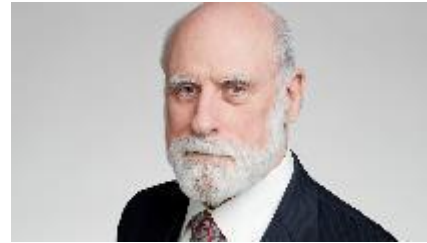


Padres del Protocolo TCP/IP

Vinton Cerf(23 de Junio 1943)



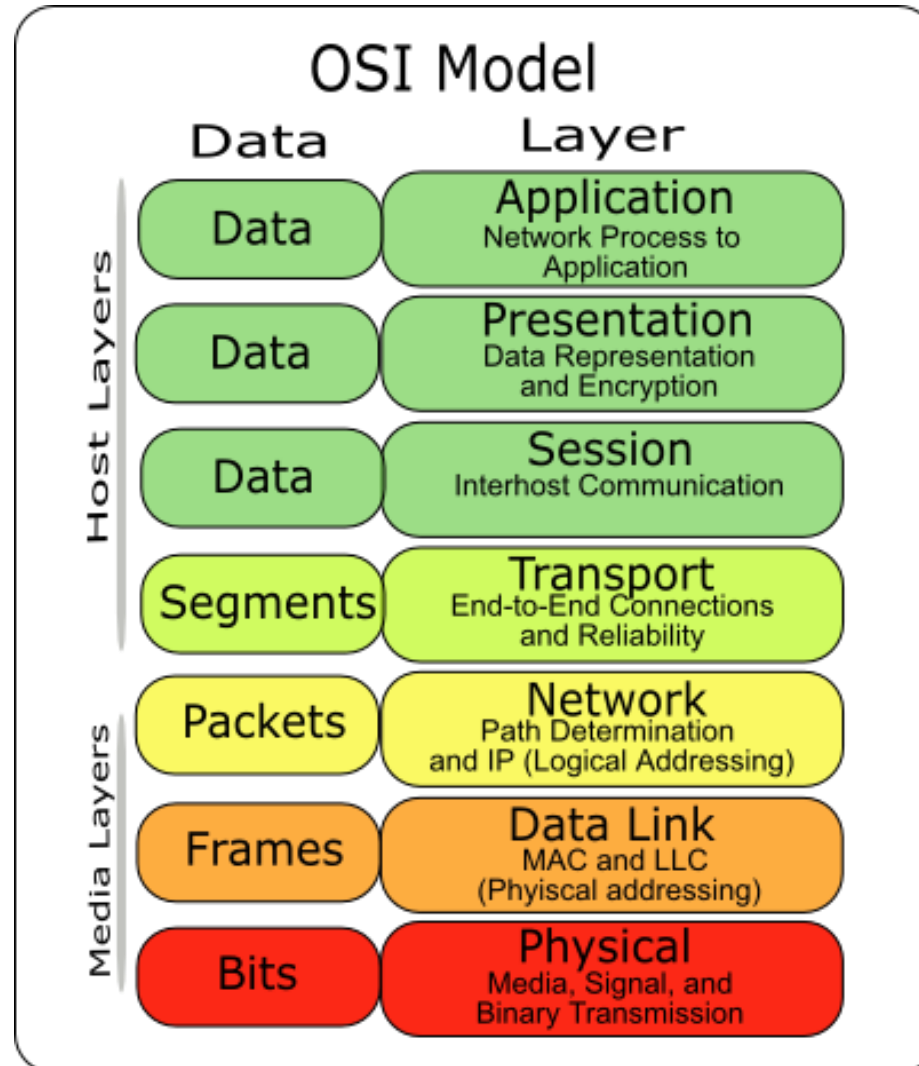
Robert Kahn (23 de Diciembre 1938)



Lo desarrollan en la década de 1970, por encargo de DARPA(Agencia del Departamento de Defensa)

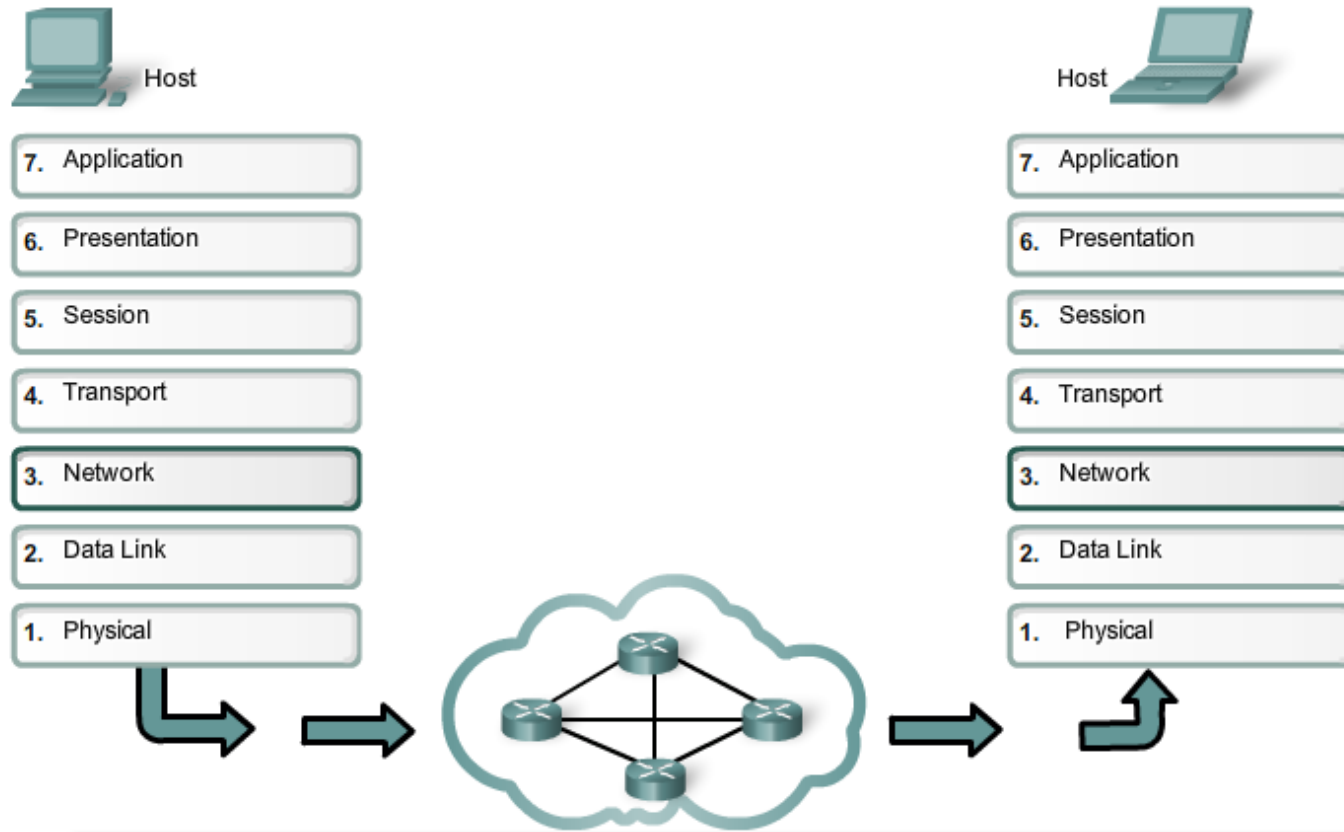
Capa de Red

Capa de Red



Comunicación en la capa de Red

Network layer protocols forward encapsulated Transport Layer PDUs between hosts



La Capa de Red

Procesos de transporte de extremo a extremo

- Direcccionando dispositivos finales
- Encapsulamiento
- Enrutamiento
- Desencapsulamiento

Protocolos de Capa de Red

Protocolos comunes de capa de red

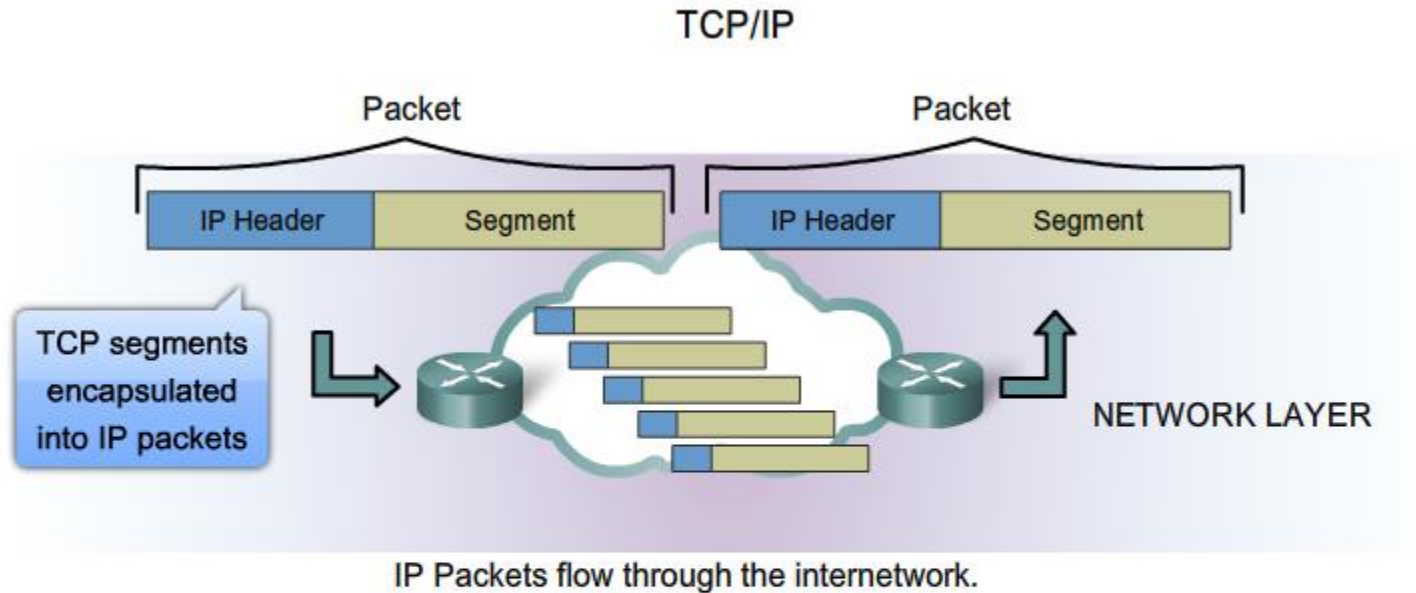
- Internet Protocol versión 4 (IPv4)
- Internet Protocol versión 6 (IPv6)

