## 1 – El protocolo DHCP

DHCP (Dynamic Host Configuration Protocol) es un protocolo de la capa de aplicación. Este nos permite conectar un equipo a la red de forma automática (la manera manual equivalente es la configuración TCP/IP que hacemos en Packet Tracer, por ejemplo). De esta forma, el equipo se encargará de iniciar un proceso en el que acabe obteniendo la configuración TCP/IP para poder comunicarse con otros elementos de la red.

Podemos ver la utilidad de este protocolo con un sencillo ejemplo:

Imaginamos una gran empresa con cientos de ordenadores. En lugar de que un técnico tenga que configurar cada uno de ellos, es mucho más sencillo que al conectarlos a la red obtengan de forma automática su configuración TCP/IP gracias al protocolo DHCP.

Sin embargo, este protocolo tiene más ventajas a parte de la automatización de la conexión, como el aprovechamiento de direcciones IP, la facilidad de la conectividad y la minimización de los errores de configuración.

### 2 – Cómo funciona

El protocolo DHCP se basa en el modelo ciente/servidor, en el que un cliente espera recibir la información de la configuración TCP/IP, y un servidor es el que la proporciona (ambos estarán conectados a la red y el servidor tendrá instalado el servicio DHCP).

Un ejemplo que podemos observar fácilmente, ocurre al configurar nuestro teléfono móvil como punto de acceso WiFi. Nuestro smartphone, no sólo actúa como punto de acceso, sino que también proporciona una dirección IP al cliente por DHCP, por lo que nuestro teléfono se habrá convertido en una especie de servidor DHCP. Este, además, es un proceso que ocurre en cualquier router cuando se conecta un nuevo dispositivo.

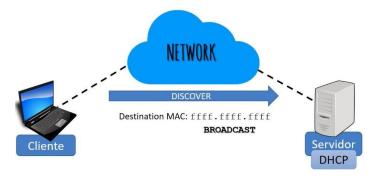
### 2.1 - DHCP handshake

Para que un servidor le proporciona la configuración TCP/IP al cliente tiene que suceder antes un proceso de 4 fases de intercambio de información entre ellos: el DHCP handshake (o DORA, por las siglas de este proceso)

## 1 – Discover

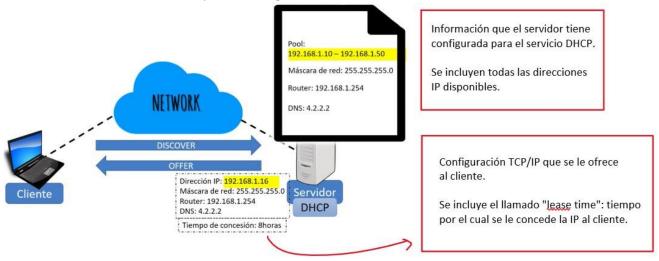
Cuando el cliente con el DHCP activado en su configuración de red, se conecta a la red, envía un mensaje DHCP de tipo discover, en el que intentará descubrir si existe un servidor DHCP en la red que le pueda ofrecer una dirección IP.

Al final, con este proceso lo que se está haciendo es un broadcast, en el que el cliente enviará una dirección MAC con la dirección de broadcast.



### 2 - Offer

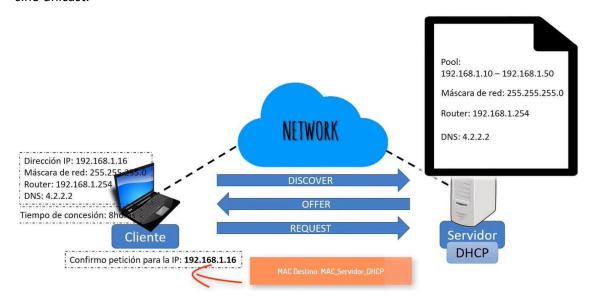
Una vez que el mensaje discover llega al servidor DHCP, este buscará una dirección IP libre dentro de la información que tiene asignada del servicio DHCP.



## 3 - Request

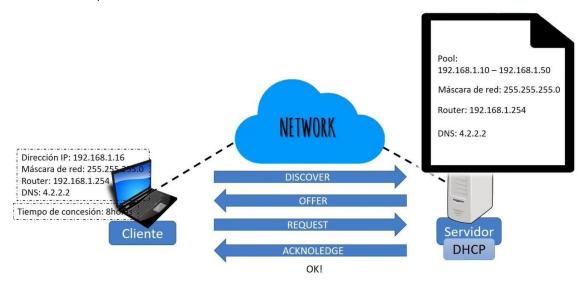
El cliente, al recibir la información proporcionada por el servidor, responderá con un mensaje de HCP request, en el que confirmará al servidor DHCP que se asignará la dirección IP concedida.

