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# QuantumRisc-VM

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## INTRODUCTION

QuantumRisc is a project that aims to extend RiscV CPUs by post-quantum secure cryptography. This enables the future users of such extended RiscV CPUs to securely execute cryptography on classical computers, irrespective of the actuality that strong quantum computers exist.

### 1.1 What is this project?

This project offers an out-of-the-box usable Virtual Machine (VM) that includes many tools required for hardware and software development within the QuantumRisc project. This VM can be created by anyone by using build and install scripts, which are supplied in this project. Those scripts are configurable and depending on the configuration completely automatically install the tools. Every tool has its own script. Those scripts can be invoked one-by-one, alternatively another script can be used though, which installs and configures all tools and projects as specified in a simple configuration file.

### 1.2 Goals

The major goals were defined before the VM was specified and ultimately led to the creation of this QuantumRisc-VM project. The goals include, but are not limited to:

- A team should be able to work on a whole set of tools with identical versions. This allows progress to be shared and executed in a way that ensures that no difference in tool versions leads to errors.
- New project members should be able to start working in the project in a fast and uncomplicated manner, eliminating the effort to build and install every tool in the correct version by themselves.
- In regards to future publications, with view on the mentioning of the used development environment, a VM with a set of tools with fixed versions (which easily can be retrieved) is convenient.
- A platform-independent development environment is required to allow any project member to choose their favorite operating system.
- Single tools and complete VMs should be setup fully automatically, reducing the preliminaries to adjusting a configuration file.

## 1.3 Contents

In this section the single components of this project (QuantumRisc-VM) are summarized. This project can be used on three layers:

1. User - Hardware or Software developer in the QuantumRisc project (chapter *Using a QuantumRisc-VM*)
2. Configurator - Usage of build and install scripts (chapter *Creating a QuantumRisc-VM* and *Tool build- and install scripts*)
3. Developer - Extension of build and install scripts (chapter *Tool build- and install scripts*, *Extending the install scripts* and *Script and configuration index*)

### 1.3.1 Tool installation scripts

Any tool that is required for hardware or software development within the QuantumRisc can be installed using a fully automated installation script. Those scripts can be used independently from the VM to install the tools. Explanation on how to use these scripts is given in chapter *Tool build- and install scripts*. All scripts and their configuration files are listed in chapter *Script and configuration index*.

### 1.3.2 QuantumRisc-VM build script

The QuantumRisc-VM build script is a configurable builder/installer of all tools for which an installation script exists. It was made with two priorities:

1. It should be easily configurable and executable
2. The operator should be able to leave the machine and come back to a fully configured VM in a couple of hours

In a configuration file every tool and project that the script will configure, build and if desired install, can be configured. After the script has been launched and possibly after answering some prompts, the script will work autonomously. A detailed description is given in chapter *Creating a QuantumRisc-VM*.

### 1.3.3 QuantumRisc-VM

RheinMain University offers an out-of-the-box usable VM that includes any tools required to work in the QuantumRisc project. The VM includes tools for open-source FPGA development from source code to simulation or programming of a real FPGA. This includes compilation of SpinalHDL code to Verilog or VHDL, synthesis, place and route, bitstream creation, bitstream programming for lattice fpgas, simulation and debugging. The VM also includes tools for RiscV CPU extension development which enable compiling, simulating and debugging. Finally, the VM includes projects that assist during the development of hardware-software-co-designs. It also includes a hello world project to test the available tools. The structure and usage of the QuantumRisc-VM is described in chapter *Using a QuantumRisc-VM*.

### 1.3.4 Documentation

The installation scripts and QuantumRisc-VM build scripts are kept up to date in this documentation. Any remote changes will be automatically build and updated, so that the most recent changes are transparent. Users of the VM, users of the build scripts and developers who extend those scripts all should be able to get a majority of their relevant questions answered here.

## USING A QUANTUMRISC-VM

This Chapter deals with the download, setup and usage of a QuantumRisc-VM. The list of tools and projects included in the VM might vary from version to version, but should be included at the download page. Additionally, the tools are listed in chapter *Script and configuration index* and in a version file at the desktop of the VM.

### 2.1 Prerequisites

- QuantumRisc-VM
- VirtualBox (tested with version 6.1.10\_Ubuntu r138449)
- ~100GB hard disk space (~80GB VM image, ~20GB archive)

### 2.2 Setup

Download and extract the QuantumRisc-VM from the link mentioned in *Prerequisites*. You can get yourself a coffee or a tee, because the archive is relatively large and the extraction can take half an hour. Also install VirtualBox, following the instructions given at the vendors page.

## 2.2.1 Setting up VirtualBox


Start VirtualBox and select “new” in the toolbar to add the QuantumRisc-VM image:



Give the Virtual Machine a name and data folder:



Create Virtual Machine




### Name and operating system

Please choose a descriptive name and destination folder for the new virtual machine and select the type of operating system you intend to install on it. The name you choose will be used throughout VirtualBox to identify this machine.

Name:


QuantumRisc-VM

Machine Folder:

 /root/VirtualBox VMs

Type:

Linux



Version:

Ubuntu (64-bit)

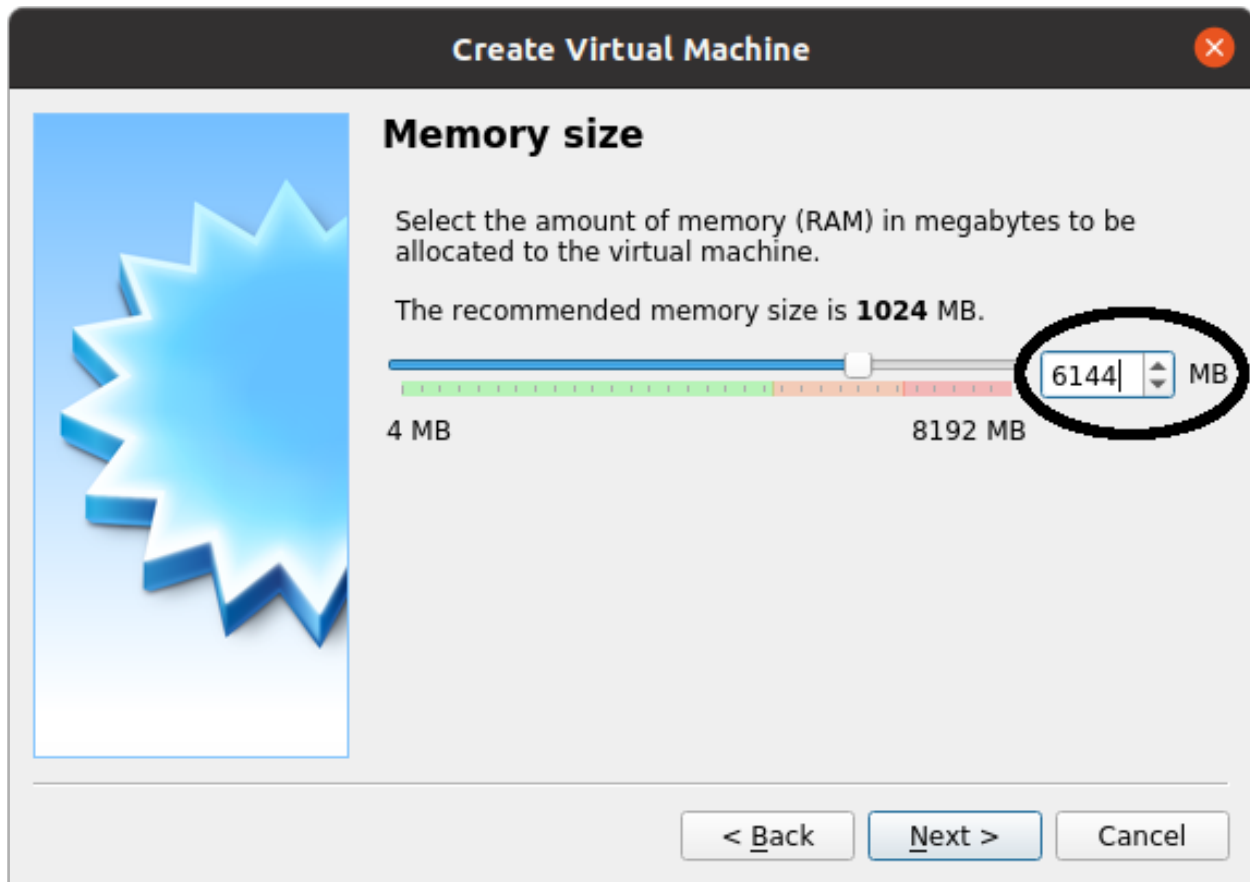
Expert Mode

< Back

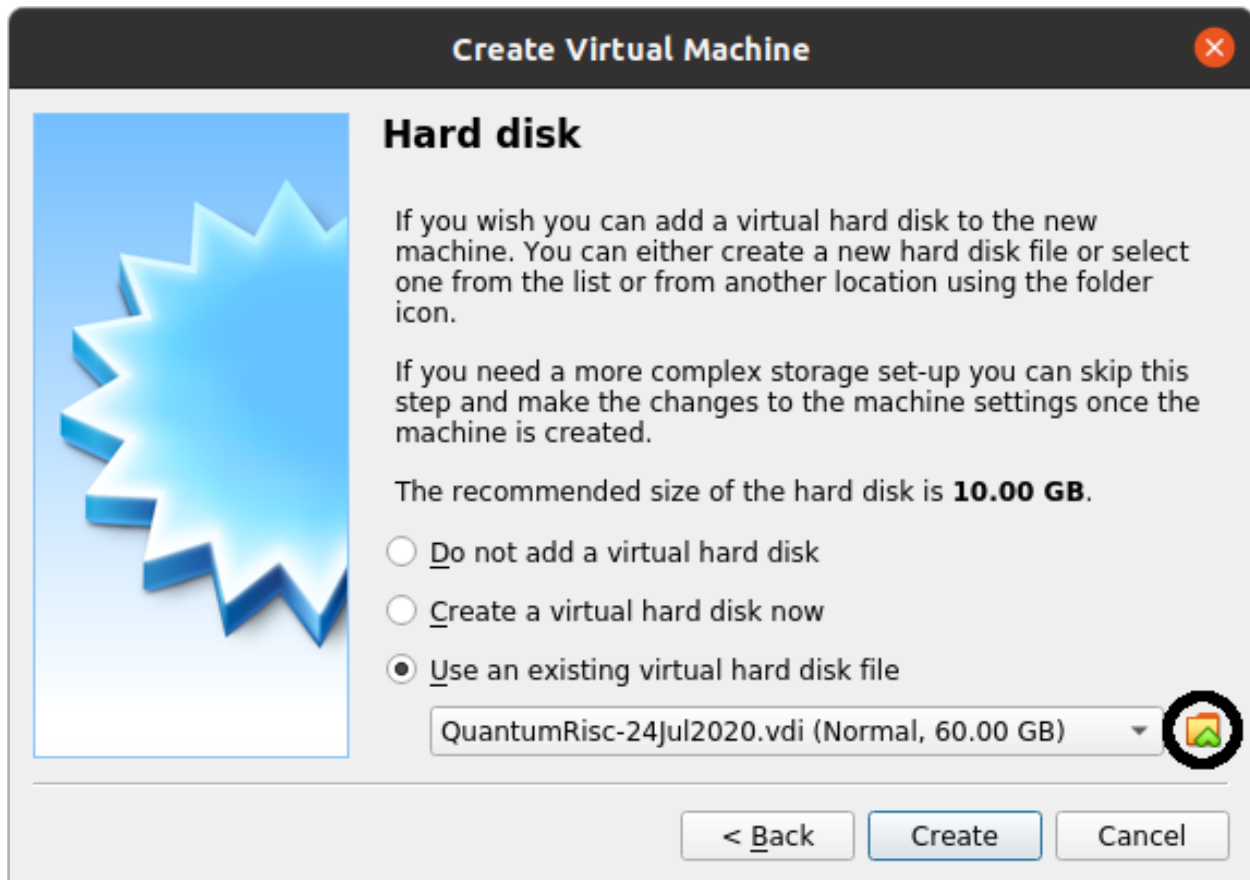
Next >

Cancel

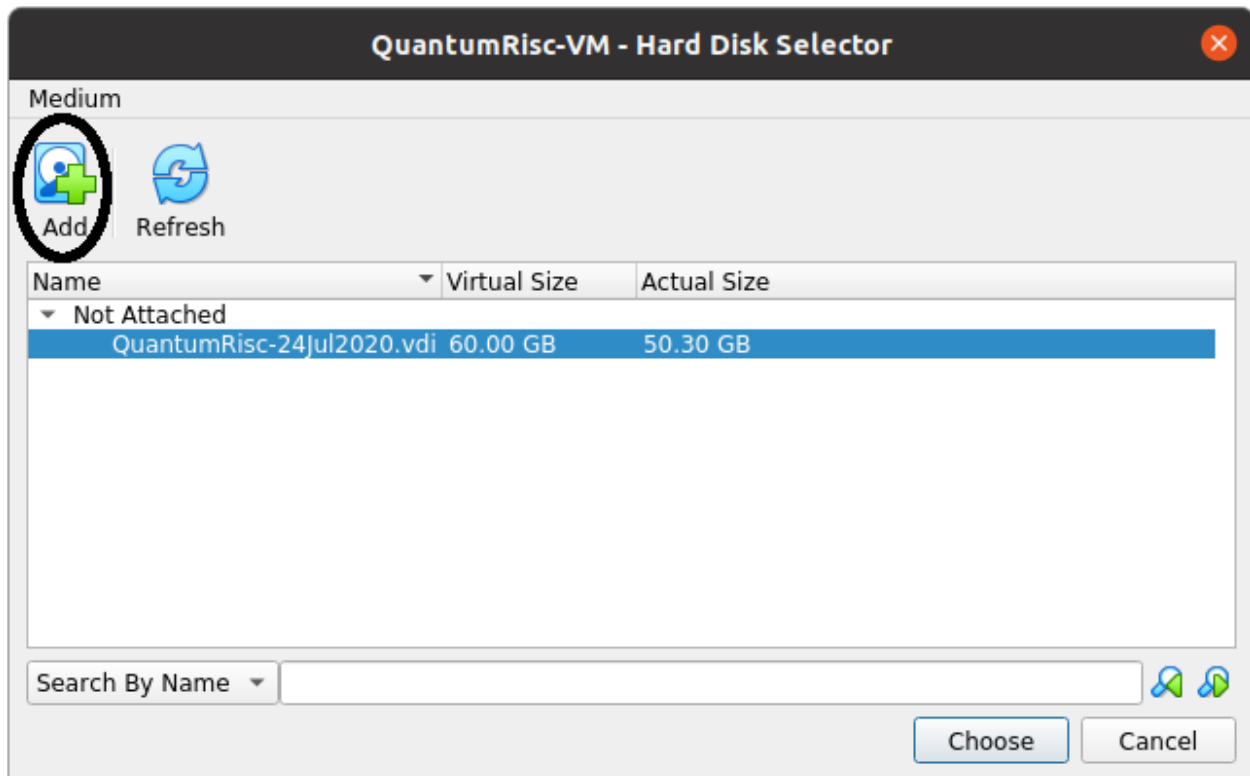
Select the amount of RAM to assign to the VM (this can be changed later). A value too low can lead either to a dysfunctional VM or massive swapping of RAM contents to the hard drive, which slows the machine down. A value too high has the same effects on the hosting machine. To use the VM, 4GB should be enough. Be aware though that building the VM requires 6GB or more of RAM, otherwise the build will fail at the RiscV toolchain (more information at chapter *Tool build- and install scripts*).



Select “use an existing virtual hard disk file” and press on the folder icon:



A new dialogue should open. Select “Add” and select the previously downloaded and extracted QuantumRisc-VM image:

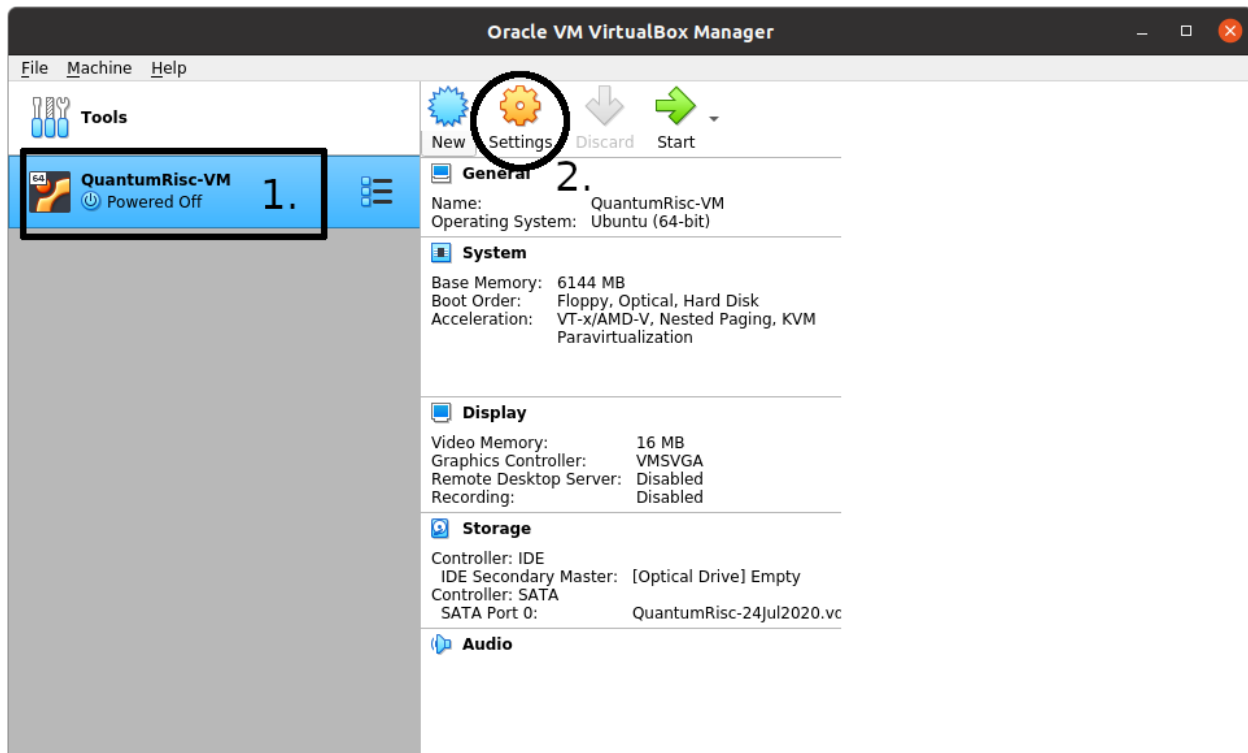


Press on “create”. Your VM has now been created and can be used. Before you use it, you should configure it as instructed in the section *Setting up QuantumRisc-VM*.

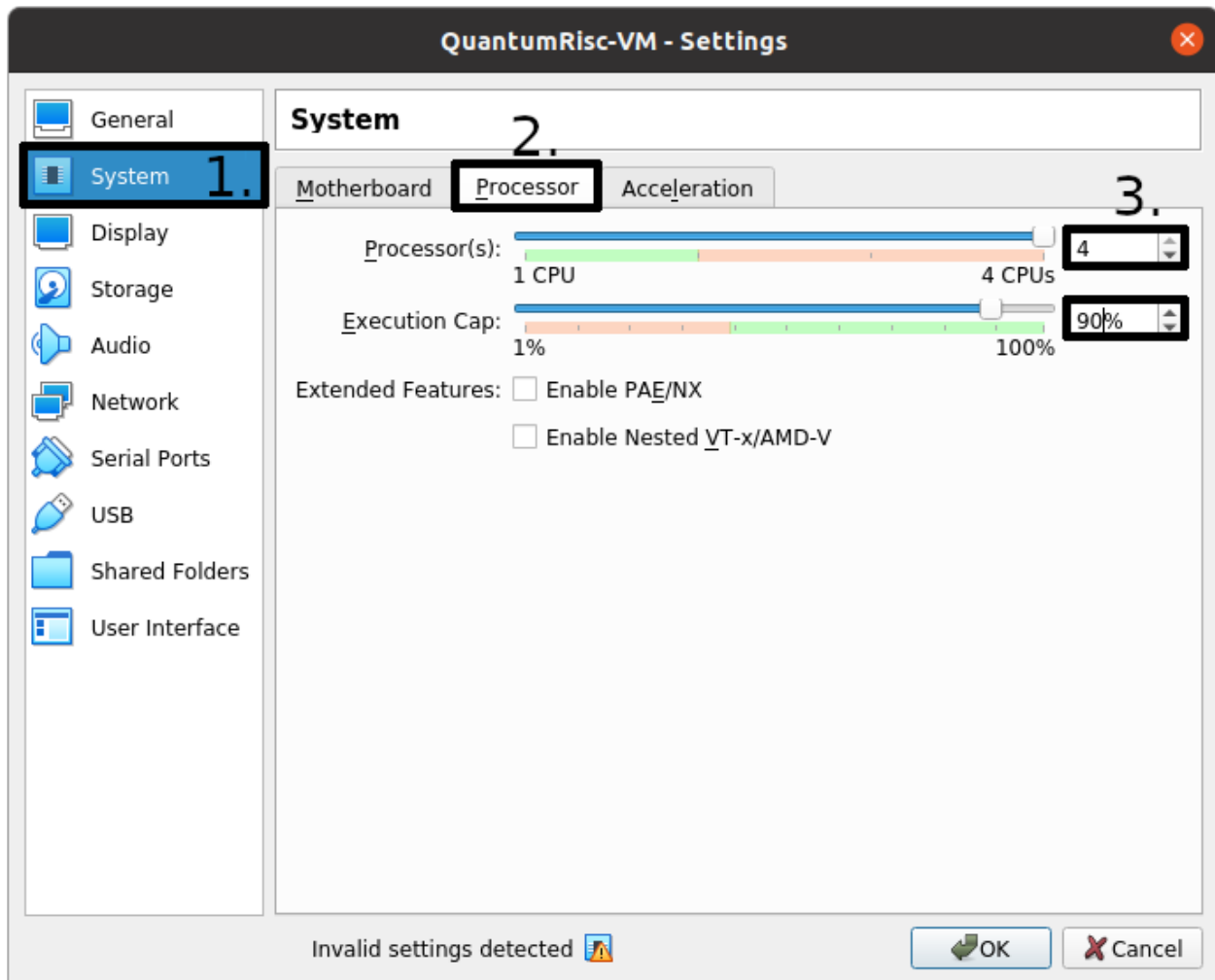
## 2.2.2 Setting up QuantumRisc-VM

After finishing the steps provided to setup VirtualBox as specified in *Setting up VirtualBox*, a virtual machine that mounts the QuantumRisc-VM image has been created. Now we are going to assign processors and the execution cap, video memory and USB access.

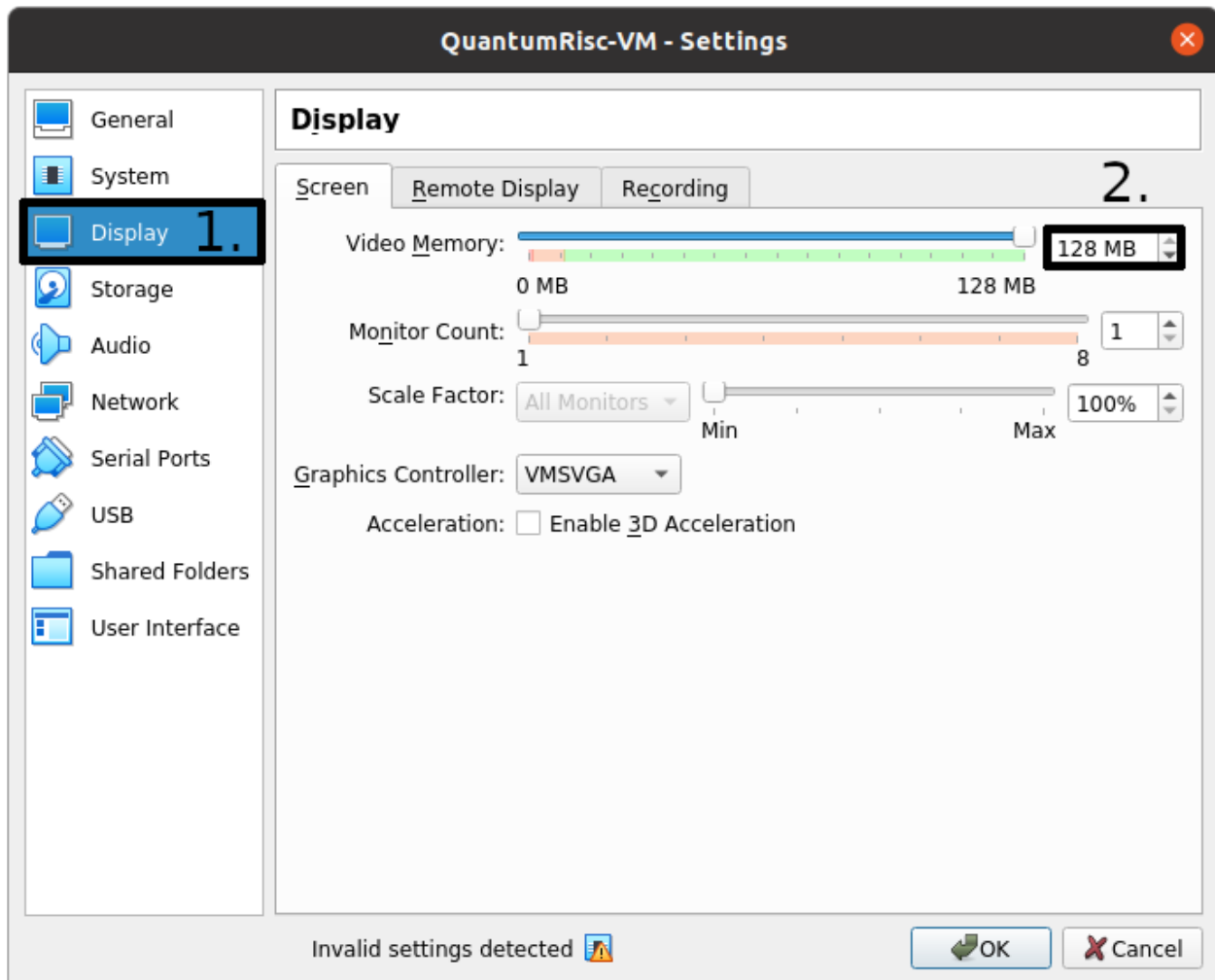
Start by selecting the VM from the list of available VMs and click on the cogwheel icon:



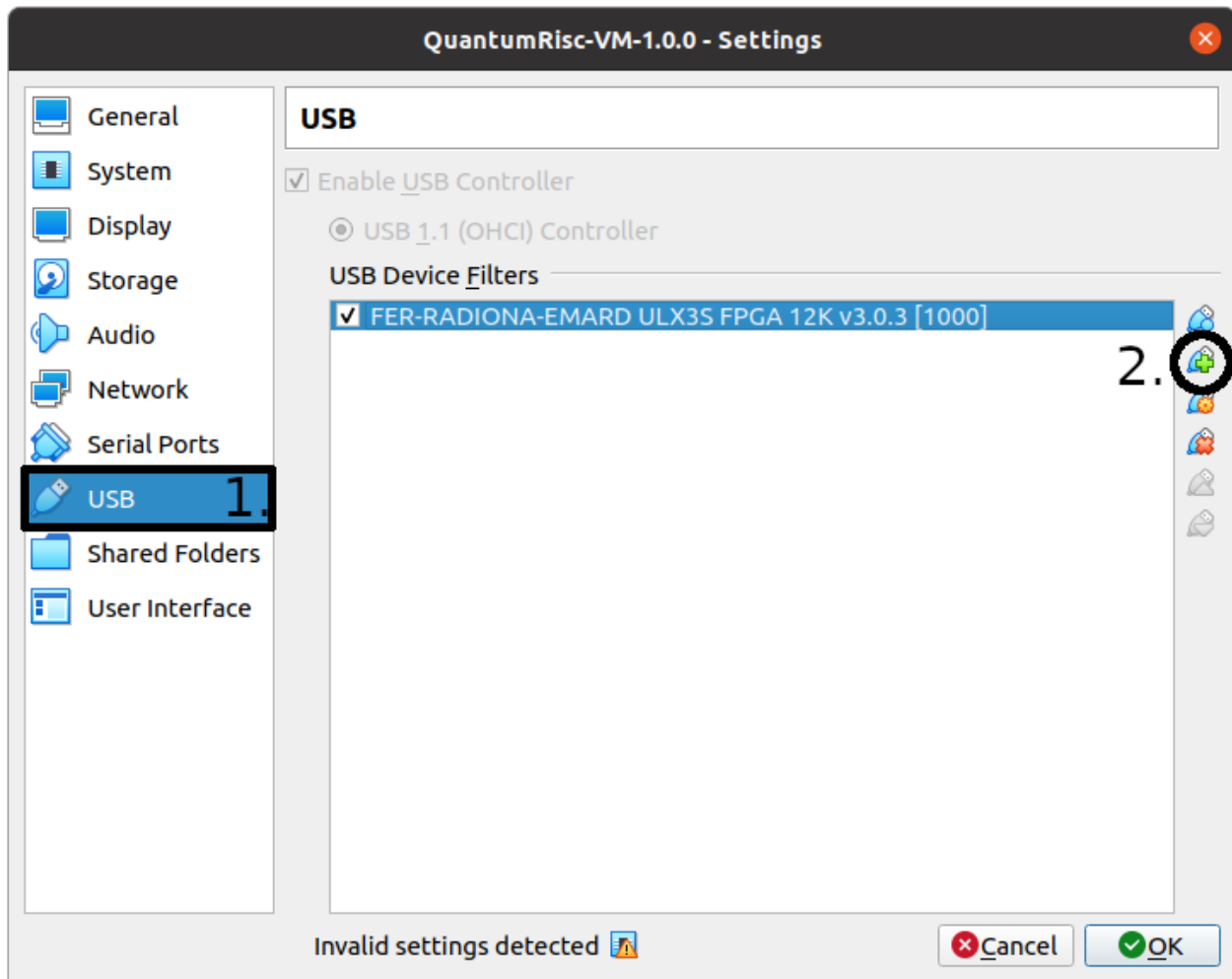
To configure the processor count and usage cap, click on “System” in the left list of categories. Select the “Processor” tab. You can specify the number of processors and the execution cap. You might not want to select 100% execution cap in case you have selected all available processors, because that might slow down or even temporarily freeze your host system.



Next select the “Display” category and specify the video memory. To avoid graphical lags you should assign as much as you can provide. You can also configure multiple monitors in that dialogue.



