

FiberCli

IPv6

MUM Valencia 2018

José Manuel Román

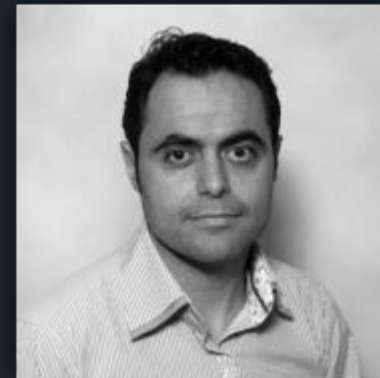
Carlos Cárdenas

MikroTik

Jose Manuel Román

Experiencia

- C.E.O @ Fibercli.com & Cloud Networking Spain
 - 6+ Years Security Consultant and Analyst
 - 7+ Years Teaching Computer Networking
 - 17+ Years on IT Industry
- Master ITIL
 - CISA & CISSP Cert.
 - Mikrotik MTC-ALL-E & Trainer (TR)



Carlos Cárdenas Cebrián

Educación

- Técnico superior en Electrónica Industrial.
- Grado en Ingeniería Informática de Sistemas en la Universidad de Cádiz (Sin completar).
- Entusiasta del networking. Autodidacta
- Certificaciones técnicas en varios fabricantes.
- Certificaciones Mikrotik:

Experiencia

- 5 años como instalador de equipos wireless, sistemas de seguridad y reparando equipos de RF.
- 8 años como técnico de banco de pruebas en el campo de la Aeronáutica, especialidad en radiocomunicaciones y sistemas de ayuda a la navegación.
- 4 años como administrador de red en WISPs.
- Actualmente trabajando en AUNNA IT como administrador de red.



INNOVACIÓN TECNOLÓGICA EN
COMUNICACIONES Y REDES

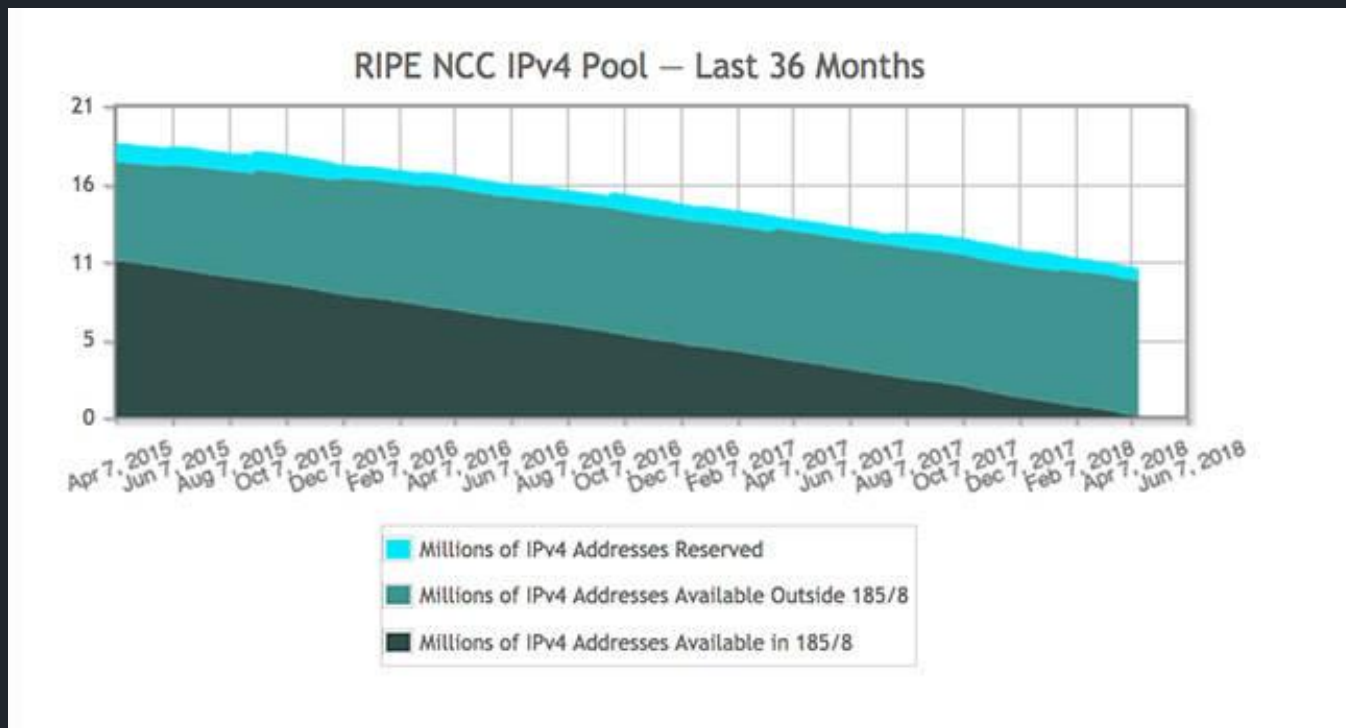
IPv6

¿Por qué necesitamos IPV6?



IPv4 está prácticamente agotado

- El espacio total de direcciones IPv4 es de 2^{32} = 4,3 billones
- Alrededor de 3,739 billones de usuarios de Internet actualmente
- Dispositivos móviles constantemente conectados a Internet
- Internet de las cosas: ¿Cómo será Internet dentro de unos años?



IPv4 es un recurso cada vez más caro

- El coste del direccionamiento necesario aumenta constantemente.
- RIPE pronto agotará las pocas IPv4 que le quedan y habrá que acudir al mercado
- Problemas de IPs de “segunda mano”:
 - Blacklists
 - GeoIP
 - CDNs
 - Precio €€€

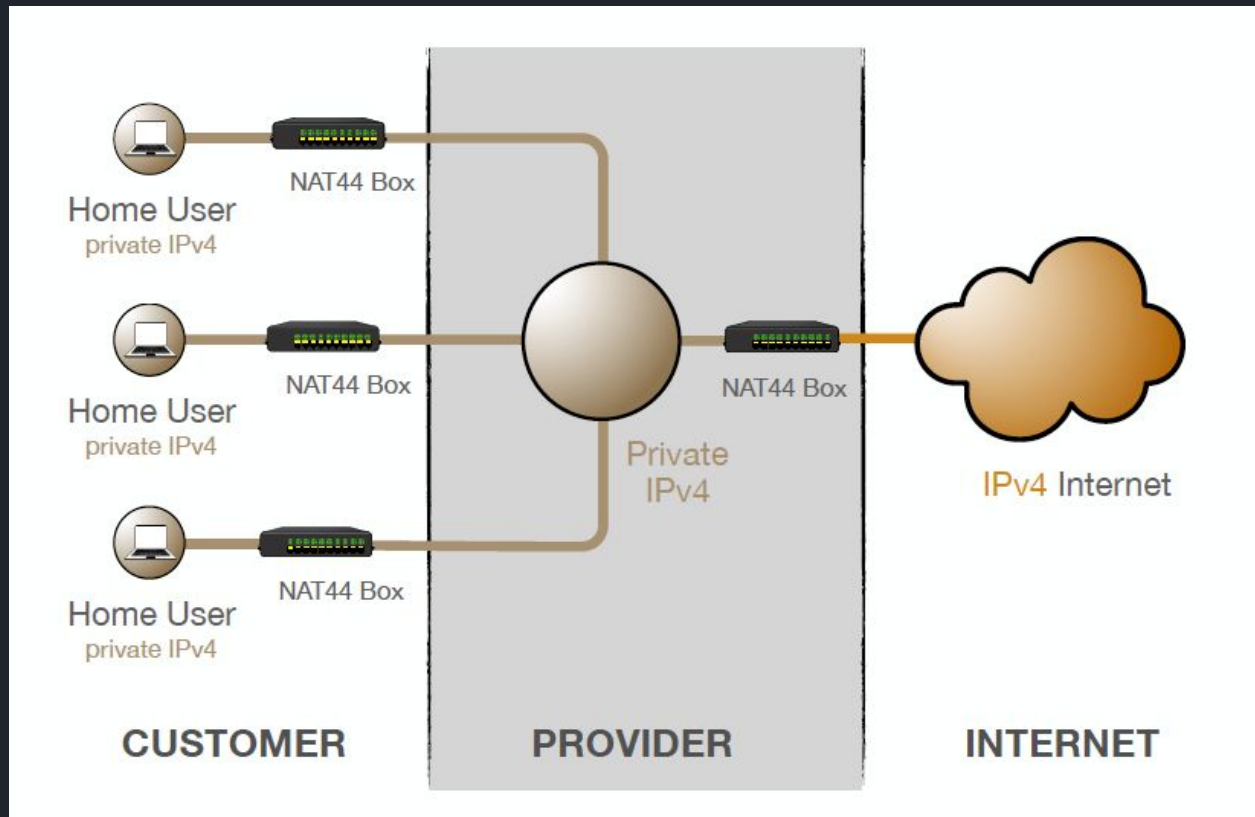
RIPE /24 BLOCK	RIPE /21 BLOCK
	
AUCTION	AUCTION
/24 Block Registered in RIPE	/21 Block Registered in RIPE
Current bid: \$4,608	Current bid: \$35,840
Avg. Cost Per Unit: \$18.00	Avg. Cost Per Unit: \$17.50
Bids: 1	Bids: 0
Closes in 2d 2h	Closes in 2d 3h

Fuente: <https://www.ipv4auctions.com/ripe-blocks>

¿Cómo podemos paliar el problema?

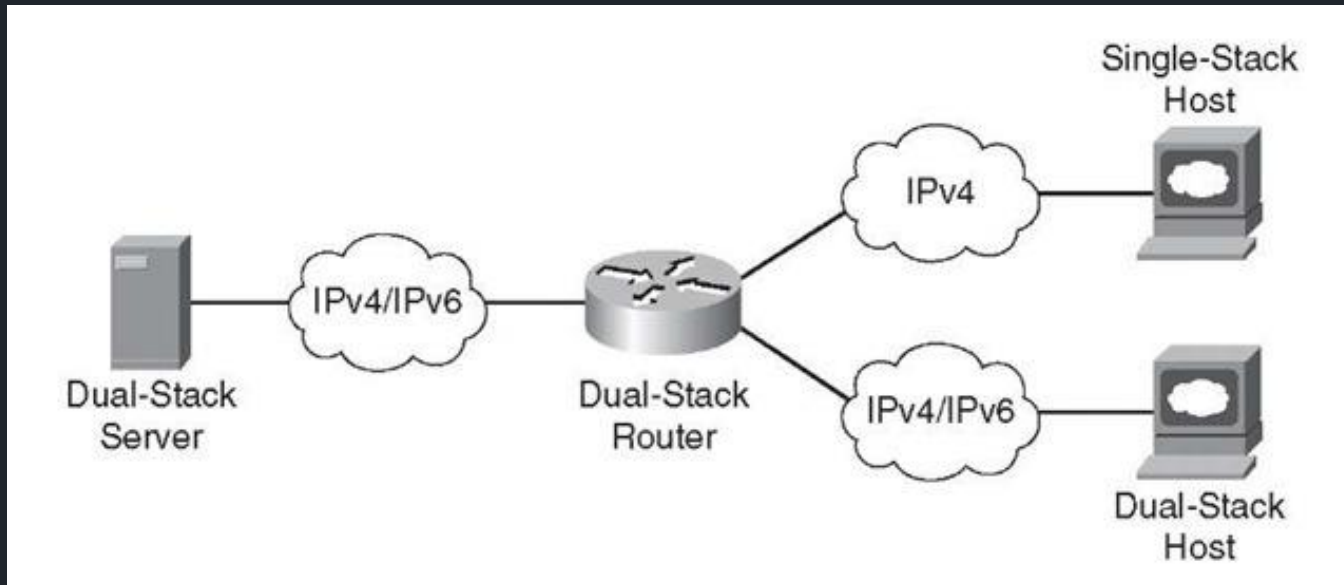
- NAT 444 (Medio Plazo)
 - Rompe modelo de conexión end to end.
 - No permite comunicación con IPv6.
 - Necesidad de identificar al usuario final ante requerimientos judiciales (logs):
 - Se recomienda usar CGNAT determinístico
 - <https://www.abogacia.es/2016/03/14/nat-autoria-en-ciberdelitos/>
- DUAL STACK: NAT444 + IPv6 (Largo Plazo)
 - El mejor mecanismo de transición.
 - Permite acceso a IPv4 e IPv6.
 - Coexistencia entre protocolos.
 - Transparente al usuario final.
 - Solventa algunos problemas del NAT444
 - Identifica a los usuarios ante la ley
 - Google, Youtube, Facebook, Netflix, etc. ya están accesibles por IPv6

CGNAT: Carrier Grade NAT



Recurso: [Maia, Wardner: "From IPv4 scarcity to IPv6 Abundance" MUM EU18](#)

DUAL STACK



- Transparente para el usuario final.
- Autoconfiguración de direcciones IPv6.
- El navegador usará IPv6 automáticamente si está disponible, en caso contrario, IPv4.



IPv6

¿Cómo conseguimos direcciones IPv6?



Conseguir un rango de direcciones IPv6

- Para poder solicitar un rango, la organización deberá:
 - Estar dado de alta en RIPE como LIR.
 - Tener un plan de asignación en un plazo de dos años.
- El rango de direcciones mínimo asignado es un /32:
 - Asignan hasta un /29 sin necesidad de justificación.
 - En función del número de clientes y extensión de la red, es posible solicitar más.

Conseguir un rango de direcciones IPv6

RIPE NCC
RIPE NETWORK COORDINATION CENTRE

RIPE Database (Whois) Website

Search IP Address or ASN

Your IP address is: 2a0b:5081:17:0

Login

Manage IPs and ASNs > Analyse > Participate > Get Support > Publications > About Us >

IPv4, IPv6 and ASNs
LIR Portal
RIPE Database
Resource Transfers and Mergers

RIPE NCC Statistics
RIPEstat
RIPE Atlas
Raw Datasets

RIPE NCC Membership
RIPE Community
Policy Development
Internet Governance

Contact Us
Training and Education
Documentation
Spam, Hacking and Phishing

RIPE Documents
RIPE Labs
IPv6 Info Centre
RIPE NCC Activity Plan

What We Do
Careers
Executive Board
Corporate Governance

News and Announcements

[RIPE NCC IPv4 Address Space Chart - Now Updated](#)
Publication date: 27 Sep 2018

[NRO NC Election Candidates Announced](#)
Publication date: 24 Sep 2018

Service Status Archived

✓ All of our services are operating normally.

Meetings Recent

RIPE 77
15 Oct 2018 - 19 Oct 2018 Amsterdam, The Netherlands

RIPE NCC General Meeting, Amsterdam, 17-19 October 2018
17 Oct 2018 - 19 Oct 2018 Amsterdam, the Netherlands

[SEE 8 / RIPE NCC Regional Meeting](#)
16 Apr 2019 - 17 Apr 2019 Sarajevo, Bosnia and Herzegovina

RIPE 78
20 May 2019 - 24 May 2019 Reykjavik, Iceland

Member Information

[Become a Member](#)

[List of Our Services](#)

[Billing Procedure and Fee Schedule](#)

Have you got a spam/hacking issue?

We want to help you find the responsible party. Please read our [abuse page](#) to find out who's responsible.

New on RIPE Labs

[Measuring Anycast DNS Services Using RIPE Atlas](#)
Publication date: 01 Oct 2018

GM - Register Your Vote Today!

RIPE NCC General Meeting - ...

Register Now!