Esta vez, el cliente incluirá en el mensaje request la dirección MAC destino del servidor, que habrá aprendido con el anterior mensaje, por lo que esto ya no es una trama tipo broadcast, sino unicast.



# 4 - Acknowledge (ACK)

El servidor responde con un ACK, confirmando la concesión de la dirección IP.



## 3 - Práctica

Se comprobará el proceso del handshake DHCP en una máquina virtual con Windows 10 (para facilitar el tráfico de red).

# 1 – ipconfig /release

Para empezar, se desconectará esta máquina de la red. Entonces, dentro de la CMD se escribirá el comando "ipconfig /release" para que renuncie a su dirección IP. Así, pasará a tener la IP 0.0.0.0.

```
C:\Users\Sergio>ipconfig /release

Configuración IP de Windows

Adaptador de Ethernet Ethernet:

Sufijo DNS específico para la conexión. .:

Vínculo: dirección IPv6 local. . . : fe80::d582:8d76:483b:b79d%5

Puerta de enlace predeterminada . . . . . :
```

Mientras se ejecutaba este comando, se escuchaba el tráfico de red con Wireshark:

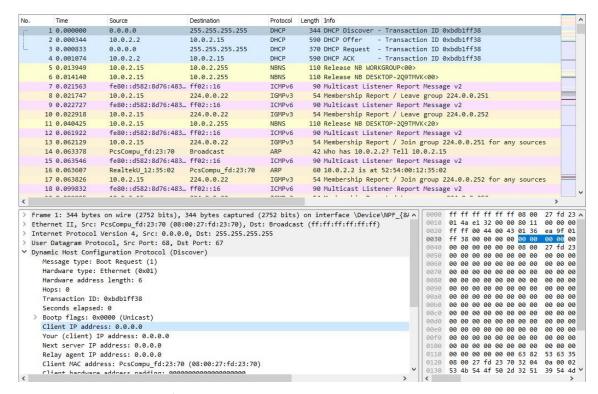
No.	Time	Source	Destination	Protocol	Length Info
	4 0.119587	10.0.2.15	10.0.2.2	DHCP	342 DHCP Release - Transaction ID 0xea96bdf1
	5 0.224130	fe80::d582:8d76:483	ff02::16	ICMPv6	90 Multicast Listener Report Message v2
	6 0.227521	fe80::d582:8d76:483	ff02::16	ICMPv6	90 Multicast Listener Report Message v2
	7 0.299410	fe80::d582:8d76:483	ff02::16	ICMPv6	90 Multicast Listener Report Message v2
	8 0.301201	fe80::d582:8d76:483	ff02::16	ICMPv6	90 Multicast Listener Report Message v2
	9 0.308737	fe80::d582:8d76:483	ff02::16	ICMPv6	90 Multicast Listener Report Message v2
	10 0.309232	fe80::d582:8d76:483	ff02::16	ICMPv6	90 Multicast Listener Report Message v2
	11 0.321444	fe80::d582:8d76:483	ff02::16	ICMPv6	90 Multicast Listener Report Message v2
	12 0.323059	fe80::d582:8d76:483	ff02::16	ICMPv6	90 Multicast Listener Report Message v2
	13 0.324772	fe80::d582:8d76:483	ff02::fb	MDNS	101 Standard query 0x0000 ANY DESKTOP-2Q9TMVK.local, "QM" question
	14 0.325129	fe80::d582:8d76:483	ff02::fb	MDNS	123 Standard query response 0x0000 AAAA fe80::d582:8d76:483b:b79d
	15 0.325914	fe80::d582:8d76:483	ff02::1:3	LLMNR	95 Standard query 0xa3d7 ANY DESKTOP-2Q9TMVK
	16 0.500150	fe80::d582:8d76:483	ff02::16	ICMPv6	130 Multicast Listener Report Message v2
	17 6.511859	fe80::d582:8d76:483	ff02::16	ICMPv6	90 Multicast Listener Report Message v2
	18 6.512132	fe80::d582:8d76:483		ICMPv6	90 Multicast Listener Report Message v2
	19 6.994444		Broadcast	ARP	42 Who has 169.254.159.118? (ARP Probe)
	20 6.994481	fe80::d582:8d76:483		ICMPv6	90 Multicast Listener Report Message v2
	21 7.994985	PcsCompu fd:23:70		ARP	42 Who has 169.254.159.118? (ARP Probe)
	22 8.994987	PcsCompu_fd:23:70		ARP	42 Who has 169.254.159.118? (ARP Probe)
	23 9.990540	PcsCompu_fd:23:70		ARP	42 ARP Announcement for 169.254.159.118
	24 9.999531	fe80::d582:8d76:483		ICMPv6	90 Multicast Listener Report Message v2
	25 9.999751	169.254.159.118	224.0.0.22	IGMPv3	
				ICMPv6	54 Membership Report / Leave group 224.0.0.251  90 Multicast Listener Report Message v2
	26 10.002029	fe80::d582:8d76:483			
	27 10.002267	169.254.159.118	224.0.0.22	IGMPv3	54 Membership Report / Join group 224.0.0.251 for any sources
	27 10.002267 28 10.003002	169.254.159.118 fe80::d582:8d76:483	224.0.0.22 ff02::16	IGMPv3 ICMPv6	54 Membership Report / Join group 224.0.0.251 for any sources 90 Multicast Listener Report Message v2
