Configuración de Direcciones IPv6

CDD2

Alternativas de configuración

Configuración de direcciones en los equipos

- Configuración automática de direcciones Ipv6 de alcance local en cada interfaz (fe80::/8)
- Configuración automática de direcciones de alcance site (ULA) y global: los routers pueden anunciar prefijos, los hosts crean una dirección por cada prefijo recibido en cada interfaz (proceso “router discovery” -radvd-)
- Configuración automática (DHCPv6)
- Configuración de direcciones específicas
- Configuración manual (ip -6 addr add)

Configuración de rutas

- Configuración manual (ip -6 route add …)
- Configuracion automatica (RIPng, OSPFv3, etc)

Neighbor Discovery (1)

Protocolo basado en ICMPv6

Funciones:

- Descubrimiento de routers en el link
- Autoconfiguración de direcciones (de diferentes alcances)
- Configuración con parámetros asignados al link
- Resolución de direcciones (ARP de IPv4)
- Chequeo de direcciones duplicadas en el link
- Descubrimiento del router correcto para un destino
- Determinación del estado de los nodos vecinos en el link (network unreachability detection -NUD-)

Neighbor Discovery (2)

Protocolo basado en ICMPv6

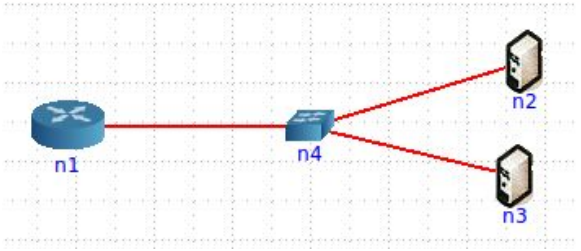
Funciones ICMPv6 utilizados

- Neighbor Solicitation (NS)
- Neighbor Advertisment (NA)
- Router Solicitation (RS)
- Router Advertisment (RA)
- Redirect

Obtención de dirección en el host (1)

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	::	ff02::16	ICMPv6	90	Multicast Listener Report Message v2
2	0.970238	::	ff02::1:ffaa:2	ICMPv6	78	Neighbor Solicitation for fe80::200:ff:feaa:2
3	1.969536	fe80::200:ff:feaa:2	ff02::2	ICMPv6	70	Router Solicitation from 00:00:00:aa:00:02
4	1.970028	fe80::200:ff:feaa:0	ff02::1	ICMPv6	142	Router Advertisement from 00:00:00:aa:00:00
5	5.899429	fe80::200:ff:feaa:2	ff02::16	ICMPv6	90	Multicast Listener Report Message v2
6	5.980046	fe80::200:ff:feaa:2	ff02::2	ICMPv6	70	Router Solicitation from 00:00:00:aa:00:02

```
▷ Frame 1: 90 bytes on wire (720 bits), 90 bytes captured (720 bits)
▷ Ethernet II, Src: 00:00:00_aa:00:02 (00:00:00:aa:00:02), Dst: IPv6mcast_00:00:00:16 (33:33:00:00:00:16)
▽ Internet Protocol Version 6, Src: :: (::), Dst: ff02::16 (ff02::16)
  ▷ 0110 .... = Version: 6
  ▷ .... 0000 0000 .... .... .... .... .... = Traffic class: 0x00000000
    .... .... .... 0000 0000 0000 0000 0000 = Flowlabel: 0x00000000
    Payload length: 36
    Next header: IPv6 hop-by-hop option (0x00)
    Hop limit: 1
    Source: :: (::)
    Destination: ff02::16 (ff02::16)
  ▷ Hop-by-Hop Option
▽ Internet Control Message Protocol v6
    Type: Multicast Listener Report Message v2 (143)
    Code: 0
    Checksum: 0x6ede [correct]
    Reserved: 0000
```