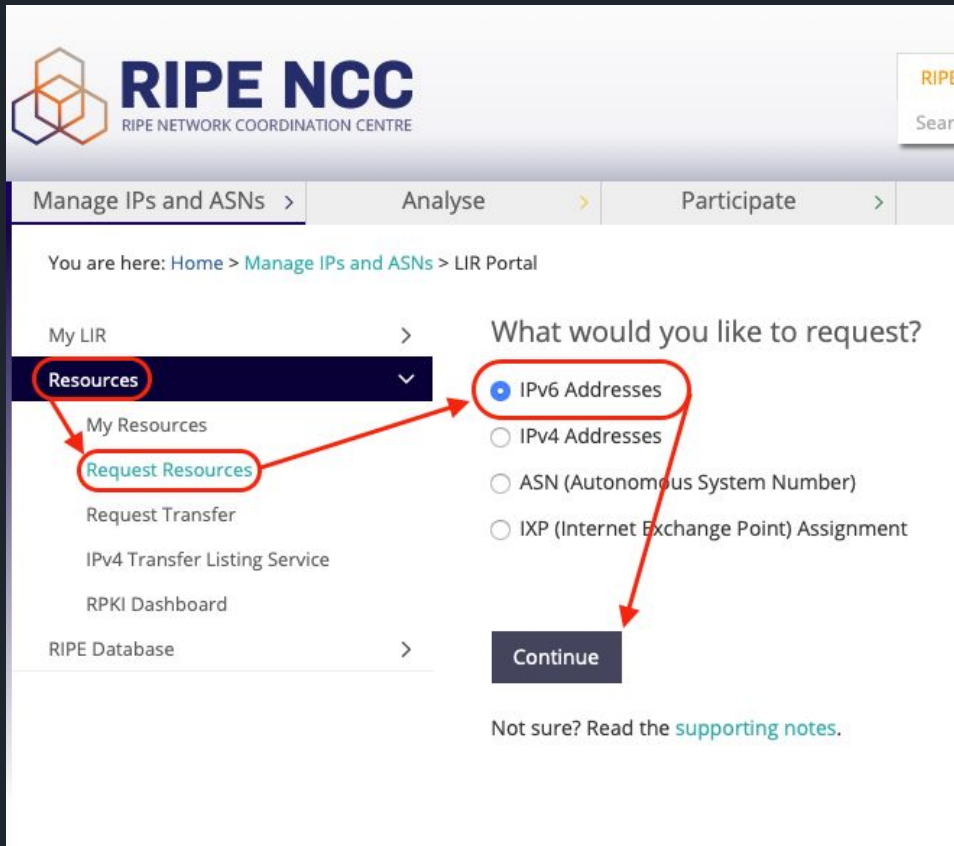
NRO News

[Preview: New NRO Website](#)

Conseguir un rango de direcciones IPv6

The screenshot displays the RIPE NCC website interface. At the top left is the RIPE NCC logo (RIPE NETWORK COORDINATION CENTRE). On the top right, the user name 'Carlos Cardenas Cebrian' is shown next to a profile icon. Below the logo is a search bar for the RIPE Database (Whois) with the text 'Search IP Address or ASN' and a search icon. A dark bar below the search bar displays 'Your IP address is: 2a0b:5081:17:'. A main navigation bar contains six categories: 'Manage IPs and ASNs', 'Analyse', 'Participate', 'Get Support', 'Publications', and 'About Us'. Each category has a corresponding image and a list of sub-links. The 'Manage IPs and ASNs' sub-link 'LIR Portal' is circled in red. Below the navigation bar are several content sections: 'News and Announcements' with links to 'RIPE NCC IPv4 Address Space Chart - Now Updated' and 'NRO NC Election Candidates Announced'; 'Meetings' with a 'Recent' tab and links to 'RIPE 77', 'RIPE NCC General Meeting, Amsterdam, 17-19 October 2018', 'SEE 8 / RIPE NCC Regional Meeting', and 'RIPE 78'; 'Member Information' with links to 'Become a Member', 'List of Our Services', and 'Billing Procedure and Fee Schedule'; 'GM - Register Your Vote Today!' featuring a video player for 'RIPE NCC General Meeting - ...' and a 'Register Now!' button; and 'NRO News' with a 'Preview: New NRO Website' link. A 'Service Status' section shows 'All of our services are operating normally.' with a green checkmark.

Conseguir un rango de direcciones IPv6



The screenshot shows the RIPE NCC LIR Portal interface. At the top, there is a navigation bar with 'Manage IPs and ASNs', 'Analyse', and 'Participate'. Below this, the breadcrumb trail reads 'You are here: Home > Manage IPs and ASNs > LIR Portal'. On the left, a 'My LIR' menu is expanded to show 'Resources', with 'Request Resources' highlighted. In the main content area, the question 'What would you like to request?' is displayed, with 'IPv6 Addresses' selected. A 'Continue' button is visible at the bottom of the selection area. A red arrow points from 'Request Resources' to 'IPv6 Addresses', and another red arrow points from 'IPv6 Addresses' to the 'Continue' button.



The screenshot shows a form titled 'What kind of IPv6 address space do you want to request?'. The 'IPv6 Allocation' option is selected and circled in red. Other options include 'IPv6 Provider Independent (PI) Assignment', 'Temporary IPv6 Provider Independent (PI) Assignment', 'IPv6 End User Site Assignment', and 'IPv6 Anycast Assignment'. A 'Continue' button is located at the bottom right of the form. A red arrow points from the selected 'IPv6 Allocation' option to the 'Continue' button.

Conseguir un rango de direcciones IPv6

What IPv6 subnet size would you like?

/29

Specify the country in which the allocation will be announced

SPAIN

Person with administrative responsibility (admin-c)

-RIPE

Person with technical responsibility (tech-c)

CCC57-RIPE

Carlos Cardenas Cebrian

Do you already have an IPv6 range?

Enter IPv6 range

Maintainers, persons and roles are RIPE Database objects, [click here to create them.](#)

- I confirm that I am going to make assignments and/or sub-allocations from the allocation, in accordance with [the IPv6 Allocation and Assignment policy](#)
- I confirm that the network that will be using these Internet number resources has an active element in the RIPE NCC service region.

< Continue

IPv6

El protocolo IPv6



IPv6 Básico

- Direcciones IPv6: 2^{128} (128 bits)
 - IPv4: 2^{32} (32 bits)
- Cada subred debe de ser como mínimo un /64
- Asignación a clientes finales:
 - /64 (1 subred)
 - /48 (65536 subredes)
- Asignación mínima al LIR /32
 - 65536 /48s
 - 16777216 /56
- No hace uso de broadcast: Multicast e ICMPv6

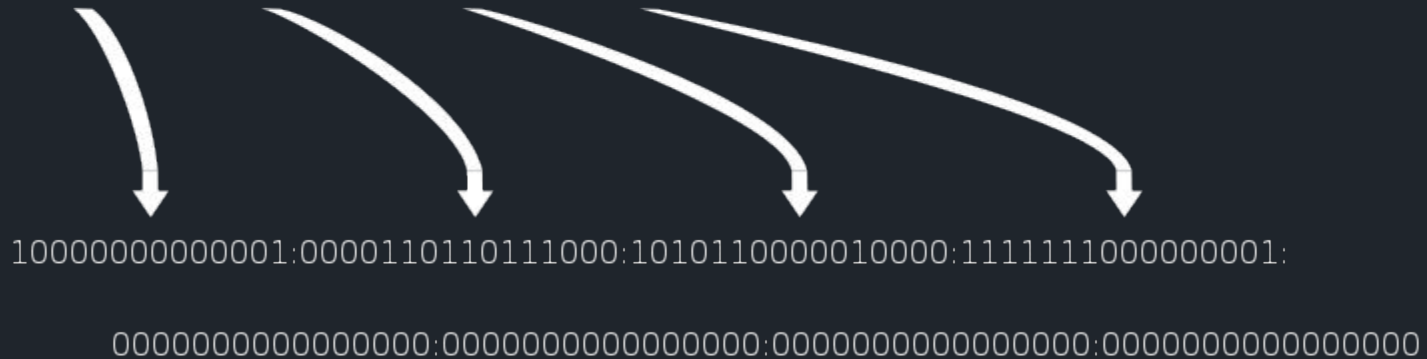
Dirección IPv6

Una dirección IPv6 (en hexadecimal)

2001:0DB8:AC10:FE01:0000:0000:0000:0000

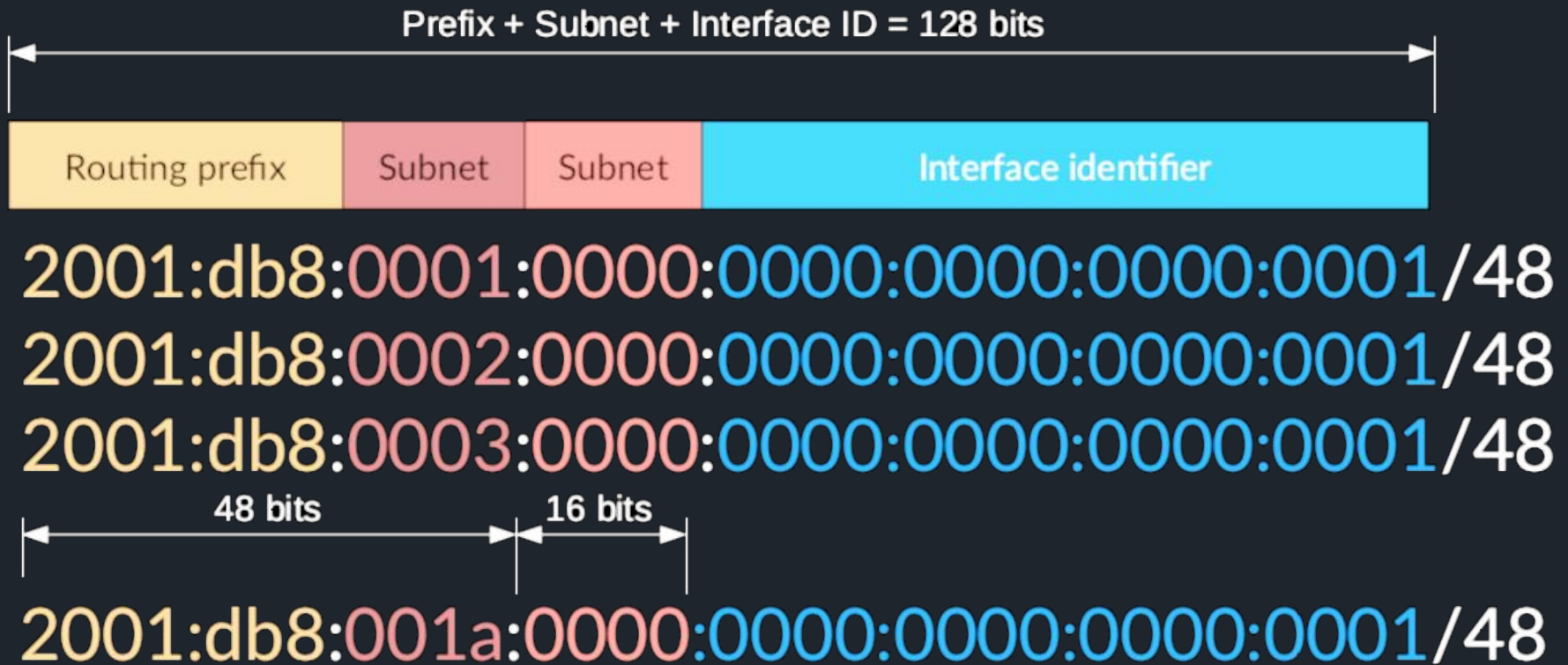


2001:0DB8:AC10:FE01:: Se pueden omitir los ceros



- 8 campos de 16 bit cada uno
- Usa notación hexadecimal (4 dígitos por campo)
- Cada grupo de 4 dígitos se separa por “:”

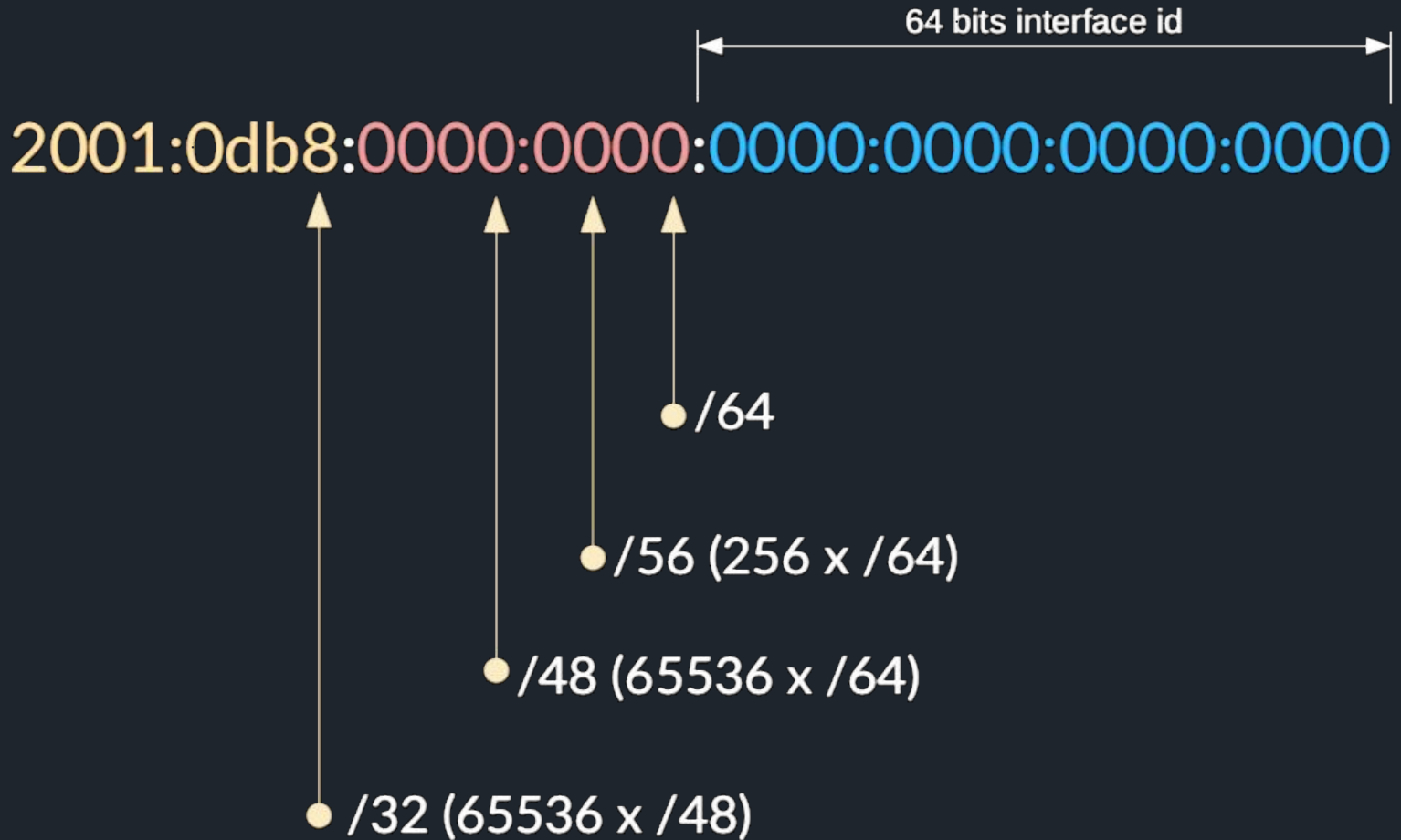
Subredes en IPv6 (/48 tomadas desde el /32 asignado por RIPE)



- 8 campos de 16 bit cada uno
- Usa notación hexadecimal (4 dígitos por campo)
- Cada grupo de 4 dígitos se separa por “:”

