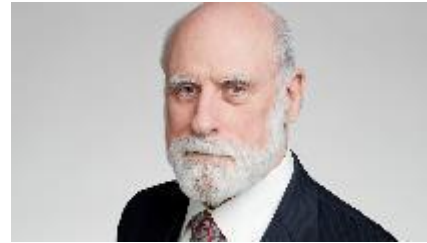# Padres del Protocolo TCP/IP

Vinton Cerf(23 de Junio 1943)
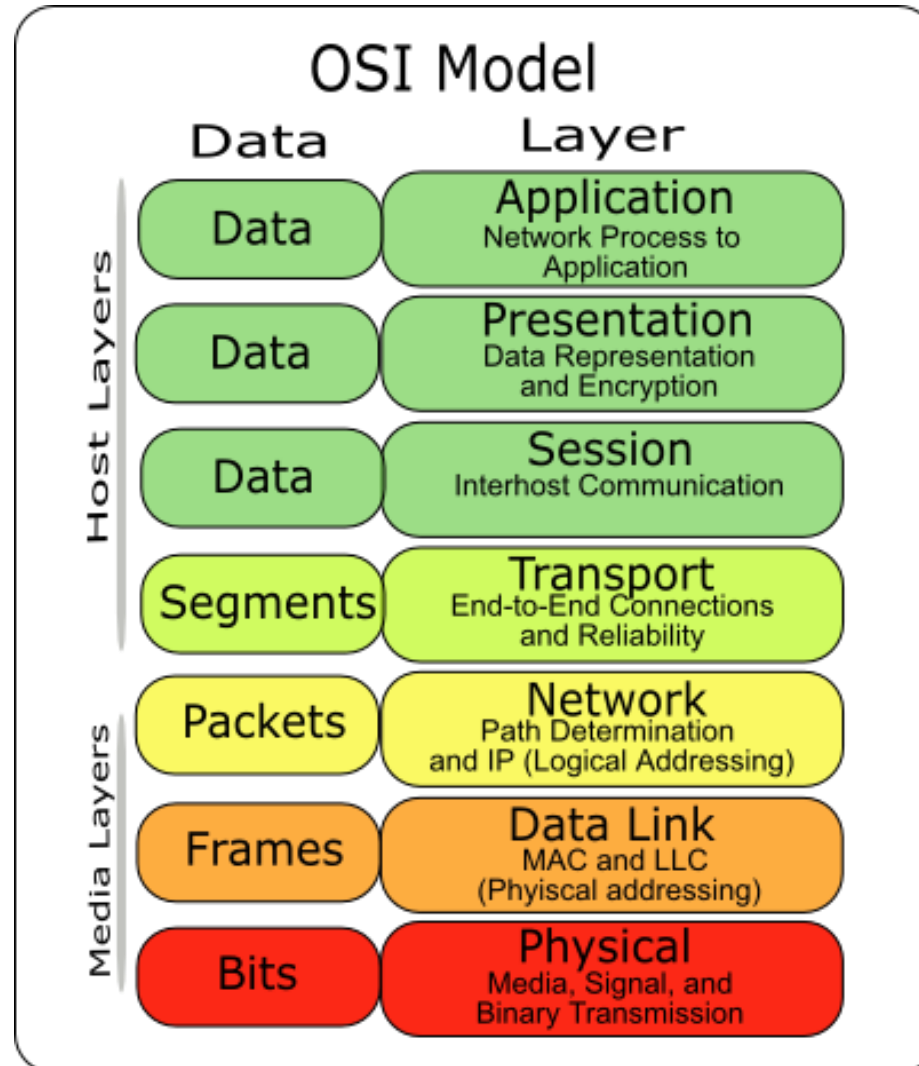
Robert Kahn (23 de Diciembre 1938)

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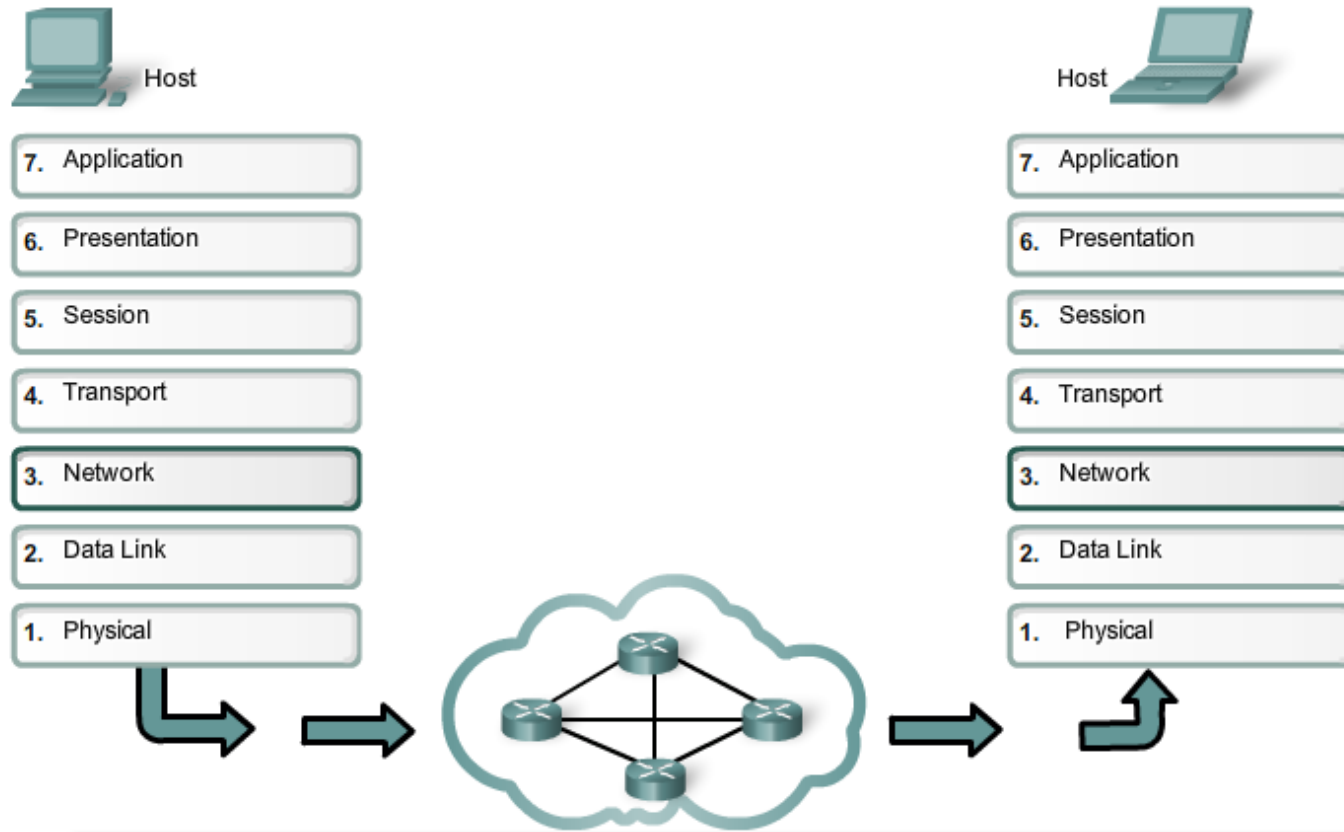
Capa de Red

