acontis technologies GmbH

SOFTWARE

HV-Codesys+RT-Linux-Guide

acontis Real-time Hypervisor running Codesys on RT-Linux

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1 Introduction

This guide describes how to set up `CODESYS Control for Linux SL` or `CODESYS Virtual Control SL` on RT-Linux for the acontis Hypervisor. It is assumed, the steps listed in the Hypervisor Quick Start guide and the Windows Guest Guide have been successfully executed.

2 CODESYS Control for Linux SL

2.1 CODESYS Support Package for the Hypervisor

The CODESYS Support Package for the Hypervisor is located in
`/hv/guests/etc/rt-linux/files/codesys`.
If you get an update, please copy it to this folder.

Hint: Update `CODESYS Control` version (optional)

The CODESYS Support Package may contain a specific version of the `CODESYS Control` for Linux SL package (e.g. "codesyscontrol_linux_4.5.0.0_amd64.deb"). Please follow the steps described in this chapter only in case you want to use a newer version of this package or if this package is missing.

You need to go to the CODESYS webstore (store.codesys.com) and search for "CODESYS Control for Linux SL" and download the respective package. Unzip the package. As a result, the folder "Delivery" will contain the `CODESYS Control` debian package (e.g. "codesyscontrol_linux_4.5.0.0_amd64.deb"). Please transfer the file you got from the webstore to the PC where the hypervisor is running. If you are running the RT-Linux example, copy the file into the `/hv/guests/guestrtlinux/files/codesys` folder. Otherwise, copy it to your `/hv/guests/guestxxxx` directory, where your RT-Linux is located.

2.2 Extract CODESYS Control

`CODESYS Control` is shipped as a debian package. Its content has to be extracted before it can be used. After extracting the debian package can be removed.

```
$ cd /hv/guests/etc/rt-linux/files/codesys
$ dpkg-deb -x codesyscontrol_linux_4.5.0.0_amd64.deb files
$ dpkg-deb -e codesyscontrol_linux_4.5.0.0_amd64.deb control
```

2.3 Adjust CODESYS Configuration

You need to adjust some configuration files. Adjust the `CODESYSControl.cfg` file to assure the user configuration file is stored at the hard disk:

```
$ cd /hv/guests/etc/rt-linux/files/codesys/files/etc
$ mousepad CODESYSControl.cfg
```

Adjust the FileReference.1 setting:

```
[CmpSettings]
IsWriteProtected=1
FileReference.0=SysFileMap.cfg, SysFileMap
FileReference.1=/mnt/rtfiles/codesys/files/etc/CODESYSControl_User.cfg
```

If you want to automatically start the PLC application, adjust the `CODESYSControl_User.cfg` file:

```
$ cd /hv/guests/etc/rt-linux/files/codesys/files/etc
$ mousepad CODESYSControl_User.cfg
```

Add the Application.1 entry:

```
[CmpApp]
Bootproject.RetainMismatch.Init=1
;RetainType.Applications=InSRAM
Application.1=Application
```

2.4 Codemeter support

CODESYS is software protected via a Codemeter USB dongle. This dongle has to be exposed from the Hypervisor Host to RT-Linux.

Hint: How to expose USB devices is described in the Hypervisor Manual in section “USB device access for RT-Linux guests”.

The standard Linux image shipped with the hypervisor does not support usbip. You need to exchange this image by the separately provided `rtlinux515.x64-usbip.bin` image file. This file is part of the CODESYS package and located in `/hv/guests/etc/rt-linux/files/codesys/rtlinux`. You need to adjust the configuration:

```
$ cd /hv/guests/guestxxxx
$ mousepad usr_guest_config.sh
```

Adjust or add the following line:

```
export osImage=$HV_ROOT/guests/etc/rt-linux/files/codesys/rtlinux/
↪rtlinux515.x64-usbip.bin
```

2.5 CODESYS autostart

You may want to automatically start CODESYS after RT-Linux has booted.

In case a Real-time Ethernet fieldbus like Ethernet/IP or EtherCAT shall be used, you must enable the Ethernet driver of RT-Linux.

For protocols like Ethernet/IP you need also to set an IP address to this Ethernet port.

Insert or uncomment the following lines in `/hv/guests/guestxxxx/files/autostart.sh`

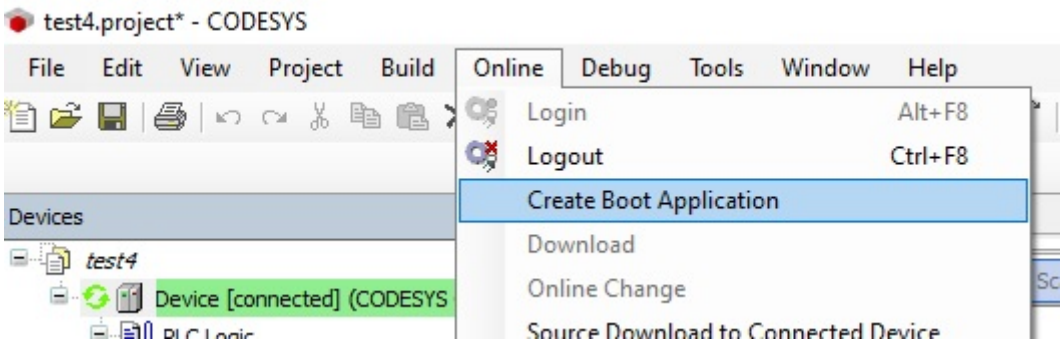
```
# load Ethernet drivers if required
modprobe e1000e
modprobe igb
modprobe igc
modprobe r8169
ifconfig eth0 up
```

Add the following commands at the end of the file
`/hv/guests/guestxxxx/files/autostart.sh`
The example below assumes, an IP address is needed, it is set to 192.168.10.10
You may have to adjust this address according to your needs.
Set the IP address to 0.0.0.0 or omit setting the IP address if no IP address is required

```
# set IP address
ifconfig eth0 192.168.10.10

# run codesys
cd /mnt/rtfiles/etc/rt-linux/files/codesys
./installcodesys.sh
```

If you want the PLC application to run automatically after CODESYS is started, you need to create a Boot Application. You need select the PLC application, log in into the PLC, download and run the application. Then create the Boot Application.