Antiguos protocolos de capa de red

- Novell Internetwork Packet Exchange (IPX)
- AppleTalk
- Connectionless Network Service (CLNS/DECNet)

Características de los protocolos de capa de red

Características de IP

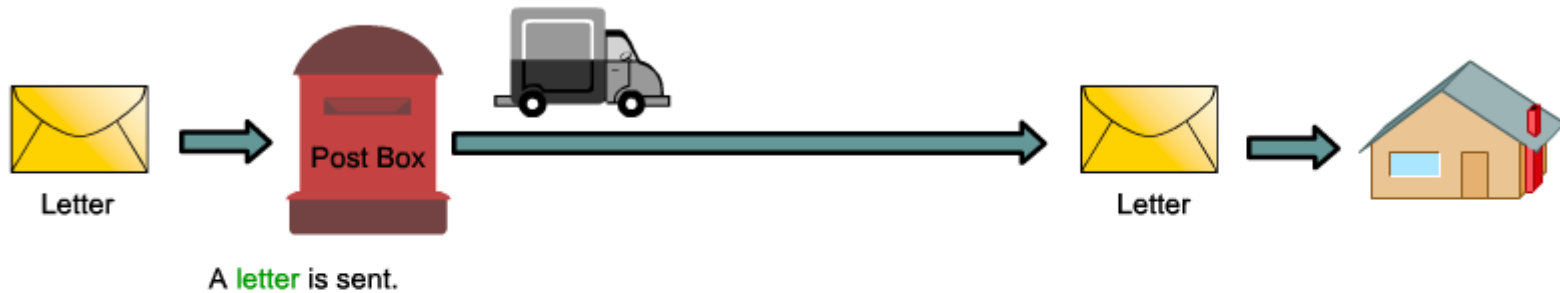


- Connectionless - No connection is established before sending data packets.
- Best Effort (unreliable) - No overhead is used to guarantee packet delivery.
- Media Independent - Operates independently of the medium carrying the data.

Características del protocolo IP

IP - Sin conexión

Connectionless Communication



The sender doesn't know:

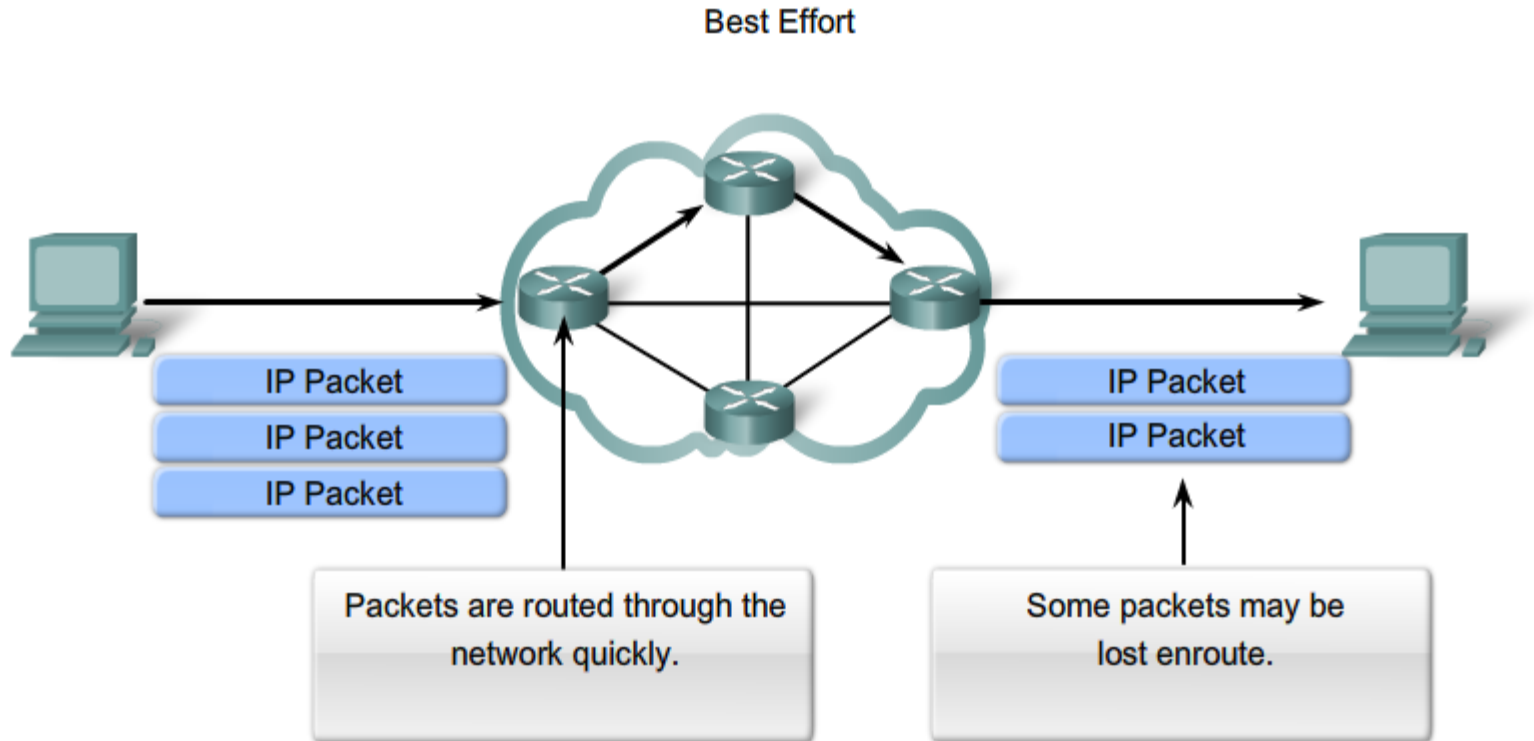
- if the receiver is present
- if the letter arrived
- if the receiver can read the letter

The receiver doesn't know:

- when it is coming

Características del protocolo IP

IP – Entrega del mejor esfuerzo

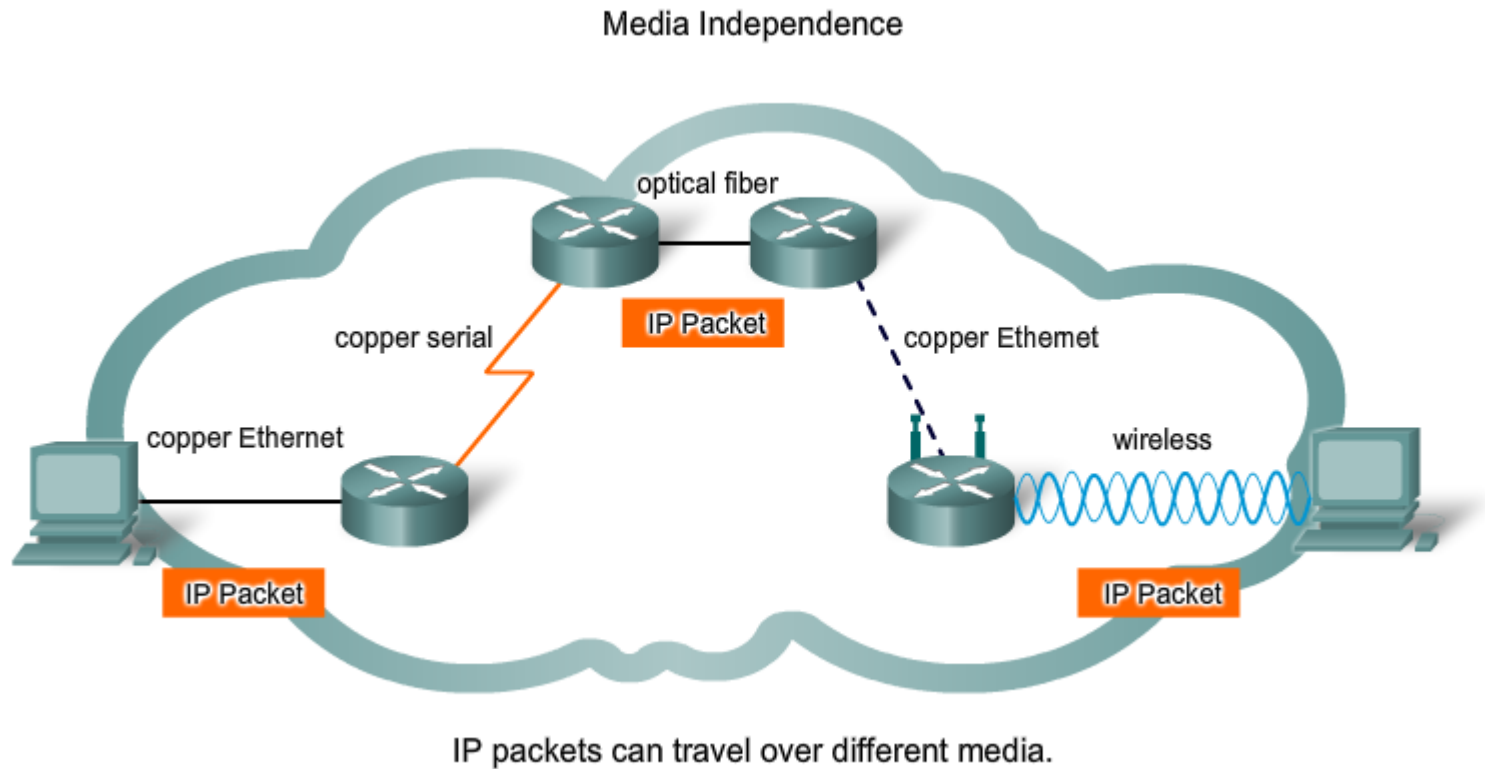


As an unreliable Network layer protocol, IP does not guarantee that all sent packets will be received.