Comunicación en la capa de Red

Network layer protocols forward encapsulated Transport Layer PDUs between hosts

Host

7.	Application
6.	Presentation
5.	Session
4.	Transport
3.	Network
2.	Data Link
1.	Physical

Host

7.	Application
6.	Presentation
5.	Session
4.	Transport
3.	Network
2.	Data Link
1.	Physical

La Capa de Red

Procesos de transporte de extremo a extremo

- Direccionando dispositivos finales

- Encapsulamiento

- Enrutamiento

- Desencapsulamiento

Protocolos de Capa de Red
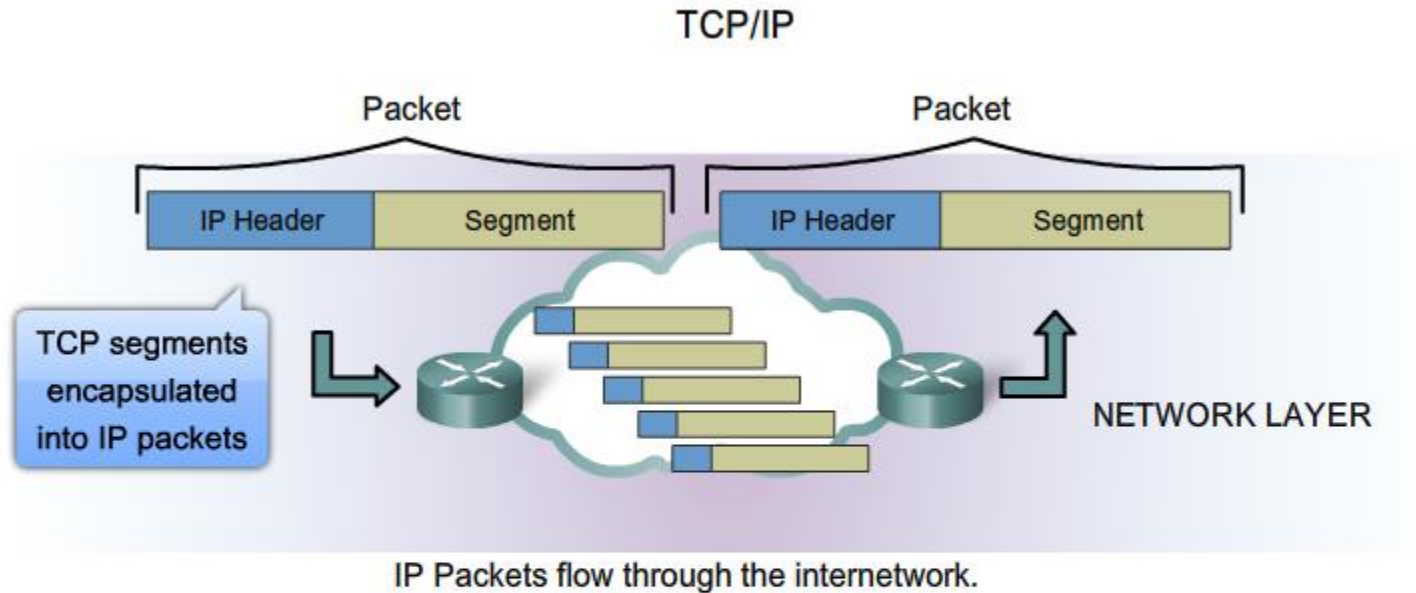
Protocolos comunes de capa de red

- 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 IP

TCP/IP

Packet | Packet

| IP Header | Segment | | IP Header | Segment |

TCP segments encapsulated into IP packets

NETWORK LAYER

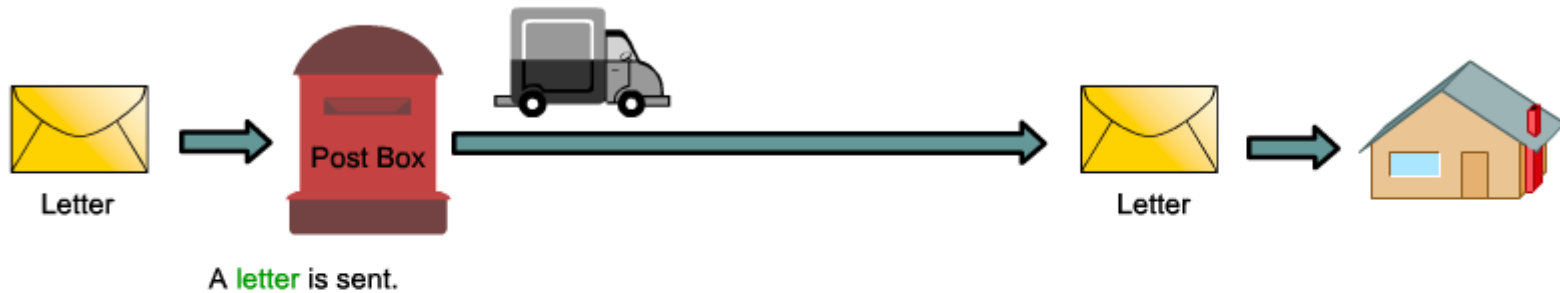IP Packets flow through the internetwork.

