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# Routerlab SoSe 2018
# Worksheet 4: DHCP, IPv6, SLAAC and DHCPv6

In this worksheet, we build an autoconfiguration environment for an enterprise network or a small ISP using *DHCP* for IPv4.

Table 1: Device and Address Overview

| Cloud | Aachen | Köln | Leverkusen |
|---|---|---|---|
| Router | aac-rj1 | cgn-rj1 | lev-rj1 |
| Switches | aac-sc1, aac-sj1 | cgn-sc1, cgn-sj1 | lev-sc1, lev-sj1 |
| IPv4 range | | `10.Z.0.0/16` | |
| IPv6 range | | `fd00:470:525b:fY00::/56` | |
| Loadgens | | groupX-lg1,2,3,4 | |

Note 1: Replace X with the number of your group with leading zero, e.g., $X = 03$ for group 3. Replace Y with the number of your group without leading zero and use hex encoding, e.g., $Y = 3$ for group 3 and $Y = a$ for group 10. Finally replace Z with the decimal group number without leading zero, e.g., $Z = 3$ for group 3.

**Warning**: we are working with the IPv6 range `fd00:470:525b:fY00::/56` in this worksheet and not `fc00:470:525b:fY00::/56`, as we did before. This is necessary for the Stateless Address Autoconfiguration (SLAAC) to run.

## Part 1: (45 (10 + 5 + 10 + 20) Points) DHCP, SLAAC and DHCPv6 in Theory

**Question 1:** (10 (3 + 3 + 4) Points) *IPv6 Address Types and Interface Identifier*

On the previous worksheets, we used a 64-bit prefix length for all IPv6 subnets. While using a /64 for most network segments is a good rule of the thumb, we now want to take a deeper look into IPv6 addressing.

In contrast to IPv4, where a Google search gives you a huge amount of accurate information, the situation for IPv6 is still a little problematic as it takes some effort to find accurate, up-to-date information.

Let us begin with a general overview of the IPv6 addressing architecture: Skim through RFC4291 and answer the following questions:

(a) Explain the difference between *Unicast*, *Anycast* and *Multicast* addresses.

(b) Explain the differences between *Global Unicast* and *Link Local* addresses.

(c) What is an *Interface Identifier* and what are the different ways to compute it?

**Question 2:** (5 (1 + 1 + 1 + 1 + 1) Points) *IPv6 Unicast Address Range Sizes*

After having obtained a general idea about IPv6 addressing, we will take a look at the best practices for assigning IPv6 prefixes to sites (e.g., universities, large companies, small companies, single-home broadband subscribers...). The answers of the next questions can be found in RFC6177 and SURFnet's Preparing an IPv6 Address Plan Manual.

To get a feeling on how these "best practices" evolve, take a look at RFC3627, RFC6164 and RFC6547.

(a) What is the recommended prefix length for a single Ethernet segment?

(b) What is the recommended prefix length for a large site (e.g., a university)?

(c) What is the recommended prefix length for a small site (e.g., a small company)?

(d) What prefix size should a provider assign to a home DSL customer?

(e) What prefix lengths should be assigned to point-to-point links between two routers (i.e., with no other devices except these two routers)?

**Question 3:** (10 (5 + 5) Points) *BOOTP and DHCP*

Take a brief look at RFC2131 (DHCPv4).

(a) Explain briefly the difference between BOOTP and DHCP.

(b) How does DHCP solve the chicken and egg problem of using IP without having an IP address yet?

**Question 4:** (20 (5 + 5 + 10) Points) *DHCP, DHCPv6 and IPv6 Stateless Autoconfiguration in Theory*

Before you do the actual setup, you should understand the fundamental principles and differences of how IPv4 and IPv6 can be configured automatically. Take a look at RFC4862 (IPv6 Stateless Address Autoconfiguration) and RFC3315 (DHCPv6) and answer the following questions.

(a) Is IPv6 also facing the problem of using IP without having an IP address yet? Explain why or why not.