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> Eth > Int > Use > Dyn	27 10.002267 28 10.003002  ame 4: 342 bytes  mernet II, Src: F  ternet Protocol V  er Datagram Proto  namic Host Config  Message type: Bo  Hardware address  Hops: 0  Transaction ID:  Seconds elapsed:  Bootp flags: 0%  Client IP addres  Your (client) IP  Next server IP a  Relay agent IP a  Client Mc addre  Client hardware	169.254.159.118 fe80::d582:8d76:483 on wire (2736 bits), i cscompu_fd:23:70 (08:6 fersion 4, Src: 10.0.2. col, Src Port: 68, Dst yuration Protocol (Rele ot Request (1) thernet (0x01) length: 6  0xea96bdf1 0 0we (Unicast) s: 10.0.2.15 address: 0.0.0.0 ddress: 0.0.0.0 ddress: 0.0.0.0 ddress: pesCompu_fd:23:70 address padding: 000000 not given	224.0.0.22 ff02::16 342 bytes captured (2 90:27:fd:23:70), Dst: 15, Dst: 10.0.2.2 Port: 67 Pase)	IGMPv3 ICMPv6	54 Membership Report / Join group 224.0.0.251 for any sources 90 Multicast Listener Report Message v2 ) on interface \Device\NPF_{8A9B63B0-48E9-4BB2-BA75-4B92ADDBABB9}, id 0
> Etil > Int > Use > Dyn	27 10.002267 28 10.003002 ame 4: 342 bytes nernet II, Src: P ternet Protocol V er Datagram Proto namic Host Config Message type: B Hardware address Hops: 0 Transaction ID: Seconds elapsed: Bootp flags: 0x0 Client IP addres Your (client) IP Next server IP a Relay agent IP a Client MAC addres Server host name	169.254.159.118 fe80::d582:8d76:483 on wire (2736 bits), if coscompu_fd:23:70 (08:6 cersion 4, Src: 10.0.2. col, Src Port: 68, Dst puration Protocol (Releated to the experiment of the exper	224.0.0.22 ff02::16 342 bytes captured (2 90:27:fd:23:70), Dst: 15, Dst: 10.0.2.2 Port: 67 Pase)	IGMPv3 ICMPv6	54 Membership Report / Join group 224.0.0.251 for any sources 90 Multicast Listener Report Message v2 ) on interface \Device\NPF_{8A9B63B0-48E9-4BB2-BA75-4B92ADDBABB9}, id 0
> Eth > Int > Use > Dyr	27 10.002267 28 10.003002  ame 4: 342 bytes  mennet II, Src: F  ternet Protocol V  er Datagram Proto  namic Host Config  Message type: Bo  Hardware address  Hops: 0  Transaction ID:  Seconds elapsed:  Bootp flags: 0v  Client IP addres  Your (client) IP  Next server IP a  Client MAC addre  Client MAC addre  Client hardware  Server host name  Boot file name n  Magic cookie: DH	169.254.159.118 fe80::d582:8d76:483 on wire (2736 bits), if coscompu_fd:23:70 (08:6 cersion 4, Src: 10.0.2. col, Src Port: 68, Dst puration Protocol (Releated to the experiment of the exper	224.0.0.22 ff02::16 342 bytes captured (2 90:27:fd:23:70), Dst: 15, Dst: 10.0.2.2 Port: 67 Pase)	IGMPv3 ICMPv6	54 Membership Report / Join group 224.0.0.251 for any sources 90 Multicast Listener Report Message v2 ) on interface \Device\NPF_{8A9B63B0-48E9-4BB2-BA75-4B92ADDBABB9}, id 0
> Eth > Ini > Usa > Dyn	27 10.002267 28 10.003002 ame 4: 342 bytes hernet II, Src: F ternet Protocol V er Datagram Protocomamic Host Config Message type: Bo Hardware type: E Hardware address Hops: 0 Transaction ID: Seconds elapsed: Bootp flags: 0% Client IP addres Your (client) IP Next server IP a Relay agent IP a Client MAC addre Client HAC addre Server host name Boot file name n magic cookie: DH Option: (53) DHC	169.254.159.118 fe80::d582:8d76:483 on wire (2736 bits), : cescompu_fd:23:70 (08:6 eresion 4, Src: 10.0.2. ecol, Src Port: 68, Dst uration Protocol (Rele of Request (1) thernet (0x01) length: 6  0xea96bdf1 0 0000 (Unicast) s: 10.0.2.15 address: 0.0.0.0 ddress: 0.0.0.0 ddress: 0.0.0.0 ddress: 0.0.0.0 ddress: padding: 00000 not given CP	224.0.0.22 ff02::16 342 bytes captured (2 00:27:fd:23:70), Dst: 15, Dst: 10.0.2.2 Port: 67 Pase)	IGMPv3 ICMPv6	54 Membership Report / Join group 224.0.0.251 for any sources 90 Multicast Listener Report Message v2 ) on interface \Device\NPF_{8A9B63B0-48E9-4BB2-BA75-4B92ADDBABB9}, id 0

