Despliegue IPv6

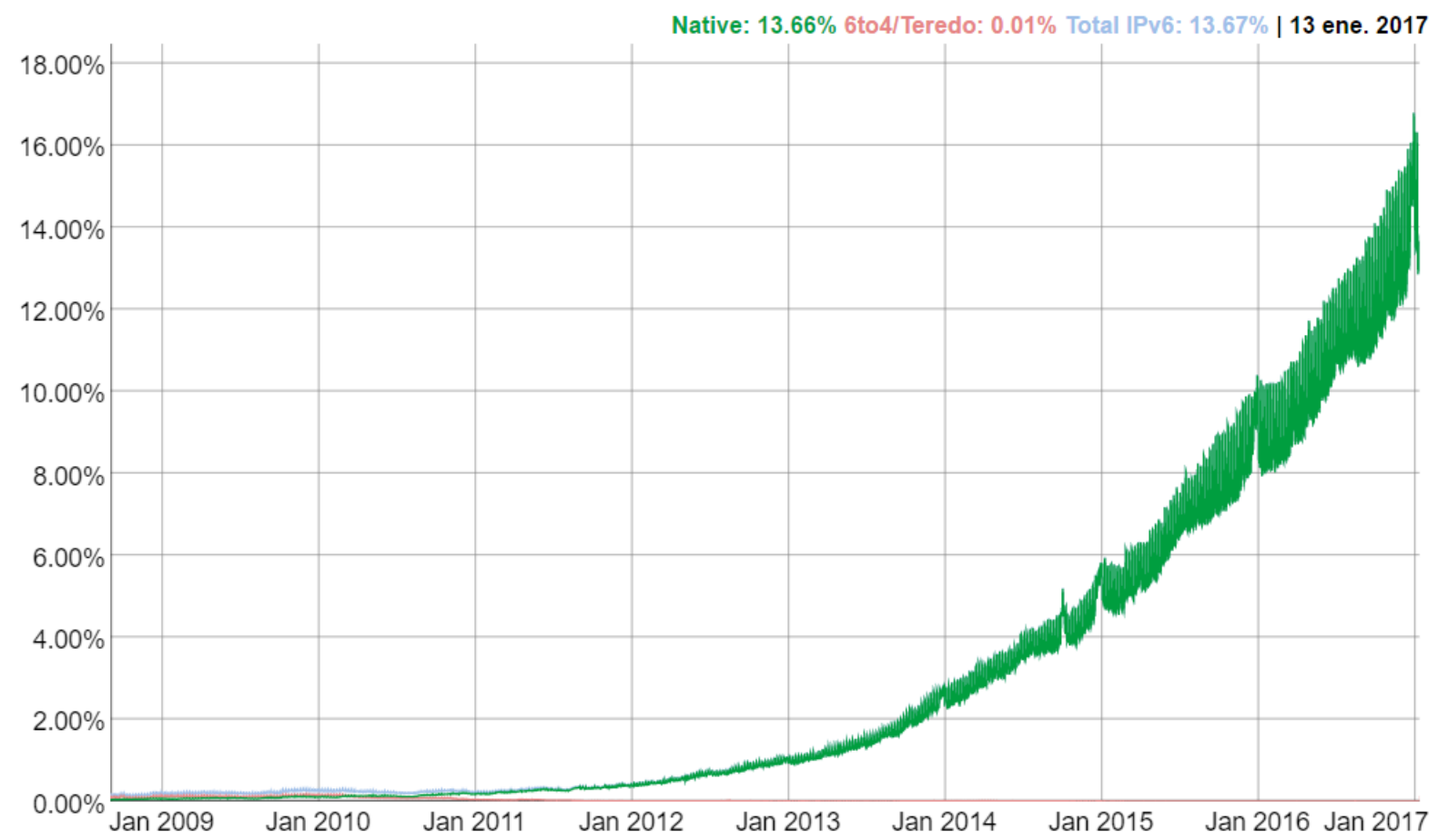
Lo aprendido en 6 años

- Historia
- Motivación
- Antes de empezar
- Primeros pasos
- Implementando IPv6 en todo
- Preguntas

2800:640:cf:22:c95c:7a48:e1c3:35b2

Breve historia

- IPv6 nació en 1996 (RFC 1883)
- Para 1998 la IETF lo definió como el sucesor de IPv4 (RFC 2460)
- En febrero 2011 IANA entregó los últimos 5 bloques /8
- El 8 de junio del 2011 fue el World IPv6 Day
- El 6 de junio del 2012 fue el World IPv6 Launch Day



Adopción Global de IPv6 – Visto desde Google

https://www.google.com/intl/en/ipv6/statistics.html

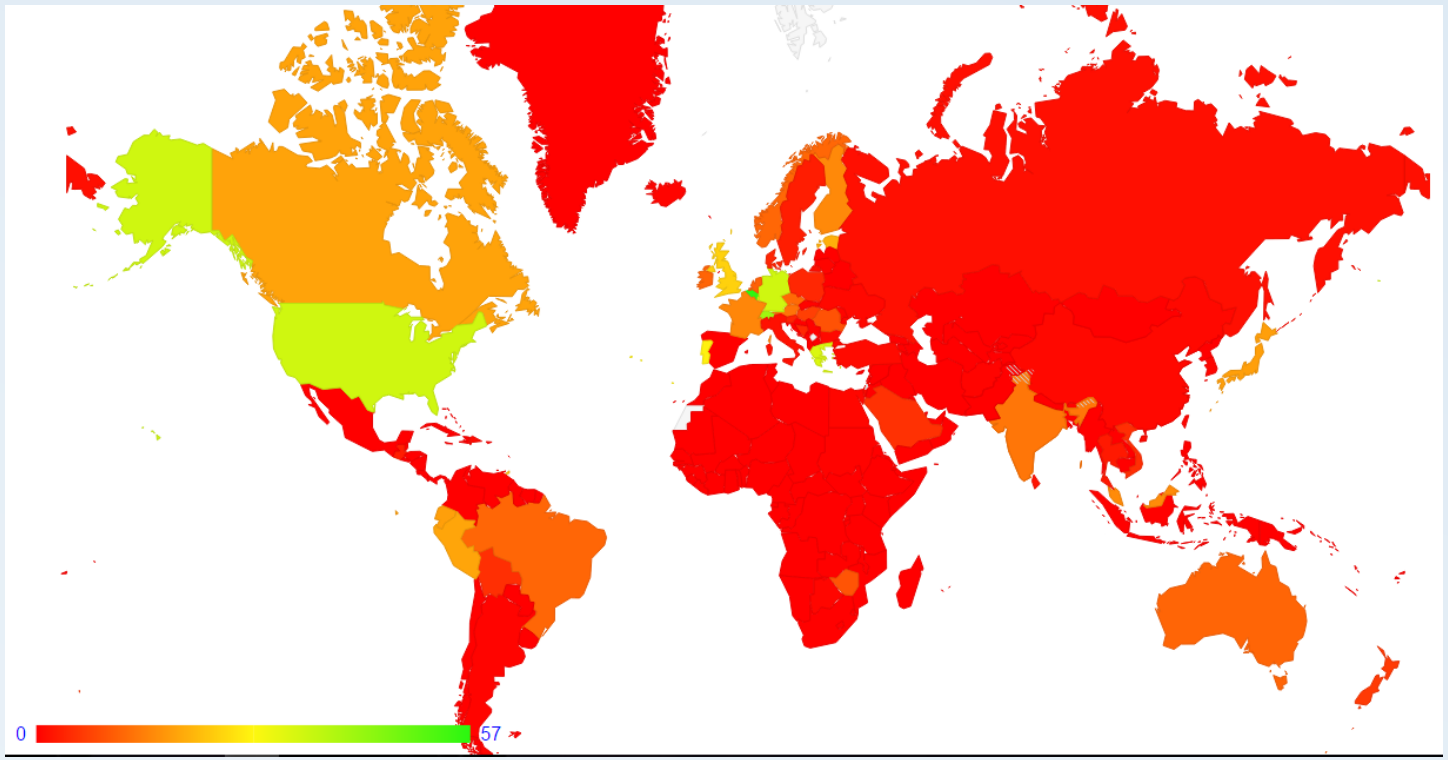
- Crecimiento exponencial de la Internet
- Seguridad
- Desempeño
- Simplicidad de diseño

Motivación

Guatemala	0.25%
Panamá	0.08%
México	0.05%
Honduras	0.03%
Costa Rica	0.02%
El Salvador	0.01%
Nicaragua	0.01%
Belice	0.00%