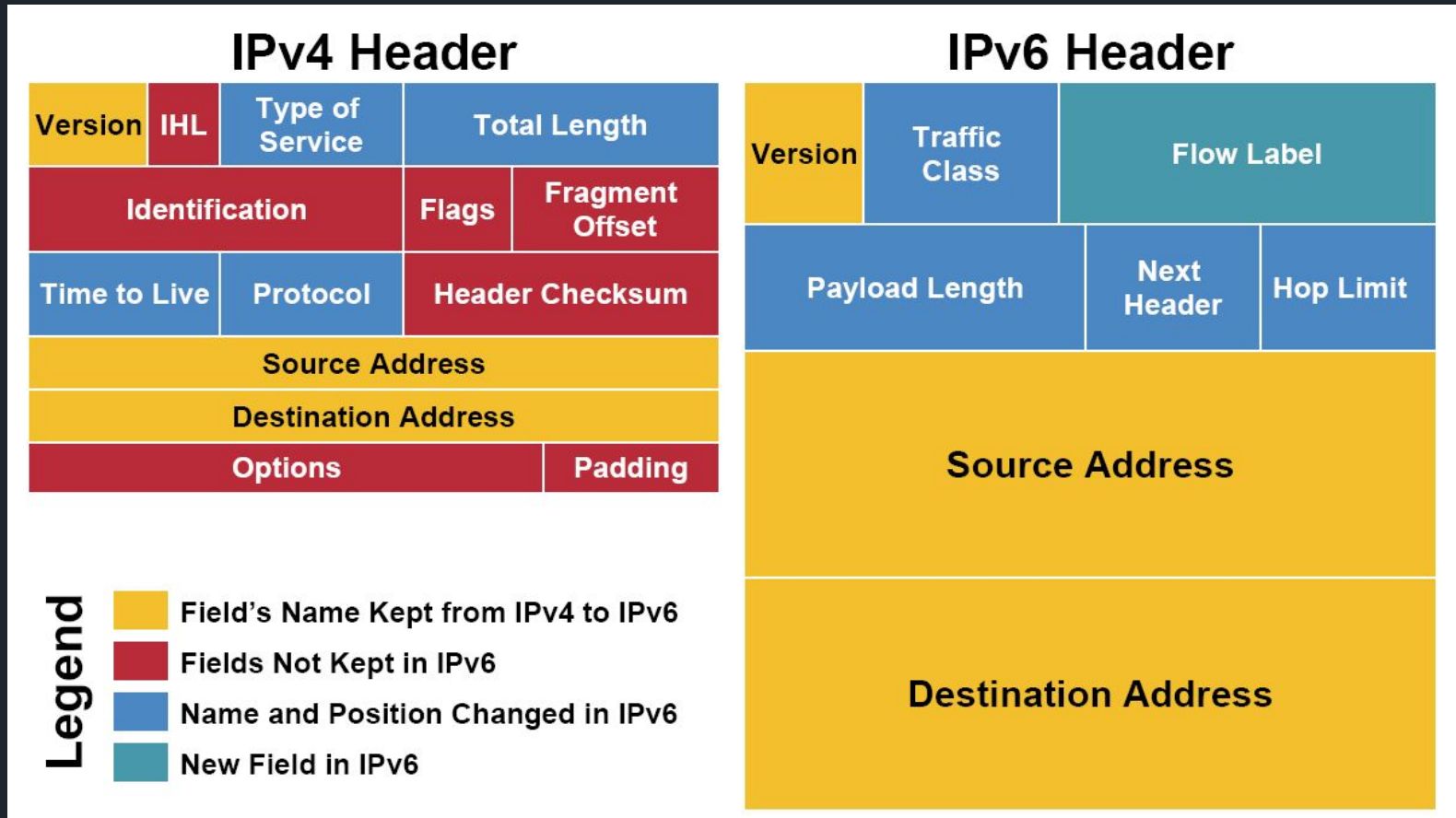
Mas info: [RFC5952](https://www.rfc-editor.org/rfc/rfc5952)

Subredes en IPv6



Mas info: [RFC5952](https://www.rfc-editor.org/rfc/rfc5952)

Cabecera IPv6



Tipos de direcciones IPv6

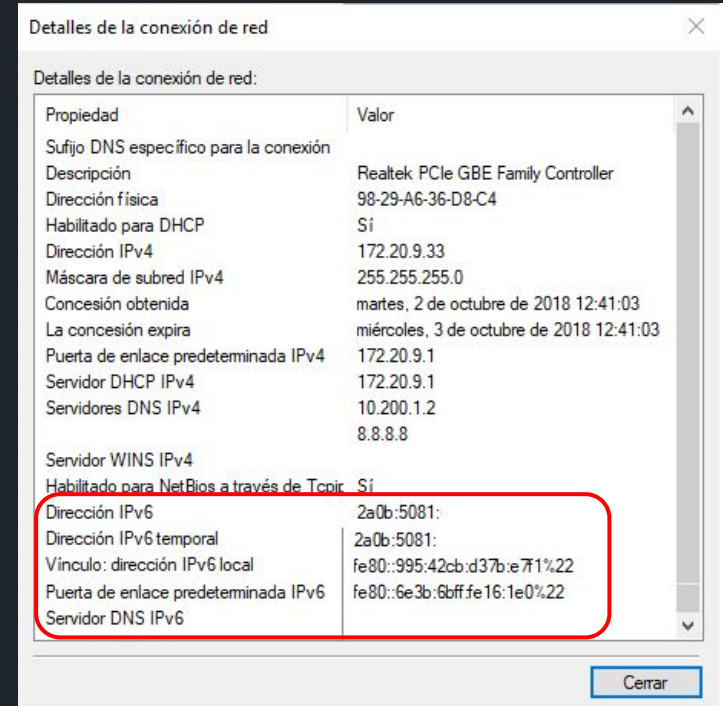
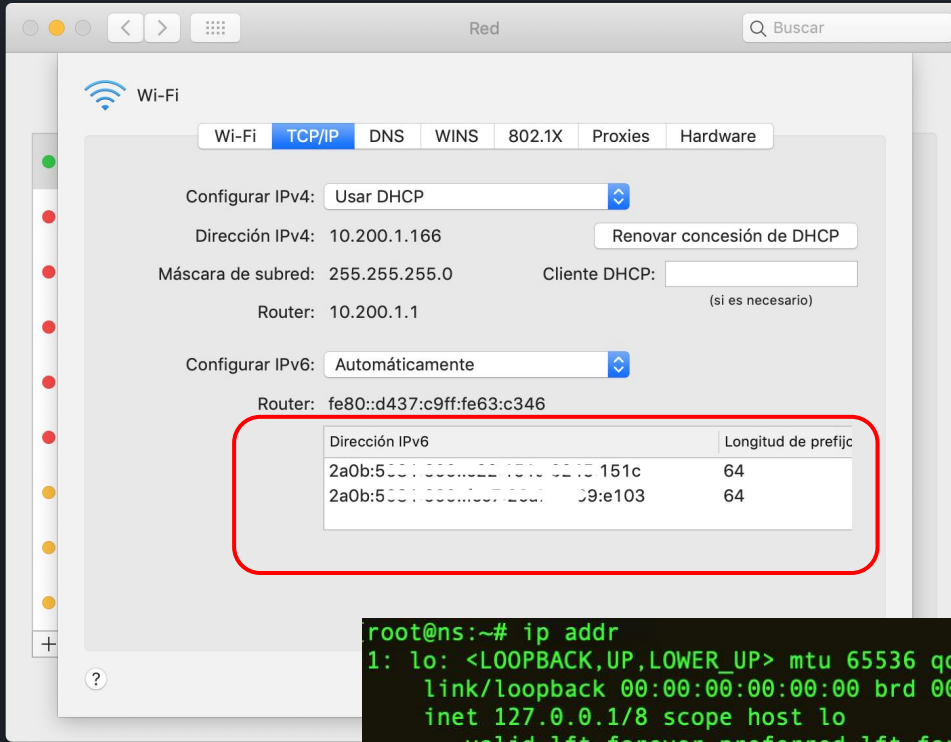
Tipos de direcciones

Type	Range
Link local	fe80::/10
Global Unicast	2000::/3
Multicast	ff00::/8
Unique local	fc00::/7

Direcciones especiales

Type	Range
Loopback	::1/128
Documentation	2001:db8::/32
6to4	2002::/16
Unspecified address	::/128
Teredo	2001::/32
Anycast	Any unicast (enable "no DAD")

IPv6 es compatible



```

root@ns:~# ip addr
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default
   link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
   inet 127.0.0.1/8 scope host lo
       valid_lft forever preferred_lft forever
   inet6 ::1/128 scope host
       valid_lft forever preferred_lft forever
2: eth0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc mq state UP group default qlen 1000
   link/ether ..... brd ff:ff:ff:ff:ff:ff
   inet ..... brd ..... scope global eth0
       valid_lft forever preferred_lft forever
   inet6 2a0b:...../48 scope global
       valid_lft forever preferred_lft forever
   inet6 fe80::20c:29ff:...../64 scope link
       valid_lft forever preferred_lft forever

```

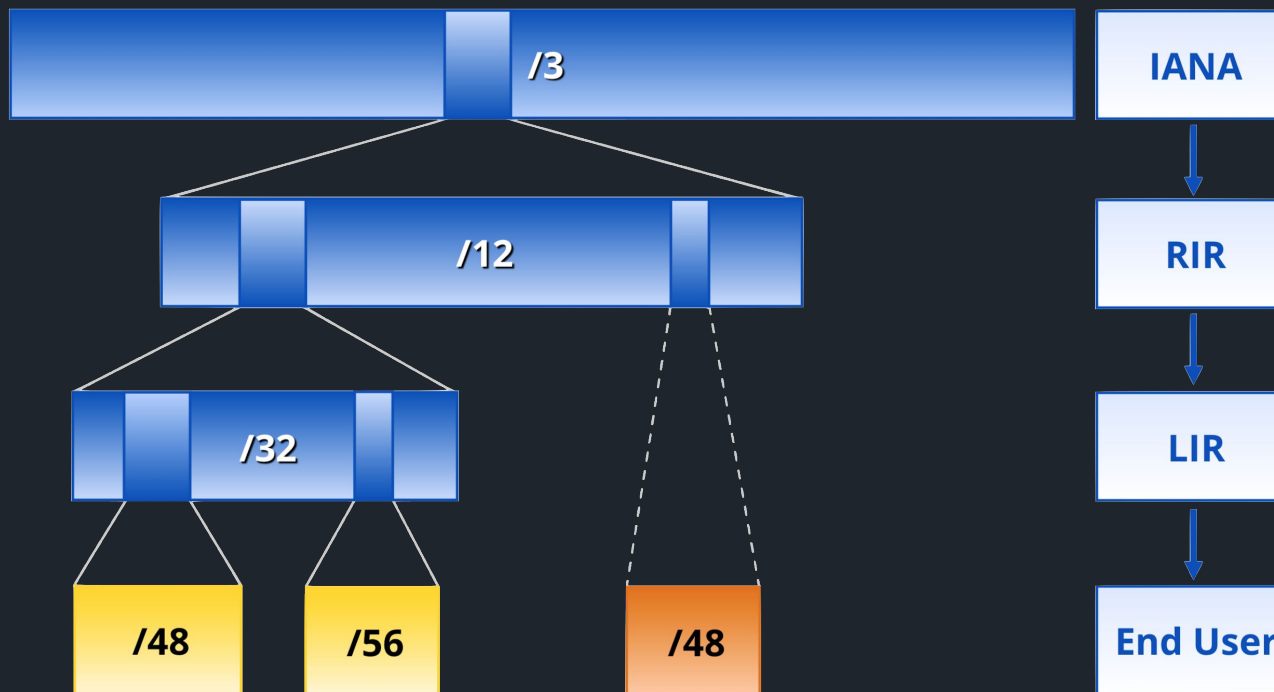
IPv6

Plan de
direccionamiento



Plan de direccionamiento IPv6

- No es necesario preocuparse por agotar el espacio de direcciones IPv6.
- Agregación de rutas es siempre recomendable (Tabla de rutas más óptima).
- Importante: ¡Las Link Local address no aparecen en un traceroute!



BCOP RIPE-690

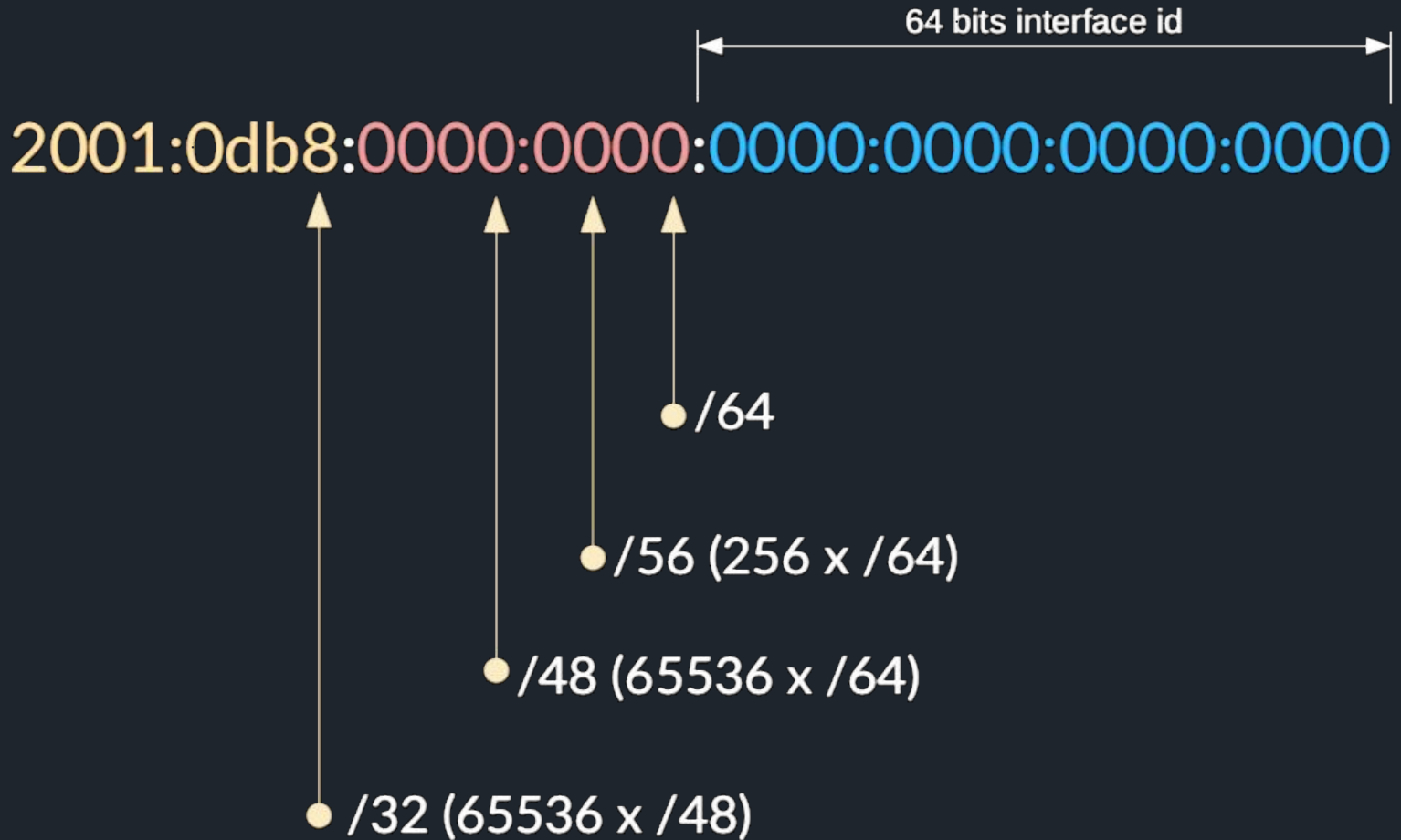
- Recomendaciones sobre tamaños de asignación y tiempo de persistencia:
 - Reservar para cada enlace PtP un /64 pero direccionar como /127.
 - Asignar al menos un /48 o un /56 por cliente.
 - Tiempo de concesión largo (mejor estático): Trazabilidad del cliente.
 - Numerar las interfaces WAN del CPE con GUAs (Global Unicast Address).

