

问题描述

实现：通过Router Solicitation (RS) 和Router Advertisement (RA) 报文实现。

优点：无需手工配置，即插即用；减轻网络管理的负担，可以无缝迁移。

配置：

Server

#

interface GigabitEthernet0/0

ipv6 nd ra prefix default 100 10

ipv6 address 1::1/64

undo ipv6 nd ra halt

#

Client

#

interface GigabitEthernet0/0

ipv6 address auto

#

解决方法

IPv6无状态报文交互简介

Source	Destination	Protocol	Length	Info
::	ff02::1:ff41:205	ICMPv6	78	Neighbor Solicitation for fe80::4e25:53ff:fe41:205
::	ff02::2	ICMPv6	62	Router Solicitation
fe80::4e25:53ff:fe41:205	ff02::1	ICMPv6	86	Neighbor Advertisement fe80::4e25:53ff:fe41:205 (rtr, ovr) is at 4c:25:53:41:02:05
fe80::4e25:53ff:fe41:205	ff02::2	ICMPv6	70	Router Solicitation from 4c:25:53:41:02:05
fe80::4e25:4fff:fec8:105	ff02::1	ICMPv6	118	Router Advertisement from 4c:25:4fc8:01:05
::	ff02::1:ff41:205	ICMPv6	78	Neighbor Solicitation for 1::4e25:53ff:fe41:205
1::4e25:53ff:fe41:205	ff02::1	ICMPv6	86	Neighbor Advertisement 1::4e25:53ff:fe41:205 (rtr, ovr) is at 4c:25:53:41:02:05
fe80::4e25:4fff:fec8:105	ff02::1	ICMPv6	118	Router Advertisement from 4c:25:4fc8:01:05
1::4e25:53ff:fe41:205	ff02::1:ff00:1	ICMPv6	86	Neighbor Solicitation for 1::1 from 4c:25:53:41:02:05
1::1	1::4e25:53ff:fe41:205	ICMPv6	86	Neighbor Advertisement 1::1 (rtr, sol, ovr) is at 4c:25:4fc8:01:05
1::4e25:53ff:fe41:205	1::1	ICMPv6	118	Echo (ping) request id=0x00d3, seq=0, hop limit=64 (reply in 79)
1::1	1::4e25:53ff:fe41:205	ICMPv6	118	Echo (ping) reply id=0x00d3, seq=0, hop limit=64 (request in 78)

第一个报文：

NS检测自己的Link-local地址，目的地址为本端的本地链路地址（此时link-local地址处在tentative阶段）。

```

> Frame 11: 78 bytes on wire (624 bits), 78 bytes captured (624 bits)
> Ethernet II, Src: 4c:25:53:41:02:05 (4c:25:53:41:02:05), Dst: IPv6mcast_ff:41:02:05 (33:33:ff:41:02:05)
> Internet Protocol Version 6, Src: ::, Dst: ff02::1:ff41:205
* Internet Control Message Protocol v6
  Type: Neighbor Solicitation (135)
  Code: 0
  Checksum: 0xd775 [correct]
  [Checksum Status: Good]
  Reserved: 00000000
  Target Address: fe80::4e25:53ff:fe41:205

```

[Client-GigabitEthernet0/0]dis ipv6 int g0/0

GigabitEthernet0/0 current state: UP

Line protocol current state: UP

IPv6 is enabled, link-local address is FE80::4E25:53FF:FE41:205 [TENTATIVE]

第二个报文：

初始发送的RS请求，源地址是：：，没有option字段。

```

> Frame 12: 62 bytes on wire (496 bits), 62 bytes captured (496 bits)
> Ethernet II, Src: 4c:25:53:41:02:05 (4c:25:53:41:02:05), Dst: IPv6mcast_02 (33:33:00:00:00:02)
> Internet Protocol Version 6, Src: ::, Dst: ff02::2
* Internet Control Message Protocol v6
  Type: Router Solicitation (133)
  Code: 0
  Checksum: 0x7bb8 [correct]
  [Checksum Status: Good]
  Reserved: 00000000

