The OSVVM Simulator Script Library

The OSVVM Simulator Script Library provides a simple way to create and activate libraries, compile designs, and run simulations.

The intent of this scripting approach is to:

- Run the same scripts on any simulator
- Be as easy to read as a compile order list.
- Know the directory the script is in, the script only manages relative paths to itself. No Awkward path management in the scripts.
- Simplify integration of other libraries

This is an evolving approach. So it may change in the future. Input is welcome.

1 Start by Running the Demo

1.1 Download OSVVM Libraries

OSVVM is available as either a git repository OSVVM Libraries or a zip file from osvvm.org Downloads Page.

On GitHub, all OSVVM libraries are a submodule of the repository OsvvmLibraries. Download all OSVVM libraries using git clone with the "–recursive" flag:

```
$ git clone --recursive https://github.com/osvvm/OsvvmLibraries
```

1.2 Create a Sim directory

Create a simulation directory. Generally I name this "sim" or "sim_vendor-name". Creating a simulation directory means that cleanup before running regressions is just a matter of deleting the sim directory and recreating a new one.

The following assumes you have created a directory named "sim" in the OsvvmLibraries directory.

Alternately, you can run simulations out of the Scripts, but cleanup is a mess as a simulator tends to create numerous temporaries.

1.3 Start the Script environment in the Simulator

Do the actions appropriate for your simulator.

1.3.1 Aldec RivieraPRO, Siemens QuestaSim and ModelSim

Initialize the OSVVM Script environment by doing:

```
source <path-to-OsvvmLibraries>/OsvvmLibraries/Scripts/StartUp.tcl
```

Want to avoid doing this every time? In Aldec RivieraPro, set the environment variable, ALDEC_STARTUPTCL to StartUp.tcl (including the path information). Similarly in Mentor QuestaSim/ModelSim, set the environment variable, MODELSIM_TCL to StartUp.tcl (including the path information).

1.3.2 Aldec ActiveHDL

Initialize the OSVVM Script environment by doing:

```
scripterconf -tcl
do -tcl <path-to-OsvvmLibraries>/OsvvmLibraries/Scripts/StartUp.tcl
```

Want to avoid doing this every time? For ActiveHDL, edit /script/startup.do and add above to it. Similarly for VSimSA, edit /BIN/startup.do and add the above to it. Note, with 2021.02, you no longer need to set the "Start In" directory to the OSVVM Scripts directory.

1.3.3 GHDL in Windows

Initialize the OSVVM Script environment by doing:

```
winpty tclsh
source <path-to-OsvvmLibraries>/OsvvmLibraries/Scripts/StartUp.tcl
```

To simplify this, put `source <path-to-OsvvmLibraries>/OsvvmLibraries/Scripts/StartUp.tcl` in the `.tclshrc` file. You can also add a windows short cut that includes `C:\tools\msys64\mingw64.exe winpty tclsh`.

1.3.4 GHDL in Linux

Initialize the OSVVM Script environment by doing:

```
rlwrap tclsh
source <path-to-OsvvmLibraries>/OsvvmLibraries/Scripts/StartUp.tcl
```

To simplify this, put `source <path-to-OsvvmLibraries>/OsvvmLibraries/Scripts/StartUp.tcl` in the `.tclshrc` file. In bash, add `alias gsim='rlwrap tclsh'` to your `.bashrc`.

1.3.5 Synopsys VCS

Initialize the OSVVM Script environment by doing:

```
rlwrap tclsh
source <path-to-OsvvmLibraries>/OsvvmLibraries/Scripts/StartVCS.tcl
```

To simplify this, put `source <path-to-OsvvmLibraries>/OsvvmLibraries/Scripts/StartVCS.tcl` in the `.tclshrc` file. In bash, add `alias ssim='rlwrap tclsh'` to your `.bashrc`.

1.3.6 Cadence Xcelium

Initialize the OSVVM Script environment by doing:

```
rlwrap tclsh
source <path-to-OsvvmLibraries>/OsvvmLibraries/Scripts/StartXcelium.tcl
```

To simplify this, put `source <path-to-OsvvmLibraries>/OsvvmLibraries/Scripts/StartXcelium.tcl` in the `.tclshrc` file. In bash, add `alias ssim='rlwrap tclsh'` to your `.bashrc`.

1.3.7 Xilinx XSIM

Using OSVVM in Xilinx XSIM is under development. So far, Xilinx seems to be able to compile OSVVM utility library, however, we have not had any of our internal test cases pass.

To run OSVVM scripts in XSIM, start Vivado and then run the StartXSIM script shown below:

```
source <path-to-OsvvmLibraries>/OsvvmLibraries/Scripts/StartXSIM.tcl
```

If someone from XILINX is interested, the internal OSVVM utility library testbenches can be provided under an NDA.

1.4 Run the Demos

Do the following in your simulator command line:

```
build  ../OsvvmLibraries
build  ../OsvvmLibraries/RunDemoTests.pro
```

These will produce some reports, such as OsvvmLibraries_RunDemoTests.html. We will discuss these in the next section, OSVVM Reports.

2 Writing Scripts by Example

OSVVM Scripts are an API layer that is build on top of TCL. The API layer simplifies the steps of running simulations. For most applications you will not need any TCL, however, it is there if you need more capability.

2.1 Basic Script Commands

- **library <library-name>**
  - Make this library the active library. Create it if it does not exist.
- **analyze <VHDL-file>**
  - Compile (aka analyze) the design into the active library.
- **simulate <test-name>**
  - Simulate (aka elaborate + run) the design using the active library.
- **include <script-name>.pro**
  - Include another project script
- **build <script-name>.pro**
  - Start a script from the simulator. It is include + start a new log file for this script.

Scripts are named in the form `<script-name>.pro`. The scripts are TCL that is agumented with the OSVVM script API. The script API is created using TCL procedures.

For more details, see Command Summary later in this document.

2.2 Running a Simple Test

At the heart of running a simulation is setting the library, compiling files, and starting the simulation. To do this, we use library, analyze, and simulate.

The following is an excerpt from the scripts used to run OSVVM verification component library regressions.

```
library  osvvm_TbAxi4_MultipleMemory
analyze  TestCtrl_e.vhd
analyze  TbAxi4_MultipleMemory.vhd
analyze  TbAxi4_Shared1.vhd
TestCase TbAxi4_Shared1
simulate TbAxi4_Shared1
```

In OSVVM scripting, calling library activates the library. An analyze or simulate that follows library uses the specified library. This is consistent with VHDL's sense of the "working library".

