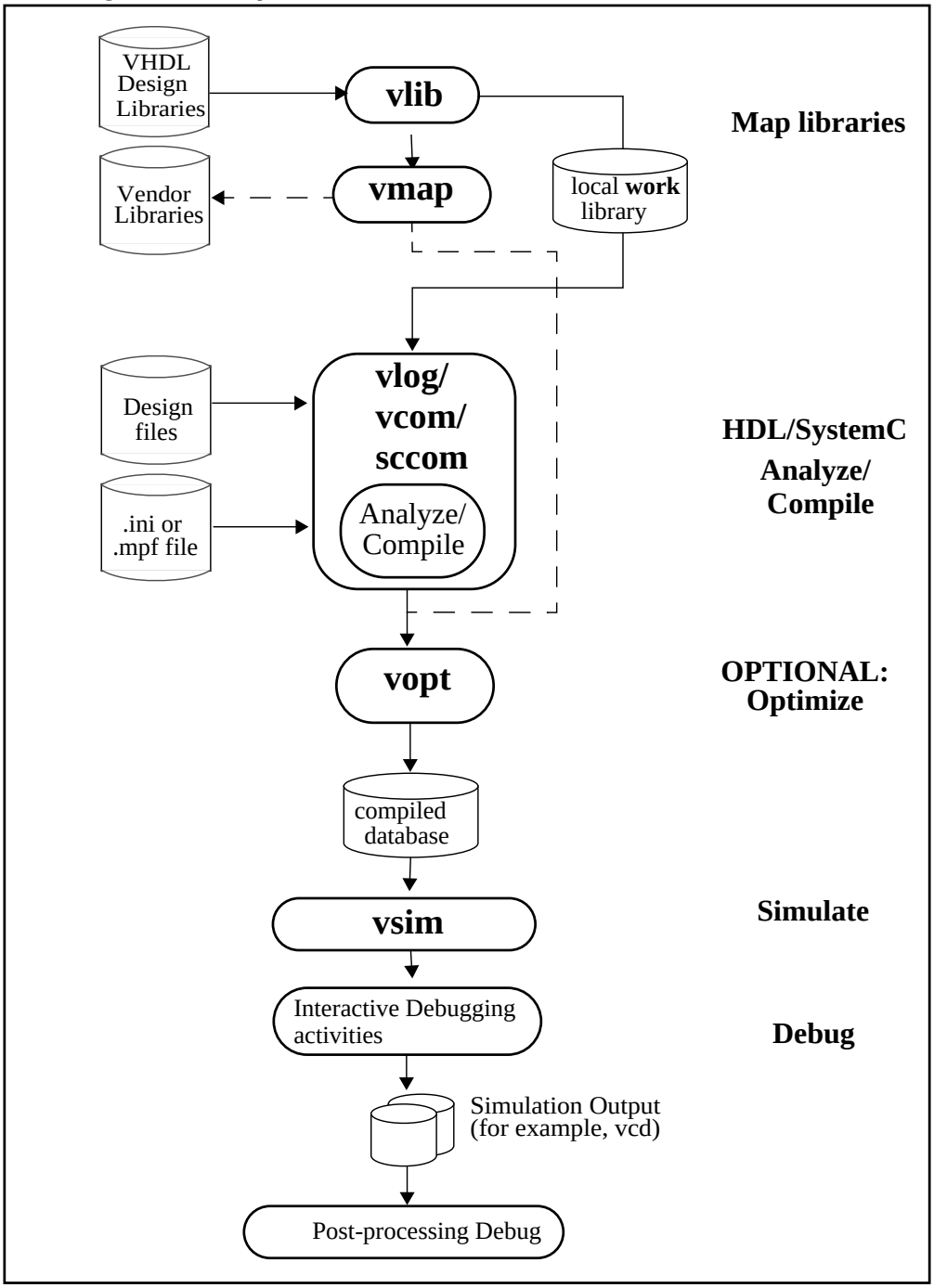
Figure 1-1. Operational Structure and Flow of ModelSim



Simulation Task Overview

The following table provides a reference for the tasks required for compiling, optimizing, loading, and simulating a design in ModelSim.

