

# **Using Tcl With Synopsys® Tools**

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# Preface

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This preface includes the following sections:

- [About This Manual](#)
- [Customer Support](#)

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## About This Manual

This manual describes how to use the open source scripting tool, Tcl (tool command language), that has been integrated into Synopsys tools. This manual provides an overview of Tcl, describes its relationship with Synopsys command shells, and explains how to create scripts and procedures.

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## Audience

The audience for *Using Tcl With Synopsys Tools* is designers who are experienced with using Synopsys tools such as Design Compiler and IC Compiler and who have a basic understanding of programming concepts such as data types, control flow, procedures, and scripting.

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## Related Publications

For additional information about *Using Tcl With Synopsys Tools*, see the Design Compiler and IC Compiler documentation on SolvNet at the following address:

<https://solvnet.synopsys.com/DocsOnWeb>

You might also want to see the documentation for the following related Synopsys products:

- Design Vision
- DesignWare components
- DFT Compiler
- PrimeTime
- Power Compiler
- HDL Compiler

For additional Tcl-related documentation, you might want to see the following:

- Ousterhout, John K. *Tcl and the Tk Toolkit*. Addison-Wesley, 1994.
- Welch, Brent B. *Practical Programming in Tcl and Tk, 3rd Edition*. Prentice Hall PTR, 1999.

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## Conventions

The following conventions are used in Synopsys documentation.

Convention	Description
Courier	Indicates syntax, such as <code>write_file</code> .
<i>Courier italic</i>	Indicates a user-defined value in syntax, such as <code>write_file design_list</code> .
<b>Courier bold</b>	Indicates user input—text you type verbatim—in examples, such as <pre>prompt&gt; <b>write_file top</b></pre>
[ ]	Denotes optional arguments in syntax, such as <code>write_file [-format <i>fmt</i>]</code>
...	Indicates that arguments can be repeated as many times as needed, such as <pre>pin1 pin2 ... pinN</pre>
	Indicates a choice among alternatives, such as <pre>low   medium   high</pre>
Ctrl+C	Indicates a keyboard combination, such as holding down the Ctrl key and pressing C.
\	Indicates a continuation of a command line.
/	Indicates levels of directory structure.
Edit > Copy	Indicates a path to a menu command, such as opening the Edit menu and choosing Copy.

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## Customer Support

Customer support is available through SolvNet online customer support and through contacting the Synopsys Technical Support Center.

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### Accessing SolvNet

SolvNet includes a knowledge base of technical articles and answers to frequently asked questions about Synopsys tools. SolvNet also gives you access to a wide range of Synopsys online services including software downloads, documentation, and technical support.

To access SolvNet, go to the following address:

<https://solvnet.synopsys.com>

If prompted, enter your user name and password. If you do not have a Synopsys user name and password, follow the instructions to register with SolvNet.

If you need help using SolvNet, click HELP in the top-right menu bar.

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### Contacting the Synopsys Technical Support Center

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- Open a support case to your local support center online by signing in to SolvNet at <https://solvnet.synopsys.com>, clicking Support, and then clicking “Open A Support Case.”
- Send an e-mail message to your local support center.
  - E-mail [support\\_center@synopsys.com](mailto:support_center@synopsys.com) from within North America.
  - Find other local support center e-mail addresses at <http://www.synopsys.com/Support/GlobalSupportCenters/Pages>
- Telephone your local support center.
  - Call (800) 245-8005 from within North America.
  - Find other local support center telephone numbers at <http://www.synopsys.com/Support/GlobalSupportCenters/Pages>

# 1

## Getting Started

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This chapter describes the relationship between the tool command language (Tcl) and Synopsys tools and provides an introduction to working with commands (both Tcl and Synopsys) within a Synopsys command shell. This chapter contains the following sections:

- [Tcl and Synopsys Tools](#)
- [Entering Commands](#)
- [Getting Help on Commands](#)
- [Command Status](#)
- [Using the echo and puts Commands to Output Data](#)
- [Command Parsing](#)

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## Tcl and Synopsys Tools

Tcl is a widely used scripting tool that was developed for controlling and extending applications. Tcl was created by John K. Ousterhout at the University of California, Berkeley, and is distributed as open source software. Tcl is used by many Synopsys command shells as a scripting tool for automating design processes.

Tcl provides the necessary programming constructs—variables, loops, procedures, and so forth—for creating scripts with Synopsys commands.

Note that it is the scripting language, not the Tcl shell, that is integrated into Synopsys tools. This aspect of Tcl encompasses how variables, expressions, scripts, control flow, and procedures work, as well as the syntax of commands (including Synopsys commands).

The examples in this book use a mixture of Tcl and Synopsys commands, so when necessary for clarity, a distinction is made between Tcl and Synopsys commands. Furthermore, Tcl commands that differ from their base implementation are referred to as Synopsys commands. These commands are `exit`, `history`, `rename`, and `source`. You can refer to the Synopsys man pages for a description of how these commands have been implemented.