2.6 CODESYS PLC logfile

In case of PLC issues, you may take a look into the log file. It is located in RT-Linux, so you need to log in into RT-Linux or get it via ssh.

The following command will store the log file from within RT-Linux into the local filesystem into file `plc.log`. The requested password is *root*:

```
$ ssh root@192.168.157.2 cat /tmp/codesyscontrol.log >plc.log
```

3 CODESYS Virtual Control SL

3.1 Virtual Control Support Package

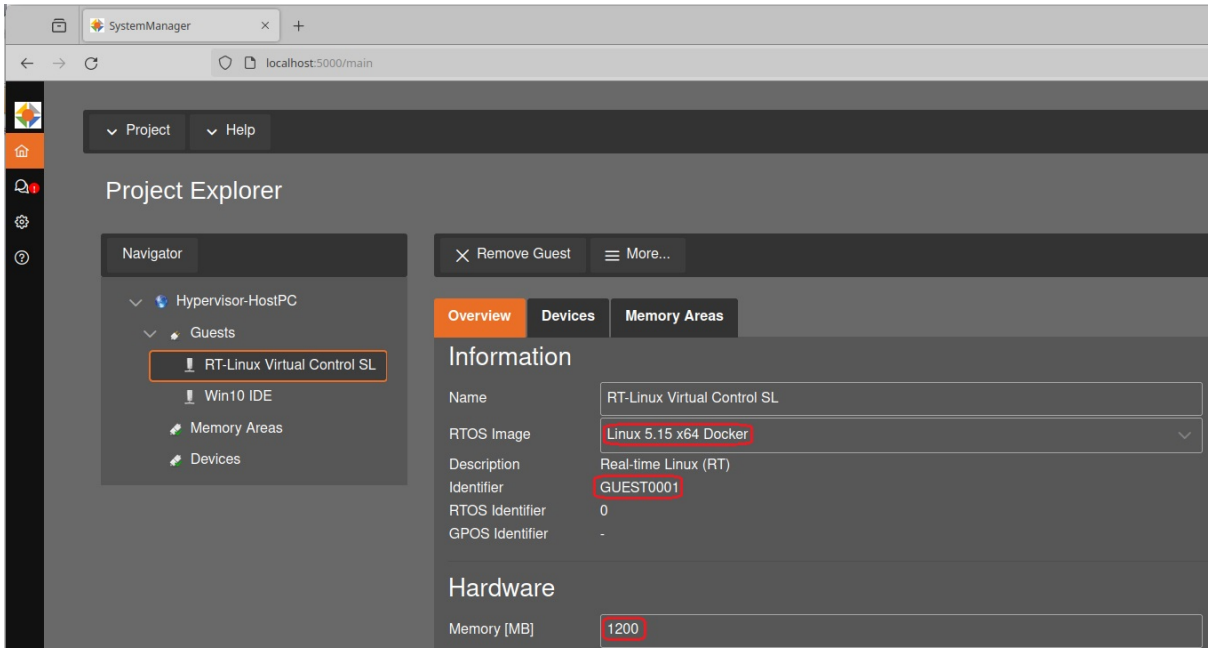
The `CODESYS Virtual Control` files for the RTOSVisor are located in `/hv/guests/etc/rt-linux/files/codesys-virtualControl`.
If you receive an update from acontis, please copy the contents to this folder.

The Codesys IDE requires version V3.5 SP20 or higher.

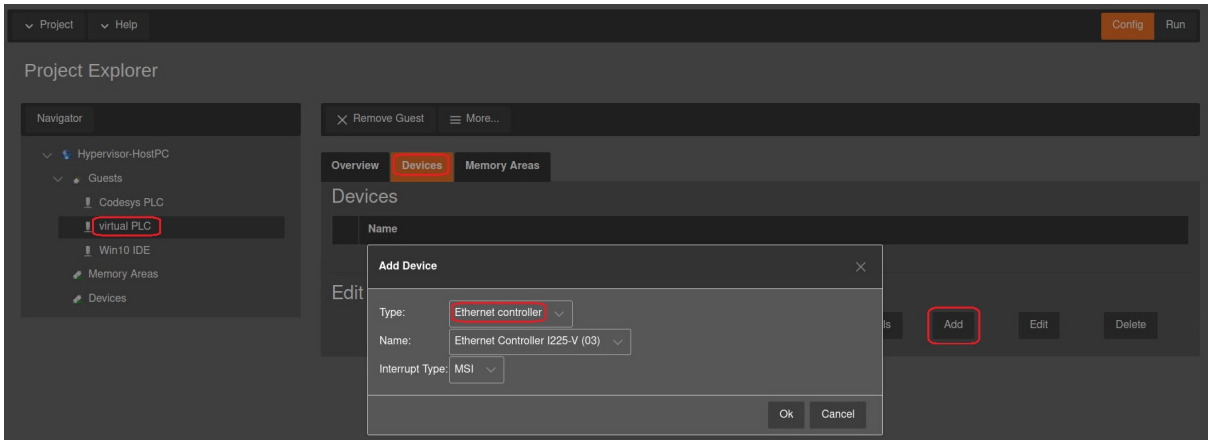
3.2 Virtual Control Realtime Guest

The `CODESYS Virtual Control SL` is started in a RT-Linux guest with Docker support. Ensure you have selected the appropriate RTOS image `Linux 5.15 x64 Docker` and allocated sufficient memory for the RT-Linux.

