

DHCPv6 Lab

SLAAC and Stateful Address Allocation

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Collaborative Project

- India Internet Engineering Society (IIESoc) and Industry Network Technology Council (INTC)
- Funding: Grant from ISIF Asia
- Thank you!



<https://www.iiesoc.in/>

<https://industry.netcouncil.org/>

Vision

Multi-year project: IPv6 deployment at enterprises.

Collaboration with American Registry for Internet Numbers (ARIN)

- Provide training,
- Analysis of security and application conversion,
- Help enterprises plan their IPv6 deployment.

Classes

- Introduction to IPv6: Feb 4, 2021 ✓
- Lab: IPv6 basics: Feb 11, 2021 ✓
- Neighbor Discovery: March 4, 2021 ✓
- Lab: Neighbor Discovery: March 18, 2021 ✓
- IPv6 Address Planning: April 8, 2021 ✓
- Lab: IPv6 Address Planning: April 15, 2021 ✓
- IPv6 Transition Mechanisms: May 6, 2021 ✓
- Lab: IPv6 Transition Mechanisms: May 13, 2021 ✓

- DHCPv6: June 3, 2021 ✓
- Lab: DHCPv6: June 10, 2021
- IPv6 and Cloud: June 17, 2021
- Lab: IPv6 and Cloud: June 24, 2021
- Introduction to IPv6 Security: July 8, 2021

The next sessions are sponsored by a generous grant from ARIN.

- Trace Reading: August 12, 2021
- Troubleshooting: August 19, 2021

A few words about me

- President: Industry Network Technology Council
- Founder & CEO: Inside Products, Inc.
- Advisory Board: India Internet Engineering Society
- RFCs: RFC8250 (Embedded performance and diagnostics for IPv6) and others
- Product developer (OEMed by IBM and others)
- Working with IPv6 for 15 years
- Working with network management, diagnostic, performance issues at large brick-and-mortar enterprises for over 30 years



Mohit P. Tahiliani

- Assistant Professor of Computer Science and Engineering at National Institute of Technology Karnataka (NITK), Surathkal
- Member of India Internet Engineering Society (IIESoc)
- Member of Advisory Board of ns-3 Consortium
- Co-maintainer of TCP and Traffic Control modules in ns-3
- Secretary of IEEE Mangalore Sub-Section
- Working on TCP optimizations, queue disciplines, network performance studies and implementation of network protocols since 12 years



Agenda

Note: Ubuntu 20.04 has been used for the demonstration

1. Address assignment using SLAAC

- Setting up Router Advertisement Daemon (RADVD)
- Tracing Router Advertisement (RA) and Neighbor Solicitation (NS) messages
- Changing the Prefix in 'radvd.conf'

2. Address assignment using Stateful DHCPv6

- Setting up a DHCPv6 Server
- Tracing Solicit, Advertise, Request and Reply messages
- Changing the Prefix in 'dhcpd6.conf'
- Checking leases
- Checking logs for debugging

Address assignment using SLAAC

Experimental Setup



Two approaches:

1. Setup two VMs

- One VM as a 'client' and another as a 'router'
- Install 'radvd' on router interface (eth-rc). Verify the address assignment on client interface (eth-cr)

Experimental Setup



Two approaches:

2. Setup two network namespaces

- One network namespace as a 'client' and another as a 'router'
- Install 'radvd' on router interface (eth-rc). Verify the address assignment on client interface (eth-cr)

Setting up Router Advertisement Daemon (RADVD)

Note: this must be done before installing the 'radvd' package

1. Create a 'radvd.conf' in /etc

```
$ sudo vi /etc/radvd.conf
```

2. Add the following configuration to 'radvd.conf'

```
interface eth-rc {
    MinRtrAdvInterval 3;      # Minimum time interval between RAs (Seconds)
    MaxRtrAdvInterval 4;      # Maximum time interval between RAs (Seconds)
    AdvSendAdvert on;         # Flag to enable/disable periodic RAs

    prefix 2001:db8::/64 {
        AdvValidLifetime 14300;      # Duration for validity of prefix
        AdvPreferredLifetime 14200;  # Duration for validity of addresses
    };
};
```