If you try to execute the examples in this book, you must do so within a Synopsys command shell because the Tcl shell does not support Synopsys commands.

### Note:

Synopsys commands are distributed per license agreement for a particular Synopsys tool or product. Because of this, your particular command shell might not support some of the commands used in the examples. Also, some Synopsys shells implement a special mode for handling Tcl commands that you might have to consider. As for Tcl commands, almost all are supported by the Synopsys command shells.

Most Tcl commands supported by Synopsys shells use a one-word form. The majority of Synopsys commands have a multiple-word form in which each word is separated by an underscore, for example, `foreach_in_collection` or `create_power_rings`. However, there are also a number of one-word Synopsys commands.

Tcl commands are referred to as built-in commands by the Synopsys `help` command and as Tcl built-in commands by the Synopsys man pages.

The following list shows the supported Tcl commands:

<code>after</code>	<code>exec</code>	<code>history*</code>	<code>open</code>	<code>split</code>
<code>append</code>	<code>expr</code>	<code>if</code>	<code>package</code>	<code>string</code>
<code>array</code>	<code>exit*</code>	<code>incr</code>	<code>pid</code>	<code>subst</code>

binary	fblocked	info	proc	switch
bgerror	fconfigure	interp	puts	tell
break	fcopy	join	pwd	time
catch	file	lappend	read	trace
cd	fileevent	lindex	regexp	unset
clock	filename	linsert	regsub	update
close	flush	list	rename*	uplevel
concat	for	llength	return	upvar
continue	foreach	lrange	scan	variable
encoding	format	lreplace	seek	vwait
eof	gets	lsearch	set	while
error	glob	lsort	socket	
eval	global	namespace	source*	

\* Synopsys implemented version. See Synopsys man pages for differences.

Lists of Synopsys commands are available in the quick reference booklet for a particular Synopsys tool.

This book provides only the essential information for using Tcl with Synopsys tools. To learn more about Tcl, consult one of the reference books available on the subject of Tcl (see [“Related Publications” on page x](#)).

---

## Entering Commands

Tcl and Synopsys commands can be entered interactively into a command shell, or they can be processed by the command shell from a script file.

For example, in `dc_shell` you can enter the Tcl `set` command as follows:

```
dc_shell> set buf_name lsi_10k/B1I
```

This command sets the variable `buf_name` to the value `lsi_10k/B1I`.

To use a script file, you enter the Synopsys `source` command with a script file name:

```
dc_shell> source load_vpna.tcl
```

This command causes `dc_shell` to process the script file `load_vpna.tcl`.

---

## Basic Command Usage

Both Tcl and Synopsys commands consist of a command followed by zero or more arguments. The syntax for a command is

```
command argument_list
```

Arguments of a command can be user-specified, or they can be options to a command. In the latter case, the command syntax becomes

```
command cmd_options argument_list
```

Commands are terminated by new-line characters or semicolons. For example,

```
set ReportFile netAttr.rpt
set Clean 0; set NumBins 20
```

When you enter a long command, you can split it across more than one line by using the backslash character (`\`). For example,

```
set physical_library \
/remote/olympia/psyn/db/pdb/physical.pdb
```

## Abbreviating Commands and Options

You can abbreviate Synopsys commands and options to their shortest unambiguous form. Most Tcl commands cannot be abbreviated, although you can abbreviate their options. For example, the following Tcl commands are both valid:

```
dc_shell> info tclversion
8.4
dc_shell> info tclver
8.4
```

However, the following command returns an error because you cannot abbreviate the `info` command:

```
dc_shell> inf tclversion
Error: unknown command 'inf' (CMD-008)
```

Set the command abbreviation mode by using the Synopsys `sh_command_abbrev_mode` variable. You can view the current command abbreviation setting by using the Synopsys `printvar` command, for example,

```
dc_shell> printvar sh_command_abbrev_mode
```

The valid values for `sh_command_abbrev_mode` are `Anywhere`, `Command-Line-Only`, and `None`.

Command abbreviation is meant as an interactive convenience. Do not use command or option abbreviation in script files because script files are susceptible to command changes in subsequent versions of Synopsys tools or Tcl. Such changes can cause abbreviations to become ambiguous.

## Using Wildcard Characters

You can use the asterisk (\*) and question mark (?) wildcard characters to perform pattern matching on objects such as variable names and strings.

You use the \* character to match any sequence of characters in an object. For example, `u*` indicates all objects that begin with the letter `u`, and `u*z` indicates all objects that begin with the letter `u` and end in the letter `z`.

You use the ? character to match any single character. For example, `u??` indicates all object names exactly two characters in length that begin with the letter `u`.

