



E-Learning – VELS Usermanual

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1. Manual Overview

The following document aims to inform an operator on how the autosub system works and how to configure and run a course using the autosub system. This manual is written primarily for using autosub with VELS (VHDL E-Learning System). Nevertheless the autosub system and the described structures are designed to be usable for diverse E-Learning purposes.

The first part of this manual (Section 2) outlines the interaction and use cases for a user and an operator with the E-Learning system.

The second part of this manual describes VELS, which itself can roughly be divided into 3 parts:

1. The autosub submission system (see Section 3)
2. The configuration and status web interface VELS_WEB (see Section 4)
3. The tasks interface (see Section 5)

The third part of this manual depicts prerequisites (see Section 6) and which steps have to be taken for system setup (see Section 7).

The fourth part describes how to create new tasks for VELS (see Section xy).

reference

The Appendix (Section 8) list Implementational details of VELS.

2. System Interaction

The VELS system is an E-Learning system for students who are learning the Very High Speed Integrated Circuit (VHSIC) Hardware Description Language (VHDL). The interaction between students and the system is solely via E-Mail. Configuration of the system is done with a configuration file (for configuration items that can not change during runtime) and a web interface (for configuration items that can change dynamically).

The VELS E-Learning system has 2 distinctive user groups: course operators and students. To satisfy the use cases for each of the 2 user groups the following interfaces have been defined:

- VELS E-Mail Interface
- VELS Web Interface
- VELS Direct Server Access

The different use cases for students and operator and the responsible interface can be seen in Table 1 and Table 2.

| Use Case | Responsible interface |
|--------------------------|-----------------------|
| register with the system | VELS E-Mail Interface |
| get status in course | VELS E-Mail Interface |
| get current task | VELS E-Mail Interface |
| submit a task | VELS E-Mail Interface |
| ask a question | VELS E-Mail Interface |

Table 1: Use cases for students

| Use Case | Responsible interface |
|--|---------------------------|
| configure a course | VELS Web Interface |
| modify task generation or testbench generation | VELS Direct Server Access |
| create a new task | VELS Direct Server Access |
| view the progress for students | VELS Web Interface |
| view task statistics | VELS Web Interface |
| read log files | VELS Direct Server Access |

Table 2: Use cases for course operators

2.1. VELS E-Mail Interface

The VELS E-Mail Interface is the primary interface for students. Students are uniquely identified by their E-Mail address to interact with this interface. The student has to interact with a single, non-changing E-Mail address during the whole duration of a course. These E-Mail addresses have to be added to the system's whitelist by a course operator in order to enable them to be authorized for interaction. If a user that is not on the whitelist sends an E-Mail to the system, the system replies with a message to use the whitelisted address or contact a course operator.

The different actions a student can take are defined via E-Mail subject and address. The following cases when using a whitelisted E-Mail address and system reactions are implemented:

- *Arbitrary Subject, user not registered:* Registration is initiated. Registration with the system creates the appropriate data entries in the database for the student. If adding the new user was successful, two E-Mails are sent to the user: a welcome message with general information on how the system works and if already available the description of the first task.
- *Subject contains the word "Question":* The student has a question about the course, this question is forwarded to all course operators. The student receives a confirmation that the question has been passed on.
- *Subject contains the phrase "Question Task N" where N is the task number:* The student has a question about a specific task of the course, this question is forwarded to all task operators for task N. The student receives a confirmation that the question has been passed on.
- *Subject contains the phrase "Result Task N" where N is the task number:* The student wants to hand in a solution, for Task N. Students are allowed to hand in solutions for all tasks that have already been solved previously, as well as the one task that has not been solved yet – they are not allowed to hand in solutions for tasks they did not receive the task description yet. The solution is tested on the server. If the task solution was appropriate the student will receive the next task (or a congratulations message, if no more examples are available). If the tests were not successful, the student receives an error message that gives a hint on what may be wrong (output of the simulation tool, expected output vs. actual output, etc.)
- *Subject contains the word "Status":* The student is send an E-Mail with the list of his completed tasks and his current task description.
- *Subject contains the word "Skip":* The student will be skipped to the task after his current task if this feature is activated. Otherwise he is sent a usage message.
- *default:* The student is sent an E-Mail with the usage for this interface.

2.2. VELS Web Interface

The VELS Web Interface is a configuration and status tool for the course operators.

Course operators can create a course. A course consists of a task queue, which explicitly orders a selection of the available tasks. The following actions for course configuration are implemented:

- Configuration of the task queue including start and end date for the task and points for task completion
- Configure course registration deadline
- Modify course registration E-Mail whitelist
- Modify Archive Directory
- Set Administrator E-Mail

Course operators can view the progress of each student and is presented with the following informations:

- Student name.
- Task the student is working on and the tasks the student has completed.
- Score which was accumulated by the student.
- Number of submissions for each task the student has received.
- List of attached files for each task the student has received.

Course operators can view statistical informations about his course:

- Number of wrong and right submissions for each tasks.
- General statistical informations about his course (e.g number E-Mails received/sent).

The VELS Web Interface may also be used by the course operator to read the results at the end of the semester, that is the points that have been scored by the individual students. In depth description on how to use the VELS_WEB interface can be found in Section 4 and Section 7.

2.3. VELS Direct Server Access

The VELS Direct Server Access is used by course operators to modify code for task generation, description and testing of existing tasks, read log files or fix bugs of the VELS system. It also can be used to view every submission a student has done.