Mas Info: [RIPE BCOP-690](#)

Dimensionamiento de las subredes

- Asignar prefijo con tamaño necesario para el número de clientes a servir.
- Procurar que se pueda hacer agregación de rutas. Tabla rutas óptima.
- Reservar uno o dos prefijos contiguos para posibles necesidades.
- Usar un /64 para direccionar los Loopbacks.
- Reservar otro /64 para servicios (DNS, WWW, etc.).

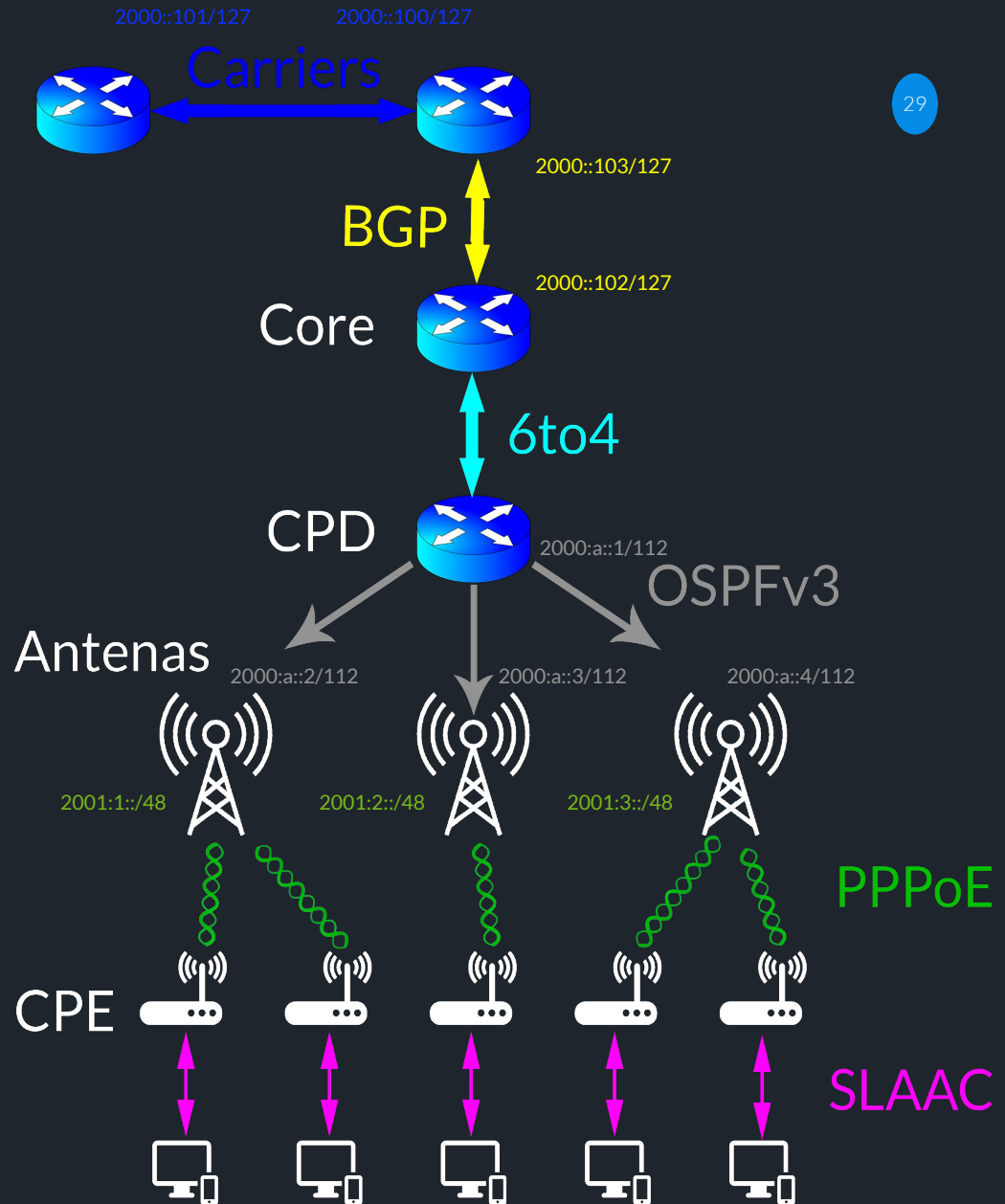
Subredes en IPv6



Mas info: [RFC5952](https://www.rfc-editor.org/rfc/rfc5952)

Escenario

- Anunciamos el prefijo asignado por RIPE 2001::/16 desde el router Core
- Numeramos todos los interfaces con GUAs para que funcione traceroute y ping
- Asignamos subred a cada Antena, según número de clientes y tamaño del prefijo a delegar a cada uno.
- En nuestro escenario asignamos un /48 a cada antena y delegamos un /60 a cada cliente final (16 subnets /64)



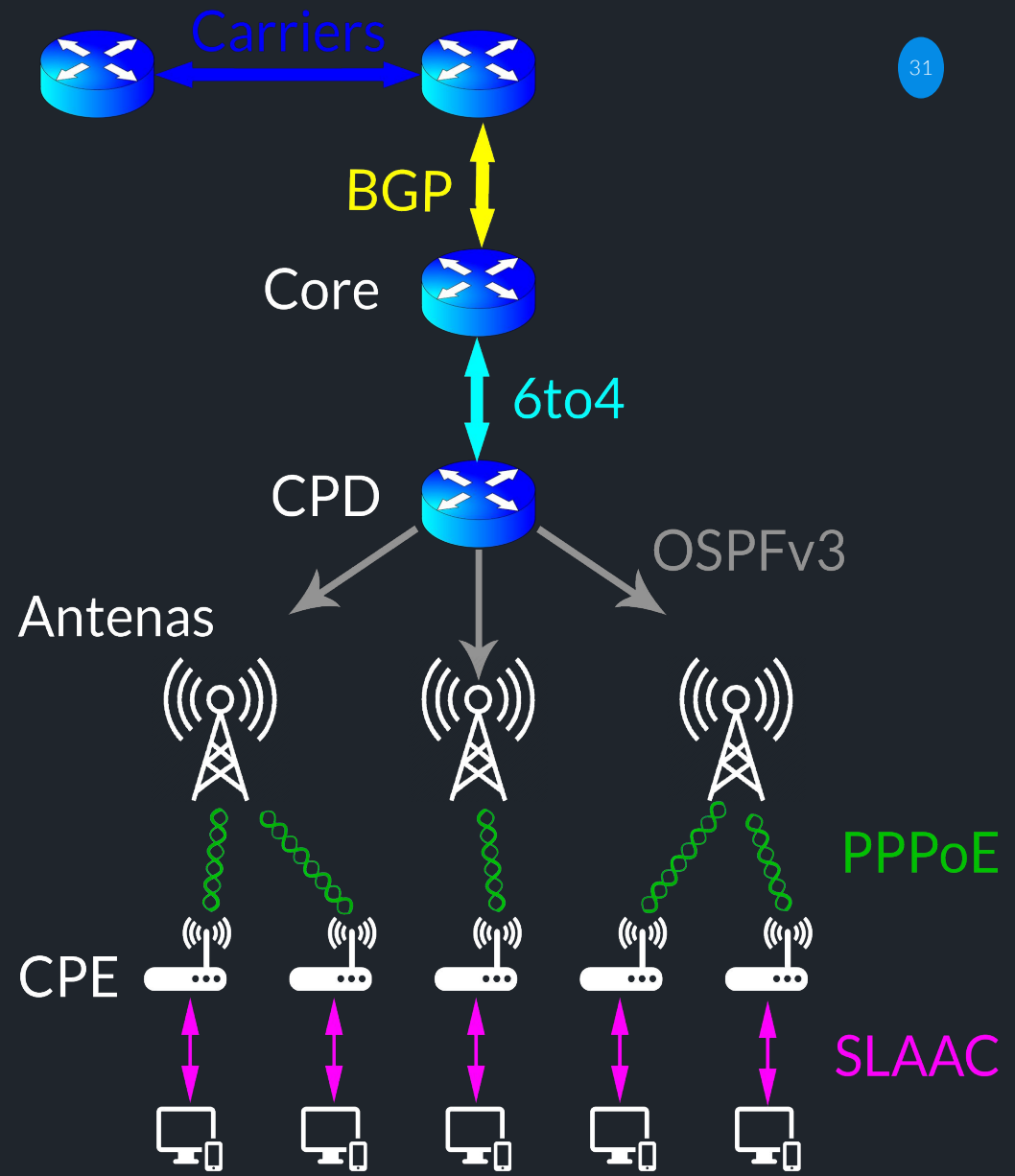
Direccionamiento

Prefijo	Uso	Localización
2000::100/127	Infraestructura	IX BGP Carrier
2000::103/127	Infraestructura	IX BGP Core
2000:a::/112	Infraestructura	OSPFv3 CPD-Antenas
2001:1::/48	Clientes	Antena 1
2001:2::/48	Clientes	Antena 2
2001:3::/48	Clientes	Antena 3
2001:100::/48	Infraestructura	Direccionamiento Interno

- Reservamos a partir del 2001:0::/48 para ampliaciones clientes

Escenario

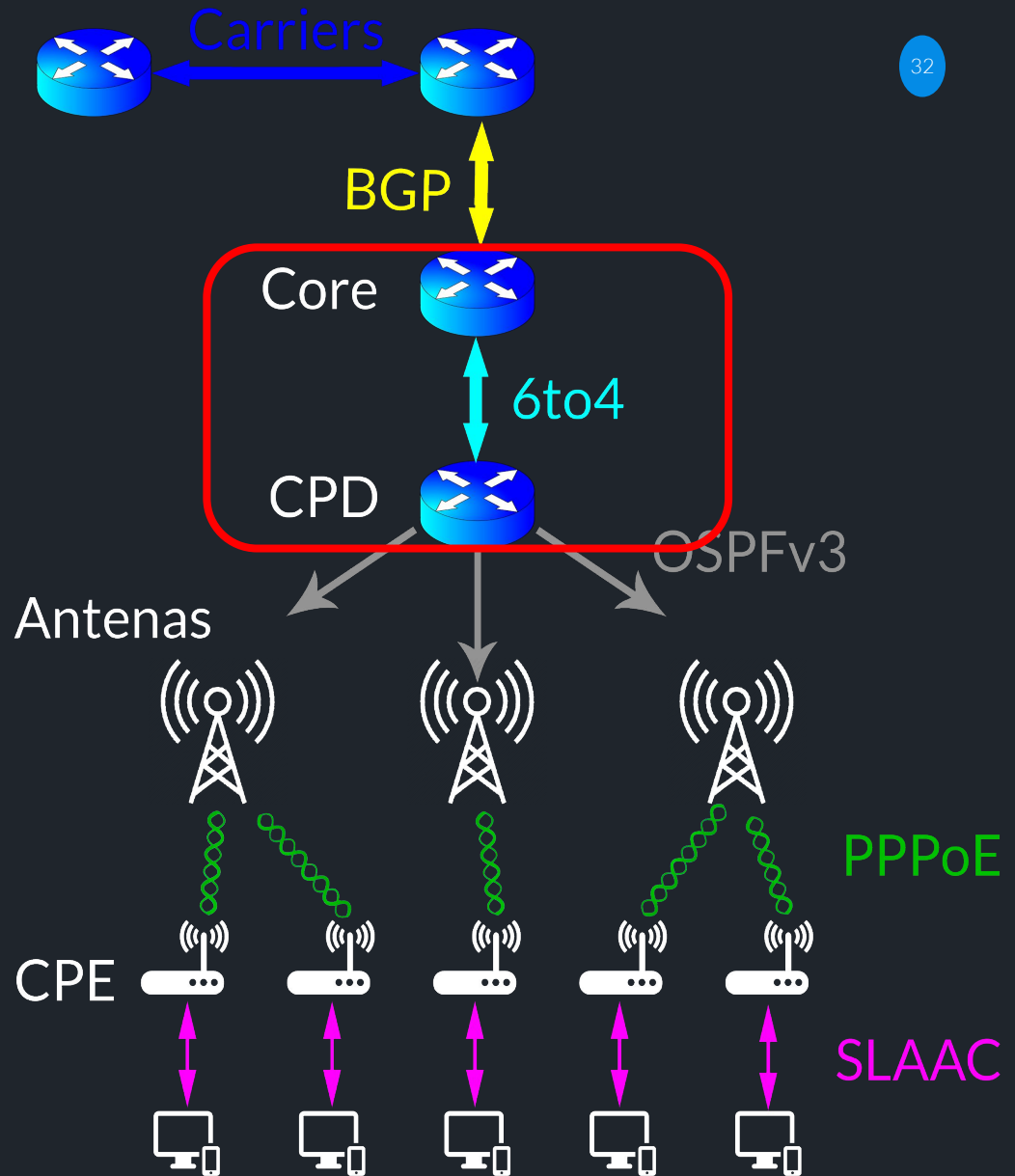
- Peer BGP IPv6 entre Carrier y Core
- Tunel 6to4 entre el core y los CPD's
- OSPFv3 con las antenas
- PPPoE para las conexiones de los clientes
- Y asignación mediante SLAAC en la LAN



Escenario

ATENCIÓN!!

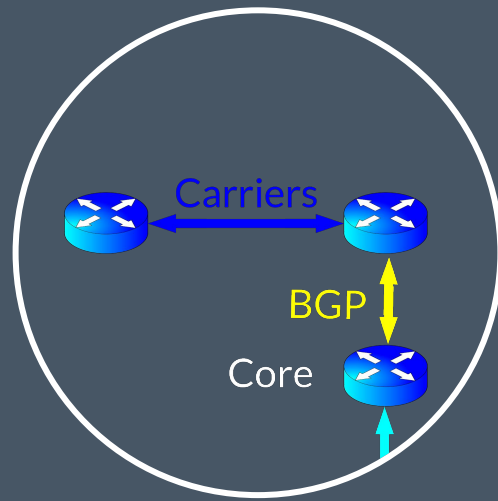
El tunel 6to4 estaría en una red IPv4 pero para simplificar el laboratorio se ha conectado directamente



BGP IPv6

Aplicaremos una configuración BGP entre dos cores con IPv6





BGP Carrier



En este lab configuraremos unos BGP carrier para ver cómo se propagan los prefijos IPv6 y poder llegar a los equipos finales de cliente desde éste, a través de nuestra infraestructura.

BGP 1

The screenshot shows the IPv6 Address List window with 5 items. The selected item is 2000::103/127. Below it are two configuration windows for this address, one for interface ether3 and one for ether1.

Address	From Pool	Interface	Advertise
G 2000::100/127		ether3	no
G 2000::103/127		ether1	no
DL fe80::5054:ff:fe45:83a...		ether3	no
DL fe80::5054:ff:fe5a:bfa...		ether1	no
DL fe80::5054:ff:fe8a:9cc...		ether2	no

5 items (1 selected)

IPv6 Address <2000::100/127>

Address: 2000::100/127

From Pool: []

Interface: ether3

EUI64
 Advertise
 No DAD

enabled Global

IPv6 Address <2000::103/127>

Address: 2000::103/127

From Pool: []

Interface: ether1

EUI64
 Advertise
 No DAD

enabled Global

```
/ipv6 address  
add address=2000::100/127  
advertise=no interface=ether3  
/ipv6 address  
add address=2000::103/127  
advertise=no interface=ether1
```

BGP 2

The screenshot shows the IPv6 Address List window with 3 items. The selected item is 2000::101/127. Below it is a configuration window for this address on interface ether1.