Table 1-1. Simulation Tasks

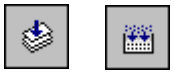
Task	Example Command Line Entry	GUI Menu Pull-down	GUI Icons
Step 1: Map libraries	**vlib** <library_name> **vmap** work <library_name>	1. **File > New > Project** 2. Enter library name 3. Add design files to project	N/A
Step 2: Compile the design	**vlog** file1.v file2.v ... (Verilog) **vcom** file1.vhd file2.vhd ... (VHDL) **sccom** <top> (SystemC) **sccom -link** <top>	**Compile > Compile** or **Compile > Compile All**	**Compile** or **Compile All** 
Step 3: Optimize the design (OPTIONAL)	Optimized when **voptflow = 1** in modelsim.ini file (default setting for version 6.2 and later.	To disable optimizations: 1. **Simulate > Start Simulation** 2. Deselect **Enable Optimization** button To set optimization options: **1. Simulate > Design Optimization** 2. Set desired optimizations	N/A
Step 4: Load the design into the simulator	**vsim** <top> or **vsim** <opt_name>	**1. Simulate > Start Simulation** 2. Click on top design module or optimized design unit name 3. Click OK This action loads the design for simulation.	**Simulate** 
Step 5: Run the simulation	run step	**Simulate > Run**	**Run**, or **Run continue**, or **Run -all** 

Table 1-1. Simulation Tasks (cont.)

Task	Example Command Line Entry	GUI Menu Pull-down	GUI Icons
Step 6: Debug the design Note: Design optimization in step 3 limits debugging visibility	Common debugging commands: bp describe drivers examine force log show	**N/A**	N/A

Basic Steps for Simulation

This section describes the basic procedure for simulating your design using ModelSim.

Step 1 — Collect Files and Map Libraries

Files needed to run ModelSim on your design:

- design files (VHDL, Verilog, and/or SystemC), including stimulus for the design
- libraries, both working and resource
- *modelsim.ini* file (automatically created by the library mapping command)

For detailed information on the files accessed during system startup (including the *modelsim.ini* file), initialization sequences, and system environment variables, see the Appendix entitled "System Initialization".

Providing Stimulus to the Design

You can provide stimulus to your design in several ways:

- Language-based test bench
- Tcl-based ModelSim interactive command, force
- VCD files / commands

  See Creating a VCD File and Using Extended VCD as Stimulus
- Third-party test bench generation tools

What is a Library?

A library is a location on your file system where ModelSim stores data to be used for simulation. ModelSim uses one or more libraries to manage the creation of data before it is needed for use in simulation. A library also helps to streamline simulation invocation. Instead of compiling all design data each time you simulate, ModelSim uses binary pre-compiled data from its libraries. For example, if you make changes to a single Verilog module, ModelSim recompiles only that module, rather than all modules in the design.

Work and Resource Libraries

You can use design libraries in two ways:

- As a local working library that contains the compiled version of your design
- As a resource library

The contents of your working library will change as you update your design and recompile. A resource library is typically unchanging, and serves as a parts source for your design. Examples of resource libraries are shared information within your group, vendor libraries, packages, or previously compiled elements of your own working design. You can create your own resource libraries, or they may be supplied by another design team or a third party (for example, a silicon vendor).

For more information on resource libraries and working libraries, refer to Working Library Versus Resource Libraries, Managing Library Contents, Working with Design Libraries, and Specifying Resource Libraries.

Creating the Logical Library (vlib)

Before you can compile your source files, you must create a library in which to store the compilation results. You can create the logical library using the GUI, by choosing **File > New > Library** from the main menu (see Creating a Library), or you can use the vlib command. For example, the following command:

```
vlib work
```

creates a library named **work**. By default, compilation results are stored in the **work** library.

Mapping the Logical Work to the Physical Work Directory (vmap)

VHDL uses logical library names that can be mapped to ModelSim library directories. If libraries are not mapped properly, and you invoke your simulation, necessary components will not be loaded and simulation will fail. Similarly, compilation can also depend on proper library mapping.

By default, ModelSim can find libraries in your current directory (assuming they have the right name), but for it to find libraries located elsewhere, you need to map a logical library name to the pathname of the library.

You can use the GUI (Library Mappings with the GUI), a command (Library Mapping from the Command Line), or a project (Getting Started with Projects) to assign a logical name to a design library.

The format for command line entry is:

```
vmap <logical_name> <directory_pathname>
```

This command sets the mapping between a logical library name and a directory.