```

第三个报文：

由于没有收到应答，即过了DAD检测，这个时候本地链路地址就可以使用。通告邻居此地址已经被自己使用。

```

> Ethernet II, Src: 4c:25:53:41:02:05 (4c:25:53:41:02:05), Dst: IPv6mcast_01 (33:33:00:00:00:01)
> Internet Protocol Version 6, Src: fe80::4e25:53ff:fe41:205, Dst: ff02::1
# Internet Control Message Protocol v6
  Type: Neighbor Advertisement (136)
  Code: 0
  Checksum: 0xf35a [correct]
  [Checksum Status: Good]
  Flags: 0xa0000000, Router, Override
  Target Address: fe80::4e25:53ff:fe41:205
  > ICMPv6 Option (Target link-layer address : 4c:25:53:41:02:05)

```

R标志表示是路由器发出的报文；O标志表示邻居通告的消息已经覆盖已有的条目信息。

[Client-GigabitEthernet0/0]dis ipv6 interface

GigabitEthernet0/0 current state: UP

Line protocol current state: UP

IPv6 is enabled, link-local address is FE80::4E25:53FF:FE41:205

第四个报文：

RS请求报文，源地址是本地链路地址，目的地址一般是FF02::2。

注：Link-layer地址填充MAC地址。

```

> Frame 18: 70 bytes on wire (560 bits), 70 bytes captured (560 bits)
> Ethernet II, Src: 4c:25:53:41:02:05 (4c:25:53:41:02:05), Dst: IPv6mcast_02 (33:33:00:00:00:02)
> Internet Protocol Version 6, Src: fe80::4e25:53ff:fe41:205, Dst: ff02::2
# Internet Control Message Protocol v6
  Type: Router Solicitation (133)
  Code: 0
  Checksum: 0x3857 [correct]
  [Checksum Status: Good]
  Reserved: 00000000
  # ICMPv6 Option (Source link-layer address : 4c:25:53:41:02:05)
    Type: Source link-layer address (1)
    Length: 1 (8 bytes)
    Link-layer address: 4c:25:53:41:02:05 (4c:25:53:41:02:05)

```

第五个报文：

RA报文，Option字段含MTU与前缀信息。

```

> Frame 19: 118 bytes on wire (944 bits), 118 bytes captured (944 bits)
> Ethernet II, Src: 4c:25:4f:c8:01:05 (4c:25:4f:c8:01:05), Dst: IPv6mcast_01 (33:33:00:00:00:01)
> Internet Protocol Version 6, Src: fe80::4e25:4fff:fec8:105, Dst: ff02::1
# Internet Control Message Protocol v6
  Type: Router Advertisement (134)
  Code: 0
  Checksum: 0xe2be [correct]
  [Checksum Status: Good]
  Cur hop limit: 64
  Flags: 0x00, Prf (Default Router Preference): Medium
  Router lifetime (s): 1800
  Reachable time (ms): 0
  Retrans timer (ms): 0
  > ICMPv6 Option (Source link-layer address : 4c:25:4f:c8:01:05)
  > ICMPv6 Option (MTU : 1500)
  > ICMPv6 Option (Prefix information : 1::/64)

```

注：这里的M与O标志都是0。

第六个报文：

收到RA后，对引用前缀生成的地址进行DAD检测（此时接口地址为生成的地址，且处于tentative阶段）。

```

> Frame 20: 78 bytes on wire (624 bits), 78 bytes captured (624 bits)
> Ethernet II, Src: 4c:25:53:41:02:05 (4c:25:53:41:02:05), Dst: IPv6mcast_ff:41:02:05 (33:33:ff:41:02:05)
> Internet Protocol Version 6, Src: ::, Dst: ff02::1:ff41:205
# Internet Control Message Protocol v6
  Type: Neighbor Solicitation (135)
  Code: 0
  Checksum: 0xd5f5 [correct]
  [Checksum Status: Good]
  Reserved: 00000000
  Target Address: 1::4e25:53ff:fe41:205

```

[Client-GigabitEthernet0/0]dis ipv6 interface brief

\*down: administratively down

(s): spoofing

Interface	Physical	Protocol	IPv6 Address
GigabitEthernet0/0	up	up	1::4E25:53FF:FE41:205 [TENTATIVE]