- 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.

IP - Sin conexión

Connectionless Communication
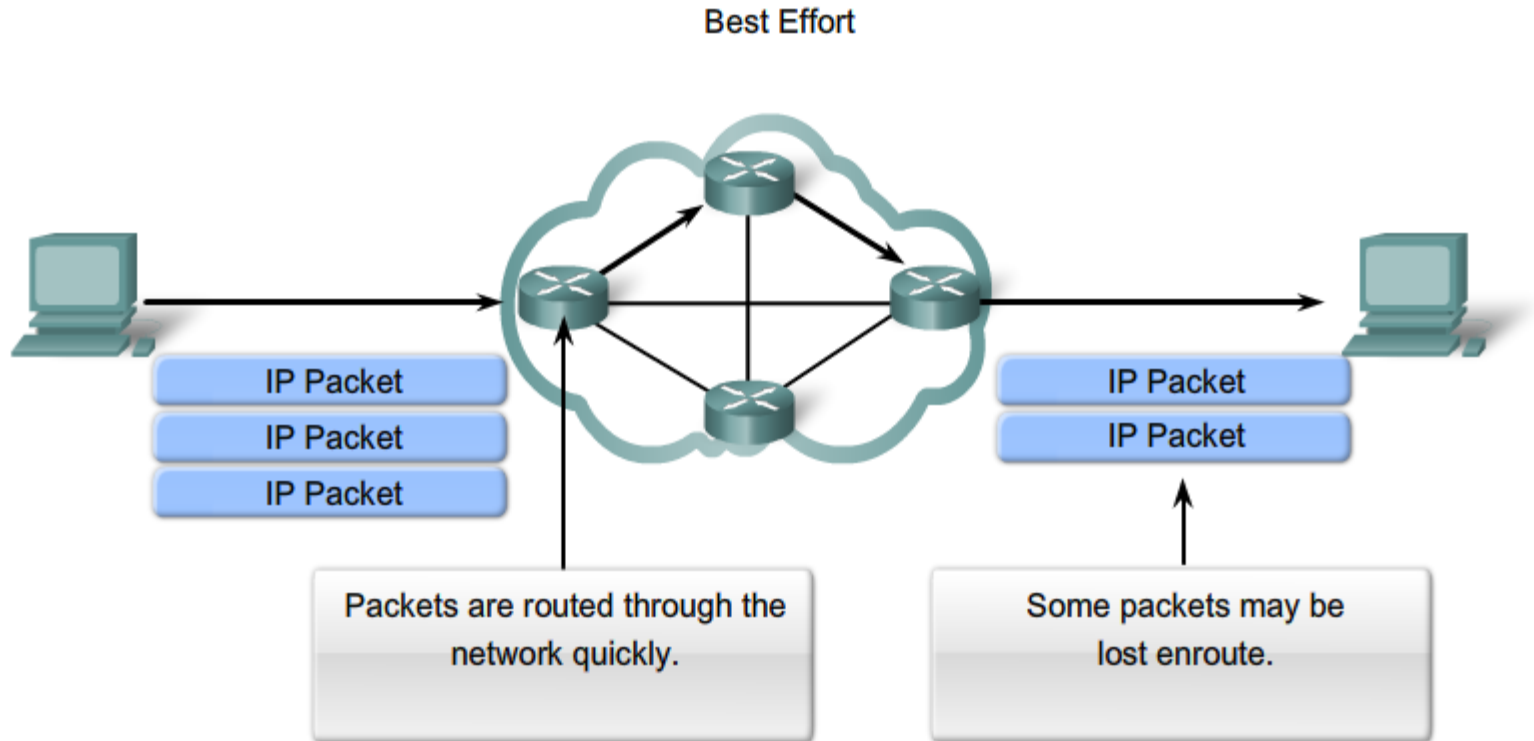
A letter is sent.

