

# **Networking under Linux**

## **Gnome Network Manager**

On current Linux systems (e.g. RHEL<sup>1</sup>/CentOS, Ubuntu, etc.) the Gnome Network Manager<sup>2</sup> is often used to configure network interfaces. The configuration can be done via a GUI applet in the menu bar or via the command "nmcli" on the command line (see also "man nmcli").

The automatisms of the Network Manager can have a disruptive effect on server systems. For this reason, the Network Manager is often switched off there:

For RHEL/CentOS 7 and Ubuntu 16.04 and 18.04 using the commands:

```
# systemctl stop NetworkManager.service
# systemctl disable NetworkManager.service
```

As an alternative, individual interfaces can also be excluded from the configuration within the Network Manager.

## **Interfaces naming**

For a long time, the naming of interfaces in Linux systems was done according to a traditional scheme, which was adopted from UNIX<sup>3</sup>:

- for ethernet interfaces: `eth0`, `eth1`, etc.
- for wireless lan interfaces: `wlan0`, `wlan1`, etc.

The number was assigned in the order in which the drivers of the network cards were loaded by the kernel. This method is error-prone, because e.g. the order in which drivers are loaded by the kernel, can change from kernel version to kernel version and thus interfaces are suddenly "renamed" or do not get any predictable names. This can lead to malfunctions or security problems when using Linux as a router or firewall system.

The introduction of dynamic device management tools such as "udev"<sup>4</sup> did not solve the problem. However, it offers new possibilities such as coupling the interface name to the MAC address<sup>5</sup> or naming interfaces with self-selected names (e.g. "extern", "local", "internet", etc.).

Another approach for a predictable naming of interfaces is provided by the "udev" help utility "biosdevname" which assigns interface names using slot and port numbers read from the system BIOS<sup>6</sup>.

This approach is also used by the "systemd"<sup>7</sup> system initialization service. This enables a predictable naming of network interfaces for systems using "systemd" (most recent Linux distributions)<sup>8</sup>.

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<sup>1</sup>RHEL Red Hat Enterprise Linux, CentOS is a freely available RHEL clone.

<sup>2</sup><https://wiki.gnome.org/Projects/NetworkManager>

<sup>3</sup>For information about UNIX see <https://en.wikipedia.org/wiki/Unix>

<sup>4</sup>For more information on "udev" see "man udev" or <https://en.wikipedia.org/wiki/Udev>

<sup>5</sup>This is especially problematic in virtualization environments when "cloning" virtual machines.

<sup>6</sup>See chapter 11 and especially 11.6 of the RHEL 7 Networking Guide.

[https://access.redhat.com/documentation/en-us/red\\_hat\\_enterprise\\_linux/7/html/networking\\_guide/index](https://access.redhat.com/documentation/en-us/red_hat_enterprise_linux/7/html/networking_guide/index)

<sup>7</sup>For "systemd" see "man systemd" or <https://www.freedesktop.org/wiki/Software/systemd/>

<sup>8</sup>See also "Predictable Network Interface Names".

<https://www.freedesktop.org/wiki/Software/systemd/PredictableNetworkInterfaceNames/>

## **Manual Configuration of Interfaces**

For the manual configuration of network interfaces and routing tables, UNIX-based systems (also MacOS<sup>9</sup>) traditionally use the utilities "`ifconfig`" and "`route`". These utilities are also available on modern Linux systems for backward compatibility reasons (e.g. shell scripts, installer scripts, etc...). Often they must be installed explicitly (package "`net-tools`").

All aspects of networking (interface configuration, routing, multicast, QoS, etc...) in modern Linux systems are covered by utilities from the "`iproute2`"<sup>10</sup> package. Thus the utility "`ip`" is used for the IPv4 and IPv6 interfaces configuration and routing tables (see manual "`man ip`" and the manuals mentioned therein, e.g. "`man ip-route`", etc.).

All configurations that are made interactively with the mentioned utilities via a command line (shell) are only valid at runtime on Linux systems and are lost at a restart.

To ensure that configurations are also used after a restart of the system, they must be stored in configuration files. These configuration files are usually processed by shell scripts, which in turn are executed by system initialization services<sup>11</sup> when the system starts (argument "`start`") or shuts down (argument "`stop`").