For this guide, we assume that the RT-Linux guest is located in `/hv/guests/guest0001` and is initialized with 1200MB of memory.



If you want to use a network interface with your Codesys instance, you need to pass this network interface from the host to the RT-Linux guest. After running `sync` and restarting the guest, you can log into the RT-Linux guest with SSH and get the name of the interface using the command `ifconfig`. You can use this interface name later in the virtual PLC configuration as the NIC.



For faster starting of the `CODESYS Virtual Control` environment, the polling rate should be set to `200µs`. To do this, adjust the `CommPollPeriodUs` entry in `usr.config`.

Open the host configuration file:

```
$ cd /hv/config
$ mousepad usr.config
```

Add or Adjust the following lines:

```
[Host\Comm]
"CommPollPeriodUs"=dword:C8
```

Open the guest configuration file:

```
$ cd /hv/guests/guest0001
$ mousepad usr.config
```

Add or Adjust the following lines:

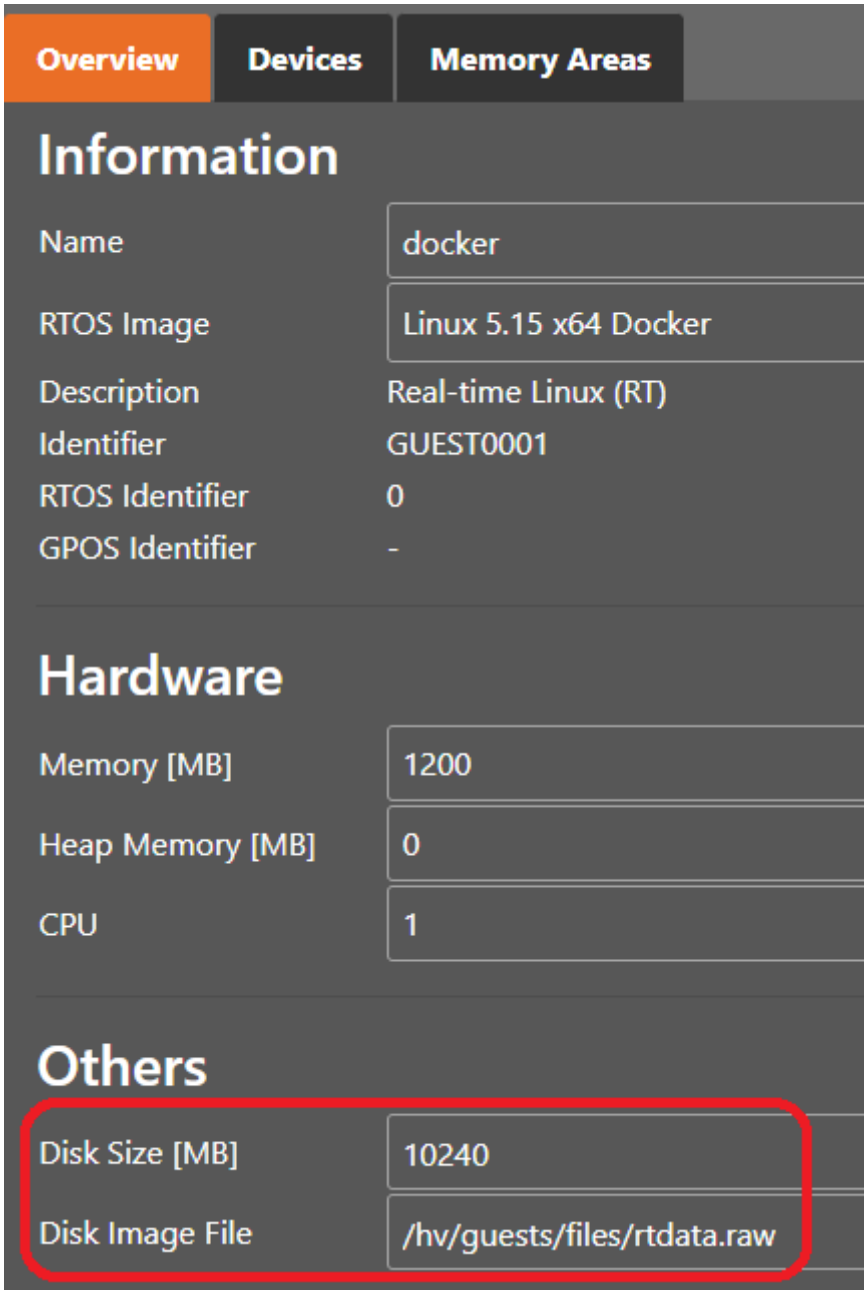
```
[Rtos1\Comm]
"CommPollPeriodUs"=dword:C8
```

Hint: The `CODESYS Virtual Control` Docker environment is stored on a data file that is created during the first start of RT-Linux. By default, the data file is located at `/hv/guests/guestxxxx/files/rtdataimage.raw`. This data file is mounted into the RT-Linux filesystem at `/mnt/rtdata` when RT-Linux starts and unmounted when RT-Linux is shut down.