Motivación

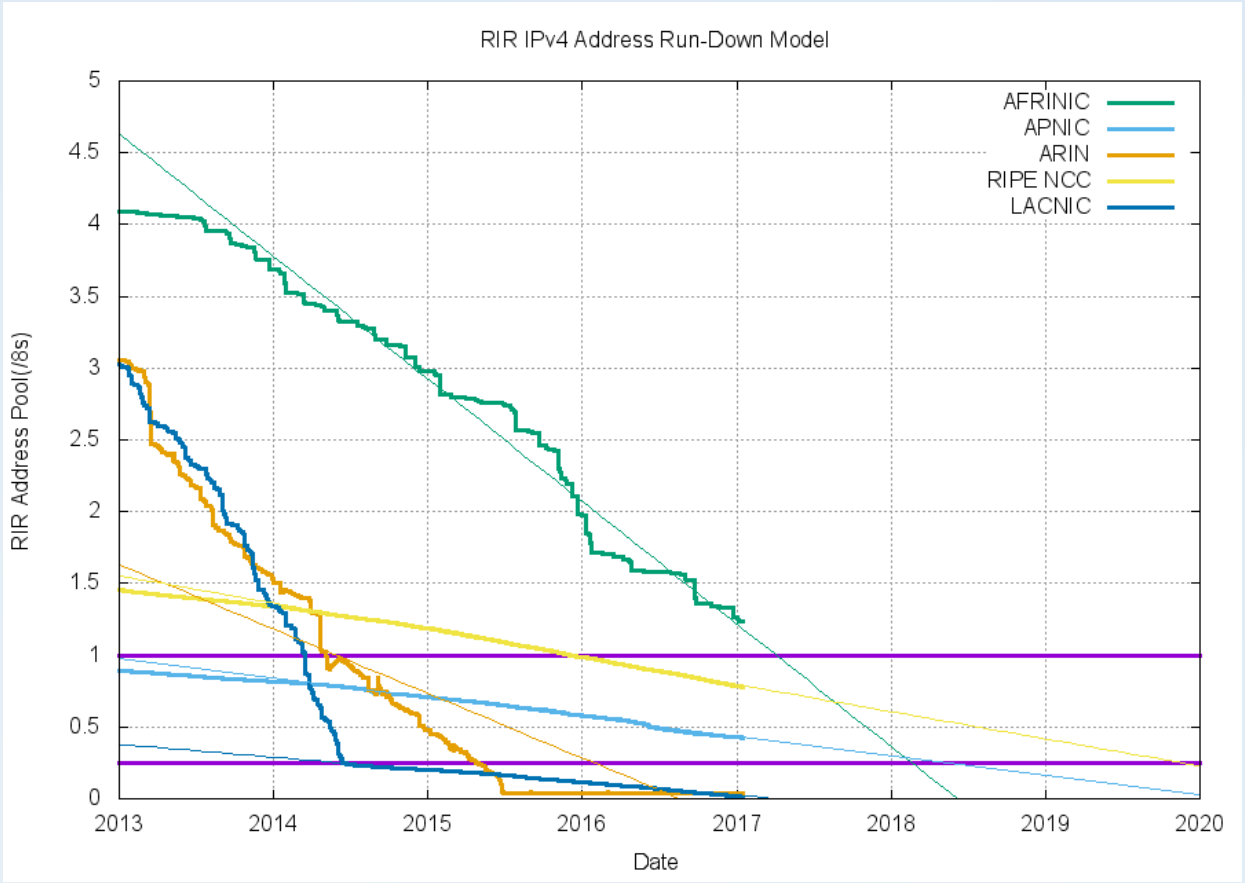
Adopción en Centro América



1. Bélgica 53.6%
2. Suiza 35.9%
3. USA 33.8%
4. Alemania 30.7%
5. Grecia 27.9%
6. Luxemburgo 26.9%
7. Portugal 22.9%
8. Inglaterra 22.0%
9. Perú 18.5%
10. Ecuador 18.1%
16. Trinidad & T 13.5%
18. Brasil 10.9%

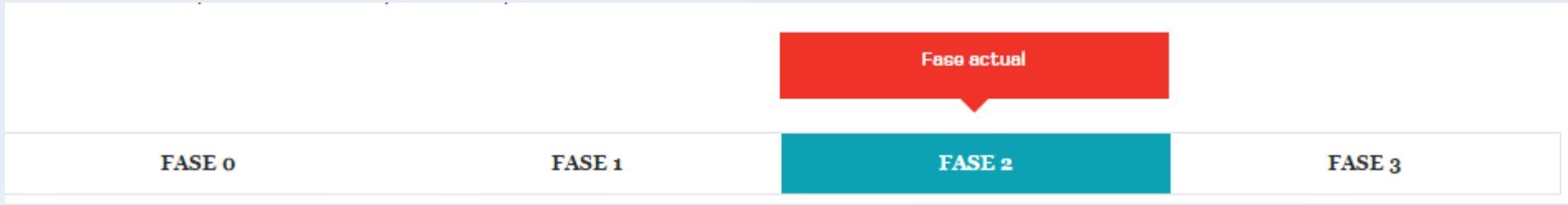
Motivación

Adopción en el mundo



Motivación

Agotamiento del pool de direcciones IPv4



- El 10 de Junio de 2.014 se ha activado la fase 2
- solo se podrá asignar bloques desde un prefijo /24 hasta un /22, pudiendo recibir un bloque adicional cada 6 meses

Motivación

- El 20 de Marzo de 2.017 se espera entrar en la última fase, la 3
- solo se podrá asignar bloques desde un prefijo /24 hasta un /22, a nuevos miembros

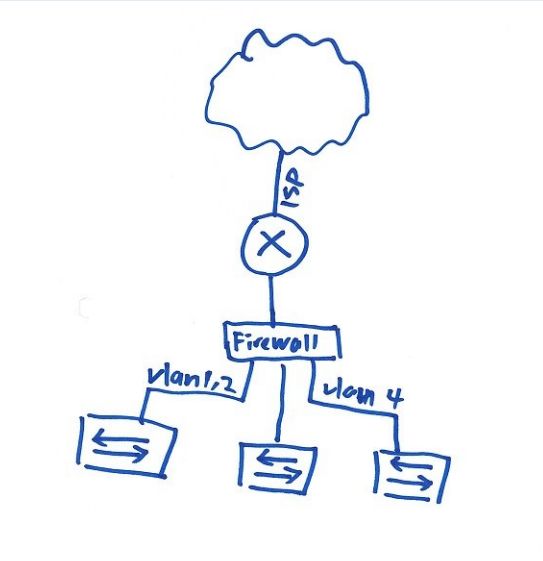
Motivación

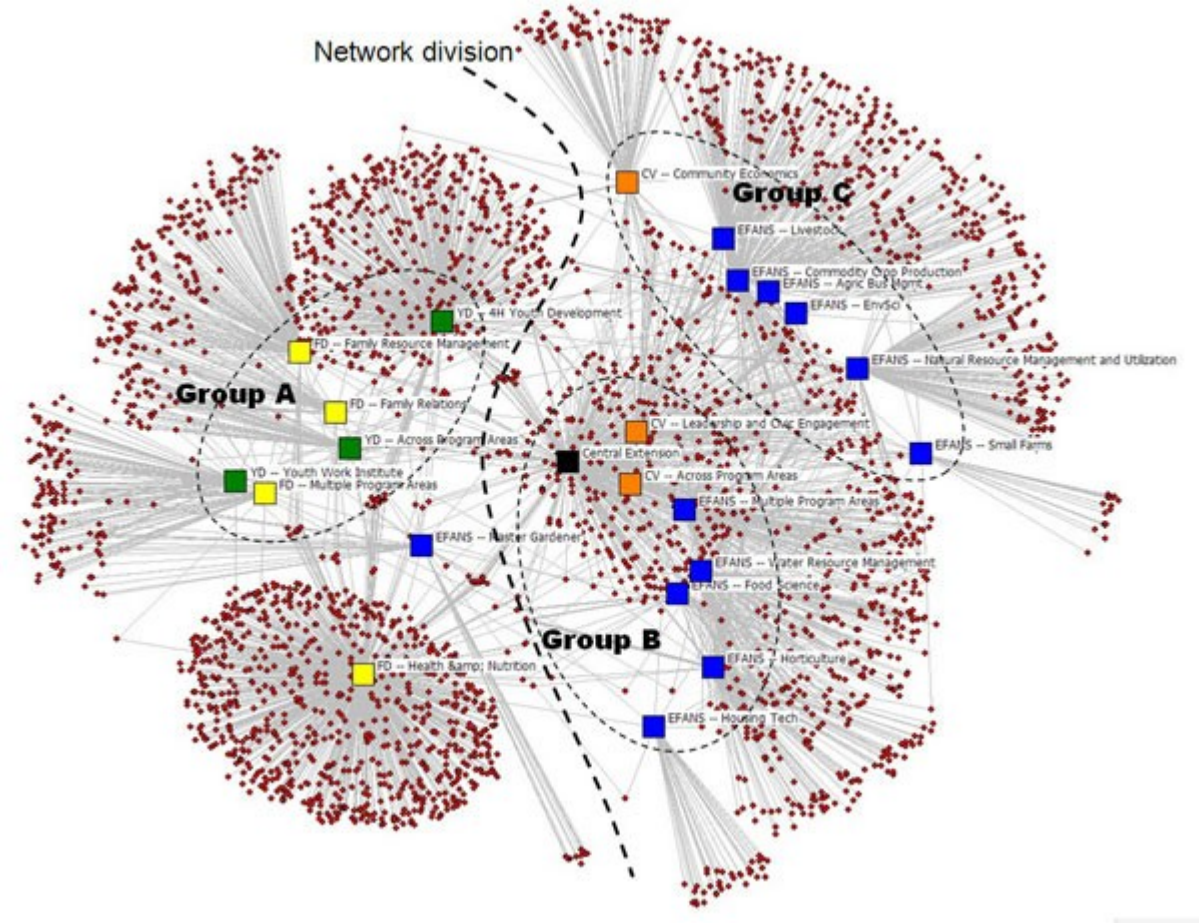
Antes de empezar

- Recursos a solicitar y a quien
- Compatibilidad del Hardware
- Esquema lógico
- Update del Software
- Entrenamiento del personal