Complete the configuration by making sure that USB connections are passed through to your VM. This is only relevant if you want to work with devices connected over USB, for example to flash a FPGA. You have to pass through each USB device or create a filter that matches a group of devices. To permanently pass through an USB device, select the USB icon that contains a green + sign on it in the USB dialog:



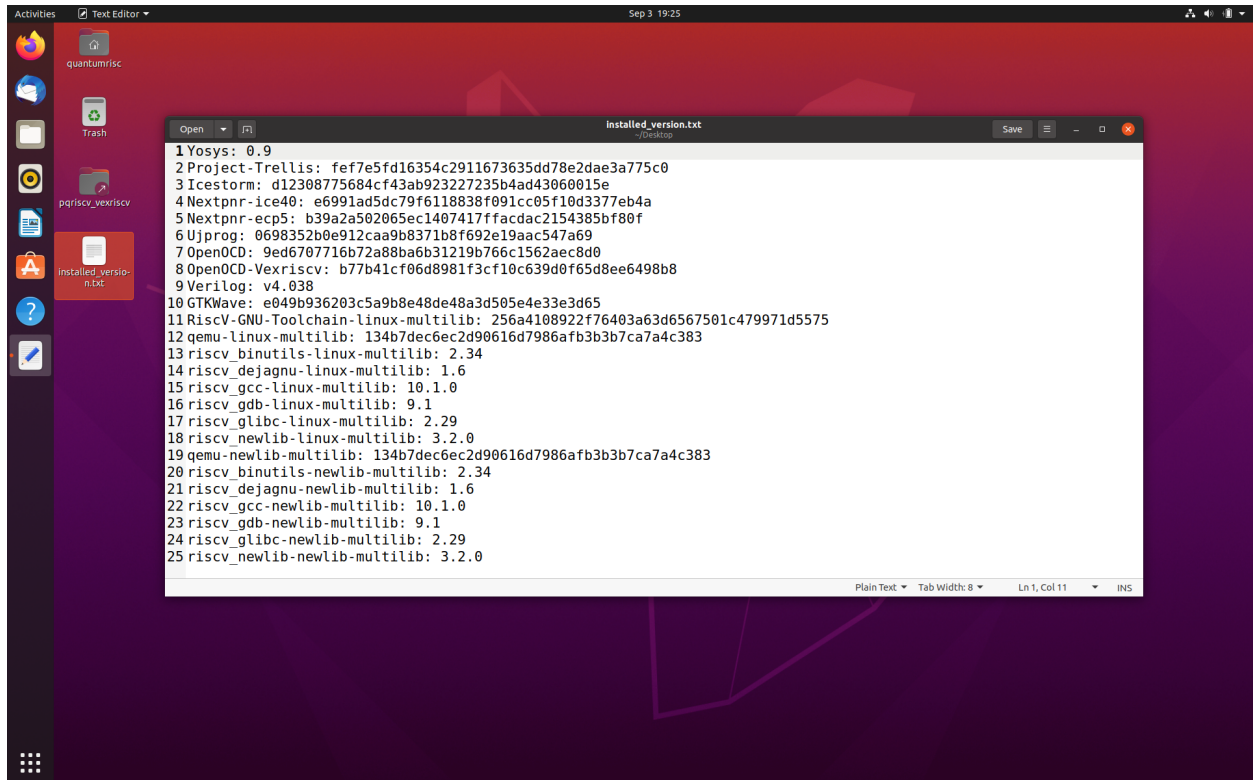
Hint: You can also add and remove permissions to pass through your USB devices during the execution of the VM. To do so, click on *Devices* -> *USB* in the menu of the running VM.

## 2.3 Usage

After setting VirtualBox and the QuantumRisc-VM up, the VM is ready to use. Start the VM, the superuser credentials can be found at the QuantumRisc-VM download page. If you can only see a black screen, press *right CTRL* + *F* twice. You might want to change the display resolution. This can be achieved by clicking on “Activities” in the top left corner, typing “displays” and pressing enter. You can switch between fullscreen and scaled mode by pressing hostkey + *F* and hostkey + *S* respectively. By default, the hostkey is mapped to right CTRL. If you experience graphical issues, switching to scaled mode (hostkey + *S*) and configuring the displays within the VM might resolve the issues.

After launching the VM you see the desktop containing a version file and symbolic links to folders:





The version file contains a version dump of all the tools that are available on the VM. All these tools are already configured and installed properly and can be used out of the box. The symbolic links to folders are links to projects that have been selected to be included into the VM by default. Those are usually projects that are being developed currently or assist during development. One of the default projects is an “Hello World” project, which serves as testkit to automatically test most of the tools that are available on the VM. This project is described in the next section [Hello World](#)

### 2.3.1 Hello World

A demo application which uses most if not all of the tools on the VM will be included in the next version.



## TOOL BUILD- AND INSTALL SCRIPTS

The entire project consists mainly of folders, which contain two scripts and sometimes a configuration file. The folder is named after the tool or the collection of tools, which are installed by the scripts contained within. One script does install the build essentials, using the apt package manager as it's primary source. The other script pulls, configures, builds and installs the tool in question. All scripts can be found in this documentation in *Script and configuration index*. The usage of those tool build and install scripts is described in section *Tool build and install scripts*.

In addition to scripts for every single tool, a major fully configurable script exists, which automatically builds and installs all tools and projects, for which a tool build script exists and for which the installation flag is toggled in the configuration file. For more details, skip to section *Fully automated and configurable tools and projects install script*

### 3.1 Prerequisites

- [Ubuntu](#) (tested with version 20.04 LTS)
- [Build tools](#)
- Bash (tested with version 5.0.17)
- Apt package manager (tested with version 2.0.2ubuntu0.1)

### 3.2 Tool build and install scripts

This section describes how to configure and use the tool build and install scripts.

#### 3.2.1 Preparation

Before attempting to install the tools, you have to install some build-essentials like make, compilers and the python interpreter. You only have to execute this script once on a specific machine. Locally browse to [build\\_tools](#) and execute [install\\_build\\_essentials.sh](#) as a superuser:

```
sudo ./install_build_essentials.sh
```

### 3.2.2 Usage

The scripts are structured similarly and most of the time offer identical configuration options. Let us simulate the usage of one tool together, using explanations of the configuration options and what the script does internally. Browse to `build_tools/verilator`. This folder contains the two script:

1. `install_verilator_essentials.sh`
2. `install_verilator.sh`

This is a common naming pattern in this project, you can replace `verilator` by the names of other tools supported by this project. Both scripts require superuser privileges. To install the build essentials, the `apt install` command is used, that requires superuser privileges. Furthermore to install the built script, superuser privileges are required. The script could be designed such that superuser privileges are requested when required. By using this alternative approach, a fully automatic sequential installation of all tools would not be possible if the user does forget to run the scripts as superuser, because after a certain time the user must type in the superuser credentials again. You should install the software required to build the tool before building it by invoking the `install_<toolname>_essentials.sh` script, in this case:

```
sudo ./install_verilator_essentials.sh
```

After the build essentials have been installed, we can build and install the tool. Let's check out the parameters by executing the script with the `-h` option:

```
./install_verilator.sh -h
```

This prints the following output (for verilator):

```
install_verilator.sh [-h] [-c] [-d dir] [-i path] [-t tag] -- Clone latested tagged_
↪verilator
version and build it. Optionally select the build directory and version, install_
↪binaries and
cleanup setup files.

where:
  -h          show this help text
  -c          cleanup project
  -d dir      build files in "dir" (default: build_and_install_verilator)
  -i path     install binaries to path (use "default" to use default path)
  -t tag      specify version (git tag or commit hash) to pull (default: Latest tag)
```

The `-c`, `-d`, `-i` and `-t` options are default options that are available for every tool build and install script.

The script creates a build folder, in which the source code for the project is being pulled into and in which temporary files might be stored. The name of the build folder can be specified by using the `-d` flag.

The source code version that should be pulled can be specified by using the `-t` flag. You can specify a branch name, tag, commit hash or one of the following options:

- `default/latest`: Pulls the default branch
- `stable`: Pulls the latest tag

The default behaviour (in case `-t` was not specified) is to pull the default branch. Before using the `stable` option, be sure to check whether the repository stopped to use tags at some point in time. If this is the case, the script will pull and use an outdated version, because it does not check timestamps. If no tags are found, the default branch is used.

The scripts only builds the tools by default. To also install them (using the default path specified in the tool itself), execute the script with the `-i` flag. The `-i` flag takes one parameter, which is used to specify the install path. Set it to default to use the default install path preconfigured within the tool in question.

The last default flag is the `-c` flag, which deletes all files after the tool has been successfully installed. It is only relevant if the `-i` flag is supplied at the same invocation. Otherwise a tool that was build but not installed would be removed, which is obviously pointless because it is equivalent to no changes at all.

Some tools have additional parameters which should be documented well enough in the output of the `-h` flag.

If the tool build essentials have been installed and the invocation of the tool is realized with superuser privileges and correct parameters, the script will fully automatically install the tool in question. Note that the build and/or installation process can be canceled by the SIGINT or SIGTERM signals, the default behavior of the scripts is to remove any files created by the script though. Therefore any progress will be lost.

## 3.3 Fully automated and configurable tools and projects install script

This section describes how to configure and use the major tools and projects install script.

### 3.3.1 Preparation

The script depends on a configuration file, which specifies which tools and projects should be installed and how they are configured. This file is located in `build_tools/config.cfg`. The configuration parameters should be commented well enough to be understood, but let's take a look at Verilators configuration section

#### Tool configuration

```
## Verilator
# Build and (if desired) install Verilator?
VERILATOR=true
# Build AND install Verilator?
VERILATOR_INSTALL=true
# Install path (default = default path)
VERILATOR_INSTALL_PATH=default
# Remove build directory after successful install?
VERILATOR_CLEANUP=true
# Folder name in which the project is built
VERILATOR_DIR=default
# Specify project version to pull (default/latest, stable, tag, branch, hash)
VERILATOR_TAG=default
```

The configuration parameter names for tools follow the name conception `TOOLNAME_PARAMETER=VALUE`. The `TOOL=true` flag specifies whether this tool should be build and optionally installed or whether it should be ignored. Other than that, the four basic tool build and install script flags, that were described in [Tool build and install script parameters](#), are mirrored by the config parameters followed by `TOOL=true`. This is the minimal configuration, at the same time it is the complete set of configuration parameters for most of the tools.

## Project configuration

Beside configuration entries for tools, projects can also be configured. The configuration is identical for every project and looks like this:

```
## Pqvexriscv project
# Download git repository
PQRISCV_VEXRISCV=false
# Git URL
PQRISCV_VEXRISCV_URL="https://github.com/mupq/pqriscv-vexriscv.git"
# Specify project version to pull (default/latest, stable, tag, branch, hash)
PQRISCV_VEXRISCV_TAG=default
# If default is selected, the project is stored in the documents folder
# of each user listed in the variable PQRISCV_VEXRISCV_USER
PQRISCV_VEXRISCV_LOCATION=default
# Space separated list of users (in quotation marks) to install the project for
# in /home/$user/Documents (if PQRISCV_VEXRISCV_LOCATION=default).
# default = all logged in users. Linking to desktop is also based on this list.
PQRISCV_VEXRISCV_USER=default
# Symbolic link to /home/$user/Desktop
PQRISCV_VEXRISCV_LINK_TO_DESKTOP=true
```

The configuration parameter names for projects follow the name conception *PROJECT\_PARAMETER=VALUE*. You can toggle whether you'd like the project to be installed by specifying *PROJECT=true*. Currently the projects are limited to projects that can be pulled by using git. The git repository url can be specified as an HTTP-link in the *PROJECT\_URL=HTTPURL* parameter. The state of the git repository that should be used is reflected in the *PROJECT\_TAG=STATE* parameter. *STATE* can take the same values as the *-t* flag from the *Tool build and install script parameters*. By specifying *PROJECT\_LOCATION=PATH* you can control where the project is copied to. Leaving this value at *default* does use the documents folder inside the home directory of the user specified in the variable *PROJECT\_USER=USER*. If *PROJECT\_USER* is default, any logged on user will be regarded. Finally, it is possible to configure whether the project is linked to the desktop of the user by specifying *PROJECT\_LINK\_TO\_DESKTOP=BOOL*.

### 3.3.2 Usage

After configuring the tools and projects that shall be installed by adjusting *config.cfg*, execute the install script *install\_everything.sh* and toggle the *-h* parameter (note that the real execution requires superuser privileges):

```
./install_everything.sh -h
```

It should emit the following output:

```
install_everything.sh [-c] [-h] [-o] [-p] [-v] [-d dir] -- Build and install_
↳QuantumRisc
toolchain.

where:
  -c      cleanup, delete everything after successful execution
  -h      show this help text
  -o      space separated list of users who shall be added to dialout
          (default: every logged in user)
  -p      space separated list of users for whom the version file shall
          be copied to the desktop (default: every logged in user)
  -v      be verbose (spams the terminal)
  -d dir  build files in "dir" (default: build_and_install_quantumrisc_tools)
```

The parameters *-c* and *-d* are equal to the default parameters mentioned in *Tool build and install script parameters*.

The `-o` parameter is used to specify the users who are added to the dialout group. By default (if `-o` is not set), the install script installs all tools and projects for every user who is logged in during the installation process. `-o` can be used in a scenario where the install script is configured to install the tools and projects for a single user or a set of users.

The `-p` parameter lets us control which users get a copy of the version file. This file is explained in the following section [Version file](#). Identical to the behavior of `-o`, `-p` does target all logged on users by default.

The `-v` parameter enables or disables the verbose output. By default, only the current operations are printed to the console. This keeps the console relatively clean. Note that errors are still logged in a file (see [Error file](#)). By setting the `-v` parameter, every output is passed to the console. This includes compiler logs, which spam the console.

The default behavior of the script in case it receives SIGINT or SIGTERM signals, is to leave everything as it was before receiving the signal and to terminate the script. Nevertheless, the tool build script will delete the tool build folder in that case.

## Version file

Every single tool installation script does log the version the tool was build for in a file called *installed\_version.txt*. The major tools and projects installation script, that is covered in this chapter, does collect the information from the version file of every tool that was build into a file called *installed\_versions.txt*. The file is copied to the desktop of each user, who was specified by the `-p` parameter (every logged on user by default). This file can be used for instance when releasing a new QuantumRisc-VM version or when publishing a paper. The contents of the version file look like this:

```
Yosys: 0.9
Project-Trellis: fef7e5fd16354c2911673635dd78e2dae3a775c0
Icestorm: d12308775684cf43ab923227235b4ad43060015e
Nextpnr-ice40: e6991ad5dc79f6118838f091cc05f10d3377eb4a
Nextpnr-ecp5: b39a2a502065ec1407417ffacdac2154385bf80f
Ujprog: 0698352b0e912caa9b8371b8f692e19aac547a69
OpenOCD: 9ed6707716b72a88ba6b31219b766c1562aec8d0
OpenOCD-Vexriscv: b77b41cf06d8981f3cf10c639d0f65d8ee6498b8
Verilog: v4.038
GTKWave: e049b936203c5a9b8e48de48a3d505e4e33e3d65
RiscV-GNU-Toolchain-linux-multilib: 256a4108922f76403a63d6567501c479971d5575
qemu-linux-multilib: 134b7dec6ec2d90616d7986afb3b3b7ca7a4c383
riscv_binutils-linux-multilib: 2.34
riscv_dejagnum-linux-multilib: 1.6
riscv_gcc-linux-multilib: 10.1.0
riscv_gdb-linux-multilib: 9.1
riscv_glibc-linux-multilib: 2.29
RiscV-GNU-Toolchain-newlib-multilib: 256a4108922f76403a63d6567501c479971d5575
qemu-newlib-multilib: 134b7dec6ec2d90616d7986afb3b3b7ca7a4c383
riscv_binutils-newlib-multilib: 2.34
riscv_dejagnum-newlib-multilib: 1.6
riscv_gcc-newlib-multilib: 10.1.0
riscv_gdb-newlib-multilib: 9.1
riscv_newlib-newlib-multilib: 3.2.0
```

### Error file

Any errors that occur during the execution of the *install\_everything.sh* script are logged in the build directory, whose name is specified by the *-d* or whose name is set to the default value “build\_and\_install\_quantumrisc\_tools” if *-d* was not set. The file is named “errors.log”. If *-v* is not set, the error messages are only redirected to this file. If *-v* is set, the error messages are additionally printed in the console.

### Checkpoints

The *install\_everything.sh* script does remember which tools or projects have been successfully installed. By default, this information is stored inside the build directory in a file that’s called “latest\_success\_tools.txt”. For projects, by default a file named “latest\_success\_projects.txt” is used. If the execution of this script is canceled by the user or an error, the script remembers the state and during the next execution offers the user to continue were it stopped. The user can either decide to go on or start over. If the script terminated successfully, the user can only decide to install the latest tool or project in case the build directory was not cleaned up (id est *-c* was not set).

### Projects

All projects are only downloaded using the version that was specified in the configuration file *config.cfg*. The downloaded files are placed in the “Documents” folder inside the home folder of all users who were specified in the configuration file. In addition, a symbolic link to the projects is placed on the desktop. Currently this part only works on English systems, because the folder names “Documents” and “Desktop” are hard-coded.



## CREATING A QUANTUMRISC-VM

In this section you can learn how to setup a virtual machine, how to configure the tool and project installation script and finally how to start the fully automatic QuantumRisc-VM setup process.

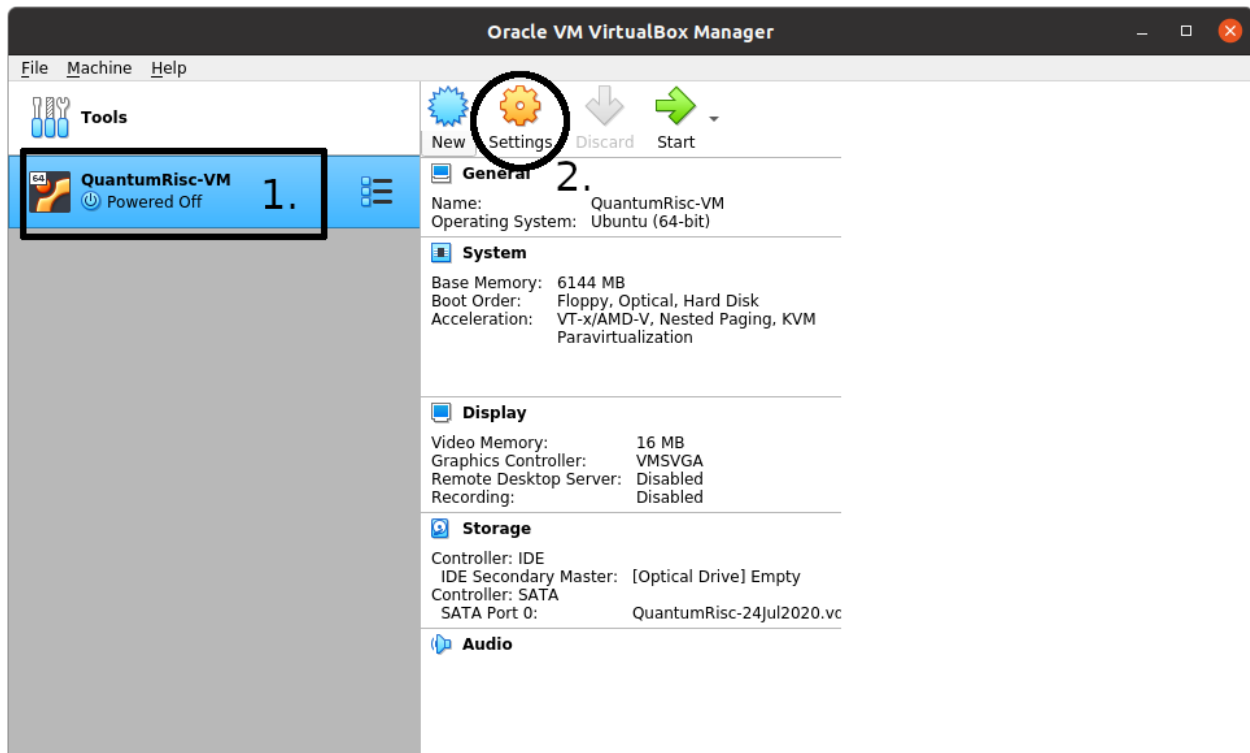
### 4.1 Prerequisites

- [VirtualBox](#) (tested with version 6.1.10\_Ubuntu r138449)
- [VirtualBox Guest Additions](#)
- [Ubuntu 20.04 LTS setup iso](#)
- [VM build tools](#)
- >6GB RAM
- >100GB hard disk space (~80GB for the VM, ~20GB to archive it)

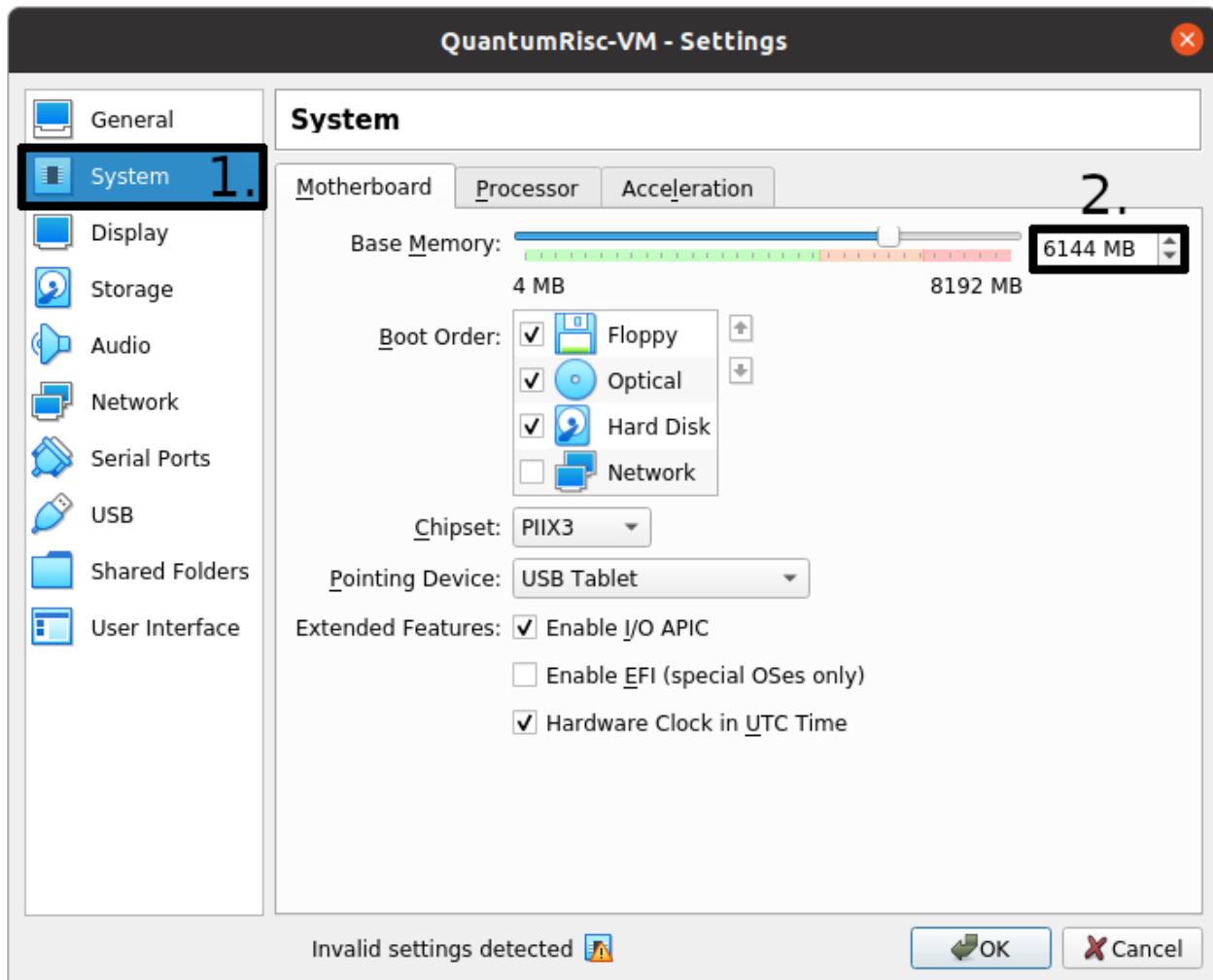
### 4.2 Preparing the VM

Follow the instructions on [how to install Ubuntu 20.04 LTS](#), but instead of allocating 30GB of disk space, choose at least 85GB (100GB recommended). You can set the username and password both to “quantumrisc”. After the successful installation of Ubuntu and all tools and projects, about 76 GB are used up. In case you selected 85GB, about 9GB are still available for the end user to download and install additional software. During the installation of the tools and projects, the disk will use up to almost 80 GB temporarily.

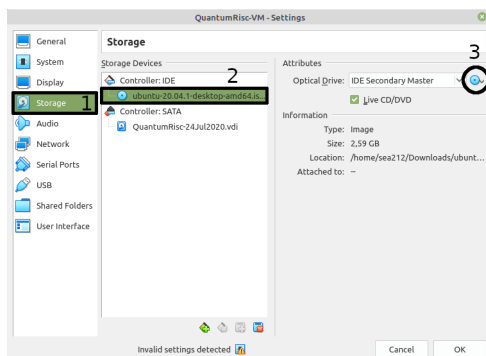
After the successful installation of [Ubuntu 20.04 LTS](#) and the [VirtualBox Guest Additions](#) on the VM, shutdown the VM and follow the instructions from section [Setting up QuantumRisc-VM](#). In addition to those instructions, you also have to raise the available memory for the VM to at least 6GB. To achieve this, select the VM and enter the *Settings* dialogue:



Switch to the *System* tab in the left menu and set the base memory to 6144 MB or more:



If you have not already removed the Ubuntu iso image from the virtual optical drive, the virtual machine will try to boot from it first. You can remove it in the *Storage* section of the *Settings* dialogue. Click on the image under the IDE Controller, next click on the disk image in the *Attributes* section and finally select “Remove Disk from Virtual Drive” in the dialogue. Since no virtual disk or floppy is detected now, the VM will boot from the virtual hard drive:



If you still experience issues booting your VM, try to change the *Boot Order* in the *System* section of the *Settings* dialogue. Give the *Hard Disk* the highest priority (top) and see if your VM boots. Note that your VM will now ignore virtual floppy or disk images during the boot process.

Start your VM and upgrade any packages on it and the kernel if desired:

```
sudo apt update && sudo apt upgrade -y && sudo apt dist-upgrade && sudo apt  
autoremove -y
```

## 4.3 Configuring and running the fully automatic install procedure

Copy the folder *build\_tools* from the [QuantumRisc-VM git project](#) to */opt/QuantumRisc-Tools*. Change the current directory to */opt/QuantumRisc-Tools/build\_tools*.

Configure the fully automated and configurable tools and project install script as desired. Instruction can be found on section *Fully automated and configurable tools and projects install script* of the scripts chapter. After an adequate configuration was created, run the install script with the desired flags (usually *-c* is enough), as explained in section *Usage* of the scripts chapter:

```
sudo ./install_everything.sh -c
```

Finally, clean up traces you left during the setup:

- browser history
- temporary files which are not required anymore
- command line history by using the command `history -c && history -w`

## EXTENDING THE INSTALL SCRIPTS

This section covers the most difficult task of this project: Extending the install scripts. Please read the chapter *Tool build- and install scripts* and get familiar with the folder structure and scripts before we dive deep into the structure of the single scripts, the relationship of the scripts and configuration files and a workflow that allows usage of generic code patterns.

### 5.1 Single tool build and install script

Inside the folder *build\_tools* are many other folders, all named after a single tool or a collection of tools. Each of those folders contains at least 2 scripts and optionally configuration files. One script, *install\_<toolname>\_essentials.sh* does install all the required libraries to build the tools. The other script, *install\_<toolname>.sh*, is a parametrizable fetch, configure, build and install script for <toolname>.

#### 5.1.1 Extending a tool script

Since all of the tool build and install scripts are very similar, it should be sufficient to explain the structure using one specific example. In this section, we will use *build\_tools/verilator/verilator* as an example.

The easiest and probably most common extension is to add (new) missing dependencies. Refer to *Missing dependencies* to understand how this is done.

All the scripts follow a specific code structure. We will disassemble *build\_tools/verilator/install\_verilator.sh* to explain the code. If you want to understand how a complete script is structured and functioning, you can just go on with this section. Alternatively, you can select one specific segment of the code:

- *Default variable initialization*
- *Parameter parsing*
- *Function section*
- *Error handling and superuser privilege enforcement*
- *Tool fetch and initialization*
- *Configuration and build*
- *Installation*
- *Cleanup*

## Missing dependencies

Take a look at `build_tools/verilator/install_verilator_essentials.sh`:

```
# require sudo
if [[ $UID != 0 ]]; then
    echo "Please run this script with sudo:"
    echo "sudo $0 $*"
    exit 1
fi

# exit when any command fails
set -e

# required tools
TOOLS="git perl python3 make g++ libfl2 libfl-dev zlibc zlibg zlibg-dev \
      ccache libgoogle-perftools-dev numactl git autoconf flex bison"

# install and upgrade tools
apt-get update
apt-get install -y $TOOLS
apt-get install --only-upgrade -y $TOOLS
```

This script is rather simple. It updates the apt cache, installs all packages specified within the *TOOLS* variable and upgrades all packages that were already installed and were therefore skipped during the installation. If you want to add new dependencies, extend the *TOOLS* variable by a space followed by the package name:

```
# required tools
TOOLS="git perl python3 make g++ libfl2 libfl-dev zlibc zlibg zlibg-dev \
      ccache libgoogle-perftools-dev numactl git autoconf flex bison MY-NEW-VALID-
↪PACKAGE"
```

Be careful though that the package exists, otherwise APT will throw an error which in return will cancel the execution of the script.