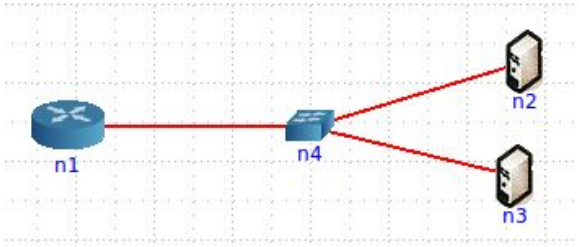
Frame 1:

- Anuncio de pertenencia al grupo (solicited node address)
- Uso de dirección no especifica

Obtención de dirección en el host (2)

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	::	ff02::16	ICMPv6	90	Multicast Listener Report Message v2
2	0.970238	::	ff02::1:ffaa:2	ICMPv6	78	Neighbor Solicitation for fe80::200:ff:feaa:2
3	1.969536	fe80::200:ff:feaa:2	ff02::2	ICMPv6	70	Router Solicitation from 00:00:00:aa:00:02
4	1.970028	fe80::200:ff:feaa:0	ff02::1	ICMPv6	142	Router Advertisement from 00:00:00:aa:00:00
5	5.899429	fe80::200:ff:feaa:2	ff02::16	ICMPv6	90	Multicast Listener Report Message v2
6	5.980046	fe80::200:ff:feaa:2	ff02::2	ICMPv6	70	Router Solicitation from 00:00:00:aa:00:02

```
▷ Frame 2: 78 bytes on wire (624 bits), 78 bytes captured (624 bits)
▷ Ethernet II, Src: 00:00:00_aa:00:02 (00:00:00:aa:00:02), Dst: IPv6mcast_ff:aa:00:02 (33:33:ff:aa:00:02)
▽ Internet Protocol Version 6, Src: :: (::), Dst: ff02::1:ffaa:2 (ff02::1:ffaa:2)
  ▷ 0110 .... = Version: 6
  ▷ .... 0000 0000 .... .... .... .... .... = Traffic class: 0x00000000
    .... .... .... 0000 0000 0000 0000 0000 = Flowlabel: 0x00000000
    Payload length: 24
    Next header: ICMPv6 (0x3a)
    Hop limit: 255
    Source: :: (::)
    Destination: ff02::1:ffaa:2 (ff02::1:ffaa:2)
▽ Internet Control Message Protocol v6
    Type: Neighbor Solicitation (135)
    Code: 0
    Checksum: 0x79cf [correct]
    Reserved: 00000000
    Target Address: fe80::200:ff:feaa:2 (fe80::200:ff:feaa:2)
```



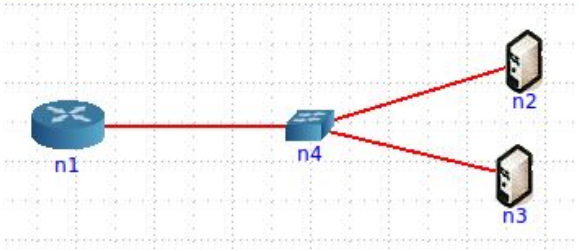
Frame 2

- Generación de direccion de alcance link (EUI) (tentativa)
- Chequeo de dirección duplicada
- Adquiere dirección permanente (fe80::200:ff:feaa:2)

Obtención de dirección en el host (3)