第七个报文：

没有收到回应，通过DAD检测，可以使用该地址（处于valid\preferred阶段）。通知邻居该地址已经被使用。

```

> Frame 22: 86 bytes on wire (688 bits), 86 bytes captured (688 bits)
> Ethernet II, Src: 4c:25:53:41:02:05 (4c:25:53:41:02:05), Dst: IPv6mcast_01 (33:33:00:00:00:01)
> Internet Protocol Version 6, Src: 1::4e25:53ff:fe41:205, Dst: ff02::1
# Internet Control Message Protocol v6
  Type: Neighbor Advertisement (136)
  Code: 0
  Checksum: 0xf05a [correct]
  [Checksum Status: Good]
  > Flags: 0xa000000, Router, Override
  Target Address: 1::4e25:53ff:fe41:205
  > ICMPv6 Option (Target link-layer address : 4c:25:53:41:02:05)

```

[Client-GigabitEthernet0/0]dis ipv6 interface brief

\*down: administratively down

(s): spoofing

Interface	Physical	Protocol	IPv6 Address
GigabitEthernet0/0	up	up	1::4E25:53FF:FE41:205

此时的邻居状态为:

<Client>dis ipv6 neighbors int g0/0

```

Type: S-Static D-Dynamic O-Openflow R-Rule I-Invalid
IPv6 address      Link layer  VID Interface/Link ID  State T Age
FE80::4E25:4FFF:FEC8:105  4c25-4fc8-0105 N/A GE0/0          STALE D 40

```

第八个报文:

路由器周期性发出的RA报文。

缺省情况下，RA消息发布的最大时间间隔为600秒，最小时间间隔为200秒。接口将在最大时间间隔与最小时间间隔之间随机选取一个值来发布RA消息。

```

> Frame 38: 118 bytes on wire (944 bits), 118 bytes captured (944 bits)
> Ethernet II, Src: 4c:25:4f:c8:01:05 (4c:25:4f:c8:01:05), Dst: IPv6mcast_01 (33:33:00:00:00:01)
> Internet Protocol Version 6, Src: fe80::4e25:4fff:fec8:105, Dst: ff02::1
# Internet Control Message Protocol v6
  Type: Router Advertisement (134)
  Code: 0
  Checksum: 0xe2be [correct]
  [Checksum Status: Good]
  Cur hop limit: 64
  > Flags: 0x00, Prf (Default Router Preference): Medium
  Router lifetime (s): 1800
  Reachable time (ms): 0
  Retrans timer (ms): 0
  > ICMPv6 Option (Source link-layer address : 4c:25:4f:c8:01:05)
  > ICMPv6 Option (MTU : 1500)
  > ICMPv6 Option (Prefix information : 1::/64)

```

第九个报文:

NS请求地址解析。

```

> Frame 76: 86 bytes on wire (688 bits), 86 bytes captured (688 bits)
> Ethernet II, Src: 4c:25:53:41:02:05 (4c:25:53:41:02:05), Dst: IPv6mcast_ff:00:00:01 (33:33:ff:00:00:01)
> Internet Protocol Version 6, Src: 1::4e25:53ff:fe41:205, Dst: ff02::1:ff00:1
# Internet Control Message Protocol v6
  Type: Neighbor solicitation (135)
  Code: 0
  Checksum: 0x35c4 [correct]
  [Checksum Status: Good]
  Reserved: 00000000
  Target Address: 1::1
  # ICMPv6 Option (Source link-layer address : 4c:25:53:41:02:05)
    Type: Source link-layer address (1)
    Length: 1 (8 bytes)
    Link-layer address: 4c:25:53:41:02:05 (4c:25:53:41:02:05)

```

第十个报文:

NA地址解析应答。

```

> Frame 77: 86 bytes on wire (688 bits), 86 bytes captured (688 bits)
> Ethernet II, Src: 4c:25:4f:c8:01:05 (4c:25:4f:c8:01:05), Dst: 4c:25:53:41:02:05 (4c:25:53:41:02:05)
> Internet Protocol Version 6, Src: 1::1, Dst: 1::4e25:53ff:fe41:205
# Internet Control Message Protocol v6
  Type: Neighbor Advertisement (136)
  Code: 0
  Checksum: 0x5640 [correct]
  [Checksum Status: Good]
  > Flags: 0xe0000000, Router, Solicited, Override
  Target Address: 1::1
  # ICMPv6 Option (Target link-layer address : 4c:25:4f:c8:01:05)
    Type: Target link-layer address (2)
    Length: 1 (8 bytes)
    Link-layer address: 4c:25:4f:c8:01:05 (4c:25:4f:c8:01:05)