Address	From Pool	Interface	Advertise
G 2000::101/127		ether1	no
DL fe80::5054:ff:feac:ecd...		ether2	no
DL fe80::5054:ff:fee8:2b4...		ether1	no

3 items (1 selected)

IPv6 Address <2000::101/127>

Address: 2000::101/127

From Pool: []

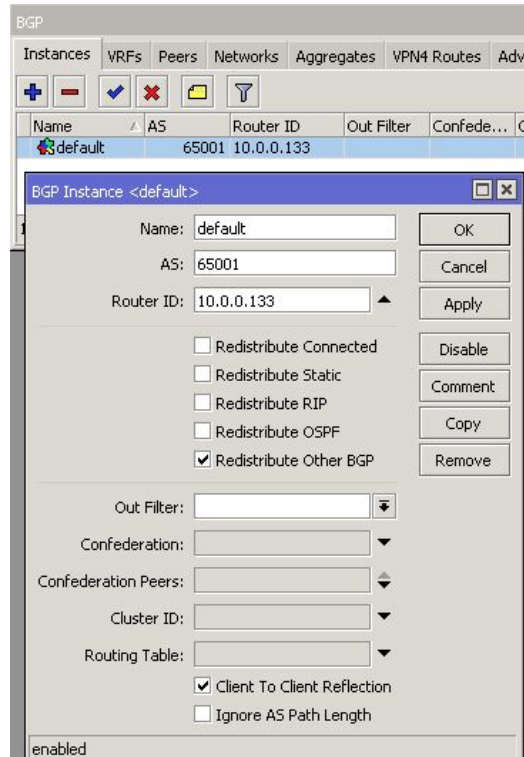
Interface: ether1

EUI64
 Advertise
 No DAD

enabled Global

```
/ipv6 address  
add address=2000::101/127  
advertise=no interface=ether1
```

BGP 1



The screenshot shows the BGP Instance configuration window for 'default'. The AS is set to 65001 and the Router ID is 10.0.0.133. The 'Redistribute Other BGP' checkbox is checked. The status at the bottom is 'enabled'.

Name	AS	Router ID	Out Filter	Confede...
default	65001	10.0.0.133		

BGP Instance <default>

Name: default
AS: 65001
Router ID: 10.0.0.133

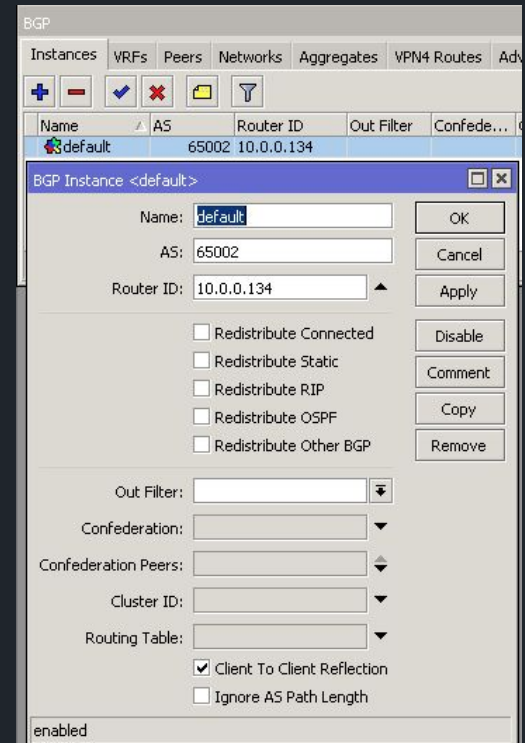
Redistribute Connected
 Redistribute Static
 Redistribute RIP
 Redistribute OSPF
 Redistribute Other BGP

Out Filter:
Confederation:
Confederation Peers:
Cluster ID:
Routing Table:
 Client To Client Reflection
 Ignore AS Path Length

enabled

```
/routing bgp instance  
set default as=65001  
redistribute-other-bgp=yes  
router-id=10.0.0.133
```

BGP 2



The screenshot shows the BGP Instance configuration window for 'default'. The AS is set to 65002 and the Router ID is 10.0.0.134. The 'Client To Client Reflection' checkbox is checked. The status at the bottom is 'enabled'.

Name	AS	Router ID	Out Filter	Confede...
default	65002	10.0.0.134		

BGP Instance <default>

Name: default
AS: 65002
Router ID: 10.0.0.134

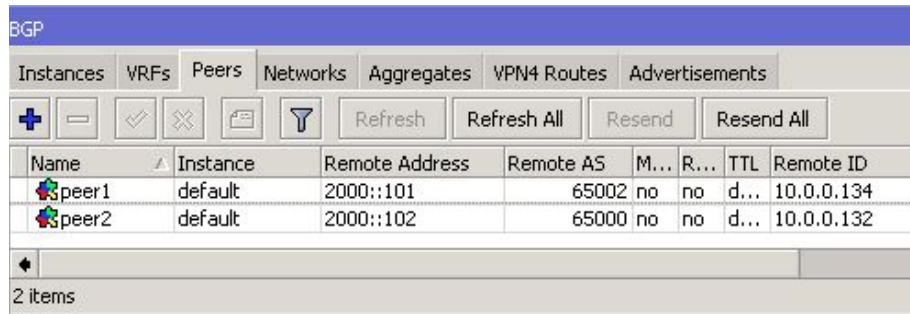
Redistribute Connected
 Redistribute Static
 Redistribute RIP
 Redistribute OSPF
 Redistribute Other BGP

Out Filter:
Confederation:
Confederation Peers:
Cluster ID:
Routing Table:
 Client To Client Reflection
 Ignore AS Path Length

enabled

```
/routing bgp instance  
set default as=65002  
router-id=10.0.0.134
```

BGP 1



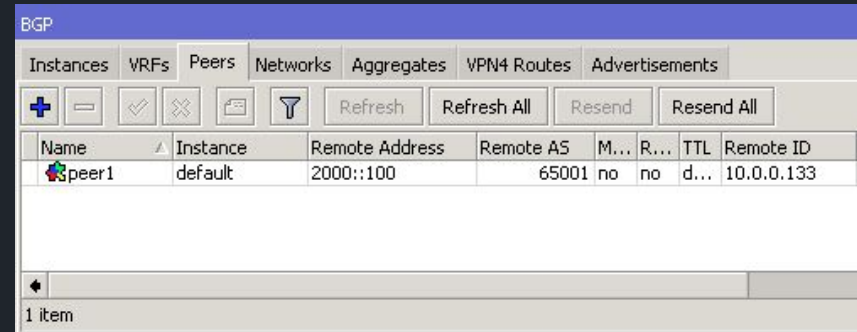
The screenshot shows the BGP configuration interface for BGP 1. The 'Peers' tab is selected, displaying a table with two entries: peer1 and peer2. The table columns are Name, Instance, Remote Address, Remote AS, M..., R..., TTL, and Remote ID. The status bar at the bottom indicates '2 items'.

Name	Instance	Remote Address	Remote AS	M...	R...	TTL	Remote ID
peer1	default	2000::101	65002	no	no	d...	10.0.0.134
peer2	default	2000::102	65000	no	no	d...	10.0.0.132

```
/routing bgp peer
add address-families=ipv6
name=peer1 remote-address=2000::101
remote-as=65002
```

```
/routing bgp peer
add address-families=ipv6
name=peer2 remote-address=2000::102
remote-as=65000
```

BGP 2



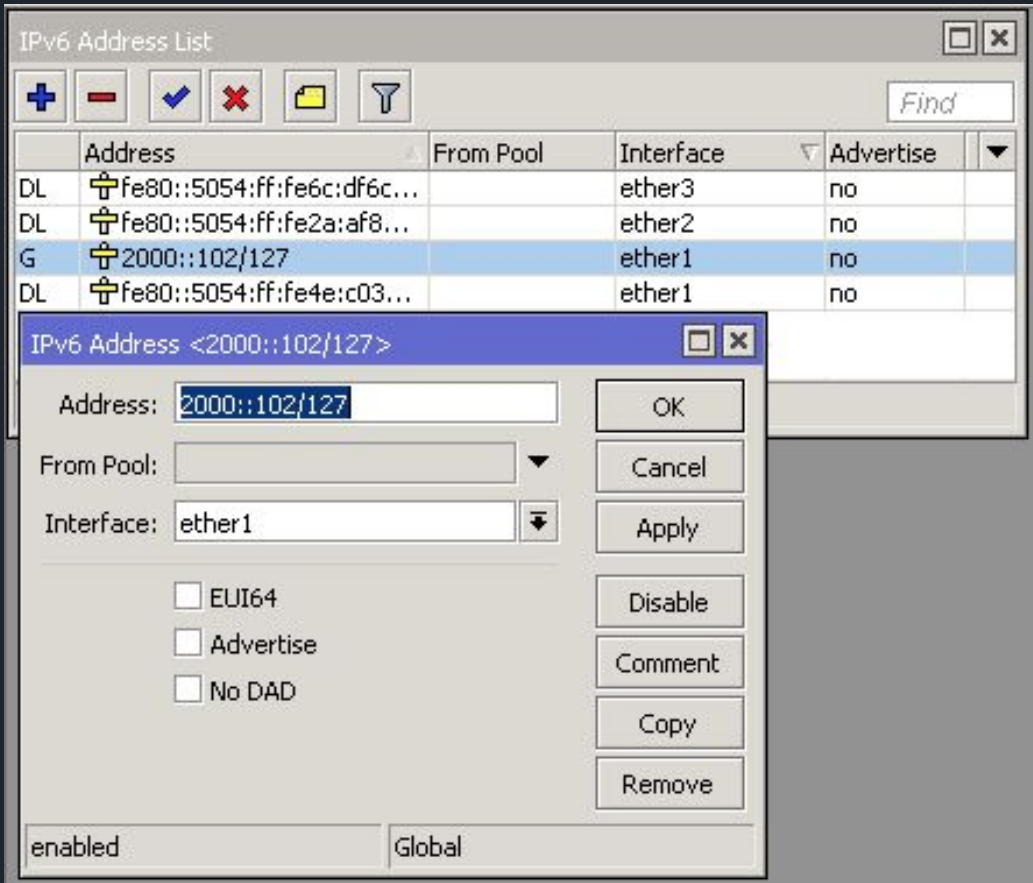
The screenshot shows the BGP configuration interface for BGP 2. The 'Peers' tab is selected, displaying a table with one entry: peer1. The table columns are Name, Instance, Remote Address, Remote AS, M..., R..., TTL, and Remote ID. The status bar at the bottom indicates '1 item'.

Name	Instance	Remote Address	Remote AS	M...	R...	TTL	Remote ID
peer1	default	2000::100	65001	no	no	d...	10.0.0.133

```
/routing bgp peer
add address-families=ipv6
name=peer1 remote-address=2000::100
remote-as=65001
```

Core

Configuramos las direcciones IPv6 que se publicarán en nuestro core y como las verán los carriers, para el Core lo configuramos de la siguiente forma, primero las IPv6 para la sesión BGP



	Address	From Pool	Interface	Advertise
DL	Fe80::5054:ff:fe6c:df6c...		ether3	no
DL	Fe80::5054:ff:fe2a:af8...		ether2	no
G	2000::102/127		ether1	no
DL	Fe80::5054:ff:fe4e:c03...		ether1	no

IPv6 Address <2000::102/127>

Address: 2000::102/127

From Pool: []

Interface: ether1

EUI64

Advertise

No DAD

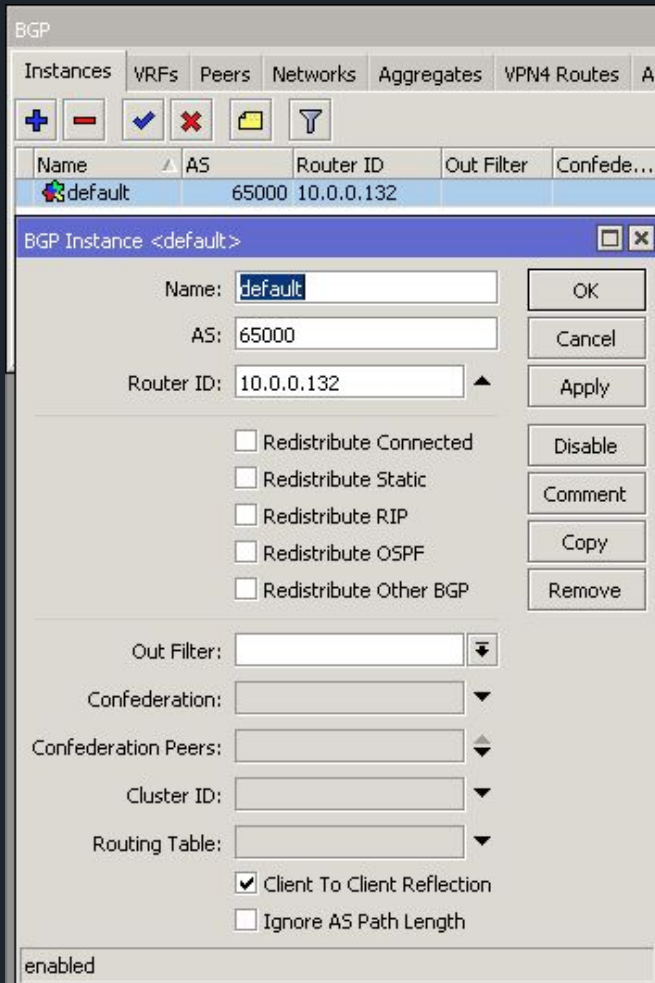
Buttons: OK, Cancel, Apply, Disable, Comment, Copy, Remove

enabled Global

```
/ipv6 address  
add address=2000::102/127  
advertise=no  
interface=ether1
```

Core

Definimos nuestro AS y el ID del router



```
/routing bgp instance  
set default as=65000  
router-id=10.0.0.132
```

Core

The screenshot shows the BGP configuration interface for a peer named 'peer1'. The configuration is as follows:

Name	Instance	Remote Address	Remote AS	M...	R...	TTL	Remote ID	Uptime
peer1	default	2000::103	65001	no	no	d...	10.0.0.133	20:16:10

BGP Peer <peer1>

General | **Advanced** | **Status**

Name: peer1
Instance: default
Remote Address: 2000::103
Remote Port:
Remote AS: 65001
TCP MD5 Key:
Nexthop Choice: default
 Multihop
 Route Reflect

Hold Time: 180 s
Keepalive Time:
TTL: default
Max Prefix Limit:
Max Prefix Restart Time:
In Filter:
Out Filter:
AllowAS In:
 Remove Private AS
 AS Override