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	::	ff02::16	ICMPv6	90	Multicast Listener Report Message v2
2	0.970238	::	ff02::1:ffaa:2	ICMPv6	78	Neighbor Solicitation for fe80::200:ff:feaa:2
3	1.969536	fe80::200:ff:feaa:2	ff02::2	ICMPv6	70	Router Solicitation from 00:00:00:aa:00:02
4	1.970028	fe80::200:ff:feaa:0	ff02::1	ICMPv6	142	Router Advertisement from 00:00:00:aa:00:00
5	5.899429	fe80::200:ff:feaa:2	ff02::16	ICMPv6	90	Multicast Listener Report Message v2
6	5.980046	fe80::200:ff:feaa:2	ff02::2	ICMPv6	70	Router Solicitation from 00:00:00:aa:00:02

```
▷ Frame 3: 70 bytes on wire (560 bits), 70 bytes captured (560 bits)
▷ Ethernet II, Src: 00:00:00_aa:00:02 (00:00:00:aa:00:02), Dst: IPv6mcast_00:00:00:02 (33:33:00:00:00:02)
▽ Internet Protocol Version 6, Src: fe80::200:ff:feaa:2 (fe80::200:ff:feaa:2), Dst: ff02::2 (ff02::2)
  ▷ 0110 .... = Version: 6
  ▷ .... 0000 0000 .... .... .... .... .... = Traffic class: 0x00000000
    .... .... .... 0000 0000 0000 0000 0000 = Flowlabel: 0x00000000
    Payload length: 16
    Next header: ICMPv6 (0x3a)
    Hop limit: 255
    Source: fe80::200:ff:feaa:2 (fe80::200:ff:feaa:2)
    [Source SA MAC: 00:00:00_aa:00:02 (00:00:00:aa:00:02)]
    Destination: ff02::2 (ff02::2)
▽ Internet Control Message Protocol v6
    Type: Router Solicitation (133)
    Code: 0
    Checksum: 0x79d6 [correct]
    Reserved: 00000000
```



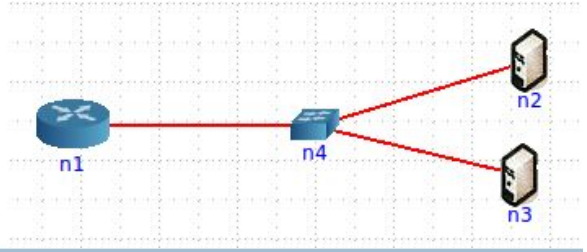
Frame 3

- Solicitud de información de rutas para todos los routers del link

Obtención de dirección en el host (4)

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	::	ff02::16	ICMPv6	90	Multicast Listener Report Message v2
2	0.970238	::	ff02::1:ffaa:2	ICMPv6	78	Neighbor Solicitation for fe80::200:ff:feaa:2
3	1.969536	fe80::200:ff:feaa:2	ff02::2	ICMPv6	70	Router Solicitation from 00:00:00:aa:00:02
4	1.970028	fe80::200:ff:feaa:0	ff02::1	ICMPv6	142	Router Advertisement from 00:00:00:aa:00:00
5	5.899429	fe80::200:ff:feaa:2	ff02::16	ICMPv6	90	Multicast Listener Report Message v2
6	5.980046	fe80::200:ff:feaa:2	ff02::2	ICMPv6	70	Router Solicitation from 00:00:00:aa:00:02

```
Next header: ICMPv6 (0x3a)
Hop limit: 255
Source: fe80::200:ff:feaa:0 (fe80::200:ff:feaa:0)
[Source SA MAC: 00:00:00_aa:00:00 (00:00:00:aa:00:00)]
Destination: ff02::1 (ff02::1)
▽ Internet Control Message Protocol v6
    Type: Router Advertisement (134)
    Code: 0
    Checksum: 0x6e0f [correct]
    Cur hop limit: 64
  ▷ Flags: 0x18
    Router lifetime (s): 30
    Reachable time (ms): 0
    Retrans timer (ms): 0
  ▷ ICMPv6 Option (Prefix information : 2001::/64)
  ▷ ICMPv6 Option (Prefix information : fd00:1200::/64)
  ▷ ICMPv6 Option (Source link-layer address : 00:00:00:aa:00:00)
```