Note that there are no paths to the files. For OSVVM commands that use paths, the path is always relative to the directory the script is located in unless an absolute path is specified.

The above script is in the file, testbench_MultipleMemory.pro. It can be run by specifying:

```
build
../OsvvmLibraries/AXI4/Axi4/testbench_MultipleMemory/testbench_MultipleMemory
.pro
```

If you were to open testbench_MultipleMemory.pro, you would find that RunTest is used instead as it is an abbreviation for the analyze, TestCase and simulate when the names are the same.

2.3 Adding Scripts to Simulate

Often with simulations, we want to add a custom waveform file. This may be for all designs or just one particular design. We may also need specific actions to be done when running on a particular simulator.

When simulate (or RunTest) is called, it will source the following files in order, if they exist:

- <ToolVendor>.tcl
- <ToolName>.tcl
- wave.do
- <LibraryUnit>.tcl
- <LibraryUnit>_<simulator>.tcl
- <TestCaseName>.tcl
- <TestCaseName>_<simulator>.tcl

ToolVendor is either {Aldec, Siemens, Cadence, Synopsys}. ToolName is one of {QuestaSim, ModelSim, RivieraPRO, ActiveHDL, VCS, Xcelium}. LibraryUnit is the name specified to simulate or RunTest. TestCaseName is the name specified to TestCase.

It will search for these files in the following directories:

- OsvvmLibraries/Scripts
- CurrentSimulationDirectory
- CurrentWorkingDirectory

CurrentSimulationDirectory is the directory in which the simulator is running. CurrentWorkingDirectory is the directory of the script that calls either RunTest or simulate.

Currently GHDL does not run any extra scripts since it is a batch simulator.

2.4 Including Scripts

We build our designs hierarchically. Therefore our scripts need to be build hierarchically. When one script calls another script, such as OsvvmLibraries.pro does, we use include. The code for OsvvmLibraries.pro is as follows. The `if` is TCL and is only building the UART, AXI4, and DpRam if their corresponding directories exist.

```
include ./osvvm/osvvm.pro
include ./Common/Common.pro

if {[DirectoryExists UART]} {
  include ./UART/UART.pro
}
if {[DirectoryExists AXI4]} {
  include ./AXI4/AXI4.pro
}
if {[DirectoryExists DpRam]} {
  include ./DpRam/DpRam.pro
}
```

Note the paths specified to include are relative to OsvvmLibriaries directory since that is where OsvvmLibraries.pro is located.

2.5 Building the OSVVM Libraries

Build is a layer on top of include (it calls include) that creates a logging point. In general, build is called from the simulator API (when we run something) and include is called from scripts.

By default, OSVVM creates collects all tool output for a build into an html based log file in ./logs/<tool_name>-<version>/<script-name>.html.

To compile all of the OSVVM libraries, use build as shown below.

```
build ../OsvvmLibraries/OsvvmLibraries.pro
```

2.6 Running OSVVM Test Cases

All OSVVM verification components are delivered with their regression test suite. There is also a script, named RunAllTests.pro, that runs all of the tests for that specific VC.

To run the AXI4 Full verification component regression suite, use the build shown below.

```
build ../OsvvmLibraries/AXI4/Axi4/RunAllTests.pro
```

Everything in OSVVM is composed hierarchically. If you want to run all AXI4 (Axi4 Full, Axi4Lite, and AxiStream), use the build shown below.

```
build ../OsvvmLibraries/AXI4/RunAllTests.pro
```

Similarly to run the tests for all VC in OsvvmLibraries use the build shown below.

```
build ../OsvvmLibraries/AXI4/RunAllTests.pro
```

For most VC and OsvvmLibraries, there is a RunDemoTests.pro that runs a small selection of the VC test cases.

2.7 Do not use TCL's source or EDA tool's do

OSVVM uses include since it helps manage the path of where the script files are located. Include uses TCL's `source` internally. However, if you use TCL's `source` (or EDA tool's `do`) instead, you will not get include's directory management features and your scripts will need to manage the directory paths themselves.

2.8 Do not use TCL's cd

Simulators create files containing library mappings and other information in the simulation directory. As a result, when running scripts, you do not want to use `cd` as simulator will be lost as the information it needs is spread across several directories.

3 OSVVM's Reports

Good reports simplify debug and help find problems quickly. This is important as according to the 2020 Wilson Verification Survey FPGA verification engineers spend 46% of their time debugging.

OSVVM produces the following reports:

- HTML Build Summary Report for human inspection that provides test completion status.
- JUnit XML Build Summary Report for use with continuous integration (CI/CD) tools.
- HTML Test Case Detailed report for each test case with Alert, Functional Coverage, and Scoreboard reports.
- HTML based simulator transcript/log files (simulator output)
- Text based test case transcript file (from TranscriptOpen)

The best way to see the reports is to look at the ones from the demo. If you have not already done `build OsvvmLibraries/RunDemoTests.pro`, then do so now.

3.1 HTML Build Summary Report

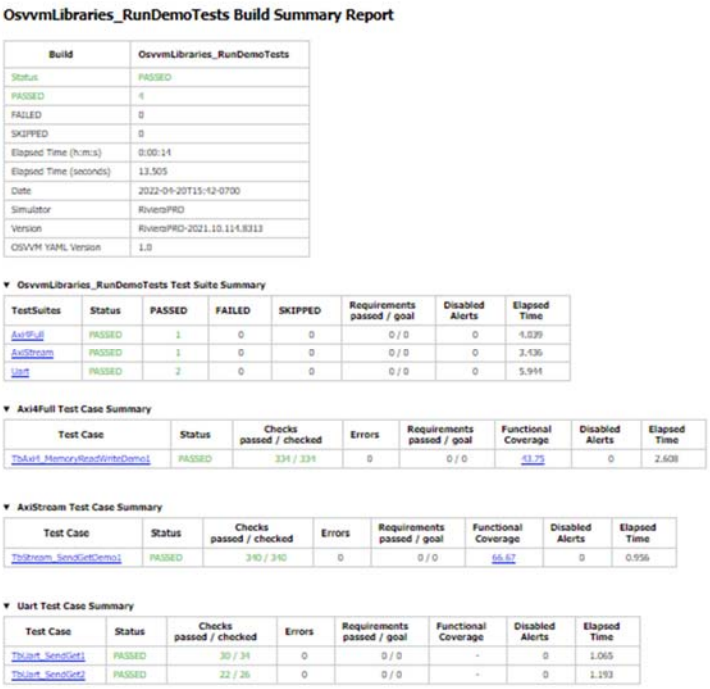
The Build Summary Report allows us to quickly confirm if a build passed or quickly identify which test cases did not PASS.