Demo: Address Assignment using SLAAC

1. Enable forwarding on the router interface

```
$ sudo sysctl -w net.ipv6.conf.eth-rc.forwarding=1
```

2. Install radvd package

```
$ sudo apt install radvd
```

3. How to start radvd? `man radvd`

```
$ sudo service radvd start
```

4. How to stop radvd? `man radvd`

```
$ sudo service radvd stop
```

Demo: Address Assignment using SLAAC

5. Tracing RA and NS packets

```
$ sudo tcpdump -i eth-cr (command line output)
```

```
$ sudo tcpdump -w client.pcap -c 20 -i eth-cr (client.pcap is created with 20 packets)
```

6. Changing prefix in 'radvd.conf'

- a. Restart radvd service
- b. Verify the new IPv6 address allocation on the client interface

Address assignment using Stateful DHCPv6

Experimental Setup



Setup two VMs

- One VM as a 'client' and another as a 'server'
- Install DHCPv6 Server which listens on server interface (eth-sc). Verify the address assignment on client interface (eth-cs)

Setting up a DHCPv6 Server

1. Download the ISC DHCP Server package from: <https://www.isc.org/downloads/>
 - Current stable release: 4.4.2-P1 (Release date: May 2021)
 - Untar the file, cd dhcp-4.4.2-P1 and ./configure, make and sudo make install
2. Update 'radvd.conf'

```
interface eth-sc {  
    MinRtrAdvInterval 3;    # Minimum time interval between RAs (Seconds)  
    MaxRtrAdvInterval 4;    # Maximum time interval between RAs (Seconds)  
    AdvSendAdvert on;      # Flag to enable/disable periodic RAs  
    AdvManagedFlag on;    # Enable stateful address allocation  
    AdvOtherConfigFlag on; # Allow stateful allocation of other information  
};
```

3. Create a 'dhcpd6.conf' in /etc/dhcp

```
$ sudo vi /etc/dhcp/dhcpd6.conf
```


Setting up a DHCPv6 Server

4. Add the following configuration to 'dhcpd6.conf'

```
default-lease-time 600;      # Default lease time (Seconds)
max-lease-time 7200;        # Maximum lease time (Seconds)
log-facility local7;        # Enable logging

subnet6 2001:db8:0:1::/64 {

    # Range for clients
    range6 2001:db8:0:1::129 2001:db8:0:1::254;

    # Additional options
    option dhcp6.name-servers fec0:0:0:1::1;
    option dhcp6.domain-search "domain.example";
}
```

5. Create a file to store DHCPv6 Leases at: /var/db/dhcpd6.leases

Demo: Address Assignment using Stateful DHCPv6

1. Start radvd service

```
$ sudo service radvd start
```

2. Start dhcpd service

```
$ sudo dhcpd -6 -d -cf /etc/dhcp/dhcpd.conf eth-sc
```

3. On the Client VM, run

```
$ sudo dhclient -6 -d eth-cs
```

4. Check the dhcpd6.leases on the machine that runs a DHCPv6 Server

```
$ sudo cat /var/db/dhcpd6.leases
```

Looking into dhcpd6.leases

```
server-uid "\000\001\000\001(S}2\000\000\000\000\000\002";
```

```
ia-na "\001\000\000\000\000\001\000\001(S}\221\000\000\000\000\000\001" {  
  cltt 3 2021/06/09 13:24:35;  
  iaaddr 2001:db8:0:1::254 {  
    binding state active;  
    preferred-life 375;  
    max-life 600;  
    ends 3 2021/06/09 13:34:35;  
  }  
}
```

Looking into dhcpd6.leases

```
server-uid "\000\001\000\001(S}2\000\000\000\000\000\002";  
ia-na "\001\000\000\000\000\001\000\001(S}\221\000\000\000\000\001" {  
  cltt 3 2021/06/09 13:24:35;  
  iaaddr 2001:db8:0:1::254 {  
    binding state active;  
    preferred-life 375;  
    max-life 600;  
    ends 3 2021/06/09 13:34:35;  
  }  
}
```

Looking into dhcpd6.leases

```
server-uid "\000\001\000\001(S}2\000\000\000\000\000\002";  
  
ia-na "\001\000\000\000\000\001\000\001(S}\221\000\000\000\000\000\001" {  
  cltt 3 2021/06/09 13:24:35;  
  iaaddr 2001:db8:0:1::254 {  
    binding state active;  
    preferred-life 375;  
    max-life 600;  
    ends 3 2021/06/09 13:34:35;  
  }  
}
```

Lease grant time

Lease expiry time

Looking into dhcpd6.leases

```
server-uid "\000\001\000\001(S}2\000\000\000\000\000\002";  
  
ia-na "\001\000\000\000\000\001\000\001(S}\221\000\000\000\000\000\001" {  
  cltt 3 2021/06/09 13:24:35;  
  iaaddr 2001:db8:0:1::254 {  
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  }  
}
```