3. Autosub Submission System

The autosub submission system has the following responsibilities:

- Fetch, process, send and archive student E-Mails.
- Store and manage tasks, users and submissions.
- Initiate generation of tasks and testing of submissions.
- Produce statistics.

In the following *Structured Analysis* will be used to specify the system. If you are not familiar with this method, you can find details e.g. in [DeM81, Goo01, Coo03].

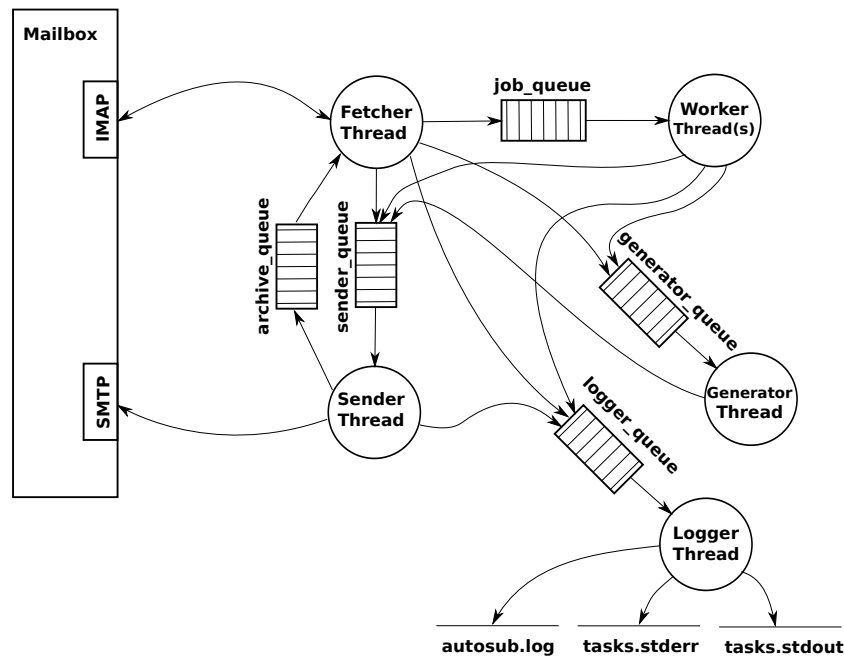


Figure 1: DFD0 – High-Level Data-Flows in the Submission System.

The autosub submission system is a daemon implemented in Python3 that is composed of multiple threads communicating over queues. This multi-threading approach is especially important for the testing process. As the test of a single task can take rather long and each student can hand in (correct and incorrect) solutions. Furthermore the goal is to assure, that there still is progress, even if a test is running. A view of the parts and data-flows of the autosub system can be seen in Figure 1. The individual entities are described in the next subsection, the message queues in the Appendix Section 8.2.

3.1. Description of Entities

MB Mailbox

| | |
|-------------|---|
| Description | Mailbox to interface with students. |
| Rate | Asynchronously by students, periodically with configurable interval by the E-Learning system. |
| Comment | The Mailbox is used to interface with the students. The Mailbox is accessed via Internet Message Access Protocol (IMAP) for reading new E-Mails and Simple Mail Transfer Protocol (SMTP) to send E-Mails. After the action triggered by an received E-Mail has been processed, the E-Mail is archived into a configurable folder on the IMAP server. |

1 Fetcher thread

| | |
|-------------|--|
| Description | Fetch E-Mails from the Mailbox. |
| Rate | Periodically with configurable interval. |
| Comment | The Fetcher thread periodically checks the Mailbox for new E-Mails. This thread initiates actions based on the user E-mail address and the subject. Further information concerning the E-Mail interface can be seen in Section 2.1 |

2 Generator thread

| | |
|-------------|---|
| Description | Generate a (unique) example for a user. |
| Rate | Triggered by registration of a new user, and successful submission of a task. |
| Comment | The Generator thread initiates generation of unique tasks for students. The Generator thread is blocking on the generator_queue, until the generation of a new example is requested. As soon as the example was generated, a request to send it out is put into the sender_queue. |

3 Worker thread(s)

| | |
|-------------|---|
| Description | Test the task submissions of students. |
| Rate | Asynchronously triggered upon arrival of a new task submission by a student. |
| Comment | The Worker threads are the ones which do the initiate testing submissions by a student. If the Fetcher thread receives an E-Mail with a result submission, a new message is added to the job_queue. The worker threads are using a blocking read on the job_queue to wait for work, as soon as the new message is added by the Fetcher thread one of the workers will read it and start the tests for the users submission. |

4 Logger thread

| | |
|-------------|--|
| Description | Format log messages and store them in the log file. |
| Rate | Triggered by all other threads. |
| Comment | <p>In order to enforce a common logging format, and allow the setting of a common log-level, all threads just put their log-messages into the <code>logger_queue</code>. The Logger thread decides (depending on the log-level and configured log-threshold) whether or not the message shall be logged or not. If so, the message is formatted and written to the log file. The log-level threshold can be configured in the config file.</p> <p>The following log-levels are implemented (from lowest to highest):</p> <p>DEBUG: Print all kind of information that might be helpful to debug problems. This includes, what user sent which e-mail, what action was taken, what was the result of that action.</p> <p>INFO: Information that might be of interest, even if not in debugging mode.</p> <p>WARNING: A problem occurred, but it did not lead to a long-term problem (e.g. could not connect to the mailserver, but after retrying it worked).</p> <p>ERROR: A problem that lead to a long-term malfunction of the submission system occurred, the system will not be able to recover from this problem.</p> |