Caution: The data file will only be created when the RT-Linux guest is started and no existing data container file is found. Once the container file is created, its size cannot be changed. The size should be large enough for your complete `CODESYS Virtual Control SL` environment. If the default path and filename for the container file shall be changed, you need to assure that it must be located below the `/hv/guest` folder!

Configure the size of the data file. In this guide, we will create a data file with a size of 10GB (10240MB).

You can configure the data container path, filename and size using the System Manager:



Or, alternatively, using the *usr_guest_config.sh* file:

```
$ cd /hv/guests/guest0001
$ mousepad usr_guest_config.sh
```

Add or Adjust the following lines (in this case, the default path and filename will be used):

```
export rt_data_size_MB=10240
```

Start the RT-Linux guest and log in as root.

3.3 Virtual Control Docker Environment

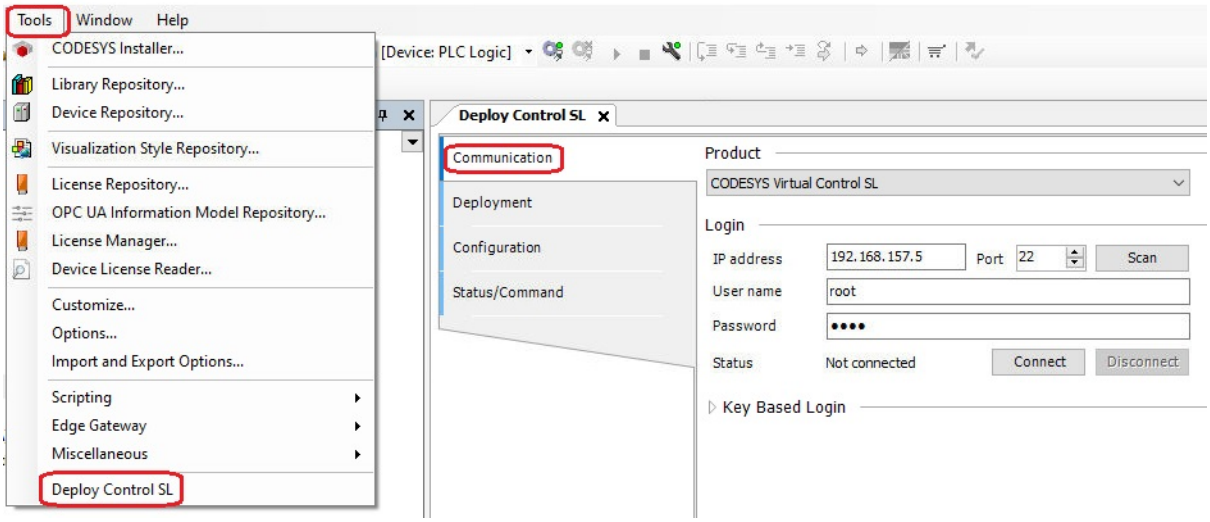
The `CODESYS Virtual Control` Docker runtime is configured using the Codesys IDE. After starting RT-Linux, you can connect with the IDE to control the Docker environment.

3.3.1 Update CODESYS Virtual Control

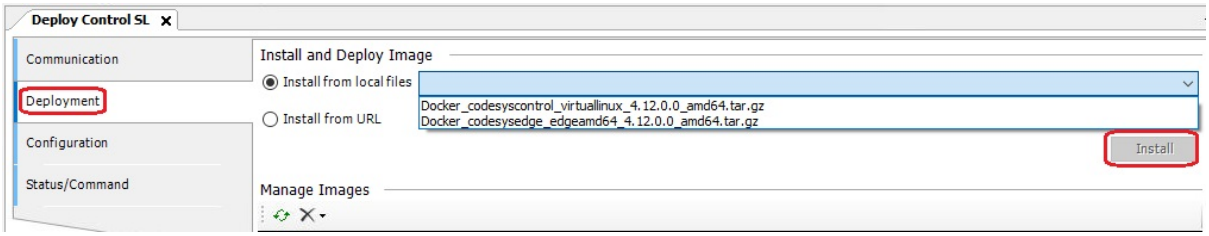
Select the menu `Tools\Codesys Installer` in the IDE and switch to the `Browse` tab. Here, you can search for `CODESYS Virtual Control for Linux SL` and select the entry. Click on `Install Selected` to install the add-on and follow the instructions.

3.3.2 Install the Virtual Control Images

Select the menu `Tools/Deploy Control SL`. In the Communication section, enter the IP address of the RT-Linux (e.g., 192.168.157.2), username (root), and password (root). Then press the `Connect` button, and the status should change to `connected`.