The Build Summary Report has three distinct pieces:

- Build Status
- Test Suite Summary
- Test Case Summary

For each Test Suite and Test Case, there is additional information, such as Functional Coverage and Disabled Alert Count.

In the sim directory, the Build Summary Report is in the file OsvvmLibraries_RunDemoTests.html.



OsvvmLibraries_RunDemoTests Build Summary Report

Build	OsvvmLibraries_RunDemoTests
Status	PASSED
PASSED	4
FAILED	0
SKIPPED	0
Elapsed Time (h:m:s)	0:00:14
Elapsed Time (seconds)	13.505
Date	2022-04-20T15:42-0700
Simulator	RivieraPRO
Version	RivieraPRO-2021.10.114.8313
OSVVM YAML Version	1.0

▼ OsvvmLibraries_RunDemoTests Test Suite Summary

TestSuites	Status	PASSED	FAILED	SKIPPED	Requirements passed / goal	Disabled Alerts	Elapsed Time
AxiMFull	PASSED	1	0	0	0 / 0	0	4.839
AxiStream	PASSED	1	0	0	0 / 0	0	3.436
Uart	PASSED	2	0	0	0 / 0	0	5.944

▼ Axi4Full Test Case Summary

Test Case	Status	Checks passed / checked	Errors	Requirements passed / goal	Functional Coverage	Disabled Alerts	Elapsed Time
TbAxi4_MemoryReadWriteDemo1	PASSED	334 / 334	0	0 / 0	43.75	0	2.608

▼ AxiStream Test Case Summary

Test Case	Status	Checks passed / checked	Errors	Requirements passed / goal	Functional Coverage	Disabled Alerts	Elapsed Time
TbStream_SendGetDemo1	PASSED	340 / 340	0	0 / 0	66.67	0	0.956

▼ Uart Test Case Summary

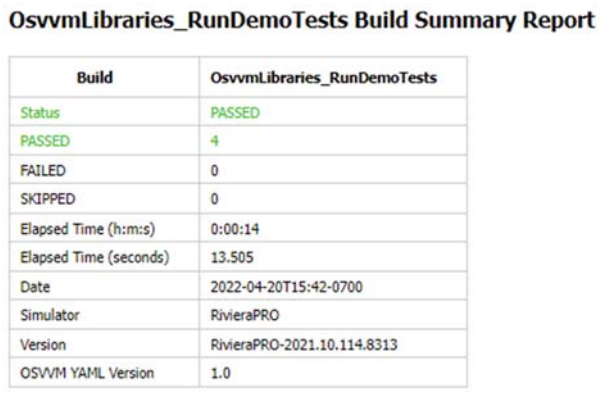
Test Case	Status	Checks passed / checked	Errors	Requirements passed / goal	Functional Coverage	Disabled Alerts	Elapsed Time
TbUart_SendGet1	PASSED	30 / 34	0	0 / 0	-	0	1.065
TbUart_SendGet2	PASSED	22 / 26	0	0 / 0	-	0	1.193

Build Summary Report

Note that any place in the report there is a triangle preceding text, pressing on the triangle will rotate it and either hide or reveal additional information.

3.1.1 Build Status

The Build Status, shown below, is in a table at the top of the Build Summary Report. If code coverage is run, there will be a link to the results at the bottom of the Build Summary Report.



OsvvmLibraries_RunDemoTests Build Summary Report

Build	OsvvmLibraries_RunDemoTests
Status	PASSED
PASSED	4
FAILED	0
SKIPPED	0
Elapsed Time (h:m:s)	0:00:14
Elapsed Time (seconds)	13.505
Date	2022-04-20T15:42-0700
Simulator	RivieraPRO
Version	RivieraPRO-2021.10.114.8313
OSVVM YAML Version	1.0

Build Status

3.1.2 Test Suite Summary

When running tests, test cases are grouped into test suites. A build can include multiple test suites. The next table we see in the Build Summary Report is the Test Suite Summary. The figure below shows that this build includes the test suites Axi4Full, AxiStream, and UART.

▼ OsvvmLibraries_RunDemoTests Test Suite Summary

TestSuites	Status	PASSED	FAILED	SKIPPED	Requirements passed / goal	Disabled Alerts	Elapsed Time
Axi4Full	PASSED	1	0	0	0 / 0	0	4.039
AxiStream	PASSED	1	0	0	0 / 0	0	3.436
Uart	PASSED	2	0	0	0 / 0	0	5.944

Test Suite Summary

3.1.3 Test Case Summary

The remainder of the Build Summary Report is Test Case Summary, see below. There is a seprate Test Case Summary for each test suite in the build.

▼ Axi4Full Test Case Summary

Test Case	Status	Checks passed / checked	Errors	Requirements passed / goal	Functional Coverage	Disabled Alerts	Elapsed Time
TbAxi4_MemoryReadWriteDemo1	PASSED	334 / 334	0	0 / 0	43.75	0	2.608

▼ AxiStream Test Case Summary

Test Case	Status	Checks passed / checked	Errors	Requirements passed / goal	Functional Coverage	Disabled Alerts	Elapsed Time
TbStream_SendGetDemo1	PASSED	340 / 340	0	0 / 0	66.67	0	0.956

▼ Uart Test Case Summary

Test Case	Status	Checks passed / checked	Errors	Requirements passed / goal	Functional Coverage	Disabled Alerts	Elapsed Time
TbUart_SendGet1	PASSED	30 / 34	0	0 / 0	-	0	1.065
TbUart_SendGet2	PASSED	22 / 26	0	0 / 0	-	0	1.193

Test Case Summary

3.2 JUnit XML Build Summary Report

The JUnit XML Build Summary Report works with continuous integration (CI/CD). The CI/CD tools use this to understand if the test is passing or not. They also have facilities for displaying the report - however, the OSVVM HTML format provides a superset of information.

OSVVM runs regressions on GitHub.

3.3 HTML Test Case Detailed Report

For each test case that is run (simulated), a Test Case Detailed Report is produced that contains consists of the following information:

- Test Information Link Table

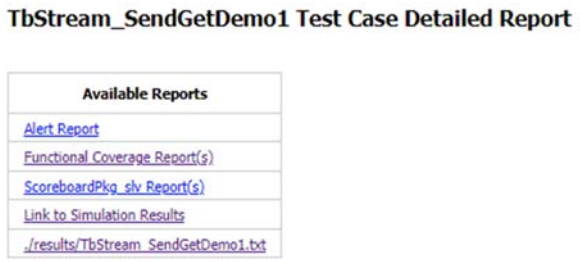
- Alert Report
- Functional Coverage Report(s)
- Scoreboard Report(s)
- Link to Test Case Transcript (opened with Transcript Open)
- Link to this test case in HTML based simulator transcript

After running one of the regressions, open one of the HTML files in the directory ./reports/<test-suite-name>.