## Default variable initialization

Every tool build and install script begins with the initialization of default variables, which are either constant values or values that might be overwritten by a parameter that was passed with a flag during the invocation of the script. Take a look at the following default variable initialization section of `build_tools/verilator/install_verilator.sh`:

```
RED='\033[1;31m'
NC='\033[0m'
REPO="https://github.com/verilator/verilator.git"
PROJ="verilator"
BUILD_FOLDER="build_and_install_verilator"
VERSIONFILE="installed_version.txt"
TAG="latest"
INSTALL=false
INSTALL_PREFIX="default"
CLEANUP=false

USAGE="--snip--"
```

Currently constants and variables cannot be distinguished, it would be a good practice to add this information to the variable name in the future. This examples are the most common default variables. *RED*, *NC*, *REPO*, *PROJ*, *VERSIONFILE* and *USAGE* are constants. *RED* and *NC* are color codes, that allow you to color your console output red

(RED) or to reset the color (NC). *REPO* contains the Git URL to the project. It's important that this URL begins with *https://*, otherwise the user must supply a key. *PROJ* contains the relevant folder. Most of the time it is just the project name, sometimes it is a path to a folder within the project, like in *build\_tools/gtkwave/install\_gtkwave.sh*. *VERSION-FILE* contains the name of the file the version number is written into. The major *build\_tools/install\_everything.sh* script relies on the circumstance that all scripts use the same version filename, so it's best to never change this value and just to adapt it or change it in every single script altogether. *USAGE* contains a help string that can be printed when the program invocation was invalid.

*BUILDFOLDER*, *TAG*, *INSTALL*, *INSTALL\_PATH* and *CLEANUP* are default variables that might be altered by parameters that were supplied during the invocation of the tool build and install script. If a parameter is not passed during invocation, the script uses the value that is assigned to the corresponding default variable during initialization. Check out *Tool build and install script parameters* to learn more about tool build and install script parameters.

## Parameter parsing

The first functional action of the script is to parse arguments. Let's take a look how *install\_verilator.sh* does that:

```
while getopts ':hi:cd:t:' OPTION; do
    case $OPTION in
        i)  INSTALL=true
            INSTALL_PREFIX="$OPTARG"
            echo "-i set: Installing built binaries to $INSTALL_PREFIX"
            ;;
        esac
    done

    OPTIND=1
```

The script checks the flags and parameters two times, because some parameters have a causal connection (e.g. cleaning up freshly built files is only reasonable if those file already have been installed/copied). The code snippet above shows the first iteration. The scripts uses *getopts* to parse the flags and parameters. The *getopts* command takes at least two parameters: A string, in this case *':hi:cd:t:'*, containing all valid flags and the information whether they expect a parameter, and a variable name to stored the flag that is currently processed. The string containing the flags *':hi:cd:t:'* starts with a colon followed by flag letters and an optional colon after the flag letter. Every letter is a valid flag, every colon after the letter indicates that the flag is followed by a parameter. In a switch-case statement, every flag can be processed. The current parameter is stored in *\$OPTARG*. After the flags have been processed, the 'flag pointer' *OPTIND* that indicates which flag is currently processed is reset to the first flag. After that the flags are parsed a second time:

```
while getopts ':hi:cd:t:' OPTION; do
    case "$OPTION" in
        h)  echo "$USAGE"
            exit
            ;;
        c)  if [ $INSTALL = false ]; then
                >&2 echo -e "${RED}ERROR: -c only makes sense if the built binaries_
↳ were installed before (-i)"
                exit 1
            fi
            CLEANUP=true
            echo "-c set: Removing build directory"
            ;;
        d)  echo "-d set: Using folder $OPTARG"
            BUILDFOLDER="$OPTARG"
            ;;
        t)  echo "-t set: Using version $OPTARG"
```

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```

        TAG="$OPTARG"
        ;;
    :) echo -e "${RED}ERROR: missing argument for -${OPTARG}\n${NC}" >&2
        echo "$USAGE" >&2
        exit 1
        ;;
    \?) echo -e "${RED}ERROR: illegal option: -${OPTARG}\n${NC}" >&2
        echo "$USAGE" >&2
        exit 1
        ;;
esac
done

shift "$((OPTIND - 1))"

```

It is important that both iterations use identical “flag strings”, otherwise some flags might be ignored. One difference to the previous run of parsing flags is that two additional cases that do not represent a specific flag are used: `:` and `\?`. The first one handles the case that a flag that requires a parameter was specified without one, the second one handles the case that a flag that is not contained in the “flag string” was passed. This is also the first output of an error messages we encounter in this section. It is printed in *RED* and redirected to stderr `>&2`. After the flags have been parsed, they are popped (removed) using the *shift* command.

## Function section

After the flag and parameters parsing section functions are defined. Common operations or complex operations are sourced out into functions. This increases the readability of the functional core section that configures, builds and installs the tool. Furthermore it increases the reusability in different context. Example:

```

# This function does checkout the correct version and return the commit hash or tag_
↪name
# Parameter 1: Branch name, commit hash, tag or one of the special keywords default/
↪latest/stable
# Parameter 2: Return variable name (commit hash or tag name)
function select_and_get_project_version {
    # --snip--
}

```

For someone who is not familiar with shell scripting it might be worth mentioning that a return value (other than a return code [int]) must be passed back to the caller using a parameter that contains the variable name to store the result in.

## Error handling and superuser privilege enforcement

After the function section behavior in error cases and superuser privilege enforcement are defined:

```

# exit when any command fails
set -e

# require sudo
if [[ $UID != 0 ]]; then
    echo -e "${RED}Please run this script with sudo:"
    echo "sudo $0 $*"
    exit 1

```

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```

fi

# Cleanup files if the programm was shutdown unexpectedly
trap 'echo -e "${RED}ERROR: Script was terminated unexpectedly, cleaning up files...'
->&& pushd -0 > /dev/null && rm -rf $BUILDFOLDER' INT TERM

```

The error handling is straightforward: If an error occurs, stop the execution (*set -e*). Since the script sequentially executes interdependent steps, this approach seems fine. If the project could not be downloaded, the version can't be set, it can be configured, build or installed. If the version could not be checked out, it won't go on and build the tool, using a wrong version. If it can't be configured, there is no point in building it. If nothing was build, nothing is to be installed. Either the user has to fix the error by himself (for example specify a correct project version) or to contact the developers. If the script receives a *SIGINT* or *SIGTERM* signal, it stops the execution and deletes any file it created (*trap* command).

Only one command might requires superuser privileges (*install*), but to avoid that long-lasting scripts ask the user after an indefinite amount of time to enter superuser credentials, the script enforces superuser privileges (*\$UID == 0*).

## Tool fetch and initialization

The next snippet fetches the git project and checks out the specified version:

```

# fetch specified version
if [ ! -d $BUILDFOLDER ]; then
    mkdir $BUILDFOLDER
fi

pushd $BUILDFOLDER > /dev/null

if [ ! -d "$PROJ" ]; then
    git clone --recursive "$REPO"
fi

pushd $PROJ > /dev/null
select_and_get_project_version "$TAG" "COMMIT_HASH"

```

First it creates a workspace by creating a folder name *\$BUILDFOLDER*, which is controlled by the *-d* flag. This approach renders a simultaneous execution of multiple instances of the script possible, for example to build different versions at the same time. After that the directory is changed to the workspace. All the scripts use *pushd* and *popd*, which uses a rotatable directory stack to keep track of visited directories. The git project is fetched if the git project does not exist in the workspace yet. The *--recursive* flag is ignored if no submodules are existent, therefore it is supplied every time *git clone* is invoked. If submodules are added to the git project in the future, the script still remains functioning. At last the git project version is changed to *\$TAG*, which is controlled by the *-t* flag. If it is a valid tag, it is stored in the variable *COMMIT\_HASH*. If it is not, the commit hash is stored in *COMMIT\_HASH*. This code block is highly flexible and can be used for most if not every git project.

## Configuration and build

Next the project is configured and built, which is a part that differs from project to project:

```
# build and install if wanted
# unset var
if [ -n "$BASH" ]; then
    unset VERILATOR_ROOT
else
    unsetenv VERILATOR_ROOT
fi

autoconf

if [ "$INSTALL_PREFIX" == "default" ]; then
    ./configure
else
    ./configure --prefix="$INSTALL_PREFIX"
fi

make -j$(nproc)
```

This part of the script is basically a copy of different instructions from the build instruction of the tool in question that are weld together in a causally correct order. In this case the parameter within *INSTALL\_PREFIX*, which is either a default value or the parameter of the *-i* flag, is specified. This can happen here or later, when the command that triggers the tool installation is executed. Be sure to always supply the *-j\$(nproc)* flag to take full advantage of multi threading during the build process.

## Installation

```
if [ $INSTALL = true ]; then
    make install
fi
```

Here the tool is installed, depending on whether the *-i* flag was set. Sometimes the install location must be supplied here, this depends on the project. This is the only code segment that potentially requires superuser privileges.

## Cleanup

At the end of the project, irrelevant data can be removed:

```
# return to first folder and store version
pushd -0 > /dev/null
echo "Verilator: $COMMIT_HASH" >> "$VERSIONFILE"

# cleanup if wanted
if [ $CLEANUP = true ]; then
    rm -rf $BUILDFOLDER
fi
```

We make use of the directory stack here that comes with *pushd* and *popd*. By executing *pushd -0*, we rotate the oldest folder from the bottom to the top of the stack. Remember that the commit hash or tag was stored during the git project retrieval? At this point it is stored in a version file, which will be created at the root directory, more specifically the directory where the scripts are located. This is important if multiple people work on the same project (to ensure consistency regarding the tools) and for publications. The fully automatic and configurable tools and projects

installation script, *install\_everything.sh*, collects all the tool versions in one single file. If the script was invoked with the *-c* flag, the workspace is removed completely.

### 5.1.2 Creating a tool script

Creating a tool build and install script might be easier than you think right now. Most of the time it requires only minor adaption to one of the existing scripts to create a new fully functional tool build and install script. In most cases even the integration in the major tools and projects installation script (*install\_everything.sh*) only takes some minutes.

#### Step 1: Naming conventions

The naming convention is very important, because the major tools and projects installation script (*install\_everything.sh*) uses them to find the scripts. Create a new folder in the *build\_tools* directory which will contain the new scripts. You can give it any name, but for convenience reasons we suggest using the tool name or the collection name that are going to be installed. We'll use *<toolname>* as the name of the folder. The scripts within must be named *install\_<toolname>.sh* and *install\_<toolname>\_essentials.sh*.

#### Step 2: Copying a template

Copy the *build\_tools/verilator/install\_verilator.sh* and *build\_tools/verilator/install\_verilator\_essentials.sh* scripts to your freshly created folder *build\_tools/<toolname>*. After that replace *verilator* in the name of the scripts with *<toolname>*. If your *<toolname>* is *yosys* for example, the scripts should be named *install\_yosys.sh* and *install\_yosys\_essentials.sh*.

#### Step 3: Adjusting dependencies

Lookup the dependencies on the project page and find appropriate packages in the apt packet manager. If you have a list of all dependencies, adjust the *install\_<toolname>\_essentials.sh* file to only install relevant apt packages, as described in section *Missing dependencies*.

#### Step 4: Changing relevant constants

The next step encompasses the adjustment of some constants. You can view all default variables and constants at section *Default variable initialization*. You have to change the repository url, the folder where the relevant project lies and the default value for the build folder (workspace):

```
REPO="https://github.com/verilator/verilator.git"
PROJ="verilator"
BUILDFOLDER="build_and_install_verilator"
```

At this point, your script already can parse the default flags *-c*, *-d*, *-i* and *-t*, interpret them, create a workspace based on *-d*, download the correct git project and checkout the desired version based on *-t*.

### Step 5: Adding additional flags

Adding additional flags is not difficult by itself, however, if new flags are added, the major install script *install\_everything.sh* must be adjusted to process those new flags. Refer to section *Fully configurable tools and project installation script* for more information. If you have to add additional flags, *Parameter parsing* elucidates how parameters are registered, received and handled.

### Step 6: Adjusting the configure, build and install section

Depending on the project, the build process is initialized and configured differently. Get to know how to configure and build the project and reflect that knowledge in the *Configuration and build* segment of the script. At last, adjust the code segment that installs the project (*Installation*).

### Step 7: Adding the script to the major install script

This last step includes the tool install script into the major install script *install\_everything.sh*. Besides potential adjustments of that script to incorporate new flags and parameters (id est any flags except *c*, *d*, *i* and *t*), the script must be registered in the major script and a config section must be created. Refer to section *Adding a tool to the script* to learn how this is done. After working through that section, you are done. You now have a fully functioning tool build and install script and it is integrated into the major install script, well done!

## 5.2 Fully configurable tools and project installation script

This section explains how the major install script *build\_tools/install\_everything.sh* is structured and how to add tool build and install scripts and projects to it.

### 5.2.1 Adding a tool to the script

Let's assume you have created a tool install script in *build\_folder/<toolname>*. To add the script to the major install script, append *<TOOLNAME>* in uppercase to the following variable within the *install\_everything.sh* script:

```
SCRIPTS="YOSYS TRELLIS ICESTORM NEXTPNR_ICE40 NEXTPNR_ECP5 UJPROG OPENOCD \
OPENOCD_VEXRISCV VERILATOR GTKWAVE RISCV_NEWLIB RISCV_LINUX <TOOLNAME>"
```

After that, open the configuration file for the major install script, *config.cfg*, and append the tool configuration section by a copy of the verilator configuration:

```
### Configure tools

# --snip--

## Verilator
# Build and (if desired) install Verilator?
VERILATOR=true
# Build AND install Verilator?
VERILATOR_INSTALL=true
# Install path (default = default path)
VERILATOR_INSTALL_PATH=default
# Remove build directory after successful install?
VERILATOR_CLEANUP=true
# Folder name in which the project is built
```

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```

VERILATOR_DIR=default
# Specify project version to pull (default/latest, stable, tag, branch, hash)
VERILATOR_TAG=default

```

now simply replace VERILATOR by `<TOOLNAME>` in uppercase and specify your desired default configuration:

```

### Configure tools

# --snip--

## <Toolname>
# Build and (if desired) install <Toolname>?
<TOOLNAME>=true
# Build AND install <Toolname>?
<TOOLNAME>_INSTALL=true
# Install path (default = default path)
<TOOLNAME>_INSTALL_PATH=default
# Remove build directory after successful install?
<TOOLNAME>_CLEANUP=true
# Folder name in which the project is built
<TOOLNAME>_DIR=default
# Specify project version to pull (default/latest, stable, tag, branch, hash)
<TOOLNAME>_TAG=default

```

## Registering additional parameters

In short, the configuration file `build_tools/config.cfg` is *sourced*, which means that every variable within it is included in the current environment. Since you followed the naming convention and included the name of your tool in the *SCRIPTS* list, the variable names that were supplied in `config.cfg` can be derived for the default configuration flags `-c`, `-d`, `-i` and `-t`. Let's take a look at the function that decides which flags and parameters are used based on the sourced `config.cfg`:

```

# Process common script parameters
# Parameter $1: Script name
# Parameter $2: Variable to store the parameters in
function parameters_tool {
    # Set "i" parameter
    if [ "$(eval "echo $\`echo $1\`_INSTALL")" = true ]; then
        eval "$2=\`"${!2} -i $(eval "echo $\`echo $1\`_INSTALL_PATH")\`""
    fi

    # Set "c" parameter
    if [ "$(eval "echo $\`echo $1\`_CLEANUP")" = true ]; then
        eval "$2=\`"${!2} -c\`""
    fi

    # Set "d" parameter
    local L_BUILD_DIR="$(eval "echo $\`echo $1\`_DIR")"

    if [ -n "$L_BUILD_DIR" ] && [ "$L_BUILD_DIR" != "default" ]; then
        eval "$2=\`"${!2} -d \"$L_BUILD_DIR\`""
    fi

    # Set "t" parameter
    local L_BUILD_TAG="$(eval "echo $\`echo $1\`_TAG")"

```

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```

if [ -n "$L_BUILD_TAG" ] && [ "$L_BUILD_TAG" != "default" ]; then
    eval "$2=\"${!2} -t \"$L_BUILD_TAG\"\""
fi

# Set "b" for Yosys only
if [ $1 == "YOSYS" ]; then
    local L_BUILD_COMPILER="$(eval "echo ${!1}_COMPILER")"

    if [ -n "$L_BUILD_COMPILER" ]; then
        eval "$2=\"${!2} -b \"$L_BUILD_COMPILER\"\""
    fi
fi

# Append special parameters for gnu-riscv-toolchain and nextpnr variants
if [ "${!1:5}" == "RISCV" ]; then
    parameters_tool_riscv "$1" "$2"
elif [ "${!1:7}" == "NEXTPNR" ]; then
    parameters_tool_nextpnr "$1" "$2"
fi
}

```

Since every tool build and install script must follow the naming convention and support the default flags *-c*, *-d*, *-i* and *-t*, and in addition must supply the corresponding entries in *config.cfg*, the script can just derive the variable name that was specified in *config.cfg* and controls a specific flag.

Let's work through one example. You have added a tool called *MYTOOL* which support the four basic flags. In addition, you have added the configuration entry in *config.cfg*:

```

## Mytool
# Build and (if desired) install Mytool?
MYTOOL=true
# Build AND install Mytool?
MYTOOL_INSTALL=true
# --snip--

```

At some point the *install\_everything.sh* script does source the configuration file, so all the variables within are now in the environment of the current instance of *install\_everything.sh*, including the configuration variables for *MYTOOL*. Now at some point the *install\_everything.sh* script must figure out which flags and parameters have to be set, which is done in the *parameters\_tool* function in the code snippet above. The function is called like that: *parameters\_tool 'MYTOOL' 'RESULT'*. First it scans the configuration variables that control the common default flags, for example for *-i*:

```

# Set "i" parameter
if [ "$(eval "echo ${!1}_INSTALL")" = true ]; then
    eval "$2=\"${!2} -i $(eval "echo ${!1}_INSTALL_PATH")\""
fi

```

In this example the variable *\$1* contains our tool name, *MYTOOL*. Within the if-statement, the eval command *"\$(eval "echo \${!1}\_INSTALL")"* evaluates to *"\$MYTOOL\_INSTALL"*. This is exactly the variable name we assigned in the configuration *config.cfg* and which the script already sourced in its own environment. If the flag is set, the parameter list, which is stored in the variable name contained within *\$2*, is appended by *"-i \$MYTOOL\_INSTALL\_PATH"*. This is repeated for every default value, which the scripts resolves to the variables *MYTOOL\_CLEANUP*, *MYTOOL\_BUILD\_DIR* and *MYTOOL\_TAG*.

If you want to add a custom parameter, let's assume *MYTOOL* does now allow a *-z* flag, which builds a specific feature, you have to add it to the configuration file *config.cfg* and you have to write some custom code to handle that parameter

in addition to the default parameters. You added a configuration variable:

```
MYTOOL_NICE_FEATURE=true
```

Take a look at the end of the *parameters\_tools* function:

```
# Append special parameters for gnu-riscv-toolchain and nextpnr variants
if [ "${1:0:5}" == "RISCV" ]; then
    parameters_tool_riscv "$1" "$2"
elif [ "${1:0:7}" == "NEXTPNR" ]; then
    parameters_tool_nextpnr "$1" "$2"
fi
```

For each tool that uses additional parameters, it calls a specific function that can handle those parameters. The ``${1:0:X}`` command reads the first X characters from the variable *\$1*. It is only required if multiple tools with the same prefix use the same additional parameter function. In our case, it is sufficient to add another *elif* branch that compares the complete name:

```
elif [ "$1" == "MYTOOL" ]; then
    parameters_tool_mytool "$1" "$2"
fi
```

Create a new function *parameters\_tool\_mytool* that handles the additional parameters:

```
# Process additional mytool script parameters
# Parameter $1: Script name
# Parameter $2: Variable to store the parameters in
function parameters_tool_mytool {
    # set -z flag
    if [ "$(eval "echo `echo $1`_NICE_FEATURE")" = true ]; then
        eval "$2=\`${1:2} -z\"
    fi
}
```

Just as for the other default flags, the if-statement checks the value of *MYTOOL\_NICE\_FEATURE* and appends the parameter string *\$2* by *-z* if it is set to true. Congratulations, you have successfully added a custom parameters to the configuration.

## 5.2.2 Adding a project to the script

To add a project to the major install script, two steps are required:

1. Copy and adapt an existing configuration for a project from *config.cfg*
2. Add the project name to the *PROJECTS* variable in *install\_everything.sh*

Step 1: Open *config.cfg* and duplicate the last project configuration, in this case it is *DEMO\_PROJECT\_ICE40*:

```
## Hello world demo application
# Download git repository
DEMO_PROJECT_ICE40=false
# Git URL
DEMO_PROJECT_ICE40_URL="https://github.com/ThorKn/icebreaker-vexriscv-helloworld.git"
# Specify project version to pull (default/latest, stable, tag, branch, hash)
DEMO_PROJECT_ICE40_TAG=default
# If default is selected, the project is stored in the documents folder
# of each user listed in the variable DEMO_PROJECT_ICE40_USER
```

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```

DEMO_PROJECT_ICE40_LOCATION=default
# Space separated list of users (in quotation marks) to install the project for
# in /home/$user/Documents (if DEMO_PROJECT_ICE40_LOCATION=default).
# default = all logged in users. Linking to desktop is also based on this list.
DEMO_PROJECT_ICE40_USER=default
# Symbolic link to /home/$user/Desktop
DEMO_PROJECT_ICE40_LINK_TO_DESKTOP=true

```

Replace DEMO\_PROJECT with the project you want to add and adjust the configuration values as you desire:

```

## Hello world demo application
# Download git repository
<YOUR_PROJECT>=false
# Git URL
<YOUR_PROJECT>_URL="<YOUR_PROJECT_GIT_HTTPS_URL>"
# Specify project version to pull (default/latest, stable, tag, branch, hash)
<YOUR_PROJECT>_TAG=default
# If default is selected, the project is stored in the documents folder
# of each user listed in the variable <YOUR_PROJECT>_USER
<YOUR_PROJECT>_LOCATION=default
# Space separated list of users (in quotation marks) to install the project for
# in /home/$user/Documents (if <YOUR_PROJECT>_LOCATION=default).
# default = all logged in users. Linking to desktop is also based on this list.
<YOUR_PROJECT>_USER=default
# Symbolic link to /home/$user/Desktop
<YOUR_PROJECT>_LINK_TO_DESKTOP=true

```

Double check every configuration parameter, especially the *URL* and if *<YOUR\_PROJECT>* is set to *true*.

Step 2: Open *install\_everything.sh* and look for the definition of the *PROJECTS* variable in the constant/default variable initialization section of the code:

```
PROJECTS="PQRISCV_VEXRISCV DEMO_PROJECT"
```

Append your project name to list, using a space as a separator:

```
PROJECTS="PQRISCV_VEXRISCV DEMO_PROJECT <YOUR_PROJECT>"
```

The major install script should now download and copy your project.



### 5.2.3 Extending the install script

The script is designed in a generic way to allow smooth integration of additional tool build and install scripts. By using naming conventions, the major install script is able to find the tool install scripts, find their configuration and invoke them with default parameters. In this section, we'll walk through the structure of the script and explain each segment.

#### Default variable initialization

The major install script first initializes default variables and constants, just like the tool build and install scripts do it:

```
RED='\033[1;31m'
NC='\033[0m'
CONFIG="config.cfg"
BUILDFOLDER="build_and_install_quantumrisc_tools"
VERSIONFILE="installed_version.txt"
SUCCESS_FILE_TOOLS="latest_success_tools.txt"
SUCCESS_FILE_PROJECTS="latest_success_projects.txt"
DIALOUT_USERS=default
VERSION_FILE_USERS=default
CLEANUP=false
VERBOSE=false
SCRIPTS="YOSYS TRELLIS ICESTORM NEXTPNR_ICE40 NEXTPNR_ECP5 UJPROG OPENOCD \
OPENOCD_VEXRISCV VERILATOR GTKWAVE RISCV_NEWLIB RISCV_LINUX"
PROJECTS="PQRISCV_VEXRISCV DEMO_PROJECT"
```

Some constants and default variables are equivalent to those of a tool build and install script, refer to section [Default variable initialization](#) to get an explanation about their function.

*CONFIG*, *SUCCESS\_FILE\_TOOLS*, *SUCCESS\_FILE\_PROJECTS*, *SCRIPTS* and *PROJECTS* are new constants. *CONFIG* specifies the location of the configuration file. *SUCCESS\_FILE\_TOOLS* defines the name of the file that contains the latest successfully installed script. *SUCCESS\_FILE\_PROJECTS* does the same for projects. Those files contain all the information required for the checkpoint mechanism used in this script. *SCRIPTS* contains a space separated list of tool install scripts. By using naming conventions, the major install script is able to find the location of the tool build scripts and configuration values within *CONFIG*. *PROJECTS* contains a space separated list of projects, which the script uses to find the configuration for each project listed there.

In addition to those constants, some default values are defined: *DIALOUT\_USERS*, *VERSION\_FILE\_USERS* and *VERBOSE*. *DIALOUT\_USERS* contains a space separated list of users that are added to the dialout group. It is modified by the parameter of the *-o* flag. By default every logged in user is added. *VERSION\_FILE\_USERS* contains a space separated list of users for whom a copy of the final version file is placed on their desktop. The default behavior is to add the version file to the desktop of every logged in user. It is modified by the parameter of the *-p* flag. *VERBOSE* contains a boolean that toggles whether warning and errors are printed to stdout. It is toggles by the *-v* flag.

#### Parameter parsing

Refer to section [Parameter parsing](#) for more information.

## Function section

Please refer to section *Function section* before continuing in this section.

This script contains many more functions than the tool build scripts. A method that is used often in those function is the deduction of other variable names. Section *Registering additional parameters* explains how to add additional parameters, which includes the explanation of two important functions that use variable name deduction.

## Error handling and superuser privilege enforcement

Refer to section *Error handling and superuser privilege enforcement* for more information. In contrast to the tool build and install scripts, the major install script does not delete the workspace (*BUILDFOLDER*) when SIGINT or SIGTERM signals are received. This decision was made because a checkpoint mechanism was implemented, which uses files within the workspace. If the workspace would be deleted, the *install\_everything.sh* script would not know the previous progress. Running tool build and install scripts are killed and their workspace is still removed though.

## Initialization

Before the tool build and install scripts are invoked, the workspace is set up and the configuration is parsed:

```
# Read config
echo_verbose "Loading configuration file"
source config.cfg

# create and cd into buildfolder
if [ ! -d $BUILDFOLDER ]; then
    echo_verbose "Creating build folder \"${BUILDFOLDER}\""
    mkdir $BUILDFOLDER
fi

cp -r install_build_essentials.sh $BUILDFOLDER
pushd $BUILDFOLDER > /dev/null
ERROR_FILE="$(pwd -P)/errors.log"

# Potentially create and empty errors.log file
echo '' > errors.log
echo "Executing: ./install_build_essentials.sh"
exec_verbose "./install_build_essentials.sh" "$ERROR_FILE"
```

Parsing the configuration file *build\_tools/config.cfg* is really simple. Since it only contains variable assignments in the form *VAR=value*, it is enough to *source* the configuration file. Now the script can use all the variables defined within *config.cfg*.

Just like for tool build and install scripts, a *BUILDFOLDER* is created to serve as a workspace. All builds will happen within it and every script will temporarily be copied into that workspace. Within that folder an error file *errors.log* is created. This file is going to contain any warnings and errors. The last step of the initialization includes the execution of the *install\_build\_essentials.sh* script, which install packages that deliver the functionality to download from git, configure, build and install projects.

## Handling the tools

At the core of the script lies one for loop, that iterates through every *SCRIPT* and utilizes the functions which were defined to build and eventually install the scripts:

```
echo -e "\n--- Installing tools ---\n"
get_latest "$SCRIPTS" "$SUCCESS_FILE_TOOLS" "tool" "SCRIPTS"

# Process scripts
for SCRIPT in $SCRIPTS; do
    # Should the tool be build/installed?
    if [ "${!SCRIPT}" = true ]; then
        echo "Installing $SCRIPT"
        PARAMETERS=""
        parameters_tool "$SCRIPT" "PARAMETERS"
        COMMAND_INSTALL_ESSENTIALS=""
        COMMAND_INSTALL=""
        find_script "$SCRIPT" "COMMAND_INSTALL_ESSENTIALS" "COMMAND_INSTALL"
        COMMAND_INSTALL="${COMMAND_INSTALL} $PARAMETERS"
        echo "Executing: $COMMAND_INSTALL_ESSENTIALS"
        exec_verbose "$COMMAND_INSTALL_ESSENTIALS" "$ERROR_FILE"
        echo "Executing: $COMMAND_INSTALL"
        exec_verbose "$COMMAND_INSTALL" "$ERROR_FILE"
        echo "$SCRIPT" > $SUCCESS_FILE_TOOLS
    fi
done
```

Before the scripts iterates over the tool build and install scripts, it checks whether some of the scripts already have successfully been installed during a previous invocation in the same workspace. The *get\_latest* function takes a list of tool build and install script names *\$SCRIPTS*, checks at which position the script contained within the checkpoint file *\$SUCCESS\_FILE\_TOOLS* is in that list, offers the users to start over or go on from there and finally stores the modified list in the last parameter, which is also called *SCRIPTS* here.

The for loop iterates over the modified list of tool build and install script names. Remember that the configuration file only contains variable assignments and the naming convention to enter *<TOOLNAME>\_PARAMETER=value?* This circumstance is used now to evaluate the tool configuration. In each iteration, the *SCRIPT* variable contains the current tool name. The command “*\${!SCRIPT}*” evaluates the variable that has the name that is stored in *\$SCRIPT*. So effectively the if statement looks like this in every iteration:

```
if [ "${!TOOLNAME}" = true ]; then
```

Since we have parsed *config.cfg* before, which contains “*TOOLNAME=value*” for any tool, we effectively have tested one element of our configuration. If the tool was configured to be build, we enter the body, which first does evaluate the configuration (using the same trick line in the if-statement) and creates a string containing the flags and parameters:

```
PARAMETERS=""
parameters_tool "$SCRIPT" "PARAMETERS"
```

After that it copies the *install\_<toolname>\_essentials.sh* script and the *install\_<toolname>.sh* script into the current workspace and appends the flags and parameters after the *install\_<toolname>.sh* script path:

```
COMMAND_INSTALL_ESSENTIALS=""
COMMAND_INSTALL=""
find_script "$SCRIPT" "COMMAND_INSTALL_ESSENTIALS" "COMMAND_INSTALL"
COMMAND_INSTALL="${COMMAND_INSTALL} $PARAMETERS"
echo "Executing: $COMMAND_INSTALL_ESSENTIALS"
```

At this point the naming convention is important again. The *find\_script* function assumes that the naming convention was incorporated. It copies the tool build and install script folder *<toolname>* to the current workspace and returns a path in the current workspace to *<toolname>/install\_<toolname>.sh* and *<toolname>/install\_<toolname>\_essentials.sh*. In addition, it copies an additional configuration file within the tool folder if it exists, that must be named *versions.cfg* (this will likely be changed to an arbitrary amount of config files with arbitrary names).

Everything is prepared now to execute the scripts, respecting the configuration:

```
echo "Executing: $COMMAND_INSTALL_ESSENTIALS"
exec_verbose "$COMMAND_INSTALL_ESSENTIALS" "$ERROR_FILE"
echo "Executing: $COMMAND_INSTALL"
exec_verbose "$COMMAND_INSTALL" "$ERROR_FILE"
```

At last, the current tool name *SCRIPT* is stored in the checkpoint file. If the next tool script should fail, this script will know where to continue.

## Handling the projects

In comparison to handling the tools, handling the projects is much simpler. Basically a project differs from tools by not requiring to be built or installed. So projects are only fetched from the web in the desired version and copied to some locations:

```
echo -e "\n--- Setting up projects ---\n"
get_latest "$PROJECTS" "$SUCCESS_FILE_PROJECTS" "project" "PROJECTS"

for PROJECT in $PROJECTS; do
    if [ "${!PROJECT}" = true ]; then
        echo "Setting up $PROJECT"
        install_project "$PROJECT"
        echo "$PROJECT" > $SUCCESS_FILE_PROJECTS
    fi
done
```

Just as for tools, a checkpoint mechanism is used for projects. Same logic, just a different file name. The configuration trick is the same here as well. *PROJECT* contains the name of the current project, *PROJECT* checks its value, which previously was defined in the configuration file in the form of *<PROJECT>=value*. If the project was configured to be installed, the body of the for loop is entered:

```
echo "Setting up $PROJECT"
install_project "$PROJECT"
echo "$PROJECT" > $SUCCESS_FILE_PROJECTS
```

The function *install\_project* is called, which downloads and configures the project based on the configuration. The project is placed at the users documents folder and if desired, linked to desktop. After the projects was successfully installed, it is stored in the projects checkpoints file.

## Cleanup

Before cleaning up the workspace (-c), that means deleting it, the version file is copied out of the workspace and into the same folder the *install\_everything.sh* script lies. Additionally, it is copied to the desktop of the users specified in the variable *VERSION\_FILE\_USERS*:

```
# secure version file before it gets deleted (-c)
pushd -0 > /dev/null

if [ -f "${BUILDFOLDER}/${VERSIONFILE}" ]; then
    cp "${BUILDFOLDER}/${VERSIONFILE}" .
fi

# --snip--

# copy version file to users desktop
if [ "$VERSION_FILE_USERS" == "default" ]; then
    copy_version_file "$(pwd -P)/${VERSIONFILE}" `who | cut -d: -f1`
else
    copy_version_file "$(pwd -P)/${VERSIONFILE}" "$VERSION_FILE_USERS"
fi
```

In addition, a set of users contained within the variable *DIALOUT\_USERS* is copied to the dialout group:

```
# add users to dialout
if [ "$DIALOUT_USERS" == "default" ]; then
    for DIALOUT_USER in `who | cut -d: -f1`; do
        usermod -a -G dialout "$DIALOUT_USER"
    done
else
    for DIALOUT_USER in "$DIALOUT_USERS"; do
        usermod -a -G dialout "$DIALOUT_USER"
    done
fi
```

After that the workspace is deleted, if the -c flag was set.



## SCRIPT AND CONFIGURATION INDEX

### 6.1 build\_tools

#### 6.1.1 install\_everything.sh

```

1  #!/bin/bash
2
3  # Author: Harald Heckmann <mail@haraldheckmann.de>
4  # Date: Jul. 23 2020
5  # Project: QuantumRisc (RheinMain University) <Steffen.Reith@hs-rm.de>
6
7  # constants
8  RED='\033[1;31m'
9  NC='\033[0m'
10 LIBRARY="libraries/library.sh"
11 CONFIG="config.cfg"
12 BUILDFOLDER="build_and_install_quantumrisc_tools"
13 VERSIONFILE="installed_version.txt"
14 SUCCESS_FILE_TOOLS="latest_success_tools.txt"
15 SUCCESS_FILE_PROJECTS="latest_success_projects.txt"
16 DIALOUT_USERS=default
17 VERSION_FILE_USERS=default
18 CLEANUP=false
19 VERBOSE=false
20 SCRIPTS="YOSYS TRELLIS ICESTORM NEXTPNR_ICE40 NEXTPNR_ECP5 UJPROG OPENOCD \
21 OPENOCD_VEXRISCV VERILATOR GTKTERM GTKWAVE RISCV_NEWLIB RISCV_LINUX FUJPROG \
22 SPINALHDL ICARUSVERILOG SPIKE GHDL COCOTB RUST_RISCV"
23 PROJECTS="PQRISCV_VEXRISCV DEMO_PROJECT_ICE40"
24
25
26 # parse arguments
27 USAGE="$(basename "$0") [-c] [-h] [-o] [-p] [-v] [-d dir] -- Build and install_
28 ↪QuantumRisc toolchain.
29
30 where:
31   -c      cleanup, delete everything after successful execution
32   -h      show this help text
33   -o      space separated list of users who shall be added to dialout
34           (default: every logged in user)
35   -p      space separated list of users for whom the version file shall
36           be copied to the desktop (default: every logged in user)
37   -v      be verbose (spams the terminal)
38   -d dir  build files in \"dir\" (default: ${BUILDFOLDER}) "

```

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```

38
39 while getopts ':chopvd:' OPTION; do
40     case "$OPTION" in
41         c) echo "-c set: Cleaning up everything in the end"
42             CLEANUP=true
43             ;;
44         d) echo "-d set: Using folder $OPTARG"
45             BUILDFOLDER="$OPTARG"
46             ;;
47         h) echo "$USAGE"
48             exit
49             ;;
50         o) echo "-o set: Adding users \"${OPTARG}\" to dialout"
51             DIALOUT_USERS="$OPTARG"
52             ;;
53         p) echo "-o set: Copying version file to desktop of \"${OPTARG}\""
54             VERSION_FILE_USERS="$OPTARG"
55             ;;
56         v) echo "-v set: Being verbose"
57             VERBOSE=true
58             ;;
59         :) echo -e "${RED}ERROR: missing argument for -${OPTARG}\n${NC}" >&2
60             echo "$USAGE" >&2
61             exit 1
62             ;;
63         \?) echo -e "${RED}ERROR: illegal option: -${OPTARG}\n${NC}" >&2
64             echo "$USAGE" >&2
65             exit 1
66             ;;
67     esac
68 done
69 shift $((OPTIND - 1))
70
71 # exit when any command fails
72 set -e
73
74 # require sudo
75 if [[ $UID != 0 ]]; then
76     echo -e "${RED}Please run this script with sudo:"
77     echo "sudo $0 *"
78     exit 1
79 fi
80
81 # load shared functions
82 source $LIBRARY
83
84 # Read config
85 echo_verbose "Loading configuration file"
86 source config.cfg
87
88 # create and cd into buildfolder
89 if [ ! -d $BUILDFOLDER ]; then
90     echo_verbose "Creating build folder \"${BUILDFOLDER}\""
91     mkdir $BUILDFOLDER
92 fi
93
94 cp -r install_build_essentials.sh $BUILDFOLDER

```

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```

95 pushd $BUILDFOLDER > /dev/null
96 ERROR_FILE="$(pwd -P)/errors.log"
97
98 # Potentially create and empty errors.log file
99 echo '' > errors.log
100 echo "Executing: ./install_build_essentials.sh"
101 exec_verbose "./install_build_essentials.sh" "$ERROR_FILE"
102
103 # Cleanup files if the programm was shutdown unexpectedly
104 # trap 'echo -e "${RED}ERROR: Script was terminated unexpectedly, cleaning up files...
→ " && pushd -0 > /dev/null && rm -rf $BUILDFOLDER' INT TERM
105
106 echo -e "\n--- Installing tools ---\n"
107 get_latest "$SCRIPTS" "$SUCCESS_FILE_TOOLS" "tool" "SCRIPTS"
108
109 # Process scripts
110 for SCRIPT in $SCRIPTS; do
111     # Should the tool be build/installed?
112     if [ "${!SCRIPT}" = true ]; then
113         echo "Installing $SCRIPT"
114         PARAMETERS=""
115         parameters_tool "$SCRIPT" "PARAMETERS"
116         COMMAND_INSTALL_ESSENTIALS=""
117         COMMAND_INSTALL=""
118         find_script "$SCRIPT" "COMMAND_INSTALL_ESSENTIALS" "COMMAND_INSTALL"
119
120         # Execute any file that is available
121         # build essentials
122         if [ -f "$COMMAND_INSTALL_ESSENTIALS" ]; then
123             echo "Executing: $COMMAND_INSTALL_ESSENTIALS"
124             exec_verbose "$COMMAND_INSTALL_ESSENTIALS" "$ERROR_FILE"
125         else
126             echo -e "Warning: ${COMMAND_INSTALL_ESSENTIALS##*/} not found"
127         fi
128
129         # tool install script
130         if [ -f "$COMMAND_INSTALL" ]; then
131             echo "Executing: ${COMMAND_INSTALL} ${PARAMETERS}"
132             exec_verbose "${COMMAND_INSTALL} ${PARAMETERS}" "$ERROR_FILE"
133             echo "$SCRIPT" > $SUCCESS_FILE_TOOLS
134         else
135             echo -e "Warning: ${COMMAND_INSTALL##*/} not found"
136         fi
137     fi
138 done
139
140
141 echo -e "\n--- Setting up projects ---\n"
142 get_latest "$PROJECTS" "$SUCCESS_FILE_PROJECTS" "project" "PROJECTS"
143
144 for PROJECT in $PROJECTS; do
145     if [ "${!PROJECT}" = true ]; then
146         echo "Setting up $PROJECT"
147         install_project "$PROJECT"
148         echo "$PROJECT" > $SUCCESS_FILE_PROJECTS
149     fi
150 done

```

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```

151
152 # secure version file before it gets deleted (-c)
153 pushd -0 > /dev/null
154
155 if [ -f "${BUILDFOLDER}/${VERSIONFILE}" ]; then
156     cp "${BUILDFOLDER}/${VERSIONFILE}" .
157 fi
158
159 # add users to dialout
160 if [ "${DIALOUT_USERS}" == "default" ]; then
161     for DIALOUT_USER in `who | cut -d' ' -f1`; do
162         usermod -a -G dialout "${DIALOUT_USER}"
163     done
164 else
165     for DIALOUT_USER in "${DIALOUT_USERS}"; do
166         usermod -a -G dialout "${DIALOUT_USER}"
167     done
168 fi
169
170 # copy version file to users desktop
171 if [ "${VERSION_FILE_USERS}" == "default" ]; then
172     copy_version_file "${(pwd -P)}/${VERSIONFILE}" `who | cut -d' ' -f1`
173 else
174     copy_version_file "${(pwd -P)}/${VERSIONFILE}" "${VERSION_FILE_USERS}"
175 fi
176
177 # cleanup
178 if [ $CLEANUP = true ]; then
179     echo_verbose "Cleaning up files"
180     rm -rf $BUILDFOLDER
181 fi
182
183 echo "Script finished successfully."

```

### 6.1.2 install\_build\_essentials.sh

```

1  #!/bin/bash
2
3  # Author: Harald Heckmann <mail@haraldheckmann.de>
4  # Date: Jun. 23 2020
5  # Project: QuantumRisc (RheinMain University) <Steffen.Reith@hs-rm.de>
6
7  # require sudo
8  if [[ $UID != 0 ]]; then
9      echo "Please run this script with sudo:"
10     echo "sudo $0 $*"
11     exit 1
12 fi
13
14 # exit when any command fails
15 set -e
16
17 # required tools
18 TOOLS="build-essential git clang gcc meson ninja-build g++ python3-dev \
19     make flex bison libc6 binutils gzip bzip2 tar perl autoconf m4 \

```

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```

20     automake gettext gperf dejagnu expect tcl"
21
22 # install and upgrade tools
23 apt-get update
24 apt-get install -y $TOOLS
25 apt-get install --only-upgrade -y $TOOLS

```

### 6.1.3 config.cfg

```

1  ### Configure tools
2
3
4  ## Yosys
5  # Build and (if desired) install Yosys?
6  YOSYS=true
7  # Build AND install yosys?
8  YOSYS_INSTALL=true
9  # Install path (default = default path)
10 YOSYS_INSTALL_PATH=default
11 # Remove build directory after successful install?
12 YOSYS_CLEANUP=true
13 # Folder name in which the project is built
14 YOSYS_DIR=default
15 # Compiler (gcc or clang)
16 YOSYS_COMPILER=clang
17 # Specify project version to pull (default/latest, stable, tag, branch, hash)
18 YOSYS_TAG=default
19
20
21 ## Project Trellis
22 # Build and (if desired) install Project Trellis?
23 TRELIS=true
24 # Build AND install Project Trellis?
25 TRELIS_INSTALL=true
26 # Install path (default = default path)
27 TRELIS_INSTALL_PATH=default
28 # Remove build directory after successful install?
29 TRELIS_CLEANUP=true
30 # Folder name in which the project is built
31 TRELIS_DIR=default
32 # Specify project version to pull (default/latest, stable, tag, branch, hash)
33 TRELIS_TAG=default
34
35
36 ## Icestorm
37 # Build and (if desired) install Icestorm?
38 ICESTORM=true
39 # Build AND install Icestorm?
40 ICESTORM_INSTALL=true
41 # Install path (default = default path)
42 ICESTORM_INSTALL_PATH=default
43 # Remove build directory after successful install?
44 ICESTORM_CLEANUP=true
45 # Folder name in which the project is built
46 ICESTORM_DIR=default

```

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```

47 # Specify project version to pull (default/latest, stable, tag, branch, hash)
48 ICESTORM_TAG=default
49
50
51 ## NextPNR-Ice40
52 # Build and (if desired) install NextPNR-ice40?
53 NEXTPNR_ICE40=true
54 # Build AND install NextPNR-ice40?
55 NEXTPNR_ICE40_INSTALL=true
56 # Install path (default = default path)
57 NEXTPNR_ICE40_INSTALL_PATH=default
58 # Remove build directory after successful install?
59 NEXTPNR_ICE40_CLEANUP=false
60 # Folder name in which the project is built
61 NEXTPNR_ICE40_DIR=default
62 # Specify project version to pull (default/latest, stable, tag, branch, hash)
63 NEXTPNR_ICE40_TAG=default
64 # Use chip dbs from the following path (default = fetch latest chip dbs)
65 NEXTPNR_ICE40_CHIPDB_PATH=default
66
67
68 ## NextPNR-Ecp5
69 # Build and (if desired) install NextPNR-Ecp5?
70 NEXTPNR_ECP5=true
71 # Build AND install NextPNR-NextPNR-Ecp5?
72 NEXTPNR_ECP5_INSTALL=true
73 # Install path (default = default path)
74 NEXTPNR_ECP5_INSTALL_PATH=default
75 # Remove build directory after successful install?
76 NEXTPNR_ECP5_CLEANUP=true
77 # Folder name in which the project is built
78 NEXTPNR_ECP5_DIR=default
79 # Specify project version to pull (default/latest, stable, tag, branch, hash)
80 NEXTPNR_ECP5_TAG=default
81 # Use chip dbs from the following path (default = fetch latest chip dbs)
82 NEXTPNR_ECP5_CHIPDB_PATH=default
83
84
85 ## Fujprog
86 # Build and (if desired) install Fujprog?
87 FUJPROG=true
88 # Build AND install Fujprog?
89 FUJPROG_INSTALL=true
90 # Install path (default = default path)
91 FUJPROG_INSTALL_PATH=default
92 # Remove build directory after successful install?
93 FUJPROG_CLEANUP=true
94 # Folder name in which the project is built
95 FUJPROG_DIR=default
96 # Specify project version to pull (default/latest, stable, tag, branch, hash)
97 FUJPROG_TAG=default
98
99
100 ## Ujprog
101 # Build and (if desired) install Ujprog?
102 UJPROG=true
103 # Build AND install Ujprog?

```

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```

104 UJPROG_INSTALL=true
105 # Install path (default = default path)
106 UJPROG_INSTALL_PATH=default
107 # Remove build directory after successful install?
108 UJPROG_CLEANUP=true
109 # Folder name in which the project is built
110 UJPROG_DIR=default
111 # Specify project version to pull (default/latest, stable, tag, branch, hash)
112 UJPROG_TAG=default
113
114
115 ## OpenOCD
116 # Build and (if desired) install OpenOCD?
117 OPENOCD=true
118 # Build AND install OpenOCD?
119 OPENOCD_INSTALL=true
120 # Install path (default = default path)
121 OPENOCD_INSTALL_PATH=default
122 # Remove build directory after successful install?
123 OPENOCD_CLEANUP=true
124 # Folder name in which the project is built
125 OPENOCD_DIR=default
126 # Specify project version to pull (default/latest, stable, tag, branch, hash)
127 OPENOCD_TAG=default
128
129
130 ## OpenOCD-VexRiscV
131 # Build and (if desired) install OpenOCD-VexRiscV?
132 OPENOCD_VEXRISCV=true
133 # Build AND install OpenOCD-VexRiscV?
134 OPENOCD_VEXRISCV_INSTALL=true
135 # Install path (default = default path)
136 OPENOCD_VEXRISCV_INSTALL_PATH=default
137 # Remove build directory after successful install?
138 OPENOCD_VEXRISCV_CLEANUP=true
139 # Folder name in which the project is built
140 OPENOCD_VEXRISCV_DIR=default
141 # Specify project version to pull (default/latest, stable, tag, branch, hash)
142 OPENOCD_VEXRISCV_TAG=default
143
144
145 ## Verilator
146 # Build and (if desired) install Verilator?
147 VERILATOR=true
148 # Build AND install Verilator?
149 VERILATOR_INSTALL=true
150 # Install path (default = default path)
151 VERILATOR_INSTALL_PATH=default
152 # Remove build directory after successful install?
153 VERILATOR_CLEANUP=true
154 # Folder name in which the project is built
155 VERILATOR_DIR=default
156 # Specify project version to pull (default/latest, stable, tag, branch, hash)
157 VERILATOR_TAG=default
158
159
160 ## GTKTerm

```

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```

161 # Build and (if desired) install GTKTerm?
162 GTKTERM=true
163 # Build AND install GTKTerm?
164 GTKTERM_INSTALL=true
165 # Install path (default = default path)
166 GTKTERM_INSTALL_PATH=default
167 # Remove build directory after successful install?
168 GTKTERM_CLEANUP=true
169 # Folder name in which the project is built
170 GTKTERM_DIR=default
171 # Specify project version to pull (default/latest, stable, tag, branch, hash)
172 GTKTERM_TAG=default
173
174
175 ## GTKWave
176 # Build and (if desired) install GTKWave?
177 GTKWAVE=true
178 # Build AND install GTKWave?
179 GTKWAVE_INSTALL=true
180 # Install path (default = default path)
181 GTKWAVE_INSTALL_PATH=default
182 # Remove build directory after successful install?
183 GTKWAVE_CLEANUP=true
184 # Folder name in which the project is built
185 GTKWAVE_DIR=default
186 # Specify project version to pull (default/latest, stable, tag, branch, hash)
187 GTKWAVE_TAG=default
188
189
190 ## RiscV-GNU-Toolchain Newlib Multilib
191 # build and install RiscV-GNU-Toolchain?
192 RISCV_NEWLIB=true
193 # Remove build directory after successful install?
194 RISCV_NEWLIB_CLEANUP=false
195 # Folder name in which the project is built
196 RISCV_NEWLIB_DIR=default
197 # Specify project version to pull (default/latest, stable, tag, branch, hash)
198 # Note: You can specify the version of every single tool of this toolchain in
199 # ./riscv_tools/versions.cfg
200 RISCV_NEWLIB_TAG=default
201 # Extend PATH by RiscV-GNU-Toolchain path?
202 RISCV_NEWLIB_EXTEND_PATH=true
203 # Specify user to install the toolchain for (default = everybody)
204 # Note: this only makes sense if PATH is extended (RISCV_NEWLIB_EXTEND_PATH)
205 RISCV_NEWLIB_USER=default
206 # Specify install path (default: /opt/riscv)
207 RISCV_NEWLIB_INSTALL_PATH=default
208
209
210 ## RiscV-GNU-Toolchain Linux Multilib
211 # build and install RiscV-GNU-Toolchain?
212 RISCV_LINUX=true
213 # Remove build directory after successful install?
214 RISCV_LINUX_CLEANUP=true
215 # Folder name in which the project is built
216 RISCV_LINUX_DIR=default
217 # Specify project version to pull (default/latest, stable, tag, branch, hash)

```

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```

218 # Note: You can specify the version of every single tool of this toolchain in
219 # ./riscv_tools/versions.cfg
220 RISC_V_LINUX_TAG=default
221 # Extend PATH by RiscV-GNU-Toolchain path?
222 RISC_V_LINUX_EXTEND_PATH=true
223 # Specify user to install the toolchain for (default = everybody)
224 # Note: this only makes sense if PATH is extended (RISC_V_LINUX_EXTEND_PATH)
225 RISC_V_LINUX_USER=default
226 # Specify install path (default: /opt/riscv)
227 RISC_V_LINUX_INSTALL_PATH=default
228
229
230 ## SpinalHDL
231 # install SpinalHDL scala libraries?
232 SPINALHDL=true
233
234
235 ## Cocotb
236 # install Cocotb python package?
237 COCOTB=true
238
239
240 ## Rust and RiscV targets
241 # install Rust and RiscV targets?
242 RUST_RISC_V=true
243
244
245 ## Spike
246 # Build and (if desired) install Spike?
247 SPIKE=true
248 # Build AND install Spike?
249 SPIKE_INSTALL=true
250 # Install path (default = default path)
251 SPIKE_INSTALL_PATH=default
252 # Remove build directory after successful install?
253 SPIKE_CLEANUP=true
254 # Folder name in which the project is built
255 SPIKE_DIR=default
256 # Specify project version to pull (default/latest, stable, tag, branch, hash)
257 SPIKE_TAG=default
258
259
260 ## Icarusverilog
261 # Build and (if desired) install Icarusverilog?
262 ICARUSVERILOG=true
263 # Build AND install Icarusverilog?
264 ICARUSVERILOG_INSTALL=true
265 # Install path (default = default path)
266 ICARUSVERILOG_INSTALL_PATH=default
267 # Remove build directory after successful install?
268 ICARUSVERILOG_CLEANUP=true
269 # Folder name in which the project is built
270 ICARUSVERILOG_DIR=default
271 # Specify project version to pull (default/latest, stable, tag, branch, hash)
272 ICARUSVERILOG_TAG=default
273
274

```

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```

275 ## Ghdl
276 # Build and (if desired) install Ghdl?
277 GHDL=true
278 # Build AND install Ghdl?
279 GHDL_INSTALL=true
280 # Install path (default = default path)
281 GHDL_INSTALL_PATH=default
282 # Remove build directory after successful install?
283 GHDL_CLEANUP=true
284 # Folder name in which the project is built
285 GHDL_DIR=default
286 # Specify project version to pull (default/latest, stable, tag, branch, hash)
287 GHDL_TAG=default
288 # Note: At least one of the following three backends must be build
289 # Build mcode backend?
290 GHDL_MCODE=true
291 # Build LLVM backend?
292 GHDL_LLVM=true
293 # Build GCC backend?
294 GHDL_GCC=true
295
296
297 ### Configure projects
298
299 ## Pqvexriscv project
300 # Download git repository
301 PQRISCV_VEXRISCV=false
302 # Git URL
303 PQRISCV_VEXRISCV_URL="https://github.com/mupq/pqriscv-vexriscv.git"
304 # Specify project version to pull (default/latest, stable, tag, branch, hash)
305 PQRISCV_VEXRISCV_TAG=default
306 # If default is selected, the project is stored in the documents folder
307 # of each user listed in the variable PQRISCV_VEXRISCV_USER
308 PQRISCV_VEXRISCV_LOCATION=default
309 # Space separated list of users (in quotation marks) to install the project for
310 # in /home/$user/Documents (if PQRISCV_VEXRISCV_LOCATION=default).
311 # default = all logged in users. Linking to desktop is also based on this list.
312 PQRISCV_VEXRISCV_USER=default
313 # Symbolic link to /home/$user/Desktop
314 PQRISCV_VEXRISCV_LINK_TO_DESKTOP=true
315
316 ## Hello world demo application
317 # Download git repository
318 DEMO_PROJECT_ICE40=false
319 # Git URL
320 DEMO_PROJECT_ICE40_URL="https://github.com/ThorKn/icebreaker-vexriscv-helloworld.git"
321 # Specify project version to pull (default/latest, stable, tag, branch, hash)
322 DEMO_PROJECT_ICE40_TAG=default
323 # If default is selected, the project is stored in the documents folder
324 # of each user listed in the variable DEMO_PROJECT_ICE40_USER
325 DEMO_PROJECT_ICE40_LOCATION=default
326 # Space separated list of users (in quotation marks) to install the project for
327 # in /home/$user/Documents (if DEMO_PROJECT_ICE40_LOCATION=default).
328 # default = all logged in users. Linking to desktop is also based on this list.
329 DEMO_PROJECT_ICE40_USER=default
330 # Symbolic link to /home/$user/Desktop
331 DEMO_PROJECT_ICE40_LINK_TO_DESKTOP=true

```



## 6.2 gtkwave

### 6.2.1 install\_gtkwave.sh

```

1  #!/bin/bash
2
3  # Author: Harald Heckmann <mail@haraldheckmann.de>
4  # Date: Jun. 25 2020
5  # Project: QuantumRisc (RheinMain University) <Steffen.Reith@hs-rm.de>
6
7  # constants
8  RED='\033[1;31m'
9  NC='\033[0m'
10 LIBRARY="../../libraries/library.sh"
11 REPO="https://github.com/gtkwave/gtkwave.git"
12 PROJ="gtkwave/gtkwave3-gtk3"
13 BUILDFOLDER="build_and_install_gtkwave"
14 VERSIONFILE="installed_version.txt"
15 TAG="latest"
16 INSTALL=false
17 INSTALL_PREFIX="default"
18 CLEANUP=false
19
20
21 # parse arguments
22 USAGE="$(basename "$0") [-h] [-c] [-d dir] [-i path] [-t tag] -- Clone latested_
   ↳tagged ${PROJ} version and build it. Optionally select the build directory and_
   ↳version, install binaries and cleanup setup files.
23
24 where:
25     -h          show this help text
26     -c          cleanup project
27     -d dir      build files in \"dir\" (default: ${BUILDFOLDER})
28     -i path     install binaries to path (use \"default\" to use default path)
29     -t tag      specify version (git tag or commit hash) to pull (default: Latest tag)
   ↳"
30
31
32 while getopts 'hi:cd:t:' OPTION; do
33     case $OPTION in
34         i)  INSTALL=true
35             INSTALL_PREFIX="$OPTARG"
36             echo "-i set: Installing built binaries to $INSTALL_PREFIX"
37             ;;
38         esac
39     done
40
41     OPTIND=1
42
43 while getopts 'hi:cd:t:' OPTION; do
44     case "$OPTION" in
45         h)  echo "$USAGE"
46             exit
47             ;;
48         c)  if [ $INSTALL = false ]; then
49             >&2 echo -e "${RED}/ERROR: -c only makes sense if the built binaries_
   ↳were installed before (-i)"

```

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```

50         exit 1
51     fi
52     CLEANUP=true
53     echo "-c set: Removing build directory"
54     ;;
55     d) echo "-d set: Using folder $OPTARG"
56        BUILDFOLDER="$OPTARG"
57        ;;
58     t) echo "-t set: Using version $OPTARG"
59        TAG="$OPTARG"
60        ;;
61     :) echo -e "${RED}ERROR: missing argument for -${OPTARG}\n${NC}" >&2
62        echo "$USAGE" >&2
63        exit 1
64        ;;
65     \?) echo -e "${RED}ERROR: illegal option: -${OPTARG}\n${NC}" >&2
66         echo "$USAGE" >&2
67         exit 1
68         ;;
69     esac
70 done
71
72 shift "$((OPTIND - 1))"
73
74 # exit when any command fails
75 set -e
76
77 # require sudo
78 if [[ $UID != 0 ]]; then
79     echo -e "${RED}Please run this script with sudo:"
80     echo "sudo $0 $*"
81     exit 1
82 fi
83
84 # cleanup files if the programm was shutdown unexpectedly
85 trap 'echo -e "${RED}ERROR: Script was terminated unexpectedly, cleaning up files..."
86 ↪&& pushd -0 > /dev/null && rm -rf $BUILDFOLDER' INT TERM
87
88 # load shared functions
89 source $LIBRARY
90
91 # fetch specified version
92 if [ ! -d $BUILDFOLDER ]; then
93     mkdir $BUILDFOLDER
94 fi
95
96 pushd $BUILDFOLDER > /dev/null
97
98 if [ ! -d "$PROJ" ]; then
99     git clone --recursive "$REPO" "${PROJ%/*}"
100 fi
101
102 pushd $PROJ > /dev/null
103 select_and_get_project_version "$TAG" "COMMIT_HASH"
104
105 # build and install if wanted
106 if [ "$INSTALL_PREFIX" == "default" ]; then

```

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```

106     ./configure
107 else
108     ./configure --prefix="$INSTALL_PREFIX"
109 fi
110
111 make -j$(nproc)
112
113 if [ $INSTALL = true ]; then
114     make install
115 fi
116
117 # return to first folder and store version
118 pushd -0 > /dev/null
119 echo "${PROJ##*/}: $COMMIT_HASH" >> "$VERSIONFILE"
120
121 # cleanup if wanted
122 if [ $CLEANUP = true ]; then
123     rm -rf $BUILDFOLDER
124 fi

```

## 6.2.2 install\_gtkwave\_essentials.sh

```

1  #!/bin/bash
2
3  # Author: Harald Heckmann <mail@haraldheckmann.de>
4  # Date: Jun. 25 2020
5  # Project: QuantumRisc (RheinMain University) <Steffen.Reith@hs-rm.de>
6
7  # require sudo
8  if [[ $UID != 0 ]]; then
9      echo "Please run this script with sudo:"
10     echo "sudo $0 $*"
11     exit 1
12 fi
13
14 # exit when any command fails
15 set -e
16
17 # required tools
18 TOOLS="build-essential git gcc make debhelper libgtk2.0-dev zlib1g-dev \
19     libbz2-dev flex gperf tcl-dev tk-dev liblzma-dev libjudy-dev \
20     libgconf2-dev"
21
22 # install and upgrade tools
23 apt-get update
24 apt-get install -y $TOOLS
25 apt-get install --only-upgrade -y $TOOLS