Looking into dhcpd6.leases

```
server-uid "\000\001\000\001(S}2\000\000\000\000\000\002";  
  
ia-na "\001\000\000\000\000\001\000\001(S}\221\000\000\000\000\001" {  
  cltt 3 2021/06/09 13:24:35;  
  iaaddr 2001:db8:0:1::254 {  
    binding state active;  
    preferred-life 375;  
    max-life 600;  
    ends 3 2021/06/09 13:34:35;  
  }  
}
```

Demo: Address Assignment using Stateful DHCPv6

5. Tracing Solicit, Advertise, Request and Reply messages

```
$ sudo tcpdump -i eth-cs (command line output)
```

```
$ sudo tcpdump -w client.pcap -c 20 -i eth-cs (client.pcap is created with 20 packets)
```

6. Changing prefix in 'dhcpd6.conf'

- a. Restart radvd and dhcpd6 service
- b. Verify the new IPv6 address allocation on the client interface

7. Checking logs for debugging

```
$ grep -nr "dhcpd" /var/log/syslog > dhcp.log
```

Another alternative is to redirect the logs to dhcp.log by editing the syslog.conf


Looking into dhcp.log

```
Jun 9 13:22:58 server dhcpd: Internet Systems Consortium DHCP Server 4.4.2-P1
Jun 9 13:22:58 server dhcpd: Copyright 2004-2021 Internet Systems Consortium.
Jun 9 13:22:58 server dhcpd: All rights reserved.
Jun 9 13:22:58 server dhcpd: For info, please visit https://www.isc.org/software/dhcp/
Jun 9 13:22:58 server dhcpd: Config file: /etc/dhcp/dhcpd6.conf
Jun 9 13:22:58 server dhcpd: Database file: /var/db/dhcpd6.leases
Jun 9 13:22:58 server dhcpd: PID file: /var/run/dhcpd6.pid
Jun 9 13:22:58 server dhcpd: Internet Systems Consortium DHCP Server 4.4.2-P1
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Jun 9 13:22:58 server dhcpd: For info, please visit https://www.isc.org/software/dhcp/
Jun 9 13:22:58 server dhcpd: Wrote 0 NA, 0 TA, 0 PD leases to lease file.
Jun 9 13:22:58 server dhcpd: Bound to *:547
Jun 9 13:22:58 server dhcpd: Listening on Socket/5/eth-sc/2001:db8:0:1::/64
Jun 9 13:22:58 server dhcpd: Sending on Socket/5/eth-sc/2001:db8:0:1::/64
Jun 9 13:22:58 server dhcpd: Server starting service.
Jun 9 13:24:34 server dhcpd: Solicit message from fe80::200:ff:fe00:1 port 546, transaction ID 0x95457D00
Jun 9 13:24:34 server dhcpd: Picking pool address 2001:db8:0:1::254
Jun 9 13:24:34 server dhcpd: Advertise NA: address 2001:db8:0:1::254 to client with duid 00:01:00:01:28:53:7d:91:00:00:00:00:00:01 iaid = 1 valid for 600 seconds
Jun 9 13:24:34 server dhcpd: Sending Advertise to fe80::200:ff:fe00:1 port 546
Jun 9 13:24:35 server dhcpd: Request message from fe80::200:ff:fe00:1 port 546, transaction ID 0x9C613B00
Jun 9 13:24:35 server dhcpd: Reply NA: address 2001:db8:0:1::254 to client with duid 00:01:00:01:28:53:7d:91:00:00:00:00:00:01 iaid = 1 valid for 600 seconds
Jun 9 13:24:35 server dhcpd: Sending Reply to fe80::200:ff:fe00:1 port 546
```

Necessary files


Looking into dhcp.log

```
Jun 9 13:22:58 server dhcpd: Internet Systems Consortium DHCP Server 4.4.2-P1
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Jun 9 13:22:58 server dhcpd: For info, please visit https://www.isc.org/software/dhcp/
Jun 9 13:22:58 server dhcpd: Config file: /etc/dhcp/dhcpd6.conf
Jun 9 13:22:58 server dhcpd: Database file: /var/db/dhcpd6.leases
Jun 9 13:22:58 server dhcpd: PID file: /var/run/dhcpd6.pid
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Looking into dhcp.log

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Questions?

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