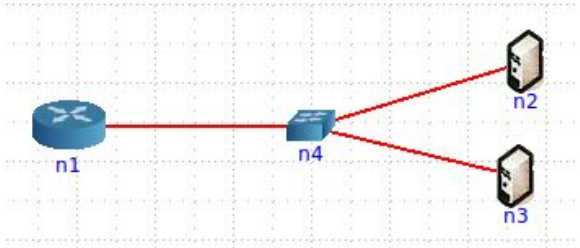
Frame 4

- Router envía información de prefijos a todos los host del link (anuncia 2 prefijos)

Obtención de dirección en el host (5)

No.	Time	Source	Destination	Protocol	Length	Info
2	0.014902	::	ff02::1:ffaa:2	ICMPv6	78	Neighbor Solicitation for fe80::200:ff:feaa:2
3	1.017691	fe80::200:ff:feaa:2	ff02::2	ICMPv6	70	Router Solicitation from 00:00:00:aa:00:02
4	1.018376	fe80::200:ff:feaa:0	ff02::1	ICMPv6	142	Router Advertisement from 00:00:00:aa:00:00
5	1.426693	fe80::200:ff:feaa:2	ff02::16	ICMPv6	90	Multicast Listener Report Message v2
6	1.539186	::	ff02::1:ffaa:2	ICMPv6	78	Neighbor Solicitation for fd00:1200::200:ff:feaa:2
7	1.714013	::	ff02::1:ffaa:2	ICMPv6	78	Neighbor Solicitation for 2001::200:ff:feaa:2

```
▷ Frame 6: 78 bytes on wire (624 bits), 78 bytes captured (624 bits)
▷ Ethernet II, Src: 00:00:00_aa:00:02 (00:00:00:aa:00:02), Dst: IPv6mcast_ff:aa:00:02 (33:33:ff:aa:00:02)
▽ Internet Protocol Version 6, Src: :: (::), Dst: ff02::1:ffaa:2 (ff02::1:ffaa:2)
  ▷ 0110 .... = Version: 6
  ▷ .... 0000 0000 .... .... .... .... .... = Traffic class: 0x00000000
    .... .... .... 0000 0000 0000 0000 0000 = Flowlabel: 0x00000000
    Payload length: 24
    Next header: ICMPv6 (0x3a)
    Hop limit: 255
    Source: :: (::)
    Destination: ff02::1:ffaa:2 (ff02::1:ffaa:2)
▽ Internet Control Message Protocol v6
    Type: Neighbor Solicitation (135)
    Code: 0
    Checksum: 0x694f [correct]
    Reserved: 00000000
    Target Address: fd00:1200::200:ff:feaa:2 (fd00:1200::200:ff:feaa:2)
```



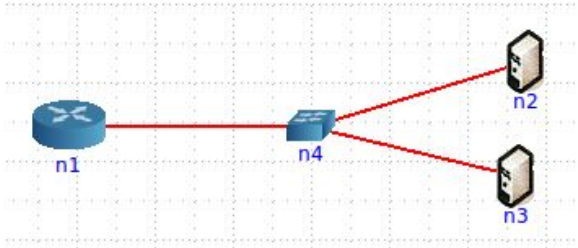
Frame 6 y 7

- Chequeo de dirección duplicada
- Adquiere direcciones permanentes (fd00:1200::200:ff:feaa:2 y 2001::200:ff:feaa:2)

