

DHCPv6

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Comparación entre IPv4 e IPv6

Characteristic	DHCPv4	DHCPv6
Address type used for server discovery/solicitation	Broadcast	Multicast
Default gateway	Obtained from server	Provided by RA
DHCP transaction acronym	“DORA” (Discovery, Offer, Request, Acknowledgement)	“SARR” (Solicit, Advertise, Request, Reply)
Host Identifier	MAC address	DUID
Source Address/Port	0.0.0.0, 68 (UDP)	link-local, 546 (UDP)
Destination Address/Port	255.255.255.255, 67 (UDP)	ff02::1:2, 547 (UDP)

DHCP Unique Identifier (DUID)

- Used by DHCPv6 instead of the MAC address to identify clients and servers
 - One, unique DUID per client
 - One, unique DUID per server
- Variable in length
- Set at boot time (persistent across reboots)

```
00-01-00-01-1E-30-93-DE-00-90-F5-D6-57-F5
```

Identity Association (IA)

- Used by DHCPv6 server to identify, group, and manage sets of related, assigned IPv6 addresses.
 - Client interfaces have multiple IPv6 addresses
 - One IA is assigned per interface
- Since IPv6 addresses can be temporary or non-temporary, separate IAs are created for each category
 - **IA_NA** for non-temporary addresses
 - **IA_TA** for temporary
 - **IA_PD** for prefix delegation

Stateful vs Stateless DHCPv6

Characteristic	Stateful DHCPv6	Stateless DHCPv6
IPv6 Address	via DHCPv6 server	via SLAAC
Additional DHCP options (DNS servers, domain-search list, etc)	via DHCPv6 server	via DHCPv6 server
Default gateway	Provided by RA	Provided by RA

Donde utilizamos DHCPv6:

- LANs corporativas.
- Cuando se requiera control administrativo.
- En todos los lados donde hoy tengamos DHCPv4.
- Donde se necesite Delegación de Prefijo.
- Stateless DHCPv6 puede ser utilizado donde el cliente no soporte Stateful IPv6

Router Advertisement (RA)

- ICMPv6 Type 134
- Enviado por el Router del segmento:
 - **Períodicamente:** Cada un período determinado (ej: 30 seg) el Router envía un paquete ICMPv6 con destino de Multicast (FF01::1) avisando a todos los neighbors que él es el Router junto información adicional.
 - **Respuesta a Router Solicitation (RS):** Puede ser en respuesta a un RS de un neighbor que quiere saber quién es el router del segmento. La respuesta va con destino unicast a la IP de Link-Local del que originó el RS.

Flags en RAs

M bit	O bit	A bit	Prefix	Host Address	Other Config/Options
0	0	0	Static		Manual
0	0	1	RA Message	Autonomous	Manual
0	1	0	Static		DHCPv6
0	1	1	RA Message	Autonomous	DHCPv6
1	0	0	DHCPv6 (Stateful)		DHCPv6
1	0	1	DHCPv6 (Stateful) and/or autonomous		DHCPv6
1	1	0	DHCPv6 (Stateful)		DHCPv6
1	1	1	DHCPv6 (Stateful) and/or autonomous		DHCPv6

Ejemplo de Router Advertisement (RA)

Se configura para enviar RA que solo permita tomar IPv6 por DHCPv6.

```
interface Ethernet0/1
  description CONNECTED TO OPENWRT
  no ip address
  ipv6 address 2001:DB8:4400::1/64
  ipv6 nd dad attempts 0
  ipv6 nd prefix default no-advertise
  ipv6 nd managed-config-flag
  ipv6 nd other-config-flag
  ipv6 nd ra interval 5
  no ipv6 redirects
  no ipv6 unreachable
  ipv6 dhcp relay destination FC00:0:100::2
  no cdp enable
end
```