Antes de empezar

Detalles del plan





Antes de empezar

La estructura de la red determina el camino a seguir y los recursos a solicitar

- Dual stack (Doble pila)
- 6to4
- 6RD
- Teredo

Antes de empezar

Opciones de despliegue

En febrero del 2011 configuramos un túnel con HE

LACNIC nos asigna la red 2800:640::/32

La anunciamos usando BGP vía el túnel de HE

Primeros Pasos

IPv6 – Hello World

Optamos por usar Dual Stack

OSPFv3 para la distribución interna

Link local (FE80::/10) para la comunicación entre routers

Solo un IPv6 global por equipo (preferiblemente en la loopback)

Un /64 por sitio

Primeros Pasos

Distribución interna

Nomenclatura fácil de entender

Redes /48 para cada función en la red

Red “BackBone”

2800:640:bb::/48

Access Point 2 en sitio 3

2800:640:bb:3::a2

Red “Cliente Final”

2800:640:cf::/48

Cliente 37

2800:640:cf:37::1

Primeros Pasos

Plan de direccionamiento

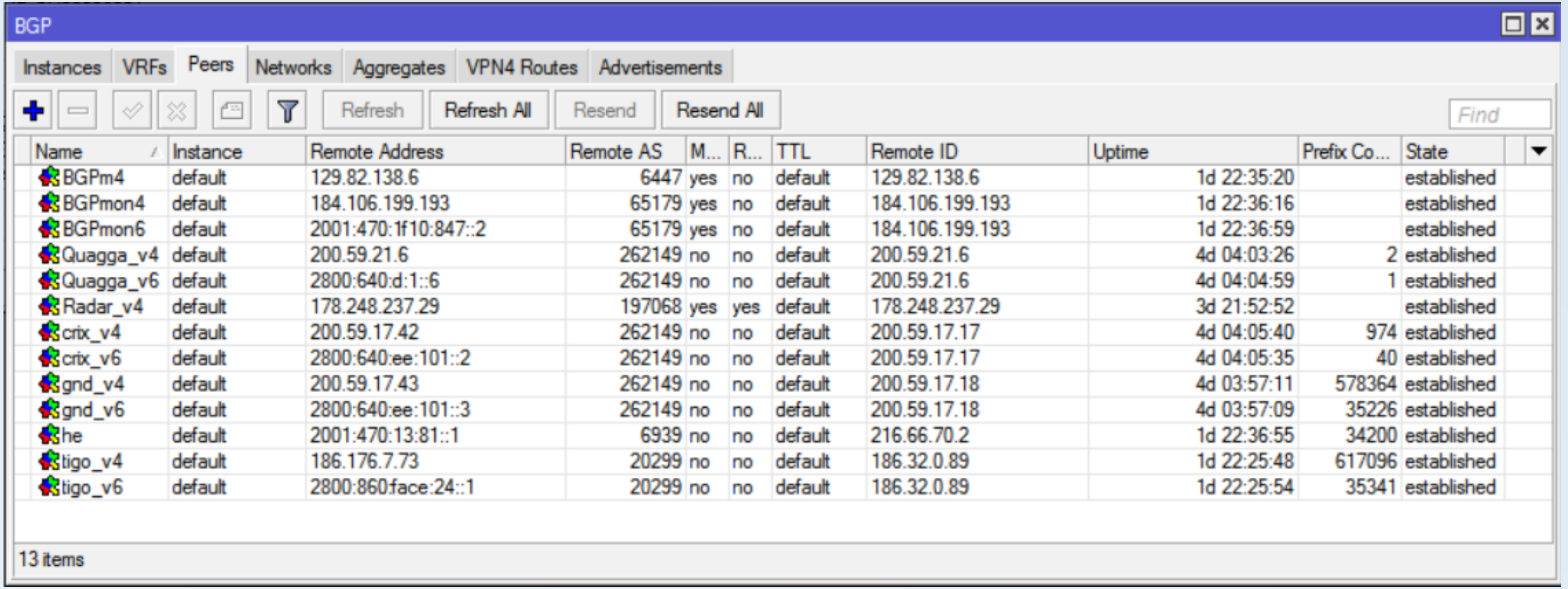
Stateless Address Autoconfiguration (SLAAC)