```

## 6.3 openocd

### 6.3.1 install\_openocd.sh

```

1  #!/bin/bash
2
3  # Author: Harald Heckmann <mail@haraldheckmann.de>
4  # Date: Jun. 25 2020
5  # Project: QuantumRisc (RheinMain University) <Steffen.Reith@hs-rm.de>
6
7  # constants
8  RED='\033[1;31m'
9  NC='\033[0m'
10 LIBRARY="../../libraries/library.sh"
11 REPO="https://git.code.sf.net/p/openocd/code"
12 PROJ="openocd"
13 BUILDFOLDER="build_and_install_openocd"
14 VERSIONFILE="installed_version.txt"
15 TAG="latest"
16 INSTALL=false
17 INSTALL_PREFIX="default"
18 CLEANUP=false
19
20
21 # parse arguments
22 USAGE="$(basename "$0") [-h] [-c] [-d dir] [-i path] [-t tag] -- Clone latested_
↳tagged ${PROJ} version and build it. Optionally select the build directory and_
↳version, install binaries and cleanup setup files.
23
24 where:
25     -h          show this help text
26     -c          cleanup project
27     -d dir      build files in \"dir\" (default: ${BUILDFOLDER})
28     -i path     install binaries to path (use \"default\" to use default path)
29     -t tag      specify version (git tag or commit hash) to pull (default: Latest tag)
↳"
30
31
32 while getopts 'hi:cd:t:' OPTION; do
33     case $OPTION in
34         i)  INSTALL=true
35             INSTALL_PREFIX="$OPTARG"
36             echo "-i set: Installing built binaries to $INSTALL_PREFIX"
37             ;;
38         esac
39 done
40
41 OPTIND=1
42
43 while getopts 'hi:cd:t:' OPTION; do
44     case "$OPTION" in
45         h)  echo "$USAGE"
46             exit
47             ;;
48         c)  if [ $INSTALL = false ]; then
49             >&2 echo -e "${RED}/ERROR: -c only makes sense if the built binaries_
↳were installed before (-i)"

```

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```

50         exit 1
51     fi
52     CLEANUP=true
53     echo "-c set: Removing build directory"
54     ;;
55     d) echo "-d set: Using folder $OPTARG"
56        BUILDFOLDER="$OPTARG"
57        ;;
58     t) echo "-t set: Using version $OPTARG"
59        TAG="$OPTARG"
60        ;;
61     :) echo -e "${RED}ERROR: missing argument for -${OPTARG}\n${NC}" >&2
62        echo "$USAGE" >&2
63        exit 1
64        ;;
65     \?) echo -e "${RED}ERROR: illegal option: -${OPTARG}\n${NC}" >&2
66         echo "$USAGE" >&2
67         exit 1
68         ;;
69     esac
70 done
71
72 shift "$((OPTIND - 1))"
73
74 # exit when any command fails
75 set -e
76
77 # require sudo
78 if [[ $UID != 0 ]]; then
79     echo -e "${RED}Please run this script with sudo:"
80     echo "sudo $0 $*"
81     exit 1
82 fi
83
84 # cleanup files if the programm was shutdown unexpectedly
85 trap 'echo -e "${RED}ERROR: Script was terminated unexpectedly, cleaning up files..."
86 ↪&& pushd -0 > /dev/null && rm -rf $BUILDFOLDER' INT TERM
87
88 # load shared functions
89 source $LIBRARY
90
91 # fetch specified version
92 if [ ! -d $BUILDFOLDER ]; then
93     mkdir $BUILDFOLDER
94 fi
95
96 pushd $BUILDFOLDER > /dev/null
97
98 if [ ! -d "$PROJ" ]; then
99     git clone --recursive "$REPO" "${PROJ%/*}"
100 fi
101
102 pushd $PROJ > /dev/null
103
104 # avoid version 10.0 when stable is selected (majorly outdated)
105 if [ "$TAG" == "stable" ]; then
106     TAGLIST=`git rev-list --tags --max-count=1`

```

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```

106
107     if [ -n "$TAGLIST" ] && [ `git describe --tags $TAGLIST` == "v0.10.0" ]; then
108         git checkout --recurse-submodules $(git symbolic-ref refs/remotes/origin/HEAD_
↪ | sed 's@^refs/remotes/origin/@@')
109         COMMIT_HASH=$(git rev-parse HEAD)
110         >&2 echo -e "${RED}WARNING: No git tags found, using default branch${NC}"
111     else
112         select_and_get_project_version "$TAG" "COMMIT_HASH"
113     fi
114 else
115     select_and_get_project_version "$TAG" "COMMIT_HASH"
116 fi
117
118 echo "selected TAG: $COMMIT_HASH"
119
120 # build and install if wanted
121 ./bootstrap
122
123 if [ "$INSTALL_PREFIX" == "default" ]; then
124     ./configure
125 else
126     ./configure --prefix="$INSTALL_PREFIX"
127 fi
128
129 make -j$(nproc)
130
131 if [ $INSTALL = true ]; then
132     make install
133 fi
134
135 # return to first folder and store version
136 pushd -0 > /dev/null
137 echo "${PROJ##*/}: $COMMIT_HASH" >> "$VERSIONFILE"
138
139 # cleanup if wanted
140 if [ $CLEANUP = true ]; then
141     rm -rf $BUILDFOLDER
142 fi

```

### 6.3.2 install\_openocd\_essentials.sh

```

1  #!/bin/bash
2
3  # Author: Harald Heckmann <mail@haraldheckmann.de>
4  # Date: Jun. 25 2020
5  # Project: QuantumRisc (RheinMain University) <Steffen.Reith@hs-rm.de>
6
7  # require sudo
8  if [[ $UID != 0 ]]; then
9      echo "Please run this script with sudo:"
10     echo "sudo $0 $*"
11     exit 1
12 fi
13
14 # exit when any command fails

```

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```

15 set -e
16
17 # required tools
18 TOOLS="build-essential git gcc make libtool pkg-config autoconf automake \
19       texinfo libftdi-dev libusb-1.0-0-dev"
20
21 # install and upgrade tools
22 apt-get update
23 apt-get install -y $TOOLS
24 apt-get install --only-upgrade -y $TOOLS

```

## 6.4 gtkterm

### 6.4.1 install\_gtkterm\_essentials.sh

```

1  #!/bin/bash
2
3  # Author: Harald Heckmann <mail@haraldheckmann.de>
4  # Date: Jun. 25 2020
5  # Project: QuantumRisc (RheinMain University) <Steffen.Reith@hs-rm.de>
6
7  # require sudo
8  if [[ $UID != 0 ]]; then
9      echo "Please run this script with sudo:"
10     echo "sudo $0 $*"
11     exit 1
12 fi
13
14 # exit when any command fails
15 set -e
16
17 # required tools
18 TOOLS="libgtk-3-dev libvte-2.91-dev intltool libgudev-1.0 meson ninja-build"
19
20 # install and upgrade tools
21 apt-get update
22 apt-get install -y $TOOLS
23 apt-get install --only-upgrade -y $TOOLS

```

### 6.4.2 install\_gtkterm.sh

```

1  #!/bin/bash
2
3  # Author: Harald Heckmann <mail@haraldheckmann.de>
4  # Date: Oct. 08 2020
5  # Project: QuantumRisc (RheinMain University) <Steffen.Reith@hs-rm.de>
6
7  # constants
8  RED='\033[1;31m'
9  NC='\033[0m'
10 LIBRARY=" ../libraries/library.sh"

```

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```

11 REPO="https://github.com/JeiJa/gtkterm"
12 PROJ="gtkterm"
13 BUILDFOLDER="build_and_install_gtkterm"
14 VERSIONFILE="installed_version.txt"
15 TAG="latest"
16 INSTALL=false
17 INSTALL_PREFIX="default"
18 CLEANUP=false
19
20
21 # parse arguments
22 USAGE="$(basename "$0") [-h] [-c] [-d dir] [-i path] [-t tag] -- Clone latested_
↳ tagged ${PROJ} version and build it. Optionally select the build directory and_
↳ version, install binaries and cleanup setup files.
23
24 where:
25     -h          show this help text
26     -c          cleanup project
27     -d dir      build files in \"dir\" (default: ${BUILDFOLDER})
28     -i path     install binaries to path (use \"default\" to use default path)
29     -t tag      specify version (git tag or commit hash) to pull (default: Latest tag)
↳ "
30
31
32 while getopts ':hi:cd:t:' OPTION; do
33     case $OPTION in
34         i)  INSTALL=true
35             INSTALL_PREFIX="$OPTARG"
36             echo "-i set: Installing built binaries to $INSTALL_PREFIX"
37             ;;
38         esac
39     done
40
41 OPTIND=1
42
43 while getopts ':hi:cd:t:' OPTION; do
44     case "$OPTION" in
45         h)  echo "$USAGE"
46             exit
47             ;;
48         c)  if [ $INSTALL = false ]; then
49             >&2 echo -e "${RED}ERROR: -c only makes sense if the built binaries_
↳ were installed before (-i)"
50             exit 1
51             fi
52             CLEANUP=true
53             echo "-c set: Removing build directory"
54             ;;
55         d)  echo "-d set: Using folder $OPTARG"
56             BUILDFOLDER="$OPTARG"
57             ;;
58         t)  echo "-t set: Using version $OPTARG"
59             TAG="$OPTARG"
60             ;;
61         :)  echo -e "${RED}ERROR: missing argument for -${OPTARG}\\n${NC}" >&2
62             echo "$USAGE" >&2
63             exit 1

```

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```

64         ;;
65         \?) echo -e "${RED}ERROR: illegal option: -${OPTARG}\n${NC}" >&2
66         echo "$USAGE" >&2
67         exit 1
68         ;;
69     esac
70 done
71
72 shift "$((OPTIND - 1))"
73
74 # exit when any command fails
75 set -e
76
77 # require sudo
78 if [[ $UID != 0 ]]; then
79     echo -e "${RED}Please run this script with sudo:"
80     echo "sudo $0 $*"
81     exit 1
82 fi
83
84 # cleanup files if the programm was shutdown unexpectedly
85 trap 'echo -e "${RED}ERROR: Script was terminated unexpectedly, cleaning up files..."
86 →&& pushd -0 > /dev/null && rm -rf $BUILDFOLDER' INT TERM
87
88 # load shared functions
89 source $LIBRARY
90
91 # fetch specified version
92 if [ ! -d $BUILDFOLDER ]; then
93     mkdir $BUILDFOLDER
94 fi
95
96 pushd $BUILDFOLDER > /dev/null
97
98 if [ ! -d "$PROJ" ]; then
99     git clone --recursive "$REPO" "${PROJ%/*}"
100 fi
101
102 pushd $PROJ > /dev/null
103 select_and_get_project_version "$TAG" "COMMIT_HASH"
104
105 if [ "$INSTALL_PREFIX" == "default" ]; then
106     meson build
107 else
108     meson build -Dprefix="$INSTALL_PREFIX"
109 fi
110
111 if [ $INSTALL = true ]; then
112     ninja -C build install
113 else
114     ninja -C build
115 fi
116
117 # return to first folder and store version
118 pushd -0 > /dev/null
119 echo "${PROJ##*/}: $COMMIT_HASH" >> "$VERSIONFILE"

```

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```

120 # cleanup if wanted
121 if [ $CLEANUP = true ]; then
122     rm -rf $BUILDFOLDER
123 fi

```

## 6.5 openocd\_vexriscv

### 6.5.1 install\_openocd\_vexriscv.sh

```

1  #!/bin/bash
2
3  # Author: Harald Heckmann <mail@haraldheckmann.de>
4  # Date: Jun. 25 2020
5  # Project: QuantumRisc (RheinMain University) <Steffen.Reith@hs-rm.de>
6
7  # constants
8  RED='\033[1;31m'
9  NC='\033[0m'
10 LIBRARY="../../libraries/library.sh"
11 REPO="https://github.com/SpinalHDL/openocd_riscv.git"
12 PROJ="openocd_vexriscv"
13 BUILDFOLDER="build_and_install_openocd_vexriscv"
14 VERSIONFILE="installed_version.txt"
15 TAG="latest"
16 INSTALL=false
17 INSTALL_PREFIX="default"
18 CLEANUP=false
19
20 CONFIGURE_STRING="--prefix=/usr/local --program-suffix=-vexriscv
21 --datarootdir=/usr/local/share/vexriscv --enable-maintainer-mode
22 --disable-werror --enable-ft232r --enable-ftdi --enable-jtag_vpi"
23
24
25 # parse arguments
26 USAGE="$0 (basename "$0") [-h] [-c] [-d dir] [-i path] [-t tag] -- Clone latested_
27 ↪tagged ${PROJ} version and build it. Optionally select the build directory and_
28 ↪version, install binaries and cleanup setup files.
29
30 where:
31     -h          show this help text
32     -c          cleanup project
33     -d dir      build files in \"dir\" (default: ${BUILDFOLDER})
34     -i path     install binaries to path (use \"default\" to use default path)
35     -t tag      specify version (git tag or commit hash) to pull (default: Latest tag)
36 ↪
37
38 while getopts ':hi:cd:t:' OPTION; do
39     case $OPTION in
40         i)  INSTALL=true
41             # Adjust configure string
42             if [ "$OPTARG" != 'default' ]; then
43                 CONFIGURE_STRING="${CONFIGURE_STRING//\"/usr/local\"/\"$OPTARG\"}"

```

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```

42         fi
43         # INSTALL_PREFIX="$OPTARG"
44         echo "-i set: Installing built binaries to $OPTARG"
45         ;;
46     esac
47 done
48
49 OPTIND=1
50
51 while getopts 'hi:cd:t:' OPTION; do
52     case "$OPTION" in
53         h) echo "$USAGE"
54            exit
55            ;;
56         c) if [ $INSTALL = false ]; then
57             >&2 echo -e "${RED}ERROR: -c only makes sense if the built binaries_
↳ were installed before (-i)"
58             exit 1
59             fi
60             CLEANUP=true
61             echo "-c set: Removing build directory"
62             ;;
63         d) echo "-d set: Using folder $OPTARG"
64            BUILDFOLDER="$OPTARG"
65            ;;
66         t) echo "-t set: Using version $OPTARG"
67            TAG="$OPTARG"
68            ;;
69         :) echo -e "${RED}ERROR: missing argument for -${OPTARG}\n${NC}" >&2
70            echo "$USAGE" >&2
71            exit 1
72            ;;
73         \?) echo -e "${RED}ERROR: illegal option: -${OPTARG}\n${NC}" >&2
74            echo "$USAGE" >&2
75            exit 1
76            ;;
77     esac
78 done
79
80 shift "$((OPTIND - 1))"
81
82 # exit when any command fails
83 set -e
84
85 # require sudo
86 if [[ $UID != 0 ]]; then
87     echo -e "${RED}Please run this script with sudo:"
88     echo "sudo $0 $*"
89     exit 1
90 fi
91
92 # cleanup files if the programm was shutdown unexpectedly
93 trap 'echo -e "${RED}ERROR: Script was terminated unexpectedly, cleaning up files..."_
↳ && pushd -0 > /dev/null && rm -rf $BUILDFOLDER' INT TERM
94
95 # load shared functions
96 source $LIBRARY

```

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```

97
98 # fetch specified version
99 if [ ! -d $BUILDFOLDER ]; then
100     mkdir $BUILDFOLDER
101 fi
102
103 pushd $BUILDFOLDER > /dev/null
104
105 if [ ! -d "${PROJ%/*}" ]; then
106     git clone --recursive "$REPO" "${PROJ%/*}"
107 fi
108
109 pushd $PROJ > /dev/null
110 select_and_get_project_version "$TAG" "COMMIT_HASH"
111 # build and install if wanted
112 ./bootstrap
113 ./configure $CONFIGURE_STRING
114
115 make -j$(nproc)
116
117 if [ $INSTALL = true ]; then
118     make install
119 fi
120
121 # return to first folder and store version
122 pushd -0 > /dev/null
123 echo "${PROJ##*/}: $COMMIT_HASH" >> "$VERSIONFILE"
124
125 # cleanup if wanted
126 if [ $CLEANUP = true ]; then
127     rm -rf $BUILDFOLDER
128 fi

```

## 6.5.2 install\_openocd\_vexriscv\_essentials.sh

```

1  #!/bin/bash
2
3  # Author: Harald Heckmann <mail@haraldheckmann.de>
4  # Date: Jun. 25 2020
5  # Project: QuantumRisc (RheinMain University) <Steffen.Reith@hs-rm.de>
6
7  # require sudo
8  if [[ $UID != 0 ]]; then
9      echo "Please run this script with sudo:"
10     echo "sudo $0 $*"
11     exit 1
12 fi
13
14 # exit when any command fails
15 set -e
16
17 # required tools
18 TOOLS="build-essential git gcc make libtool pkg-config autoconf automake \
19     texinfo libftdi-dev libusb-1.0-0-dev libyaml-dev"
20

```

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```

21 # install and upgrade tools
22 apt-get update
23 apt-get install -y $TOOLS
24 apt-get install --only-upgrade -y $TOOLS

```

## 6.6 icestorm

### 6.6.1 install\_icestorm\_essentials.sh

```

1  #!/bin/bash
2
3  # Author: Harald Heckmann <mail@haraldheckmann.de>
4  # Date: Jun. 24 2020
5  # Project: QuantumRisc (RheinMain University) <Steffen.Reith@hs-rm.de>
6
7  # require sudo
8  if [[ $UID != 0 ]]; then
9      echo "Please run this script with sudo:"
10     echo "sudo $0 $*"
11     exit 1
12 fi
13
14 # exit when any command fails
15 set -e
16
17 # required tools
18 TOOLS="build-essential clang bison flex libreadline-dev \
19       gawk tcl-dev libffi-dev git mercurial graphviz \
20       xdot pkg-config python python3 libftdi-dev \
21       qt5-default python3-dev libboost-all-dev cmake libeigen3-dev"
22
23 # install and upgrade tools
24 apt-get update
25 apt-get install -y $TOOLS
26 apt-get install --only-upgrade -y $TOOLS

```

### 6.6.2 install\_icestorm.sh

```

1  #!/bin/bash
2
3  # Author: Harald Heckmann <mail@haraldheckmann.de>
4  # Date: Jun. 24 2020
5  # Project: QuantumRisc (RheinMain University) <Steffen.Reith@hs-rm.de>
6
7  # constants
8  RED='\033[1;31m'
9  NC='\033[0m'
10 LIBRARY="../../libraries/library.sh"
11 REPO="https://github.com/cliffordwolf/icestorm.git"
12 PROJ="icestorm"
13 BUILDFOLDER="build_and_install_icestorm"

```

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```

14 VERSIONFILE="installed_version.txt"
15 RULE_FILE="/etc/udev/rules.d/53-lattice-ftdi.rules"
16 # space separate multiple rules
17 RULES=('ACTION=="add", ATTR{idVendor}=="0403", ATTR{idProduct}=="6010", MODE=="666"')
18 TAG="latest"
19 INSTALL=false
20 INSTALL_PREFIX="default"
21 CLEANUP=false
22
23
24 # parse arguments
25 USAGE="$(basename "$0") [-h] [-c] [-d dir] [-i path] [-t tag] -- Clone latested_
↳ tagged ${PROJ} version and build it. Optionally select the build directory and_
↳ version, install binaries and cleanup setup files.
26
27 where:
28     -h          show this help text
29     -c          cleanup project
30     -d dir      build files in \"dir\" (default: ${BUILDFOLDER})
31     -i path     install binaries to path (use \"default\" to use default path)
32     -t tag      specify version (git tag or commit hash) to pull (default: Latest tag)
↳ "
33
34
35 while getopts 'hi:cd:t:' OPTION; do
36     case $OPTION in
37         i)  INSTALL=true
38             INSTALL_PREFIX="$OPTARG"
39             echo "-i set: Installing built binaries to $INSTALL_PREFIX"
40             ;;
41         esac
42     done
43
44 OPTIND=1
45
46 while getopts 'hi:cd:t:' OPTION; do
47     case "$OPTION" in
48         h)  echo "$USAGE"
49             exit
50             ;;
51         c)  if [ $INSTALL = false ]; then
52             >&2 echo -e "${RED}ERROR: -c only makes sense if the built binaries_
↳ were installed before (-i)"
53             exit 1
54             fi
55             CLEANUP=true
56             echo "-c set: Removing build directory"
57             ;;
58         d)  echo "-d set: Using folder $OPTARG"
59             BUILDFOLDER="$OPTARG"
60             ;;
61         t)  echo "-t set: Using version $OPTARG"
62             TAG="$OPTARG"
63             ;;
64         :)  echo -e "${RED}ERROR: missing argument for -${OPTARG}\\n${NC}" >&2
65             echo "$USAGE" >&2
66             exit 1

```

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```

67         ;;
68         \?) echo -e "${RED}ERROR: illegal option: -${OPTARG}\n${NC}" >&2
69         echo "$USAGE" >&2
70         exit 1
71         ;;
72     esac
73 done
74
75 shift "$((OPTIND - 1))"
76
77 # exit when any command fails
78 set -e
79
80 # require sudo
81 if [[ $UID != 0 ]]; then
82     echo -e "${RED}Please run this script with sudo:"
83     echo "sudo $0 $*"
84     exit 1
85 fi
86
87 # cleanup files if the programm was shutdown unexpectedly
88 trap 'echo -e "${RED}ERROR: Script was terminated unexpectedly, cleaning up files..."
89 →&& pushd -0 > /dev/null && rm -rf $BUILDFOLDER' INT TERM
90
91 # load shared functions
92 source $LIBRARY
93
94 # fetch specified version
95 if [ ! -d $BUILDFOLDER ]; then
96     mkdir $BUILDFOLDER
97 fi
98
99 pushd $BUILDFOLDER > /dev/null
100
101 if [ ! -d "$PROJ" ]; then
102     git clone --recursive "$REPO" "${PROJ%/*}"
103 fi
104
105 pushd $PROJ > /dev/null
106
107 select_and_get_project_version "$TAG" "COMMIT_HASH"
108
109 # build and install if wanted
110 make -j$(nproc)
111
112 if [ $INSTALL = true ]; then
113     if [ "$INSTALL_PREFIX" == "default" ]; then
114         make install
115     else
116         make install PREFIX="$INSTALL_PREFIX"
117     fi
118 fi
119
120 # allow any user to access ice fpgas (no sudo)
121 touch "$RULE_FILE"
122
123 for RULE in "${RULES[@]}; do

```

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```

123     if ! grep -q "$RULE" "$RULE_FILE"; then
124         echo -e "$RULE" >> "$RULE_FILE"
125     fi
126 done
127
128 # return to first folder and store version
129 pushd -0 > /dev/null
130 echo "${PROJ##*/}: $COMMIT_HASH" >> "$VERSIONFILE"
131
132 # cleanup if wanted
133 if [ $CLEANUP = true ]; then
134     rm -rf $BUILDFOLDER
135 fi

```

## 6.7 uiprogram

### 6.7.1 install\_uiprogram\_essentials.sh

```

1  #!/bin/bash
2
3  # Author: Harald Heckmann <mail@haraldheckmann.de>
4  # Date: Jun. 25 2020
5  # Project: QuantumRisc (RheinMain University) <Steffen.Reith@hs-rm.de>
6
7  # require sudo
8  if [[ $UID != 0 ]]; then
9      echo "Please run this script with sudo:"
10     echo "sudo $0 $*"
11     exit 1
12 fi
13
14 # exit when any command fails
15 set -e
16
17 # required tools
18 TOOLS="build-essential clang make"
19
20 # install and upgrade tools
21 apt-get update
22 apt-get install -y $TOOLS
23 apt-get install --only-upgrade -y $TOOLS

```

### 6.7.2 install\_uiprogram.sh

```

1  #!/bin/bash
2
3  # Author: Harald Heckmann <mail@haraldheckmann.de>
4  # Date: Jun. 25 2020
5  # Project: QuantumRisc (RheinMain University) <Steffen.Reith@hs-rm.de>
6
7  # constants

```

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```

8 RED='\033[1;31m'
9 NC='\033[0m'
10 LIBRARY="./libraries/library.sh"
11 REPO="https://github.com/f32c/tools.git"
12 PROJ="tools/ujprog"
13 BUILDFOLDER="build_and_install_ujprog"
14 VERSIONFILE="installed_version.txt"
15 TAG="latest"
16 INSTALL=false
17 INSTALL_PREFIX="default"
18 CLEANUP=false
19
20
21 # parse arguments
22 USAGE="$(basename "$0") [-h] [-c] [-d dir] [-i path] [-t tag] -- Clone latested_
↳tagged ${PROJ} version and build it. Optionally select the build directory and_
↳version, install binaries and cleanup setup files.
23
24 where:
25     -h          show this help text
26     -c          cleanup project
27     -d dir      build files in \"dir\" (default: ${BUILDFOLDER})
28     -i path     install binaries to path (use \"default\" to use default path)
29     -t tag      specify version (git tag or commit hash) to pull (default: Latest tag)
↳"
30
31
32 while getopts ':hi:cd:t:' OPTION; do
33     case $OPTION in
34         i)  INSTALL=true
35             INSTALL_PREFIX="$OPTARG"
36             echo "-i set: Installing built binaries to $INSTALL_PREFIX"
37             ;;
38         esac
39     done
40
41     OPTIND=1
42
43     while getopts ':hi:cd:t:' OPTION; do
44         case "$OPTION" in
45             h)  echo "$USAGE"
46                 exit
47                 ;;
48             c)  if [ $INSTALL = false ]; then
49                 >&2 echo -e "${RED}ERROR: -c only makes sense if the built binaries_
↳were installed before (-i)"
50                 exit 1
51             fi
52             CLEANUP=true
53             echo "-c set: Removing build directory"
54             ;;
55             d)  echo "-d set: Using folder $OPTARG"
56                 BUILDFOLDER="$OPTARG"
57                 ;;
58             t)  echo "-t set: Using version $OPTARG"
59                 TAG="$OPTARG"
60                 ;;

```

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```

61         :) echo -e "${RED}ERROR: missing argument for -${OPTARG}\n${NC}" >&2
62         echo "$USAGE" >&2
63         exit 1
64         ;;
65     \?) echo -e "${RED}ERROR: illegal option: -${OPTARG}\n${NC}" >&2
66         echo "$USAGE" >&2
67         exit 1
68         ;;
69     esac
70 done
71
72 shift "$((OPTIND - 1))"
73
74 # exit when any command fails
75 set -e
76
77 # require sudo
78 if [[ $UID != 0 ]]; then
79     echo -e "${RED}Please run this script with sudo:"
80     echo "sudo $0 $*"
81     exit 1
82 fi
83
84 # cleanup files if the programm was shutdown unexpectedly
85 trap 'echo -e "${RED}ERROR: Script was terminated unexpectedly, cleaning up files..."
86     && pushd -0 > /dev/null && rm -rf $BUILDFOLDER' INT TERM
87
88 # load shared functions
89 source $LIBRARY
90
91 # fetch specified version
92 if [ ! -d $BUILDFOLDER ]; then
93     mkdir $BUILDFOLDER
94 fi
95
96 pushd $BUILDFOLDER > /dev/null
97
98 if [ ! -d "$PROJ" ]; then
99     git clone --recursive "$REPO" "${PROJ%/*}"
100 fi
101
102 pushd $PROJ > /dev/null
103 select_and_get_project_version "$TAG" "COMMIT_HASH"
104
105 # build and install if wanted
106 cp Makefile.linux Makefile
107
108 # Adjust path if required
109 if [ "$INSTALL_PREFIX" != "default" ]; then
110     mkdir -p "${INSTALL_PREFIX}/bin"
111     sed -i "s /usr/local ${INSTALL_PREFIX} g" Makefile
112 fi
113
114 make -j$(nproc)
115
116 if [ $INSTALL = true ]; then
117     make install

```

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```

117 fi
118
119 # return to first folder and store version
120 pushd -0 > /dev/null
121 echo "${PROJ##*/}: $COMMIT_HASH" >> "$VERSIONFILE"
122
123 # cleanup if wanted
124 if [ $CLEANUP = true ]; then
125     rm -rf $BUILDFOLDER
126 fi

```

## 6.8 trellis

### 6.8.1 install\_trellis\_essentials.sh

```

1  #!/bin/bash
2
3  # Author: Harald Heckmann <mail@haraldheckmann.de>
4  # Date: Jun. 25 2020
5  # Project: QuantumRisc (RheinMain University) <Steffen.Reith@hs-rm.de>
6
7  # require sudo
8  if [[ $UID != 0 ]]; then
9      echo "Please run this script with sudo:"
10     echo "sudo $0 $*"
11     exit 1
12 fi
13
14 # exit when any command fails
15 set -e
16
17 # required tools
18 TOOLS="build-essential clang cmake python3 python3-dev libboost-all-dev git"
19
20 # install and upgrade tools
21 apt-get update
22 apt-get install -y $TOOLS
23 apt-get install --only-upgrade -y $TOOLS

```

### 6.8.2 install\_trellis.sh

```

1  #!/bin/bash
2
3  # Author: Harald Heckmann <mail@haraldheckmann.de>
4  # Date: Jun. 25 2020
5  # Project: QuantumRisc (RheinMain University) <Steffen.Reith@hs-rm.de>
6
7  # constants
8  RED='\033[1;31m'
9  NC='\033[0m'
10 LIBRARY="../libraries/library.sh"

```

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```

11 REPO="https://github.com/SymbiFlow/prjtrellis"
12 PROJ="prjtrellis/libtrellis"
13 BUILDFOLDER="build_and_install_trellis"
14 VERSIONFILE="installed_version.txt"
15 TAG="latest"
16 INSTALL=false
17 INSTALL_PREFIX="default"
18 CLEANUP=false
19
20
21 # parse arguments
22 USAGE="$(basename "$0") [-h] [-c] [-d dir] [-i path] [-t tag] -- Clone latested_
↳ tagged ${PROJ} version and build it. Optionally select the build directory and_
↳ version, install binaries and cleanup setup files.
23
24 where:
25     -h          show this help text
26     -c          cleanup project
27     -d dir      build files in \"dir\" (default: ${BUILDFOLDER})
28     -i path     install binaries to path (use \"default\" to use default path)
29     -t tag      specify version (git tag or commit hash) to pull (default: Latest tag)
↳ "
30
31
32 while getopts 'hi:cd:t:' OPTION; do
33     case $OPTION in
34         i)  INSTALL=true
35             INSTALL_PREFIX="$OPTARG"
36             echo "-i set: Installing built binaries to $INSTALL_PREFIX"
37             ;;
38         esac
39     done
40
41 OPTIND=1
42
43 while getopts 'hi:cd:t:' OPTION; do
44     case "$OPTION" in
45         h)  echo "$USAGE"
46             exit
47             ;;
48         c)  if [ $INSTALL = false ]; then
49             >&2 echo -e "${RED}ERROR: -c only makes sense if the built binaries_
↳ were installed before (-i)"
50             exit 1
51             fi
52             CLEANUP=true
53             echo "-c set: Removing build directory"
54             ;;
55         d)  echo "-d set: Using folder $OPTARG"
56             BUILDFOLDER="$OPTARG"
57             ;;
58         t)  echo "-t set: Using version $OPTARG"
59             TAG="$OPTARG"
60             ;;
61         :)  echo -e "${RED}ERROR: missing argument for -${OPTARG}\\n${NC}" >&2
62             echo "$USAGE" >&2
63             exit 1