Other protocols manage the process of tracking packets and ensuring their delivery.

Características del protocolo IP

IP – Independiente del Medio



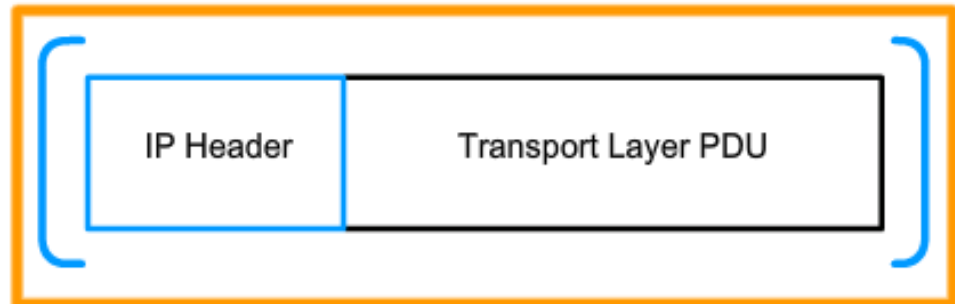
Encapsulamiento IP

Generating IP Packets

Transport Layer Encapsulation



Network Layer Encapsulation

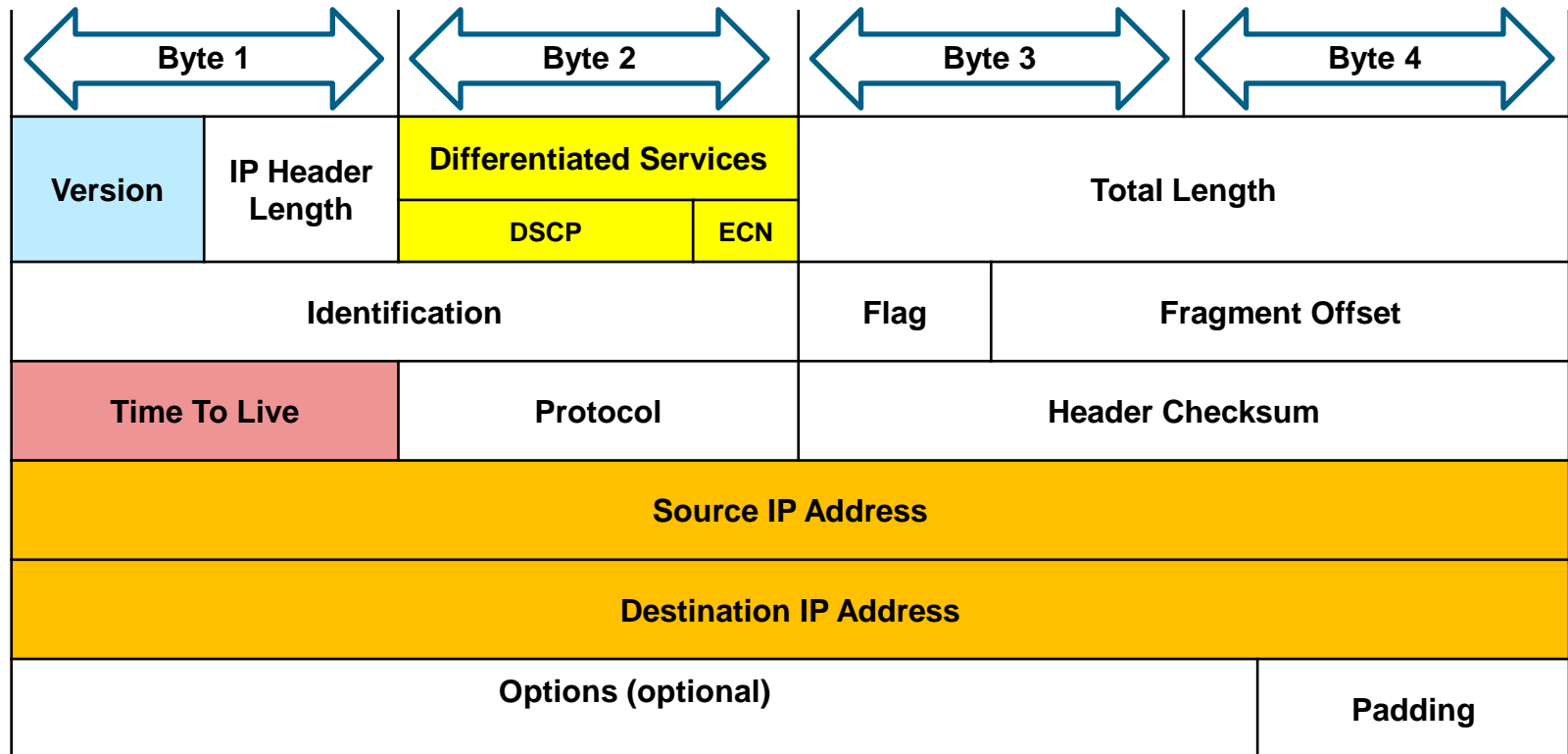


IP Packet

In TCP/IP based networks, the Network layer PDU is the IP packet.

Encabezado de paquete IPv4

Versión, Differentiated Services (DS), Time-to-Live (TTL), Protocol, Source IP Address, Destination IP Address



Paquete IPv4

Muestra de encabezado IPv4

Microsoft: \Device\NPF_{7BB3C130-30C5-4419-B79E-C0868085ABED} [Wireshark 1.8.2 (SVN Rev 44520 from /trunk-1.8)]

File Edit View Go Capture Analyze Statistics Telephony Tools Internals Help

Filter: Expression... Clear Apply Save

No.	Time	Source	Destination	Protocol	Length	Info
16	3.64050300	192.168.1.109	192.168.1.1	ICMP	74	Echo (ping) request id=0x0001, seq=5/1280, ttl=128
17	3.64506800	192.168.1.1	192.168.1.109	ICMP	74	Echo (ping) reply id=0x0001, seq=5/1280, ttl=64
18	3.68215500	192.168.1.109	38.112.107.53	TCP	54	55502 > https [ACK] Seq=1 Ack=134 Win=16661 Len=0
19	4.19945400	fe80::15ff:98d8:d28ff02::c		SSDP	208	M-SEARCH * HTTP/1.1
20	4.60748800	fe80::15ff:98d8:d28ff02::c		SSDP	453	HTTP/1.1 200 OK
21	4.64229900	192.168.1.109	192.168.1.1	ICMP	74	Echo (ping) request id=0x0001, seq=6/1536, ttl=128
22	4.64509200	192.168.1.1	192.168.1.109	ICMP	74	Echo (ping) reply id=0x0001, seq=6/1536, ttl=64
23	4.73605200	192.168.1.109	255.255.255.255	DB-LSP-	154	Dropbox LAN sync Discoverv Protocol

Frame 16: 74 bytes on wire (592 bits), 74 bytes captured (592 bits) on interface 0

Ethernet II, Src: IntelCor_45:5d:c4 (24:77:03:45:5d:c4), Dst: Cisco-Li_a0:d1:be (00:18:39:a0:d1:be)

Internet Protocol Version 4, Src: 192.168.1.109 (192.168.1.109), Dst: 192.168.1.1 (192.168.1.1)

- Version: 4
- Header length: 20 bytes
- Differentiated Services Field: 0x00 (DSCP 0x00: Default; ECN: 0x00: Not-ECT (Not ECN-Capable Transport))
- Total Length: 60
- Identification: 0x3704 (14084)
- Flags: 0x00
- Fragment offset: 0
- Time to live: 128
- Protocol: ICMP (1)
- Header checksum: 0x7ffe [correct]
- Source: 192.168.1.109 (192.168.1.109)
- Destination: 192.168.1.1 (192.168.1.1)
- [Source GeoIP: Unknown]
- [Destination GeoIP: Unknown]

Internet Control Message Protocol

0000 00 18 39 a0 d1 be 24 77 03 45 5d c4 08 00 45 00 ..9...\$w .E]...E.
0010 00 3c 37 04 00 00 80 01 7f fe c0 a8 01 6d c0 a8 .<7.....m..
0020 01 01 08 00 4d 56 00 01 00 05 61 62 63 64 65 66 ...MV.. ..abcdef
0030 67 68 69 6a 6b 6c 6d 6e 6f 70 71 72 73 74 75 76 ghijklmn opqrstuv
0040 77 61 62 63 64 65 66 67 68 69 wabcdefg hi

Internet Protocol Version 4 (ip), 20 bytes Packets: 35 Displayed: 35 Marked: 0 Dropped: 0 Profile: Default

Limitaciones de IPv4

- Agotamiento de direcciones IPv4
- Expansión de la tabla de enrutamiento de Internet
- Falta de conectividad de extremo a extremo



