191	
C	110xxxxx	192 - 223	
D	1110xxxx	224 - 239	→ Multicast addresses
E	11111xxx	240 - 255	→ Reserved (Experimental)

The End of the class A range is usually considered to be 126, NOT 127 Why is that? Let's take a look.

Loopback Addresses

The 127 range is reserved for 'loopback Addresses'
The range is anythings with a first octel of 127

So, 127.0.0.0 to 127.255.255.255

These addresses are used to test the 'network stack' (think OSI, TCP/IP Model) on the local device.

If a device sends any Traffic to an address in this range it simply processed back up the TCP/IP stack as if it were traffic received from another device.

For Example :- If I pinged 127.0.0.1 on my windows PC You see the responses My PC is responding to its own pings. Notice the round trip times all 0 millisecond That's because the traffic isn't going anywhere my PC just sending and receiving these pings. to & from itself.

Class	first octel	first octel numberic range	Prefix Length
A	0xxxxxxx	0-127	/8
B	10xxxxxx	128-191	/16
C	110xxxxx	192-223	/24

CLASSA: 12.128.251.23/8
CLASSB: 154.78.111.32/16
CLASSC: 192.168.1.254/24

Net Mask

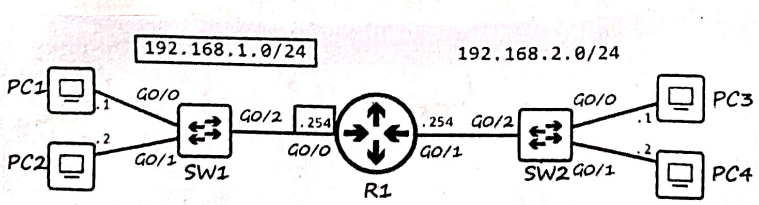
Another way of writing these prefix length Using a slash, followed by length of the prefix is a newer & easier way writing the prefix length or Juniper network devices for example, you write prefix length using slash notation, However Cisco devices still use an older slightly more complicated way of writing the prefix length That is using a dotted decimal netmask. A netmask is written in dotted decimal like an IP address, where the network portion is all 1s & the host portion is all 0s

Class A : /8 255.0.0.0
(11111111 00000000 00000000 00000000)

Class B : /16 255.255.0.0
(11111111 11111111 00000000 00000000)

class C : /24 255.255.255.0
(11111111 11111111 11111111 00000000)

Both these are same things only written in different way.



Host portion of the address is all '0's = Network Address -> is the first address with host portion all 0.
The Network address cannot be assigned to a host.

Host portion of the address is all 1's = Broadcast Address -> it is the last address in the network, the last useable is one under the broadcast Ad
The broadcast address cannot be assigned to a host

Day-6 → Part 2

Class	first Octet	Size of network bit field / Prefix length	Size of rest bit field	No. of Network	Addresses Per network
Class A	0xxxxxxx	8	24	128 (2^7)	16,777,216
Class B	10xxxxxx	16	16	16,384 (2^{14})	65,536 (2^{16})
class C	110xxxxx	24	8	2,097,152 (2^{21})	256 (2^8)

Maximum Hosts per Network

192.168.1.0/24 ⟶ 192.168.1.255/24

Host portion = 8 bits = 2^8 = 256

Host portion all 0's = network address (network ID)

Host portion all 1's = broadcast Address

Maximum hosts per network = $2^8 - 2$ = 254

172.16.0.0/16 ⟶ 172.16.255.255/16

Host portion = 16 bits = 2^{16} = 65,536

Host portion all 0's = network address (network ID)

Host portion all 1's = broadcast address.

Maximum hosts per network = $2^{16} - 2$ = 65,534

10.0.0.0/8 ⟶ 10.255.255.255/8

Host portion = 24 bits = 2^{24} = 16,777,216

Host portion all 0's = network Address (Network ID)

Host portion all 1's = broadcast address.

Maximum hosts per network = $2^{24}-2$ = 16,777,214

> Maximum hosts per Network = 2^n-2
> (n = number of host bits)

First/Last Usable Address

192.168.1.0/24 ⟶ 192.168.1.255/24

Host portion all 0's = network address (network ID)

Host portion all 1's = broadcast addre.