Note:

For restrictions on pattern matching, see [Appendix A, “Tcl Implementation Differences and Limitations.”](#)

## Case Sensitivity

Tcl and Synopsys command names and arguments are case sensitive. For example, the following commands are not equivalent; they refer to two different clocks—one named `Clk` and one named `CLK`.

```
create_clock -period 20.0 {Clk}
create_clock -period 20.0 {CLK}
```

Note:

In general, do not use case to differentiate object names because other tools used in the design process might not support case sensitivity and can mistakenly treat `Clk` and `CLK`, in the previous example, as the same object.

---

## Listing and Rerunning Previously Entered Commands

You can use the Synopsys `history` command to list and execute previously entered commands. If you use the `history` command without options, a list of executed commands is printed; by default 20 commands are listed. The list of commands is printed as a formatted string that shows the event number for each command.

You use the `info` option of the `history` command to list a specific number of previously entered commands. For example, the following command lists the last five executed commands:

```
dc_shell> history info 5
```

You use the `redo` option of the `history` command to reexecute a specific command. You can specify the command to reexecute by its event number or by a relative event number.

The following command executes the command whose event number is 54:

```
dc_shell> history redo 54
```

The following command reexecutes the second-to-the-last command:

```
dc_shell> history redo -2
```

If you do not specify an event number, the last command entered is reexecuted.

As a shortcut, you can also use the exclamation point operator (!) for reexecuting commands. For example, to reexecute the last command, enter

```
dc_shell> !!
```

To reexecute the command whose event number is 6, enter

```
dc_shell> !6
```

### Note:

The Synopsys implementation of `history` varies from the Tcl implementation. For `history` usage information, see the Synopsys man pages.

---

## Getting Help on Commands

You can get help on a command by using the Synopsys `help` or `man` commands.

Additionally, you can get quick help on a Synopsys command by using its `-help` option. For example,

```
dc_shell> create_clock -help
```

Note:

To distinguish between Tcl and Synopsys commands, the Synopsys `help` and `man` commands categorize Tcl commands as built-in commands and Tcl built-in commands, respectively.

---

## Using the help Command

The syntax for the `help` command is

```
help [-verbose] pattern
```

The arguments are as follows:

`-verbose`

Displays a short description of the command arguments.

*pattern*

Specifies a command pattern to match.

Use the `help` command to get quick help on one or more commands. Use the `-verbose` option to see a list of the command's arguments, as well as a brief description of each argument.

If you enter `help` without arguments, a list of all commands arranged by command group (for example, Procedures, Builtins, and Default) is displayed.

You specify a command pattern to view help on one or more commands. For example, the following command shows help for all commands starting with `for`:

```
dc_shell> help for*
```

You can get a list of all commands for a particular command group by entering a command group name as the argument to `help`. For example,

```
dc_shell> help Procedures
```

---

## Using the man Command

You use the `man` command, as shown, to get help from the Synopsys man pages:

```
dc_shell> man query_objects
```

The man pages provide detailed information about a command.

The syntax for the `man` command is

```
man topic
```

The `topic` argument can be a command or a topic. For example, you can get information about a specific command like `query_objects`, or you can get information about a topic like `attributes`.

---

## Command Status

The command status is the value that a command returns. All commands return a string or null. By default, the command status is outputted to the console window. For example,

```
dc_shell> set total_cells 0
0
dc_shell> incr total_cells
1
```

You can redirect this output by using the redirection operator (`>`) or the Synopsys `redirect` command. For example, to redirect the incremented command status to a file, enter

```
dc_shell> report_timing > file_name.rpt
```

To both redirect the incremented command status to a file and display it, enter

```
dc_shell> redirect -tee file_name {incr total_cells}
```

For more information about redirection, see the `redirect` man page.

---

## Using the echo and puts Commands to Output Data

The `echo` and `puts` commands allow you to output data to the screen. The `echo` command is a Synopsys command that prints out its argument to a console window. Most Tcl tools also include an `echo` command; the behavior of this version of `echo` is different from that of the Synopsys `echo` command.

The `puts` command is a Tcl command, and when used in its simplest form, it prints its argument to the standard output. Note that the console window might not be the same as the standard output. The console window is an integral component of the Synopsys tool you are running, and the standard output is, by default, the operating system command shell from which you invoked your Synopsys tool.

The syntax for the `echo` command is

```
echo -n argument
```

The arguments are as follows:

`-n`

Suppresses new-line character output.

*argument*

The item to output.

The `echo` command prints the value of *argument* to the console window, and if the `-n` argument is used, `echo` does not attach a new line to the end of the argument.

The following example prints a line of text and a new line to the console window:

```
dc_shell> echo "Have a good day."  
Have a good day.
```

The syntax for the `puts` command is

```
puts -nonewline file_id arg
```

The arguments are as follows:

`-nonewline`

Suppresses output of the new-line character.