Ejemplo de Router Advertisement (RA)

```
> Frame 267331: 86 bytes on wire (688 bits), 86 bytes captured (688 bits) on interface 0
> Ethernet II, Src: CiscoInc_32:73:05 (40:55:39:32:73:05), Dst: IPv6mcast_01 (33:33:00:00:00:01)
> Internet Protocol Version 6, Src: fe80::4255:39ff:fe32:7305, Dst: ff02::1
▼ Internet Control Message Protocol v6
  Type: Router Advertisement (134)
  Code: 0
  Checksum: 0x4e60 [correct]
  Cur hop limit: 64
  ▼ Flags: 0xc0
    1... .... = Managed address configuration: Set
    .1.. .... = Other configuration: Set
    ..0. .... = Home Agent: Not set
    ...0 0... = Prf (Default Router Preference): Medium (0)
    .... .0.. = Proxy: Not set
    .... ..0. = Reserved: 0
  Router lifetime (s): 1800
  Reachable time (ms): 0
  Retrans timer (ms): 0
  > ICMPv6 Option (Source link-layer address : 40:55:39:32:73:05)
  > ICMPv6 Option (MTU : 1500)
```

Ejemplo de Router Advertisement (RA)

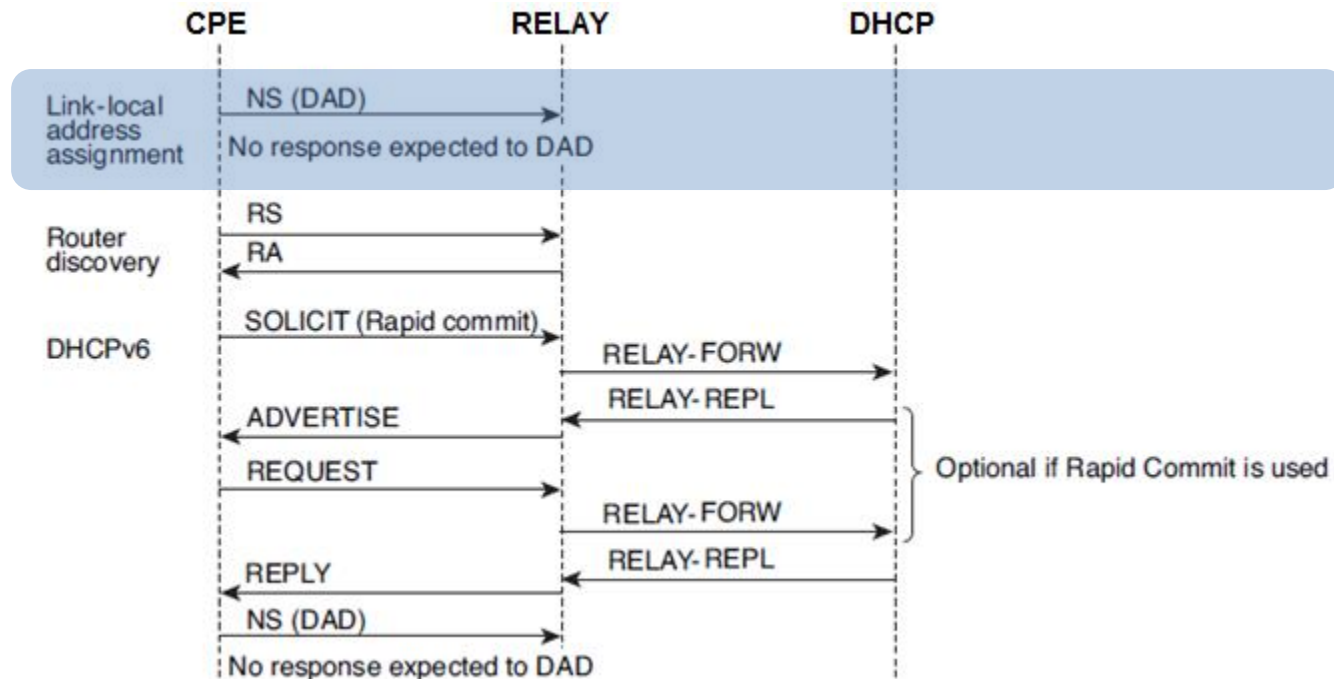
Se configura para enviar RA que permita tomar IPv6 por DHCPv6 y por SLAAC.

```
interface Ethernet0/1
description CONNECTED TO OPENWRT
no ip address
ipv6 address 2001:DB8:4400::1/64
ipv6 nd dad attempts 0
ipv6 nd managed-config-flag
ipv6 nd other-config-flag
ipv6 nd ra interval 5
no ipv6 redirects
no ipv6 unreachable
ipv6 dhcp relay destination FC00:0:100::2
no cdp enable
end
```