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

IP – Entrega del mejor esfuerzo

Best Effort

IP Packet
IP Packet
IP Packet

IP Packet
IP Packet

Packets are routed through the network quickly.
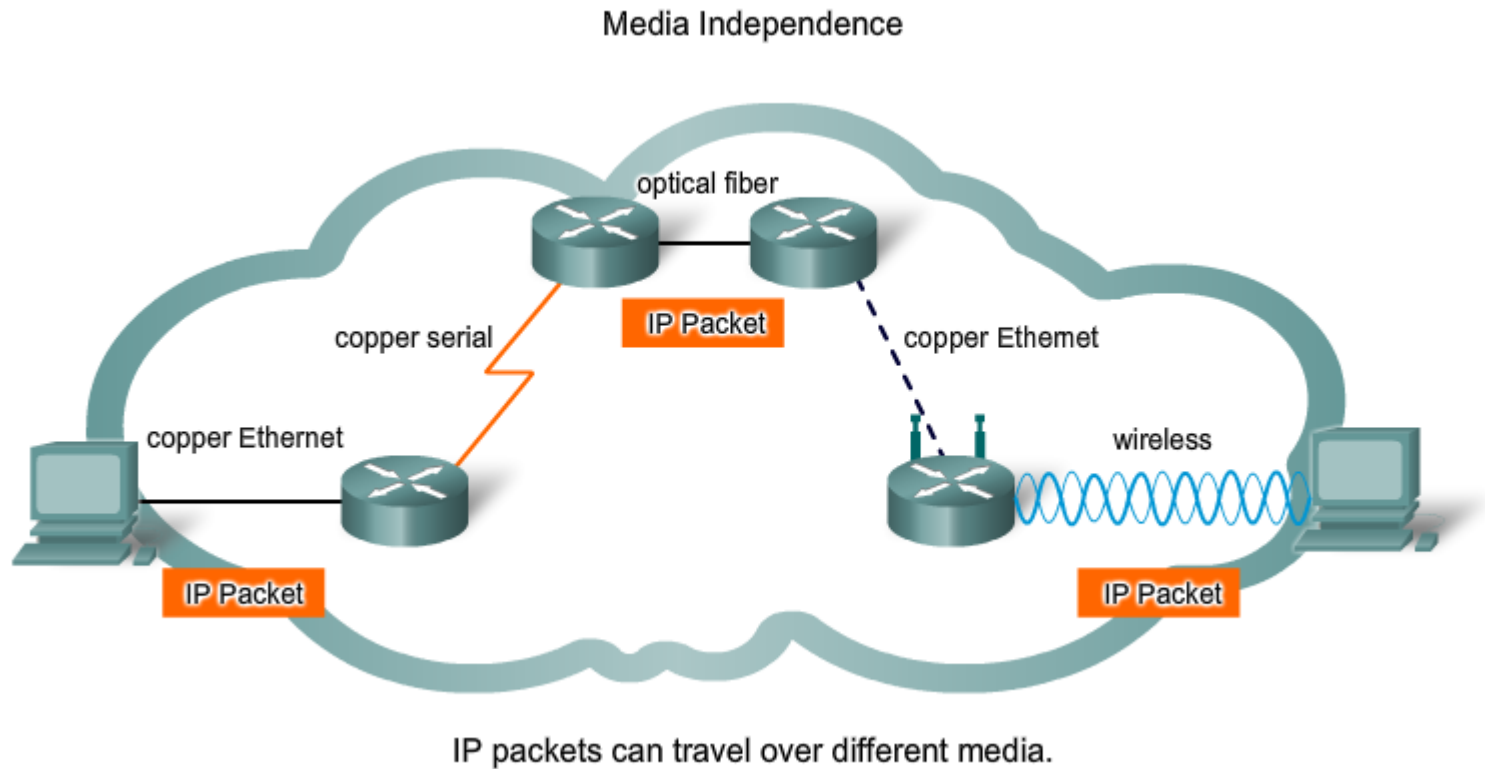
Some packets may be lost enroute.

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.

IP – Independiente del Medio

Encapsulamiento IP

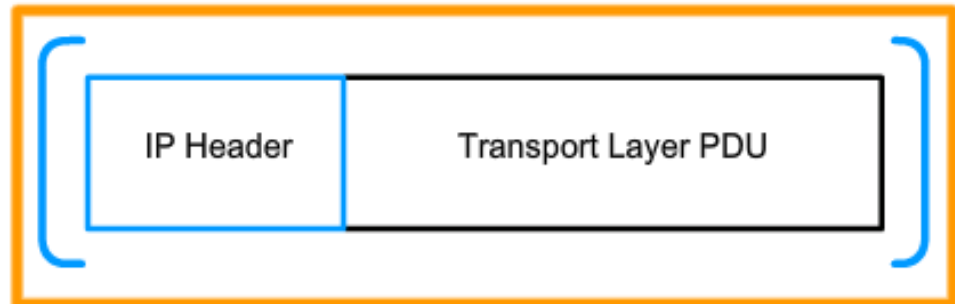Generating IP Packets

Transport Layer Encapsulation

Segment Header	Data

Network Layer Encapsulation
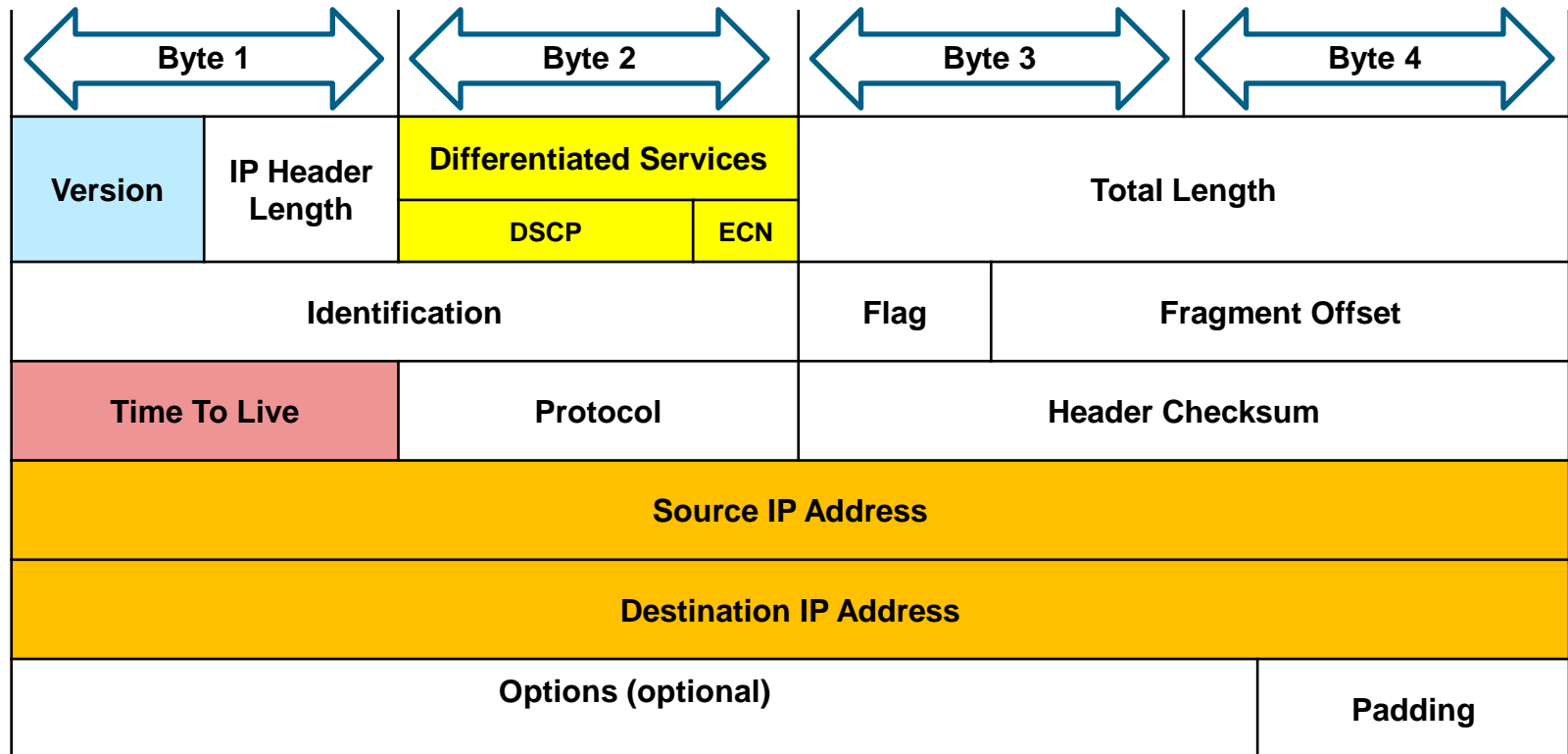
IP Header	Transport Layer PDU