00000000 ↓ 00000001

11111111 ↓ 11111110

192.168.1.1/24 = first usable address

192.168.1.254/24 = Last usable address.

172.16.0.0/16 ⟶ 172.16.255.255/16

Host portion all 0's = network address

Host portion all 1's = broadcast address.

00000000 00000000

↓

00000000 00000001

172.16.0.1/16

= first usable address

11111111 11111111

↓

11111111 11111110

172.16.255.254/16

= last usable address

10.0.0.0/8

Host portion all 0's = network address.

10.255.255.255/8

Host portion all 1's = broadcast address.

00000000 00000000 00000000

...

00000000 00000000 00000001

10.0.0.1/8

= first usable address.

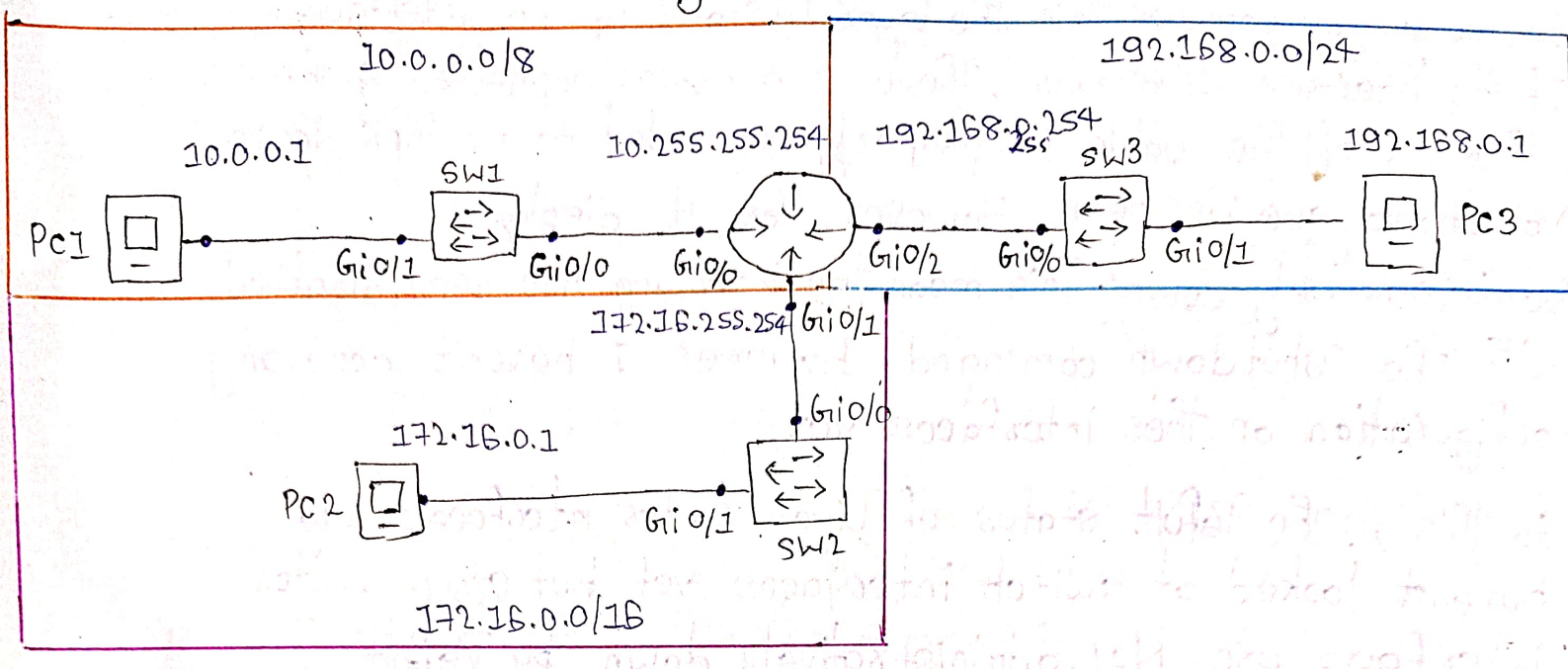
11111111 11111111 11111111

11111111 11111111 11111110

10.255.255.254/8

= last usable address.