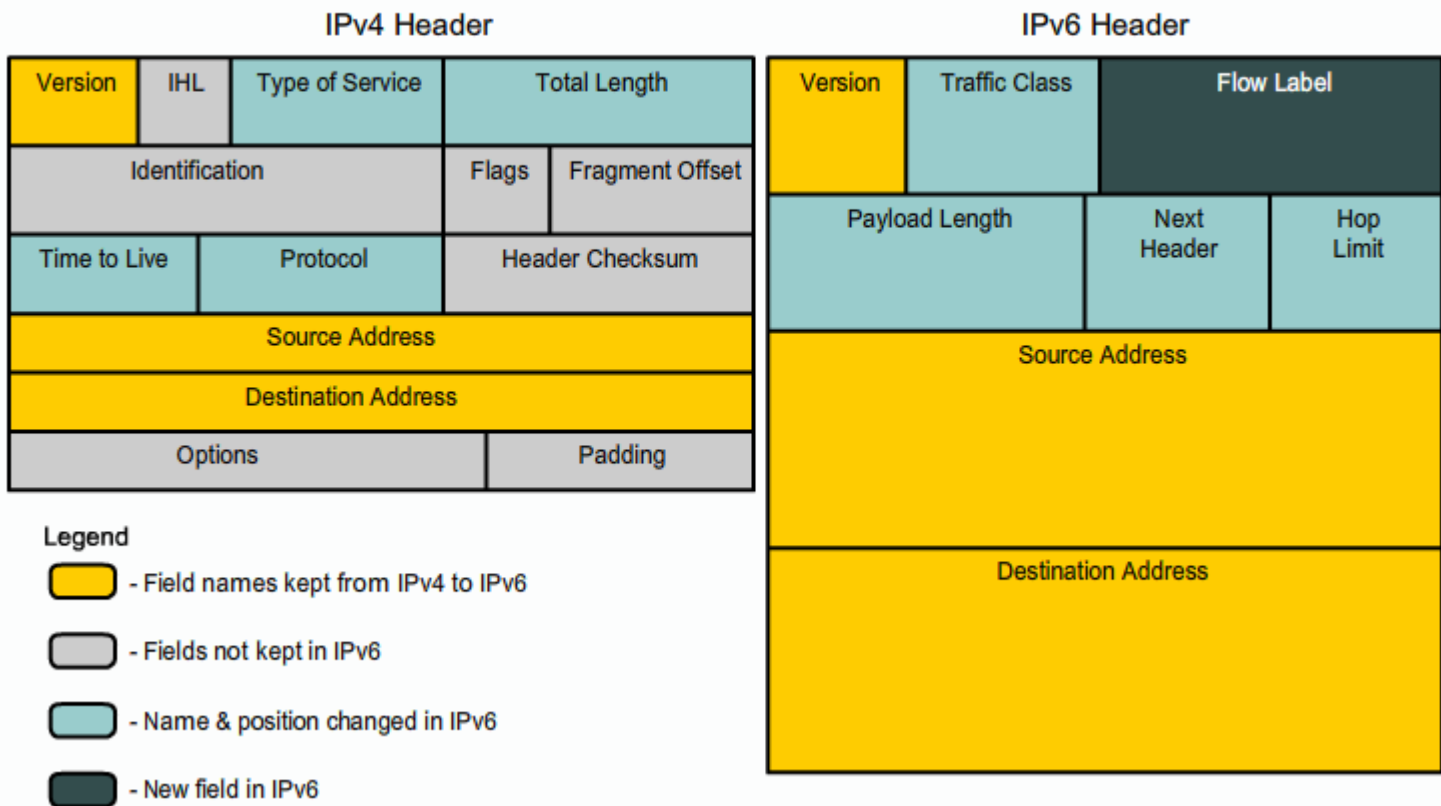
Comunicaciones en la capa de Red

Introducción a IPv6

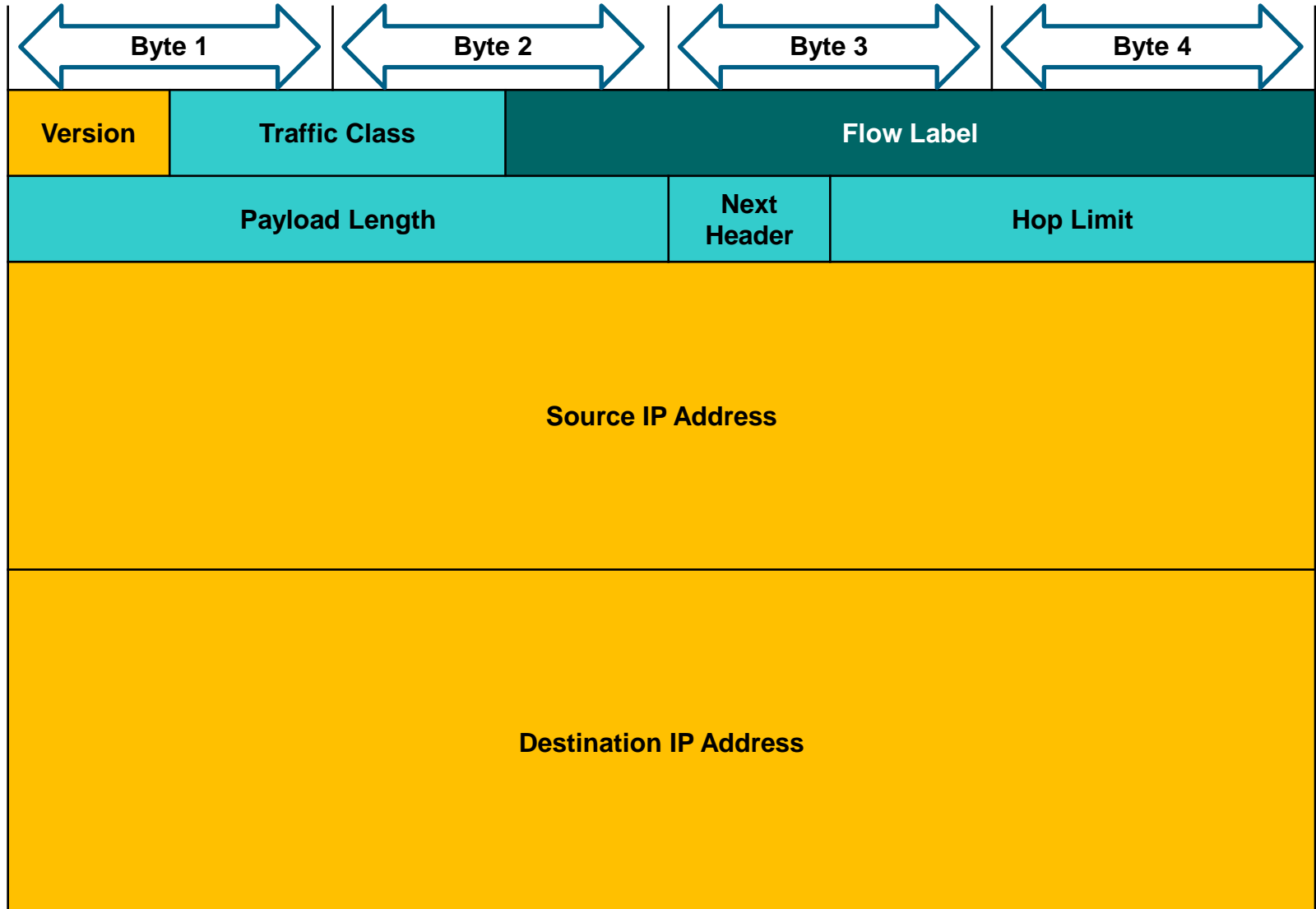
- Espacio de direccionamiento incrementado
 - Manejo de paquete mejorado
 - Elimina la necesidad de NAT
 - Seguridad Integrada
-
- 4 billion de direcciones IPv4
4,000,000,000
 - 340 decillones de direcciones IPv6
340,000,000,000,000,000,000,000,000,000,000,000,000,000,000

Encapsulamiento IPv6

IPv4 and IPv6 Headers



Encabezado de paquete IPv6



Muestra de encabezado IPv6

Wireshark 1.8.2 (SVN Rev 44520 from /trunk-1.8) v6-http.cap

Filter: Expression... Clear Apply Save

No.	Time	Source	Destination	Protocol	Length	Info
47	325.030878	2001:6f8:900:7c0::2	2001:6f8:102d:0:2d0:9ff:fee3:e8de	TCP	82	59201 > http [ACK] Seq=1 Ack=1 win=5760
48	325.031166	2001:6f8:102d:0:2d0:9ff:fee3:e8de	2001:6f8:900:7c0::2	TCP	74	59201 > http [ACK] Seq=1 Ack=1 win=5760
49	325.040411	2001:6f8:102d:0:2d0:9ff:fee3:e8de	2001:6f8:900:7c0::2	HTTP	314	GET / HTTP/1.0
50	325.045496	2001:6f8:900:7c0::2	2001:6f8:102d:0:2d0:9ff:fee3:e8de	TCP	1506	[TCP segment of a reassembled PDU]
51	325.045525	2001:6f8:900:7c0::2	2001:6f8:102d:0:2d0:9ff:fee3:e8de	HTTP	901	HTTP/1.1 200 OK (text/html)
52	325.045627	2001:6f8:900:7c0::2	2001:6f8:102d:0:2d0:9ff:fee3:e8de	TCP	74	http > 59201 [FIN, ACK] Seq=2260 Ack=241

Frame 49: 314 bytes on wire (2512 bits), 314 bytes captured (2512 bits)

Ethernet II, Src: HsingTec_e3:e8:de (00:d0:09:e3:e8:de), Dst: Ibm_82:95:b5 (00:11:25:82:95:b5)

Internet Protocol Version 6, Src: 2001:6f8:102d:0:2d0:9ff:fee3:e8de (2001:6f8:102d:0:2d0:9ff:fee3:e8de), Dst: 2001:6f8:900:7c0::2 (2001:6f8:900:7c0::2)

0110 = Version: 6

.... 0000 0000 = Traffic class: 0x00000000

.... 0000 0000 0000 0000 = Flowlabel: 0x00000000

Payload length: 260

Next header: TCP (6)

Hop limit: 64

Source: 2001:6f8:102d:0:2d0:9ff:fee3:e8de (2001:6f8:102d:0:2d0:9ff:fee3:e8de)

[Source SA MAC: HsingTec_e3:e8:de (00:d0:09:e3:e8:de)]

Destination: 2001:6f8:900:7c0::2 (2001:6f8:900:7c0::2)

[Source GeoIP: Unknown]

[Destination GeoIP: Unknown]

Transmission Control Protocol, Src Port: 59201 (59201), Dst Port: http (80), Seq: 1, Ack: 1, Len: 240

Hypertext Transfer Protocol

0000 00 11 25 82 95 b5 00 d0 09 e3 e8 de 86 dd 60 00 ..%.....