RA habilitado solo en un equipo de Backbone por sitio

RA habilitado y DHCPv6 en las antenas cliente en la interface Ether1

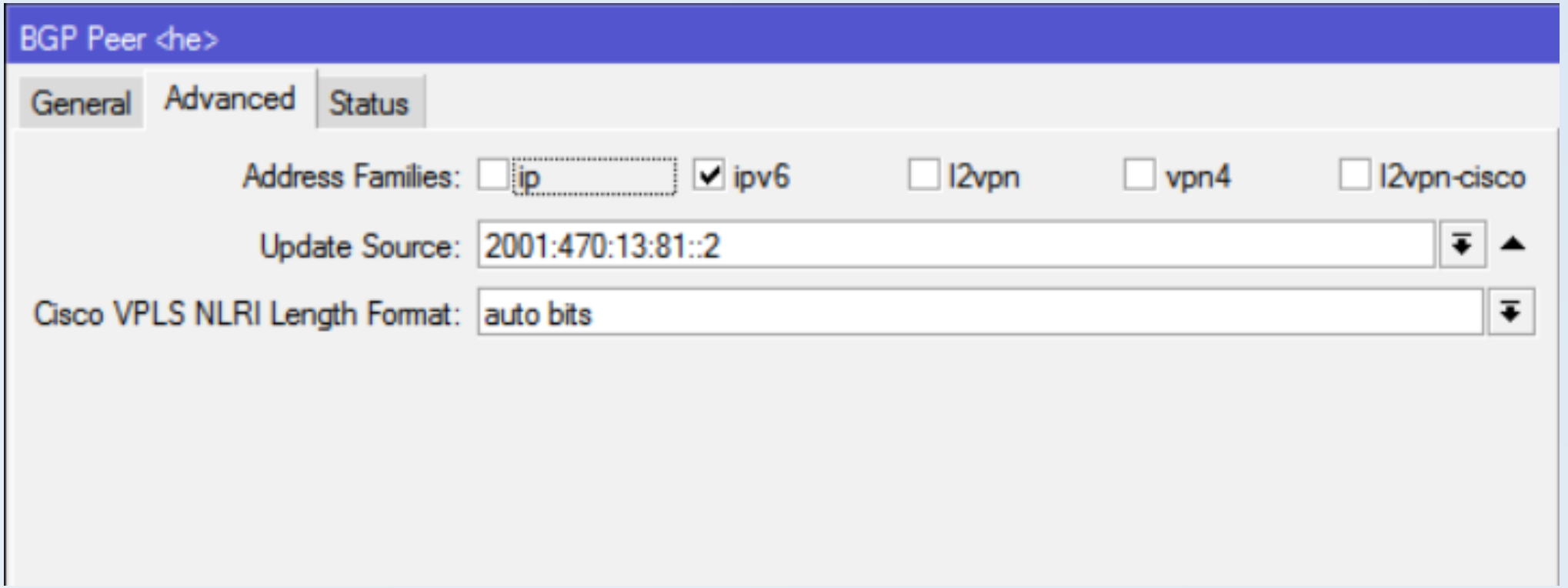
Primeros Pasos

SLAAC - Router Advertisement



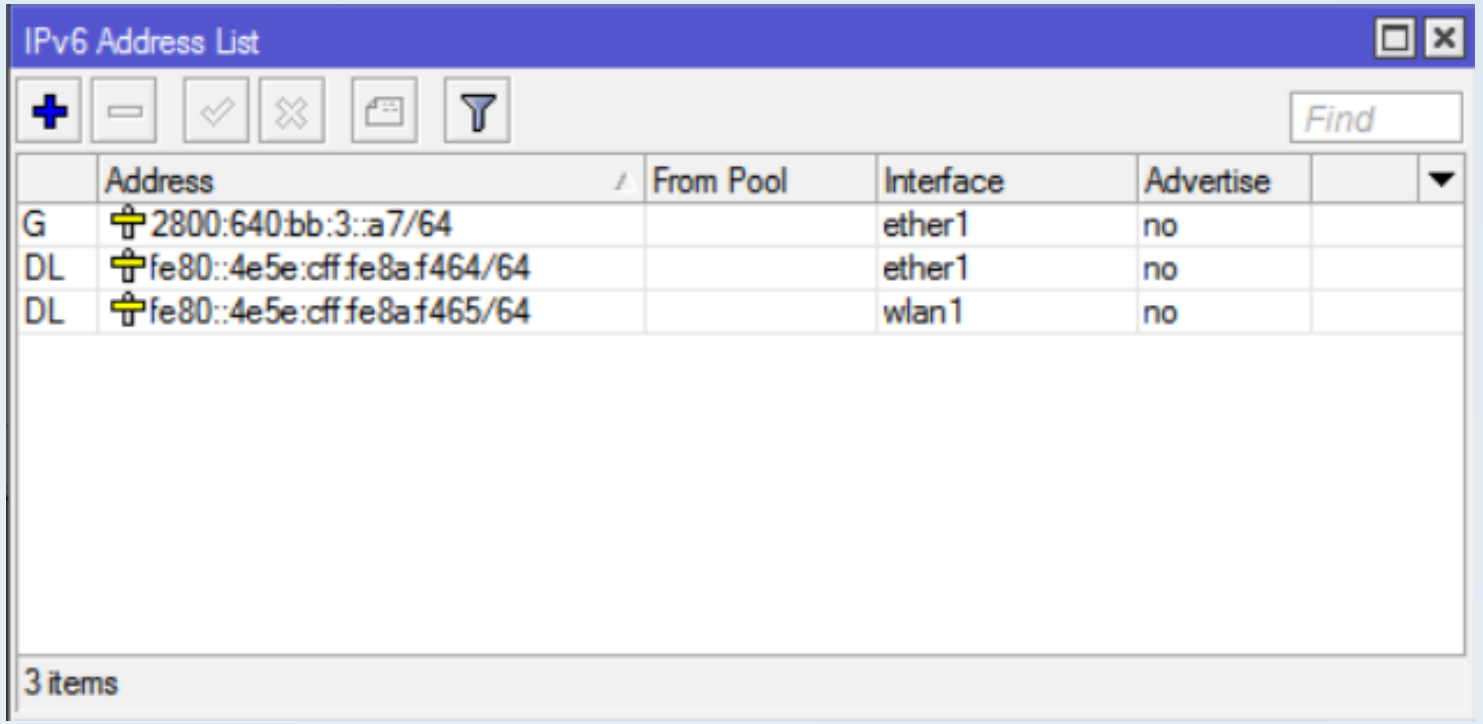
Primeros Pasos

Sesiones BGP



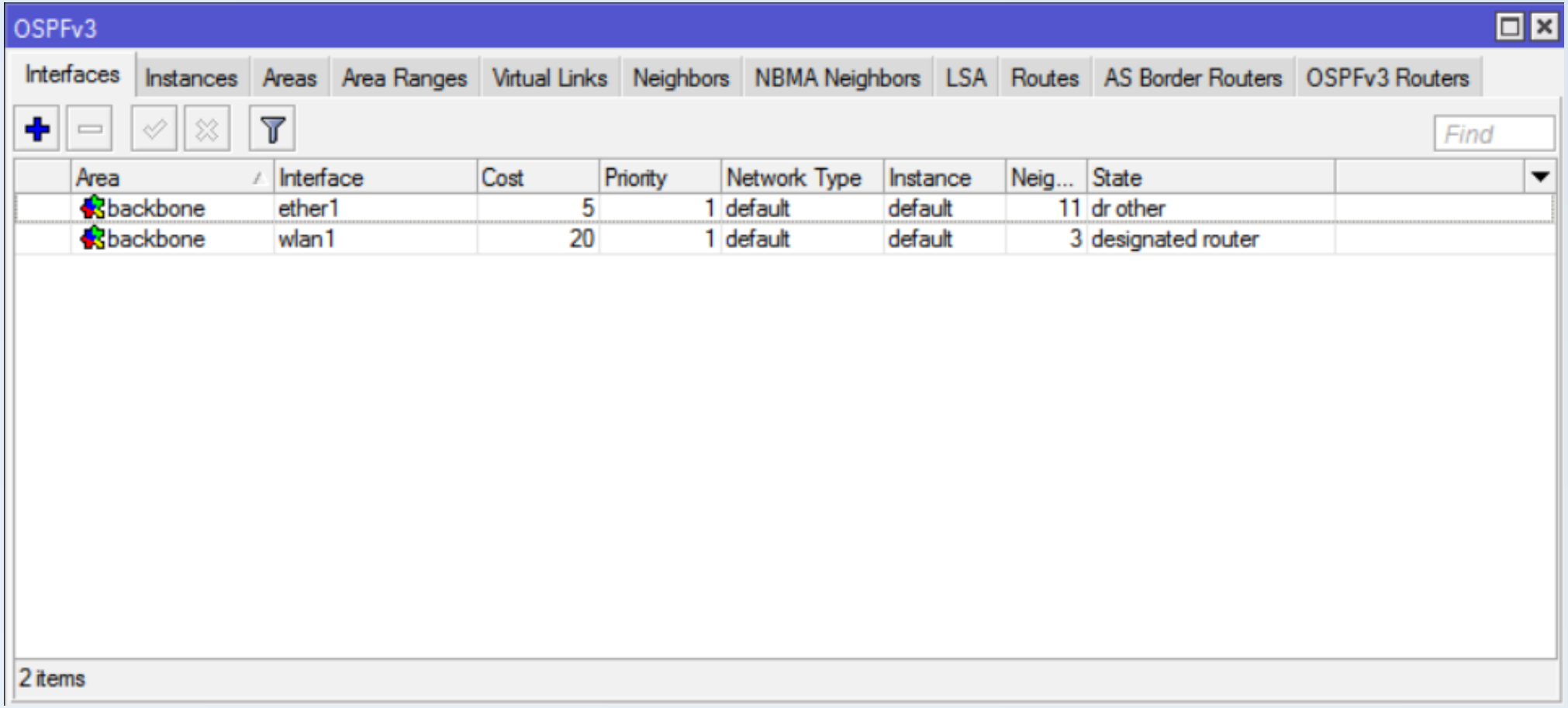
Primeros Pasos

Peer BGP



Primeros Pasos

Asignación de IPs v6 Access Point



Primeros Pasos

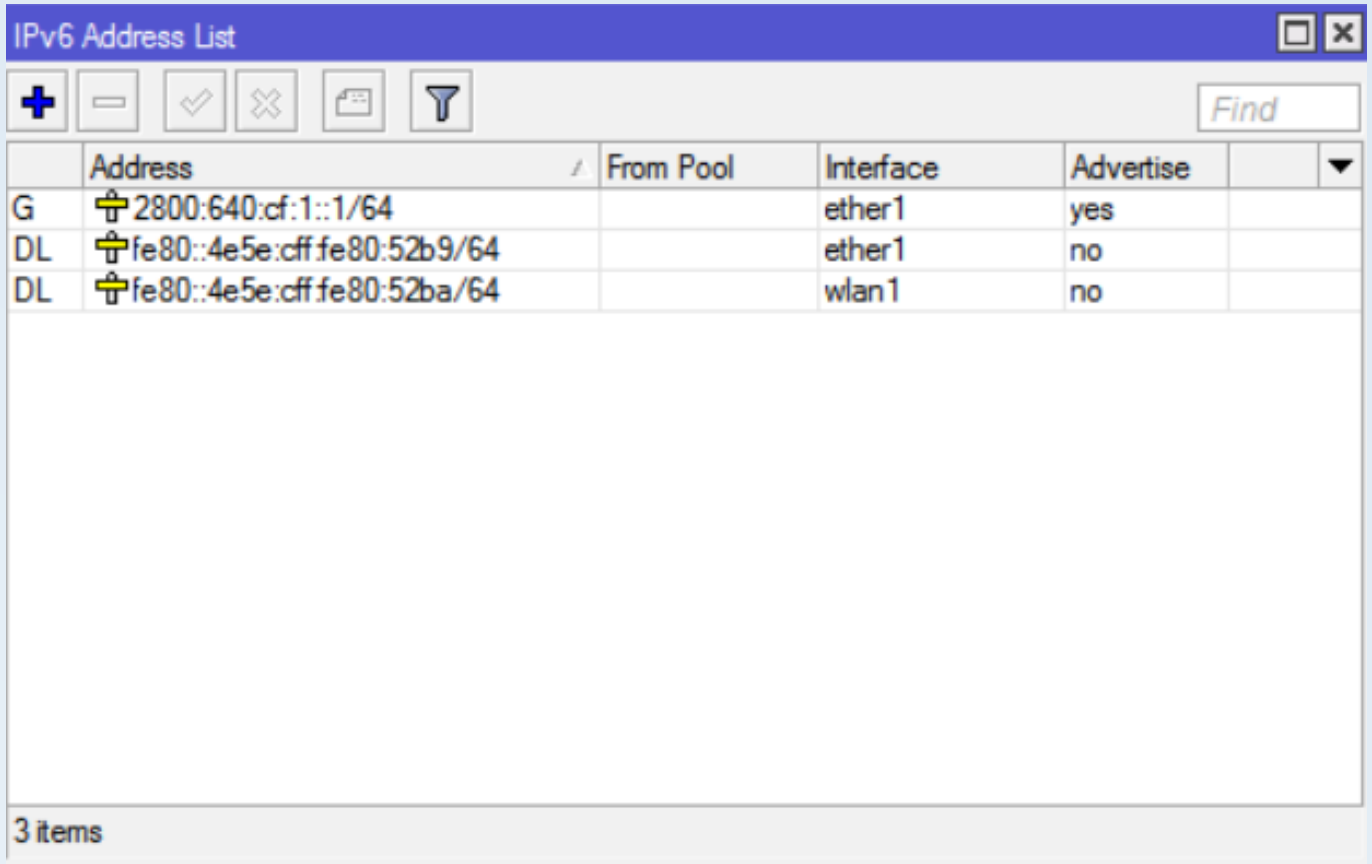
Configuración OSPF v3

Primeros Pasos

Tabla de ruteo IPv6

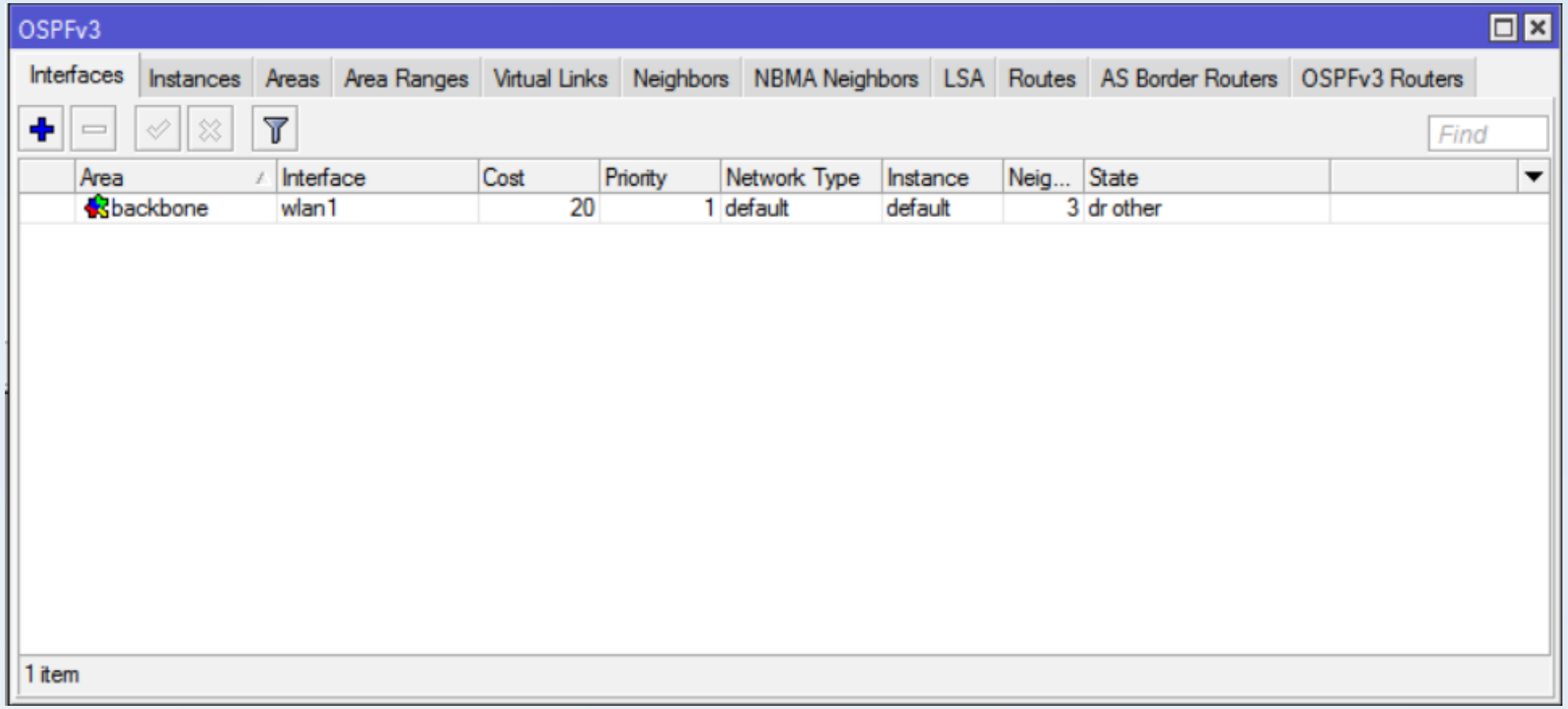
IPv6 Route List

	Dst. Address	Gateway	Distance
DAo	::/0	fe80::4e5e:cff:fe8f:8fb0%ether1 reachable	110
DAo	2000::/3	fe80::4e5e:cff:fe8f:8fb0%ether1 reachable	110
DAo	2001:470:13:81::/64	fe80::4e5e:cff:fe8f:8fb0%ether1 reachable	110
DAo	2001:13d8:a800::4/126	fe80::4e5e:cff:fe8f:8fb0%ether1 reachable	110
DAo	2607:f238:2::1	fe80::4e5e:cff:fe8f:8fb0%ether1 reachable	110
DAo	2800:640:d:1::/64	fe80::4e5e:cff:fe8f:8fb0%ether1 reachable	110
DAo	2800:640:f:1000::/64	fe80::4e5e:cff:fe8f:8fb0%ether1 reachable	110
DAo	2800:640:f:1111::/64	fe80::4e5e:cff:fe8f:8fb0%ether1 reachable	110
DAo	2800:640:f:2000::/64	fe80::4e5e:cff:fe8f:8fb0%ether1 reachable	110
DAo	2800:640:f:2222::/64	fe80::4e5e:cff:fe8f:8fb0%ether1 reachable	110
DAo	2800:640:f:6666::/64	fe80::4e5e:cff:fe8f:8fb0%ether1 reachable	110
DAo	2800:640:bb:1::/64	fe80::4e5e:cff:fe8f:8fb0%ether1 reachable	110
DAo	2800:640:bb:2::/64	fe80::4e5e:cff:fe8f:8fb0%ether1 reachable	110
DAC	2800:640:bb:3::/64	ether1 reachable	0
DAo	2800:640:bb:4::/64	fe80::4e5e:cff:fe63:4b44%ether1 reachable	110
DAo	2800:640:bb:5::/64	fe80::4e5e:cff:fe8f:8fb0%ether1 reachable	110
