Network Configuration and Diagnostics in LXC Containers

1. Introduction

This documentation covers **network configuration in LXC containers**, specifically setting a **static IP address**. It also introduces important **network diagnostic tools** that can be used to identify and fix network problems within an LXC container.

The estimated time for this topic is about **2–4 hours** and is suitable for both learners in the field of Linux networking and for practical use in server or container operations.

> Tip: Create your own LXC container to test the configurations. If something goes wrong, delete the LXC container, create a new one, and repeat the test.

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2. Fundamentals of Network Configuration in LXC Containers

By default, an LXC container gets its IP address via **DHCP** from the host or a bridge (e.g., `vmbr0`). In distributed container environments where, for example, databases or web servers need to communicate with each other, either DNS name resolution or the assignment of **static IP addresses** is required to ensure reliable accessibility.

However, since we are not using a DNS server, it is essential to assign static IP addresses here.

2.1 Network Files

Depending on the server/LXC version used, there are two variants:

1. **Newer Ubuntu versions (>= 18.04):**
   - Configuration via **Netplan** in `/etc/netplan/*.yaml`.
2. **Older Ubuntu versions (< 18.04) or Debian containers:**
   - Configuration via **/etc/network/interfaces**.

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3. Configuring a Static IP Address

3.1 Configuration with Netplan

1. Open the Netplan configuration file (e.g., `01-netcfg.yaml`):

```
sudo nano /etc/netplan/01-netcfg.yaml
```

2. Example configuration for a static IP:

```

```

```
network:
  version: 2
  ethernets:
    eth0:
      dhcp4: no
      addresses:
        - 192.168.137.110/24
      gateway4: 192.168.137.1
      nameservers:
        addresses:
          - 192.168.137.1
          - 8.8.8.8
```

Explanation:

- `eth0` → Network interface of the LXC container
- `dhcp4: no` → Disable DHCP
- `addresses` → Static IP address with subnet
- `gateway4` → Default gateway
- `nameservers` → DNS servers

> Note: ⚠ **Caution with Netplan/YAML:** The Netplan configuration file uses the **YAML format**, which is very sensitive to **spelling and indentation**. YAML works exclusively with **spaces** for indentation – **tabs are not allowed**. Incorrect indentation or syntax errors will prevent Netplan from **applying the configuration**. In this case, either the old network configuration remains, or an error occurs, rendering the network unavailable.

3. Test configuration (safe option):

```
sudo netplan try
```

- This command applies the new network configuration on a trial basis.
- You have **120 seconds** to confirm the changes with `ENTER`.
- If you made a mistake and the network is unreachable, it will automatically revert to the old working configuration after the time expires.

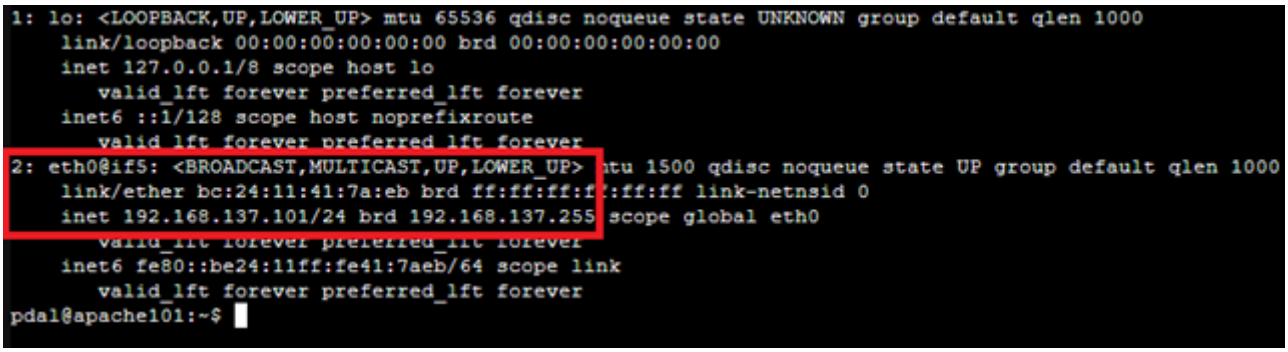
4. Apply changes permanently:

```
sudo netplan apply
```

- The new configuration is **permanently applied**.
- From this point on, the configuration remains active until it is changed again.