```

S标志表示该邻居通告是响应某个邻居的请求。

后续就可以正常通信:

<Client>ping ipv6 1::1

Ping6(56 data bytes) 1::4E25:53FF:FE41:205 --> 1::1, press CTRL\_C to break

56 bytes from 1::1, icmp\_seq=0 hlim=64 time=2.000 ms

56 bytes from 1::1, icmp\_seq=1 hlim=64 time=0.000 ms

79	00:01:23.890237	1::1	1::4e25:53ff:fe41:205	ICMPv6	118 Echo (ping) reply id=0x00d3, seq=0, hop limit=64 (request in 78)
81	00:01:24.093691	1::4e25:53ff:fe41:205	1::1	ICMPv6	118 Echo (ping) request id=0x00d3, seq=1, hop limit=64 (reply in 82)
82	00:01:24.094095	1::1	1::4e25:53ff:fe41:205	ICMPv6	118 Echo (ping) reply id=0x00d3, seq=1, hop limit=64 (request in 81)
83	00:01:24.296363	1::4e25:53ff:fe41:205	1::1	ICMPv6	118 Echo (ping) request id=0x00d3, seq=2, hop limit=64 (reply in 84)
84	00:01:24.296895	1::1	1::4e25:53ff:fe41:205	ICMPv6	118 Echo (ping) reply id=0x00d3, seq=2, hop limit=64 (request in 83)

此时的邻居状态为:

<Client>dis ipv6 neighbors int g0/0

```
Type: S-Static D-Dynamic O-Openflow R-Rule I-Invalid
IPv6 address      Link layer  VID Interface/Link ID  State T Age
1::1              4c25-4fc8-0105 N/A GE0/0           REACH D 6
FE80::4E25:4FFF:FEC8:105 4c25-4fc8-0105 N/A GE0/0           DELAY D 1
```

邻居状态回切:

<Client>dis ipv6 neighbors int g0/0

```
Type: S-Static D-Dynamic O-Openflow R-Rule I-Invalid
IPv6 address      Link layer  VID Interface/Link ID  State T Age
1::1              4c25-4fc8-0105 N/A GE0/0           REACH D 11
FE80::4E25:4FFF:FEC8:105 4c25-4fc8-0105 N/A GE0/0           REACH D 1
```

接口状态:

[Client]dis ipv6 int g0/0

GigabitEthernet0/0 current state: UP

Line protocol current state: UP

IPv6 is enabled, link-local address is FE80::4E25:53FF:FE41:205

Global unicast address(es):

1::4E25:53FF:FE41:205, subnet is 1::/64 [AUTOCFG]

[valid lifetime 2591770s/preferred lifetime 604570s]

Joined group address(es):

FF02::1

FF02::2

FF02::1:FF41:205

MTU is 1500 bytes

ND DAD is enabled, number of DAD attempts: 1

ND reachable time is 30000 milliseconds

ND retransmit interval is 1000 milliseconds

Hosts use stateless autoconfig for addresses

IPv6 Packet statistics:

```
InReceives:          17
InTooShorts:         0
InTruncatedPkts:    0
InHopLimitExceeds:  0
InBadHeaders:       0
InBadOptions:       0
ReasmReqds:         0
ReasmOKs:           0
InFragDrops:        0
InFragTimeouts:    0
OutFragFails:       0
InUnknownProtos:   0
InDelivers:         17
OutRequests:        15
OutForwDatagrams:   0
InNoRoutes:         0
InTooBigErrors:     0
OutFragOKs:         0
OutFragCreates:    0
InMcastPkts:        8
InMcastNotMembers:  0
OutMcastPkts:       14
InAddrErrors:       0
InDiscards:         0
OutDiscards:        0
```