DAo	2800:640:bb:6::/64	fe80::4e5e:cff:fe8f:8fb0%ether1 reachable	110
DAo	2800:640:bb:7::/64	fe80::4e5e:cff:fe63:4b44%ether1 reachable	110
DAo	2800:640:bb:8::/64	fe80::4e5e:cff:fe8f:8fb0%ether1 reachable	110
DAo	2800:640:bb:9::/64	fe80::4e5e:cff:fe63:4b44%ether1 reachable	110
DAo	2800:640:bb:10::/64	fe80::4e5e:cff:fe8f:8fb0%ether1 reachable	110
DAo	2800:640:bb:11::/64	fe80::4e5e:cff:fe8f:8fb0%ether1 reachable	110
DAo	2800:640:bb:12::/64	fe80::4e5e:cff:fe8f:8fb0%ether1 reachable	110
DAo	2800:640:bb:13::/64	fe80::4e5e:cff:fe8d:223c%ether1 reachable	110
DAo	2800:640:bb:14::/64	fe80::4e5e:cff:fe8d:223c%ether1 reachable	110
DAo	2800:640:bb:15::/64	fe80::4e5e:cff:fe8d:223c%ether1 reachable	110
DAo	2800:640:bb:16::/64	fe80::4e5e:cff:fe8d:223c%ether1 reachable	110
DAo	2800:640:bb:20::/64	fe80::4e5e:cff:fe8f:8fb0%ether1 reachable	110
DAo	2800:640:bb:21::/64	fe80::4e5e:cff:fe8f:8fb0%ether1 reachable	110
DAo	2800:640:bb:22::/64	fe80::4e5e:cff:fe8f:8fb0%ether1 reachable	110
DAo	2800:640:bb:23::/64	fe80::4e5e:cff:fe8f:8fb0%ether1 reachable	110
DAo	2800:640:cf:1::/64	fe80::4e5e:cff:fe80:52ba%wlan1 reachable	110
DAo	2800:640:cf:2::/64	fe80::4e5e:cff:fe8f:8fb0%ether1 reachable	110
DAo	2800:640:cf:3::/64	fe80::e68d:8cff:fe61:57c7%wlan1 reachable	110
DAo	2800:640:cf:6::/64	fe80::4e5e:cff:fe63:4b44%ether1 reachable	110
DAo	2800:640:cf:7::/64	fe80::4e5e:cff:fe63:4b44%ether1 reachable	110
DAo	2800:640:cf:8::/64	fe80::4e5e:cff:fe63:4b44%ether1 reachable	110
DAo	2800:640:cf:9::/64	fe80::4e5e:cff:fe8f:8fb0%ether1 reachable	110
DAo	2800:640:cf:10::/64	fe80::4e5e:cff:fe8d:223c%ether1 reachable	110
DAo	2800:640:cf:11::/64	fe80::4e5e:cff:fe8f:8fb0%ether1 reachable	110