Note that any place in the report there is a triangle preceding text, pressing on the triangle will rotate it and either hide or reveal additional information.

3.3.1 Test Information Link Table

The Test Information Link Table is in a table at the top of the Test Case Detailed Report. The figure below has links to the Alert Report (in this file), Functional Coverage Report (in this file), Scoreboard Reports (in this file), a link to simulation results (if the simulation report is in HTML), and a link to any transcript files opened by OSVVM.



Test Information Link Table

3.3.2 Alert Report

The Alert Report, shown below, provides detailed information for each AlertLogID that is used in a test case.

TbStream_SendGetDemo1 Alert Report

▼ **TbStream_SendGetDemo1 Alert Settings**

Setting		Value	Description
FailOnWarning		true	If true, warnings are a test error
FailOnDisabledErrors		true	If true, Disabled Alert Counts are a test error
FailOnRequirementErrors		true	If true, Requirements Errors are a test error
External	Failures	0	Added to Alert Counts in determine total errors
	Errors	0	
	Warnings	0	
Expected	Failures	0	Subtracted from Alert Counts in determine total errors
	Errors	0	
	Warnings	0	

▼ **TbStream_SendGetDemo1 Alert Results**

Name	Status	Checks		Total Errors	Alert Counts			Requirements		Disabled Alert Counts		
		Passed	Total		Failures	Errors	Warnings	Passed	Checked	Failures	Errors	Warnings
TbStream_SendGetDemo1	PASSED	340	340	0	0	0	0	0	0	0	0	0
Default	PASSED	67	67	0	0	0	0	0	0	0	0	0
OSVVM	PASSED	0	0	0	0	0	0	0	0	0	0	0
Cov1	PASSED	0	0	0	0	0	0	0	0	0	0	0
Cov2	PASSED	0	0	0	0	0	0	0	0	0	0	0
Cov1a	PASSED	0	0	0	0	0	0	0	0	0	0	0
Cov2a	PASSED	0	0	0	0	0	0	0	0	0	0	0
Cov1b	PASSED	0	0	0	0	0	0	0	0	0	0	0
Cov2b	PASSED	0	0	0	0	0	0	0	0	0	0	0
transmitter_1	PASSED	0	0	0	0	0	0	0	0	0	0	0
No response	PASSED	0	0	0	0	0	0	0	0	0	0	0
TransmitFifo	PASSED	0	0	0	0	0	0	0	0	0	0	0
TxBurstFifo	PASSED	0	0	0	0	0	0	0	0	0	0	0
receiver_1	PASSED	30	30	0	0	0	0	0	0	0	0	0
Data Check	PASSED	32	32	0	0	0	0	0	0	0	0	0
No response	PASSED	0	0	0	0	0	0	0	0	0	0	0
ReceiveFifo	PASSED	0	0	0	0	0	0	0	0	0	0	0
RxBurstFifo	PASSED	211	211	0	0	0	0	0	0	0	0	0

Alert Report

3.3.3 Functional Coverage Report(s)

The Test Case Detailed Reportcontains a Functional Coverage Report, shown below, for each functional coverage model used in the test case. Note this report is not from the demo.

Uart7_Random_part3 Coverage Report

Total Coverage: 100.00

▼ **UART_RX_STIM_COV Coverage Model** **Coverage: 100.0**

▼ UART_RX_STIM_COV Coverage Settings

CovWeight	1
Goal	100.0
WeightMode	AT_LEAST
Seeds	824213985 792842968
CountMode	COUNT_FIRST
IllegalMode	ILLEGAL_ON
Threshold	45.0
ThresholdEnable	FALSE
TotalCovCount	100
TotalCovGoal	100

▼ UART_RX_STIM_COV Coverage Bins

Name	Type	Mode	Data	Idle	Count	AtLeast	Percent Coverage
NORMAL	COUNT	1 to 1	0 to 255	0 to 0	63	63	100.0
NORMAL	COUNT	1 to 1	0 to 255	1 to 15	7	7	100.0
PARITY	COUNT	3 to 3	0 to 255	2 to 15	11	11	100.0
STOP	COUNT	5 to 5	1 to 255	2 to 15	11	11	100.0
PARITY_STOP	COUNT	7 to 7	1 to 255	2 to 15	6	6	100.0
BREAK	COUNT	9 to 15	11 to 30	2 to 15	2	2	100.0
Total Percent Coverage:	100.0						

▼ **UART_RX_COV Coverage Model** **Coverage: 100.0**

► UART_RX_COV Coverage Settings

▼ UART_RX_COV Coverage Bins

Name	Type	Mode	Count	AtLeast	Percent Coverage
NORMAL	COUNT	1 to 1	70	1	7000.0
PARITY	COUNT	3 to 3	11	1	1100.0

Functional Coverage Report

3.3.4 Scoreboard Report(s)

The Test Case Detailed Report contains a Scoreboard Report, shown below, for each scoreboard model used in the test case.

TbStream_SendGetDemo1 Scoreboard Report

▼ **TransmitFifo Scoreboard**

Name	TransmitFifo
ItemCount	317
ErrorCount	0
ItemsChecked	0
ItemsPopped	317
ItemsDropped	0

▼ **ReceiveFifo Scoreboard**

Name	ReceiveFifo
ItemCount	317
ErrorCount	0
ItemsChecked	0
ItemsPopped	317
ItemsDropped	0

▼ **TxBurstFifo Scoreboard**

Name	TxBurstFifo
ItemCount	253
ErrorCount	0
ItemsChecked	0
ItemsPopped	253
ItemsDropped	0