(b) How can IPv6 Stateless Address Autoconfiguration and DHCPv6 interact?

(c) Which client parameters can be configured via DHCP, DHCPv6 and IPv6 Stateless Address Autoconfiguration? Give a small overview of the most important features and differences in a table.

## Part 2: 55 (5 + 10 + 15 + 15 + 10) Points) DHCP, SLAAC and DHCPv6 in Practice

After the theory, you will now set up autoconfiguration via DHCP for IPv4 and then IPv6 Stateless Address Autoconfiguration with *stateless DHCPv6* for IPv6.

**Question 1:** (5 Points) *Manual Address Configuration*

To begin with, set up the network topology according to Figure 1 with groupX-lg3 and groupX-lg4 in VLAN A with the router and VLAN B between groupX-lg2 and the router — for A and B choose VLAN IDs from your group's range.

As in our previous worksheet, create a topology map that shows your IPv4 and IPv6 address assignment. Note that you only have to configure IPv4 and IPv6 addresses for the router and groupX-lg4 as the other loadgens will be automatically configured later on.

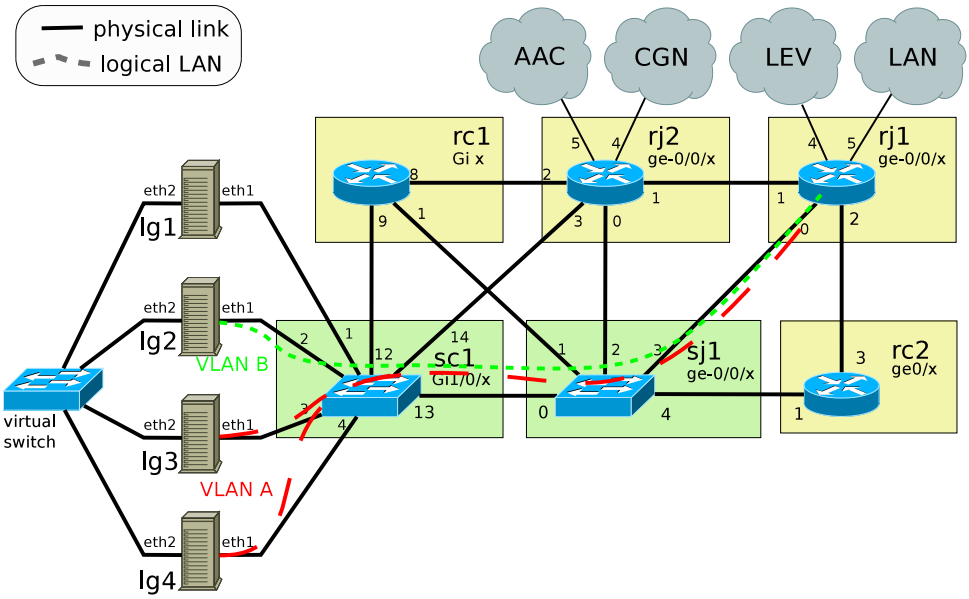


Figure 1: Topology for DHCP and IPv6 stateless autoconfiguration

**Question 2:** (10 Points) *DHCP Server Setup*

Let us now come to the installation of the ISC DHCP server on groupX-lg4. Normally you would just execute `apt-get install isc-dhcp-server` on groupX-lg4. This won't be sufficient in the current version of the Debian as the `isc-dhcp-server` package does not support operating as DHCP and DHCPv6 server at the same time. Therefore we will need to install the packages from Debian Stretch which makes things a bit more complicated.

To install the `isc-dhcp-server` package from Debian Stretch (and its dependencies), we will use APT pinning.