5. Verify network settings:

```
ip a
```



3.2 Configuration with /etc/network/interfaces

1. Open the file:

```
sudo nano /etc/network/interfaces
```

2. Example configuration:

```
auto eth0
iface eth0 inet static
    address 192.168.137.110
    netmask 255.255.255.0
    gateway 192.168.137.1
    dns-nameservers 192.168.137.1 8.8.8.8
```

3. Restart the networking service:

```
sudo systemctl restart networking
```

4. Verification:

```
ip a
```

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4. Network Diagnostic Tools in the LXC Container

Various commands are available for diagnosing network problems. Below is an overview of the most important tools with examples of their use.

4.1 `ping` – Check Reachability

```
ping 192.168.137.1
```

checks the reachability of the internal network. If the test is successful...

```
ping 8.8.8.8
```

checks the reachability of Google's DNS, and therefore the connection to the internet. If the test is successful...

```
ping google.com
```

checks name resolution on the internet.

- Identifies fundamental problems such as a missing internet connection or DNS resolution issues.

4.2 `ip a` – Display Network Interfaces

```
ip a
```

- Lists all interfaces, IP addresses, and their status.
- Important for checking if the static IP was set correctly.

4.3 `ip r` – Display Routing Table

```
ip r
```

- Shows the default gateway and routing rules.
- Source of error: If the gateway is missing, no connection to the internet is possible.

4.4 `netstat -tulnp` – Display Open Ports

```
sudo netstat -tulnp
```

- `-t` → TCP connections
- `-u` → UDP connections
- `-l` → listening ports only

- `-n` → numerical output (IP instead of name)
- `-p` → process information

Example output:

Proto	Recv-Q	Send-Q	Local Address	Foreign Address	State	PID/Program name
tcp	0	0	0.0.0.0:22	0.0.0.0:*	LISTEN	450/sshd

4.5 `curl` – Test HTTP Requests

```
curl http://google.com
curl -I http://google.com
```

- `-I` shows only the headers.
- Useful for testing if a web server is reachable.

4.6 `wget` – Download Files from the Web

```
wget https://dlcdn.apache.org/tomcat/tomcat-10/v10.1.43/bin/apache-tomcat-10.1.43.tar.gz
```

- Useful for checking connectivity and download capability.
- Can also be used for automated installations.

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5. Network Flow: Host ↔ LXC Container ↔ Internet

To better understand network configuration, the following diagram shows the typical data flow:

```
            +-------------------------+
            |      Internet           |
            +-------------------------+
                      |
                (Gateway/Router)
                      or
            (Windows Host with ICS)
                      |
            +-------------------------+
            |   Proxmox Host          |
            |   Bridge: vmbr0         |
            +-------------------------+
                      |
            +-------------------------+
            |   LXC Container         |
```

```
              |   eth0: 192.168.137.110 |
              +-------------------------+
```

- **Internet ↔ Gateway/Router or Windows Host with ICS:** Connection to the external network
- **Proxmox Host (Bridge vmbr0):** mediates between the physical network and the LXC container
- **LXC Container (eth0):** receives a static IP (e.g., `192.168.137.110`)

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6. Typical Sources of Error – Graphical Overview

The following scenarios help with diagnosis:

6.1 Gateway Problem

```
[LXC Container] ---X---> [Gateway/Router] ---> [Internet]
    eth0: 192.168.137.110
    ping 192.168.137.1  --> ERROR
    ping 8.8.8.8        --> ERROR
```

- **Symptoms:** No connection to the internet, gateway is unreachable.
- **Solution:** Check the gateway entry in `netplan` or `interfaces`.

If connectivity from the LXC container to the gateway or the internet is not working, you can also check and change the network parameters directly in the **Proxmox web interface**:

1. **Log in to the Proxmox web interface:**

   ```
   https://<Proxmox-IP>:8006
   ```

2. **Select the LXC container:**
   - On the left, select the corresponding LXC container.
3. **Check the network:**
   - Open the **"Network"** tab.
   - Here you can see the configuration of `eth0` or other interfaces:
     - **IP Address**
     - **Netmask**
     - **Gateway**
4. **Adjust settings (if necessary):**
   - Set the IP address to the correct subnet.
   - Enter the correct gateway (e.g., 192.168.137.1).
   - Save the changes.