Ejemplo de Router Advertisement (RA)

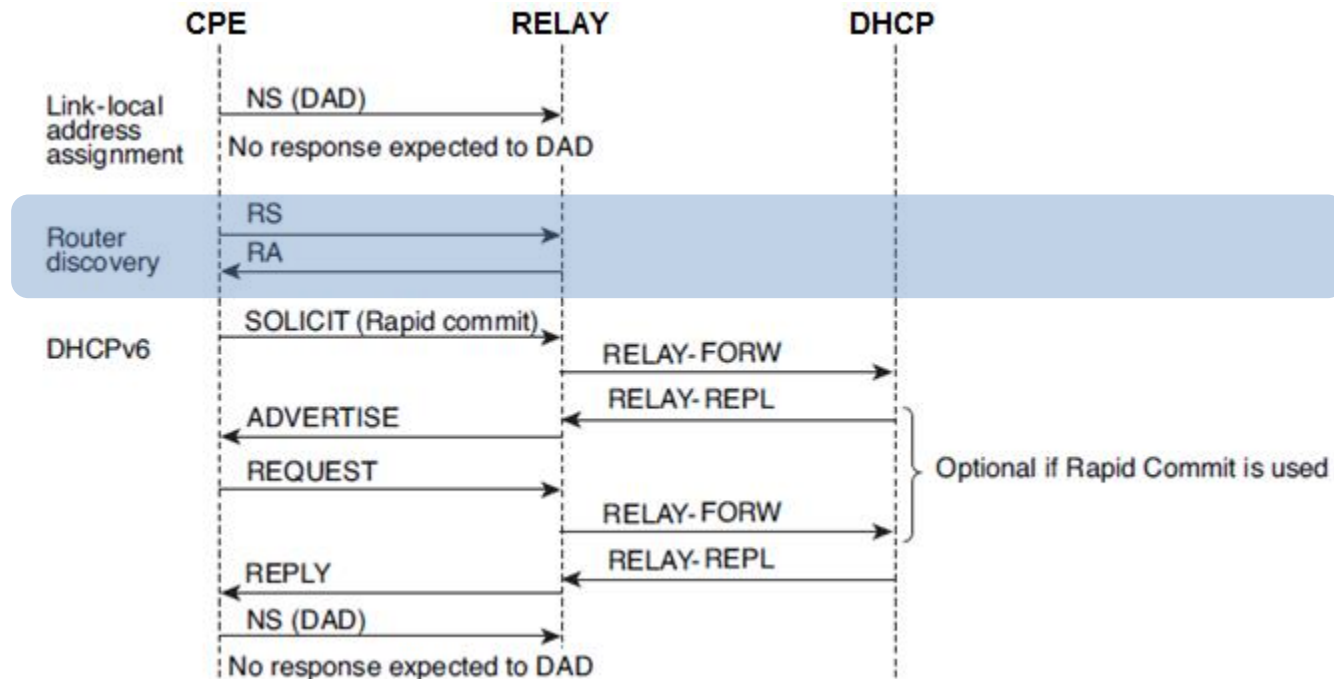
```
> Frame 6: 118 bytes on wire (944 bits), 118 bytes captured (944 bits) on interface 0
> Ethernet II, Src: aa:bb:cc:00:06:10 (aa:bb:cc:00:06:10), Dst: IPv6mcast_01 (33:33:00:00:00:01)
> Internet Protocol Version 6, Src: fe80::a8bb:ccff:fe00:610, Dst: ff02::1
v Internet Control Message Protocol v6
  Type: Router Advertisement (134)
  Code: 0
  Checksum: 0xb492 [correct]
  Cur hop limit: 64
  v Flags: 0xc0
    1... .... = Managed address configuration: Set
    .1.. .... = Other configuration: Set
    ..0. .... = Home Agent: Not set
    ...0 0... = Prf (Default Router Preference): Medium (0)
    .... .0.. = Proxy: Not set
    .... ..0. = Reserved: 0
  Router lifetime (s): 1800
  Reachable time (ms): 0
  Retrans timer (ms): 0
  > ICMPv6 Option (Source link-layer address : aa:bb:cc:00:06:10)
  > ICMPv6 Option (MTU : 1500)
  v ICMPv6 Option (Prefix information : 2001:db8:4400::/64)
    Type: Prefix information (3)
    Length: 4 (32 bytes)
    Prefix Length: 64
    v Flag: 0xc0
      1... .... = On-link flag(L): Set
      .1.. .... = Autonomous address-configuration flag(A): Set
      ..0. .... = Router address flag(R): Not set
      ...0 0000 = Reserved: 0
    Valid Lifetime: 2592000
    Preferred Lifetime: 604800
    Reserved
    Prefix: 2001:db8:4400::
```