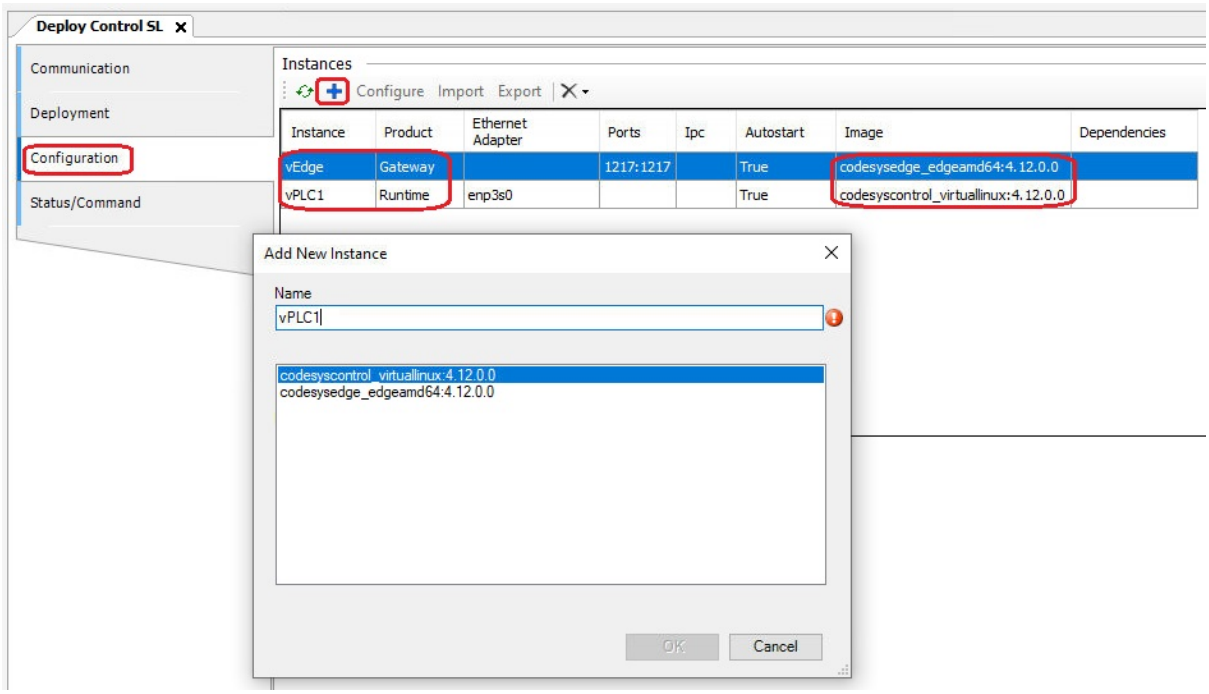


In the Deployment section, select `Install from local files` and open the drop-down menu. Here, you will find the Docker images for Virtual Control and the gateway. Install both images by selecting each file from the drop-down menu and clicking the `Install` button.



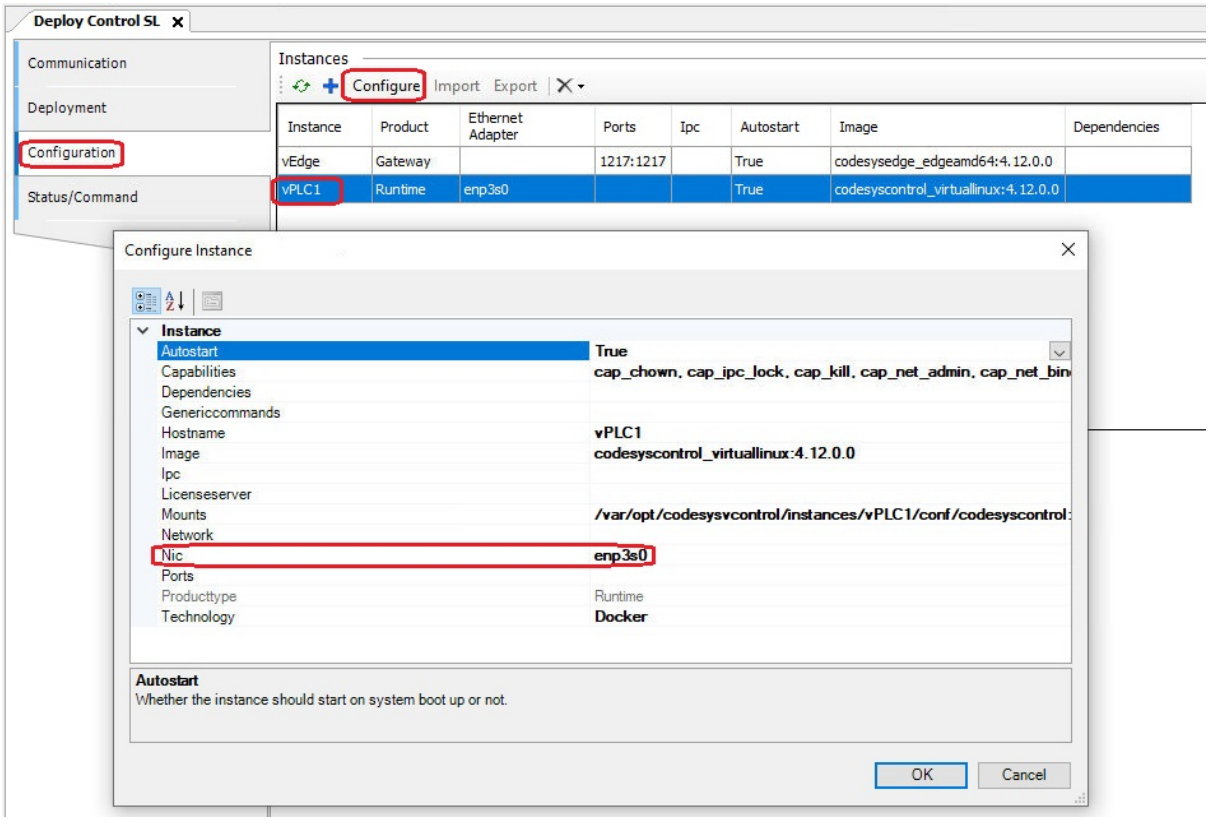
3.3.3 Configure Virtual Control

In the Configuration section, you can add and configure your instances. At least one Runtime and one Gateway instance should be configured. To add a new instance, click the blue *plus* button, select the image, and give it a name.