Use braces ({}) for cases where the path contains multiple items that need to be escaped, such as spaces in the pathname or backslash characters. For example:

```
vmap celllib {$LIB_INSTALL_PATH/Documents And Settings/All/celllib}
```

Step 2 — Compile the Design

To compile a design, run one of the following ModelSim commands, depending on the language used to create the design:

- vlog — Verilog
- vcom — VHDL
- sccom — SystemC

Compiling Verilog (vlog)

The vlog command compiles Verilog modules in your design. You can compile Verilog files in any order, since they are not order dependent. See Verilog Compilation for details.

Compiling VHDL (vcom)

The vcom command compiles VHDL design units. You must compile VHDL files in the order necessitate to any design requirements. Projects may assist you in determining the compile order: for more information, see Auto-Generating Compile Order**.** See Compilation and Simulation of VHDL for details on VHDL compilation.

Compiling SystemC (sccom)

The sccom command compiles SystemC design units. Use this command only if you have SystemC components in your design. See Compiling SystemC Files for details.

Step 3 — Load the Design for Simulation

Running the vsim Command on the Top Level of the Design

After you have compiled your design, it is ready for simulation. You can then run the vsim command using the names of any top-level modules (many designs contain only one top-level module). For example, if your top-level modules are named “testbench” and “globals,” then invoke the simulator as follows:

```
vsim testbench globals
```

After the simulator loads the top-level modules, it iteratively loads the instantiated modules and UDPs in the design hierarchy, linking the design together by connecting the ports and resolving hierarchical references.

You can optionally optimize the design with vopt. For more information on optimization, see Optimizing Designs with vopt.

Using Standard Delay Format Files

You can incorporate actual delay values to the simulation by applying standard delay format (SDF) back-annotation files to the design. For more information on how SDF is used in the design, see Specifying SDF Files for Simulation.

Step 4 — Simulate the Design

Once you have successfully loaded the design, simulation time is set to zero, and you must enter a **run** command to begin simulation. For more information, see Verilog and SystemVerilog Simulation, SystemC Simulation, and VHDL Simulation.

The basic commands you use to run simulation are:

- add wave
- bp
- force
- run
- step

Step 5 — Debug the Design

The ModelSim GUI provides numerous commands, operations, and windows useful in debugging your design. In addition, you can also use the command line to run the following basic simulation commands for debugging:

- describe
- drivers
- examine
- force
- log
- checkpoint
- restore
- show

Modes of Operation

Many users run ModelSim interactively with the graphical user interface (GUI)—using the mouse to perform actions from the main menu or in dialog boxes. However, there are really three modes of ModelSim operation, as described in Table 1-2.

Table 1-2. Use Modes for ModelSim

Mode	Characteristics	How ModelSim is invoked
GUI	interactive; has graphical windows, push-buttons, menus, and a command line in the transcript. Default mode	from a desktop icon or from the OS command shell prompt. Example: `OS> vsim`
Command-line	interactive command line; no GUI	with **-c** argument at the OS command prompt. Example: `OS> vsim -c`
Batch	non-interactive batch script; no windows or interactive command line	at OS command shell prompt using "here document" technique or redirection of standard input. Example: `C:\ vsim vfiles.v <infile >outfile`

The ModelSim User's Manual focuses primarily on the GUI mode of operation. However, this section provides an introduction to the Command-line and Batch modes.

Command Line Mode

In command line mode ModelSim executes any startup command specified by the Startup variable in the *modelsim.ini* file. If vsim is invoked with the **-do "command_string"** option, a DO file (macro) is called. A DO file executed in this manner will override any startup command in the *modelsim.ini* file.

During simulation a transcript file is created containing any messages to stdout. A transcript file created in command line mode may be used as a DO file if you invoke the transcript **on** command after the design loads (see the example below). The transcript **on** command writes all of the commands you invoke to the transcript file.

For example, the following series of commands results in a transcript file that can be used for command input if *top* is re-simulated (remove the **quit -f** command from the transcript file if you want to remain in the simulator).

```
vsim -c top
```

library and design loading messages… then execute:

```
transcript on
force clk 1 50, 0 100 -repeat 100
run 500
run @5000
quit -f
```

Rename a transcript file that you intend to use as a DO file—if you do not rename it, ModelSim will overwrite it the next time you run **vsim**. Also, simulator messages are already commented out, but any messages generated from your design (and subsequently written to the transcript file) will cause the simulator to pause. A transcript file that contains only valid simulator commands will work fine; comment out anything else with a pound sign (#).