Unfortunately, not all Linux distributions use uniform configuration files for network configuration. The two main Linux variants RHEL based distributions (like CentOS) and Debian based distributions (like Ubuntu) use the following configuration files:

### ***RHEL/CentOS:***

General Network Configurations:

`/etc/sysconfig/network`

Interface-specific configurations:

`/etc/sysconfig/network-scripts/ifcfg-<ifname>` like, for example:

`/etc/sysconfig/network-scripts/ifcfg-ens3`

Information on how to configure these files can be found in the RHEL 7 Networking Guide<sup>12</sup>.

### ***Debian / Ubuntu (until 16.04 LTS)***

Network configuration file `/etc/network/interfaces`

For information on configuring this file, see "`man interfaces`".

### ***Ubuntu (starting with 18.04 LTS):***

Network configuration file `/etc/netplan/01-netcfg.yaml` or `/etc/netplan/50-cloud-init.yaml`

For information on configuring this file, see "`man netplan`".

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<sup>9</sup><https://en.wikipedia.org/wiki/MacOS>

<sup>10</sup>Information about "`iproute2`": <https://wiki.linuxfoundation.org/networking/iproute2>

<sup>11</sup>The main Linux system initialization services are:

- System V "`init`" <https://en.wikipedia.org/wiki/SysVinit> and <https://savannah.nongnu.org/projects/sysvinit>
- "`upstart`" <http://upstart.ubuntu.com/> (today mostly replaced by "`systemd`")
- "`systemd`" <https://www.freedesktop.org/wiki/Software/systemd/>

For UNIX system initialization see also <https://en.wikipedia.org/wiki/Init>

For the controversy "`systemd`" versus "`init`" see <https://www.tecmint.com/systemd-replaces-init-in-linux/>

<sup>12</sup>See chapter 3.5 and 4.6 of the RHEL 7 Networking Guide

[https://access.redhat.com/documentation/en-us/red\\_hat\\_enterprise\\_linux/7/html/networking\\_guide/index](https://access.redhat.com/documentation/en-us/red_hat_enterprise_linux/7/html/networking_guide/index)

## **Hostname and DNS Client Resolver configuration**

In addition to the interface(s) configurations, systems require a computer name. This can be set on current Linux systems with the utility "hostnamectl".

As a rule, the "Fully Qualified Domain Name" FQDN is set as the hostname.

For example, the command "hostnamectl set-hostname router.n101.nslab.ch" sets the host name to "router.n101.nslab.ch" (see also "man hostnamectl"). In order to ensure that host names set in this way are not lost when the system is restarted, they will be entered in the file "/etc/hostname". This procedure works with current RHEL/CentOS and Ubuntu systems.

One problem that often occurs when testing network systems, is a missing or incorrect configuration of the DNS client resolver.

Mistakenly, network problems are often inferred, even though the network connectivity itself would work and only DNS name resolution does not work.

To avoid false conclusions due to a malfunctioning DNS configuration, it is recommended to perform connection tests with IP addresses as well.

For a computer to be able to resolve hostnames, its DNS client resolver must be configured.

The configured nameservers must be reachable and running.

On Linux systems, the configuration is made in the file "/etc/resolv.conf" and must contain at least entries for one or more accessible name servers.

For the lab setup it could look like this (as long as your name server is not configured):

```
search n001.nslab.ch nslab.ch
```

```
nameserver 147.87.80.2
```

For more information, see "man resolv.conf" and the (upcoming) theory on DNS.

## **Further information about Linux**

Online documentation exists for the Linux distributions used in the lab:

### ***RHEL/CentOS:***

The official documentation of Red Hat Enterprise Linux can be found at:

<https://access.redhat.com/documentation/en/red-hat-enterprise-linux/>

Version 7: [https://access.redhat.com/documentation/en-us/red\\_hat\\_enterprise\\_linux/7](https://access.redhat.com/documentation/en-us/red_hat_enterprise_linux/7)

In particular, the "System Administrator's Guide" and the "Networking Guide" mentioned above provide assistance for solving laboratory tasks on RHEL/CentOS systems.

### ***Ubuntu:***

The official documentations of Ubuntu 16.04 LTS (Long Term Support) or 18.04 LTS can be found here: <https://help.ubuntu.com/>

### ***Linux in general:***

General information on the use of Linux can be found, for example, in the Galileo Openbook "Linux - Das umfassende Handbuch" by Johannes Plötner, Steffen Wendzel.

Online version: <http://openbook.rheinwerk-verlag.de/linux/>