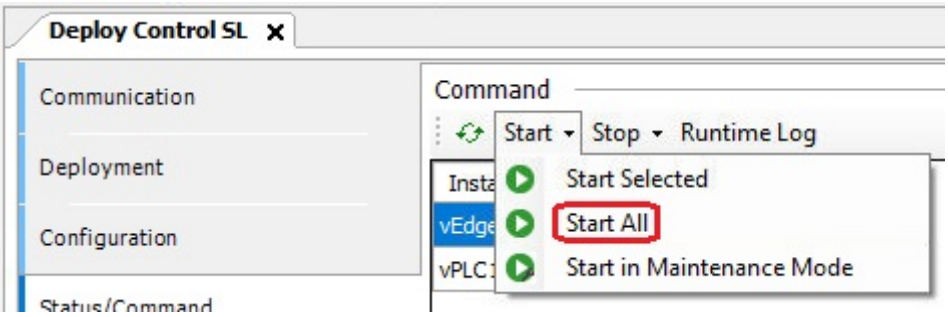


After adding an instance, you can configure it to fit your needs. If you are using EtherCat, a network interface (NIC) needs to be assigned to the runtime instance. It is assumed that a network interface was assigned to the RT-Linux using the system manager. In this guide, the network interface `enp3s0` was assigned to the RT-Linux.

To configure the runtime instance, select it and click the `Configure` button to open the `Configure Instance` dialog. Here, you can enter the name of the NIC you want to assign to the instance.



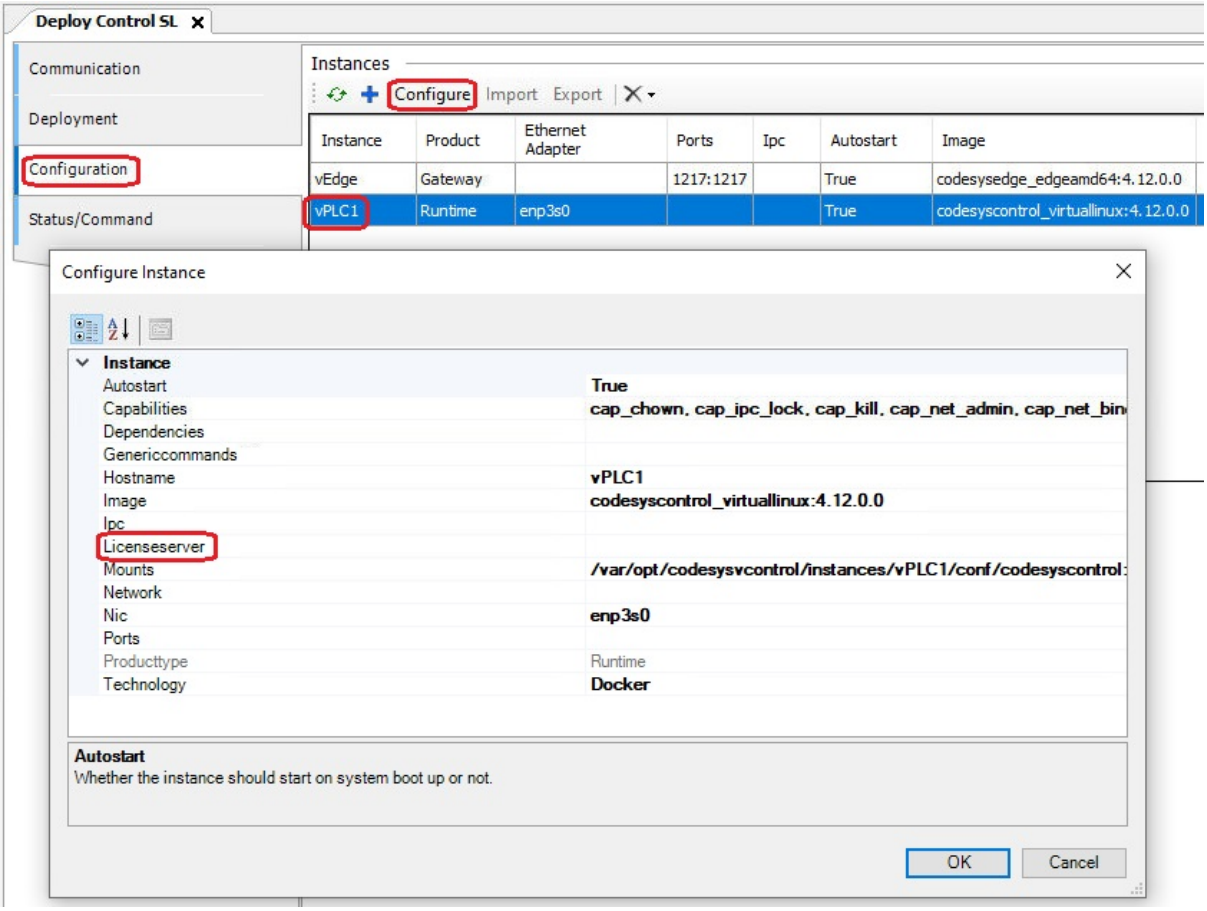
In the Status/Command section, you can check and change the status of your instances. Open the `Start` drop-down menu and select `Start All`. Click on `Runtime Log` to open the log file.