*file\_id*

Specifies the file ID of the channel to which to send output.

*arg*

Contains the output.

The `puts` command sends its output, *arg*, to a channel specified by the *file\_id* argument. If the `-newline` option is used, `puts` does not attach a new line to the end of *arg*. If the *file\_id* argument is not specified, `puts` prints to the standard output.

The following example shows how to use `puts` in its simplest form:

```
dc_shell> puts "Have a good day."  
Have a good day.
```

For more information about the `puts` command, see [“gets and puts” on page 2-19](#).

---

## Command Parsing

A Synopsys command shell parses commands (Tcl and Synopsys) and makes substitutions in a single pass from left to right. At most, a single substitution occurs for each character. The result of one substitution is not scanned for further substitutions.

---

## Substitution

The substitution types are

- Command substitution

You can use the result of a command in another command (nested commands) by enclosing the nested command in square brackets (`[]`). (For an exception, see [“Command Substitution Exception” on page A-2](#).)

For example,

```
dc_shell> set a [expr 24 * 2]
```

You can use a nested command as a conditional statement in a control structure, as an argument to a procedure, or as the value to which a variable is set. Tcl imposes a depth limit of 1,000 for command nesting.

- Variable substitution

You can use variable values in commands by using the dollar sign character (`$`) to reference the value of the variable. (For more information about Tcl variables, see [“Variables” on page 2-2](#).)

For example,

```
dc_shell> set a 24  
24  
dc_shell> set b [expr $a * 2]  
48
```

- Backslash (\) substitution

You use backslash substitution to insert special characters, such as a new line, into text. For example

```
dc_shell> echo "This is line 1.\nThis is line 2."  
This is line 1.  
This is line 2.
```

You can also use backslash substitution to disable special characters when weak quoting is used (see “[Quoting](#)” next).

---

## Quoting

You use quoting to disable the interpretation of special characters (for example, [], \$, and ;). You disable command substitution and variable substitution by enclosing the arguments in braces ({}); you disable word and line separators by enclosing the arguments in double quotation marks ("").

Braces specify rigid quoting. Rigid quoting disables all substitution, so that the characters between the braces are treated literally. For example,

```
dc_shell> set a 5; set b 10  
10  
dc_shell> echo {[expr $b - $a]} evaluates to [expr $b - $a]  
[expr $b - $a] evaluates to 5
```

Double quotation marks specify weak quoting. Weak quoting disables word and line separators while allowing command, variable, and backslash substitution. For example,

```
dc_shell> set A 10; set B 4  
4  
dc_shell> echo "A is $A; B is $B.\nNet is [expr $A - $B]."  
A is 10; B is 4.  
Net is 6.
```

---

## Special Characters

[Table 1-1](#) lists the characters that have special meaning in Tcl. If you do not want these characters treated specially, you can precede the special characters with a backslash (\).

For example,

```
dc_shell> set gp 1000; set ex 750
750
dc_shell> echo "Net is: \"[expr $gp - $ex]\"
Net is: $250
```

*Table 1-1 Tcl Special Characters*

---

Character	Meaning
\$	Used to access the value of a variable.
()	Used to group expressions.
[]	Denotes a nested command. (For an exception, see <a href="#">“Command Substitution Exception” on page A-2.</a> )
\	Used for escape quoting and as a line continuation character.
""	Denotes weak quoting. Nested commands and variable substitutions still occur.
{ }	Denotes rigid quoting. There are no substitutions.
;	Ends a command.
#	Begins a comment.

---

# 2

## Tcl Basics

---

This chapter provides an overview of the Tcl scripting language. It contains the following sections:

- [Variables](#)
- [Scripts](#)
- [Data Types](#)
- [Expressions](#)
- [Control Flow](#)
- [Basic File Commands](#)

This chapter is not an exhaustive Tcl reference. It covers the most important aspects of Tcl to give you a foundation for using Tcl with Synopsys commands. For more information about Tcl, consult one of the reference books available on the subject of Tcl (see [“Related Publications”](#) on page x).

---

## Variables

Tcl supports two types of variables, simple and array. This section describes how to work with simple variables; arrays are described later in this chapter (see [“Arrays” on page 2-9](#)).

The simplest way to create a variable and assign it a value is by using the `set` command. For example,

```
dc_shell> set buf_name lsi_10k/B1I
lsi_10k/B1I
dc_shell> set a 1
1
dc_shell> set b 2.5
2.5
```

In Tcl, all variables are strings. However, Tcl does recognize variables whose values represent integer and real numbers (see [“Numeric Variable Precision” on page 2-3](#)).