Default Originate: never
 Passive
 Use BFD

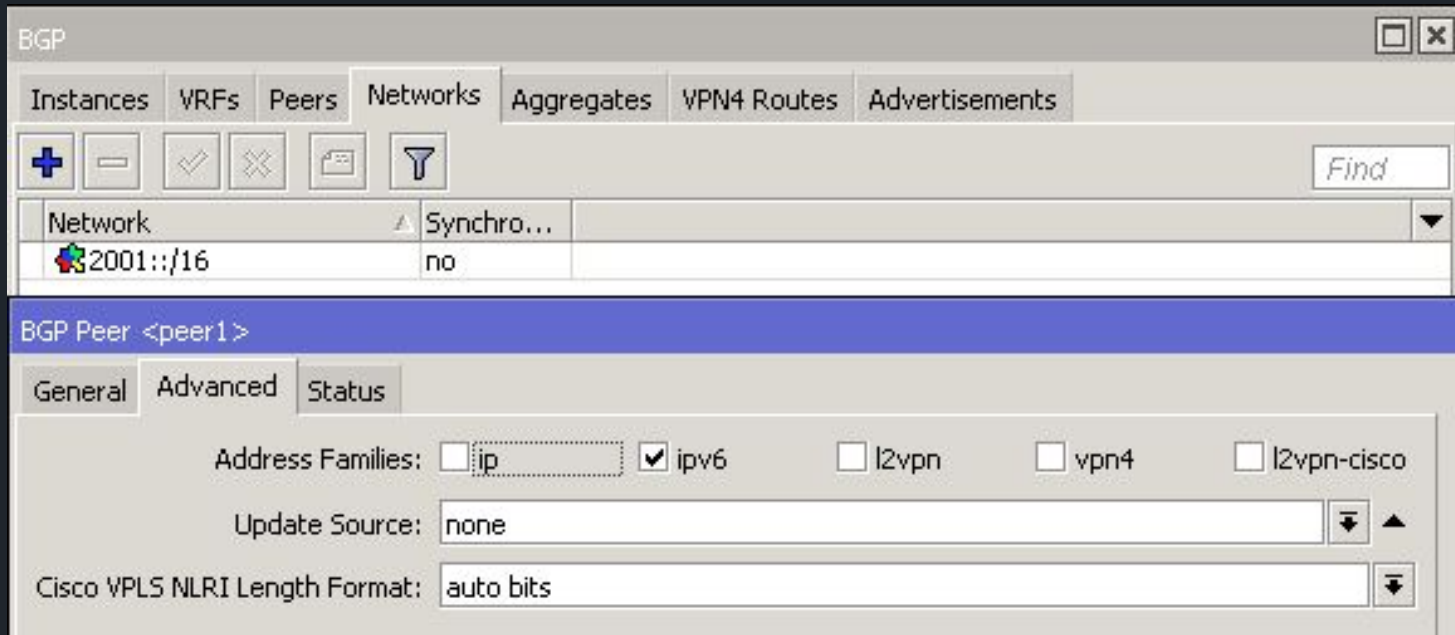
enabled | established

Configuramos el peer del carrier

```
/routing bgp peer  
add address-families=ipv6  
name=peer1  
remote-address=2000::103  
remote-as=65001
```


Core

Añadimos el rango de red que queremos publicar, y comprobamos que esté marcado ipv6



```
/routing bgp network  
add network=2001::/16 synchronize=no
```

Core

Añadimos la ruta para nuestro rango de ip's esté apuntando a una salida.

```
/ipv6 route  
add distance=1  
dst-address=2001::/16  
gateway=fe80::1%ether1
```

The screenshot displays the 'IPv6 Route List' configuration interface. At the top, there is a toolbar with icons for adding (+), removing (-), checking (✓), deleting (✗), saving (floppy), and filtering (funnel). Below the toolbar is a table with two columns: 'Dst. Address' and 'Gateway'. The table contains two entries: 'AS' with '2001::/16' and 'fe80::1%ether1 reachable', and 'DAC' with '2000::102/127' and 'ether1 reachable'. Below the table, the selected route 'IPv6 Route <2001::/16>' is shown in a detailed view. This view has two tabs: 'General' and 'Attributes'. The 'General' tab is active, showing fields for 'Dst. Address' (2001::/16), 'Gateway' (fe80::1%ether1), 'Check Gateway' (empty), 'Type' (unicast), 'Distance' (1), 'Scope' (30), and 'Target Scope' (10).

	Dst. Address	Gateway
AS	2001::/16	fe80::1%ether1 reachable
DAC	2000::102/127	ether1 reachable

IPv6 Route <2001::/16>

General Attributes

Dst. Address: 2001::/16

Gateway: fe80::1%ether1 reachable

Check Gateway:

Type: unicast

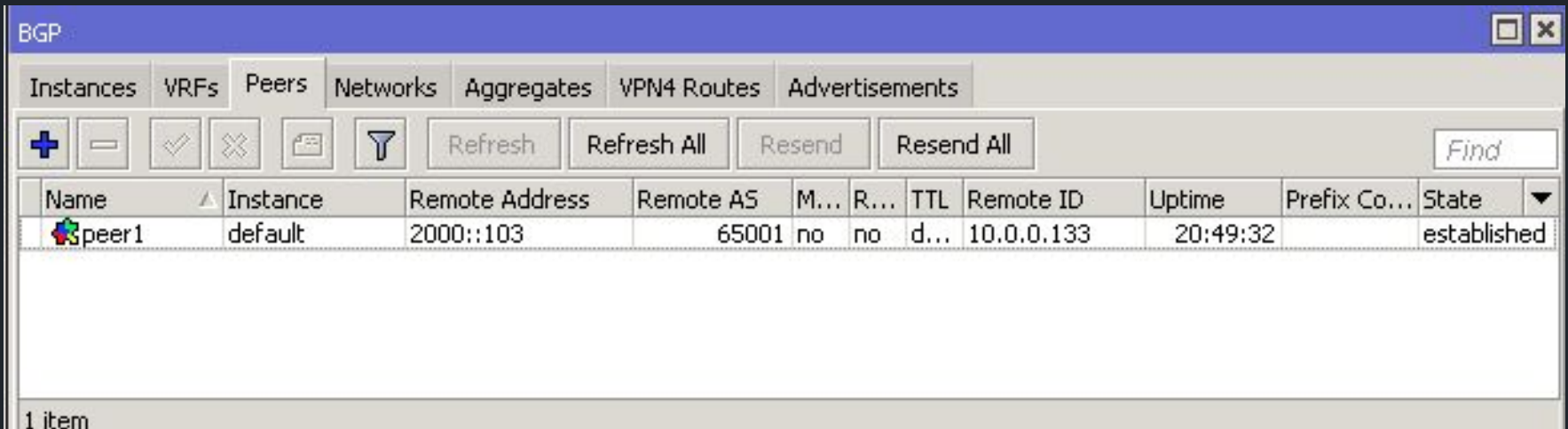
Distance: 1

Scope: 30

Target Scope: 10

Core

Comprobamos que éste el peering establecido y comprobaremos sí se propagan hacia el carrier



The screenshot shows a window titled "BGP" with several tabs: Instances, VRFs, Peers, Networks, Aggregates, VPN4 Routes, and Advertisements. The "Peers" tab is selected. Below the tabs is a toolbar with icons for adding, removing, checking, and deleting peers, along with buttons for Refresh, Refresh All, Resend, and Resend All, and a Find search box. The main area contains a table with the following data:

Name	Instance	Remote Address	Remote AS	M...	R...	TTL	Remote ID	Uptime	Prefix Co...	State
peer1	default	2000::103	65001	no	no	d...	10.0.0.133	20:49:32		established

At the bottom left of the window, it says "1 item".

BGP 1

BGP 2

The screenshot shows a BGP configuration window with the 'Peers' tab selected. The table below lists two BGP peers:

Name	Instance	Remote Address	Remote AS	M...	R...	TTL	Remote ID	Uptime	Prefix Co...	State
peer1	default	2000::101	65002	no	no	d...	10.0.0.134	18:54:29		established
peer2	default	2000::102	65000	no	no	d...	10.0.0.132	20:48:31	1	established

2 items

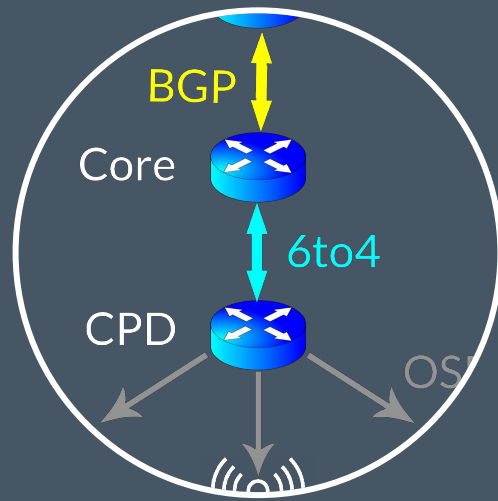
The screenshot shows a BGP configuration window with the 'Peers' tab selected. The table below lists one BGP peer:

Name	Instance	Remote Address	Remote AS	M...	R...	TTL	Remote ID	Uptime	Prefix Co...	State
peer1	default	2000::100	65001	no	no	d...	10.0.0.133	18:54:15	1	established

1 item

Tunnel 6to4

¿Por qué no usar una red existente IPv4 para enlazar los CPD's con nuestro Core?



Tunnel 6to4



Conectaremos los CPD's con el Core mediante una red WAN IPv4 para hacer la distribución de los CPD's más sencilla al usar las redes actuales.

En este laboratorio no se representará la red IPv4 y se conectarán directamente los interfaces simulando las ip's como direcciones públicas

Core

Address	Network	Interface
172.16.100.1/30	172.16.100.0	ether2

2 items

Address <172.16.100.1/30>

Address: 172.16.100.1/30

Network: 172.16.100.0

Interface: ether2

enabled

```
/ip address  
add address=172.16.100.1/30  
interface=ether2  
network=172.16.100.0
```

CPD

Address	Network	Interface
172.16.100.2/30	172.16.100.0	ether1

2 items

Address <172.16.100.2/30>

Address: 172.16.100.2/30

Network: 172.16.100.0

Interface: ether1

enabled

```
/ip address  
add address=172.16.100.2/30  
interface=ether1  
network=172.16.100.0
```

Core

The screenshot shows the Mikrotik WinBox interface configuration for a Core device. The interface list at the top shows:

Name	Type	Actual MTU	L2 MTU	Tx
R 6to4	6to4 Tunnel	1280	65535	
;;; Sw4-BGP				
R ether1	Ethernet	1500		
;;; Sw5.CPD				
R ether2	Ethernet	1500		

The 'Interface <6to4>' configuration window is open, showing the following settings:

- Name: 6to4
- Type: 6to4 Tunnel
- MTU: 1280
- Actual MTU: 1280
- L2 MTU: 65535
- Local Address: 172.16.100.1
- Remote Address: 172.16.100.2
- IPsec Secret: (empty)
- Keepalive: (empty)
- DSCP: 10
- Dont Fragment: no
- Clamp TCP MSS

```
/interface 6to4
add local-address=172.16.100.1
mtu=1280 name=6to4 remote-address=
172.16.100.2
```

CPD

The screenshot shows the Mikrotik WinBox interface configuration for a CPD device. The interface list at the top shows:

Name	Type	Actual MTU	L2 MTU	Tx
R 6to4	6to4 Tunnel	1280	65535	
;;; Sw5-Core				
R ether1	Ethernet	1500		
;;; Sw7-Ant				
R ether2	Ethernet	1500		

The 'Interface <6to4>' configuration window is open, showing the following settings:

- Name: 6to4
- Type: 6to4 Tunnel
- MTU: 1280
- Actual MTU: 1280
- L2 MTU: 65535
- Local Address: 172.16.100.2
- Remote Address: 172.16.100.1
- IPsec Secret: (empty)
- Keepalive: (empty)
- DSCP: 10
- Dont Fragment: no
- Clamp TCP MSS

```
/interface 6to4
add local-address=172.16.100.2
mtu=1280 name=6to4 remote-address=
172.16.100.1
```


IPv6

Para obtener la dirección IPv6 correspondiente al túnel 6to4 hay que hacer una conversión entre la ipv4 y el pool a usar. En la siguiente dirección se puede obtener:

<http://silmor.de/ipaddrcalc.html#ip46>

← → C No es seguro silmor.de/ipaddrcalc.html#ip46 ☆ ⋮

IPv4 to IPv6 Transitional

[\[hide\]](#)

IPv4 in IPv6 Addresses

In some configurations IPv4 addresses can be written or used in IPv6 notation or they become part of an IPv6 address. This form allows you to convert from IPv4 to IPv6 and back. Depending on your application you may have to shift the IPv6 segments.

IPv4 Address: Please use dotted decimal notation.

IPv6 Address: Please use hexadecimal notation with the relevant 32 bits to the far right.

6to4 and 6RD Network Prefix

6to4 and 6rd are transitional mechanisms that will be used until native IPv6 is universally available. With both mechanisms you can assign an IPv6 prefix to an entire network based on the IPv4 address of the gateway. Both use the 6in4 encapsulation to transport IPv6 packets inside IPv4 packets between the border gateway of the local network and the gateway servers outside.

6to4 is a public service, everybody can configure a gateway to use it - no subscription is necessary, since gateways will always know where to route responses based on the prefix. All 6to4 prefixes are in the 2002::/16 network and are /48 bits long (16bits for 2002::/16 and 32bits from the IPv4 address of the gateway). Unfortunately this service has become quite unreliable since public gateway servers seem to be unable to scale with the demand for prefixes.

6rd is the provider internal equivalent of 6to4. The provider establishes a gateway (or cluster of gateways) in its internal network and customer gateways are configured to use this gateway. The provider side prefix can be considerable longer than with 6to4 (/32 is normal), but it is also quite common to use only some bits of the IPv4 address - normally IPv4 addresses for customers are either assigned from a limited pool of public addresses (a /16 being the norm) or from one of the "private" pools (e.g. 10.0.0.0/8), so the leftmost bits of every customer IP will be identical and can be ignored. For this mechanism to work you have to be a subscriber of an ISP that provides this mechanism to its customers. The values that go into this calculation may or may not have some resemblance to what you can find out using the whois service, but the provider is free to use sub-nets, so you will need information directly from the provider.