IPv4 Addressing



Go into the CLI of R1 & Make the configurations.
So, I logged in CIL of R1 & used 'EN', the shortcut of the enable to enter privileged exec mode

"show ip interface brief" Command.

first off the column lists the interfaces on the device this router has four interfaces gigabitethernet 0/0, 0/1, 0/2 & 0/3

Next column lists the IP Address of each Interface at this moment all unassigned.

Next is ok?

Next is Method → this indicates the method by which the interface was assigned an IP address currently status is unset.

Next is the status column
Basically, you consider this the layer 1 status of the interface
If the interface is enabled, there is a cable connected & the other end of the cable is properly connected to another device you should see 'up' here. However, here it displays 'administratively down' This mean the interface has been disabled with the 'shutdown' command. However, I haven't done any configuration on thes interfaces yet,

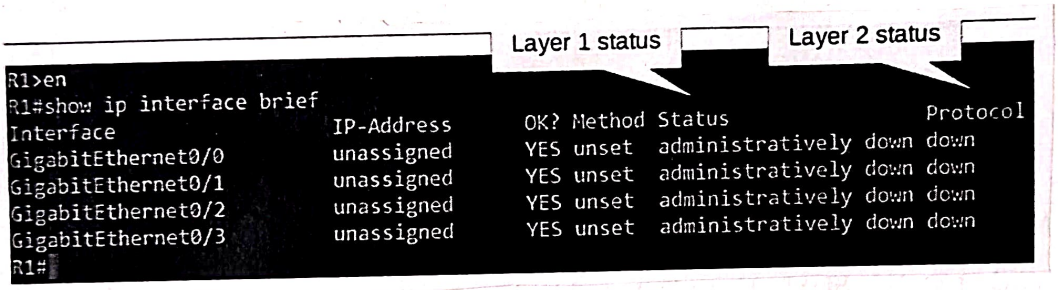
So this is the Default status of Cisco router interfaces. We haven't looked at switch interfaces yet but Cisco switch interfaces are NOT administratively down by Default They will either be up, if they are connected to another devices or Down if they are not connected.

Notice that even, though gigabit ethernet 0/0, 0/1 & 0/2 on this routers are connected to switches, the interfaces remain administratively down because the 'shutdown' command is applied to them by default The final field of the output is 'protocol',

While the 'status' column reffered to layer 1 status of the interface, this is the layer 2 status. Because the interfaces are down at layer 1, layer 2 can't operate, so all of these interfaces are down at layer 2.

You will never seen a interface with 'down' in the status column & 'up' in the protocol column, although the reverse is possible

Once we configure these interfaces & enable them, we should see up both the status & protocol columns. So remember these point the 'status' column refers to the layer1 for example is the interface shutdown, is there a cable attached etc. & The protocol column refers to the layer2 status, for example is ethernet functioning properly b/w this device & the device it's connected to Expect both of these columns to show up once we're finished with the configurations.



let's configure the gigabit ethernet 0/0 interface first

Used → 'conf t' → shortcut of 'Configure terminal' command.

Next → for configure the interface itself, I haved to enter interface config mode so. I used the command 'interface followed by the name of the interface' for example 'interface gigabitethernet 0/0'

OR 'interface gigabiethernet 0/0'

OR 'in g0/0'

→ Now we are in the interface configuration mode. let's set the IP address.

→ That is Done By command ip address, and then type the IP address Ex → 'ip address 10.255.255.254

Note → you may rember 18 is equivalent to 255.0.0.0

→ ip address 10.255.255.254 255.0.0.0

→ Next, I entes the command 'no shutdown'. This is the command we use to enable the interface,

Rember, I said that cisco routes interfaces have the 'shutdown' command applied to them by default? Well, to cancle the command type 'no' in front of the command like thes.