0010 00 00 01 04 06 40 20 01 06 f8 10 2d 00 00 02 d0@.....

0020 09 ff fe e3 e8 de 20 01 06 f8 09 00 07 c0 00 00A.P...a.J

0030 00 00 00 00 00 02 e7 41 00 50 ab dc d6 61 01 4a s.P....H..GET /

0040 73 9f 50 18 16 80 f4 48 00 00 47 45 54 20 2f 20 HTTP/1.0 ..Host:

0050 48 54 54 50 2f 31 2e 30 0d 0a 48 6f 73 74 3a 20 c1-1985. ham-01.d

0060 63 6c 2d 31 39 38 35 2e 68 61 6d 2d 30 31 2e 64 e.sixxs. net..Acc

0070 65 2e 73 69 78 78 73 2e 6e 65 74 0d 0a 41 63 63

Internet Protocol Version 6 (IPv6), 40 bytes

Packets: 55 Displayed: 55 Mark...

Profile: Default

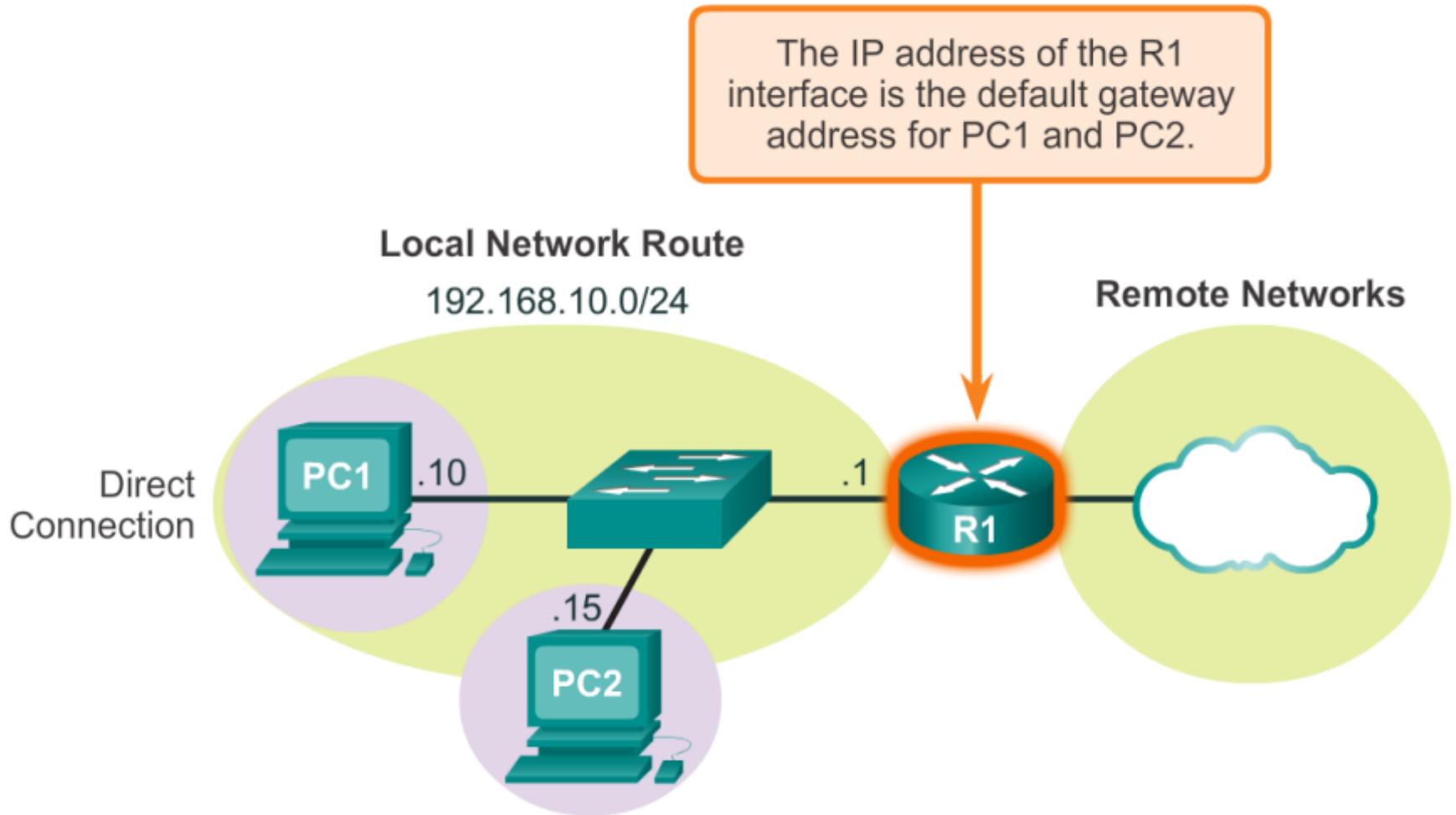
Enrutamiento

Tablas de enrutamiento en un host

```
C:\WINDOWS\system32\cmd.exe

C:\>route print
=====
Interface List
0x1 ..... MS TCP Loopback interface
0x2 ... .. Broadcom NetXtreme 57xx Gigabit Controller - Pac
ket Scheduler Miniport
0x3 ... .. Bluetooth PAN Network Adapter - Packet Scheduler
Miniport
0x4 ... .. VirtualBox Host-Only Ethernet Adapter - Packet S
cheduler Miniport
=====
Active Routes:
Network Destination    Netmask          Gateway          Interface        Metric
0.0.0.0                0.0.0.0         192.168.100.254  192.168.100.123    20
127.0.0.0             255.0.0.0         127.0.0.1       127.0.0.1         1
169.254.0.0           255.255.0.0      192.168.100.123  192.168.100.123    20
192.168.56.0           255.255.255.0    192.168.56.1     192.168.56.1       20
192.168.56.1          255.255.255.255   127.0.0.1       127.0.0.1         20
192.168.56.255        255.255.255.255   192.168.56.1     192.168.56.1       20
192.168.100.0          255.255.255.0    192.168.100.123  192.168.100.123    20
192.168.100.123       255.255.255.255   127.0.0.1       127.0.0.1         20
192.168.100.255       255.255.255.255   192.168.100.123  192.168.100.123    20
224.0.0.0             240.0.0.0        192.168.56.1     192.168.56.1       20
224.0.0.0             240.0.0.0        192.168.100.123  192.168.100.123    20
255.255.255.255       255.255.255.255   192.168.56.1     192.168.56.1       1
255.255.255.255       255.255.255.255   192.168.56.1     3                 1
255.255.255.255       255.255.255.255   192.168.100.123  192.168.100.123    1
Default Gateway:      192.168.100.254
=====
Persistent Routes:
None
C:\>
```

Decisión de reenvío de paquetes de host



Default Gateway

Los Hosts deben mantener su propia tabla de enrutamiento local, para asegurar que los paquetes de capa de red son direccionados a la red de destino correcta. La tabla local de los host típicamente contiene:

- Conexiones directas
- Ruta de red local
- Ruta local por defecto

Tablas de enrutamiento de host

Tabla de enrutamiento IPv4 de Host



```
C:\Users\PC1>netstat -r
```

<Output omitted>

IPv4 Route Table

Active Routes:

Network	Destination	Netmask	Gateway	Interface	Metric
	0.0.0.0	0.0.0.0	192.168.10.1	192.168.10.10	25
	127.0.0.0	255.0.0.0	On-link	127.0.0.1	306
	127.0.0.1	255.255.255.255	On-link	127.0.0.1	306
	127.255.255.255	255.255.255.255	On-link	127.0.0.1	306
	192.168.10.0	255.255.255.0	On-link	192.168.10.10	281
	192.168.10.10	255.255.255.255	On-link	192.168.10.10	281
	192.168.10.255	255.255.255.255	On-link	192.168.10.10	281
	224.0.0.0	240.0.0.0	On-link	127.0.0.1	306
	224.0.0.0	240.0.0.0	On-link	192.168.10.10	281
	255.255.255.255	255.255.255.255	On-link	127.0.0.1	306
	255.255.255.255	255.255.255.255	On-link	192.168.10.10	281

<Output omitted>

Muestra de la tabla de enrutamiento IPv4 de Host



```
C:\Users\PC1> netstat -r
```

```
<Output omitted>
```

```
IPv4 Route Table
```

```
=====
```

```
Active Routes:
```