You can append one or more values to a variable by using the Tcl `append` command. For example,

```
dc_shell> set c1 U1; set c2 U2
U2
dc_shell> append c1 " " $c2
U1 U2
```

The following example shows how you can use a variable to save the result of a command:

```
dc_shell> set a [expr 42 * 2]
```

To increase or decrease an integer variable by a fixed amount, use the Tcl `incr` command. For example,

```
dc_shell> set b 10
10
dc_shell> incr b
11
dc_shell> incr b -6
5
```

The default increment value for `incr` is 1. An error message is displayed if you try to increment a variable that is not an integer.

You use the `unset` command to delete variables. Any type of variable can be deleted with the `unset` command.

To find out whether a variable exists, you can use the Tcl `info exists` command. For example, to see whether the variable `total_cells` exists, enter

```
dc_shell> info exists total_cells
```

The `info exists` command returns 1 if the variable exists, and it returns 0 otherwise.

To see whether variables exist that match a specified pattern, use the Tcl `info vars` command. For example,

```
dc_shell> info vars total_c*
```

---

## Numeric Variable Precision

The precision of a numeric variable depends on how you assign a numeric value to it. A numeric variable becomes a floating number if you use the decimal point; otherwise it becomes an integer. An integer variable can be treated as a decimal, octal, or hexadecimal number when used in expressions.

To avoid unexpected results, you must be aware of the precision of a numeric variable when using it in an expression. For example, in the following commands, the division operator produces different results when used with integer and floating-point numbers:

```
dc_shell> set a 10; set b 4.0; set c 4
4
dc_shell> expr $a/$b
2.5
dc_shell> expr $a/$c
2
```

The first `expr` command performs floating-point division; the second `expr` command performs integer division. Integer division does not yield the fractional portion of the result. When integer and floating-point variables are used in the same expression, the operation becomes a floating-point operation, and the result is represented as floating point.

---

## Variable Substitution

You use variable substitution to access the value of a variable. You invoke variable substitution by preceding a variable name with the `$` operator.

The following example uses the Synopsys `echo` command to print out the value of a variable:

```
dc_shell> set buf_name lsi_10k/B1I
lsi_10k/B1I
dc_shell> echo $buf_name
lsi_10k/B1I
```

---

## Predefined Variables

Tcl maintains only a few predefined variables. In contrast, Synopsys command shells use numerous predefined variables of which you should be aware. For detailed information about Synopsys predefined variables, see the quick reference booklet for a particular Synopsys tool.

An example of a Tcl predefined variable is `env`. The `env` variable is an array (see [“Arrays” on page 2-9](#)) that contains the environment variable names of the UNIX shell in which the Synopsys command shell is running. You can view a list of the environment variables by using the Tcl `array` command with its `names` option. For example,

```
dc_shell> array names env
```

The list that prints out contains element names that correspond to the names of environment variables. To reference the value of an environment variable, use `$env(ENV_VAR_NAME)`. For example, you can view the value of the `HOME` environment variable by entering

```
dc_shell> echo $env(HOME)
```

You can also use the Synopsys `getenv` command to view the value of an environment variable. For example,

```
dc_shell> getenv HOME
```

If you change the value of an `env` element, the change is reflected in the environment variable of the process in which the command shell is running. The `env` element is returned to its previous value after the command shell exits.

---

## Scripts

A script is made up of commands (both Tcl and Synopsys) grouped together. Typically, these commands are stored in a script file to perform a specific process (compiling a design, for example). However, you can enter a script directly into a command shell by using semicolons and command continuation.

A command is composed of a command word followed by zero or more options or arguments. Command names, options, and arguments are separated by white-space characters (except for new line, which terminates a command).

For more information about command syntax, see [“Basic Command Usage” on page 1-4](#).

---

## Creating Comments

Comment lines are created by placing a pound sign (#) as the first nonblank character of a line. You can create inline comments by placing a semicolon between a command and the pound sign. For example,

```
echo abc; # this is an inline comment
```

When the command continuation character (\) is placed at the end of a commented command line, the subsequent line is also treated as a comment. In the following example, none of the `set` commands will be executed:

```
# set CLK_NAME Sysclk; set CLK_PERIOD 10; \  
set INPUT_DELAY 2
```

---

## Loading and Running a Script File

You load and run a script file by using the Synopsys `source` command. For example, if your script is contained in a file called `mysession.tcl`, you run the script file by entering

```
dc_shell> source mysession.tcl
```

When you specify a file name without directory information, the `source` command examines the `sh_source_uses_search_path` variable to determine whether to use the value of the `search_path` variable to search for files. For more information, see the `sh_source_uses_search_path` and `search_path` man pages.

Note:

The Synopsys implementation of `source` varies from the Tcl implementation. For `source` usage information, see the Synopsys man pages.

---

## Redirecting Script Output

As a script file is being processed, you can have the Synopsys `source` command display commands and command results by using its `-echo` and `-verbose` options. For example,

```
dc_shell> source -echo -verbose myrun.tcl
```

You can also save the execution results to an output file by using the pipe operator (>). For example,

```
dc_shell> source -echo -verbose myrun.tcl > myrun.out
```

The execution output of a script file can be changed in various ways. For example, you can change how variable initializations and error and warning messages are displayed. For more information about controlling execution output, see the `sh_new_variable_message` and `suppress_message` man pages.