→ Now that we entesed the no shutdown command on the interface, we get two message on the device. The first one say's 'Interface gigabitethesnet 0/0, changed state to up'. This sefes to the physical layes status of the Interface, the 'STATUS' column of the show ip interface brief command we looked at

→ The Second message say's 'Line protocol on interface gigabitethesnet 0/0, changed state to up' This is the layes 2 status of the interface, The 'PROTOCOL' colum of the show ip interface brief command

```
R1(config-if)#ip address 10.255.255.254 ?
  A.B.C.D  IP subnet mask

R1(config-if)#ip address 10.255.255.254 255.0.0.0
R1(config-if)#no shutdown
R1(config-if)#
*Dec  7 08:29:08.937: %LINK-3-UPDOWN: Interface GigabitEthernet0/0, changed state to up
*Dec  7 08:29:09.938: %LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/
0, changed state to up
R1(config-if)#
```

→ Now, if we take look at the show ip interface brief command, both of those columns should display up
Let's check
↳ Here i do to let me execute this privileged exec mode command from interface config mode

'do show ip interface brief' → full
OR 'do sh ip int br' → shortcut

```
R1(config-if)#do sh ip int br
Interface              IP-Address      OK? Method Status                Protocol
GigabitEthernet0/0     10.255.255.254  YES manual up                    up
GigabitEthernet0/1     unassigned      YES unset  administratively down down
GigabitEthernet0/2     unassigned      YES unset  administratively down down
GigabitEthernet0/3     unassigned      YES unset  administratively down down
R1(config-if)#
```

→ As you can see, we can now see the IP address, the Method displayed as manual instead of unset, & both the status & protocol display 'up'. Our configuration was a success!

→ Now, Do same like rest interface, G0/1, G0/2, G0/3.

Show interfaces [interface]

→ You can enter just 'show interface' but it shows a lot of information for each interface so, specifying which interface you want to check, in this cases I specified Go/0. Thi

'show interfaces go/o'

This command shows primarily Layer1 & Layer 2 infosmatio about the interface but also some layer 3 gigabitethernet 0/0 is up. That means the layer 1 is working line protocol is up that refer to the layer 2 status of the interface.

The line is like the status & protocol columns of the 'show ip interface brief' command.

Hardware is iGbe, meaning 1 gigabit ethernet, address is 0c1b.8494.f000. That's is mac Address. of this interface

Notice it says bia, followed by MAC Address agai. I Mentio in previous video that MAC address can also be called the burned in address.

Why is it listed twice?

→ Well, BIA refer to the actual physical address of the interface However you can actually configure a different MAC address in the CLI, although usually you won't configure a different MAC address.

→ Internet address is 10.255.255.254/8 This is the IP address.

More in detail later.

```
R1#show interfaces g0/0
GigabitEthernet0/0 is up, line protocol is up
  Hardware is iGbE, address is 0c1b.8444.f000 (bia 0c1b.8444.f000)
  Internet address is 10.255.255.254/8
  MTU 1500 bytes, BW 1000000 Kbit/sec, DLY 10 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation ARPA, loopback not set
  Keepalive set (10 sec)
  Auto Duplex, Auto Speed, link type is auto, media type is RJ45
  output flow-control is unsupported, input flow-control is unsupported
  ARP type: ARPA, ARP Timeout 04:00:00
  Last input 00:00:06, output 00:00:05, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/40 (size/max)
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     167 packets input, 30159 bytes, 0 no buffer
     Received 0 broadcasts (0 IP multicasts)
     0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored
     0 watchdog, 0 multicast, 0 pause input
     350 packets output, 39097 bytes, 0 underruns
     0 output errors, 0 collisions, 2 interface resets
     105 unknown protocol drops
     0 babbles, 0 late collision, 0 deferred
     1 lost carrier, 0 no carrier, 0 pause output
     0 output buffer failures, 0 output buffers swapped out
```

Show interface description

→ One More command 'show interfaces description' you can see it has status & protocol columns like the show ip interface brief Command but it also have Description column.

Interface Descriptions are optional but can be very helpful in identifying the purpose of each interface

```
R1#show interfaces description
Interface                      Status         Protocol Description
Gi0/0                          up             up
Gi0/1                          up             up
Gi0/2                          up             up
Gi0/3                          admin down     down
```

Let's quickly go back & Configure description on each of these interfaces

```
R1(config)#int g0/0
R1(config-if)#description ## to SW1 ##
R1(config-if)#int g0/1
R1(config-if)#desc ## to SW2 ##
R1(config-if)#int g0/2
R1(config-if)#desc ## to SW3 ##
R1(config-if)#do sh int desc
Interface                      Status         Protocol Description
Gi0/0                          up             up       ## to SW1 ##
Gi0/1                          up             up       ## to SW2 ##
Gi0/2                          up             up       ## to SW3 ##
Gi0/3                          admin down     down
```