Observamos que se produce un DHCP release, en el que observamos la dirección IP 0.0.0.0.

# 2 - ipconfig /renew

Asignamos al equipo una nueva dirección IP mediante el comando "ipconfig /renew" en la CMD. En este momento se producirá el DHCP handshake que nos proporcionará una nueva configuración TCP/IP automáticamente tal y como se explicó anteriormente.

Mientras se ejecutaba este comando, se escuchaba el tráfico de red con Wireshark:



#### Prestamos especial atención al DHCP handshake:

No.	Time	Source	Destination	Protocol	Length Info
	1 0.000000	0.0.0.0	255.255.255.255	DHCP	344 DHCP Discover - Transaction ID 0xbdb1ff38
	2 0.000344	10.0.2.2	10.0.2.15	DHCP	590 DHCP Offer - Transaction ID 0xbdb1ff38
	3 0.000833	0.0.0.0	255.255.255.255	DHCP	370 DHCP Request - Transaction ID 0xbdb1ff38
	4 0.001074	10.0.2.2	10.0.2.15	DHCP	590 DHCP ACK - Transaction ID 0xbdb1ff38

Observamos los 4 pasos: discover, offer, request y acknowledge.

### 1 - Discover

```
Frame 1: 344 bytes on wire (2752 bits), 344 bytes captured (2752 bits) on interface \Device\NPF_{8A9B63B0-48E9-4B82-BA75-4B92ADDBABB9}, id 0
  Ethernet II, Src: PcsCompu fd:23:70 (08:00:27:fd:23:70), Dst: Broadcast (ff:ff:ff:ff:ff:ff)
Internet Protocol Version 4, Src: 0.0.0.0, Dst: 255.255.255.255
   User Datagram Protocol, Src Port: 68, Dst Port: 67

→ Dynamic Host Configuration Protocol (Discover)

      Message type: Boot Request (1)
      Hardware type: Ethernet (0x01)
      Hardware address length: 6
      Hops: 0
      Transaction ID: 0xbdb1ff38
      Seconds elapsed: 0

∨ Bootp flags: 0x0000 (Unicast)

         0... ... = Broadcast flag: Unicast
.000 0000 0000 0000 = Reserved flags: 0x0000
      Client IP address: 0.0.0.0
      Your (client) IP address: 0.0.0.0 Client IP
Next server IP address: 0.0.0.0
      Relay agent IP address: 0.0.0.0
      Client MAC address: PcsCompu_fd:23:70 (08:00:27:fd:23:70)
Client hardware address padding: 0000000000000000000
      Server host name not given
      Boot file name not given
      Magic cookie: DHCP
      Option: (53) DHCP Message Type (Discover)
      Option: (61) Client identifier
      Option: (50) Requested IP Address (10.0.2.15)
      Option: (12) Host Name
      Option: (60) Vendor class identifier
      Option: (55) Parameter Request List
      Option: (255) End
```

El cliente con IP 0.0.0.0 realiza el broadcast.