Provider prefix IPv6: /16 Use **2002::/16** for 6to4 and whatever you ISP gave you for 6rd

Customer IPv4: IP: using bits; use your public IPv4 address (PPP: your own, not the peer address) and the bits value from the ISP or 32 for 6to4

IPv6 Customer prefix: /46

convert the ISP prefix and public IPv4 to a IPv6 customer prefix

convert the IPv6 customer prefix to ISP prefix and public IPv4 (the provider prefix length will be used as is)

Core

The screenshot shows the IPv6 Address List window for the Core network. The list contains the following entries:

	Address	From Pool	Interface	Advertise
G	2002:b041:9004::/3		6to4	no
DL	fe80::3:ac10:6401/64		6to4	no
DL	fe80::5054:ff:fe4e:c03...		ether1	no
G	2000::102/127		ether1	no
DL	fe80::5054:ff:fe2a:af8...		ether2	no
DL	fe80::5054:ff:fe6c:df6c...		ether3	no

The configuration dialog for the selected address (2002:b041:9004::/3) shows the following settings:

- Address: 2002:b041:9004::/3
- From Pool: (empty)
- Interface: 6to4
- EUI64
- Advertise
- No DAD

Buttons: OK, Cancel, Apply, Disable, Comment, Copy, Remove. Status: enabled, Global.

```
/ipv6 address  
add address=2002:b041:9004::/3  
advertise=no interface=6to4
```

CPD

The screenshot shows the IPv6 Address List window for the CPD network. The list contains the following entries:

	Address	From Pool	Interface	Advertise
G	2002:b041:9008::/3		6to4	no
DL	fe80::3:ac10:6402/64		6to4	no
DL	fe80::5054:ff:fe7c:55d...		ether2	no
DL	fe80::5054:ff:febd:fdcb...		ether1	no

The configuration dialog for the selected address (2002:b041:9008::/3) shows the following settings:

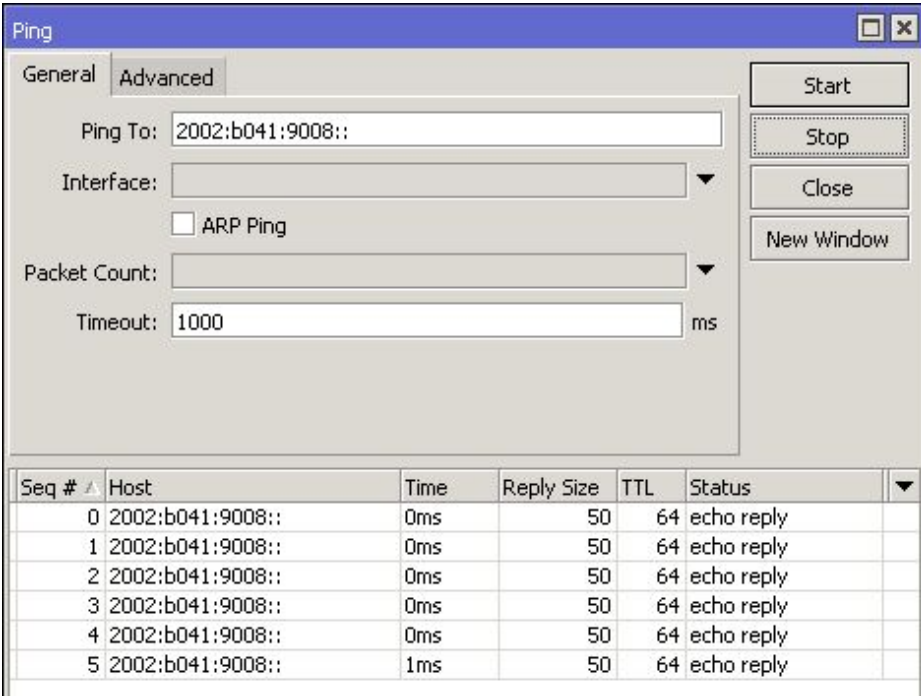
- Address: 2002:b041:9008::/3
- From Pool: (empty)
- Interface: 6to4
- EUI64
- Advertise
- No DAD

Buttons: OK, Cancel, Apply, Disable, Comment, Copy, Remove. Status: enabled, Global.

```
/ipv6 address  
add address=2002:b041:9008::/3  
advertise=no interface=6to4
```

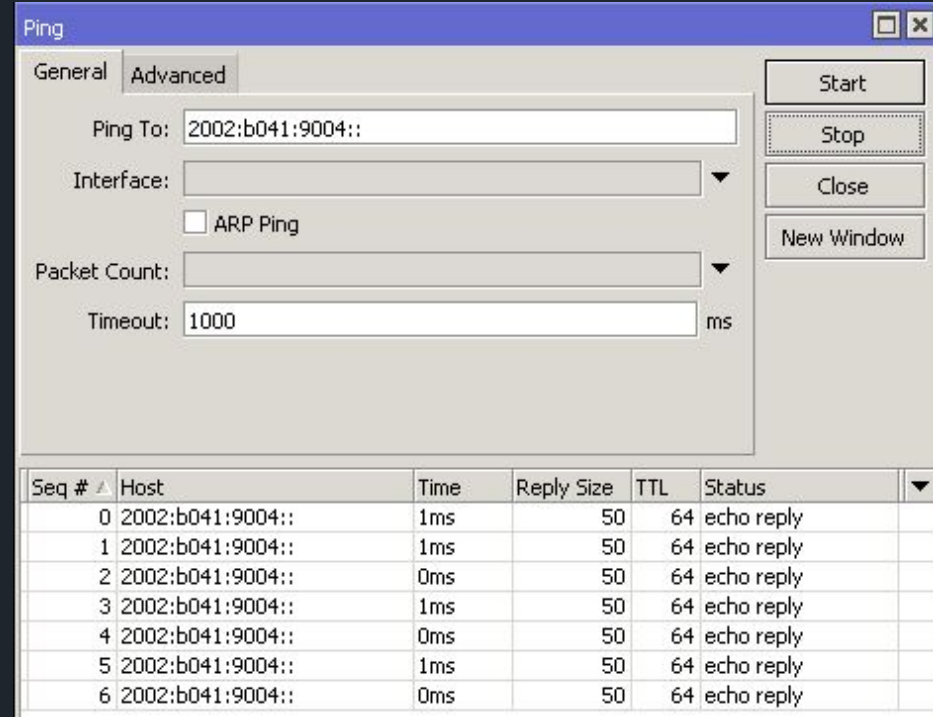
Core

CPD



The screenshot shows the Windows Ping utility window for the 'Core' server. The 'General' tab is selected. The 'Ping To' field contains '2002:b041:9008::'. The 'Interface' field is empty. The 'ARP Ping' checkbox is unchecked. The 'Packet Count' field is empty. The 'Timeout' field is set to '1000' ms. The 'Start' button is highlighted. Below the settings is a table with the following data:

Seq #	Host	Time	Reply Size	TTL	Status
0	2002:b041:9008::	0ms	50	64	echo reply
1	2002:b041:9008::	0ms	50	64	echo reply
2	2002:b041:9008::	0ms	50	64	echo reply
3	2002:b041:9008::	0ms	50	64	echo reply
4	2002:b041:9008::	0ms	50	64	echo reply
5	2002:b041:9008::	1ms	50	64	echo reply



The screenshot shows the Windows Ping utility window for the 'CPD' server. The 'General' tab is selected. The 'Ping To' field contains '2002:b041:9004::'. The 'Interface' field is empty. The 'ARP Ping' checkbox is unchecked. The 'Packet Count' field is empty. The 'Timeout' field is set to '1000' ms. The 'Start' button is highlighted. Below the settings is a table with the following data:

Seq #	Host	Time	Reply Size	TTL	Status
0	2002:b041:9004::	1ms	50	64	echo reply
1	2002:b041:9004::	1ms	50	64	echo reply
2	2002:b041:9004::	0ms	50	64	echo reply
3	2002:b041:9004::	1ms	50	64	echo reply
4	2002:b041:9004::	0ms	50	64	echo reply
5	2002:b041:9004::	1ms	50	64	echo reply
6	2002:b041:9004::	0ms	50	64	echo reply

Core

Ahora que tenemos por donde van a ir las direcciones ip, las apuntamos en esa ruta.

```
/ipv6 route  
add distance=1  
dst-address=2001::/16  
gateway=6to4
```

The screenshot displays a network configuration window titled "IPv6 Route List". It features a toolbar with icons for adding (+), removing (-), checking (✓), deleting (✗), saving (floppy disk), and filtering (funnel). Below the toolbar is a table with three rows:

	Dst. Address	Gateway
DAC	2000::102/127	ether1 reachable
AS	2001::/16	6to4 reachable
DAC	2000::/3	6to4 reachable

Below the table, the selected route "IPv6 Route <2001::/16>" is shown in a blue header. The configuration details are organized into two tabs: "General" and "Attributes".

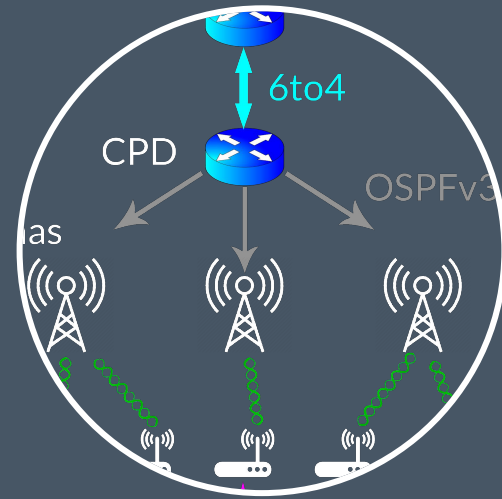
General Tab:

- Dst. Address: 2001::/16
- Gateway: 6to4 (dropdown menu) reachable
- Check Gateway: (checkbox)
- Type: unicast
- Distance: 1
- Scope: 30
- Target Scope: 10

OSPFv3

Usar OSPFv3 para enrutar las direcciones IPv6 hasta los concentradores PPPoE





OSPFv3



La versión 3 es mucho más sencillo de configurar, en pocos pasos está funcionando.

CPD

The screenshot shows the IPv6 Address List window for CPD. The list contains 6 items, with 1 selected. The selected item is 2000::a:1/112 on interface ether2. Below the list is a configuration dialog for this address.

	Address	From Pool	Interface	Advertise
G	2002:b041:9008::/3		6to4	no
DL	fe80::3:ac10:6402/64		6to4	no
DL	fe80::5054:ff:fe7c:55d...		ether2	no
DL	fe80::5054:ff:febd:fdcb...		ether1	no
G	2000::a:1/112		ether2	no
DL	fe80::5054:ff:fef2:9a5/64		ether3	no

6 items (1 selected)

IPv6 Address <2000::a:1/112>

Address: 2000::a:1/112

From Pool: [dropdown]

Interface: ether2

EUI64
 Advertise
 No DAD

Buttons: OK, Cancel, Apply, Disable, Comment, Copy, Remove

enabled Global

```
/ipv6 address  
add address=2000::a:1/112  
advertise=no interface=ether2
```

Antena

The screenshot shows the IPv6 Address List window for Antena. The list contains 5 items, with 1 selected. The selected item is 2000::a:2/112 on interface ether1. Below the list is a configuration dialog for this address.

	Address	From Pool	Interface	Advertise
G	2000::a:2/112		ether1	no
DL	fe80::5054:ff:fe40:6f0...		ether1	no
DL	fe80::5054:ff:fe6a:55a...		ether3	no
DL	fe80::5054:ff:fee8:b26...		ether2	no

IPv6 Address <2000::a:2/112>

Address: 2000::a:2/112

From Pool: [dropdown]

Interface: ether1

EUI64
 Advertise
 No DAD

Buttons: OK, Cancel, Apply, Disable, Comment, Copy, Remove

enabled Global

```
/ipv6 address  
add address=2000::a:2/112  
advertise=no interface=ether1
```

CPD

The screenshot shows the OSPFv3 configuration window for interface ether2. The main table lists the configuration for the interface:

Area	Interface	Cost	Priority	Network Type
backb...	ether2	10	1	default

The configuration details for ether2 are as follows:

- Area: backbone
- Interface: ether2
- Cost: 10
- Priority: 1
- Network Type: default
- Instance ID: 0
- Passive
- Use BFD
- Retransmit Interval: 5 s
- Transmit Delay: 1 s
- Hello Interval: 10 s
- Router Dead Interval: 40 s

Buttons: OK, Cancel, Apply, Disable, Copy, Remove.

State: designated ro...

```
/routing ospf-v3 interface  
add area=backbone interface=ether2
```

Antena

The screenshot shows the OSPFv3 configuration window for interface ether1. The main table lists the configuration for the interface:

Area	Interface	Cost	Priority	Network Type
backb...	ether1	10	1	default

The configuration details for ether1 are as follows:

- Area: backbone
- Interface: ether1
- Cost: 10
- Priority: 1
- Network Type: default
- Instance ID: 0
- Passive
- Use BFD
- Retransmit Interval: 5 s
- Transmit Delay: 1 s
- Hello Interval: 10 s
- Router Dead Interval: 40 s

Buttons: OK, Cancel, Apply, Disable, Copy, Remove.

State: backup

```
/routing ospf-v3 interface  
add area=backbone interface=ether1
```


CPD

Name	Router ID	Running
* default	10.0.10.1	yes

OSPFv3 Instance <default>

General Metrics Status

Name: default

Router ID: 10.0.10.1

Redistribute Default Route: never

Redistribute Connected Routes: no

Redistribute Static Routes: as type 1

Redistribute RIP Routes: no

Redistribute BGP Routes: no

Redistribute Other OSPF Routes: no

enabled default

```
/routing ospf-v3 instance  
set redistribute-static=as-type-1  
router-id=10.0.10.1
```

Antena

Name	Router ID	Running
* default	10.0.10.2	yes

OSPFv3 Instance <default>

General Metrics Status

Name: default

Router ID: 10.0.10.2

Redistribute Default Route: never

Redistribute Connected Routes: no

Redistribute Static Routes: as type 1

Redistribute RIP Routes: no

Redistribute BGP Routes: no

Redistribute Other OSPF Routes: no


enabled default



```
/routing ospf-v3 instance  
set redistribute-static=as-type-1  
router-id=10.0.10.2  
/ipv6 route add dst-address=2001:1::/48  
type=unreachable
```

CPD

OSPFv3

Virtual Links Neighbors NBMA Neighbors LSA Routes AS Bo




Instance ▲	Router ID	Address	Interface
 default	10.0.10.2	fe80::5054:f...	ether2
 default	10.0.10.3	fe80::5054:f...	ether2



2 items

Antena

OSPFv3

Virtual Links Neighbors NBMA Neighbors LSA Routes AS B



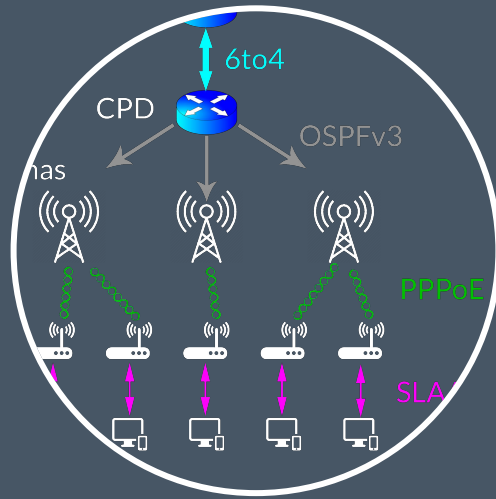
Instance ▲	Router ID	Address	Interface
 default	10.0.10.1	fe80::5054:f...	ether1
 default	10.0.10.3	fe80::5054:f...	ether1

2 items

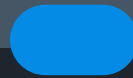
PPPoE

No vamos a
inventar la rueda





PPPoE

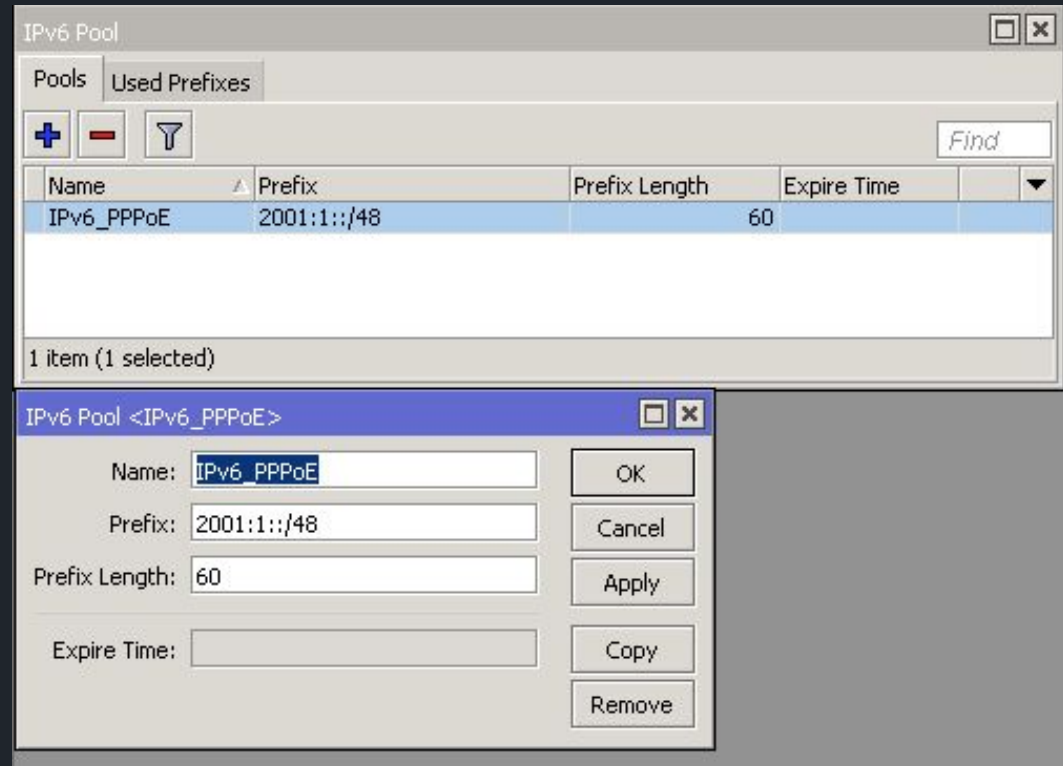


Conectar los clientes a las antenas mediante el PPPoE, una forma eficiente y asentada en el mercado