```

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```

64         ;;
65         \?) echo -e "${RED}ERROR: illegal option: -${OPTARG}\n${NC}" >&2
66         echo "$USAGE" >&2
67         exit 1
68         ;;
69     esac
70 done
71
72 shift "$((OPTIND - 1))"
73
74 # exit when any command fails
75 set -e
76
77 # require sudo
78 if [[ $UID != 0 ]]; then
79     echo -e "${RED}Please run this script with sudo:"
80     echo "sudo $0 $*"
81     exit 1
82 fi
83
84 # cleanup files if the program was shutdown unexpectedly
85 trap 'echo -e "${RED}ERROR: Script was terminated unexpectedly, cleaning up files..."
86 →&& pushd -0 > /dev/null && rm -rf $BUILDFOLDER' INT TERM
87
88 # load shared functions
89 source $LIBRARY
90
91 # fetch specified version
92 if [ ! -d $BUILDFOLDER ]; then
93     mkdir $BUILDFOLDER
94 fi
95
96 pushd $BUILDFOLDER > /dev/null
97
98 if [ ! -d "$PROJ" ]; then
99     git clone --recursive "$REPO" "${PROJ%/*}"
100 fi
101
102 pushd $PROJ > /dev/null
103 select_and_get_project_version "$TAG" "COMMIT_HASH"
104
105 # build and install if wanted
106 if [ "$INSTALL_PREFIX" == "default" ]; then
107     cmake -DCMAKE_INSTALL_PREFIX=/usr .
108 else
109     cmake -DCMAKE_INSTALL_PREFIX="$INSTALL_PREFIX" .
110 fi
111
112 make -j$(nproc)
113
114 if [ $INSTALL = true ]; then
115     make install
116 fi
117
118 # return to first folder and store version
119 pushd -0 > /dev/null
120 echo "${PROJ##*/}: $COMMIT_HASH" >> "$VERSIONFILE"

```

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```

120
121 # cleanup if wanted
122 if [ $CLEANUP = true ]; then
123     rm -rf $BUILDFOLDER
124 fi

```

## 6.9 spike

### 6.9.1 install\_spike\_essentials.sh

```

1  #!/bin/bash
2
3  # Author: Harald Heckmann <mail@haraldheckmann.de>
4  # Date: Oct. 24 2020
5  # Project: QuantumRisc (RheinMain University) <Steffen.Reith@hs-rm.de>
6
7  # require sudo
8  if [[ $UID != 0 ]]; then
9      echo "Please run this script with sudo:"
10     echo "sudo $0 $*"
11     exit 1
12 fi
13
14 # exit when any command fails
15 set -e
16
17 # required tools
18 TOOLS="device-tree-compiler"
19
20 # install and upgrade tools
21 apt-get update
22 apt-get install -y $TOOLS
23 apt-get install --only-upgrade -y $TOOLS

```

### 6.9.2 install\_spike.sh

```

1  #!/bin/bash
2
3  # Author: Harald Heckmann <mail@haraldheckmann.de>
4  # Date: Oct. 24 2020
5  # Project: QuantumRisc (RheinMain University) <Steffen.Reith@hs-rm.de>
6
7  # constants
8  RED='\033[1;31m'
9  NC='\033[0m'
10 LIBRARY="../../libraries/library.sh"
11 REPO="https://github.com/riscv/riscv-isa-sim.git"
12 PROJ="spike"
13 BUILDFOLDER="build_and_install_spike"
14 VERSIONFILE="installed_version.txt"
15 TAG="latest"

```

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```

16 INSTALL=false
17 INSTALL_PREFIX="default"
18 CLEANUP=false
19
20
21 # parse arguments
22 USAGE="$(basename "$0") [-h] [-c] [-d dir] [-i path] [-t tag] -- Clone latested_
↳ tagged ${PROJ} version and build it. Optionally select the build directory and_
↳ version, install binaries and cleanup setup files.
23
24 where:
25     -h          show this help text
26     -c          cleanup project
27     -d dir      build files in \"dir\" (default: ${BUILDFOLDER})
28     -i path     install binaries to path (use \"default\" to use default path)
29     -t tag      specify version (git tag or commit hash) to pull (default: Latest tag)
↳ "
30
31
32 while getopts 'hi:cd:t:' OPTION; do
33     case $OPTION in
34         i)  INSTALL=true
35             INSTALL_PREFIX="$OPTARG"
36             echo "-i set: Installing built binaries to $INSTALL_PREFIX"
37             ;;
38         esac
39     done
40
41     OPTIND=1
42
43 while getopts 'hi:cd:t:' OPTION; do
44     case "$OPTION" in
45         h)  echo "$USAGE"
46             exit
47             ;;
48         c)  if [ $INSTALL = false ]; then
49             >&2 echo -e "${RED}ERROR: -c only makes sense if the built binaries_
↳ were installed before (-i)"
50             exit 1
51             fi
52             CLEANUP=true
53             echo "-c set: Removing build directory"
54             ;;
55         d)  echo "-d set: Using folder $OPTARG"
56             BUILDFOLDER="$OPTARG"
57             ;;
58         t)  echo "-t set: Using version $OPTARG"
59             TAG="$OPTARG"
60             ;;
61         :)  echo -e "${RED}ERROR: missing argument for -${OPTARG}\\n${NC}" >&2
62             echo "$USAGE" >&2
63             exit 1
64             ;;
65         \\?) echo -e "${RED}ERROR: illegal option: -${OPTARG}\\n${NC}" >&2
66             echo "$USAGE" >&2
67             exit 1
68             ;;

```

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```

69     esac
70 done
71
72 shift "$((OPTIND - 1))"
73
74 # exit when any command fails
75 set -e
76
77 # require sudo
78 if [[ $UID != 0 ]]; then
79     echo -e "${RED}Please run this script with sudo:"
80     echo "sudo $0 $*"
81     exit 1
82 fi
83
84 # cleanup files if the programm was shutdown unexpectedly
85 trap 'echo -e "${RED}ERROR: Script was terminated unexpectedly, cleaning up files..."
86 ↪&& pushd -0 > /dev/null && rm -rf $BUILDFOLDER' INT TERM
87
88 # load shared functions
89 source $LIBRARY
90
91 # fetch specified version
92 if [ ! -d $BUILDFOLDER ]; then
93     mkdir $BUILDFOLDER
94 fi
95
96 pushd $BUILDFOLDER > /dev/null
97
98 if [ ! -d "$PROJ" ]; then
99     git clone --recursive "$REPO" "${PROJ%/*}"
100 fi
101
102 pushd $PROJ > /dev/null
103 select_and_get_project_version "$TAG" "COMMIT_HASH"
104
105 # build and install if wanted
106 mkdir -p 'build'
107 pushd 'build' > /dev/null
108
109 if [ "$INSTALL_PREFIX" == "default" ]; then
110     ../configure
111 else
112     ../configure --prefix="$INSTALL_PREFIX"
113 fi
114
115 make -j$(nproc)
116
117 if [ $INSTALL = true ]; then
118     make install
119 fi
120
121 # return to first folder and store version
122 pushd -0 > /dev/null
123 echo "${PROJ##*/}: $COMMIT_HASH" >> "$VERSIONFILE"
124
125 # cleanup if wanted

```

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```

125 if [ $CLEANUP = true ]; then
126     rm -rf $BUILDFOLDER
127 fi

```

## 6.10 fujprog

### 6.10.1 install\_fujprog.sh

```

1  #!/bin/bash
2
3  # Author: Harald Heckmann <mail@haraldheckmann.de>
4  # Date: Oct. 23 2020
5  # Project: QuantumRisc (RheinMain University) <Steffen.Reith@hs-rm.de>
6
7  # constants
8  RED='\033[1;31m'
9  NC='\033[0m'
10 LIBRARY="../../libraries/library.sh"
11 REPO="https://github.com/kost/fujprog.git"
12 PROJ="fujprog"
13 BUILDFOLDER="build_and_install_fujprog"
14 VERSIONFILE="installed_version.txt"
15 RULE_FILE="/etc/udev/rules.d/80-fpga-ulx3s.rules"
16 # space separate multiple rules
17 RULES=(
18     'SUBSYSTEM=="tty", ATTRS{idVendor}=="0403", ATTRS{idProduct}=="6015", MODE="664",
19     ↪GROUP="dialout"'
20     'ATTRS{idVendor}=="0403", ATTRS{idProduct}=="6015", GROUP="dialout", MODE="666"'
21 )
22 TAG="latest"
23 INSTALL=false
24 INSTALL_PREFIX="default"
25 CLEANUP=false
26
27 # parse arguments
28 USAGE="$ (basename "$0") [-h] [-c] [-d dir] [-i path] [-t tag] -- Clone latested_
29 ↪tagged ${PROJ} version and build it. Optionally select the build directory and_
30 ↪version, install binaries and cleanup setup files.
31
32 where:
33     -h          show this help text
34     -c          cleanup project
35     -d dir      build files in \"dir\" (default: ${BUILDFOLDER})
36     -i path     install binaries to path (use \"default\" to use default path)
37     -t tag      specify version (git tag or commit hash) to pull (default: Latest tag)
38     ↪"
39
40 while getopts ':hi:cd:t:' OPTION; do
41     case $OPTION in
42         i)  INSTALL=true
43             INSTALL_PREFIX="$OPTARG"

```

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```

42         echo "-i set: Installing built binaries to $INSTALL_PREFIX"
43         ;;
44     esac
45 done
46
47 OPTIND=1
48
49 while getopts 'hi:cd:t:' OPTION; do
50     case "$OPTION" in
51         h) echo "$USAGE"
52            exit
53            ;;
54         c) if [ $INSTALL = false ]; then
55             >&2 echo -e "${RED}ERROR: -c only makes sense if the built binaries
↳ were installed before (-i)"
56             exit 1
57         fi
58         CLEANUP=true
59         echo "-c set: Removing build directory"
60         ;;
61         d) echo "-d set: Using folder $OPTARG"
62            BUILD_FOLDER="$OPTARG"
63            ;;
64         t) echo "-t set: Using version $OPTARG"
65            TAG="$OPTARG"
66            ;;
67         :) echo -e "${RED}ERROR: missing argument for -${OPTARG}\n${NC}" >&2
68            echo "$USAGE" >&2
69            exit 1
70            ;;
71         \?) echo -e "${RED}ERROR: illegal option: -${OPTARG}\n${NC}" >&2
72            echo "$USAGE" >&2
73            exit 1
74            ;;
75     esac
76 done
77
78 shift "$((OPTIND - 1))"
79
80 # exit when any command fails
81 set -e
82
83 # require sudo
84 if [[ $UID != 0 ]]; then
85     echo -e "${RED}Please run this script with sudo:"
86     echo "sudo $0 $*"
87     exit 1
88 fi
89
90 # cleanup files if the program was shutdown unexpectedly
91 trap 'echo -e "${RED}ERROR: Script was terminated unexpectedly, cleaning up files..."
↳ && pushd -0 > /dev/null && rm -rf $BUILD_FOLDER' INT TERM
92
93 # load shared functions
94 source $LIBRARY
95
96 # fetch specified version

```

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```

97 if [ ! -d $BUILDFOLDER ]; then
98     mkdir $BUILDFOLDER
99 fi
100
101 pushd $BUILDFOLDER > /dev/null
102
103 if [ ! -d "$PROJ" ]; then
104     git clone --recursive "$REPO" "${PROJ%%/*}"
105 fi
106
107 pushd $PROJ > /dev/null
108 select_and_get_project_version "$TAG" "COMMIT_HASH"
109
110 # build and install if wanted
111 if [ "$INSTALL_PREFIX" == "default" ]; then
112     cmake .
113 else
114     cmake -DCMAKE_INSTALL_PREFIX="$${INSTALL_PREFIX}" .
115 fi
116
117 make -j$(nproc)
118
119 if [ $INSTALL = true ]; then
120     make install
121 fi
122
123 # allow any user to access ulx3s fpgas (no sudo)
124 touch "$RULE_FILE"
125
126 for RULE in "${RULES[@]"; do
127     if ! grep -q "$RULE" "$RULE_FILE"; then
128         echo -e "$RULE" >> "$RULE_FILE"
129     fi
130 done
131
132 # return to first folder and store version
133 pushd -0 > /dev/null
134 echo "${PROJ##*/}: $COMMIT_HASH" >> "$VERSIONFILE"
135
136 # cleanup if wanted
137 if [ $CLEANUP = true ]; then
138     rm -rf $BUILDFOLDER
139 fi

```

## 6.10.2 install\_fujprog\_essentials.sh

```

1  #!/bin/bash
2
3  # Author: Harald Heckmann <mail@haraldheckmann.de>
4  # Date: Oct. 23 2020
5  # Project: QuantumRisc (RheinMain University) <Steffen.Reith@hs-rm.de>
6
7  # require sudo
8  if [[ $UID != 0 ]]; then
9      echo "Please run this script with sudo:"

```

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```
10     echo "sudo $0 $*"
11     exit 1
12 fi
13
14 # exit when any command fails
15 set -e
16
17 # required tools
18 TOOLS="libftd1l-dev libusb-dev cmake make build-essential"
19
20 # install and upgrade tools
21 apt-get update
22 apt-get install -y $TOOLS
23 apt-get install --only-upgrade -y $TOOLS
```

## 6.11 verilator

### 6.11.1 install\_verilator\_essentials.sh

```
1  #!/bin/bash
2
3  # Author: Harald Heckmann <mail@haraldheckmann.de>
4  # Date: Jun. 25 2020
5  # Project: QuantumRisc (RheinMain University) <Steffen.Reith@hs-rm.de>
6
7  # require sudo
8  if [[ $UID != 0 ]]; then
9      echo "Please run this script with sudo:"
10     echo "sudo $0 $*"
11     exit 1
12 fi
13
14 # exit when any command fails
15 set -e
16
17 # required tools
18 TOOLS="git perl python3 make g++ libfl2 libfl-dev zlibc zlibg zlibg-dev \
19       ccache libgoogle-perftools-dev numactl git autoconf flex bison"
20
21 # install and upgrade tools
22 apt-get update
23 apt-get install -y $TOOLS
24 apt-get install --only-upgrade -y $TOOLS
```

## 6.11.2 install\_verilator.sh

```

1  #!/bin/bash
2
3  # Author: Harald Heckmann <mail@haraldheckmann.de>
4  # Date: Jun. 25 2020
5  # Project: QuantumRisc (RheinMain University) <Steffen.Reith@hs-rm.de>
6
7  # constants
8  RED='\033[1;31m'
9  NC='\033[0m'
10 LIBRARY="../../libraries/library.sh"
11 REPO="https://github.com/verilator/verilator.git"
12 PROJ="verilator"
13 BUILDFOLDER="build_and_install_verilator"
14 VERSIONFILE="installed_version.txt"
15 TAG="latest"
16 INSTALL=false
17 INSTALL_PREFIX="default"
18 CLEANUP=false
19
20
21 # parse arguments
22 USAGE="$(basename "$0") [-h] [-c] [-d dir] [-i path] [-t tag] -- Clone latested_
↳tagged ${PROJ} version and build it. Optionally select the build directory and_
↳version, install binaries and cleanup setup files.
23
24 where:
25     -h          show this help text
26     -c          cleanup project
27     -d dir      build files in \"dir\" (default: ${BUILDFOLDER})
28     -i path     install binaries to path (use \"default\" to use default path)
29     -t tag      specify version (git tag or commit hash) to pull (default: Latest tag)
↳"
30
31
32 while getopts ':hi:cd:t:' OPTION; do
33     case $OPTION in
34         i)  INSTALL=true
35             INSTALL_PREFIX="$OPTARG"
36             echo "-i set: Installing built binaries to $INSTALL_PREFIX"
37             ;;
38         esac
39     done
40
41     OPTIND=1
42
43 while getopts ':hi:cd:t:' OPTION; do
44     case "$OPTION" in
45         h)  echo "$USAGE"
46             exit
47             ;;
48         c)  if [ $INSTALL = false ]; then
49             >&2 echo -e "${RED}ERROR: -c only makes sense if the built binaries_
↳were installed before (-i)"
50             exit 1
51             fi

```

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```

52         CLEANUP=true
53         echo "-c set: Removing build directory"
54         ;;
55     d) echo "-d set: Using folder $OPTARG"
56        BUILDFOLDER="$OPTARG"
57        ;;
58     t) echo "-t set: Using version $OPTARG"
59        TAG="$OPTARG"
60        ;;
61     :) echo -e "${RED}ERROR: missing argument for -${OPTARG}\n${NC}" >&2
62        echo "$USAGE" >&2
63        exit 1
64        ;;
65     \?) echo -e "${RED}ERROR: illegal option: -${OPTARG}\n${NC}" >&2
66         echo "$USAGE" >&2
67         exit 1
68         ;;
69     esac
70 done
71
72 shift "$((OPTIND - 1))"
73
74 # exit when any command fails
75 set -e
76
77 # require sudo
78 if [[ $UID != 0 ]]; then
79     echo -e "${RED}Please run this script with sudo:"
80     echo "sudo $0 *"
81     exit 1
82 fi
83
84 # cleanup files if the programm was shutdown unexpectedly
85 trap 'echo -e "${RED}ERROR: Script was terminated unexpectedly, cleaning up files..."
86 ↪&& pushd -0 > /dev/null && rm -rf $BUILDFOLDER' INT TERM
87
88 # load shared functions
89 source $LIBRARY
90
91 # fetch specified version
92 if [ ! -d $BUILDFOLDER ]; then
93     mkdir $BUILDFOLDER
94 fi
95
96 pushd $BUILDFOLDER > /dev/null
97
98 if [ ! -d "$PROJ" ]; then
99     git clone --recursive "$REPO" "${PROJ%/*}"
100 fi
101
102 pushd $PROJ > /dev/null
103 select_and_get_project_version "$TAG" "COMMIT_HASH"
104
105 # build and install if wanted
106 # unset var
107 if [ -n "$BASH" ]; then
108     unset VERILATOR_ROOT

```

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```

108 else
109     unsetenv VERILATOR_ROOT
110 fi
111
112 autoconf
113
114 if [ "$INSTALL_PREFIX" == "default" ]; then
115     ./configure
116 else
117     ./configure --prefix="$INSTALL_PREFIX"
118 fi
119
120 make -j$(nproc)
121
122 if [ $INSTALL = true ]; then
123     make install
124 fi
125
126 # return to first folder and store version
127 pushd -0 > /dev/null
128 echo "${PROJ##*/}: $COMMIT_HASH" >> "$VERSIONFILE"
129
130 # cleanup if wanted
131 if [ $CLEANUP = true ]; then
132     rm -rf $BUILDFOLDER
133 fi

```

## 6.12 rust\_riscv

### 6.12.1 install\_rust\_riscv.sh

```

1  #!/bin/bash
2
3  # Author: Harald Heckmann <mail@haraldheckmann.de>
4  # Date: Oct. 24 2020
5  # Project: QuantumRisc (RheinMain University) <Steffen.Reith@hs-rm.de>
6
7  # require sudo
8  if [[ $UID != 0 ]]; then
9      echo "Please run this script with sudo:"
10     echo "sudo $0 $*"
11     exit 1
12 fi
13
14 # exit when any command fails
15 set -e
16
17 BUILDFOLDER="install_rust_riscv"
18 VERSIONFILE="installed_version.txt"
19 LIBRARY="../libraries/library.sh"
20 # required tools
21 TOOLS="curl"
22 # available rust targets

```

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```

23 DEFAULT_TARGETS="riscv32i-unknown-none-elf riscv32imac-unknown-none-elf \
24 riscv32imc-unknown-none-elf riscv64gc-unknown-linux-gnu \
25 riscv64gc-unknown-none-elf riscv64imac-unknown-none-elf"
26
27 source $LIBRARY
28
29 # install and upgrade tools
30 apt-get update
31 apt-get install -y $TOOLS
32 apt-get install --only-upgrade -y $TOOLS
33
34 # install rust
35 mkdir -p $BUILDFOLDER
36 pushd $BUILDFOLDER > /dev/null
37 curl --proto '=https' --tlsv1.2 -sSf https://sh.rustup.rs > 'rustup_installer.sh'
38 chmod +x './rustup_installer.sh'
39
40 # Install rust in the context of every logged in user
41 for RUST_USER in `who | cut -d' ' -f1`; do
42     # check if rustup is installed
43     RUSTUP_SCRIPT="$(pwd -P)/rustup_installer.sh"
44
45     if ! runuser -l $RUST_USER -c "command -v rustup" &> /dev/null; then
46         runuser -l $RUST_USER -c "$RUSTUP_SCRIPT -y"
47         RUSTUP="\$HOME/.cargo/bin/rustup"
48     else
49         RUSTUP=`runuser -l $RUST_USER -c "command -v rustup"`
50     fi
51
52     # update rust
53     runuser -l $RUST_USER -c "$RUSTUP install stable"
54     runuser -l $RUST_USER -c "$RUSTUP install nightly"
55     runuser -l $RUST_USER -c "$RUSTUP update"
56     runuser -l $RUST_USER -c "$RUSTUP update nightly"
57
58     # add riscv target
59     # scan for available targets first, if it fails use DEFAULT_TARGETS
60     PRRT=`runuser -l $RUST_USER -c "$RUSTUP target list | grep riscv"`
61     DEFAULT_TC=`runuser -l $RUST_USER -c "rustup default"`
62     DEFAULT_TC="${DEFAULT_TC// (default)}"
63
64     if [ -n "$PRRT" ]; then
65         DEFAULT_TARGETS=`echo $PRRT`
66     fi
67
68     runuser -l $RUST_USER -c "$RUSTUP target add --toolchain ${DEFAULT_TC} ${DEFAULT_
69 ↪TARGETS// (installed)}"
70     runuser -l $RUST_USER -c "$RUSTUP target add --toolchain nightly ${DEFAULT_
71 ↪TARGETS// (installed)}"
72
73     # add some useful dev components
74     runuser -l $RUST_USER -c "$RUSTUP component add --toolchain ${DEFAULT_TC} rls_
75 ↪rustfmt rust-analysis clippy"
76     runuser -l $RUST_USER -c "$RUSTUP component add --toolchain nightly rls rustfmt_
77 ↪rust-analysis clippy"
78 done

```

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```

76 # cleanup
77 popd > /dev/null
78 rm -r $BUILDFOLDER
79
80 VER_DEFAULT=`runuser -l $RUST_USER -c "$RUSTUP run ${DEFAULT_TC} rustc --version"`
81 VER_DEFAULT="${VER_DEFAULT//(*)}"
82 VER_DEFAULT="${VER_DEFAULT#rustc }"
83
84 VER_NIGHTLY=`runuser -l $RUST_USER -c "$RUSTUP run nightly rustc --version"`
85 VER_NIGHTLY="${VER_NIGHTLY//(*)}"
86 VER_NIGHTLY="${VER_NIGHTLY#rustc }"
87 echo -e "rustc (${DEFAULT_TC}, with riscv targets): ${VER_DEFAULT}\nrustc (nightly,
  ↳with riscv targets): ${VER_NIGHTLY}" >> "$VERSIONFILE"

```

## 6.13 libraries

### 6.13.1 library.sh

```

1  #!/bin/bash
2
3  # Author: Harald Heckmann <mail@haraldheckmann.de>
4  # Date: Oct. 22 2020
5  # Project: QuantumRisc (RheinMain University) <Steffen.Reith@hs-rm.de>
6
7  # This file contains functions that are shared by the build and install scripts.
8
9  # constants
10 RED='\033[1;31m'
11 NC='\033[0m'
12
13 # This function does checkout the correct version and return the commit hash or tag_
  ↳name
14 # Parameter 1: Branch name, commit hash, tag or one of the special keywords default/
  ↳latest/stable
15 # Parameter 2: Return variable name (commit hash or tag name)
16 # Parameter 3: (OPTIONAL) glob string filter for stable tag list
17 function select_and_get_project_version {
18     # Stable selected: Choose latest tag if available, otherwise use default branch
19     if [ "$1" == "stable" ]; then
20         if [ -n "$3" ]; then
21             local L_TAGLIST=`git rev-list --tags="$3" --max-count=1`
22         else
23             local L_TAGLIST=`git rev-list --tags --max-count=1`
24         fi
25
26         # tags found?
27         if [ -n "$L_TAGLIST" ]; then
28             local L_COMMIT_HASH=`git describe --tags $L_TAGLIST`
29             git checkout --recurse-submodules "$L_COMMIT_HASH"
30             return 0
31         else
32             git checkout --recurse-submodules $(git symbolic-ref refs/remotes/origin/
  ↳HEAD | sed 's/^refs/remotes/origin/@@')

```

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```

33     local L_COMMIT_HASH="$(git rev-parse HEAD)"
34     >&2 echo -e "${RED}WARNING: No git tags found, using default branch${NC}"
35     fi
36     else
37         # Either checkout default/stable branch or use custom commit hash, tag or
↪branch name
38         if [ "$1" == 'default' ] || [ "$1" == 'latest' ]; then
39             git checkout --recurse-submodules $(git symbolic-ref refs/remotes/origin/
↪HEAD | sed 's@^refs/remotes/origin/@@')
40         else
41             # Check if $1 contains a valid tag and use it as the version if it does
42             git checkout --recurse-submodules "$1"
43         fi
44
45         local L_COMMIT_HASH="$(git rev-parse HEAD)"
46         fi
47
48         # Set return value to tag name if available
49         local L_POSSIBLE_TAGS=`git tag --points-at $L_COMMIT_HASH`
50
51         if [ -n "$L_POSSIBLE_TAGS" ] && [ "$L_POSSIBLE_TAGS" != "nightly" ]; then
52             L_COMMIT_HASH="${L_POSSIBLE_TAGS%%[${'\n'}]*}"
53         fi
54
55         # Apply return value
56         eval "$2=\"${L_COMMIT_HASH}\""
57     }
58
59     # Prints only if verbose is set
60     function echo_verbose {
61         if [ $VERBOSE = true ]; then
62             echo "$1"
63         fi
64     }
65
66     # Prints only errors from executed commands if verbose is set
67     # Parameter $1: Command to execute
68     # Parameter $2: Path to error file
69     function exec_verbose {
70         if [ $VERBOSE = false ]; then
71             $1 > /dev/null 2>> "$2"
72         else
73             $1 2>> "$2"
74         fi
75     }
76
77     # Read latest executed tool/project/etc.
78     # Parameter $1: tool/project/etc. list
79     # Parameter $2: success file
80     # Parameter $3: string containing list element type (tool/project/etc.)
81     # Parameter $4: Return variable name
82     function get_latest {
83         if [ ! -f "$2" ]; then
84             return 0
85         fi
86
87         local LATEST_SCRIPT=`cat $2`

```

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```

88     local SCRIPTS_ADAPTED=`echo "$1" | sed "s/.*${LATEST_SCRIPT} //"`
89
90     if [ "$SCRIPTS_ADAPTED" == "$1" ]; then
91         local AT_END=true
92         echo -e "\nThe script detected a checkpoint after the last ${3}. This means,
↳ that all ${3}s already have been checked and installed if configured that way. Do
↳ you want to check every ${3} and install them again if configured that way (y/n)?"
93     else
94         local AT_END=false
95         echo -e "\nThe script detected a checkpoint. Do you want to install every ${3}
↳ from the checkpoint onwards (y) if configured that way or do you want to start
↳ over from the beginning (n)?"
96         echo "${3}s yet to be check for installation after the checkpoint: $SCRIPTS_
↳ ADAPTED"
97     fi
98
99     local DECISION="z"
100
101     while [ $DECISION != "n" ] && [ $DECISION != "y" ]; do
102         read -p "Decision(y/n): " DECISION
103
104         if [ -z $DECISION ]; then
105             DECISION="z"
106         fi
107     done
108
109     echo -e "\n"
110
111     if [ $DECISION == "n" ]; then
112         if [ $AT_END = true ]; then
113             eval "$4=\"\""
114         fi
115     else
116         eval "$4=\"${SCRIPTS_ADAPTED}\""
117     fi
118 }
119
120 # Process riscv_gnu_toolchain script parameters
121 # Parameter $1: Script name
122 # Parameter $2: Variable to store the parameters in
123 function parameters_tool_riscv {
124     # set -n flag
125     if [ "${1:6}" == "NEWLIB" ]; then
126         eval "$2=\"${2} -n\""
127     fi
128
129     # Set "e" parameter
130     if [ "$(eval "echo ${1}_EXTEND_PATH")" = true ]; then
131         eval "$2=\"${2} -e\""
132     fi
133
134     # set "u" parameter
135     local L_BUILD_USER="$(eval "echo ${1}_USER")"
136
137     if [ -n "$L_BUILD_USER" ] && [ "$L_BUILD_USER" != "default" ]; then
138         eval "$2=\"${2} -u \"\$L_BUILD_USER\""
139     fi