5 Sender thread

| | |
|-------------|---|
| Description | Sends E-Mails to the students |
| Rate | Triggered by Fetcher, Worker or Generator thread. |
| Comment | <p>If a message has to be returned to the student, the thread that wants to send the message just puts the necessary information into the <code>sender_queue</code>. The sender thread then takes that information, formats an e-mail and sends it out using SMTP.</p> <p>The unique message-id is passed from the fetcher (possibly via other threads) to the sender thread. If the sender thread has sent out the answering E-Mails, the E-Mail with the given message-id is moved into an archive folder on the mail server.</p> |

6 Dailystats thread

| | |
|-------------|---|
| Description | Creates statistical information. |
| Rate | Activated every 12 hours. |
| Comment | The dailystats thread is used to get a timeline of some very basic statistics. Currently the number users, sent e-mails, received e-mails and received questions over time are evaluated and plotted into a graph. The graphs are stored and can e.g. be viewed in the Statistics tab of the web interface. |

3.2. Datastores

For storing data two databases are used. The name and location of those databases can be configured through the configuration file, in the following we will refer to them with the default name that is used, if no other name is provided in the configuration file:

semester.db: The `semester.db` database is used to store all data that is specific to one semester. This includes, users, parameterization of tasks assigned for users, statistics, etc. The `semester.db` default location is in "`autosub/src`".

course.db: The `course.db` database consists of configuration data that will very likely be reused in multiple semesters. This separation makes it very easy to start a new semester: just backup `semester.db` to some safe location and remove it in the original location (a new empty one will be made automatically upon starting the autosub daemon). Then use the VELS web interface to perform the small modifications(year/semester,deadlines, etc.) needed in `course.db`. The `course.db` default location is in "`autosub/src`".

Specifics about the tables of these databases can be found in the Appendix Section 8.3 and 8.4.

In addition there is one important directory that is used by autosub to store data in, the directory: `autosub/src/users`. In this directory a unique directory for every user is created, and this directory the description of each individual received task and submissions for the individual tasks are stored. Every directory has the form "`autosub/src/users/<user_id>/Task<nr>/`". Submissions are stored in separate folders which are named "`Submission<nr>_<date>_<time>/`". Task description files are stored in the folder named "`desc/`".

3.3. Config File

The autosub system uses a config file (`.cfg`) which is passed to the daemon to configure the individual threads and overall system. The file is read when starting the daemon. If no

.cfg file is specified, the used file is default.cfg located in "autosub/src/". Information about the config file can be found in the Appendix Section 8.1 and an example config file in Section 7.2.

3.4. Logging and error detection

The autosub system is implemented as a daemon process. As such it does not directly print any information to the `stdout` (i.e. the screen), instead all messages for the administrator are stored in log files. All log and error files are stored in a configurable directory (default "autosub/src").

autosub.log This is the main log file that is used by the actual autosub daemon software to log everything. The format in this log file is as follows:

```
<date> <time> [<logger name>] <loglevel> <logmessage>
```

Here is a small section of `autosub.log` taken from startup – first the daemon checks whether a directory `users` used to store the users submissions is existing, then it checks if necessary tables in the database exist. After those checks have been done further threads (described in Section 3.1) are started, and announce themselves.

```
2015-09-17 22:23:40,629 [autosub.py ] WARNING: Directory already exists: users
2015-09-17 22:23:40,630 [autosub.py ] DEBUG: table SpecialMessages does not exist
2015-09-17 22:23:43,679 [autosub.py ] DEBUG: table TaskConfiguration does not exist
2015-09-17 22:23:43,955 [autosub.py ] DEBUG: table GeneralConfig does not exist
2015-09-17 22:23:45,878 [sender    ] INFO: Starting Mail Sender Thread!
2015-09-17 22:23:45,884 [fetcher  ] INFO: Starting Mail Fetcher Thread!
2015-09-17 22:23:45,884 [fetcher  ] DEBUG: Imapserver: 'mail.intern.tuwien.ac.at'
2015-09-17 22:23:45,884 [generator] INFO: Task Generator thread started
2015-09-17 22:23:45,890 [activator] INFO: Starting activator
2015-09-17 22:23:45,890 [Main     ] INFO: Used config-file: testzid.cfg
2015-09-17 22:23:45,891 [Worker1  ] INFO: Starting Worker1
2015-09-17 22:23:45,892 [Main     ] INFO: All threads started successfully
2015-09-17 22:23:45,892 [Worker1  ] INFO: Worker1: waiting for a new job.
2015-09-17 22:23:45,893 [Worker2  ] INFO: Starting Worker2
```

As you can see from these examples, a lot of information is available, with exact timestamps and a way to know which thread the message is coming from. In addition the debug level gives a sense of how important (or even critical) the message is. The log-level threshold can be configured using the config file.

Autosub tries to give information on severe problems on all available channels. An example would be, if no task is configured, the email sent to the student will contain the message that something went wrong as well – although the error can be seen in the `autosub.log` file as well.

4. The web interface VELS_WEB

The configuration and status web interface VELS_WEB was designed as an easy interface for a course operator to view and change course parameters and monitor the course progress. It is implemented with web2py and can be run as a daemon accessing the datastores of the autosub submission system. This web interface was only designed for internal operator use! Therefore it should only be reachable via the internal networks using a web browser.

The menu items of the VELS_WEB are the following:

Start: The start page.

Users: View of the registered students, allows to change or a student via the "Edit" button, delete a student via the "Delete" button and show the progress of a student in the course via the "View" button. The table is sortable by column by clicking on the head of the column.

Tasks: The task configuration, will be discussed in Section 7.7.