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

Byte 1		Byte 2		Byte 3	Byte 4
Version	IP Header Length	Differentiated Services		Total Length	
		DSCP	ECN		
Identification				Flag	Fragment Offset
Time To Live		Protocol		Header Checksum	
Source IP Address					
Destination IP Address					
Options (optional)					Padding

Muestra de encabezado IPv4

Limitaciones de IPv4

- Agotamiento de direcciones IPv4

- Expansión de la tabla de enrutamiento de Internet

- Falta de conectividad de extremo a extremo

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 direccionesIPv6
  340,000,000,000,000,000,000,000,000,000,000,000,000

Encapsulamiento IPv6

IPv4 and IPv6 Headers

Encabezado de paquete IPv6

Byte 1	Byte 2	Byte 3	Byte 4

Version	Traffic Class	Flow Label	
Payload Length		Next Header	Hop Limit
Source IP Address			
Destination IP Address			

Muestra de encabezado IPv6

Tablas de enrutamiento en un host

Desición de reenvío de paquetes de host

The IP address of the R1 interface is the default gateway address for PC1 and PC2.

Local Network Route
192.168.10.0/24

Remote Networks

Direct Connection

PC1 .10

.1 R1

.15

PC2
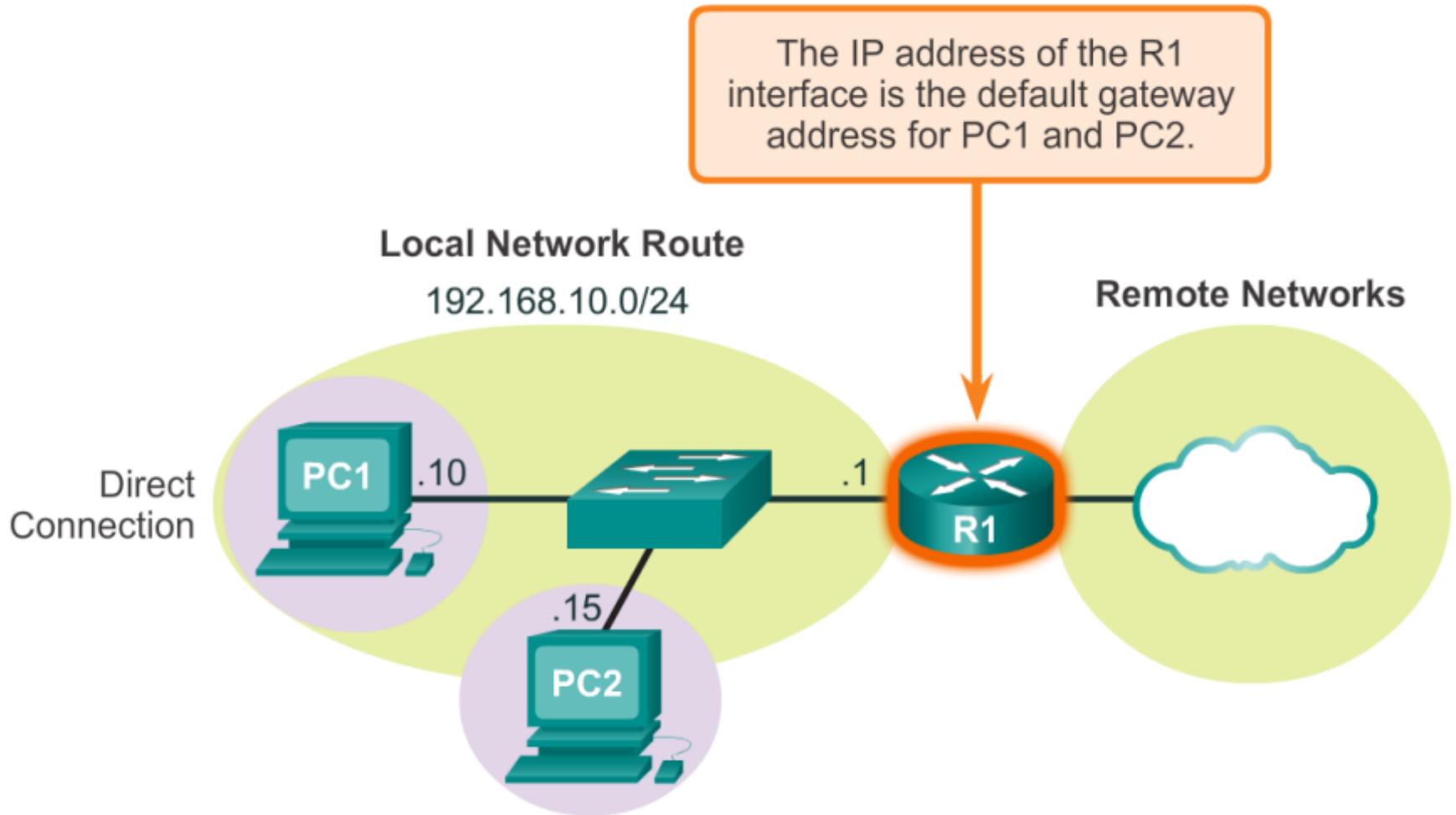
Default Gateway

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

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>
```

Muestra de la tabla de enrutamiento IPv6 de Host

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

fe80::/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

Directly connected network

192.168.10.0/24