Scoreboard Report

3.4 Test Case Transcript

OSVVM's transcript utility facilitates collecting all test output to into a single file, as shown below.

```
%% Log   ALWAYS  in Default, Transmit 32 words at 110 ns
%% Log   INFO    in transmitter_1, Axi Stream Send.  TData: 00000001  TStrb: 1111  TKeep: 1111  TID: 00  TDest: 0  TUser: 0  TLast: 0  Operation# 1 at 110 ns
%% Log   INFO    in receiver_1, Word Receive.  Operation# 1  Data: 00000001  TID: 00  TDest: 0  TUser: 0  TLast: 0 at 120 ns
%% Log   PASSED  in Default, RxData Received : 00000001 at 120 ns
%% Log   INFO    in transmitter_1, Axi Stream Send.  TData: 00000002  TStrb: 1111  TKeep: 1111  TID: 00  TDest: 0  TUser: 0  TLast: 0  Operation# 2 at 120 ns
%% Log   INFO    in receiver_1, Word Receive.  Operation# 2  Data: 00000002  TID: 00  TDest: 0  TUser: 0  TLast: 0 at 130 ns
%% Log   PASSED  in Default, RxData Received : 00000002 at 130 ns
%% Log   INFO    in transmitter_1, Axi Stream Send.  TData: 00000003  TStrb: 1111  TKeep: 1111  TID: 00  TDest: 0  TUser: 0  TLast: 0  Operation# 3 at 130 ns
%% Log   INFO    in receiver_1, Word Receive.  Operation# 3  Data: 00000003  TID: 00  TDest: 0  TUser: 0  TLast: 0 at 140 ns
%% Log   PASSED  in Default, RxData Received : 00000003 at 140 ns
%% Log   INFO    in transmitter_1, Axi Stream Send.  TData: 00000004  TStrb: 1111  TKeep: 1111  TID: 00  TDest: 0  TUser: 0  TLast: 0  Operation# 4 at 140 ns
%% Log   INFO    in receiver_1, Word Receive.  Operation# 4  Data: 00000004  TID: 00  TDest: 0  TUser: 0  TLast: 0 at 150 ns
%% Log   PASSED  in Default, RxData Received : 00000004 at 150 ns
%% Log   INFO    in transmitter_1, Axi Stream Send.  TData: 00000005  TStrb: 1111  TKeep: 1111  TID: 00  TDest: 0  TUser: 0  TLast: 0  Operation# 5 at 150 ns
%% Log   INFO    in receiver_1, Word Receive.  Operation# 5  Data: 00000005  TID: 00  TDest: 0  TUser: 0  TLast: 0 at 160 ns
%% Log   PASSED  in Default, RxData Received : 00000005 at 160 ns
%% Log   INFO    in transmitter_1, Axi Stream Send.  TData: 00000006  TStrb: 1111  TKeep: 1111  TID: 00  TDest: 0  TUser: 0  TLast: 0  Operation# 6 at 160 ns
%% Log   INFO    in receiver_1, Word Receive.  Operation# 6  Data: 00000006  TID: 00  TDest: 0  TUser: 0  TLast: 0 at 170 ns
%% Log   PASSED  in Default, RxData Received : 00000006 at 170 ns
%% Log   INFO    in transmitter_1, Axi Stream Send.  TData: 00000007  TStrb: 1111  TKeep: 1111  TID: 00  TDest: 0  TUser: 0  TLast: 0  Operation# 7 at 170 ns
%% Log   INFO    in receiver_1, Word Receive.  Operation# 7  Data: 00000007  TID: 00  TDest: 0  TUser: 0  TLast: 0 at 180 ns
%% Log   PASSED  in Default, RxData Received : 00000007 at 180 ns
%% Log   INFO    in transmitter_1, Axi Stream Send.  TData: 00000008  TStrb: 1111  TKeep: 1111  TID: 00  TDest: 0  TUser: 0  TLast: 0  Operation# 8 at 180 ns
%% Log   INFO    in receiver_1, Word Receive.  Operation# 8  Data: 00000008  TID: 00  TDest: 0  TUser: 0  TLast: 0 at 190 ns
%% Log   PASSED  in Default, RxData Received : 00000008 at 190 ns
%% Log   INFO    in transmitter_1, Axi Stream Send.  TData: 00000009  TStrb: 1111  TKeep: 1111  TID: 00  TDest: 0  TUser: 0  TLast: 0  Operation# 9 at 190 ns
%% Log   INFO    in receiver_1, Word Receive.  Operation# 9  Data: 00000009  TID: 00  TDest: 0  TUser: 0  TLast: 0 at 200 ns
%% Log   PASSED  in Default, RxData Received : 00000009 at 200 ns
%% Log   INFO    in transmitter_1, Axi Stream Send.  TData: 0000000A  TStrb: 1111  TKeep: 1111  TID: 00  TDest: 0  TUser: 0  TLast: 0  Operation# 10 at 200 ns
%% Log   INFO    in receiver_1, Word Receive.  Operation# 10  Data: 0000000A  TID: 00  TDest: 0  TUser: 0  TLast: 0 at 210 ns
%% Log   PASSED  in Default, RxData Received : 0000000A at 210 ns
%% Log   INFO    in transmitter_1, Axi Stream Send.  TData: 0000000B  TStrb: 1111  TKeep: 1111  TID: 00  TDest: 0  TUser: 0  TLast: 0  Operation# 11 at 210 ns
%% Log   INFO    in receiver_1, Word Receive.  Operation# 11  Data: 0000000B  TID: 00  TDest: 0  TUser: 0  TLast: 0 at 220 ns
%% Log   PASSED  in Default, RxData Received : 0000000B at 220 ns
%% Log   INFO    in transmitter_1, Axi Stream Send.  TData: 0000000C  TStrb: 1111  TKeep: 1111  TID: 00  TDest: 0  TUser: 0  TLast: 0  Operation# 12 at 220 ns
%% Log   INFO    in receiver_1, Word Receive.  Operation# 12  Data: 0000000C  TID: 00  TDest: 0  TUser: 0  TLast: 0 at 230 ns
%% Log   PASSED  in Default, RxData Received : 0000000C at 230 ns
%% Log   INFO    in transmitter_1, Axi Stream Send.  TData: 0000000D  TStrb: 1111  TKeep: 1111  TID: 00  TDest: 0  TUser: 0  TLast: 0  Operation# 13 at 230 ns
%% Log   INFO    in receiver_1, Word Receive.  Operation# 13  Data: 0000000D  TID: 00  TDest: 0  TUser: 0  TLast: 0 at 240 ns
%% Log   PASSED  in Default, RxData Received : 0000000D at 240 ns
%% Log   INFO    in transmitter_1, Axi Stream Send.  TData: 0000000E  TStrb: 1111  TKeep: 1111  TID: 00  TDest: 0  TUser: 0  TLast: 0  Operation# 14 at 240 ns
%% Log   INFO    in receiver_1, Word Receive.  Operation# 14  Data: 0000000E  TID: 00  TDest: 0  TUser: 0  TLast: 0 at 250 ns
%% Log   PASSED  in Default, RxData Received : 0000000E at 250 ns
```