Refer to Creating a Transcript File for more information about creating, locating, and saving a transcript file.

Stand-alone tools pick up project settings in command-line mode if you invoke them in the project's root directory. If invoked outside the project directory, stand-alone tools pick up project settings only if you set the **MODELSIM** environment variable to the path to the project file (*<Project_Root_Dir>/<Project_Name>.mpf*).

Basic Command Line Editing and Navigation

While in command line mode you can use basic command line editing and navigation techniques similar to other command line environments, such as:

- History navigation — use the up and down arrows to select commands you have already used.
- Command line editing — use the left and right arrows to edit your current command line.
- Filename completion — use the Tab key to expand filenames.

Batch Simulation

Batch simulation is an operational mode that provides the user with the ability to perform simulations without invoking the GUI. The simulations are executed via scripted files from a Windows command prompt or UNIX terminal and do not provide for interaction with the design during simulation. Data from the simulation run is typically sent to stdout or redirected to a log file.

You have two options for running batch simulations:

1. BatchMode modelsim.ini Variable and vsim -batch — Batch simulations are run using either the *modelsim.ini* variable BatchMode or the **-batch** argument to **vsim**.
2. Input Output Redirection — Batch simulations can also run from the Windows or UNIX command prompt using the "here-document" technique redirecting I/O from one process to another.

BatchMode modelsim.ini Variable and vsim -batch

The Batch Mode feature yields fast simulation times especially for simulations that generate a large amount of textual output. Refer to Batch Mode Log Files and stdout for information about saving transcript data.

There are two options for enabling Batch Mode:

1. Specifying vsim **-batch** with scripted simulations via the **-do "<command_string>" | <macro_file_name>** argument. Combining **vsim -batch** with the **-nostdou**t and **-logfile** arguments to **vsim** yields the best simulation performance.
2. Uncommenting the BatchMode *modelsim.ini* variable. If this variable is set to 1, **vsim** runs as if the **-batch** option were specified. If this variable is set to 0 (default), **vsim** runs as if the **-i** option were specified. Transcript data is sent to stdout by default. You can automatically create a log file by uncommenting the BatchTranscriptFile *modelsim.ini* variable.

Note

You will receive an error message if you specify **vsim -batch** with the **-c**, **-gui**, or the **-i** options. The BatchMode variable will be ignored if you specify the **-batch**, **-c**, **-gui**, or **-i** options to **vsim**.

Batch Mode Scripts

The commands supported within a **-do** script are similar to those available when using **vsim -c** however, none of the GUI-related commands or command options are supported by **vsim -batch**. A command is available to help batch users access commands not available for use in batch mode. Refer to the batch_mode command in the ModelSim Reference Manual for more information.

You can use the CTRL-C keyboard interrupt to terminate batch simulation in UNIX and Windows environments.

Batch Mode Log Files and stdout

The default behavior when using **vsim -batch** or BatchMode is to send transcript data to stdout and not create a log file. You can save a log file in two ways:

- Specify **vsim -batch -logfile <file_name>**.
- Uncomment the BatchTranscriptFile *modelsim.ini* variable to automatically create a log file. If **BatchTranscriptFile** is enabled, you can disable log file creation by specifying **vsim -nolog**.

Table 1-3. vsim -batch Output Options

Operating Mode	Stdout	Logfile
vsim -batch or BatchMode = 1	Yes	No
vsim -batch -logfile <file_name>	Yes	Yes
vsim -batch -nostdout -logfile <file_name>	No	Yes
vsim -batch; BatchTranscriptFile = <file_name>	Yes	Yes
vsim -batch; TranscriptFile = <filename>	Yes	No

Input Output Redirection

In a Windows environment, you run vsim from a Windows command prompt. Standard input and output are redirected to and from files. In a UNIX environment, you can invoke **vsim** in batch mode by redirecting standard input using the “here-document” technique.

Note

By default, the here-document technique causes vsim to run in command (**-c**) mode. If you want to run in batch mode, you need to specify **vsim -batch** or set BatchMode to 1 in the *modelsim.ini* file.