Detección de direcciones duplicadas

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	fe80::200:ff:feaa:0	ff02::1	ICMPv6	142	Router Advertisement from 00:00:00:aa:00:00
2	1.407825	fe80::200:ff:feaa:2	ff02::16	ICMPv6	110	Multicast Listener Report Message v2
3	1.999312	::	ff02::1:ffaa:1	ICMPv6	78	Neighbor Solicitation for fe80::200:ff:feaa:1
4	1.999386	fe80::200:ff:feaa:1	ff02::1	ICMPv6	86	Neighbor Advertisement fe80::200:ff:feaa:1 (ovr) is at 00:
5	3.477251	fe80::200:ff:feaa:2	ff02::16	ICMPv6	110	Multicast Listener Report Message v2
6	4.878236	fe80::200:ff:feaa:0	ff02::1	ICMPv6	142	Router Advertisement from 00:00:00:aa:00:00

```
▷ Frame 4: 86 bytes on wire (688 bits), 86 bytes captured (688 bits)
▷ Ethernet II, Src: 00:00:00_aa:00:01 (00:00:00:aa:00:01), Dst: IPv6mcast_00:00:00:01 (33:33:00:00:00:01)
▽ Internet Protocol Version 6, Src: fe80::200:ff:feaa:1 (fe80::200:ff:feaa:1), Dst: ff02::1 (ff02::1)
  ▷ 0110 .... = Version: 6
  ▷ .... 0000 0000 .... .... .... .... .... = Traffic class: 0x00000000
    .... .... .... 0000 0000 0000 0000 0000 = Flowlabel: 0x00000000
    Payload length: 32
    Next header: ICMPv6 (0x3a)
    Hop limit: 255
    Source: fe80::200:ff:feaa:1 (fe80::200:ff:feaa:1)
    [Source SA MAC: 00:00:00_aa:00:01 (00:00:00:aa:00:01)]
    Destination: ff02::1 (ff02::1)
▽ Internet Control Message Protocol v6
    Type: Neighbor Advertisement (136)
    Code: 0
    Checksum: 0x559d [correct]
  ▷ Flags: 0x20000000
```



Frame 3

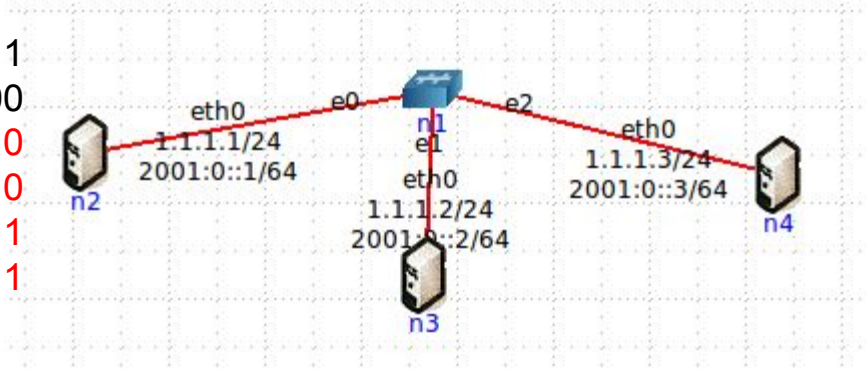
- Chequeo de dirección duplicada

Frame 4

- Respuesta de otro nodo indicando que ya existe otro nodo con esa dirección

Obtención de direcciones de capa de enlace (ARP en IPv4)

IPv4: 1.1.1.1
MAC: 00:00:00:aa:00:00
IPv6 link: fe80::200:ff:feaa:0
SNA: ff02::1:ffaa:0
IPv6 global: 2001:0::1
SNA: ff02::1:ff00:1



IPv4: 1.1.1.3
MAC: 00:00:00:aa:00:02
IPv6 link: fe80::200:ff:feaa:2
SNA: ff02::1:ffaa:2
IPv6 global: 2001:0::3
SNA: ff02::1:ff00:3

ARP IPv4: uso de mensaje Broadcast

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	00:00:00_aa:00:00	Broadcast	ARP	42	Who has 1.1.1.3? Tell 1.1.1.1
2	0.000083	00:00:00_aa:00:02	00:00:00_aa:00:00	ARP	42	1.1.1.3 is at 00:00:00:aa:00:02

ICMP Neighbor v6: uso de Solicited Node Address

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	2001::1	ff02::1:ff00:3	ICMPv6	86	Neighbor Solicitation for 2001::3 from 00:00:00:aa:00:00
2	0.000126	2001::3	2001::1	ICMPv6	86	Neighbor Advertisement 2001::3 (sol, ovr) is at 00:00:00:aa:00:02