Primeros Pasos

Configuración IPs v6 cliente



Primeros Pasos

OSPFv3 Cliente

```
PS C:\Users\jorge> ipconfig

Configuración IP de Windows


Adaptador de Ethernet Ethernet 2:

   Sufijo DNS específico para la conexión. . :
   Dirección IPv6 . . . . . . . . . . . . : 2800:640:cf:1:f5b0:bd38:f98e:dab2
   Dirección IPv6 temporal. . . . . . . . : 2800:640:cf:1:a1da:3192:1727:9bb5
   Vínculo: dirección IPv6 local. . . . . : fe80::f5b0:bd38:f98e:dab2%16
   Dirección IPv4. . . . . . . . . . . . . . : 192.168.11.83
   Máscara de subred . . . . . . . . . . . . : 255.255.255.0
   Puerta de enlace predeterminada . . . . . : fe80::4e5e:cff:fe80:52b9%16
                                               192.168.11.1
```

Primeros Pasos

IPv6 stateless autoconfiguration

```
PS C:\Users\jorge> tracert www.google.com

Traza a la dirección www.google.com [2607:f8b0:4008:807::2004]
sobre un máximo de 30 saltos:

  1    <1 ms    <1 ms    <1 ms  ether1.mikrotik-casa-jorge.fratec.net [2800:640:cf:1::1]
  2    11 ms     9 ms     3 ms  ether1.mikrotik-ap-sm7.fratec.net [2800:640:bb:3::a7]
  3     8 ms     5 ms    10 ms  ether1.mikrotik-bb-sm1.fratec.net [2800:640:bb:3::b1]
  4    15 ms     9 ms    14 ms  ether1.mikrotik-bb-noc-2.fratec.net [2800:640:bb:1::b2]
  5    18 ms    17 ms    21 ms  ether3.mikrotik-bb-zeus.fratec.net [2800:640:bb:1::1]
  6    15 ms    16 ms    27 ms  sfp-sfpplus1.mikrotik-bb-router-gnd1.fratec.net [2800:640:ee:101::3]
  7    29 ms    55 ms    38 ms  2803:1300::e:c:0:2
  8    16 ms    16 ms    12 ms  2803:1300::e:0:103:1
  9    18 ms    36 ms    19 ms  2607:f438:0:3502:190:242:134:95
 10    46 ms    44 ms    35 ms  2607:f438:0:1:63:245:107:189
 11    57 ms    70 ms    71 ms  2607:f438:0:1:63:245:107:126
 12    54 ms    58 ms    53 ms  2607:f438:0:1002:63:245:6:182
 13    68 ms    75 ms    61 ms  2001:4860::1:0:245c
 14    60 ms    56 ms    92 ms  2001:4860:0:1::f5
 15    54 ms    90 ms    76 ms  mia07s25-in-x04.1e100.net [2607:f8b0:4008:807::2004]

Traza completa.
```

Primeros Pasos

Traceroute

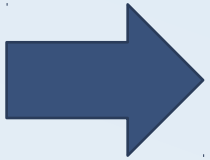
Otros equipos (routers) en la red

Red “Cliente Final DHCP”