Whitelist: Change whitelisting for students, will be discussed in Section 7.6.

General Config: Change dynamic configuration items of VELS, will be discussed in Section 7.5.

Statistics: View statistics about sent and received emails and task success of the students.

User Tasks: View mappings from students to individual tasks.

Usage of the VELS_WEB interface will be discussed with system setup in Section 7.

5. The Tasks System

5.1. Minimal and optional task structure

Every task is located in an individual folder in the tasks directory (configurable via the autosub config file). Certain structures with minimum behavior are needed in order to use the task with the autosub system. In detail instructions how to create a task can be found in Section xy .

reference

| | |
|---------|---|
| Minimal | <ul style="list-style-type: none"> • Generator executable: Generates random task parameters for the task, creates entity and behavioral vhdl files and description pdf file for the student. Copies these files to the user taskpath ("autosub/src/users/<user_id>/Task<nr>/"). Declares the files that shall be attached to the task description email and the task parameters and adds them to the autosub system using the tool "autosub/src/tools/add_to_usertasks.py". • Tester executable: Given the individual task parameters, tries to test the student's solution located in "autosub/src/users/<user_id>/Task<nr>/" . Generates an individual test bench for the student's solution. Tests the solution and creates feedback textfile "error_msg", error attachments in the directory "error_attachments" and tells the autosub system the test result via returncode • description.txt: Contains a textual task description. The text in description.txt is sent to the user as the body of the e-mail that contains a new task description. |
|---------|---|

Certain optional structures have proven to be useful.

| | |
|----------|---|
| Optional | <ul style="list-style-type: none"> • Directory scripts: Scripts that are called from the executables in order to aid the generation or test process • Directory templates: Files that are filled with parameters and can be used to generate entity declarations, test benches or description texts and files for the students. • Directory static: Files that are static for the task, therefore the same for every student. • Directory exam: Files that are needed for the VELs exam mode. |
|----------|---|

An usual sequence for the task generation in VELs is:

1. The generator executable is called by the autosub Generator thread.
2. The generator executable calls a task generation script `"scripts/generateTask.py"`.
3. The task generation script generates random task parameters and returns them, fills a LaTeX description template and vhdL templates and stores the results in the directory `"tmp/"`.
4. The generator executable generates the task description pdf file from the filled template and copies it, all filled vhdL files and static vhdL files to the users task description path. `"autosub/src/users/<user_id>/Task<task_nr>/desc/"`.
5. The generator executable calls `"autosub/src/users/<user_id>/Task<nr>/"` with the task parameters and path to files that need to be attached to the task email for the student.

An usual sequence for submission testing in VELs is:

1. The tester executable is called by a autosub Worker thread.
2. The tester executable calls a testbench generation script `"scripts/generateTestBench.py"`.
3. The testbench generation script creates a testbench with test vectors and returns it.

4. The tester executable stores the testbench and copies needed files from the task. description to the user task directory "autosub/src/users/<user_id>/Task<task_nr>"
5. The tester executable checks if the needed submission files are present in the user task directory. These files are stored from email attachments by the Fetcher thread.
6. The tester executable analyzes files generated by the task generation, if errors occur the process stops and sends an email to student and system administrator.
7. The tester executable analyzes the student submission files, if errors occur they are written to a **error_msg** file and the process stops.
8. The tester elaborates and runs the testbench, if the tests fail meaningful messages are written to a **error_msg** file and the process stops.
9. The tester returns success.

5.2. Tasks error detection and logging

The autosub daemon calls generator and tester scripts for the individual tasks. The logging of these scripts is done by piping the output of called generator and tester scripts into separate log files. All output to stdout is piped into the logfile **tasks.stdout**, all error output to stderr is piped into the logfile **tasks.stderr**. The location of these files (default "autosub/src") can be configured using the log file. Messages to the files are logged in the format:

```
-----
<date> <time> [Task<task_nr>] <ERROR/INFO>:
-----
```

```
<logmessage>
```

An example for the tester of a submission from the gates task to **tasks.stdout** is:

```
-----
2017-05-09 15:07:16,124 [Tester1(10) ]INFO:
-----
Parsing VHDL file "gates.vhdl" into library work
Parsing VHDL file "gates_tb_10_Task1.vhdl" into library work
Parsing VHDL file "IEEE_1164_Gates_pkg.vhdl" into library work
Parsing VHDL file "IEEE_1164_Gates.vhdl" into library work
Parsing VHDL file "IEEE_1164_Gates_beh.vhdl" into library work
Parsing VHDL file "gates_beh.vhdl" into library work
Task 1 analyze success for user 10!
Task 1 not using the provided gate entities for user 10!
```

6. VELS Pre-Requisites

In the following, the installation of pre-requisites for autosub is documented for the two current debian versions. Wheezy is currently the old-stable which was used for development of autosub, and jessie is the current stable which has been used to test autosub as well.

6.1. Debian 7 (Wheezy)

The probably easiest step is to install standard debian packages:

```
apt-get install python3 python3-mock python3-pip python3-nose zip flip git
apt-get install gnat-4.6-base libgnat-4.6 texlive-latex-extra pgf graphviz
apt-get build-dep python-matplotlib
```

Unfortunately there is a small bug in one of the latex packages that we use, therefore you need to apply a patch to that package:

```
cd /usr/share/texlive/texmf-dist/tex/generic/pst-circ
patch < /path/to/autosub/doc/patch/pst-circ.tex.patch
```

In case the pdfs you get are not beautiful as you are used to, it might have happened that an update was applied over that patch and you need to re-apply it (sorry for that little mess).