### 2 - Offer

```
> Frame 2: 590 bytes on wire (4720 bits), 590 bytes captured (4720 bits) on interface \Device\NPF_{8A986380-48E9-48B2-BA75-4892ADDBA8B9}, id 0
  Ethernet II, Src: RealtekU_12:35:02 (52:54:00:12:35:02), Dst: PcsCompu_fd:23:70 (08:00:27:fd:23:70) Internet Protocol Version 4, Src: 10.0.2.2, Dst: 10.0.2.15
  User Datagram Protocol, Src Port: 67, Dst Port: 68
Dynamic Host Configuration Protocol (Offer)
      Message type: Boot Reply (2)
Hardware type: Ethernet (0x01)
       Hardware address length: 6
       Hops: 0
       Transaction ID: 0xbdb1ff38
   Seconds elapsed: 0

> Bootp flags: 0x0000 (Unicast)
           0... .... = Broadcast flag: Unicast
.000 0000 0000 0000 = Reserved flags: 0x0000
       Client IP address: 0.0.0.0

Your (client) IP address: 10.0.2.15 | P ofrecida por el servidor
      Next server IP address: 10.0.2.4
Relay agent IP address: 0.0.0.0
Client NAC address: PcsCompu_fd:23:70 (08:00:27:fd:23:70)
      Client hardware address padding: 0000
Server host name not given
      Boot file name: Windows 10.pxe
Magic cookie: DHCP
      Option: (53) DHCP Message Type (Offer)
      Option: (1) Subnet Mask (255.255.255.0)
Option: (3) Router
      Option: (6) Domain Name Server
Option: (51) IP Address Lease Time
      Option: (54) DHCP Server Identifier (10.0.2.2)
      Option: (255) End
```

El servidor ofrece la IP "10.0.2.15".

### 3 - Request

```
> Frame 3: 370 bytes on wire (2960 bits), 370 bytes captured (2960 bits) on interface \Device\NPF_{8A9B63B0-48E9-48B2-BA75-4B92ADDBABB9}, id 0 > Ethernet II, Src: PcsCompu_fd:23:70 (08:00:27:fd:23:70), Dst: Broadcast (ff:ff:ff:ff:ff)
   Internet Protocol Version 4, Src: 0.0.0.0, Dst: 255.255.255.255
User Datagram Protocol, Src Port: 68, Dst Port: 67

→ Dynamic Host Configuration Protocol (Request)

       Message type: Boot Request (1)
       Hardware type: Ethernet (0x01)
       Hardware address length: 6
       Hops: 0
       Transaction ID: 0xbdb1ff38
       Seconds elapsed: 0

▼ Bootp flags: 0x0000 (Unicast)

          0... ... = Broadcast flag: Unicast
.000 0000 0000 0000 = Reserved flags: 0x0000
       Client IP address: 0.0.0.0
       Your (client) IP address: 0.0.0.0
       Next server IP address: 0.0.0.0
Relay agent IP address: 0.0.0.0
       Client MAC address: PcsCompu_fd:23:70 (08:00:27:fd:23:70)
Client hardware address padding: 00000000000000000000
       Server host name not given
Boot file name not given
       Magic cookie: DHCP
      Option: (53) DHCP Message Type (Request)
Option: (61) Client identifier
       Option: (50) Requested IP Address (10.0.2.15)
                                                                        Confirmación de IP
       Option: (54) DHCP Server Identifier (10.0.2.2)
       Option: (12) Host Name
       Option: (81) Client Fully Qualified Domain Name
       Option: (60) Vendor class identifier
       Option: (55) Parameter Request List
       Option: (255) End
```

El cliente confirma la IP ofrecida por el servidor "10.0.2.15".

# 4 - Acknowledge

Bibliografía: (438) Protocolo DHCP - ¿Qué es? y ¿Como funciona? - Curso Fundamentos de Networking para Redes IP - YouTube