2800:640:cfd::/48

Cliente 37

2800:640:cfd:370::/60



2800:640:cfd:370::/64

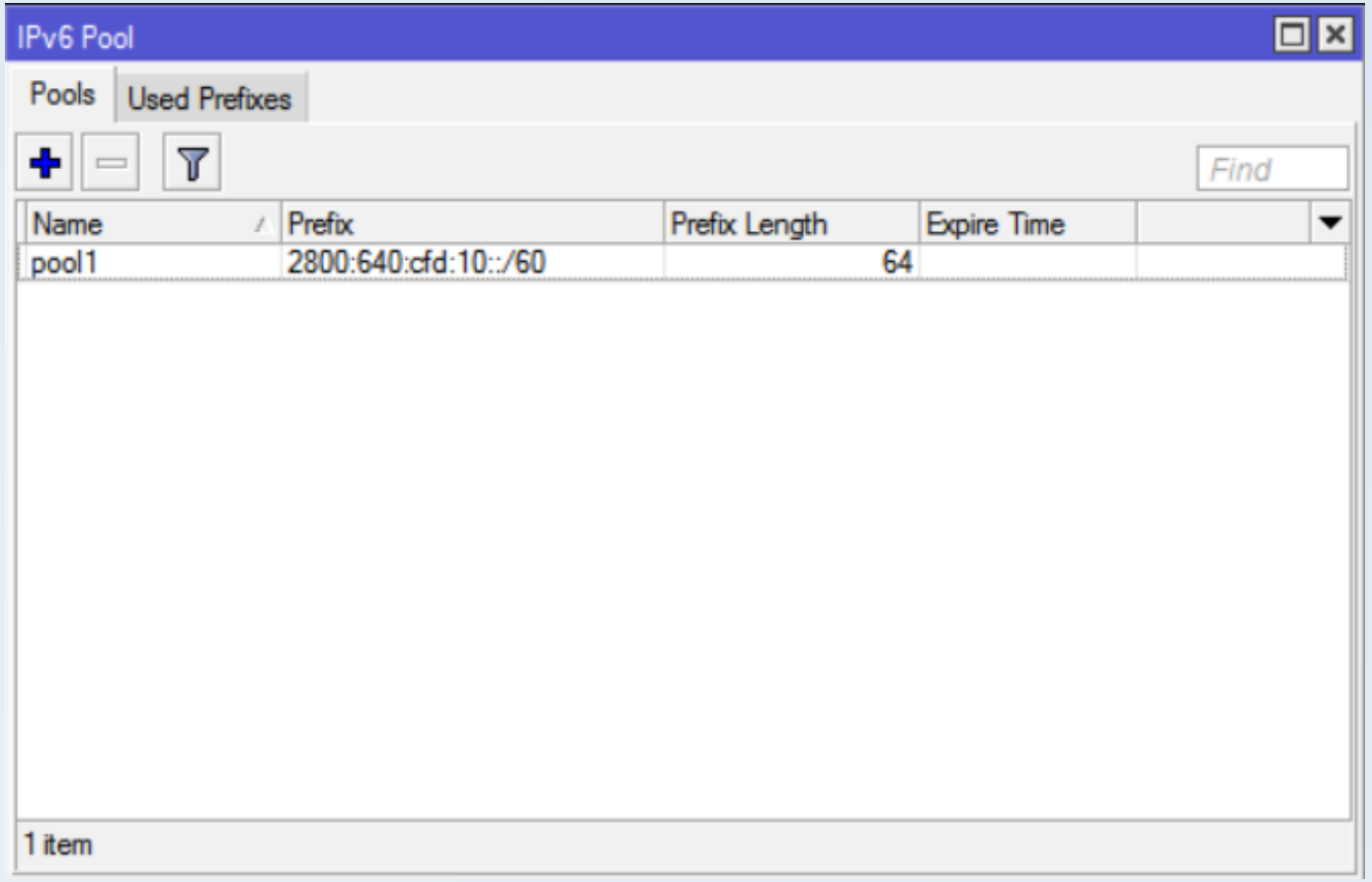
2800:640:cfd:371::/64

…

2800:640:cfd:37f::/64

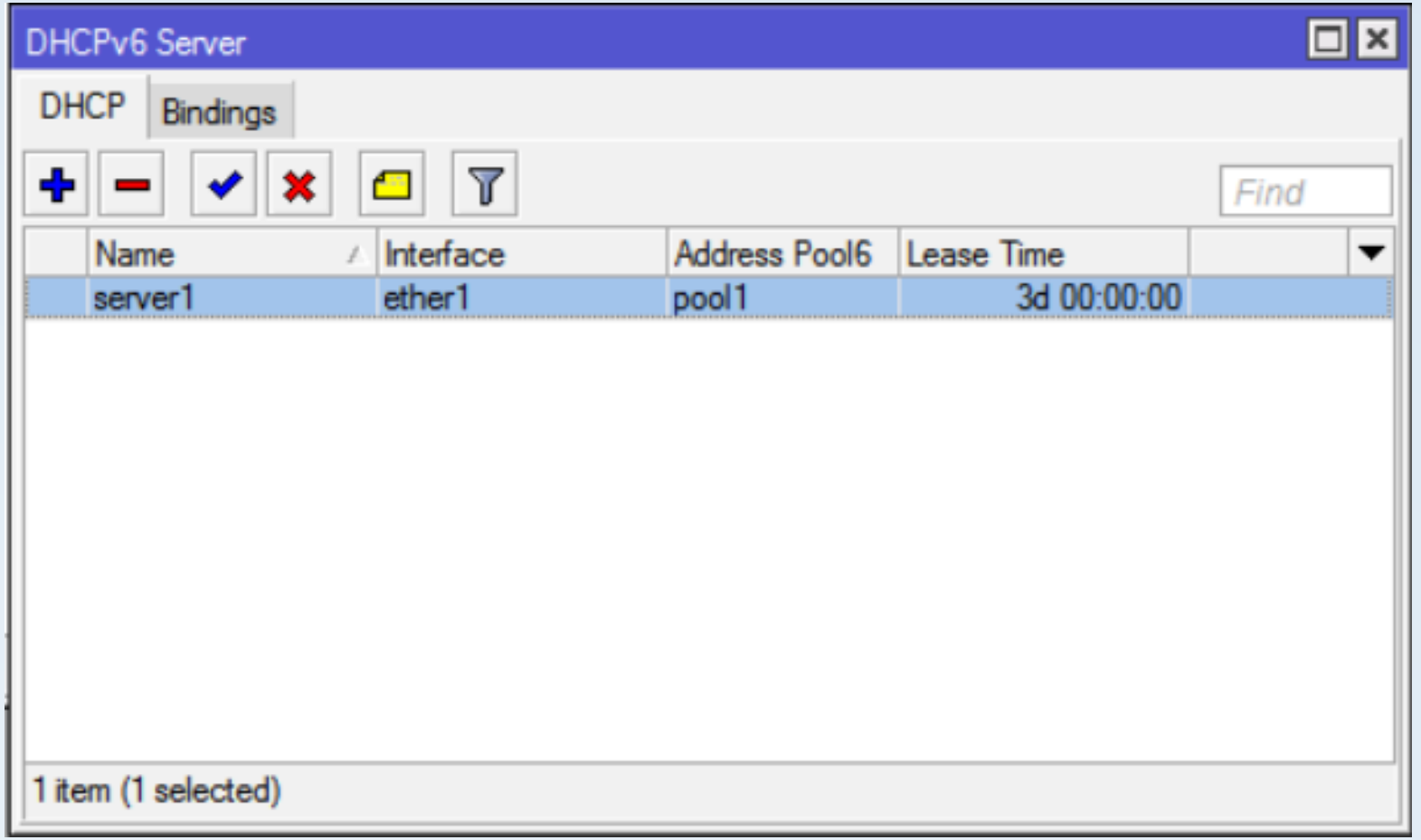
Primeros Pasos

DHCPv6



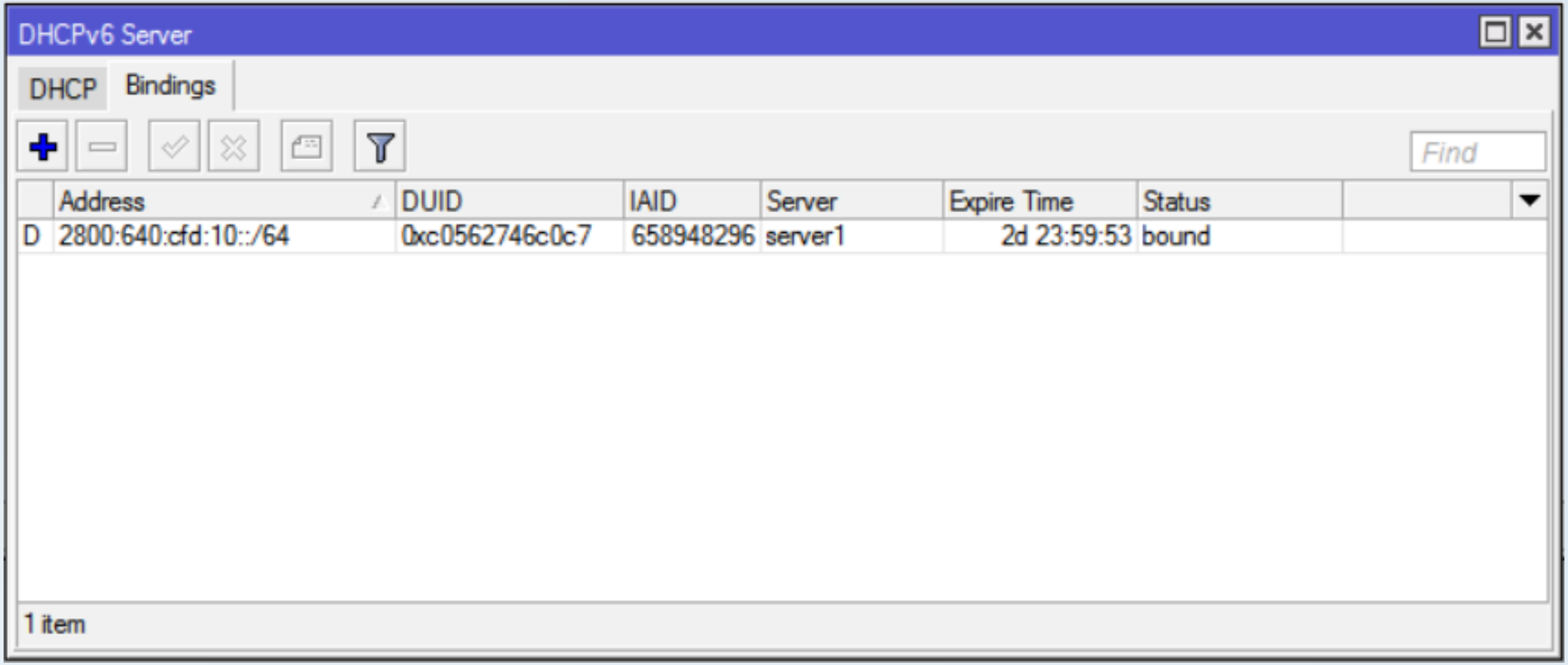
Primeros Pasos

DHCPv6 - Pool



Primeros Pasos

DHCPv6



Primeros Pasos

DHCPv6

Primeros Pasos

IPv6 stateless autoconfiguration

```
PS C:\Users\jorge> tracert www.google.com

Traza a la dirección www.google.com [2607:f8b0:4008:807::2004]
sobre un máximo de 30 saltos:

  1     8 ms     1 ms     8 ms  2800:640:cfd:10:c256:27ff:fe46:c0c7
  2    14 ms    14 ms     9 ms  ether1.mikrotik-casa-jorge.fratec.net [2800:640:cf:1::1]
  3    55 ms    27 ms    27 ms  ether1.mikrotik-ap-sm7.fratec.net [2800:640:bb:3::a7]
  4    18 ms    17 ms    17 ms  ether1.mikrotik-bb-sm1.fratec.net [2800:640:bb:3::b1]
  5    28 ms    17 ms    28 ms  ether1.mikrotik-bb-noc-2.fratec.net [2800:640:bb:1::b2]
  6    43 ms    45 ms    55 ms  ether3.mikrotik-bb-zeus.fratec.net [2800:640:bb:1::1]
  7    27 ms    27 ms    27 ms  sfp-sfpplus1.mikrotik-bb-router-gnd1.fratec.net [2800:640:ee:101::3]
  8    29 ms    67 ms    37 ms  2803:1300::e:c:0:2
  9    29 ms    37 ms    37 ms  2803:1300::e:0:103:1
 10    30 ms    36 ms    28 ms  2607:f438:0:3502:190:242:134:95
 11    50 ms    47 ms    35 ms  2607:f438:0:1:63:245:106:167
 12    74 ms    77 ms   107 ms  2607:f438:0:1:63:245:107:126
 13    72 ms    78 ms    67 ms  2607:f438:0:1002:63:245:6:182
 14    75 ms    77 ms    74 ms  2001:4860::1:0:245c
 15    81 ms    83 ms    97 ms  2001:4860:0:1::f5
 16    70 ms   107 ms    84 ms  mia07s25-in-x04.1e100.net [2607:f8b0:4008:807::2004]

Traza completa.
```