Network	Destination	Netmask	Gateway	Interface	Metric
	0.0.0.0	0.0.0.0	192.168.10.1	192.168.10.10	25
127.0.0.0		255.0.0.0	On-link	127.0.0.1	306
127.0.0.1		255.255.255.255	On-link	127.0.0.1	306
127.255.255.255		255.255.255.255	On-link	127.0.0.1	306
192.168.10.0		255.255.255.0	On-link	192.168.10.10	281
192.168.10.10		255.255.255.255	On-link	192.168.10.10	281
192.168.10.255		255.255.255.255	On-link	192.168.10.10	281
224.0.0.0		240.0.0.0	On-link	127.0.0.1	306
224.0.0.0		240.0.0.0	On-link	192.168.10.10	281
255.255.255.255		255.255.255.255	On-link	127.0.0.1	306
255.255.255.255		255.255.255.255	On-link	192.168.10.10	281

```
=====
```

```
<Output omitted>
```

Tablas de enrutamiento de host

Muestra de la tabla de enrutamiento IPv6 de Host

fe80::2c30:3071:e718:a926/128
2001:db8:9d38:953c:2c30:3071:e718:a926/128



```
C:\Users\PC1> netstat -r
```

<Output omitted>

IPv6 Route Table

=====

Active Routes:

If	Metric	Network	Destination	Gateway
16	58	::/0		On-link
1	306	::1/128		On-link
16	58	2001::/32		On-link
16	306	2001:0:9d38:953c:2c30:3071:e718:a926/128		On-link
15	281	fe80::/64		On-link
16	306	fe80::/64		On-link
16	306	fe80::2c30:3071:e718:a926/128		On-link
15	281	fe80::b1ee:c4ae:a117:271f/128		On-link
1	306	ff00::/8		On-link
16	306	ff00::/8		On-link
15	281	ff00::/8		On-link

=====

<Output omitted>

Decisiones de reenvío de paquetes en Router

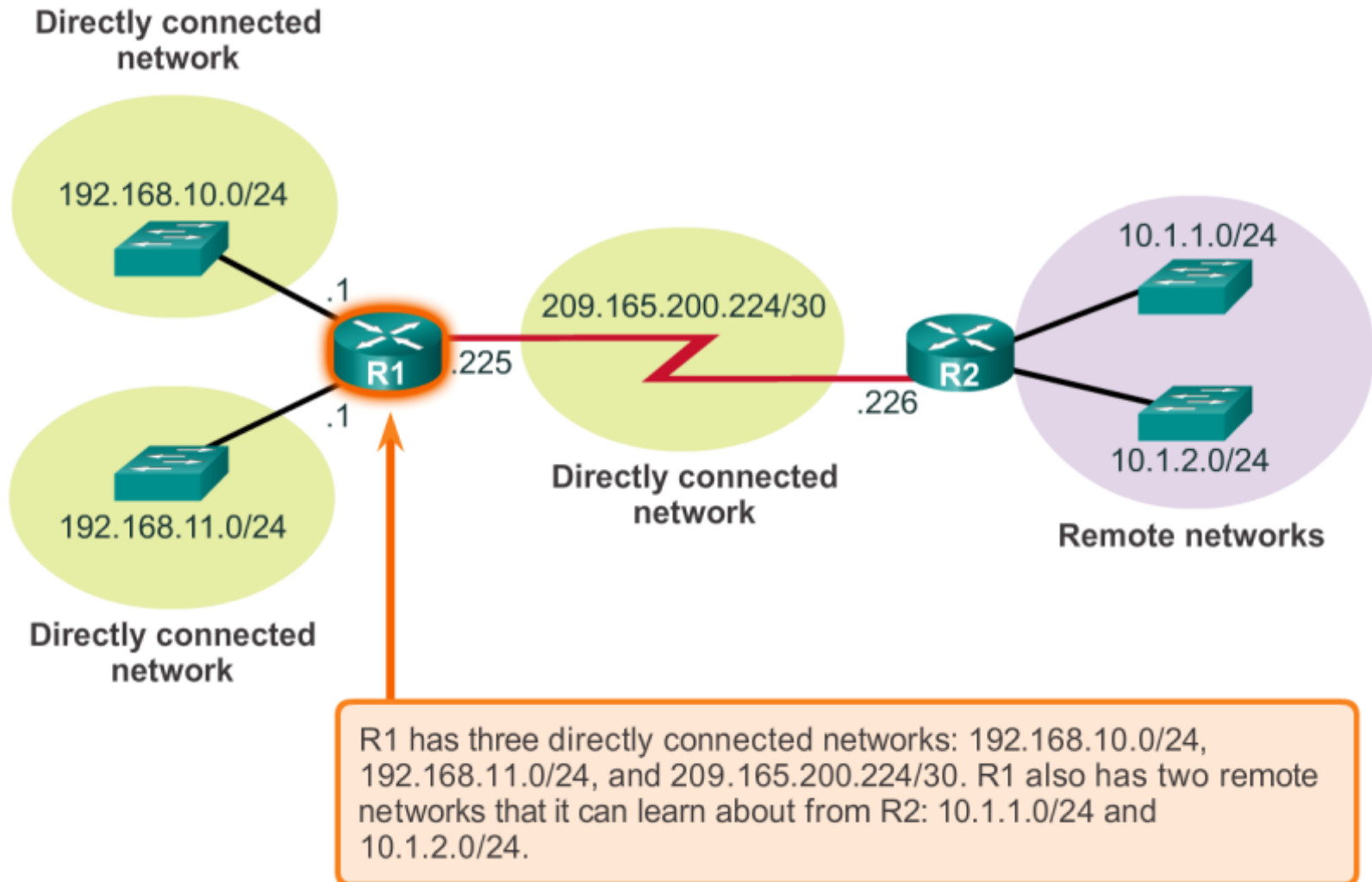
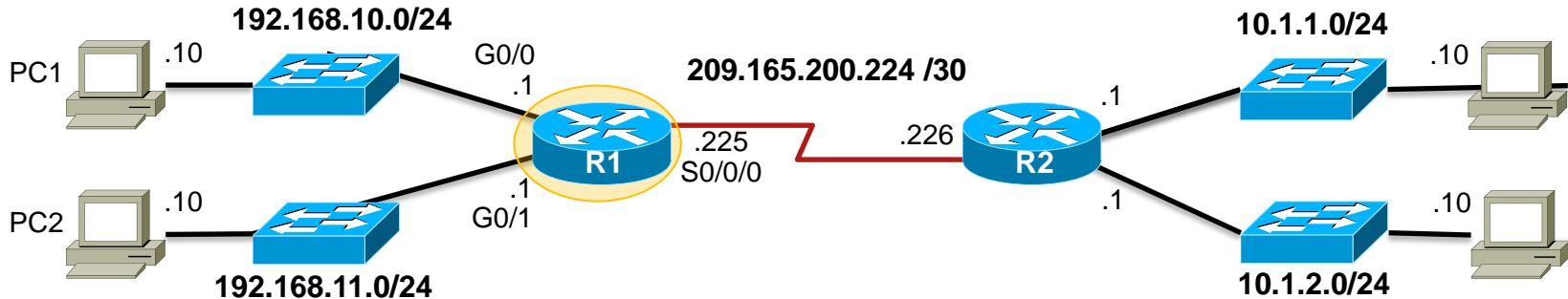


Tabla de enrutamiento de router

Tabla de enrutamiento IPv4 de Router



```
R1#show ip route
```

```
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP  
D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area  
N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2  
E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP  
i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area  
* - candidate default, U - per-user static route, o - ODR  
P - periodic downloaded static route
```

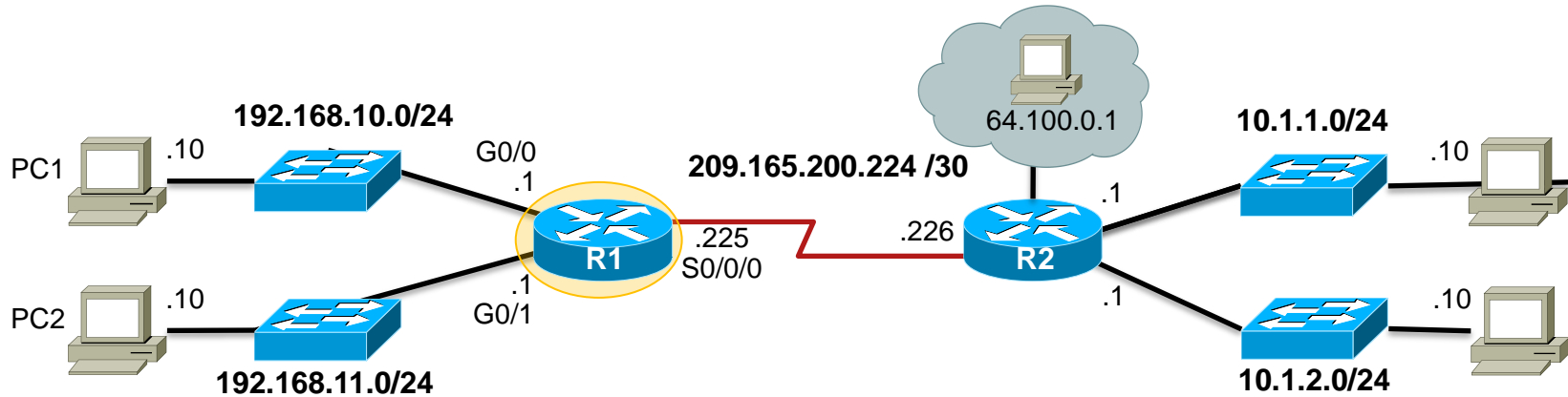
```
Gateway of last resort is not set
```

```
10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks  
D    10.1.1.0/24 [90/2170112] via 209.165.200.226, 00:00:05, Serial0/0/0  
D    10.1.2.0/24 [90/2170112] via 209.165.200.226, 00:00:05, Serial0/0/0  
192.168.10.0/24 is variably subnetted, 2 subnets, 3 masks  
C    192.168.10.0/24 is directly connected, GigabitEthernet0/0  
L    192.168.10.1/32 is directly connected, GigabitEthernet0/0  
192.168.11.0/24 is variably subnetted, 2 subnets, 3 masks  
C    192.168.11.0/24 is directly connected, GigabitEthernet0/1  
L    192.168.11.1/32 is directly connected, GigabitEthernet0/1  
209.165.200.0/24 is variably subnetted, 2 subnets, 3 masks  
C    209.165.200.224/30 is directly connected, Serial0/0/0  
L    209.165.200.225/32 is directly connected, Serial0/0/0
```

```
R1#
```