The following is an example of the "here-document" technique. This example will open the GUI in addition to running a batch simulation:

```
vsim top <<!
log -r *
run 100
do test.do
quit -f
!
```

Here is an example of a batch simulation using redirection of std input and output. In this example, the **-batch** argument to vsim is included which prevents the GUI opening:

```
vsim -batch counter <yourfile >outfile
```

where “yourfile” represents a script containing various ModelSim commands, and the angle brackets (< >) are redirection indicators.

You can use the CTRL-C keyboard interrupt to terminate batch simulation in UNIX and Windows environments.

A command is available to help batch users access commands not available for use in batch mode. Refer to the batch_mode command in the ModelSim Reference Manual for more details.

Definition of an Object

Because ModelSim supports a variety of design languages (SystemC, Unified Power Format (UPF), PSL, Verilog, VHDL, and SystemVerilog), the word “object” is used to refer to any valid design element in those languages, whenever a specific language reference is not needed. Table 1-4 summarizes the language constructs that an object can refer to.

Table 1-4. Possible Definitions of an Object, by Language

Design Language	An object can be
VHDL	block statement, component instantiation, constant, generate statement, generic, package, signal, alias, variable
Verilog	function, module instantiation, named fork, named begin, net, task, register, variable
SystemVerilog	In addition to those listed above for Verilog: class, package, program, interface, array, directive, property, sequence
SystemC	module, channel, port, variable, aggregate
PSL	property, sequence, directive, endpoint
Unified Power Format (UPF)	

Graphic Interface Overview

While your operating system interface provides the window-management frame, ModelSim controls all internal window features including menus, buttons, and scroll bars. Because the graphical interface is based on Tcl/TK, you also have the capability to build your own simulation environment. Preference variables and configuration commands (see modelsim.ini Variables for details) give you control over the use and placement of windows, menus, menu options, and buttons. See Tcl and Macros (DO Files) for more information on Tcl.

Standards Supported

Standards documents are sometimes informally referred to as the Language Reference Manual (LRM). This standards listed here are the complete name of each manual. Elsewhere in this manual the individual standards are referenced using the IEEE Std number.

The following standards are supported for the ModelSim products:

- VHDL —
  - IEEE Std 1076-2008, *IEEE Standard VHDL Language Reference Manual.*

    ModelSim supports the VHDL 2008 standard features with a few exceptions. For detailed standard support information see the vhdl2008 technote available at <install_dir>/docs/technotes/vhdl2008.note, or from the GUI menu pull-down **Help > Technotes > vhdl2008**.

    Potential migration issues and mixing use of VHDL 2008 with older VHDL code are addressed in the vhdl2008migration technote.
  - IEEE Std 1164-1993, *Standard Multivalue Logic System for VHDL Model Interoperability*
  - IEEE Std 1076.2-1996, *Standard VHDL Mathematical Packages*

  Any design developed with ModelSim will be compatible with any other VHDL system that is compliant with the 1076 specifications.
- Verilog/SystemVerilog —
  - IEEE Std 1364-2005, *IEEE Standard for Verilog Hardware Description Language*
  - IEEE Std 1800-2012. *IEEE Standard for SystemVerilog -- Unified Hardware Design, Specification, and Verification Language*

  Both PLI (Programming Language Interface) and VCD (Value Change Dump) are supported for ModelSim users.
- SDF and VITAL —
  - SDF – IEEE Std 1497-2001, *IEEE Standard for Standard Delay Format (SDF) for the Electronic Design Process*
  - VITAL 2000 – IEEE Std 1076.4-2000, *IEEE Standard for VITAL ASIC Modeling Specification*
- SystemC —
  - IEEE Std 1666-2005, SystemC Language Reference Manual
- Unified Power Format (UPF) —

- (UPF 1.0) The Accellera Unified Power Format (UPF) Standard Version 1.0 – February 22, 2007
- (UPF 2.0) IEEE Std 1801-2009 – Standard for Design and Verification of Low Power Integrated Circuits – March 27, 2009

ModelSim supports most of the UPF 1.0 UPF 2.0 features. Support details are summarized in the *Power Aware Simulation User's Manual*.

- PSL —
  - IEEE Std 1850-2005, *IEEE Standard for Property Specific Language (PSL)*. For exceptions, see the Verification with Assertions and Cover Directives chapter.