.1

.225

209.165.200.224/30

R1

.1

192.168.11.0/24

Directly connected network

Directly connected network

.226

R2

10.1.1.0/24

10.1.2.0/24

Remote networks

R1 has three directly connected networks: 192.168.10.0/24, 192.168.11.0/24, and 209.165.200.224/30. R1 also has two remote networks that it can learn about from R2: 10.1.1.0/24 and 10.1.2.0/24.

Tabla de enrutamiento IPv4 de Router

192.168.10.0/24

PC1 .10

G0/0
.1

209.165.200.224 /30

.225
S0/0/0

R1

.226

R2

10.1.1.0/24

.10

.1

PC2 .10

.1
G0/1

192.168.11.0/24

.1

10.1.2.0/24

.10

```
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#
```

Entradas directamente conectadas

192.168.10.0/24

PC1   .10   G0/0   209.165.200.224 /30   64.100.0.1   10.1.1.0/24   .10

.1   .225   .226   .1

R1   S0/0/0   R2

PC2   .10   .1   .1   .10

G0/1

192.168.11.0/24   10.1.2.0/24
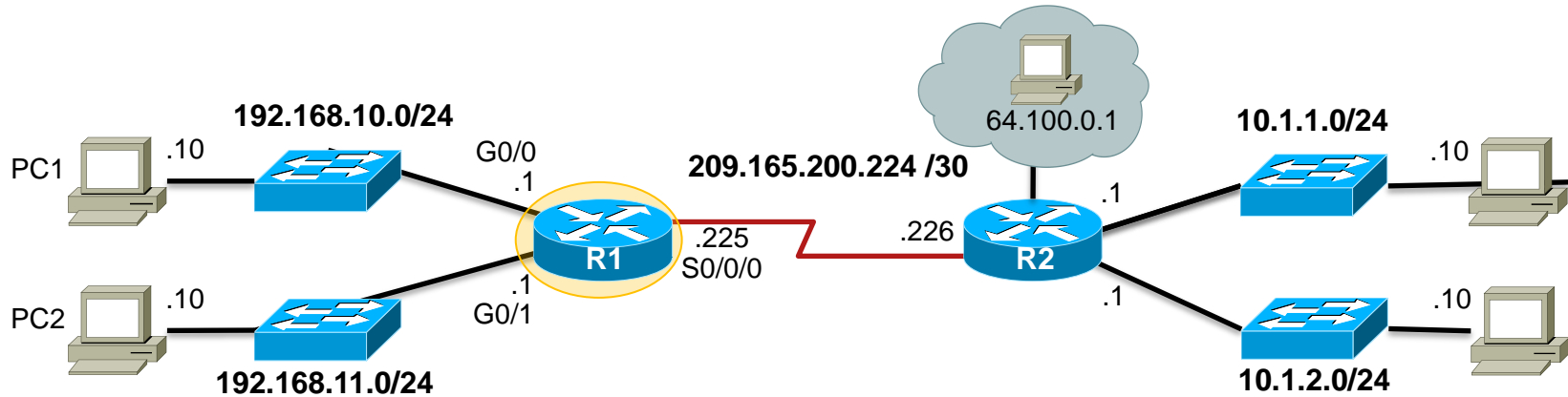
A	B	C
C	192.168.10.0/24 is directly connected,	GigabitEthernet0/0
L	192.168.10.1/32 is directly connected,	GigabitEthernet0/0

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

192.168.10.0/24

PC1   .10

G0/0
.1

209.165.200.224 /30

64.100.0.1   **10.1.1.0/24**   .10

.1

.225
S0/0/0   .226

R1   R2

PC2   .10

.1
G0/1

.1   .10

192.168.11.0/24

10.1.2.0/24

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.

Dirección de Next-Hop

192.168.10.0/24

64.100.0.1

10.1.1.0/24

PC1 .10

G0/0
.1

209.165.200.224 /30

.1

.10

.225
S0/0/0

.226

R1

R2

PC2 .10

.1
G0/1

.1

.10

192.168.11.0/24

10.1.2.0/24