First we edit the file `/etc/apt/sources.list` and add the following lines:

```
#
# stretch
#
deb     http://apt-proxy:9999/debian/     stretch main contrib non-free
deb-src http://apt-proxy:9999/debian/     stretch main contrib non-free
```

Then add the rules needed to install the correct packet versions by placing a new apt preferences file with the following contents to `/etc/apt/preferences.d/stretch`. This will make sure that all packages starting with `isc-dhcp` will be prioritized over the default priority 500 and all other packages of the testing distribution (currently Stretch) will be prioritized below that value.

```
Package: *
Pin: release a=testing
Pin-Priority: 450

Package: isc-dhcp*
Pin: release a=testing
Pin-Priority: 550
```

Now you can install the dhcp-server package using
`apt install --no-install-suggests --no-install-recommends isc-dhcp-server`

Configure the DHCP server to not only provide IP addresses to the clients but also to configure the DNS server `172.16.255.254`, the DNS search domains `routerlab dmz.routerlab inet.tu-berlin.de` and the NTP `172.16.0.2` server.

Make sure to only provide DHCP functionality on eth1. You need to create a matching subnet declaration for each of your subnets in the DHCP configuration file on groupX-lg4.

Hint: You have to apply some changes to `/etc/default/isc-dhcp-server`.

Finally, start the DHCP server on groupX-lg4. To certify your success, provide us with the output of the command `ps -aux | grep dhcp` run on groupX-lg4, so that we can make sure the DHCP server is running.

**Question 3:** (15 (1 + 4 + 5 + 5) Points) *DHCP without and with Relay Agents*

(a) Make sure the DHCP offers are received by groupX-lg3. To certify your success, provide us with the output of the command `tcpdump -vvvv -X -i eth1 -n src host z` run on groupX-lg3, where `z` is the IP address of groupX-lg4. The output should be such that we can see the DHCP offer received from groupX-lg4.

(b) Automatically assign an IP address to eth1 on groupX-lg3 using the DHCP server running on groupX-lg4. To certify your success, provide us with the command output obtained when running `service networking restart; ifconfig eth1` on groupX-lg3. Hint: You need to append some lines in /etc/network/interfaces.

(c) Configure a DHCP relay agent on aac-rj1 (cgn-rj1 or lev-rj1) so that DHCP offers from the DHCP server running on groupX-lg4 are received by groupX-lg2. To certify your success, provide us with the output of the command `tcpdump -vvvv -X -i eth1 -n src host z` run on groupX-lg2, where `z` is the IP address of the subinterface of aac-rj1 (cgn-rj1 or lev-rj1) in VLAN B. The output should be such that we can see the DHCP offer received from groupX-lg4.

(d) Using DHCP offers from the DHCP server running on groupX-lg4 transmitted by the relay agent on aac-rj1 (cgn-rj1 or lev-rj1), automatically assign an IP address to eth1 on groupX-lg2. To certify your success, provide us with the command output obtained when running `service networking restart; ifconfig eth1` on groupX-lg2.

**Submission details (more in ISIS):**
Please submit an archive (.tar.gz or .zip) containing a *directory*, which contains all files you want to submit. Please have *your group number* in the file name and the directory name.
A report (one single PDF file, named *worksheet(num)-group(num).pdf*) containing the following elements is mandatory:

- Your group number on the first page
- Topology map with relevant routers, switches, *loadgens*, and interfaces, IPs and subnet masks (CIDR).
- For each question, the written answers with the **relevant** portions of output from all commands such as ping, tcpdump, etc in a text format. **No** screenshots of terminal windows are accepted. For ping 3-4 lines of ping requests are usually sufficient.
- For each question all commands needed to configure the *loadgens*.
- For each question all **changed parts** in the configuration of routers and switches (differences to the default config).
- **Never** include the full verbatim switch or router configuration in the pdf report.

- For all questions, state your assumptions, say what you did, describe what you observed, explain your conclusions.

Additionally, please include your config files in the archive.
For each question, please provide the full switch and router configuration in a separate text file named after the device and question, e.g.: *q01-config-sc1.txt*. This makes it easier for us to reproduce your configuration and understand what you did.
We can only grade what we find in your submission and what we understand. Please state your assumptions and observations as clearly as possible.
**Due Date: Thursday, May 31, 2018, 23:55 PM**[1]

[1] We will not accept any solutions submitted after this allowed time.