Test Case Transcript

3.5 HTML Simulator Transcript

Simulator transcript files can be long. The basic OSVVM regression test (OsvvmLibraries/RunAllTests.pro), produces a log file that is 84K lines long. As a plain text file, this is not browsable, however, when converted to an html file it is. OSVVM gives you the option to create either html (default), shown below, or plain text. In the html report, any place there is a triangle preceding text, pressing on the triangle will rotate it and either hide or reveal additional information.

```
▶ build ../../OsvvmLibraries/RunDemoTests.pro
▶ include ../../OsvvmLibraries/RunDemoTests.pro
▶ library default C:/tools/sim_temp/RivieraPRO/VHDL_LIBS/RivieraPRO-2021.10.114.8313
▶ include ./AXI4/Axi4/RunDemoTests.pro
▶ TestSuite Axi4Full
▶ library osvvm_TbAxi4 C:/tools/sim_temp/RivieraPRO/VHDL_LIBS/RivieraPRO-2021.10.114.8313
▶ include ./testbench
▶ library osvvm_TbAxi4 C:/tools/sim_temp/RivieraPRO/VHDL_LIBS/RivieraPRO-2021.10.114.8313
▶ analyze TestCtrl_e.vhd
▶ analyze TbAxi4.vhd
▶ analyze TbAxi4Memory.vhd
▶ RunTest ./TestCases/TbAxi4_MemoryReadWriteDemo1.vhd
▶ include ./AXI4/AxiStream/RunDemoTests.pro
▶ TestSuite AxiStream
▶ library osvvm_TbAxiStream C:/tools/sim_temp/RivieraPRO/VHDL_LIBS/RivieraPRO-2021.10.114.8313
▶ include ./testbench
▶ library osvvm_TbAxiStream C:/tools/sim_temp/RivieraPRO/VHDL_LIBS/RivieraPRO-2021.10.114.8313
▶ analyze TestCtrl_e.vhd
▶ analyze TbStream.vhd
▶ RunTest ./TestCases/TbStream_SendGetDemo1.vhd
▶ include ./UART/RunDemoTests.pro
▶ TestSuite Uart
▶ library osvvm_TbUart C:/tools/sim_temp/RivieraPRO/VHDL_LIBS/RivieraPRO-2021.10.114.8313
▶ analyze ./testbench/TestCtrl_e.vhd
▶ analyze ./testbench/TbUart.vhd
▶ RunTest ./testbench/TbUart_SendGet1.vhd
▶ RunTest ./testbench/TbUart_SendGet2.vhd
```

HTML Simulator Transcript

4 How To Generate Reports

4.1 VHDL Aspects of Generating Reports

To generate reports, you need to have the following in your VHDL testbench: * Name your test case with `SetAlertLogName("TestName")`. * Do some self-checking with `AffirmIf`, `AffirmIfEqual`, or `AffirmIfNotDiff`. * End the test case with `EndOfTestReports`.

These following code snippet shows these in use. More details of this are in OSVVM Test Writers User Guide in the documentation repository.

```
-- Reference to OSVVM Utility Library
library OSVVM ;
context OSVVM.OsvvmContext ;
. . .
TestProc : process
begin
  -- Name the Test
  SetAlertLogName("TbDut") ;
  . . .
  -- Do some Checks
  AffirmIfEqual(Data, X"A025", "Check Data") ;
  . . .
  -- Generate Reports (replaces call to ReportAlerts)
  EndOfTestReports ;
  std.env.stop(GetAlertCount) ;
end process TestProc ;
```

4.2 Generating Reports and Simple Tests

If we have a simple test, where the design name is Dut.vhd and the testbench is TbDut.vhd, then we can run it with the following script

```
# File name:  Dut.pro
analyze   Dut.vhd
analyze   TbDut.vhd
simulate  TbDut
```

If we run this test with using `build Dut.pro`, Dut and TbDut will be compiled into the library named default. The simulation TbDut will run and a build summary report will be created with only one test case in it. The test suite will be named Default. The test case will be named TbDut. Be sure to name the test internally to TbDut using SetAlertLogName as otherwise, a NAME_MISMATCH failure will be generated.

4.3 Generating Reports and Running Tests without Configurations

In OSVVM, we use the testbench framework shown in the OSVVM Test Writers User Guide (see documentation repository). The test harness in the following example is named TbUart. The test sequencer entity is in file TestCtrl_e.vhd. Tests are in architectures of TestCtrl in the files, TestCtrl_SendGet1.vhd, TestCtrl_SendGet2.vhd, and

TbtCtrl_Scoreboard1.vhd. The tests are run by calling "simulate TbUart". TestCase is used to specify the test name that is running. This is needed here as otherwise the name TbUart would be used. The test case that is run is the latest one that was analyzed.

```
TestSuite Uart
library   osvvm_TbUart
analyze   TestCtrl_e.vhd
analyze   TbUart.vhd

TestCase  TbUart_SendGet1
analyze   TestCtrl_SendGet1.vhd
simulate  TbUart

TestCase  TbUart_SendGet2
analyze   TestCtrl_SendGet2.vhd
simulate  TbUart

TestCase  TbUart_Scoreboard1
analyze   TestCtrl_Scoreboard1.vhd
simulate  TbUart
```

The above call to TestCase puts the TestCase name into the build test summary YAML file. If the simulation for any reason fails to run, there will be no test status information in the YAML file. As a result, when the build summary report is being created, it will detect this as a test failure.

Another possibility in the above test scenario is that a particular test case fails to analyze. In this case, if the script continues and calls simulate, the previously successfully compiled test will run. In this case, if each test is given a unique name in VHDL using SetAlertLogName (which is also recorded in the YAML file), then the VHDL test name will not match the test case name and a NAME_MISMATCH failure will be generated by the scripts.

4.4 Generating Reports and Running Tests with Configurations

The OSVVM verification component regression suite uses configurations to specify an exact architecture to run in a given test. We give the configuration, the test case, and the file the same name. We also put the configuration declaration at the end of the file containing the test case (try it, you will understand why). When we run a test that uses a configuration, simulate specifies the configuration's design unit name. Hence, we revise the sequence of running one test to be as follows.

```
TestCase  TbUart_SendGet1
analyze   TbUart_SendGet1.vhd
simulate  TbUart_SendGet1
```

When running a large test suite, this gets tedious, so we added a shortcut named RunTest that encapsulates the above three steps into the single step. This changes our original script to the following. If the name in RunTest has a path, the path is only used with analyze.

```
TestSuite Uart
library   osvvm_TbUart
analyze   TestCtrl_e.vhd
analyze   TbUart.vhd

RunTest   TbUart_SendGet1.vhd
RunTest   TbUart_SendGet2.vhd
RunTest   TbUart_Scoreboard1.vhd
```

One advantage of using configurations is that on a clean build (library deleted before starting it), if a test case fails to analyze, then the corresponding configuration will fail to analyze, and the simulation will fail to run. If this happens, it will be detected and recorded as a test failure in the build summary report.