Asignación por DHCPv6



Dirección de Link-Local: El CPE envía un mensaje de Neighbor Solicitation(NS) con su dirección de link local (LLA), el cual inicia el proceso de detección de dirección duplicada (DAD) para esa LLA. El CPE no se queda esperando respuesta.

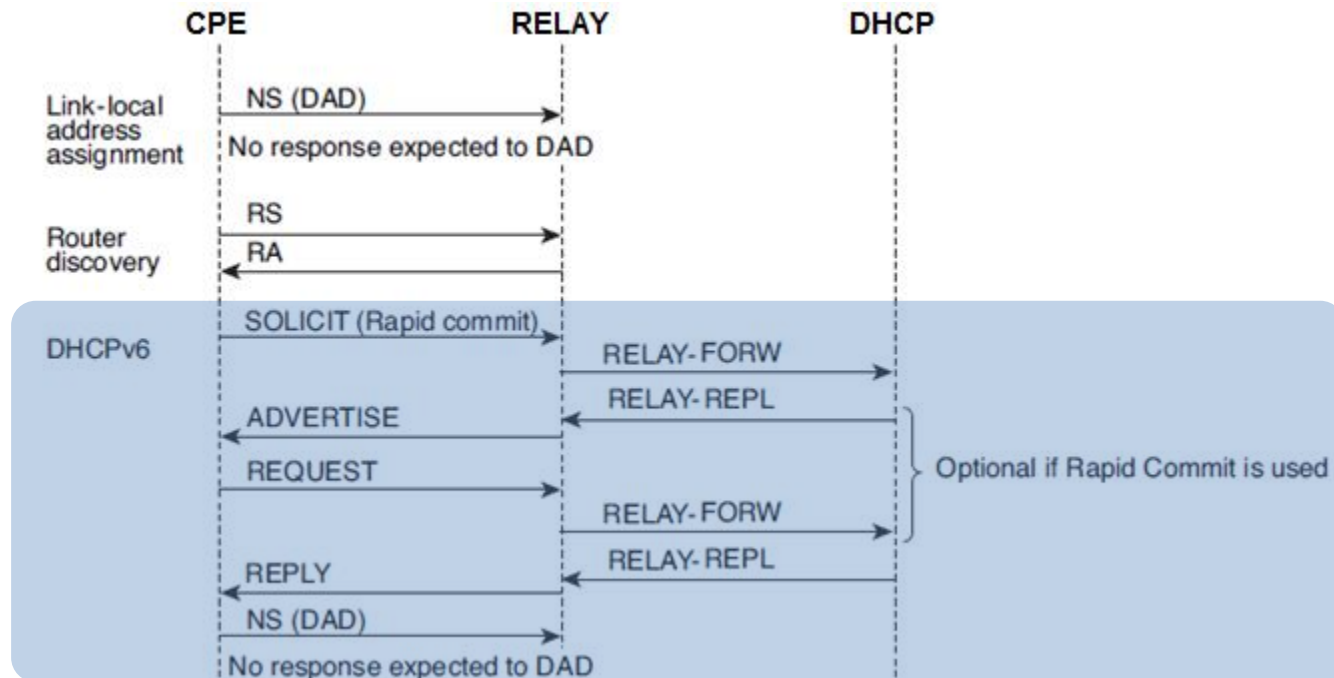
Asignación por DHCPv6



- Router Discovery:

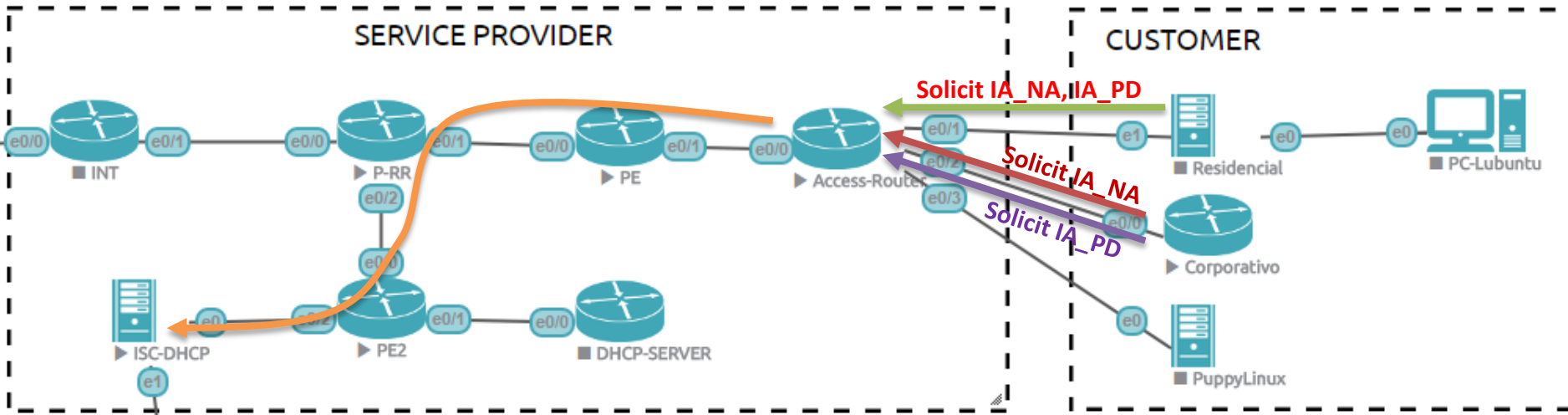
- Envío de Router Solicitation (RS) para buscar al router en el link.
- El Relay (Access-Router) responde con un mensaje de Router Advertisement (RA) con los Bits M y O en 1 indicando que el método de asignación es DHCPv6.
 - Flag M (Managed): Con esto le decimos al CPE que sólo tome IPv6 por DHCPv6 (no puede utilizar SLAAC).
 - Flag O (Other Configuration): Utilizar DHCPv6 también para otros parámetros como DNS, NTP, etc.