Tabla de enrutamiento de router

Entradas directamente conectadas



A

B

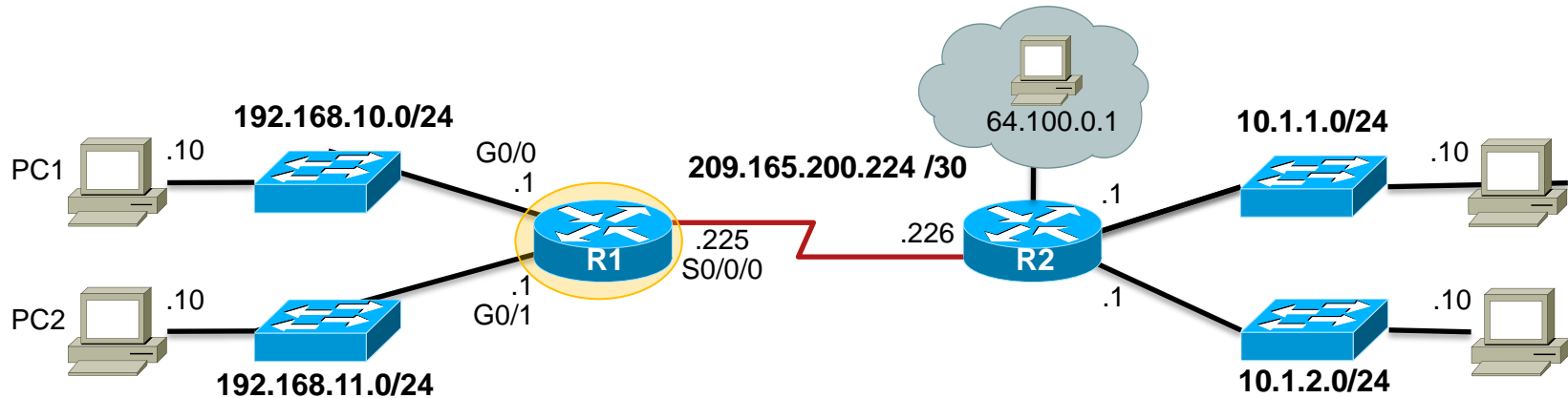
C

C	192.168.10.0/24 is directly connected,	GigabitEthernet0/0
L	192.168.10.1/32 is directly connected,	GigabitEthernet0/0

A	Identifica cómo la red fue aprendida por el router.
B	Identifica la red destino y cómo está conectada.
C	Identifica la interfaz en el router conectada a la red destino.

Tabla de enrutamiento de router

Entradas de red remotas

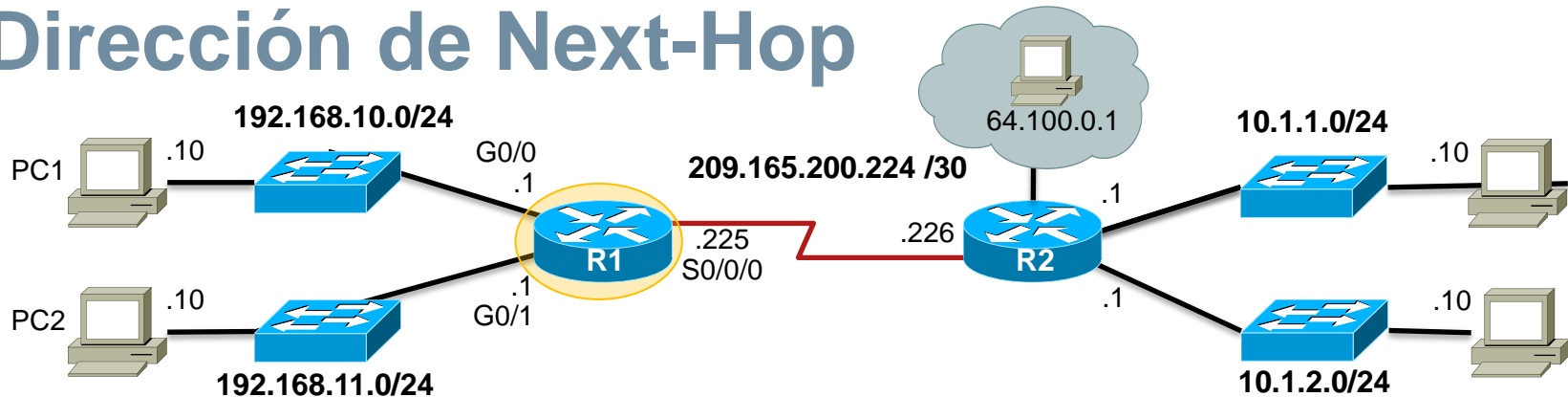


D	10.1.1.0/24	[90/2170112]	via	209.165.200.226,	00:00:05,	Serial0/0/0
---	-------------	--------------	-----	------------------	-----------	-------------

A	Identifica cómo la red fue aprendida por el.
B	Identifica la red destino.
C	Identifica la distancia administrativa (confiabilidad) del origen de la ruta.
D	Identifica la métrica para alcanzar la red remota.
E	Identifica la dirección de próximo salto para alcanzar la red remota.
F	Identifica la cantidad de tiempo transcurrido desde que la red fue descubierta.
G	Identifica la interfaz saliente en el router para alcanzar la red destino.

Tabla de enrutamiento de router

Dirección de Next-Hop



R1#show ip route

Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
 D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
 N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
 E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
 i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
 * - candidate default, U - per-user static route, o - ODR
 P - periodic downloaded static route

Gateway of last resort is not set

10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks

D 10.1.1.0/24 [90/2170112] via 209.165.200.226, 00:00:05, Serial0/0/0

D 10.1.2.0/24 [90/2170112] via 209.165.200.226, 00:00:05, Serial0/0/0

192.168.10.0/24 is variably subnetted, 2 subnets, 3 masks

C 192.168.10.0/24 is directly connected, GigabitEthernet0/0

L 192.168.10.1/32 is directly connected, GigabitEthernet0/0

192.168.11.0/24 is variably subnetted, 2 subnets, 3 masks

C 192.168.11.0/24 is directly connected, GigabitEthernet0/1

L 192.168.11.1/32 is directly connected, GigabitEthernet0/1

209.165.200.0/24 is variably subnetted, 2 subnets, 3 masks

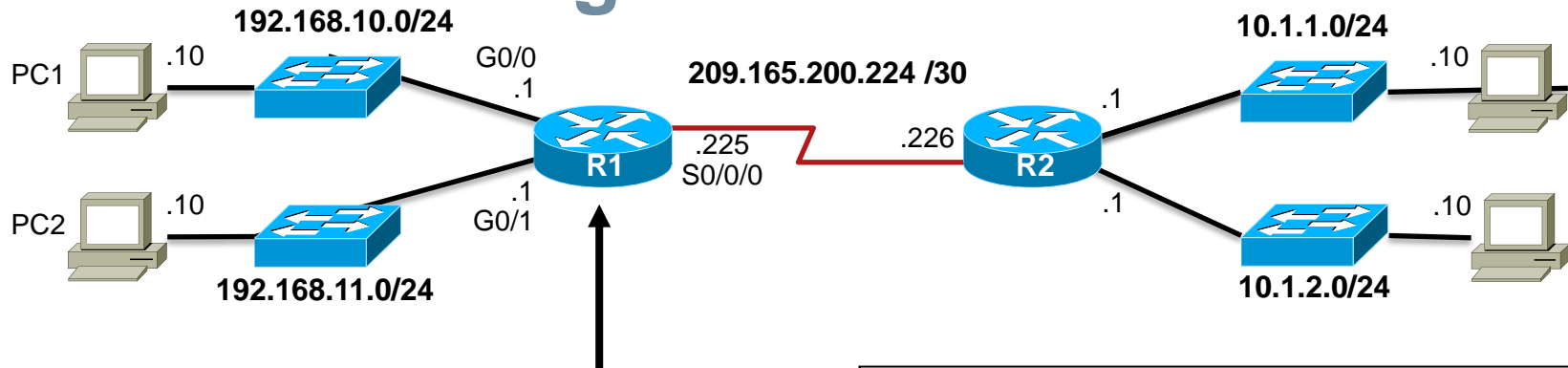
C 209.165.200.224/30 is directly connected, Serial0/0/0

L 209.165.200.225/32 is directly connected, Serial0/0/0

R1#

Configuraciones Iniciales

Pasos de Configuración de Router



```
Router> enable
Router# configure terminal
Enter configuration commands, one per line.
End with CNTL/Z.
Router(config)# hostname R1
R1(config)#
```

```
R1(config)# enable secret class
R1(config)#
R1(config)# line console 0
R1(config-line)# password cisco
R1(config-line)# login
R1(config-line)# exit
R1(config)#
R1(config)# line vty 0 4
R1(config-line)# password cisco
R1(config-line)# login
R1(config-line)# exit
R1(config)#
R1(config)# service password-encryption
R1(config)#
```