Primeros Pasos

Traceroute

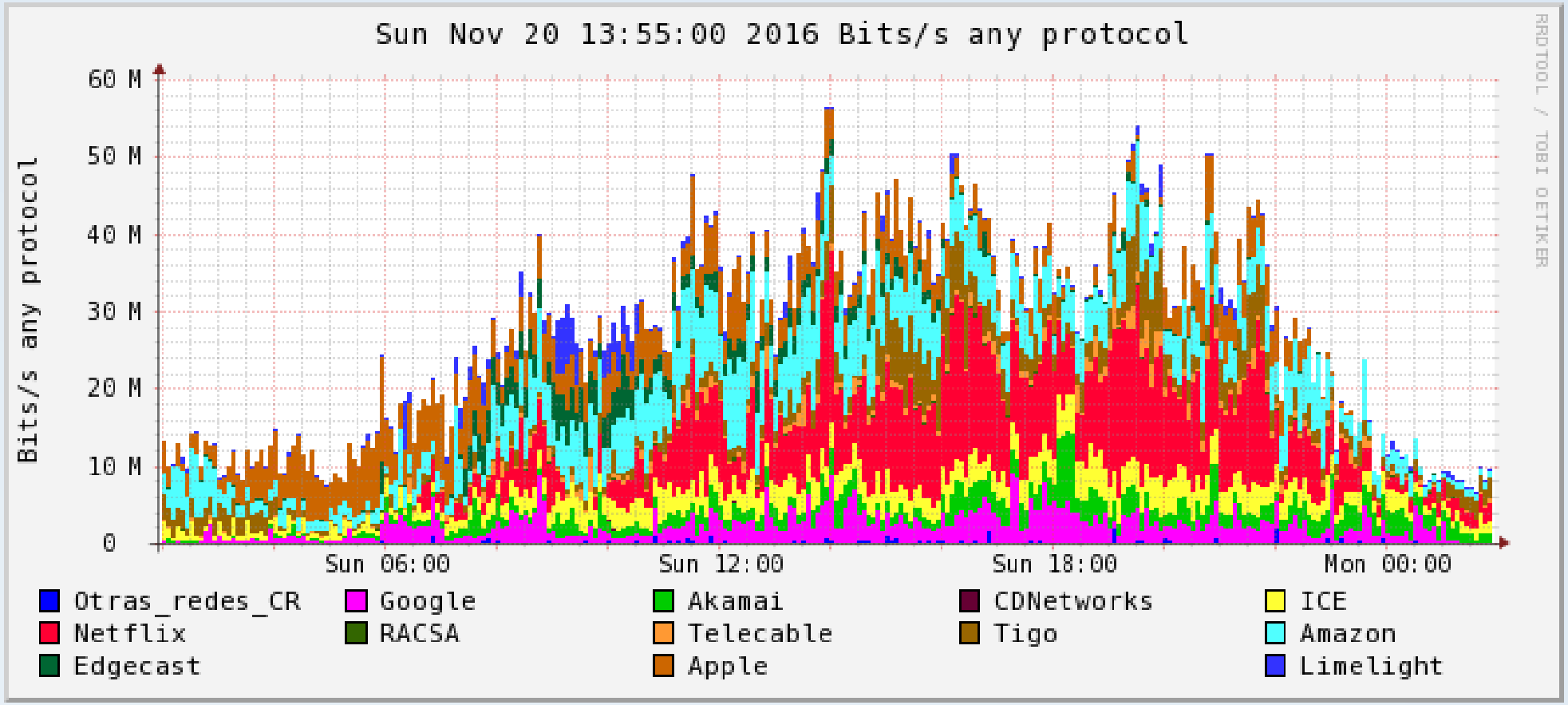
```
/ipv6 firewall address-list
add address=2800:640:cf::/48 list=valid
add address=2800:640:cfd::/48 list=valid
/ipv6 firewall filter
add action=drop chain=forward in-interface=ether1 src-address-list=!valid
```

Primeros Pasos

Firewall – IETF BCP 38

Implementando IPv6 en todo

VPN, DNS, Correo, Páginas Web, etc.



Implementando IPv6 en todo

Monitoreo – Herramientas como NFSen ocupan netflow v9 para desplegar IPv6

```
Top 20 flows ordered by flows:
Date flow start          Duration Proto                                    Src IP Addr:Port                                    Dst IP Addr:Port   Packets    Bytes Flows
2016-11-21 16:52:23.040  1707.860 TCP                        2801:1d:a001:1::d.443   ->      2800:640:cf:57:3100:2f67:e201:7377.54450    22695   28.9 M    78
2016-11-21 16:52:23.000  1707.870 TCP       2800:640:cf:57:3100:2f67:e201:7377.54450 ->                        2801:1d:a001:1::d.443     12215   958264    78
2016-11-21 16:46:10.680  2319.310 UDP                        2801:1d:a001:1::c.443   ->      2800:640:cf:18:c4ca:306b:2cfb:6fcc.53776    68802   95.9 M    55
2016-11-21 16:46:10.680  2319.310 UDP       2800:640:cf:18:c4ca:306b:2cfb:6fcc.53776 ->                        2801:1d:a001:1::c.443     36143   3.4 M     54
2016-11-21 15:51:42.720  1688.990 UDP                        2801:1d:a001:1::d.443   ->        2800:640:cf:18:89f:e64:4b2c:c7b2.48030    32854   44.6 M    50
2016-11-21 15:51:42.700  1688.980 UDP         2800:640:cf:18:89f:e64:4b2c:c7b2.48030 ->                        2801:1d:a001:1::d.443     17041   1.7 M     50
2016-11-21 16:03:49.260  3097.500 UDP                        2801:1d:a001:1::c.443   ->    2800:640:cfd:440:e4dd:8368:391a:14fb.14600    56724   78.2 M    49
2016-11-21 16:03:49.260  3097.470 UDP     2800:640:cfd:440:e4dd:8368:391a:14fb.14600 ->                        2801:1d:a001:1::c.443     29105   2.8 M     49
2016-11-21 15:46:43.060  6177.540 UDP       2800:640:cf:64:d4e0:5dc6:cd42:4d95.27428 ->                        2801:1d:a001:1::d.443     239753  21.8 M    40
2016-11-21 15:46:43.100  6177.500 UDP                        2801:1d:a001:1::d.443   ->      2800:640:cf:64:d4e0:5dc6:cd42:4d95.27428    474759  658.5 M   40
2016-11-21 16:39:32.490  1191.410 UDP                        2801:1d:a001:1::d.443   ->      2800:640:cf:70:cc8a:f977:61bd:423d.52815    25013   33.7 M    36
2016-11-21 16:39:32.480  1191.820 UDP       2800:640:cf:70:cc8a:f977:61bd:423d.52815 ->                        2801:1d:a001:1::d.443     12622   1.2 M     35
2016-11-21 15:32:49.850  1056.810 UDP                        2801:1d:a001:1::d.443   ->        2800:640:cf:18:89f:e64:4b2c:c7b2.24439    23733   32.9 M    30
2016-11-21 15:32:49.830  1056.820 UDP         2800:640:cf:18:89f:e64:4b2c:c7b2.24439 ->                        2801:1d:a001:1::d.443     12659   1.2 M     30
2016-11-21 15:44:02.880  1132.050 TCP                        2801:1d:a001:1::d.443   ->        2800:640:cf:1:5cf:ea95:5070:fb44.61395    7944    10.1 M    27
2016-11-21 15:44:02.840  1132.070 TCP         2800:640:cf:1:5cf:ea95:5070:fb44.61395 ->                        2801:1d:a001:1::d.443     5219    532524    27
2016-11-21 15:44:28.210   556.550 TCP                        2801:1d:a001:1::c.443   ->      2800:640:cf:57:6dfd:7d46:8263:164f.51653    17591   22.5 M    19
2016-11-21 15:44:28.180   556.560 TCP       2800:640:cf:57:6dfd:7d46:8263:164f.51653 ->                        2801:1d:a001:1::c.443     14893   980920    19
2016-11-21 16:03:48.780  3073.790 Frag6     2800:640:cfd:440:e4dd:8368:391a:14fb.0   ->                        2801:1d:a001:1::c.0       47      8178      17
2016-11-21 16:46:22.560   325.540 TCP                        2801:1d:a001:1::d.443   ->      2800:640:cf:57:3100:2f67:e201:7377.54413    4015    5.1 M     13

Summary: total flows: 3369, total bytes: 2.6 G, total packets: 2.9 M, avg bps: 3.0 M, avg pps: 412, avg bpp: 908
Time window: 2016-11-21 15:06:22 - 2016-11-21 17:29:43
Total flows processed: 2932398, Blocks skipped: 0, Bytes read: 176354532
Sys: 0.290s flows/second: 10078527.6 Wall: 0.288s flows/second: 10151377.6
```

Implementando IPv6 en todo

Monitoreo – Herramientas como NFSen ocupan netflow v9 para desplegar IPv6

Mantener los mismos nombres para los registros A (IPv4) y AAAA (IPv6)

No usar menos de /64 aunque sean 2 equipos

Asignar redes /48 /56 o /60 a los clientes de manera estática

No filtrar ICMP

Preferir Router Advertisement sobre DHCP

DNS gestionable por el cliente final

BCP38

Implementando IPv6 en todo

Buenas prácticas

Preguntas?