Antenas

Asignamos el pool de prefijos IPv6 que va a delegar esa antena hacia los CPEs

```
/ipv6 pool  
add name=IPv6_PPPoE  
prefix=2001:1::/48  
prefix-length=60
```



Antenas

Configuración sencilla de un servidor
PPPoE

```
/ppp profile
```

```
add dhcpv6-pd-pool=IPv6_PPpOE
```

```
name=IPv6 only-one=no
```

```
use-ipv6=required
```

```
/ppp secret
```

```
add name=pppv6 password=ipv6
```

```
profile=IPv6 service=pppoe
```

```
/interface pppoe-server server
```

```
add default-profile=IPv6
```

```
disabled=no interface=ether2
```

```
service-name=PPPoEv6
```

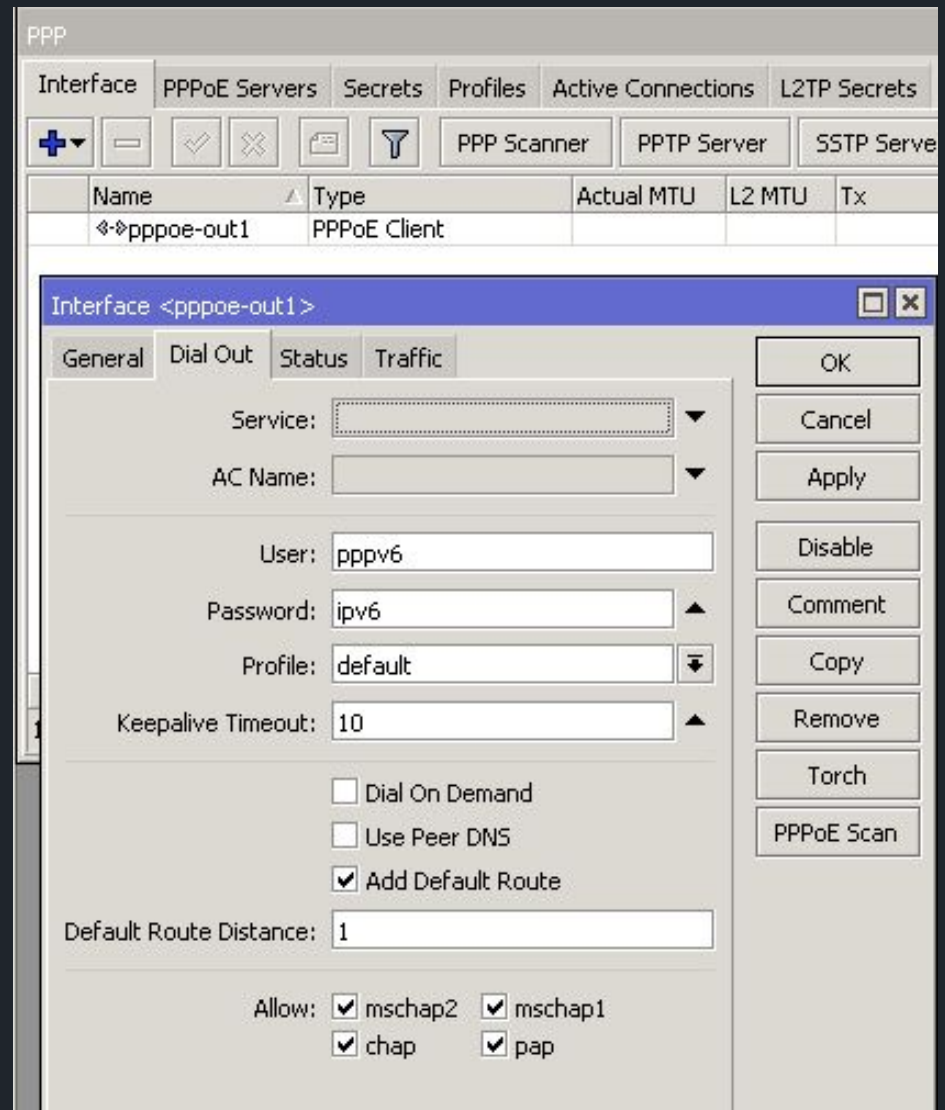
The screenshot displays the Mikrotik WinBox interface for configuring PPP services. It is divided into three main configuration windows:

- PPP Secret <pppv6>:** Shows a secret named 'pppv6' with a password of 'ipv6', service 'pppoe', and profile 'IPv6'. It includes fields for Local Address, Remote Address, Remote IPv6 Prefix, and Routes, along with Limit Bytes In/Out and Last Logged Out information.
- PPP Profile <IPv6>:** Shows a profile named 'IPv6' with 'use-ipv6' set to 'required'. It includes fields for Local Address, Remote Address, Remote IPv6 Prefix Pool, and DHCPv6 PD Pool. It also has sections for Bridge, Incoming/Outgoing Filters, Address List, Interface List, DNS Server, and WINS Server.
- PPPoE Service <PPPoEv6>:** Shows a service named 'PPPoEv6' on interface 'ether2'. It includes fields for Max MTU, Max MRU, MRRU, and Keaplive Timeout. The 'Default Profile' is set to 'IPv6', and 'One Session Per Host' is unchecked. It also shows authentication options for mschap2, mschap1, chap, and pap.

CPE

Ciente de PPPoE en el CPE que conecta con la antena

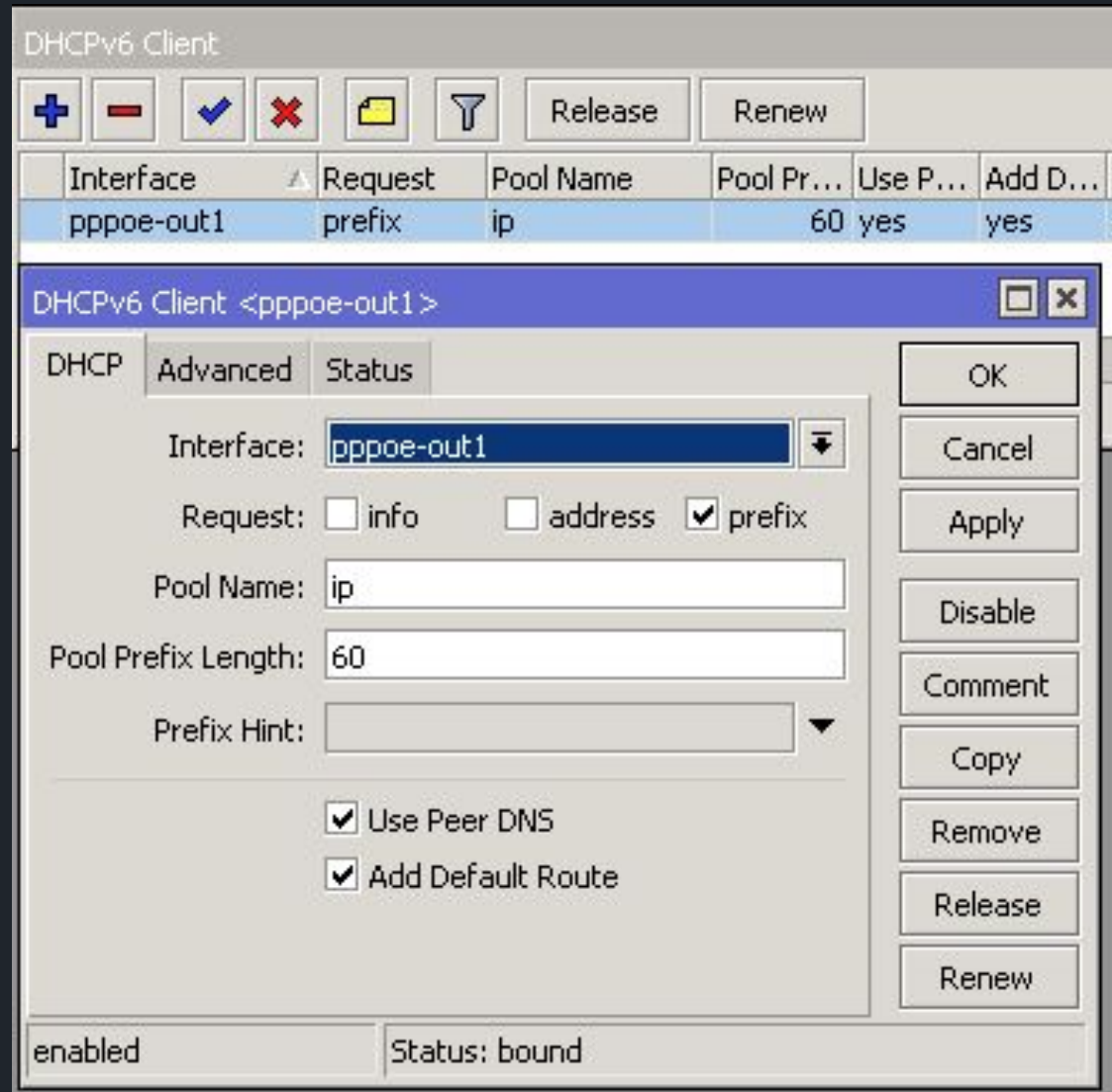
```
/interface pppoe-client
add add-default-route=yes
disabled=no interface=ether1
name=pppoe-out1
password=ipv6 user=pppv6
```



CPE

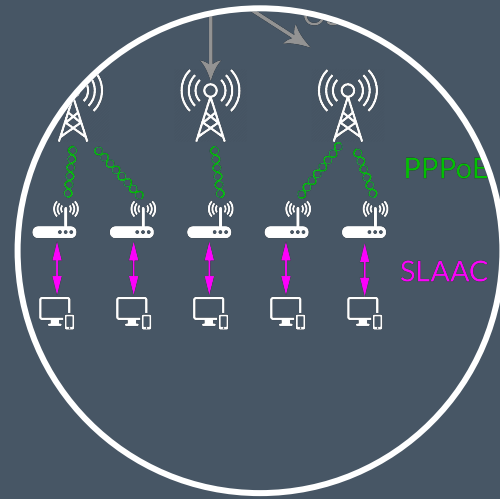
Ponemos un DHCPv6 Client para obtener el prefijo para el cliente.

```
/ipv6 dhcp-client
add add-default-route=yes
interface=pppoe-out1
pool-name=ip
pool-prefix-length=60
request=prefix
```



SLAAC

Asignación de direcciones IPv6 a los clientes finales



SLAAC



Cómo distribuir el prefijo asignado al CPE entre los equipos de los clientes

CPE

Se configura la interfaz para repartir el prefijo asignado

```

/ipv6 address
add from-pool=ip
interface=ether3

```

IPv6 Address List

	Address	From Pool	Interface	Advertise
G	2001:2::/64	ip	ether3	yes
DL	fe80::3/64		pppoe-out1	no
DL	fe80::5054:ff:fe57:637...		ether1	no
DL	fe80::5054:ff:feab:785...		ether3	no
DL	fe80::5054:ff:feea:702...		ether2	no

IPv6 Address <2001:2::/64>

Address: 2001:2::/64

From Pool: ip

Interface: ether3

EUI64

Advertise

No DAD

Buttons: OK, Cancel, Apply, Disable, Comment, Copy, Remove

enabled Global

CPE

La IPv6 asignada al equipo en la red del CPE

Centro de redes y recursos compartidos

Panel de control > Redes e Internet > Centro de redes y recursos compartidos

Buscar en el Panel de control

Ventana principal del Panel de control

Cambiar configuración del adaptador

Cambiar configuración de uso compartido avanzado

Ver información básica de la red y configurar conexiones

VENTANAS-PC (Este equipo) — Red 2 — Internet

Ver las redes activas — Conectar o desconectar

Red 2
Red doméstica

Tipo de acceso: Sin acceso a Internet
Grupo Hogar: Unido
Conexiones: Conexión de área local

Estado de Conexión de área local

General

Conexión

Conectividad IPv4: Sin acceso a la red
Conectividad IPv6: Sin acceso a Internet
Estado del medio: Habilitado
Duración: 00:05:48
Velocidad: 1,0 Gbps

Detalles...

Actividad

Enviados — Recibidos

Bytes: 81.343 | 50.210

Propiedades Deshabilitar Diagnosticar

Cerrar

Detalles de la conexión de red

Detalles de la conexión de red:

Propiedad	Valor
Sufijo DNS específico p...	
Descripción	Conexión de red Intel(R) PRO/1000 MT
Dirección física	52-54-00-2D-2A-79
Habilitado para DHCP	Sí
Dirección IPv4 de config...	169.254.91.156
Máscara de subred IPv4	255.255.0.0
Puerta de enlace predet...	
Servidor DNS IPv4	
Servidor WINS IPv4	
Habilitado para NetBios ...	Sí
Dirección IPv6	2001:::4465:6810:258e:5b9c
Dirección IPv6 temporal	2001:::10f9:7cb1:942d:9e21
Vínculo: dirección IPv6 l...	fe80::4465:6810:258e:5b9c%11
Puerta de enlace predet...	fe80::5054:ff:feab:7853%11
Servidores DNS IPv6	fec0:0:0:fff::1%1 fec0:0:0:fff::2%1 fec0:0:0:fff::3%1

Cerrar

CPE

Se comprueba que se llegue desde los Carriers hasta los equipos del cliente final

BGP

Instances VRFs Peers Networks Aggregates VPN4 Routes Advertisements

+ - ✓ ✗ 📄 🔍 Refresh Refresh All Resend Resend All Find

Name	Instance	Remote Address	Remote AS	M...	R...	TTL	Remote ID	Uptime
peer1	default	2000::101	65002	no	no	d...	10.0.0.134	20:26:
peer2	default	2000::102	65000	no	no	d...	10.0.0.132	22:20:

2 items

Ping (Running)

General Advanced

Ping To: 2001:2::4465:6810:258e:5b9c

Interface:

ARP Ping

Packet Count:

Timeout: 1000 ms

Start Stop Close New Window

Seq #	Host	Time	Reply Size	TTL	Status
142	2001:2::4465:6810:258e:5...	2ms	50	126	echo reply
143	2001:2::4465:6810:258e:5...	2ms	50	126	echo reply
144	2001:2::4465:6810:258e:5...	2ms	50	126	echo reply
145	2001:2::4465:6810:258e:5...	2ms	50	126	echo reply
146	2001:2::4465:6810:258e:5...	2ms	50	126	echo reply
147	2001:2::4465:6810:258e:5...	3ms	50	126	echo reply
148	2001:2::4465:6810:258e:5...	2ms	50	126	echo reply
149	2001:2::4465:6810:258e:5...	2ms	50	126	echo reply
150	2001:2::4465:6810:258e:5...	2ms	50	126	echo reply
151	2001:2::4465:6810:258e:5...	2ms	50	126	echo reply
152	2001:2::4465:6810:258e:5...	2ms	50	126	echo reply
153	2001:2::4465:6810:258e:5...	2ms	50	126	echo reply
154	2001:2::4465:6810:258e:5...	2ms	50	126	echo reply

155 items 155 of 155 packet... 0% packet loss Min: 2 ms Avg: 2 ms Max: 9 ms

¿Preguntas?

IPv6

MUM Valencia 2018

MikroTik



¡Gracias!

IPv6

MUM Valencia 2018

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AUNNA

INNOVACIÓN TECNOLÓGICA EN
COMUNICACIONES Y REDES