5. **Restart the LXC container** or apply the network configuration:

```
sudo ip a    # check
sudo ping 192.168.137.1
```

Note: Changes made via the web interface are automatically applied to the LXC container configuration file `/etc/pve/lxc/<CTID>.conf`.

6.2 DNS Problem

```
[LXC Container] ---> [Gateway/Router] ---> [Internet]
    eth0: 192.168.137.110
    ping 8.8.8.8   --> OK
    ping google.com --> ERROR
```

- **Symptoms:** IPs are reachable, but domains are not.
- **Solution:** Check the nameserver entry in `netplan` or `interfaces`.

Alternative: Check DNS settings via the Proxmox web interface

1. Log in to the Proxmox web interface:

```
https://<Proxmox-IP>:8006
```

2. Select the LXC container:
    - On the left, select the corresponding LXC container.
3. Check the network:
    - Open the "Network" tab.
    - Here you can see the configuration of `eth0` or other interfaces:
        - IP Address
        - Netmask
        - Gateway
        - DNS Server
4. Adjust DNS servers:
    - Add e.g., 8.8.8.8 or another working nameserver.
    - Save the changes.

5. Restart the LXC container or apply the network configuration:

```
sudo netplan apply # if netplan is used
sudo ping google.com # check
```

6.3 ICS Adapter Fails After Windows Update

It sometimes happens that (after Windows updates) the **ICS adapter (Internet Connection Sharing)** no longer works. This leads to **no connection from the internal network to the internet and vice versa**.

Procedure for resolution:

1. Open **Network Settings** in Windows.
2. Select **Advanced network settings** → **More adapter options**.
3. In the new window, select the network connection used, right-click, and open **Properties**.
4. Go to the **Sharing** tab and **deactivate** Internet Connection Sharing (uncheck the box).
    - Confirm with **OK**.
5. Re-open the adapter options and go back to **Sharing**.
6. **Reactivate** the checkbox for Internet Connection Sharing, select the **ICS adapter** in the field below, and confirm with **OK**.

➥ The ICS connection should then work as usual.

7. Example Workflows

This section shows **practical workflows for network configuration and diagnostics in LXC containers**. The goal is to demonstrate with concrete examples how to:

- Correctly set up a **static IP address** and test the network connection.
- Check **connectivity to the local network, internet, and DNS**.
- Recognize and systematically diagnose common **causes of a missing internet connection**.
- Check network services and open ports to identify potential problems with server applications.

The workflows are intended to serve as practical, step-by-step instructions that can be applied directly in real container environments.

7.1 Set up and test static IP

1. Adjust Netplan → `sudo netplan apply`.
2. `ping 192.168.137.1` → Check connectivity to the gateway, in this case, the ICS network interface.
3. `ping 8.8.8.8` → Check connectivity to Google DNS.
4. `ping google.com` → Check if name resolution works.
5. `curl http://google.com` → Test HTTP connection.

7.2 Troubleshooting a Missing Internet Connection

1. **Check IP:**

```
ip a
```

2. **Check Gateway:**

```
ip r
```

3. **Check DNS:**

```
ping 8.8.8.8
ping google.com
```

   - If `8.8.8.8` works, but `google.com` does not → DNS problem.

4. **Check Ports (e.g., web server in the LXC container):**

```
netstat -tulnp
```

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8. Summary

- **Static IPs** are configured via `/etc/netplan/*.yaml` (newer systems) or `/etc/network/interfaces` (older systems).
- Diagnostic tools like `ping`, `ip a`, `ip r`, `netstat`, `curl`, and `wget` help to quickly identify network problems.
- **Graphical overviews** facilitate understanding network flow and troubleshooting.

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9. Further Exercises

- Setting up multiple static IPs (e.g., for different services in the container).
- Using `ss` as a modern replacement for `netstat`.
- Combining `curl` with REST APIs to test the functionality of web services.
- The general error analysis and troubleshooting will follow in a later module.

Sources

- "Command Overview › Shell › Wiki › ubuntuusers.de". Accessed: August 20, 2025. [Online]. Available at: Ubuntuuser Command Overview

- H. Lasch, "Linux-Kommandos Kurzreferenz | Linux | Nutzungshinweise | FRIZ | Fakultät für Informatik | TU Chemnitz". Accessed: August 20, 2025. [Online]. Available at: Linux Reference

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