Asignación por DHCPv6



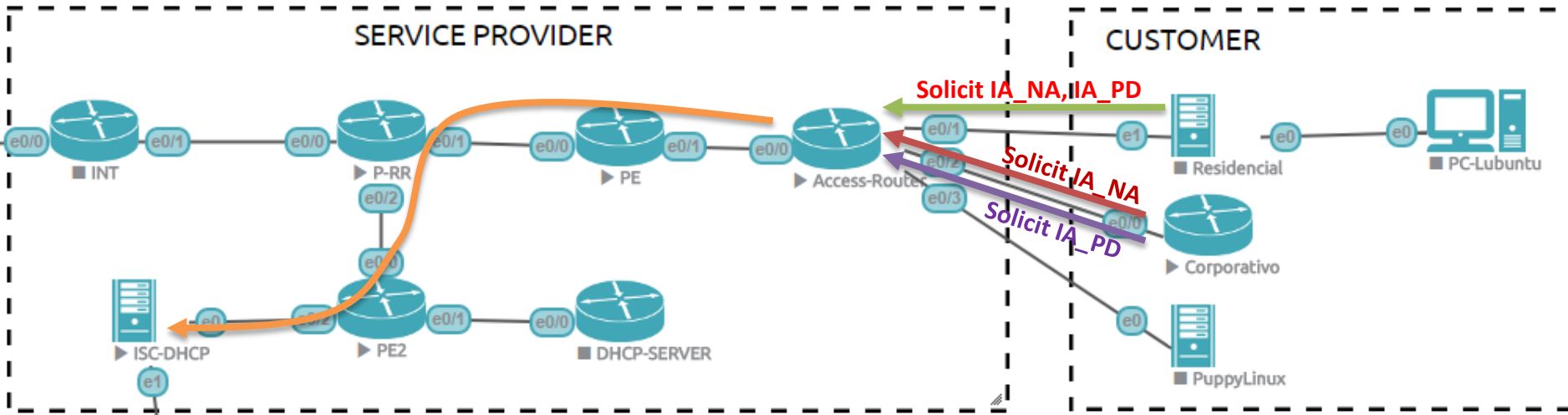
- DHCPv6: El CPE envía un mensaje DHCPv6 Solicit al Relay. El Relay reenvía esta solicitud al servidor DHCPv6. Este último responde con un Advertise indicando su disponibilidad. Si no se utiliza Rapid-Commit, el CPE responde con un Request, luego el DHCP Server responde con la confirmación.
- Después inicia el proceso de DAD para verificar que no haya IP duplicada.

DHCPv6 - Solicit



- Todo Router que tome IP por DHCPv6, debe pedir:
 - IPv6 No Temporal (IA_NA) para WAN.
 - IPv6 Prefix Delegation (IA_PD) para LAN.
- Router Hogareño / Residencial:
 - Solicita IA_NA e IA_PD en único Solicit.
- Router Corporativo:
 - Solicita IA_NA en un mensaje.
 - En otro mensaje, solicita IA_PD.
- Access-Router: Ruta Estática de cada IA_PD hacia WAN de cada CPE.

DHCPv6 - Solicit



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- Router Hogareño / Residencial:
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DHCPv6 – Solicit Residencial

- ▼ DHCPv6
 - Message type: Solicit (1)
 - Transaction ID: 0x294b08
 - > Elapsed time
 - ▼ Option Request
 - Option: Option Request (6)
 - Length: 26
 - Value: 0015001600170018001f00380040004300520053005e005f...
 - Requested Option code: SIP Server Domain Name List (21)
 - Requested Option code: SIP Servers IPv6 Address List (22)
 - Requested Option code: DNS recursive name server (23)
 - Requested Option code: Domain Search List (24)
 - Requested Option code: Simple Network Time Protocol Server (31)
 - Requested Option code: NTP Server (56)
 - Requested Option code: Dual-Stack Lite AFTR Name (64)
 - Requested Option code: Prefix Exclude (67)
 - Requested Option code: SOL_MAX_RT (82)
 - Requested Option code: INF_MAX_RT (83)
 - Requested Option code: Unknown (94)
 - Requested Option code: Unknown (95)
 - Requested Option code: Unknown (96)
 - > Client Identifier
 - > Reconfigure Accept
 - > Fully Qualified Domain Name
 - Requested Option code: Identity Association for Non-temporary Address
 - Requested Option code: Identity Association for Prefix Delegation