Next we need to upgrade easy_install for python3 to a newer version – this is the pre-requisite for the installation of the matplotlib for python3.

```
easy_install3 -U distribute
```

And finally we may now install some libraries that are not (yet) available in the debian package system via using pip:

```
pip-3.2 install graphviz
pip-3.2 install bitstring
pip-3.2 install matplotlib
```

Last, we install a vhdl simulator. If you want to use ghdl you may download the debian package from sourceforge ¹ and install it using dpkg:

```
dpkg -i Downloads/ghdl_0.31-2wheezy1_amd64.deb
```

All the dependencies of that package have already been resolved by the above list of packages installed with apt.

To use the Simulator of Xilinx's ISE: ISim, see Section 6.3

At this point you may run the test-suite, as explained in Section 7.11. If those tests run through without complications, everything you need to run the VELS E-Learning system has been installed successfully.

6.2. Debian 8 (Jessie)

For jessie everything is even easier as more libraries are available for python3 in the apt package pool now:

```
apt-get install python3 python3-mock zip flip graphviz python3-pip
apt-get install python3-matplotlib python3-nose gnat-4.9-base libgnat-4.9
apt-get install zlib1g-dev texlive-latex-extra pgf git
```

Unfortunately there is a small bug in one of the latex packages that we use, therefore you need to apply a patch to that package:

```
cd /usr/share/texlive/texmf-dist/tex/generic/pst-circ
patch < /path/to/autosub/doc/patch/pst-circ.tex.patch
```

In case the pdfs you get are not beautiful as you are used to, it might have happended that an update was applied over that patch and you need to re-apply it (sorry for that little mess).

So now, only two more packages that need to be installed using pip:

```
pip3 install bitstring
pip3 install graphviz
```

¹<http://sourceforge.net/projects/ghdl-updates/files/Builds/ghdl-0.31/Debian/>

Last, we install a vhdl simulator. If you want to use ghdl there you can use the version from ² as there are no .deb packages for jessie of the older ghdl version (and vice-versa).

```
dpkg -i ghdl_0.33-1jessie1_amd64.deb
```

To use the Simulator of Xilinx's ISE: ISim, see Section 6.3

At this point you may run the test-suite, as explained in Section 7.11. If those tests run through without complications, everything you need to run the VELS E-Learning system has been installed successfully.

6.3. Instalation Notes for Xilinx ISE 14.7

An additional option, to using the open-source software ghdl as the VHDL Simulation tool for VELS, is to use the Simulator of Xilinx's ISE: ISim. The ISE ("Full Installer for Linux") can be downloaded from Xilinx's official download page. It requires registration and licensing agreement, but there is no charge.

For installing ISE to the default location /opt/Xilinx/ where the VELS system expects it to be, you need permission to write to this location. So we will use the user root to call the graphical installer. To do so we need to allow root to use the users X server. As a user run:

```
$ xhost +
```

to allow root (or anyone) to connect to your users X server temporarily. Now as root start the graphical installer, located at the top of the extracted download, with

```
# ./xsetup
```

In case that you are using the KDE desktop environment, you have to remove the QT_PLUGIN_PATH environment variable before starting the graphical installer:

```
# unset QT_PLUGIN_PATH
```

If you are running the VELS system on a machine without a graphical user interface, the best way we found to get Xilinx's ISE onto a remote debian server was to copy the entire installation directory after it has been installed on a non-headless machine.

²<http://sourceforge.net/projects/ghdl-updates/files/Builds/ghdl-0.33/debian/>

7. Setting up the VELS system

7.1. VELS server setup

The first thing to do when you want to install the autosub submission system and the VELS web interface is to clone the git repository:

```
git clone https://github.com/autosub-team/autosub.git
```

7.2. Configuration File Creation

The autosub config file is used to configure the connection to the mail server and set configuration parameters for the system. In order to run the autosub daemon a config file has to be created. The config file fields each belong to one of the groups embraced in [...]. An example config file can be seen below, the full list of fields and their meaning is described in Appendix Section 8.1

```
[imapserver]
servername: imap.gmail.com
serverport: 993
security: ssl
username: submission@gmail.com
password: mysupersecurepassword
email: submission@gmail.com

[smtpserver]
servername: smtp.gmail.com
serverport: 587
security: starttls
username: submission@gmail.com
password: mysupersecurepassword
email: submission@gmail.com

[system]
num_workers: 20
queue_size: 200
poll_period: 5
log_dir: /home/martin/autosub/src
log_threshold: INFO
```

```
[ course ]
tasks_dir: /home/martin/autosub/tasks/implementation/VHDL
course_name: My Cool Course
mode: normal
allow_skipping: no
auto_advance: no
```

Listing 1: example.cfg

7.3. Starting the Daemon

Autosub is implemented as a daemon process, that means all messages provided are written to files (see Section 3.4 and 5.2 for details on those files) – nothing is written to the console. The daemon is started using a shell-script located in `autosub/src/`:

```
./autosub.sh start
```

This starts the daemon using the default configuration file named `default.cfg`. If you want to use your own configuration file, you have to pass the file name to the script when starting the daemon:

```
./autosub.sh start myconfig.cfg
```

To stop the daemon just run the command:

```
./autosub.sh stop
```

7.4. Setting up the VELS_WEB Configuration Interface

To use the VELS_WEB Configuration Interface it has first to be installed and configured using these steps:

Change to the VELS_WEB directory.

```
python3 installer.py <pathtoautosub> <pathtoconfigfile>
```

Use the same configfile you used for starting the autosub daemon! This step will also download web2py to the user's home folder and set needed symbolic links to connect VELS_WEB to the autosub system.