```

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```

140
141     # set "p" parameter
142     local L_BUILD_INSTALL_PATH="$(eval "echo $\`echo $1\`_INSTALL_PATH")"
143
144     if [ -n "$L_BUILD_INSTALL_PATH" ] && [ "$L_BUILD_INSTALL_PATH" != "default" ];
→then
145         eval "$2=\"${!2} -p \"$L_BUILD_INSTALL_PATH\"\""
146     fi
147 }
148
149 # Process nextpnr script parameters
150 # Parameter $1: Script name
151 # Parameter $2: Variable to store the parameters in
152 function parameters_tool_nextpnr {
153     # set -e flag
154     if [ "${1:8}" == "ECP5" ]; then
155         eval "$2=\"${!2} -e\""
156     fi
157
158     local L_BUILD_CHIPDB="$(eval "echo $\`echo $1\`_CHIPDB_PATH")"
159
160     if [ -n "$L_BUILD_CHIPDB" ] && [ "$L_BUILD_CHIPDB" != "default" ]; then
161         eval "$2=\"${!2} -l \"$L_BUILD_CHIPDB\"\""
162     fi
163 }
164
165 # Process ghdl script parameters
166 # Parameter $1: Script name
167 # Parameter $2: Variable to store the parameters in
168 function parameters_tool_ghdl {
169     # Set "g" flag
170     if [ "$(eval "echo $\`echo $1\`_GCC")" = true ]; then
171         eval "$2=\"${!2} -g\""
172     fi
173
174     # Set "l" flag
175     if [ "$(eval "echo $\`echo $1\`_LLVM")" = true ]; then
176         eval "$2=\"${!2} -l\""
177     fi
178
179     # Set "m" flag
180     if [ "$(eval "echo $\`echo $1\`_MCODE")" = true ]; then
181         eval "$2=\"${!2} -m\""
182     fi
183 }
184
185 # Process common script parameters
186 # Parameter $1: Script name
187 # Parameter $2: Variable to store the parameters in
188 function parameters_tool {
189     # Set "i" parameter
190     if [ "$(eval "echo $\`echo $1\`_INSTALL")" = true ]; then
191         eval "$2=\"${!2} -i $(eval "echo $\`echo $1\`_INSTALL_PATH")\""
192     fi
193
194     # Set "c" parameter
195     if [ "$(eval "echo $\`echo $1\`_CLEANUP")" = true ]; then

```

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```

196     eval "$2=\"${!2} -c\""
197 fi
198
199 # Set "d" parameter
200 local L_BUILD_DIR="$(eval "echo `${echo $1`_DIR}")"
201
202 if [ -n "$L_BUILD_DIR" ] && [ "$L_BUILD_DIR" != "default" ]; then
203     eval "$2=\"${!2} -d \"$L_BUILD_DIR\""
204 fi
205
206 # Set "t" parameter
207 local L_BUILD_TAG="$(eval "echo `${echo $1`_TAG}")"
208
209 if [ -n "$L_BUILD_TAG" ] && [ "$L_BUILD_TAG" != "default" ]; then
210     eval "$2=\"${!2} -t \"$L_BUILD_TAG\""
211 fi
212
213 # Set "b" for Yosys only
214 if [ $1 == "YOSYS" ]; then
215     local L_BUILD_COMPILER="$(eval "echo `${echo $1`_COMPILER}")"
216
217     if [ -n "$L_BUILD_COMPILER" ]; then
218         eval "$2=\"${!2} -b \"$L_BUILD_COMPILER\""
219     fi
220 fi
221
222 # Append special parameters
223 if [ "${1:0:5}" == "RISCV" ]; then
224     parameters_tool_riscv "$1" "$2"
225 elif [ "${1:0:7}" == "NEXTPNR" ]; then
226     parameters_tool_nextpnr "$1" "$2"
227 elif [ "$1" == "GHDL" ]; then
228     parameters_tool_ghdl "$1" "$2"
229 fi
230 }
231
232 # Copies the project to documents and creates a symbolic link if desired
233 # Parameter $1: Project name
234 # Parameter $2: User name
235 # Parameter $3: Create symbolic link (bool)
236 # Parameter $4: Project directory (where to copy it)
237 function install_project_for_user {
238     local L_USER_HOME=$(getent passwd "$2" | cut -d: -f6)
239
240     # User not found (link to desktop impossible)
241     if [ $3 = true ] || [ "$4" == "default" ]; then
242         if [ -z "$L_USER_HOME" ]; then
243             echo -e "${RED}ERROR: User ${L_USER} does not exist (home directory not_
↳ found).${NC}"
244             exit 1;
245         fi
246     fi
247
248     # Lookup Documents and Desktop and create if not existant
249     if [ "$4" == "default" ]; then
250         local L_DESTINATION="${L_USER_HOME}/Documents"
251     else

```

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```

252     # Strip last possible "/" path
253     if [ "${4: -1}" == "/" ]; then
254         local L_DESTINATION="${4: -1}"
255     else
256         local L_DESTINATION="$4"
257     fi
258 fi
259
260 local L_PROJECT="$1"
261 local L_USER="$2"
262
263 # TODO: Improve for multiple languages (Documents / Desktop only in en)
264 if [ ! -d "${L_DESTINATION}" ]; then
265     mkdir "${L_DESTINATION}"
266     chown -R "${L_USER}:${L_USER}" "${L_DESTINATION}"
267 fi
268
269 # Copy project
270 cp -r "${L_PROJECT}" "${L_DESTINATION}"
271 chown -R "${L_USER}:${L_USER}" "${L_DESTINATION}/${L_PROJECT}"
272
273 # Create symbolic link to desktop if desired
274 if [ $3 = true ]; then
275     local L_USER_DESKTOP="${L_USER_HOME}/Desktop"
276
277     if [ ! -d "${L_USER_DESKTOP}" ]; then
278         mkdir "${L_USER_DESKTOP}"
279         chown -R "${L_USER}:${L_USER}" "${L_USER_DESKTOP}"
280     fi
281
282     ln -s "${L_DESTINATION}/${L_PROJECT}" "${L_USER_DESKTOP}/${L_PROJECT}"
283 fi
284 }
285
286 # Install project ("configure projects" section in config.cfg)
287 # Parameter $1: Project name
288 function install_project {
289     if [ "${!1}" = false ]; then
290         return 0
291     fi
292
293     local L_NAME_LOWER=`echo "$1" | tr [A-Z] [a-z]`
294
295     # Clone
296     if [ ! -d "${L_NAME_LOWER}" ]; then
297         exec_verbose "git clone --recurse-submodules ""$(eval "echo $`echo $1`_URL")"
↪ " "${L_NAME_LOWER}" "" "$ERROR_FILE"
298     fi
299
300     # Checkout specified version
301     local L_TAG="$(eval "echo $`echo $1`_TAG")"
302
303     if [ "${L_TAG}" != "default" ]; then
304         pushd "${L_NAME_LOWER}" > /dev/null
305         exec_verbose "select_and_get_project_version ""${L_TAG}" "" "L_COMMIT_HASH"" ""
↪ "$ERROR_FILE"
306         popd > /dev/null

```

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```

307     fi
308
309     local L_LINK="$(eval "echo \$`echo $1`_LINK_TO_DESKTOP")"
310     # Get users to install the projects for
311     local L_USERLIST="$(eval "echo \$`echo $1`_USER")"
312     # Get project install location
313     local L_INST_LOC="$(eval "echo \$`echo $1`_LOCATION")"
314
315     if [ "$L_USERLIST" == "default" ]; then
316         for L_USER in `who | cut -d' ' -f1`; do
317             install_project_for_user "$L_NAME_LOWER" "$L_USER" $L_LINK "$L_INST_LOC"
318         done
319     else
320         for L_USER in "$L_USERLIST"; do
321             install_project_for_user "$L_NAME_LOWER" "$L_USER" $L_LINK "$L_INST_LOC"
322         done
323     fi
324
325     rm -rf "$L_NAME_LOWER"
326 }
327
328 # Moves script folder into build folder and returns script path
329 # Parameter $1: Script name
330 # Parameter $2: Variable to store the script path for requirements script in
331 # Parameter $3: Variable to store the script path for installation script in
332 function find_script {
333     if [ "${SCRIPT::5}" == "RISCV" ]; then
334         cp -r ../riscv_tools .
335         eval "$2=\"$(pwd -P)/riscv_tools/install_riscv_essentials.sh\""
336         eval "$3=\"$(pwd -P)/riscv_tools/install_riscv.sh\""
337         cp "$(pwd -P)/riscv_tools/versions.cfg" .
338     elif [ "${SCRIPT::7}" == "NEXTPNR" ]; then
339         cp -r ../nextpnr .
340         eval "$2=\"$(pwd -P)/nextpnr/install_nextpnr_essentials.sh\""
341         eval "$3=\"$(pwd -P)/nextpnr/install_nextpnr.sh\""
342     else
343         local L_NAME_LOWER=`echo "$1" | tr [A-Z] [a-z]`
344         cp -r ../${L_NAME_LOWER} .
345         eval "$2=\"$(pwd -P)/${L_NAME_LOWER}/install_${L_NAME_LOWER}_essentials.sh\""
346         eval "$3=\"$(pwd -P)/${L_NAME_LOWER}/install_${L_NAME_LOWER}.sh\""
347         local L_CFG_FILES=`find "$(pwd -P)/${L_NAME_LOWER}" -iname "*.cfg"`
348
349         for CFG_FILE in $L_CFG_FILES; do
350             cp "$CFG_FILE" .
351         done
352     fi
353 }
354
355 # Copies version file $1 to the desktop of the users specified in $2
356 # Parameter $1: Version file path
357 # Parameter $2: User list
358 function copy_version_file {
359     if [ ! -f "$1" ]; then
360         return
361     fi
362
363     for L_USER in "$2"; do

```

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```

364     local L_VERSION_USER_DESKTOP="$(getent passwd "$L_USER" | cut -d: -f6)/Desktop
↪"
365
366     # TODO: add multiple language support
367     if [ ! -d "$L_VERSION_USER_DESKTOP" ]; then
368         mkdir "$L_VERSION_USER_DESKTOP"
369     fi
370
371     cp "$1" "$L_VERSION_USER_DESKTOP"
372 done
373 }

```

## 6.14 spinalhdl

### 6.14.1 install\_spinalhdl\_essentials.sh

```

1  #!/bin/bash
2
3  # Author: Harald Heckmann <mail@haraldheckmann.de>
4  # Date: Jun. 23 2020
5  # Project: QuantumRisc (RheinMain University) <Steffen.Reith@hs-rm.de>
6
7  # require sudo
8  if [[ $UID != 0 ]]; then
9      echo "Please run this script with sudo:"
10     echo "sudo $0 $*"
11     exit 1
12 fi
13
14 # exit when any command fails
15 set -e
16
17 # required tools
18 TOOLS="openjdk-8-jdk scala sbt"
19
20 # install and upgrade tools
21 echo "deb https://dl.bintray.com/sbt/debian /" | sudo tee -a /etc/apt/sources.list.d/
↪sbt.list
22 apt-key adv --keyserver hkp://keyserver.ubuntu.com:80 --recv 642AC823
23 apt-get update
24 apt-get install -y $TOOLS
25 apt-get install --only-upgrade -y $TOOLS

```



## 6.15 yosys

### 6.15.1 install\_yosys.sh

```

1  #!/bin/bash
2
3  # Author: Harald Heckmann <mail@haraldheckmann.de>
4  # Date: Jun. 24 2020
5  # Project: QuantumRisc (RheinMain University) <Steffen.Reith@hs-rm.de>
6
7  # constants
8  RED='\033[1;31m'
9  NC='\033[0m'
10 LIBRARY="../../libraries/library.sh"
11 REPO="https://github.com/YosysHQ/yosys.git"
12 PROJ="yosys"
13 BUILDFOLDER="build_and_install_yosys"
14 VERSIONFILE="installed_version.txt"
15 COMPILER="clang"
16 TAG="latest"
17 INSTALL=false
18 INSTALL_PREFIX="default"
19 CLEANUP=false
20
21
22 # parse arguments
23 USAGE="$0 (basename "$0") [-h] [-c] [-d dir] [-b buildtool] [-i path] [-t tag] -- Clone
↳latested tagged ${PROJ} version and build it. Optionally select compiler
↳(buildtool), build directory and version, install binaries and cleanup setup files.
24
25 where:
26     -h          show this help text
27     -c          cleanup project
28     -d dir      build files in \"dir\" (default: ${BUILDFOLDER})
29     -i path     install binaries to path (use \"default\" to use default path)
30     -b compiler specify compiler (default: ${COMPILER}, alternative: gcc)
31     -t tag      specify version (git tag or commit hash) to pull (default: default
↳branch) "
32
33
34 while getopts ':hi:cd:b:t:' OPTION; do
35     case $OPTION in
36         i)  INSTALL=true
37             INSTALL_PREFIX="$OPTARG"
38             echo "-i set: Installing built binaries to $INSTALL_PREFIX"
39             ;;
40         esac
41     done
42
43     OPTIND=1
44
45 while getopts ':hi:cd:b:t:' OPTION; do
46     case "$OPTION" in
47         h)  echo "$USAGE"
48             exit
49             ;;

```

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```

50     c)  if [ $INSTALL = false ]; then
51         >&2 echo -e "${RED}ERROR: -c only makes sense if the built binaries_
↳ were installed before (-i) "
52         exit 1
53     fi
54     CLEANUP=true
55     echo "-c set: Removing build directory"
56     ;;
57     d)  echo "-d set: Using folder $OPTARG"
58         BUILDFOLDER="$OPTARG"
59     ;;
60     b)  echo "-b set: Using compiler $OPTARG"
61         COMPILER="$OPTARG"
62     ;;
63     t)  echo "-t set: Using version $OPTARG"
64         TAG="$OPTARG"
65     ;;
66     :)  echo -e "${RED}ERROR: missing argument for -${OPTARG}\n${NC}" >&2
67         echo "$USAGE" >&2
68         exit 1
69     ;;
70     \?) echo -e "${RED}ERROR: illegal option: -${OPTARG}\n${NC}" >&2
71         echo "$USAGE" >&2
72         exit 1
73     ;;
74 done
75
76 shift "$((OPTIND - 1))"
77
78 # exit when any command fails
79 set -e
80
81 # require sudo
82 if [[ $UID != 0 ]]; then
83     echo -e "${RED}Please run this script with sudo:"
84     echo "sudo $0 $*"
85     exit 1
86 fi
87
88 # cleanup files if the programm was shutdown unexpectedly
89 trap 'echo -e "${RED}ERROR: Script was terminated unexpectedly, cleaning up files..."_
↳ && pushd -0 > /dev/null && rm -rf $BUILDFOLDER' INT TERM
90
91 # load shared functions
92 source $LIBRARY
93
94 # fetch specified version
95 if [ ! -d $BUILDFOLDER ]; then
96     mkdir $BUILDFOLDER
97 fi
98
99 pushd $BUILDFOLDER > /dev/null
100
101 if [ ! -d "$PROJ" ]; then
102     git clone --recursive "$REPO" "${PROJ%/*}"
103 fi
104

```

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```

105
106 pushd $PROJ > /dev/null
107 select_and_get_project_version "$TAG" "COMMIT_HASH"
108
109 # build and install if wanted
110 make config-$COMPILER
111 make -j$(nproc)
112
113 if [ $INSTALL = true ]; then
114     if [ "$INSTALL_PREFIX" == "default" ]; then
115         make install
116     else
117         make install PREFIX="$INSTALL_PREFIX"
118     fi
119 fi
120
121 # return to first folder and store version
122 pushd -0 > /dev/null
123 echo "${PROJ##*/}: $COMMIT_HASH" >> "$VERSIONFILE"
124
125 # cleanup if wanted
126 if [ $CLEANUP = true ]; then
127     rm -rf $BUILDFOLDER
128 fi

```

### 6.15.2 install\_yosys\_essentials.sh

```

1  #!/bin/bash
2
3  # Author: Harald Heckmann <mail@haraldheckmann.de>
4  # Date: Jun. 23 2020
5  # Project: QuantumRisc (RheinMain University) <Steffen.Reith@hs-rm.de>
6
7  # require sudo
8  if [[ $UID != 0 ]]; then
9      echo "Please run this script with sudo:"
10     echo "sudo $0 $*"
11     exit 1
12 fi
13
14 # exit when any command fails
15 set -e
16
17 # required tools
18 TOOLS="build-essential clang bison flex libreadline-dev gawk tcl-dev \
19     libffi-dev git graphviz xdot pkg-config python3 libboost-system-dev \
20     libboost-python-dev libboost-filesystem-dev zlib1g-dev"
21
22 # install and upgrade tools
23 apt-get update
24 apt-get install -y $TOOLS
25 apt-get install --only-upgrade -y $TOOLS

```

## 6.16 icarusverilog

### 6.16.1 install\_icarusverilog.sh

```

1  #!/bin/bash
2
3  # Author: Harald Heckmann <mail@haraldheckmann.de>
4  # Date: Oct. 24 2020
5  # Project: QuantumRisc (RheinMain University) <Steffen.Reith@hs-rm.de>
6
7  # constants
8  RED='\033[1;31m'
9  NC='\033[0m'
10 LIBRARY="../../libraries/library.sh"
11 REPO="https://github.com/steveicarus/iverilog.git"
12 PROJ="iverilog"
13 BUILDFOLDER="build_and_install_iverilog"
14 VERSIONFILE="installed_version.txt"
15 TAG="latest"
16 INSTALL=false
17 INSTALL_PREFIX="default"
18 CLEANUP=false
19
20
21 # parse arguments
22 USAGE="$(basename "$0") [-h] [-c] [-d dir] [-i path] [-t tag] -- Clone latested_
    ↳tagged ${PROJ} version and build it. Optionally select the build directory and_
    ↳version, install binaries and cleanup setup files.
23
24 where:
25     -h          show this help text
26     -c          cleanup project
27     -d dir      build files in \"dir\" (default: ${BUILDFOLDER})
28     -i path     install binaries to path (use \"default\" to use default path)
29     -t tag      specify version (git tag or commit hash) to pull (default: Latest tag)
    ↳"
30
31
32 while getopts ':hi:cd:t:' OPTION; do
33     case $OPTION in
34         i)  INSTALL=true
35             INSTALL_PREFIX="$OPTARG"
36             echo "-i set: Installing built binaries to $INSTALL_PREFIX"
37             ;;
38         esac
39 done
40
41 OPTIND=1
42
43 while getopts ':hi:cd:t:' OPTION; do
44     case "$OPTION" in
45         h)  echo "$USAGE"
46             exit
47             ;;
48         c)  if [ $INSTALL = false ]; then
49             >&2 echo -e "${RED}ERROR: -c only makes sense if the built binaries_
    ↳were installed before (-i)"

```

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```

50         exit 1
51     fi
52     CLEANUP=true
53     echo "-c set: Removing build directory"
54     ;;
55     d) echo "-d set: Using folder $OPTARG"
56        BUILDFOLDER="$OPTARG"
57        ;;
58     t) echo "-t set: Using version $OPTARG"
59        TAG="$OPTARG"
60        ;;
61     :) echo -e "${RED}ERROR: missing argument for -${OPTARG}\n${NC}" >&2
62        echo "$USAGE" >&2
63        exit 1
64        ;;
65     \?) echo -e "${RED}ERROR: illegal option: -${OPTARG}\n${NC}" >&2
66         echo "$USAGE" >&2
67         exit 1
68         ;;
69     esac
70 done
71
72 shift "$((OPTIND - 1))"
73
74 # exit when any command fails
75 set -e
76
77 # require sudo
78 if [[ $UID != 0 ]]; then
79     echo -e "${RED}Please run this script with sudo:"
80     echo "sudo $0 $*"
81     exit 1
82 fi
83
84 # cleanup files if the programm was shutdown unexpectedly
85 trap 'echo -e "${RED}ERROR: Script was terminated unexpectedly, cleaning up files..."
86 ↪&& pushd -0 > /dev/null && rm -rf $BUILDFOLDER' INT TERM
87
88 # load shared functions
89 source $LIBRARY
90
91 # fetch specified version
92 if [ ! -d $BUILDFOLDER ]; then
93     mkdir $BUILDFOLDER
94 fi
95
96 pushd $BUILDFOLDER > /dev/null
97
98 if [ ! -d "$PROJ" ]; then
99     git clone --recursive "$REPO" "${PROJ%/*}"
100 fi
101
102 pushd $PROJ > /dev/null
103 select_and_get_project_version "$TAG" "COMMIT_HASH"
104
105 # build and install if wanted
106 autoconf

```

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```

106
107 if [ "$INSTALL_PREFIX" == "default" ]; then
108     ./configure
109 else
110     ./configure --prefix="$INSTALL_PREFIX"
111 fi
112
113 make -j$(nproc)
114
115 if [ $INSTALL = true ]; then
116     make install
117 fi
118
119 # return to first folder and store version
120 pushd -0 > /dev/null
121 echo "${PROJ##*/}: $COMMIT_HASH" >> "$VERSIONFILE"
122
123 # cleanup if wanted
124 if [ $CLEANUP = true ]; then
125     rm -rf $BUILDFOLDER
126 fi

```

## 6.16.2 install\_icarusverilog\_essentials.sh

```

1  #!/bin/bash
2
3  # Author: Harald Heckmann <mail@haraldheckmann.de>
4  # Date: Oct. 24 2020
5  # Project: QuantumRisc (RheinMain University) <Steffen.Reith@hs-rm.de>
6
7  # require sudo
8  if [[ $UID != 0 ]]; then
9      echo "Please run this script with sudo:"
10     echo "sudo $0 $*"
11     exit 1
12 fi
13
14 # exit when any command fails
15 set -e
16
17 # required tools
18 TOOLS="make g++ autoconf flex bison gperf autoconf libbz2-1.0 libc6 libgcc-s1 \
19     libreadline8 libstdc++6 zlib1g"
20
21 # install and upgrade tools
22 apt-get update
23 apt-get install -y $TOOLS
24 apt-get install --only-upgrade -y $TOOLS

```

## 6.17 ghdl

### 6.17.1 install\_ghdl.sh

```

1  #!/bin/bash
2
3  # Author: Harald Heckmann <mail@haraldheckmann.de>
4  # Date: Oct. 23 2020
5  # Project: QuantumRisc (RheinMain University) <Steffen.Reith@hs-rm.de>
6
7  # constants
8  RED='\033[1;31m'
9  NC='\033[0m'
10 LIBRARY="../../libraries/library.sh"
11 REPO="https://github.com/ghdl/ghdl.git"
12 REPO_LIBBACKTRACE="https://github.com/ianlancetaylor/libbacktrace.git"
13 REPO_GCC="https://gcc.gnu.org/git/gcc.git"
14 PROJ="ghdl"
15 BUILDFOLDER="build_and_install_ghdl"
16 VERSIONFILE="installed_version.txt"
17 TAG="latest"
18 INSTALL=false
19 INSTALL_PREFIX="default"
20 CLEANUP=false
21 BUILD_MCODE=false
22 BUILD_LLVM=false
23 BUILD_GCC=false
24 DEFAULT_PREFIX='/usr/local'
25 GHDL_GCC_SUFFIX='-ghdl'
26 BUILD_GCC_DEFAULT_CONFIG="--enable-languages=c,vhdl --disable-bootstrap \
27 --disable-lto --disable-multilib --disable-libssp --program-suffix=${GHDL_GCC_SUFFIX}"
28
29 # parse arguments
30 USAGE="$ (basename "$0") [-h] [-c] [-m] [-l] [-g] [-d dir] [-i path] [-t tag] -- Clone
↳ latested tagged ${PROJ} version and build it. Optionally select the build directory
↳ and version, install binaries and cleanup setup files.
31
32 where:
33     -h          show this help text
34     -c          cleanup project
35     -g          build GCC backend
36     -l          build LLVM backend
37     -m          build mcode backend
38     -d dir      build files in \"dir\" (default: ${BUILDFOLDER})
39     -i path     install binaries to path (use \"default\" to use default path)
40     -t tag      specify version (git tag or commit hash) to pull (default: Latest tag)
↳ "
41
42
43 while getopts ':hi:cd:glmt:' OPTION; do
44     case $OPTION in
45         i)  INSTALL=true
46             INSTALL_PREFIX="$OPTARG"
47             echo "-i set: Installing built binaries to $INSTALL_PREFIX"
48             ;;
49     esac

```

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```

50 done
51
52 OPTIND=1
53
54 while getopts ':hi:cd:glmt:' OPTION; do
55     case "$OPTION" in
56         h) echo "$USAGE"
57            exit
58            ;;
59         c) if [ $INSTALL = false ]; then
60             >&2 echo -e "${RED}ERROR: -c only makes sense if the built binaries_
↳ were installed before (-i)"
61             exit 1
62         fi
63         CLEANUP=true
64         echo "-c set: Removing build directory"
65         ;;
66         g) echo "-g set: Building GCC backend for GHDL"
67            BUILD_GCC=true
68            ;;
69         l) echo "-l set: Building LLVM backend for GHDL"
70            BUILD_LLVM=true
71            ;;
72         m) echo "-m set: Building MCODE backend for GHDL"
73            BUILD_MCODE=true
74            ;;
75         d) echo "-d set: Using folder $OPTARG"
76            BUILD_FOLDER="$OPTARG"
77            ;;
78         t) echo "-t set: Using version $OPTARG"
79            TAG="$OPTARG"
80            ;;
81         :) echo -e "${RED}ERROR: missing argument for -${OPTARG}\n${NC}" >&2
82            echo "$USAGE" >&2
83            exit 1
84            ;;
85         \?) echo -e "${RED}ERROR: illegal option: -${OPTARG}\n${NC}" >&2
86            echo "$USAGE" >&2
87            exit 1
88            ;;
89     esac
90 done
91
92 shift "$((OPTIND - 1))"
93
94 function build_mcode {
95     mkdir -p 'build_mcode'
96     pushd 'build_mcode' > /dev/null
97     local L_FAKE_PREFIX="$(pwd -P)/adjust_filename"
98     ../configure --prefix="$L_FAKE_PREFIX"
99     make -j$(nproc)
100
101     if [ $INSTALL = true ]; then
102         make install
103         # Add suffix (why does configure not offer it anyways?)
104         pushd $L_FAKE_PREFIX > /dev/null
105

```

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```

106     for L_FILE in `find . -iname ghdl -type f`; do
107         mv $L_FILE ${L_FILE}-mcode
108     done
109
110     if [ "$INSTALL_PREFIX" != "default" ]; then
111         mkdir -p $INSTALL_PREFIX
112         cp -r ./* $INSTALL_PREFIX
113     else
114         mkdir -p $DEFAULT_PREFIX
115         cp -r ./* $DEFAULT_PREFIX
116     fi
117
118     popd > /dev/null
119     rm -r $L_FAKE_PREFIX
120 fi
121
122 popd > /dev/null
123 }
124
125 function build_llvm {
126     mkdir -p 'build_llvm'
127     pushd 'build_llvm' > /dev/null
128     local L_FAKE_PREFIX="$(pwd -P)/adjust_filename"
129
130     # compile latest libbacktrace.a to compile ghdl-llvm with stack backtrace support
131     if [ ! -d './libbacktrace' ]; then
132         git clone --recursive "$REPO_LIBBACKTRACE" 'libbacktrace'
133     fi
134
135     pushd 'libbacktrace' > /dev/null
136     ./configure
137     make -j$(nproc)
138     local L_LIBBACKTRACE_PATH="$(pwd -P)/.libs/libbacktrace.a"
139     popd > /dev/null
140     ../configure --with-llvm-config --with-backtrace-lib="$L_LIBBACKTRACE_PATH" --
141     ↪ prefix="$L_FAKE_PREFIX"
142     make -j$(nproc)
143
144     if [ $INSTALL = true ]; then
145         make install
146
147         # Add suffix (why does configure not offer it anyways?)
148         pushd $L_FAKE_PREFIX > /dev/null
149
150         for L_FILE in `find . -iname ghdl -type f`; do
151             mv $L_FILE ${L_FILE}-llvm
152         done
153
154         if [ "$INSTALL_PREFIX" != "default" ]; then
155             mkdir -p $INSTALL_PREFIX
156             cp -r ./* $INSTALL_PREFIX
157         else
158             mkdir -p $DEFAULT_PREFIX
159             cp -r ./* $DEFAULT_PREFIX
160         fi
161
162         popd > /dev/null

```

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```

162     rm -r $L_FAKE_PREFIX
163 fi
164
165 popd > /dev/null
166 }
167
168 function build_gcc {
169     # download GCC sources
170     if [ ! -d 'gcc' ]; then
171         git clone --recursive "$REPO_GCC" 'gcc'
172     fi
173
174     # checkout latest release and build prerequisites
175     pushd 'gcc' > /dev/null
176     local L_GCC_SRC_PATH=`pwd -P`
177     select_and_get_project_version 'stable' 'THROWAWAY_VAR' 'releases/*'
178     ./contrib/download_prerequisites
179     popd > /dev/null
180     # configure ghdl-gcc
181     mkdir -p 'build_gcc'
182     pushd 'build_gcc' > /dev/null
183
184     if [ "$INSTALL_PREFIX" != 'default' ]; then
185         ../configure --with-gcc="$L_GCC_SRC_PATH" --prefix="$INSTALL_PREFIX"
186         local L_GCC_CONFIG="--prefix=${INSTALL_PREFIX}"
187     else
188         ../configure --with-gcc="$L_GCC_SRC_PATH"
189         local L_GCC_CONFIG=''
190     fi
191
192     make -j$(nproc) copy-sources
193     mkdir -p 'gcc-objs'
194     pushd 'gcc-objs' > /dev/null
195
196     # Check if the gcc used to compile ghdl-gcc uses default pie
197     if [ `gcc -v 2>&1 | grep -c -- "--enable-default-pie" -gt 0 ]; then
198         L_GCC_CONFIG="$L_GCC_CONFIG --enable-default-pie"
199     fi
200
201     $L_GCC_SRC_PATH/configure $L_GCC_CONFIG $BUILD_GCC_DEFAULT_CONFIG
202     make -j$(nproc)
203
204     if [ $INSTALL = true ]; then
205         make install
206     fi
207
208     popd > /dev/null
209     make -j$(nproc) ghdl-lib
210
211     if [ $INSTALL = true ]; then
212         make install
213     fi
214
215     popd > /dev/null
216 }
217
218

```

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```

219 # exit when any command fails
220 set -e
221
222 # require sudo
223 if [[ $UID != 0 ]]; then
224     echo -e "${RED}Please run this script with sudo:"
225     echo "sudo $0 $*"
226     exit 1
227 fi
228
229 # cleanup files if the programm was shutdown unexpectedly
230 trap 'echo -e "${RED}ERROR: Script was terminated unexpectedly, cleaning up files..."
↪&& pushd -0 > /dev/null && rm -rf $BUILDFOLDER' INT TERM
231
232 # invalid configuration
233 if [ $BUILD_MCODE = false ] && [ $BUILD_LLVM = false ] && [ $BUILD_GCC = false ]; then
234     echo -e "${RED}ERROR: Invalid configuration (at least one of -m, -l and -g must
↪be specified)$ {NC}"
235     exit 2
236 fi
237
238 # load shared functions
239 source $LIBRARY
240
241 # fetch specified version
242 if [ ! -d $BUILDFOLDER ]; then
243     mkdir $BUILDFOLDER
244 fi
245
246 pushd $BUILDFOLDER > /dev/null
247
248 if [ ! -d "$PROJ" ]; then
249     git clone --recursive "$REPO" "${PROJ%/*}"
250 fi
251
252 pushd $PROJ > /dev/null
253 select_and_get_project_version "$TAG" "COMMIT_HASH"
254
255 # build and install if wanted
256 if [ $BUILD_MCODE = true ]; then
257     build_mcode
258 fi
259 if [ $BUILD_LLVM = true ]; then
260     build_llvm
261 fi
262 if [ $BUILD_GCC = true ]; then
263     build_gcc
264 fi
265
266 # return to first folder and store version
267 pushd -0 > /dev/null
268 echo "${PROJ##*/}: $COMMIT_HASH" >> "$VERSIONFILE"
269
270 # cleanup if wanted
271 if [ $CLEANUP = true ]; then
272     rm -rf $BUILDFOLDER
273 fi

```

## 6.17.2 install\_ghdl\_essentials.sh