After finishing the setup, switch to the system manager and restart the RT-Linux guest by selecting `Shutdown Guest` and then `Start Guest`.

3.4 Codemeter License Server

CODESYS software is protected via a CodeMeter license server. The license server is specified in the configuration section of the instance.



3.5 Virtual Control Autostart

You may want to automatically start `CODESYS Virtual Control` after RT-Linux has booted.

First, check or configure the RT-Linux data file where the Virtual Control environment will be installed. In this guide, we will create a data file with a size of 10GB (10240MB).

```
$ cd /hv/guests/guest0001
$ mousepad usr_guest_config.sh
```

Add or adjust the entry for rt_data_size_MB.:

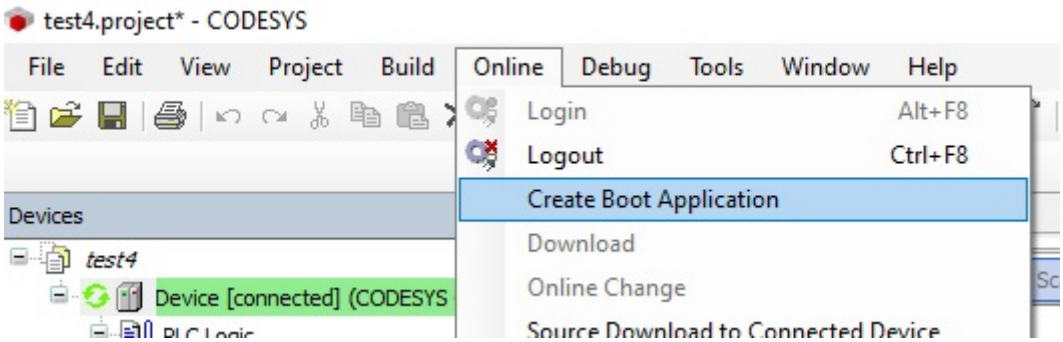
```
export rt_data_size_MB=10240
```

Add the following commands at the end of the file
`/hv/guests/guest0001/files/autostart.sh`
The example below assumes, an IP address is needed and is set to 192.168.10.10. You may have to adjust this address according to your needs. Set the IP address to 0.0.0.0 or omit setting the IP address if no IP address is required
Adjust the containername in the call to `VirtualControlAPI.py` to start the `CODESYS Virtual Control` during the startup of RT-Linux.

```
# set IP address
ifconfig eth0 192.168.10.10

# run CODESYS Virtual Control
python3 ~/VirtualControlAPI.py -r vPLC1
python3 ~/VirtualControlAPI.py -r vEdge
```

If you want the PLC application to run automatically after CODESYS is started, you need to create a Boot Application. You need to select the PLC application, log in into the PLC, download and run the application. Then create the Boot Application.



3.6 Virtual Control Logfile

In case of PLC issues, you can check the log file.

To open the log file in the IDE, go to the menu `Tools/Deploy Control SL`. In the `Status/Command` section, select the instance and click on `Runtime Log`.

The following command on the RTOSVisor Host will store the log file from within the running RT-Linux docker instance into the local filesystem in the file `vplc1.log`. You may need to adjust the IP address of the RT-Linux and the instance name (VPLC1). The required password is `root`:

```
$ ssh root@192.168.157.2 /mnt/rtfiles/etc/rt-linux/files/codesys-
↪  virtualControl/show_codesys_log.sh vPLC1 | tee
↪  vplc1.log
```

4 Windows Guest

4.1 CODESYS Windows VM Port Forwarding

If the CODESYS development system shall be connected with the PLC runtime system, this can be accomplished using the Windows VM IP address and enabling port forwarding. The following steps have to be executed (in the Hypervisor Host).

- Replace the file guest_gateway.config in the windows guest folder `/hv/guests/guestxxxx`