Router Discovery(1)

Objeto

- Ubicar routers adyacentes (en el mismo link)
- Conocer cuáles pueden actuar como default routers
- Conocer prefijos de direcciones de red locales al link
- Adquirir información relativa a autoconfiguración de direcciones
- MTU
- Tipo de autoconfiguración
- Tiempos de validez de los parámetros anunciados

Router Discovery(2)

- Periódicamente los routers en el link anuncian su presencia (unsolicited advertisment)
  - Disponibilidad de actuar como default router
  - Prefijos de red
  - Otros parámetros de configuración de hosts
- Un router puede emitir un advertisment en cualquier momento, en circunstancias especiales (unsolicited advertisments)
- Un router puede emitir un (solicited) advertisment a pedido de un host
- Chequeos de consistencia entre advertisments de los diferentes routers
- Un host en el link utiliza la información de los advertisments para mantener su información local
  - Lista de default routers
  - Lista de prefijos
  - MTU, etc
- Acepta información de distintos routers (prevalece último valor si hay inconsistencias)
- Un host que necesite configurarse puede enviar un mensaje Router Solicitation
- Todos los routers en el link responderán con advertisments unicast

Router Discovery Linux IPv6 Router Advertisement Daemon (radvd)

radvd

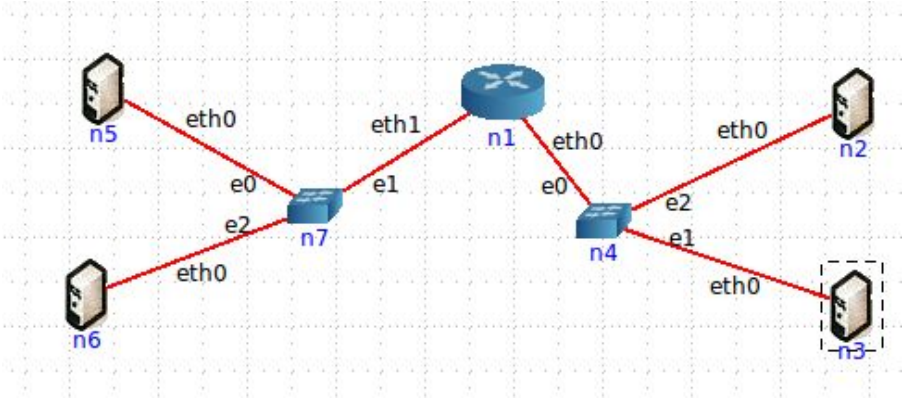
- Permite configurar a los hosts de manera stateless
- Configuración en /etc/ravdv/radvd.config
- Utiliza Router Advertisments y Router Solicitations
- Puede configurarse una variedad de parámetros

radvdump

- Permite monitorear los anuncios emitidos y parámetros enviados

Configuración RADVD (1)

Prefijo Red Global: 2001:1::/64



Prefijo Red Global: 2001::/64
Prefijo Red ULA: fd00:1200::/64

Wireshark en n5

No.	Time	Source	Destination	Pro
53	353.871473	fe80::200:ff:feaa:4	ff02::1	ICM
54	360.501796	fe80::200:ff:feaa:4	ff02::1	ICM
55	368.280921	fe80::200:ff:feaa:4	ff02::1	ICM