---

## Sample Script File

[Example 2-1](#) shows a sample script file that sets up a particular session and then performs a compile:

### Example 2-1 Sample Script File

```
set DESIGN_NAME top
set SUB_MODULE [list sub1.v sub2.v sub3.v]
set CLK_NAME Sysclk
set CLK_PERIOD 10
set INPUT_DELAY 2
set OUTPUT_DELAY 3
read_verilog [list $SUB_MODULE $DESIGN_NAME.v]
current_design $DESIGN_NAME
link
create_clock -p $CLK_PERIOD -n $CLK_NAME [get_ports $CLK_NAME]
set_input_delay $INPUT_DELAY -clock $CLK_NAME [list [all_inputs]]
set_output_delay $OUTPUT_DELAY -clock $CLK_NAME [list [all_outputs]]
compile
```

---

## Data Types

You can use the following data types, which are described in the sections that follow:

- [Strings](#)
- [Lists](#)
- [Arrays](#)

Note:

Synopsys tools also support a collection data type, which is described in [Chapter 4](#), “[Working With Collections](#).”

---

## Strings

A string is a sequence of characters. Tcl treats command arguments as strings and returns command results as strings. The following are string examples:

```
sysclk
"FF3 FF4 FF5"
```

To include special characters, such as space, backslash, or new line, in a string, you must use quoting to disable the interpretation of the special characters (see “[Quoting](#)” on [page 1-11](#)).

Most string operations are done by means of the Tcl `string` command.

The syntax for the `string` command is

```
string option arg ...
```

The arguments are as follows:

`option`

Specifies an option for the `string` command.

`arg ...`

Specifies the argument or arguments for the `string` command.

For example, to compare two strings you use the `compare` option as follows:

```
string compare string1 string2
```

To convert a string to all uppercase characters, you use the `toupper` option as follows:

```
string toupper string
```

[Table 2-1](#) lists Tcl commands you can use with strings. For more information about these commands, see the Synopsys man pages.

*Table 2-1 Tcl Commands to Use With Strings*

<b>Command</b>	<b>Description</b>
<code>format</code>	Formats a string.
<code>regexp</code>	Searches for a regular expression within a string.
<code>regsub</code>	Performs substitutions based on a regular expression.
<code>scan</code>	Assigns fields in the string to variables.
<code>string</code>	Provides a set of string manipulation functions.
<code>subst</code>	Performs substitutions.

---

## Lists

A list is an ordered group of elements; each element can be a string or another list. You use lists to group items such as a set of cell instance pins or a set of report file names. You can then conveniently manipulate the grouping as a single entity.

You can create a simple list by enclosing the list elements in double quotation marks (") or braces ({}), or by using the Tcl `list` command. You must delimit list elements with spaces—do not use commas.

For example, you could create a list of cell instance D-input pins, I1/FF3/D, I1/FF4/D, and I1/FF5/D, in one of the following ways:

```
set D_pins "I1/FF3/D I1/FF4/D I1/FF5/D"
set D_pins {I1/FF3/D I1/FF4/D I1/FF5/D}
set D_pins [list I1/FF3/D I1/FF4/D I1/FF5/D]
```

You use the `list` command to create a compound (nested) list. For example, the following command creates a list that contains three elements, each of which is also a list:

```
set compound_list [list {x y} {1 2.5 3.75 4} {red green blue}]
```

To access a specific element in a simple or compound list, you use the `lindex` command. For example, the following commands print out the first element of the `D_pins` list and the second element of the `compound_list` list:

```
dc_shell> lindex $D_pins 0
I1/FF3/D
```

```
dc_shell> lindex $compound_list 1
1 2.5 3.75 4
```

Note that `lindex` is zero based.

Because braces prevent substitutions, you must use double quotation marks or the `list` command to create a list if the list elements include nested commands or variable substitution.

For example, if variable `a` is set to 5, the following commands generate very different results:

```
dc_shell> set a 5
5
```

```
dc_shell> set b {c d $a [list $a z]}
c d $a [list $a z]
```

```
dc_shell> set b [list c d $a [list $a z]]
c d 5 {5 z}
```

[Table 2-2](#) lists Tcl commands you can use with lists. For more information about these commands, see the Synopsys man pages.