If you change parameters in the category [system] in your autosub config file or need to switch to another config file run the installer with the reinstall flag:

```
python3 installer.py --reinstall <pathtoautosub> <pathtoconfigfile>
```

To use https you have to use a SSL key. The system expects the keyfiles (server.crt , server.csr , server.key) to be in the web2py directory. To generate keys and place them run the following (this can be skipped if you already have keyfiles you can use!):

```
./genkeys.sh
```

To start the VELS_WEB daemon at port <port> and with web2py admin password <password> (this can be set by you!) run:

```
./daemon.sh start <port> <password>
```

After this step the VELS_WEB interface will be reachable via your browser at address:

```
https://<server_ip>:<port>/VELS_WEB
```

To stop the daemon just run the command:

```
./daemon.sh stop
```

7.5. General Configuration

Configuration items that can be changed dynamically are changeable in VELS_WEB -> General Config. These configurable items are:

- **Registration Deadline:** Users who are try to register after this deadline will get an error e-mail.
- **Archive Directory:** Directory in which processed e-mails are moved, this directory has to be present on the IMAP server!
- **Administration E-Mail:** E-Mail addresses which get question and system error E-Mails.

7.6. Whitelisting

Students that participate in the course have to be whitelisted in the VELS system. If the student tries to write an E-Mail to the system from an E-Mail address that is not on the Whitelist, an E-Mail with an error message is sent to him.

Whitelisting can be done in VELS_WEB under the tab *Whitelist*. E-Mail addresses can be added one at a time or multiple at a time (mass subscription). Removal of a single E-Mail address can also be done in the VELS_WEB. Names which will be used when users register can also be specified. This is usefull, because many users don't send E-Mails with their name configured in the "From" header.

7.7. Configuring the Tasks

Existing tasks can be assembled into a task queue. This configuration is done in VELS_WEB. Each task in the queue has to be created with the following properties:

- **TaskStart:** The start datetime for the task. The task will automatically be set to active if this datetime is reached. Users waiting for a task to become active will automatically receive an e-mail with the task description for that task.
- **TaskDeadline:** The end datetime for the task. Submissions for a tasks after this datetime will be rejected.
- **TaskName:** The name of the folder with the implementation of the task in respect to the configured tasks_dir.
- **CommonFile:** Name of a common script that offers a tester functionalities. Such scripts have to be stored in a directory "_common" in the configured tasks_dir.
- **GeneratorExecutable:** The name of the generator executable.
- **TestExecutable:** The name of the tester executable.
- **Score:** The score a student gets for successful completion of the task. The scores for all completed tasks are added and can therefore also be used for grading.
- **TaskOperator:** The E-mail(s) of the operator of the task seperated by commas. These task operators are recipient of task specific questions ("Question Task N").
- **TaskActive:** The state of the task, for inactive tasks the generator won't be called.

7.8. Notes on multiple VELS instances on the same machine

The following should be adhered if you want to use multiple VELS instances on one machine:

- Use different users for running the different instances. If you don't do so you might run into problems concerning the usage of the tmp directories of tasks in the test phase.
- Be sure to use different ports when starting the VELS_WEB daemon.

7.9. Configuration Checklist

1. Installed all needed libraries and tools for autosub, the tasks and VELS_WEB.
2. Configured the E-Mail server, including an E-Mail archive folder.
3. Created a config file for autosub.
4. Started the autosub system via `autosub.sh start <configfile>`.
5. Started VELS_WEB using the daemon.
6. Configured all parameters in General Config in VELS_WEB.
7. Configured all Tasks in VELS_WEB.
8. Whitelisted all students in VELS_WEB.

If you forget one of this steps or mis-configure, autosub tries to generate a meaningful message, still it's nicer to get everything running without being yelled at.

7.10. The Exam Mode

In Exam Mode the students additionally get sent a minimal testbench to test their design. To enable test mode, change the challenge-mode to exam in VELS_WEB -> General Config for an existing course (databases exist) and in the config file for a new course (databases don't exist).

The remaining configuration is similar to configuration for normal mode.

7.11. Testing VELs

VELs has a testing suite located in "autosub/src/tests". It consists of unit and doctests, testing both the autosub system and the tasks itself. With this test suite you can test if everything is set up the right way before starting a course. To run the test suite issue the following command from the "autosub/src/" directory:

```
nosetests3 --with-doctest --doctest-extension=txt --nologcapture -v
```

This will run all doctest as well as unittest test cases.

If you also want the code coverage of the test-suite then run it as follows:

```
nosetests3 --with-doctest --doctest-extension=txt --nologcapture -v --with-coverage
```

While the above commands run all of the tests, it is also possible to include or exclude only specific tests. In example it is possible to only execute the load test:

```
nosetests3 --nologcapture -s -v tests/load_test.py:Test_LoadTest
```

or it is possible to exclude the load test (which makes sense, as that one takes a considerable amount of time):

```
nosetests3 --nologcapture -s -v --ignore-files=load_test.py
```

The following is tested by the testsuite:

- Connecting to the databases.
- Logging a message.
- Sending an E-Mail.
- Functionality of the activator thread.
- Functionality of the generator thread.
- Functionality of the sender thread.
- Functionality of the fetcher thread.
- Functionality of the common used functions.
- Behavior under high load (load test).
- Creation off all description files for every task.
- Compilation of all generated VHDL files with ghdl.
- Tester functionalities for given right submissions with ghdl.