DHCPv6 – Solicit Corporativo

▼ DHCPv6
Message type: Solicit (1)
Transaction ID: 0xcc1326
> Elapsed time
> Client Identifier
> Option Request
> Identity Association for Non-temporary Address

▼ DHCPv6
Message type: Solicit (1)
Transaction ID: 0xcc1333
> Elapsed time
> Client Identifier
> Option Request
> Identity Association for Prefix Delegation

Ejemplo de Configuración DHCPv6 Server (ISC-DHCP)

```
subnet6 fc00:0:100::/64 {  
}  
subnet6 2001:db8:4400::/64 {  
    # Range for clients  
    # range6 2001:db8:4000::2 2001:db8:4000::ffff;  
    range6 2001:db8:4400::/64;  
  
    # Additional options  
    option dhcp6.name-servers 2001:4860:4860::8888;  
    option dhcp6.domain-search "lacnic.net";  
  
    # Prefix range for delegation to sub-routers  
    prefix6 2001:db8:4800:: 2001:db8:4bff:ffff:: /64;  
}
```

Captura DHCPv6

Time	Source	Destination	Protocol	Length	Info
52.336231	fe80::5200:ff:fe0a:1	ff02::1:2	DHCPv6	166	Solicit XID: 0xa75f93 C
52.400238	fe80::a8bb:ccff:fe00:610	fe80::5200:ff:fe0a:1	DHCPv6	227	Advertise XID: 0xa75f93
53.125690	fe80::5200:ff:fe0a:1	ff02::1:2	DHCPv6	241	Request XID: 0xa72de8 C
53.128131	fe80::a8bb:ccff:fe00:610	fe80::5200:ff:fe0a:1	DHCPv6	227	Reply XID: 0xa72de8 IAA

Información de Prefijos en Access-Router

```
ACCESS-ROUTER#sh ipv6 dhcp relay binding
```

```
Relay Bindings associated with default vrf:
```

```
Prefix: 2001:DB8:4BFF:FFFF::/64 (Ethernet0/1)  
  DUID: 000300015000000A0001  
  IAID: 1  
  lifetime: 600  
  expiration: 16:30:20 UTC May 20 2017  
Prefix: 2001:DB8:4FFF::/48 (Ethernet0/2)  
  DUID: 00030001AABBCC000700  
  IAID: 196609  
  lifetime: 600  
  expiration: 16:28:36 UTC May 20 2017
```

```
Summary:
```

```
Total number of Relay bindings = 2  
Total number of IAPD bindings = 2  
Total number of IANA bindings = 0
```

```
ACCESS-ROUTER#sh ipv6 route static
```

```
IPv6 Routing Table - default - 13 entries
```

```
Codes: C - Connected, L - Local, S - Static, U - Per-user Static route
```

```
  B - BGP, HA - Home Agent, MR - Mobile Router, R - RIP
```

```
  H - NHRP, I1 - ISIS L1, I2 - ISIS L2, IA - ISIS interarea
```

```
  IS - ISIS summary, D - EIGRP, EX - EIGRP external, NM - NEMO
```

```
  ND - ND Default, NDP - ND Prefix, DCE - Destination, NDR - Redirect
```

```
  O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2
```

```
  ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2, ls - LISP site
```

```
  ld - LISP dyn-EID, a - Application
```

```
S 2001:DB8:4BFF:FFFF::/64 [1/0]  
  via FE80::5200:FF:FE0A:1, Ethernet0/1
```

```
S 2001:DB8:4FFF::/48 [1/0]  
  via FE80::A8BB:CCFF:FE00:700, Ethernet0/2
```

Muchas gracias