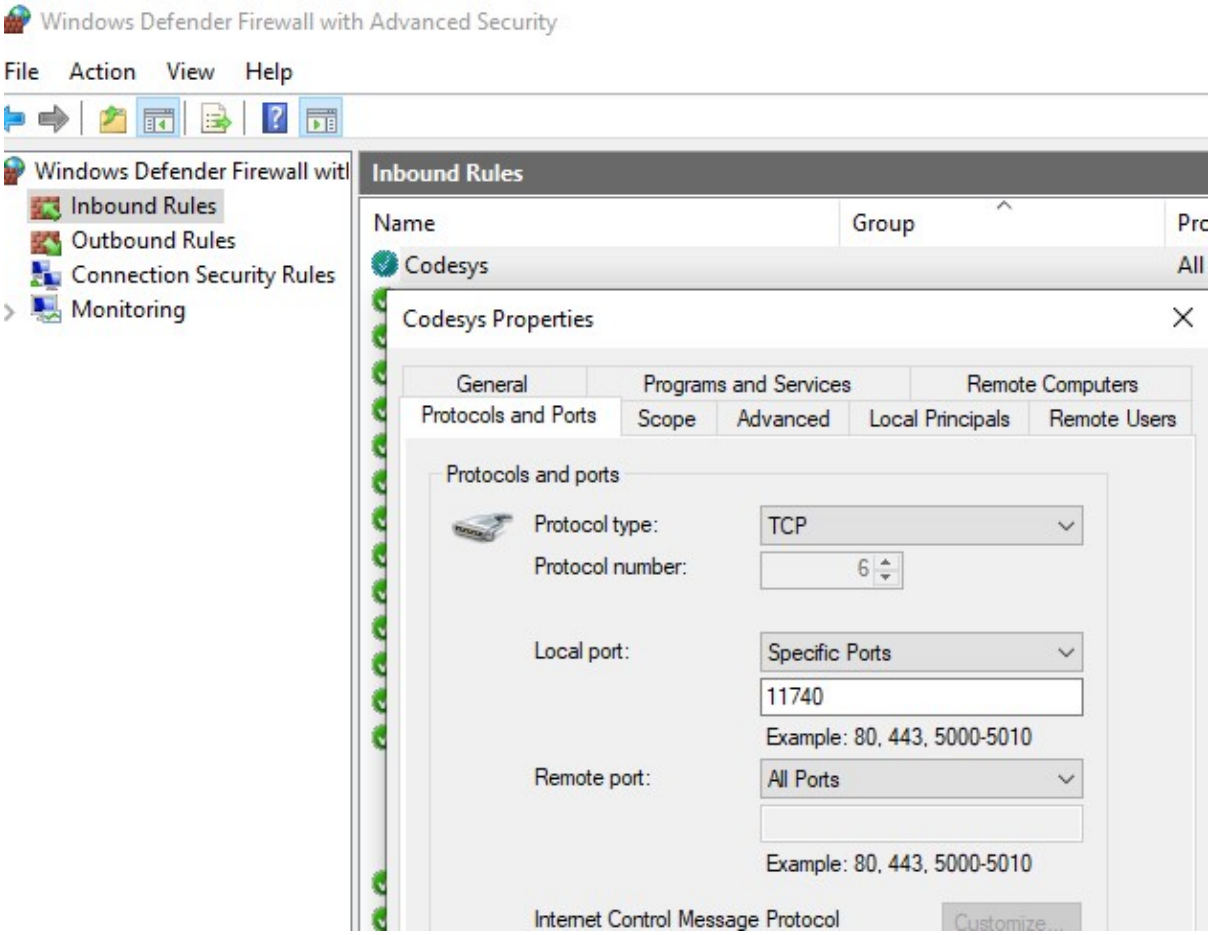
```
$ cd /hv/guests/guestxxxx
$ [ ! -f guest_gateway.config.orig ] && mv guest_gateway.config
↪  guest_gateway.config.orig
$ cp /hv/guests/etc/rt-linux/files/codesys/guest_gateway.config .
```

- Check or add the following line in /hv/config/hv.config. Replace `guestxxxx` with your Windows Guest folder name.

```
#include "/hv/guests/guestxxxx/guest_gateway.config"
```

Then you need to start the Windows guest.

You need to create a firewall rule to accept incoming TCP packets on port 11740 (the CODESYS port)



4.2 Diagnosis shortcuts

For diagnosis purposes additional shortcuts can be placed on the Windows desktop.

- Start the Windows guest

```
$ cd /hv/guests/guestxxxx
$ hv_guest_start -view
```

- Open the Explorer
- Switch to folder `\\10.0.2.4\qemu\etc\rt-linux\files\codesys\CodesysDesktopShortcuts`
- Copy all the shortcuts onto your desktop (you may have to adjust the shortcuts based on your Windows version and language)

Caution: These shortcuts will not work with virtualPLC

Hint: To avoid being asked to allow execution any time you start such shortcut, you may adjust the related Windows settings.

- Open the Control Panel

- Select Internet Options
- Select security
- Select local intranet
- Select sites
- Select advanced
- Add `\\10.0.2.4\qemu`

4.3 Connection to RT-Linux

It is required to attach the Windows guest with the hypervisor communication layer.
This is accomplished with the command executed in the *"Hypervisor Attach"* shortcut

Hint: This shortcut executes the following command.

```
%RTE_ROOT%\RtosUpload.exe -attach -osid 1
```

To automatically attach the communication layer, please copy this shortcut into the Windows startup folder.

```
-  Press the Windows key as well as the R key
-  Enter the following command: shell:startup
-  Copy the shortcut
```

Running this command can be accelerated by adding the following registry key:

```
[HKEY_CURRENT_USER\Software\Microsoft\Windows\CurrentVersion\Explorer\
↪Serialize]
"StartupDelayInMSec"=dword:00000000
```

4.4 Execute PLC commands

This section shows how to execute PLC control commands (e.g. PLC status check).

Caution: This requires the putty ssh client application being installed and security keys being exchanged.

- Download and install .. https://www.putty.org/
- Open putty and connect to `192.168.157.2`, accept the connection (do **not** login)
- Close putty (we only need to execute this step to accept the security keys, they are needed to run the RT-Linux application)

Execute the *"PLC Status"* shortcut
Then the current PLC status should be shown.

4.5 Remove Power Button

To avoid Windows being accidentally shutdown by the user, the power button can be disabled.

- run the group policy editor: gpedit
- Select User Configuration > Administrative Templates > Start Menu and Taskbar
- set "Remove and prevent access to the Shut Down, Restart, Sleep, and Hibernate commands" to Enabled

The whole system then can be shutdown or rebooted as shown in the Windows Guest Guide Tutorial.