5 Turning on Code Coverage

Code coverage is a metric that tells us if certain parts of our design have been exercised or not. Turning on code coverage with OSVVM is simple. In the following example, we enable coverage options during analysis and simulation separately.

```
# File name:  Dut.pro
SetCoverageAnalyzeEnable true
analyze   Dut.vhd
SetCoverageAnalyzeEnable false
SetCoverageSimulateEnable true
analyze   TbDut.vhd
simulate  TbDut
SetCoverageSimulateEnable false
```

Note that CoverageAnalyzeEnable is specifically turned off before compiling the testbench so that the testbench is not included in the coverage metrics.

You can also set specific options by using SetCoverageAnalyzeOptions and SetCoverageSimulateOptions. By default, OSVVM sets these options so that statement, branch, and statemachine coverage is collected.

When coverage is turned on for a build, coverage is collected for each test. If there are multiple test suites in the build, when a test suite completes execution, the coverage for each test in the test suite is merged. When a build completes the coverage from each test suite is merged and an html coverage report is produced.

6 Command Summary

Commands are case sensitive. Single word names are all lower case. Multiple word names are CamelCase.

The following are general commands.

- **library <library> [<path>]**
  - Make this library the active library. Create it if it does not exist. Libraries are created in the path specified by VhdlLibraryDirectory in Scripts/OsvvmScriptDefaults.tcl.
- **LinkLibrary <library> [<path>]**
  - Create a mapping to a library that was already created.
- **LinkLibraryDirectory [LibraryDirectory]**
  - Map all of the libraries in the specified `LibraryDirectory`. If `LibraryDirectory` is not specified, the current directory is used.
- **LinkCurrentLibraries**
  - If you use `cd`, then use LinkCurrentLibraries immediately after to map all libraries in the current directory
- **RemoveAllLibraries**
  - Delete all of the working libraries.
- **SetLibraryDirectory [LibraryDirectory]**
  - Set the directory in which the libraries will be created. If `LibraryDirectory` is not specified, the current directory is used. By default, libraries are created in `<LibraryDirectory>/VHDL_LIBS/<tool version>/`.
- **GetLibraryDirectory**
  - Get the Library Directory.
- **analyze [<path>/]<name>**
  - Analyze (aka compile) the design into the active library. Name must be a file with an extension that is either *.vhd or*.vhdl.
- **simulate <test-name>**
  - Simulate (aka elaborate + run) the design using the active library.
- **TestCase <test-name>**
  - Identify the TestCase that is active. Must match name in the testbench call to SetAlertLogName.
- **RunTest [<path>/]<name> [<test-name>]**
  - Combines analyze, TestCase, and simulate into one step. If `test-name` is not specified, use the base name of `file`.
- **SkipTest <test-name> Reason**
  - Add Skip test to the Build Summary Reports with `Reason` as part of the report.
- **TestSuite <test-suite-name>**
  - Identify the current TestSuite. If not specified the name is default.

- **include [<path>/]<name>**
  - Include another project script. If `name` is a file and its extension is .pro, .tcl, or .do, it will be sourced. If `name` is a directory then any file whose name is `name` and extension is .pro, .tcl, or .do will be sourced.
- **build [<path>/]<name>**
  - Start a script from the simulator. It is include + start a new log file for this script.
- **SetTranscriptType [html|log]**
  - Select the Transcript file to be either html or log. The default is html.
- **GetTranscriptType**
  - Get the Transcript file type (either html or log).

In all commands that accept a path, relative paths (including no path) is relative to the directory in which the current script is running.

The following commands set options for analyze and simulate.

- **SetVHDLVersion [2008 | 2019 | 1993 | 2002]**
  - Set VHDL analyze version. OSVVM libraries require 2008 or newer.
- **GetVHDLVersion**
  - Return the current VHDL Version.
- **SetSimulatorResolution <value>**
  - Set Simulator Resolution. Any value supported by the simulator is ok.
- **GetSimulatorResolution**
  - Return the current Simulator Resolution.
- **SetCoverageAnalyzeEnable <value>**
  - If `value` is true, enable coverage during analyze,
  - otherwise, if the `value` is "", set the enable to the specified by SetCoverageEnable,
  - otherwise, disable coverage during analyze.
- **GetCoverageAnalyzeEnable**
  - Returns the setting for coverage during analyze.
- **SetCoverageAnalyzeOptions <options>**
  - Use the string specified in `options` as the coverage options during analyze.
- **GetCoverageAnalyzeOptions**
  - Return the coverage options for analyze.
- **SetCoverageSimulateEnable <value>**
  - If `value` is true, enable coverage during simulate,
  - otherwise, if the `value` is "", set the enable to the specified by SetCoverageEnable,
  - otherwise, disable coverage during simulate.
- **GetCoverageSimulateEnable**
  - Returns the setting for coverage during simulate.

- **SetCoverageSimulateOptions <options>**
  - Use the string specified in `options` as the coverage options during simulate.
- **GetCoverageSimulateOptions**
  - Return the coverage options for simulate.
- **SetCoverageEnable <value>**
  - If `value` is true, set coverage enable to true,
  - otherwise, set coverage enable to false.
  - The default value is "true"
- **GetCoverageEnable**
  - Get the CoverageEnable value.
- **SetVhdlAnalyzeOptions <options>**
  - Set the VHDL options for analyze to `options`.
- **GetVhdlAnalyzeOptions**
  - Get the VHDL options for analyze.
- **SetVerilogAnalyzeOptions <options>**
  - Set the Verilog options for analyze to `options`.
- **GetVerilogAnalyzeOptions**
  - Get the Verilog options for analyze.
- **SetExtendedAnalyzeOptions <options>**
  - Set extended (additional) options for analyze to `options`.
- **GetExtendedAnalyzeOptions**
  - Get extended (additional) options for analyze.
- **SetExtendedSimulateOptions <options>**
  - Set extended (additional) options for simulate to `options`.
- **GetExtendedSimulateOptions**
  - Get extended (additional) options for simulate.