*Table 2-2 Tcl Commands to Use With Lists*

Command	Task
<code>concat</code>	Concatenates lists and returns a new list.
<code>join</code>	Joins elements of a list into a string.
<code>lappend</code>	Appends elements to a list.
<code>lindex</code>	Returns a specific element from a list.
<code>linsert</code>	Inserts elements into a list.
<code>list</code>	Returns a list formed from its arguments.
<code>llength</code>	Returns the number of elements in a list.
<code>lrange</code>	Extracts elements from a list.
<code>lreplace</code>	Replaces a specified range of elements in a list.
<code>lsearch</code>	Searches a list for a regular expression.
<code>lsort</code>	Sorts a list.
<code>split</code>	Splits a string into a list.

## Arrays

Tcl uses associative arrays. This type of array uses arbitrary strings, which can include numbers, as its indices. The associative array is composed of a group of elements where each element is a variable with its own name and value. To reference an array element, you use the following form:

```
array_name (element_name)
```

For example, you can create an array of report file name extensions as follows:

```
dc_shell> set vio_rpt_ext(ir_drop) .volt
.volt
dc_shell> set vio_rpt_ext(curr_dens) .em
.em
dc_shell> set vio_rpt_ext(curr) .current
.current
```

The first `set` command creates the `vio_rpt_ext` array and sets its `ir_drop` element to `.volt`. The subsequent commands create new array elements and assign them with values. [Figure 2-1](#) illustrates how the `vio_rpt_ext` array is organized.

*Figure 2-1 Structure of `vio_rpt_ext` Array*

Element Names	Element Values
<code>ir_drop</code>	<code>.volt</code>
<code>curr_dens</code>	<code>.em</code>
<code>curr</code>	<code>.current</code>

The following example prints out the `curr_dens` element:

```
dc_shell> echo $vio_rpt_ext(curr_dens)
.em
```

You can use the Tcl `array` command, along with one of its options, to get information about the elements of an array. The following commands use the `size` and `names` options to print the size and element names of the `vio_rpt_ext` array.

```
dc_shell> array size vio_rpt_ext
3
dc_shell> array names vio_rpt_ext
curr curr_dens ir_drop
```

For more information about array usage, see the `array` man page.

## Expressions

You use the Tcl `expr` command to evaluate an expression.

For example, if you want to multiply the value of variable `p` by 12 and place the result into variable `a`, enter the following commands:

```
dc_shell> set p 5
5
dc_shell> set a [expr (12*$p)]
60
```

The following command does not perform the desired multiplication:

```
dc_shell> set a (12 * $p)
```

Where possible, expression operands are interpreted as integers. Integer values can be decimal, octal, or hexadecimal. Operands not in an integer format are treated as

floating-point numbers, if possible (see [“Numeric Variable Precision” on page 2-3](#)). Operands can also be one of the mathematical functions supported by Tcl. For more information, see the `expr` man page.

**Note:**

The `expr` command is the simplest way to evaluate an expression. You will also find expressions in other commands, such as the control flow `if` command. The rules for evaluating expressions are the same whether you use the `expr` command or use the expression within the conditional statement of a control flow command (see [“Control Flow” on page 2-12](#)).

[Table 2-3](#) lists the Tcl operators in order of precedence. The operators at the top of the table have precedence over operators lower in the table.

*Table 2-3 Tcl Operators*

Syntax	Description	Operand types
-a	Negative of a	int, real
!a	Logical NOT: 1 if a is zero, 0 otherwise	int, real
~a	Bitwise complement of a	int
a*b	Multiply a and b	int, real
a/b	Divide a by b	int, real
a%b	Remainder after dividing a by b	int
a+b	Add a and b	int, real
a-b	Subtract b from a	int, real
a<<b	Left-shift a by b bits	int
a>>b	Right-shift a by b bits	int
a<b	1 if a is less than b, 0 otherwise	int, real, string
a>b	1 if a is greater than b, 0 otherwise	int, real, string
a<=b	1 if a is less than or equal to b, 0 otherwise	int, real, string
a>=b	1 if a is greater than or equal to b, 0 otherwise	int, real, string
a==b	1 if a is equal to b, 0 otherwise	int, real, string
a!=b	1 if a is not equal to b, 0 otherwise	int, real, string
a&b	Bitwise AND of a and b	int
a^b	Bitwise exclusive OR of a and b	int
a b	Bitwise OR of a and b	int

Table 2-3 Tcl Operators (Continued)

Syntax	Description	Operand types
a&&b	Logical AND of a and b	int, real
a  b	Logical OR of a and b	int, real
a?b:c	If a is nonzero, then b, else c	a: int, real b, c: int, real, string

---

## Control Flow

The Tcl control flow commands—`if`, `while`, `for`, `foreach`, `break`, `continue`, and `switch`—determine the execution order of other commands.

The `if` and `switch` commands provide a way to select for execution one block of script from several blocks. The `while`, `for`, and `foreach` commands provide a way to repeat a block of script (looping). The `break` and `continue` commands are used in conjunction with looping to change the normal execution order of loops.