8. Appendix

8.1. Config file fields

The configuration file can include the following groups and fields. Bold fields are mandatory, all other fields can be omitted. Default paths are in respect to the `autosub/src` directory

[imapserver]

| Field | Description | Default |
|-------------------|---|------------------|
| servername | Hostname.domain of the IMAP server. | |
| username | Username to be used to login. | |
| password | Password to be used to login. | |
| email | E-Mail address to be used at the IMAP server. | |
| security | Security protocol to be used when connecting. Possible values: none ssl starttls | ssl |
| serverport | Port to be used. | ssl:993 else:143 |

[smtpserver]

| Field | Description | Default |
|-------------------|---|-----------------------------------|
| servername | Hostname.domain of the SMTP server. | |
| username | Username to be used to login. | |
| password | Password to be used to login. | |
| email | E-Mail address to be used at the SMTP server. | |
| security | Security protocol to be used when connecting. Possible values: none ssl starttls | starttls |
| serverport | Port to be used. | ssl:465 start- tls:587 none:25 |

[system]

| Field | Description | Default |
|--------------------|--|-------------|
| num_workers | Number of Worker threads. This influences how many tests can be conducted in parallel. | |
| queue_size | Size of the thread communication queues. | |
| poll_period | Period in seconds at which the mailbox is checked. | 60 |
| semesterdb | The name and path of the semester database. | semester.db |
| coursedb | The name and path of the course database. | course.db |
| log_dir | Directory to put tasks and autosub log files. | logs |

| | | |
|----------------|---|------|
| log_threshhold | Threshold from which level up log entries should be logged. Possible values: DEBUG INFO WARNING ERROR | INFO |
|----------------|---|------|

[course]

| Field | Description | Default |
|-----------------|---|-----------------|
| specialmsgs_dir | Directory for messages that are sent to users on special events. | SpecialMessages |
| tasks_dir | Directory of the tasks implementations. | |
| course_name | The name of the course. | No name set |
| mode | The mode in which to run. Possible values: exam normal). | normal |
| allow_skipping | Allows users to skip ahead to the next task with a skip email. Possible values: yes no | no |
| auto_advance | Decides if users get auto advanced to a task which is activated by its TaskStart. Possible values: yes no | no |

8.2. Description of the message queues

job_queue The job_queue is used to trigger Worker threads to start testing solutions that were received. The messages in the job_queue are comprised of the following fields:

- **user_id:** The unique User ID of the user who submitted this solution.
- **user_email:** The E-Mail address of the user who submitted this solution.
- **task_nr:** Number of the task that solution has been submitted for.
- **message_id:** The unique message-id of the E-Mail on the server.

sender_queue If a thread wants to send an E-Mail to a user, the Sender thread is notified via this queue. The data needed by the Sender thread is in the messages in the sender_queue. These messages consist of the following fields:

- **user_id:** The unique User ID of the user who shall receive this E-Mail.
- **recipient** E-Mail address of the recipient (the content of the 'To' field in the E-Mail).
- **message_type** The message type is used to decide on how to format the E-Mail, and whether or not additional E-Mails have to be sent out (e.g. when a question is handled). Possible message_types are:

- **Task** – A task description.
 - **Success** – A Task has been tested successfully.
 - **Failed** – An error message for a failed test-run of a result submission.
 - **SecAlert** – Scanning the code revealed that this might be an attack on the system.
 - **TaskAlert** – An error message for failures in files that were created for tasks.
 - **InvalidTask** – A result submission for a non-existent task.
 - **Usage** – An E-Mail with usage explanation shall be sent to the student.
 - **Question** – Confirm that a question was received.
 - **QFwd** – Forward a question to the administrator.
 - **Welcome** – Send a welcome message to a new student.
 - **NotAllowed** – A user who is not on the whitelist sent a mail to the system.
 - **SkipNotPossible** – A user wants to skip to the next task, when he is either at the last task or the next task has not started yet.
 - **TaskNotSubmittable** – A user wants to submit to a task which has not started yet.
- **task_nr** Number of the task that message concerns (e.g. the current one if the test failed, the next one if the task description shall be sent).
 - **message_id**: The unique message-id of the E-Mail on the server.

logger_queue Trigger the logger to write a log message about an event that happened.

- **message**: The text that describes the event that shall be logged.
- **level**: The log-level of this log message; available log-levels are DEBUG, INFO, WARNING and ERROR.
- **src**: Name of the thread that reported the event that shall be logged.
- **dst**: Log destination (autosub log, task message, task error).

generator_queue The generator_queue is used to trigger the Generator thread to generate a new (variant of) a task. That means that certain parameters of the task are randomized, in order to assure that each student receives his/her very own example.

- **user_id:** The unique UserID of the User for whom the task is generated.
- **user_email:** E-Mail address of the User for whom the task is generated.
- **task_nr:** Number of the task that shall be generated.
- **message_id:** The unique message-id of the E-Mail on the server.

archive_queue The archive_queue is used to announce that a E-Mail has been finished processing. This triggers archiving and removing task submissions from the active queue. own example.

- **message_id:** The unique message-id of the E-Mail on the server.
- **is_finished_job:** Flag to show that the message-id belongs to a finished processed submitted task.