O

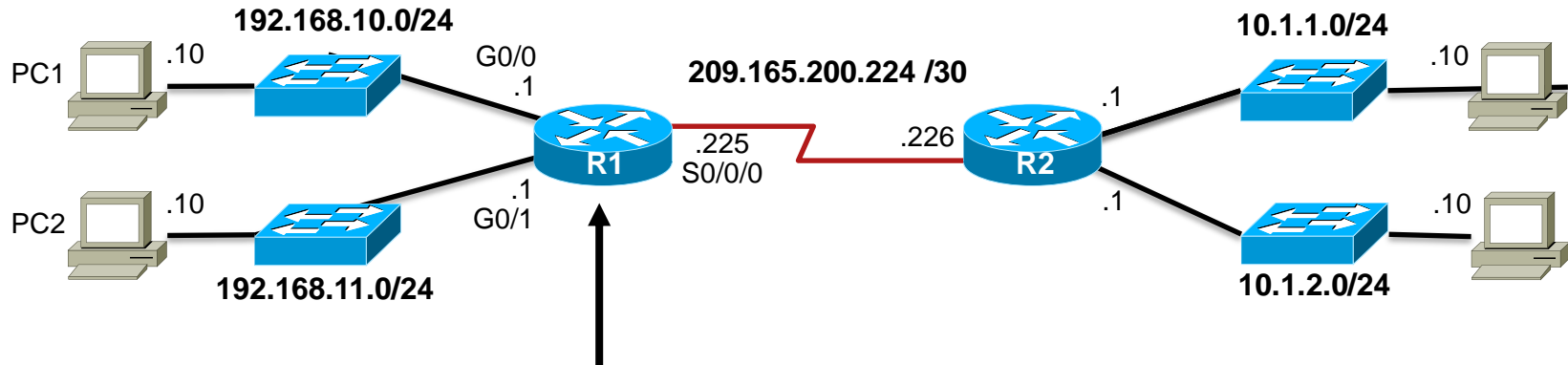
```
Router> en
Router# conf t
Enter configuration commands, one per line.
End with CNTL/Z.
Router(config)# ho R1
R2(config)#
```

```
R1(config)# banner motd #
Enter TEXT message. End with the character '#'.
*****
WARNING: Unauthorized access is prohibited!
*****
#
R1(config)#
```

```
R1# copy running-config startup-config
Destination filename [startup-config]?
Building configuration...
[OK]
R1#
```

Configura Interfaces

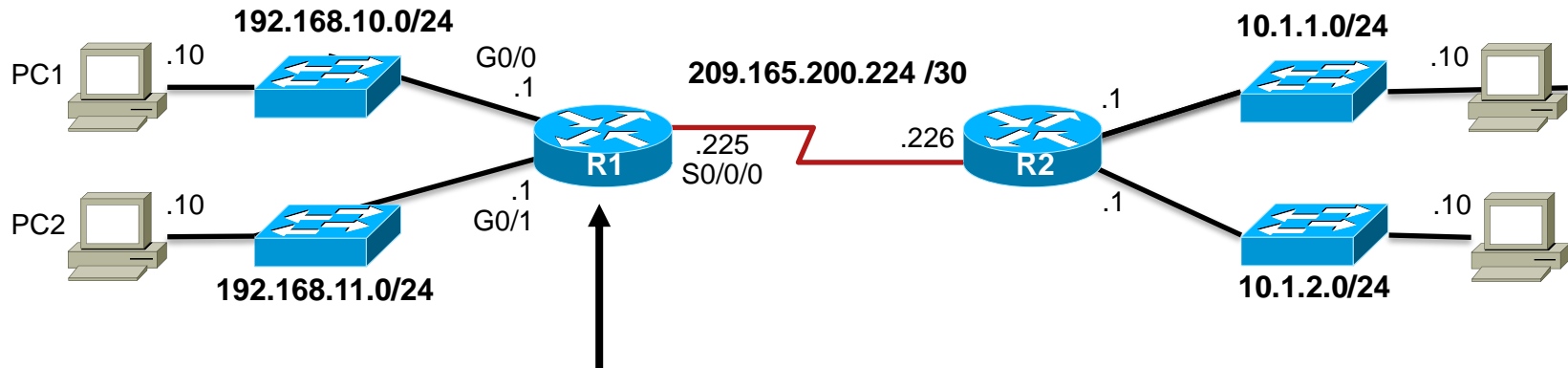
Configura Interfaces LAN



```
R1# conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)#
R1(config)# interface gigabitethernet 0/0
R1(config-if)# ip address 192.168.10.1 255.255.255.0
R1(config-if)# description Link to LAN-10
R1(config-if)# no shutdown
%LINK-5-CHANGED: Interface GigabitEthernet0/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/0,
changed state to up
R1(config-if)# exit
R1(config)#
R1(config)# int g0/1
R1(config-if)# ip add 192.168.11.1 255.255.255.0
R1(config-if)# des Link to LAN-11
R1(config-if)# no shut
%LINK-5-CHANGED: Interface GigabitEthernet0/1, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/1,
changed state to up
R1(config-if)# exit
R1(config)#
```

Configura Interfaces

Verifica Configuración de Interfaces



```
R1# show ip interface brief
```

Interface	IP-Address	OK?	Method	Status	Protocol
GigabitEthernet0/0	192.168.10.1	YES	manual	up	up
GigabitEthernet0/1	192.168.11.1	YES	manual	up	up
Serial0/0/0	209.165.200.225	YES	manual	up	up
Serial0/0/1	unassigned	YES	NVRAM	administratively down	down
Vlan1	unassigned	YES	NVRAM	administratively down	down

```
R1#
```

```
R1# ping 209.165.200.226
```

```
Type escape sequence to abort.
```

```
Sending 5, 100-byte ICMP Echos to 209.165.200.226, timeout is 2 seconds:
```

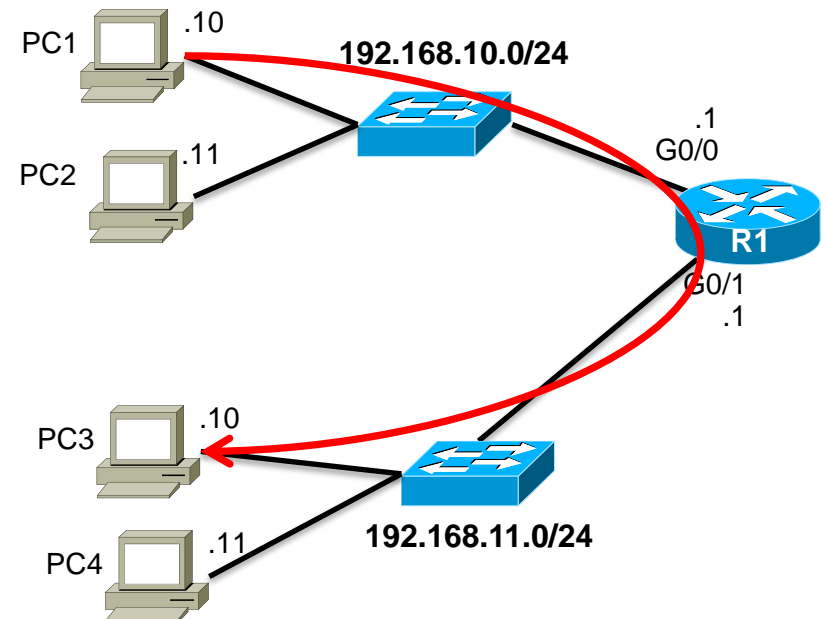
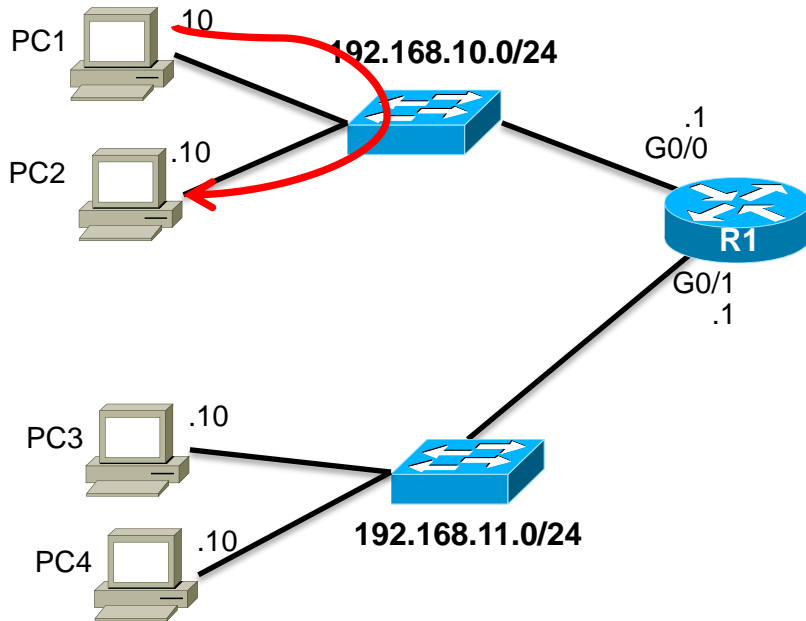
```
!!!!
```

```
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/2/9 ms
```

```
R1#
```

Configurando el Default Gateway

Default Gateway on a Host



Configurando el Default Gateway

Default Gateway en un Switch