```
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#
```
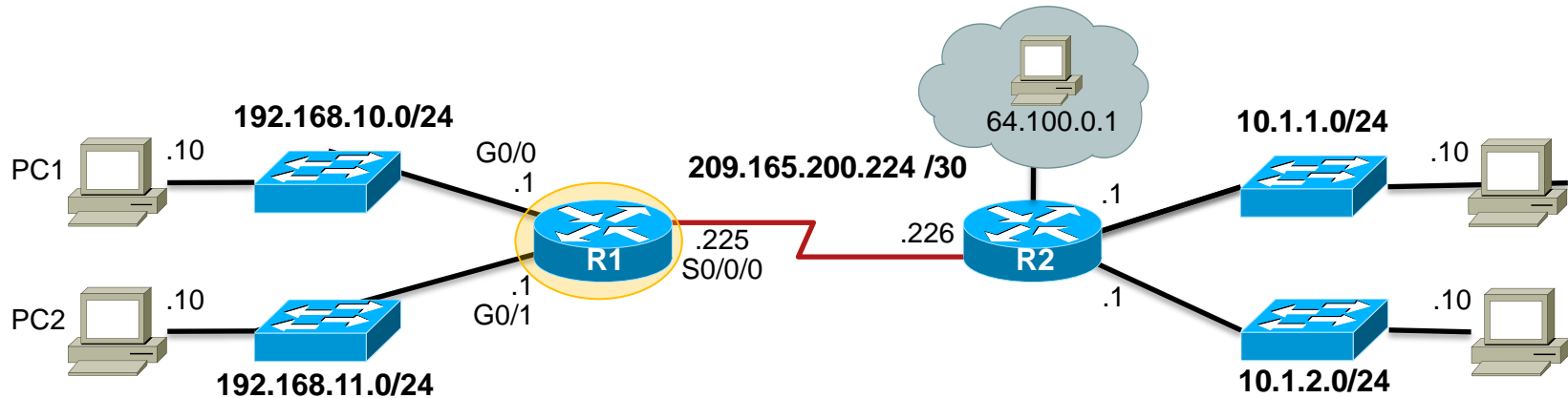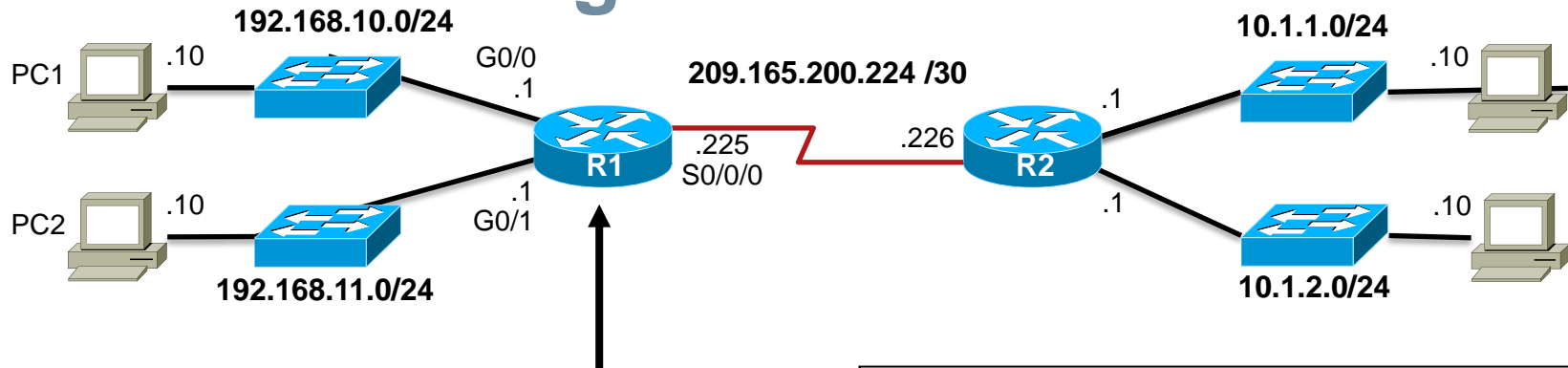
Pasos de Configuración de Router

192.168.10.0/24

10.1.1.0/24

PC1 .10   G0/0   **209.165.200.224 /30**   .1   .10

.1

.225
R1   .226   **R2**   .1
S0/0/0

PC2 .10   .1   .10
G0/1

192.168.11.0/24   **10.1.2.0/24**

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

```
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 LAN

192.168.10.0/24

PC1 .10

G0/0
.1

209.165.200.224 /30

10.1.1.0/24

.1 .10

.225
S0/0/0

.226

R1

R2

PC2 .10

.1
G0/1

.1

.10

192.168.11.0/24

10.1.2.0/24
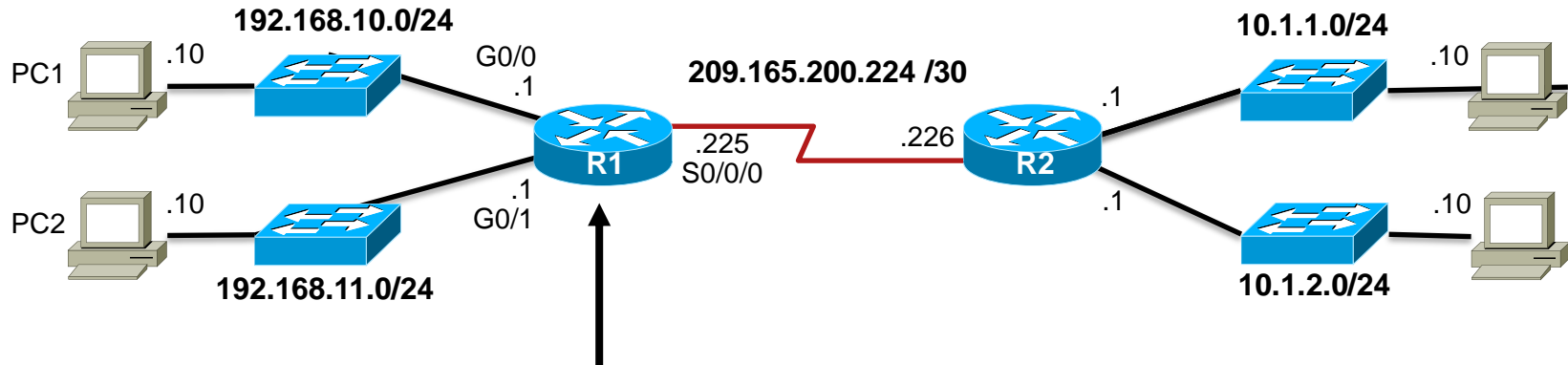
```
R1# conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)#
R1(config)# interface gigabitethernet 0/0
R1(config-if)# ip address 192.168.10.1 255.255.255.0
R1(config-if)# description Link to LAN-10
R1(config-if)# no shutdown
%LINK-5-CHANGED: Interface GigabitEthernet0/0, changed 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)#
```