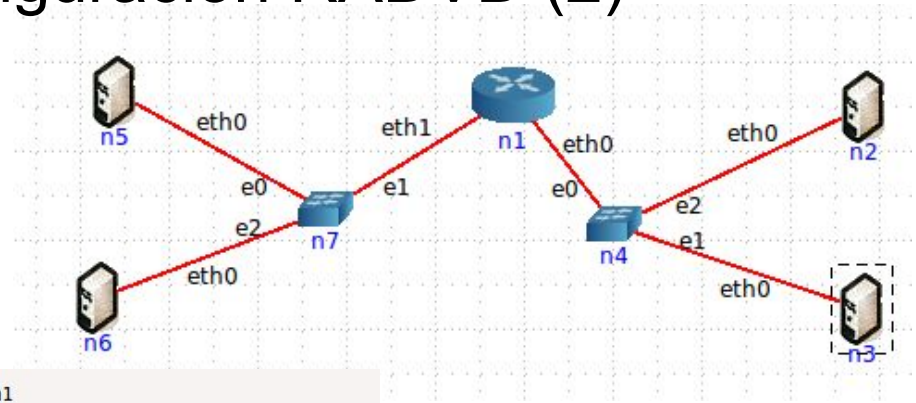
```
Router lifetime (s): 30
Reachable time (ms): 0
Retrans timer (ms): 0
▷ ICMPv6 Option (Prefix information : 2001:1::/64)
▷ ICMPv6 Option (Source link-layer address : 00:00:00:aa:00:04)
```

Wireshark en n2

No.	Time	Source	Destination	Pro
45	285.675098	fe80::200:ff:feaa:0	ff02::1	ICM
46	295.011132	fe80::200:ff:feaa:0	ff02::1	ICM
47	303.151163	fe80::200:ff:feaa:0	ff02::1	ICM

```
Reachable time (ms): 0
Retrans timer (ms): 0
▷ ICMPv6 Option (Prefix information : 2001::/64)
▷ ICMPv6 Option (Prefix information : fd00:1200::/64)
▷ ICMPv6 Option (Source link-layer address : 00:00:00:aa:00:00)
```

Configuración RADVD (2)




```
interface eth1
{
        AdvSendAdvert on;
        # Note: {Min,Max}RtrAdvInterval cannot
        AdvManagedFlag off;
        AdvOtherConfigFlag off;
        AdvReachableTime 0;
        AdvRetransTimer 0;
        AdvCurHopLimit 64;
        AdvDefaultLifetime 30;
        AdvHomeAgentFlag off;
        AdvDefaultPreference low;
        AdvSourceLLAddress on;

        prefix 2001:1::/64
        {
                AdvValidLifetime 86400;
                AdvPreferredLifetime 14400;
                AdvOnLink on;
                AdvAutonomous on;
                AdvRouterAddr on;
        }; # End of prefix definition

}; # End of interface definition
```

Instalar radvd
Configurar /etc/radvd/radvd.conf
Definir rutas

Utilitario radvdump

```
interface eth0
{
        AdvSendAdvert on;
        # Note: {Min,Max}RtrAdvInterval cannot be obt
        AdvManagedFlag off;
        AdvOtherConfigFlag off;
        AdvReachableTime 0;
        AdvRetransTimer 0;
        AdvCurHopLimit 64;
        AdvDefaultLifetime 30;
        AdvHomeAgentFlag off;
        AdvDefaultPreference low;
        AdvSourceLLAddress on;

        prefix 2001::/64
        {
                AdvValidLifetime 86400;
                AdvPreferredLifetime 14400;
                AdvOnLink on;
                AdvAutonomous on;
                AdvRouterAddr on;
        }; # End of prefix definition


        prefix fd00:1200::/64
        {
                AdvValidLifetime 86400;
                AdvPreferredLifetime 14400;
                AdvOnLink on;
                AdvAutonomous on;
                AdvRouterAddr on;
        }; # End of prefix definition

}; # End of interface definition
```

Aprovisionamiento direcciones en IPv6

Función	IPv4	IPv6
Asignación de direcciones	DHCPv4	DHCPv6, SLAAC, Reconfiguration
Resolución de direcciones	ARP, RARP	NS, NA (ICMPv6) *Neighbor Solicitation & Advertisement*
Descubrimiento de routers	ICMP Router Discovery	RS, RA (ICMPv6) *Router Solicitation & Advertisement*
Resolución de nombres	DNSv4	DNSv6