```
1  #!/bin/bash
2
3  # Author: Harald Heckmann <mail@haraldheckmann.de>
4  # Date: Oct. 23 2020
5  # Project: QuantumRisc (RheinMain University) <Steffen.Reith@hs-rm.de>
6
7  # require sudo
8  if [[ $UID != 0 ]]; then
9      echo "Please run this script with sudo:"
10     echo "sudo $0 $*"
11     exit 1
12 fi
13
14 # exit when any command fails
15 set -e
16
17 # required tools
18 TOOLS="build-essential git make gcc gnat llvm clang flex libc6 binutils gzip \
19       bzip2 tar perl autoconf m4 automake gettext gperf dejagnu expect tcl \
20       autogen guile-3.0 ssh texinfo"
21
22 # install and upgrade tools
23 apt-get update
24 apt-get install -y $TOOLS
25 apt-get install --only-upgrade -y $TOOLS
```

## 6.18 riscv\_tools

### 6.18.1 install\_riscv.sh

```
1  #!/bin/bash
2
3  # Author: Harald Heckmann <mail@haraldheckmann.de>
4  # Date: Jul. 02 2020
5  # Project: QuantumRisc (RheinMain University) <Steffen.Reith@hs-rm.de>
6
7  # constants
8  RED='\033[1;31m'
9  NC='\033[0m'
10 LIBRARY="../../libraries/library.sh"
11 REPO="https://github.com/riscv/riscv-gnu-toolchain.git"
12 PROJ="riscv-gnu-toolchain"
13 BUILDFOLDER="build_and_install_riscv_gnu_toolchain"
14 VERSIONFILE="installed_version.txt"
15 TOOLCHAIN_SUFFIX="linux-multilib"
16 TAG="latest"
17 NEWLIB=false
18 # INSTALL=false
19 INSTALL_PATH="/opt/riscv"
20 PROFILE_PATH="/etc/profile"
21 CLEANUP=false
22 EXPORTPATH=false
```

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```

23
24 VERSION_FILE_NAME="versions.cfg"
25 VERSION_FILE='## Define sourcecode branch
26 # default = use predefined versions from current riscv-gnu-toolchain branch
27 # or any arbitrary git tag or commit hash
28 # note that in most projects there is no master branch
29 QEMU=default
30 RISC_V_BINUTILS=default
31 RISC_V_DEJAGNU=default
32 RISC_V_GCC=default
33 RISC_V_GDB=default
34 RISC_V_GLIBC=default
35 RISC_V_NEWLIB=default
36
37 ## Define which RiscV architectures and ABIs are supported (space seperated list
  ↪ "arch-abi")
38
39 # Taken from Sifive:
40 # https://github.com/sifive/freedom-tools/blob/
  ↪ 120fa4d48815fc9e87c59374c499849934f2ce10/Makefile
41 NEWLIB_MULTILIBS_GEN="\
42     rv32e-ilp32e--c \
43     rv32ea-ilp32e--m \
44     rv32em-ilp32e--c \
45     rv32eac-ilp32e-- \
46     rv32emac-ilp32e-- \
47     rv32i-ilp32--c,f,fc,fd,fdc \
48     rv32ia-ilp32-rv32ima,rv32iaf,rv32imaf,rv32iafd,rv32imafd- \
49     rv32im-ilp32--c,f,fc,fd,fdc \
50     rv32iac-ilp32--f,fd \
51     rv32imac-ilp32-rv32imafc,rv32imafdc- \
52     rv32if-ilp32f--c,d,dc \
53     rv32iaf-ilp32f--c,d,dc \
54     rv32imf-ilp32f--d \
55     rv32imaf-ilp32f-rv32imafd- \
56     rv32imfc-ilp32f--d \
57     rv32imafc-ilp32f-rv32imafdc- \
58     rv32ifd-ilp32d--c \
59     rv32imfd-ilp32d--c \
60     rv32iafd-ilp32d-rv32imafd,rv32iafdc- \
61     rv32imafdc-ilp32d-- \
62     rv64i-lp64--c,f,fc,fd,fdc \
63     rv64ia-lp64-rv64ima,rv64iaf,rv64imaf,rv64iafd,rv64imafd- \
64     rv64im-lp64--c,f,fc,fd,fdc \
65     rv64iac-lp64--f,fd \
66     rv64imac-lp64-rv64imafc,rv64imafdc- \
67     rv64if-lp64f--c,d,dc \
68     rv64iaf-lp64f--c,d,dc \
69     rv64imf-lp64f--d \
70     rv64imaf-lp64f-rv64imafd- \
71     rv64imfc-lp64f--d \
72     rv64imafc-lp64f-rv64imafdc- \
73     rv64ifd-lp64d--c \
74     rv64imfd-lp64d--c \
75     rv64iafd-lp64d-rv64imafd,rv64iafdc- \
76     rv64imafdc-lp64d--"
77

```

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```

78
79 # Linux install (cross-compile for linux)
80 # Default value from riscv-gcc repository
81 GLIBC_MULTILIBS_GEN="\
82     rv32imac-ilp32-rv32ima,rv32imaf,rv32imafd,rv32imafc,rv32imafdc- \
83     rv32imafdc-ilp32d-rv32imafd- \
84     rv64imac-lp64-rv64ima,rv64imaf,rv64imafd,rv64imafc,rv64imafdc- \
85     rv64imafdc-lp64d-rv64imafd-"
86
87
88 # parse arguments
89 USAGE="$(basename "$0") [-h] [-c] [-n] [-d dir] [-t tag] [-u user] [-p path] -- Clone
↳latested ${PROJ} version and build it. Optionally select compiler (buildtool),
↳build directory and version, install binaries and cleanup setup files.
90
91 where:
92     -h          show this help text
93     -c          cleanup project
94     -n          use \"newlib multilib\" instead of \"linux multilib\" cross-compiler
95     -e          extend PATH in by RiscV binary path (default: /etc/profile)
96     -d dir      build files in \"dir\" (default: ${BUILDFOLDER})
97     -t tag      specify version (git tag or commit hash) to pull (default: default
↳branch)
98     -u user     install RiscV tools for user \"user\". (default: install globally)
99     -p path     choose install path (default: /opt/riscv)
100
101 while getopts ':hcend:t:u:p:' OPTION; do
102     case "$OPTION" in
103         h) echo "$USAGE"
104             exit
105             ;;
106         c) if [ $INSTALL = false ]; then
107             >&2 echo -e "${RED}ERROR: -c only makes sense if the built binaries
↳were installed before (-i)"
108             exit 1
109             fi
110             CLEANUP=true
111             echo "-c set: Removing build directory"
112             ;;
113         e) EXPORTPATH=true
114             echo "-e set: Extending PATH by RiscV binary path"
115             ;;
116         n) echo "-n set: Using newlib cross-compiler"
117             NEWLIB=true
118             TOOLCHAIN_SUFFIX="newlib-multilib"
119             ;;
120         d) echo "-d set: Using folder $OPTARG"
121             BUILDFOLDER="$OPTARG"
122             ;;
123         t) echo "-t set: Using version $OPTARG"
124             TAG="$OPTARG"
125             ;;
126         p) echo "-p set: Using install path $OPTARG"
127             INSTALL_PATH="$OPTARG"
128             ;;
129         u) echo "-u set: Installing for user $OPTARG"
130             PROFILE_PATH="$(grep $OPTARG /etc/passwd | cut -d ":" -f6)/.profile"

```

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```

131         if [ ! -f "$PROFILE_PATH" ]; then
132             echo -e "${RED}ERROR: No .profile file found for user \"${OPTARG}\" \"${NC}\" >&2
133             ↪{NC}" >&2
134             exit 1;
135         fi
136         ;;
137     :) echo -e "${RED}ERROR: missing argument for -${OPTARG}\" \"${NC}\" >&2
138     echo "$USAGE" >&2
139     exit 1
140     ;;
141     \?) echo -e "${RED}ERROR: illegal option: -${OPTARG}\" \"${NC}\" >&2
142     echo "$USAGE" >&2
143     exit 1
144     ;;
145 esac
146 done
147 shift $((OPTIND - 1))
148
149 # exit when any command fails
150 set -e
151
152 # require sudo
153 if [[ $UID != 0 ]]; then
154     echo -e "${RED}Please run this script with sudo:"
155     echo "sudo $0 $*"
156     exit 1
157 fi
158
159 # cleanup files if the programm was shutdown unexpectedly
160 trap 'echo -e "${RED}ERROR: Script was terminated unexpectedly, cleaning up files..."
161 ↪>&2 && pushd -0 > /dev/null && rm -rf $BUILDFOLDER' INT TERM
162
163 # load shared functions
164 source $LIBRARY
165
166 # does the config exist?
167 if [ ! -f "$VERSION_FILE_NAME" ]; then
168     echo -e "${RED}Warning: No version.cfg file found. Generating file and using_
169 ↪default versions${NC}";
170     echo "$VERSION_FILE" > "$VERSION_FILE_NAME"
171 fi
172
173 source "$VERSION_FILE_NAME"
174 CFG_LOCATION=`pwd -P`
175
176 # fetch specified version
177 if [ ! -d $BUILDFOLDER ]; then
178     mkdir $BUILDFOLDER
179 fi
180
181 pushd $BUILDFOLDER > /dev/null
182
183 if [ ! -d "$PROJ" ]; then
184     git clone --recursive "$REPO" "${PROJ%/*}"
185 fi

```

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```

185 pushd $PROJ > /dev/null
186 select_and_get_project_version "$TAG" "COMMIT_HASH"
187 VERSIONLIST="RiscV-GNU-Toolchain-`${TOOLCHAIN_SUFFIX}`: $COMMIT_HASH"
188
189 # fetch versions for all subrepos (as specified in versions.cfg)
190 while read LINE; do
191     if [ -n "$LINE" ] && [ "${LINE:0:1}" != "#" ]; then
192         SUBREPO=`echo "$LINE" | sed "s/[=].*$/"`
193         if [ -n "${SUBREPO}" ]; then
194             SUBREPO_LOWER=`echo "$SUBREPO" | tr [A-Z,_] [a-z,-]`
195             if [ -d "$SUBREPO_LOWER" ]; then
196                 pushd $SUBREPO_LOWER > /dev/null
197
198                 if [ "${SUBREPO}" != "default" ]; then
199                     git checkout --recurse-submodules ${SUBREPO}
200                 fi
201
202                 SUBREPO_COMMIT_HASH="$(git rev-parse HEAD)"
203
204                 # set return value to tag name if available
205                 # we have to cheat here: Since riscv-collaborators used branch names,
206                 ↪ instead
207                 # of tag names (why?!), we have to check both and hack the version a,
208                 ↪ bit to
209                 # indicate that.
210                 POSSIBLE_TAGS=`git tag --points-at $SUBREPO_COMMIT_HASH`
211
212                 if [ -n "$POSSIBLE_TAGS" ]; then
213                     SUBREPO_COMMIT_HASH="${POSSIBLE_TAGS%%[${'\n'}]*}"
214                 else
215                     # check branches
216                     POSSIBLE_BRANCHES=`git branch -r --points-at $SUBREPO_COMMIT_HASH`
217                     if [ -n "$POSSIBLE_BRANCHES" ]; then
218                         ONE_BRANCH="${POSSIBLE_BRANCHES%%[${'\n'}]*}"
219                         # this is hacky. Extracts the number and anything after the,
220                         ↪ number
221                         # matching the the pattern d.d, where d is an arbitrary long,
222                         ↪ number
223                         SUBREPO_COMMIT_HASH="$(echo "$ONE_BRANCH" | grep -Po '\d+\.\d+.*') ($SUBREPO_COMMIT_HASH)"
224                     fi
225                 fi
226
227                 fi
228
229                 popd > /dev/null
230                 VERSIONLIST="${VERSIONLIST}\n${SUBREPO_LOWER}-${TOOLCHAIN_SUFFIX}: $
231                 ↪ ${SUBREPO_COMMIT_HASH}"
232             fi
233         fi
234     done < "${CFG_LOCATION}/${VERSION_FILE_NAME}"
235
236 # build and install if wanted
237 PATH="${INSTALL_PATH}:${PATH}"
238
239 if [ $NEWLIB = true ]; then
240     ./configure --prefix=$INSTALL_PATH --enable-multilib --disable-linux

```

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```

236 # activate custom multilibs
237 pushd "riscv-gcc/gcc/config/riscv" > /dev/null
238 chmod +x ./multilib-generator
239 ./multilib-generator $NEWLIB_MULTILIBS_GEN > t-elf-multilib
240 popd > /dev/null
241 NEWLIB_MULTILIB_NAMES=`echo $NEWLIB_MULTILIBS_GEN | sed "s/-\ (rv\ (32\|64\)) [a-zA-
→Z]*,*) *- \ ([a-zA-Z]*,*) */g"`
242 echo "Building newlib-multilib for \"$NEWLIB_MULTILIB_NAMES\""
243 # build
244 make -j$(nproc) NEWLIB_MULTILIB_NAMES="$NEWLIB_MULTILIB_NAMES"
245 else
246 ./configure --prefix=$INSTALL_PATH --enable-multilib --enable-linux
247 # activate custom multilibs
248 pushd "riscv-gcc/gcc/config/riscv" > /dev/null
249 chmod +x ./multilib-generator
250 ./multilib-generator $GLIBC_MULTILIBS_GEN > t-linux-multilib
251 popd > /dev/null
252 GLIBC_MULTILIB_NAMES=`echo $GLIBC_MULTILIBS_GEN | sed "s/-\ (rv\ (32\|64\)) [a-zA-Z]*,
→*) *- \ ([a-zA-Z]*,*) */g"`
253 echo "Building linux-multilib for \"$GLIBC_MULTILIB_NAMES\""
254 # build
255 make -j$(nproc) GLIBC_MULTILIB_NAMES="$GLIBC_MULTILIB_NAMES" linux
256 fi
257
258 # extend path
259 if [ $EXPORTPATH = true ]; then
260     PATH_STRING="\n# Add RiscV tools to path
261 if [ -d \"${INSTALL_PATH}/bin\" ]; then
262     PATH=\"${INSTALL_PATH}/bin:${PATH}\"
263 fi"
264
265     if ! grep -q "PATH=\"${INSTALL_PATH}/bin:${PATH}\" \"$PROFILE_PATH"; then
266         echo -e "$PATH_STRING" >> "$PROFILE_PATH"
267     fi
268 fi
269
270 # return to first folder and store version
271 pushd -0 > /dev/null
272 echo -e "$VERSIONLIST" >> "$VERSIONFILE"
273
274 # cleanup if wanted
275 if [ $CLEANUP = true ]; then
276     rm -rf $BUILDFOLDER
277 fi

```

## 6.18.2 install\_riscv\_essentials.sh

```

1  #!/bin/bash
2
3  # Author: Harald Heckmann <mail@haraldheckmann.de>
4  # Date: Jul. 02 2020
5  # Project: QuantumRisc (RheinMain University) <Steffen.Reith@hs-rm.de>
6
7  # require sudo
8  if [[ $UID != 0 ]]; then

```

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```

9     echo "Please run this script with sudo:"
10     echo "sudo $0 $*"
11     exit 1
12 fi
13
14 # exit when any command fails
15 set -e
16
17 # required tools
18 TOOLS="autoconf automake autotools-dev curl python3 libmpc-dev libmpfr-dev \
19       libgmp-dev gawk build-essential bison flex texinfo gperf libtool \
20       patchutils bc zlib1g-dev libexpat-dev"
21
22 # install and upgrade tools
23 apt-get update
24 apt-get install -y $TOOLS
25 apt-get install --only-upgrade -y $TOOLS

```

### 6.18.3 versions.cfg

```

1  ## Define sourcecode branch
2
3  # default = use predefined versions from current riscv-gnu-toolchain branch
4  # or any arbitrary git tag or commit hash
5  # note that in most projects there is no master branch
6  QEMU=default
7  RISCY_BINUTILS=default
8  RISCY_DEJAGNU=default
9  RISCY_GCC=default
10 RISCY_GDB=default
11 RISCY_GLIBC=default
12 RISCY_NEWLIB=default
13
14
15 ## Define which RiscV architectures and ABIs are supported (space seperated list
16 ↪ "arch-abi")
17
18 # Taken from Sifive:
19 # https://github.com/sifive/freedom-tools/blob/
20 ↪ 120fa4d48815fc9e87c59374c499849934f2ce10/Makefile
21 NEWLIB_MULTILIBS_GEN="\
22     rv32e-ilp32e--c \
23     rv32ea-ilp32e--m \
24     rv32em-ilp32e--c \
25     rv32eac-ilp32e-- \
26     rv32emac-ilp32e-- \
27     rv32i-ilp32--c,f,fc,fd,fdc \
28     rv32ia-ilp32-rv32ima,rv32iaf,rv32imaf,rv32iafd,rv32imafd- \
29     rv32im-ilp32--c,f,fc,fd,fdc \
30     rv32iac-ilp32--f,fd \
31     rv32imac-ilp32-rv32imafc,rv32imafdc- \
32     rv32if-ilp32f--c,d,dc \
33     rv32iaf-ilp32f--c,d,dc \
34     rv32imf-ilp32f--d \
35     rv32imaf-ilp32f-rv32imafd- \

```

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```

34     rv32imfc-ilp32f--d \
35     rv32imaafc-ilp32f-rv32imafdc- \
36     rv32ifd-ilp32d--c \
37     rv32imfd-ilp32d--c \
38     rv32iafd-ilp32d-rv32imafd,rv32iafdc- \
39     rv32imafdc-ilp32d-- \
40     rv64i-lp64--c,f,fc,fd,fdc \
41     rv64ia-lp64-rv64ima,rv64iaf,rv64imaf,rv64iafd,rv64imafd- \
42     rv64im-lp64--c,f,fc,fd,fdc \
43     rv64iac-lp64--f,fd \
44     rv64imac-lp64-rv64imaafc,rv64imafdc- \
45     rv64if-lp64f--c,d,dc \
46     rv64iaf-lp64f--c,d,dc \
47     rv64imf-lp64f--d \
48     rv64imaf-lp64f-rv64imafd- \
49     rv64imfc-lp64f--d \
50     rv64imaafc-lp64f-rv64imafdc- \
51     rv64ifd-lp64d--c \
52     rv64imfd-lp64d--c \
53     rv64iafd-lp64d-rv64imafd,rv64iafdc- \
54     rv64imafdc-lp64d--"
55
56 # Linux install (cross-compile for linux)
57 # Default value from riscv-gcc repository
58 GLIBC_MULTILIBS_GEN="\
59     rv32imac-ilp32-rv32ima,rv32imaf,rv32imafd,rv32imaafc,rv32imafdc- \
60     rv32imafdc-ilp32d-rv32imafd- \
61     rv64imac-lp64-rv64ima,rv64imaf,rv64imafd,rv64imaafc,rv64imafdc- \
62     rv64imafdc-lp64d-rv64imafd-"

```

## 6.19 cocotb

### 6.19.1 install\_cocotb\_essentials.sh

```

1  #!/bin/bash
2
3  # Author: Harald Heckmann <mail@haraldheckmann.de>
4  # Date: Oct. 24 2020
5  # Project: QuantumRisc (RheinMain University) <Steffen.Reith@hs-rm.de>
6
7  # require sudo
8  if [[ $UID != 0 ]]; then
9      echo "Please run this script with sudo:"
10     echo "sudo $0 $*"
11     exit 1
12 fi
13
14 # exit when any command fails
15 set -e
16
17 # required tools
18 TOOLS="g++ python3 python3-pip"
19

```

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```

20 # install and upgrade tools
21 apt-get update
22 apt-get install -y $TOOLS
23 apt-get install --only-upgrade -y $TOOLS
24 # install cocotb
25 python3 -m pip install --upgrade pip
26 python3 -m pip install cocotb

```

## 6.20 nextpnr

### 6.20.1 install\_nextpnr.sh

```

1  #!/bin/bash
2
3  # Author: Harald Heckmann <mail@haraldheckmann.de>
4  # Date: Jun. 25 2020
5  # Project: QuantumRisc (RheinMain University) <Steffen.Reith@hs-rm.de>
6
7  # constants
8  RED='\033[1;31m'
9  NC='\033[0m'
10 LIBRARY="../../libraries/library.sh"
11 REPO="https://github.com/YosysHQ/nextpnr.git"
12 PROJ="nextpnr"
13 CHIP="ice40"
14 BUILDFOLDER="build_and_install_nextpnr"
15 VERSIONFILE="installed_version.txt"
16 TAG="latest"
17 LIBPATH=""
18 INSTALL=false
19 CLEANUP=false
20 # trellis config
21 TRELIS_LIB="/usr"
22 TRELIS_REPO="https://github.com/SymbiFlow/prjtrellis"
23 TRELIS_PROJ="prjtrellis"
24 # icestorm config
25 ICESTORM_REPO="https://github.com/cliffordwolf/icestorm.git"
26 ICESTORM_PROJ="icestorm"
27 ICESTORM_LIB="/usr/local/share/icebox"
28 ICESTORM_ICEBOX_DIR="icestorm"
29
30
31 # parse arguments
32 USAGE="$(basename "$0") [-h] [-c] [-e] [-d dir] [-i path] [-l path] [-t tag] -- Clone,
33   ↳ latested tagged ${PROJ} version and build it. Optionally select the build directory,
34   ↳ chip files, chipset and version, install binaries and cleanup setup files.
35
36 where:
37   -h          show this help text
38   -c          cleanup project
39   -e          install NextPNR for ecp5 chips (default: ice40)
40   -d dir      build files in \"dir\" (default: ${BUILDFOLDER})
41   -i path     install binaries to path (use \"default\" to use default path)

```

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```

40     -l path      use local chip files for ice40 or ecp5 from \"path\" (use empty_
↳string for default path in ubuntu)
41     -t tag       specify version (git tag or commit hash) to pull (default: Latest tag)
↳"
42
43
44 while getopts ":hcd:i:t:l:" OPTION; do
45     case $OPTION in
46         i)  INSTALL=true
47             INSTALL_PREFIX="$OPTARG"
48             echo "-i set: Installing built binaries to $INSTALL_PREFIX"
49             ;;
50         e)  echo "-e set: Installing NextPNR for ecp5 chipset"
51             CHIP="ecp5"
52             ;;
53     esac
54 done
55
56 OPTIND=1
57
58 while getopts ':hcd:i:t:l:' OPTION; do
59     case "$OPTION" in
60         h)  echo "$USAGE"
61             exit
62             ;;
63         c)  if [ $INSTALL = false ]; then
64             >&2 echo -e "${RED}ERROR: -c only makes sense if the built binaries were_
↳installed before (-i)"
65             exit 1
66         fi
67         CLEANUP=true
68         echo "-c set: Removing build directory"
69         ;;
70         d)  echo "-d set: Using folder $OPTARG"
71             BUILDFOLDER="$OPTARG"
72             ;;
73         t)  echo "-t set: Using version $OPTARG"
74             TAG="$OPTARG"
75             ;;
76         l)  echo "-l set: Using local chip data"
77             if [ -z "$OPTARG" ]; then
78                 if [ "$CHIP" = "ice40" ]; then
79                     LIBPATH="$ICESTORM_LIB"
80                 else
81                     LIBPATH="$TRELLIS_LIB"
82                 fi
83             else
84                 if [ ! -d "$OPTARG" ]; then
85                     echo -e "${RED}ERROR: Invalid path \"${OPTARG}\""
86                     exit 1
87                 fi
88                 LIBPATH="$OPTARG"
89             fi
90         fi
91         ;;
92         :)  echo -e "${RED}ERROR: missing argument for -${OPTARG}\n${NC}" >&2
93             echo "$USAGE" >&2

```

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```

94     exit 1
95     ;;
96     \?) echo -e "${RED}ERROR: illegal option: -${OPTARG}\n${NC}" "${OPTARG}" >&2
97     echo "${USAGE}" >&2
98     exit 1
99     ;;
100  esac
101 done
102
103 shift "$((OPTIND - 1))"
104
105 # exit when any command fails
106 set -e
107
108 # require sudo
109 if [[ $UID != 0 ]]; then
110     echo -e "${RED}Please run this script with sudo:"
111     echo "sudo $0 $*"
112     exit 1
113 fi
114
115 # cleanup files if the programm was shutdown unexpectedly
116 trap 'echo -e "${RED}ERROR: Script was terminated unexpectedly, cleaning up files..."_
↳ && pushd -0 > /dev/null && rm -rf $BUILDFOLDER' INT TERM
117
118 # load shared functions
119 source $LIBRARY
120
121 # fetch specified version
122 if [ ! -d $BUILDFOLDER ]; then
123     mkdir $BUILDFOLDER
124 fi
125
126 pushd $BUILDFOLDER > /dev/null
127
128 if [ ! -d "$PROJ" ]; then
129     git clone --recursive "$REPO" "${PROJ%/*}"
130 fi
131
132 pushd $PROJ > /dev/null
133
134 select_and_get_project_version "$TAG" "COMMIT_HASH"
135
136 # build and install if wanted
137 # chip ice40?
138 if [ "$CHIP" = "ice40" ]; then
139     # is icestorm installed?
140     if [ -n "$LIBPATH" ]; then
141         if [ "$INSTALL_PREFIX" == "default" ]; then
142             cmake -DARCH=ice40 -DICEBOX_ROOT=$LIBPATH .
143         else
144             cmake -DARCH=ice40 -DICEBOX_ROOT=$LIBPATH -DCMAKE_INSTALL_PREFIX="
↳ $INSTALL_PREFIX" .
145         fi
146     else
147         echo "Note: Pulling Icestorm from Github."
148

```

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```

149     if [ ! -d "$ICESTORM_PROJ" ]; then
150         git clone $ICESTORM_REPO "$ICESTORM_ICEBOX_DIR"
151     fi
152
153     NEXTPNR_FOLDER=`pwd -P`
154     # build icebox (chipdbs)
155     pushd "${ICESTORM_ICEBOX_DIR}/icebox" > /dev/null
156     make -j$(nproc)
157     make install DESTDIR=$NEXTPNR_FOLDER PREFIX=''
158     popd +0 > /dev/null
159     # build icetime (timing)
160     pushd "${ICESTORM_ICEBOX_DIR}/icetime" > /dev/null
161     make -j$(nproc) PREFIX=$NEXTPNR_FOLDER
162     make install DESTDIR=$NEXTPNR_FOLDER PREFIX=''
163     popd +0 > /dev/null
164     # build nextpnr-ice40 next
165
166     if [ "$INSTALL_PREFIX" == "default" ]; then
167         cmake -j$(nproc) -DARCH=ice40 -DICEBOX_ROOT="${NEXTPNR_FOLDER}/share/
168 ↪icebox" .
169     else
170         cmake -j$(nproc) -DARCH=ice40 -DICEBOX_ROOT="${NEXTPNR_FOLDER}/share/
171 ↪icebox" -DCMAKE_INSTALL_PREFIX="$INSTALL_PREFIX" .
172     fi
173     # chip ecp5?
174     else
175         # is project trellis installed?
176         if [ -d "$LIBPATH" ]; then
177             if [ "$INSTALL_PREFIX" == "default" ]; then
178                 cmake -j$(nproc) -DARCH=ecp5 -DTRELLIS_INSTALL_PREFIX=$LIBPATH .
179             else
180                 cmake -j$(nproc) -DARCH=ecp5 -DTRELLIS_INSTALL_PREFIX=$LIBPATH -DCMAKE_
181 ↪INSTALL_PREFIX="$INSTALL_PREFIX" .
182             fi
183         else
184             echo "Note: Pulling Trellis from Github."
185
186             if [ ! -d "$TRELLIS_PROJ" ]; then
187                 git clone --recursive $TRELLIS_REPO
188             fi
189
190             TRELLIS_MAKE_PATH="$(pwd -P)/${TRELLIS_PROJ}/libtrellis"
191             pushd "$TRELLIS_MAKE_PATH" > /dev/null
192             cmake -j$(nproc) -DCMAKE_INSTALL_PREFIX="$TRELLIS_MAKE_PATH" .
193             make -j$(nproc)
194             make install
195             popd +0 > /dev/null
196
197             if [ "$INSTALL_PREFIX" == "default" ]; then
198                 cmake -j$(nproc) -DARCH=ecp5 -DTRELLIS_INSTALL_PREFIX="$TRELLIS_MAKE_PATH
199 ↪" .
200             else
201                 cmake -j$(nproc) -DARCH=ecp5 -DTRELLIS_INSTALL_PREFIX="$TRELLIS_MAKE_PATH
202 ↪" -DCMAKE_INSTALL_PREFIX="$INSTALL_PREFIX" .
203             fi
204         fi

```

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```

201 fi
202
203 make -j$(nproc)
204
205 if [ $INSTALL = true ]; then
206     make install
207 fi
208
209 # return to first folder and store version
210 pushd -0 > /dev/null
211
212 if [ "$CHIP" == "ice40" ]; then
213     echo "${PROJ##*/}-ice40: $COMMIT_HASH" >> "$VERSIONFILE"
214 else
215     echo "${PROJ##*/}-ecp5: $COMMIT_HASH" >> "$VERSIONFILE"
216 fi
217
218 # cleanup if wanted
219 if [ $CLEANUP = true ]; then
220     rm -rf $BUILDFOLDER
221 fi

```

## 6.20.2 install\_nextpnr\_essentials.sh

```

1  #!/bin/bash
2
3  # Author: Harald Heckmann <mail@haraldheckmann.de>
4  # Date: Jun. 24 2020
5  # Project: QuantumRisc (RheinMain University) <Steffen.Reith@hs-rm.de>
6
7  # require sudo
8  if [[ $UID != 0 ]]; then
9      echo "Please run this script with sudo:"
10     echo "sudo $0 $*"
11     exit 1
12 fi
13
14 # exit when any command fails
15 set -e
16
17 # required tools
18 TOOLS="clang-format qt5-default libboost-dev libboost-filesystem-dev \
19     libboost-thread-dev libboost-program-options-dev libboost-python-dev \
20     libboost-iostreams-dev libboost-dev libeigen3-dev python3-dev cmake"
21
22 # install and upgrade tools
23 apt-get update
24 apt-get install -y $TOOLS
25 apt-get install --only-upgrade -y $TOOLS

```



## **FURTHER REFERENCES**

- Project page
- VM page
- Further reads



## CHANGELOG

### 8.1 1.0.0

First release