Verifica Configuración de Interfaces
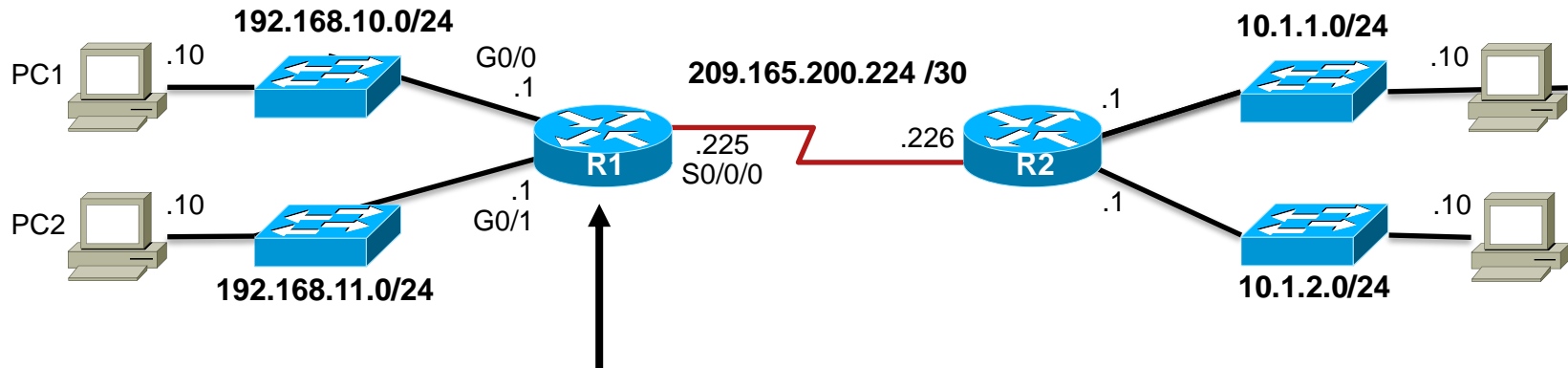

```
R1# show ip interface brief
Interface            IP-Address       OK? Method Status                Protocol

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#
```
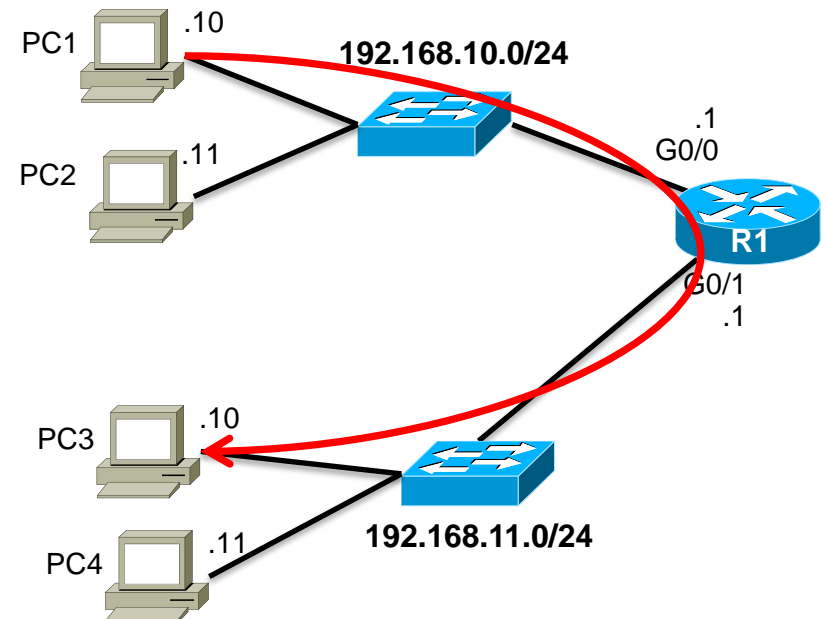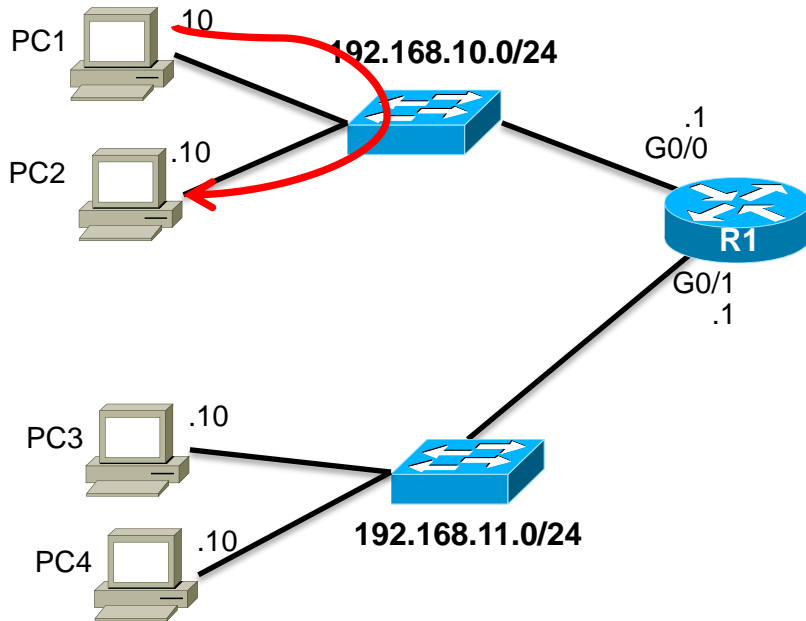
Default Gateway on a Host

Default Gateway en un Switch

```
S1#show running-config
Building configuration...
!
<output omitted>
service password-encryption
!
hostname S1
!
Interface Vlan1
ip address 192.168.10.50
!
ip default-gateway 192.168.10.1
<output omitted>
```

PC1 .10

192.168.10.0/24

192.168.11.0/24

.1
G0/0   R1   G0/1

S1

S2

PC2 .11

.50

Si el the default gateway no fue configurado en S1, las respuestad de paquetes desde S1 no podrían alcanzar al administrador en 192.168.11.10. El administrador no podría manejar el dispositivo remotamente