Assumptions

Using the ModelSim product and its documentation is based on the following assumptions:

- You are familiar with how to use your operating system and its graphical interface.
- You have a working knowledge of the design languages. Although ModelSim is an excellent application to use while learning HDL concepts and practices, this document is not written to support that goal.
- You have worked through the appropriate lessons in the ModelSim Tutorial and are familiar with the basic functionality of ModelSim. You can find the ModelSim Tutorial by choosing Help from the main menu.

Text Conventions

Table 1-5 lists the text conventions used in this manual.

Table 1-5. Text Conventions

Text Type	Description
italic text	provides emphasis and sets off filenames, pathnames, and design unit names
bold text	indicates commands, command options, menu choices, package and library logical names, as well as variables, dialog box selections, and language keywords
`monospace type`	monospace type is used for program and command examples
The right angle (>)	is used to connect menu choices when traversing menus as in: **File > Quit**

Table 1-5. Text Conventions (cont.)

Text Type	Description
path separators	examples will show either UNIX or Windows path separators - use separators appropriate for your operating system when trying the examples
UPPER CASE	denotes file types used by ModelSim (such as DO, WLF, INI, MPF, PDF.)

Installation Directory Pathnames

When referring to installation paths, this manual uses "<installdir>" as a generic representation of the installation directory for all versions of ModelSim. The actual installation directory on your system may contain version information.

Where to Find ModelSim Documentation

Table 1-6. Documentation List

Document	Format	How to get it
Installation & Licensing Guide	PDF	**Help > PDF Bookcase**
	HTML and PDF	**Help > InfoHub**
Quick Guide (command and feature quick-reference)	PDF	**Help > PDF Bookcase** and **Help > InfoHub**
Tutorial	PDF	**Help > PDF Bookcase**
	HTML and PDF	**Help > InfoHub**
User's Manual	PDF	**Help > PDF Bookcase**
	HTML and PDF	**Help > InfoHub**
Command Reference Manual	PDF	**Help > PDF Bookcase**
	HTML and PDF	**Help > InfoHub**
Graphical User Interface (GUI) Reference Manual	PDF	**Help > PDF Bookcase**
	HTML and PDF	**Help > InfoHub**
Power Aware Simulation User's Manual	PDF	**Help > PDF Bookcase**
	HTML and PDF	**Help > InfoHub**

Table 1-6. Documentation List (cont.)

Document	Format	How to get it
Foreign Language Interface Manual	PDF	**Help > PDF Bookcase**
	HTML	**Help > InfoHub**
OVL Checkers Manager User's Guide	PDF	**Help > PDF Bookcase**
	HTML	**Help > InfoHub**
Command Help	ASCII	type **help [command name]** at the prompt in the Transcript pane
Error message help	ASCII	type **verror <msgNum>** at the Transcript or shell prompt
Tcl Man Pages (Tcl manual)	HTML	select **Help > Tcl Man Pages**, or find *contents.htm* in *\modeltech\docs\tcl_help_html*
Technotes	HTML	available from the support site

Mentor Graphics Support

Mentor Graphics product support includes software enhancements, technical support, access to comprehensive online services with SupportNet, and the optional On-Site Mentoring service. For details, refer to the following location on the Worldwide Web:

http://supportnet.mentor.com/about/

If you have questions about this software release, please log in to the SupportNet web site. You can search thousands of technical solutions, view documentation, or open a Service Request online at:

http://supportnet.mentor.com/

If your site is under current support and you do not have a SupportNet login, you can register for SupportNet by filling out the short form at:

http://supportnet.mentor.com/user/register.cfm

For any customer support contact information, refer to the following web site location:

http://supportnet.mentor.com/contacts/supportcenters/

Deprecated Features, Commands, and Variables

This section provides tables of features, commands, command arguments, and *modelsim.ini* variables that have been superseded by new versions. Although you can still use superseded

features, commands, arguments, or variables, Mentor Graphics deprecates their usage—you should use the corresponding new version whenever possible or convenient.

The following tables indicate the in which the item was superseded and a link to the new item that replaces it, where applicable.

Table 1-7. Deprecated Features

Feature	Version	New Feature / Information
Source Window Language Template	10.3	No longer available.

Table 1-9. Deprecated Command Arguments

Argument	Version	New Argument / Information

Table 1-10. Deprecated modelsim.ini Variables

Variable	Version	New Variable / Information

Table 1-11. Deprecated HDL Attributes

Variable	Version	Language	New Variable / Information