The values for a commands `options` value are typically simulator dependent. To keep a set of scripts simulator independent, be sure to call these at a high level, such as in `LocalScriptDefaults.tcl`.

Caution any undocumented commands are experimental and may change or be removed in a future revision.

7 Variables

7.1 Variables set by OSVVM Scripts

All osvvm VendorScripts_xxx.tcl set the variables ToolVendor, ToolName, ToolType, and ToolNameVersion. These are useful for personalizing scripts. For example,

```
if {$ToolName eq "GHDL"} {
  # ... do something based on GHDL
}
```

ToolVendor is the name of the vendor. ToolName is the name of the tool. ToolType can be either "simulator" or "synthesis". ToolNameVersion is formatted "<ToolName-version>", where version is specific to a tool and revision.

Note that ToolName was formerly named simulator. The variable simulator is deprecated. Use ToolName instead.

The settings for ToolVendor and ToolName is as defined in the table below.

ToolVendor	ToolName	ToolType	Notes
Aldec	ActiveHDL	simulator	
Aldec	RivieraPRO	simulator	
Aldec	VSimSA	simulator	ActiveHDL command line
Cadence	Xcelium	simulator	
GHDL	GHDL	simulator	
Siemens	ModelSim	simulator	
Siemens	QuestaSim	simulator	
Synopsys	VCS	simulator	
Xilinx	XSIM	simulator	Still in Debug
Xilinx	Vivado	synthesis	Currently supports analyze

7.2 Variables used to configure OSVVM

Variables that the user can customize for OSVVM are in the file, OsvvmDefaultSettings.tcl. If you wish to change these, copy OsvvmDefaultSettings to LocalScriptDefaults.tcl and edit them there.

Variable Name	Description
Controlling Directories	
OutputBaseDirectory	Directory that holds OSVVM output files and separates them from other stuff.
LogSubdirectory	Contains simulator transcripts in html or log format
ReportsSubdirectory	Test case detailed reports (Alerts, Functional Coverage, Scoreboard) are stored in the subdirectory, <TestSuiteName>. Must not include any path indicators. Maybe empty string "".
ResultsSubdirectory	Files printed by TranscriptOpen are stored in the subdirectory, <TestSuiteName>.
CoverageSubdirectory	Code coverage output for simulators that support it
VhdlLibraryParentDirectory	Specify a directory here to put library in a different parent directory - such as c:/temp/sim
VhdlLibraryDirectory	Primary directory when library is in $OutputBaseDirectory.
VhdlLibrarySubdirectory	Subdirectory for libraries. Default is "<ToolNameVersion>".
Simulator Settings	
DefaultVHDLVersion	OSVVM requires > 2008. Valid values 1993, 2002, 2008, 2019
SimulateTimeUnits	ps, ns, us, ms, ...
TranscriptExtension	Either html or log
VhdlAnalyzeOptions	Additional options for analyze
VerilogAnalyzeOptions	Additional options for analyze
ExtendedAnalyzeOptions	Additional options for analyze
ExtendedSimulateOptions	Additional options for simulate
Coverage Settings	
CoverageAnalyzeOptions	Default coverage options for analyze
CoverageSimulateOptions	Default coverage options for simulate

7.3 Example LocalScriptDefaults.tcl

LocalScriptDefaults is not in the OSVVM release. It is a file you create. This way it does not get destroyed when you do a pull on the OsvvmLibraries git repository.

```
namespace eval ::osvvm {
  variable OutputBaseDirectory         "OSVVM" ;              # Put output in
a Subdirectory
  variable VhdlLibraryParentDirectory  "C:/tools/sim_temp" ;  # put libraries
somewhere else
  variable VhdlLibraryDirectory        ""  ;                  # only use
VhdlLibrarySubdirectory
}
```

8 Script File Summary

- **StartUp.tcl**
  - StartUp script for ActiveHDL, GHDL, Mentor, RivieraPro, and VSimSA (ActiveHDL)
  - Detects the simulator running and calls the VendorScript_vendor-name.tcl. Also calls OsvvmProjectScripts.tcl and OsvvmScriptDefaults.tcl
- **StartVCS.tcl**
  - StartUp script for Synopsys VCS. Does what StartUp.tcl does except is specific to VCS
- **StartXcelium.tcl**
  - StartUp script for Cadence Xcelium. Does what StartUp.tcl does except is specific to Xcelium
- **StartXSIM.tcl**
  - StartUp script for Xilinx XSIM. Does what StartUp.tcl does except is specific to Xsim
  - Note, XSIM is currently a alpha level, experimental release.
- **VendorScript_tool-name.tcl**
  - TCL procedures that do simulator specific actions.
  - "tool-name" = one of (ActiveHDL, GHDL, Mentor, RivieraPro, VSimSA, VCS, Xcelium, Xsim)
  - VSimSA is the one associated with ActiveHDL.
  - Called by StartUp.tcl
- **OsvvmProjectScripts.tcl**
  - TCL procedures that do common simulator and project build tasks.
  - Called by StartUp.tcl
- **OsvvmScriptDefaults.tcl**
  - Default settings for the OSVVM Script environment.
  - Called by StartUp.tcl
- **LocalScriptDefaults.tcl**
  - User default settings for the OSVVM Script environment.
  - Not in OSVVM repository so it will not be replaced on OSVVM updates
  - If it exists, called by StartUp.tcl

9 Deprecated Descriptor Files

Include with a file extension of ".dirs" or ".files" is deprecated and is only supported for backward compatibility.

<Name>.dirs is a directory descriptor file that contains a list of directories. Each directory is handled by calling "include <directory>".

<Name>.files is a file descriptor that contains a list of names. Each name is handled by calling "analyze <name>". If the extension of the name is ".vhd" or ".vhdl" the file will be compiled as VHDL source. If the extension of the name is ".v" the file will be compiled as verilog source. If the extension of the name is ".lib", it is handled by calling "library <name>".

10 Release History

For the release history see, CHANGELOG.md

11 Participating and Project Organization

The OSVVM project welcomes your participation with either issue reports or pull requests. For details on how to participate see

You can find the project Authors here and Contributors here.

12 More Information on OSVVM

OSVVM Forums and Blog: http://www.osvvm.org/

SynthWorks OSVVM Blog: http://www.synthworks.com/blog/osvvm/

Gitter: https://gitter.im/OSVVM/Lobby

Documentation: osvvm.github.io

Documentation: Documentation for the OSVVM libraries can be found here

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