8.3. Semester database semester.db

The database semester.db contains the following tables (and entries in those tables):

| | |
|---------------|--|
| Table Name | Users |
| Description | Used to collect all necessary information on the Students. |
| Table Entries | <ul style="list-style-type: none"> • UserId: A unique UserID given at registration time (when the first E-Mail is received from the users E-Mail address). • Name: The name of the user as specified in the "from" field of the E-Mail. • Email: The E-Mail address of the user as specified in the "from" field of the E-Mail. • FirstMail: Timestamp of the first E-Mail received by this user. • LastDone: Timestamp of the email that contained the successful solution of the last task (only if this user has already finished the last task). • CurrentTask: The task the user is currently working on. |

| | |
|---------------|--|
| Table Name | TaskStats |
| Description | Contains one entry for each available task, collecting statistics on the individual tasks. |
| Table Entries | <ul style="list-style-type: none">• TaskId: Unique ID of the task.• NrSubmissions: Number of solutions received for the task with this TaskId.• NrSuccessful: Number of correct solutions received for the task with this TaskId. |

| | |
|---------------|---|
| Table Name | TaskCounters |
| Description | Implements counters for certain events, examples for such events are: E-Mail received, E-Mail sent, question received, new user. |
| Table Entries | <ul style="list-style-type: none">• CounterId: Unique ID of the counter.• Name: Name of the counter.• Value: Value of the counter. |

| | |
|---------------|--|
| Table Name | UserTasks |
| Description | Used to map configured tasks to users – e.g. store the generated examples so they can be fetched later on for testing. |
| Table Entries | <ul style="list-style-type: none">• TaskNr: Unique number of the task.• UserId: Unique ID of the user – the combination of TaskNr and UserId make the entry unique.• TaskParameters: Either the parameters that describe the setting for this particular student, or a value that can be used to derive the parameters from.• TaskDescription: Message that describes the task that was specifically generated for the student. and shall be sent to the student.• TaskAttachments: List of attachments that shall be sent to the student (path+filename).• NrSubmissions: Number of submissions the student has done for this task.• FirstSuccessful: Number of the first successful submission. |

| | |
|---------------|---|
| Table Name | UserWhiteList |
| Description | A Whitelist of E-Mail addresses that shall be authorized to interact with the system. |
| Table Entries | <ul style="list-style-type: none">• UniqueId: Unique ID in the whitelist table.• Email: E-mail address that shall be authorized to interact with the system.• Name: The name the user shall be assigned instead of the value from the "From" field of the registration E-Mail. |

8.4. Course database `course.db`

The database `course.db` contains the following tables (and entries in those tables):

| | |
|---------------|---|
| Table Name | TaskConfiguration |
| Description | Used to configure tasks, including their order, the scripts used to test submissions, etc. |
| Table Entries | <ul style="list-style-type: none">• TaskNr: The unique number of the task – this number is used to establish the order of tasks as received by the students.• TaskStart: Timestamp of when the task shall be available for students (if any).• TaskDeadline: The deadline until which the task has to be successfully submitted (if any).• TaskName: The name of the task folder of the task in respect to the configured <code>tasks_</code> directory.• CommonFile: Name of a common script that offers a tester functionalities.• GeneratorExecutable: The executable (script, binary, etc.) used to generate unique examples for each student. If this is not set, all students will receive the same task.• TestExecutable: The executable (script, binary, etc.) used to test the results submitted by the students.• Score: The points the student scores by solving this task.• TaskOperator: The E-Mail address of the course operator, who is responsible for this task. |

| | |
|---------------|--|
| Table Name | SpecialMessages |
| Description | A collection of texts that shall be sent, in the case special events. |
| Table Entries | <ul style="list-style-type: none"> • EventName: Currently the following events are implemented: <ul style="list-style-type: none"> • WELCOME – A welcome message that is sent upon first E-Mail from a student and that gives an explanation of how the system works. • USAGE – In case an E-Mail that can not be interpreted is received, this messageshall be sent to the user. • QUESTION – A message that is sent as a confirmation if a question was received. • INVALID – A message that is sent, in case a result for an invalid task has been received. • CONGRATS – A message that congratulates the student upon solving the last task. • REGOVER – A message sent in case a student tries to register after the registration deadline has passed. • NOTALLOWED – A mesage sent in case the student is not on the whitelist. • CURLAST – A message sent to inform the student that he has solved the current last task. • DEADTASK – A message sent to inform the student that he submitted a task which's deadline is allready over. • SKIPNOTPOSSIBLE – A message sent to the user that the skip he requested was not possible. Only sent if skipping is allowed. • TASKNOTSUBMITTABLE – A message sent to the user to tell him that he cannot submit a solution to a task he has not received yet. • Text: The text that shall be sent in case of the event Event-Name occurs. |

| | |
|---------------|---|
| Table Name | GeneralConfig |
| Description | Store some general configuration for the semester to be used in the VELS_WEB interface. |
| Table Entries | <ul style="list-style-type: none">• ConfigItem: Name of the Configuration Item.• Content: Content of the Configuration Item. |

8.5. Handling of concurrent testing

Handling of testing multiple submissions from users is handled in autosub in the following ways:

- Multiple Worker threads and seperated user tasks directories make it possible that multiple task submissions can be processed at the same time.
- Active task submissions are put in an active queue and removed once they have been fully processed and an response has been sent to the student. Active task submissions that are not processed after 5 minutes are presumed dead and removed from the active queue.
- To prevent conflicts only one combination of user and task_nr is allowed to be active at any time. If the user submits a solution for the same task before it has been fully processed, it will be put in a backlog queue. Tasks from backlog are made active once the conflicting submission has been fully processed.

Abbreviations

- IMAP** Internet Message Access Protocol. 6
- SMTP** Simple Mail Transfer Protocol. 6, 7
- VHDL** VHSIC Hardware Description Language. 2
- VHSIC** Very High Speed Integrated Circuit. 2

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