---

### Using the if Command

An `if` command requires two arguments; in addition, it can be extended to contain `elseif` and `else` arguments. The required arguments are

- An expression to evaluate
- A script to conditionally execute based on the result of the expression

The basic form of the `if` command is

```
if {expression} {
    script
}
```

The `if` command evaluates `expression`, and if the `expression` result is not zero, `script` is executed.

The `if` command can be extended to contain one or more `elseif` arguments and a final `else` argument. An `elseif` argument requires two additional arguments: an expression and a script. An `else` argument requires only a script.

The basic form is as follows:

```
if {expression1} {  
    script1  
} elseif {expression2} {  
    script2  
} else {  
    script3  
}
```

The following example shows how to use the `elseif` and `else` arguments.

```
if {$x == 0} {  
    echo "Equal"  
} elseif {$x > 0} {  
    echo "Greater"  
} else {  
    echo "Less"  
}
```

The `elseif` and `else` arguments appear on the same line with the closing brace (`}`). This syntax is required because a new line indicates a new command. If the `elseif` argument is on a separate line, it is treated as a command, which it is not.

---

## Using the while Command

The `while` command has two arguments:

- An expression to evaluate
- A script to conditionally execute based on the result of the expression

The `while` command has the following form:

```
while {expression} {  
    script  
}
```

The `while` command evaluates `expression`, and if the `expression` result is not zero, `script` is executed. After `script` is executed, the `while` command evaluates `expression` again; if `expression` is still not zero, `script` is executed again.

For example, the following `while` command prints squared values from 0 to 10:

```
set p 0  
while {$p <= 10} {  
    echo "$p squared is: [expr $p * $p]"; incr p  
}
```

---

## Using the for Command

The `for` command has four arguments:

- An initialization expression
- A loop-termination expression
- A reinitialization expression
- The script to execute for each iteration of the `for` loop

The `for` command has the following form:

```
for {initial_expr} {termination_expr} {reinit_expr}{
    script
}
```

The following example prints the squared values from 0 to 10:

```
for {set p 0} {$p <= 10} {incr p} {
    echo "$p squared is: [expr $p * $p]"
}
```

---

## Using the foreach Command

The `foreach` command iterates over the elements in a list. It has three arguments:

- A variable name
- A list
- A script to execute

The `foreach` command has the following form:

```
foreach var $somelist{
    script
}
```

The `foreach` command executes `script` for each element in the specified list. Before executing `script`, `foreach` sets `var` to the value of the next element in the list.

For example, the following `foreach` command prints the elements of a simple list:

```
dc_shell> set mylist {I1/FF3/D I1/FF4/D I1/FF5/D}
I1/FF3/D I1/FF4/D I1/FF5/D
dc_shell> foreach i $mylist {echo $i}
I1/FF3/D
I1/FF4/D
I1/FF5/D
```

---

## Using the break and continue Commands

The `break` and `continue` commands change the flow of the `while`, `for`, and `foreach` commands.

- The `break` command causes the innermost loop to terminate.
- The `continue` command causes the current iteration of the innermost loop to terminate.

In the following example, a list of file names is scanned until the first file name that is a directory is encountered. The `break` command is used to terminate the `foreach` loop when the first directory name is encountered.

```
foreach f [which {VDD.ave GND.tech p4mvm2mb.idm}] {
  echo -n "File $f is "
  if { [file isdirectory $f] == 0 } {
    echo "NOT a directory"
  } else {
    echo "a directory"
    break
  }
}
```

In the following example, the `continue` command causes the printing of only the squares of even numbers between 0 to 10:

```
set p 0
while {$p <= 10} {
  if {$p % 2} {
    incr p
    continue
  }
  echo "$p squared is: [expr $p * $p]"; incr p
}
```

---

## Using the switch Command

The `switch` command provides a more compact encoding alternative to using an `if` command with lots of `elseif` arguments. The `switch` command tests a value against a number of string patterns and executes the script corresponding to the first pattern that matches.

The `switch` command has the following form:

```
switch $s {pat1 {scripta} pat2 {scriptb} pat3 {scriptc}...}
```

For readability, the following form is often used:

```
switch $s {
  pat1 {scripta}
  pat2 {scriptb}
  pat3 {scriptc}
  ...}
```

The *\$s* argument is the value to be tested against each pattern (*pat1*, *pat2*, and *pat3*), and *scripta*, *scriptb*, and *scriptc* represent the script that is executed for each pattern match.

In the following example, the Tcl `glob` command is used to generate a list of particular file types within the current directory, and then the number of files of a particular file type (file extension) are tabulated and printed.

```
# Tabulates files by their type
set fnames [glob *.em *.volt *.current]
set curr_ct 0; set em_ct 0; set volt_ct 0
foreach f $fnames {
  set f_ext [file extension $f]
  switch $f_ext {
    .current {incr curr_ct}
    .em      {incr em_ct}
    .volt    {incr volt_ct}
  }
}
echo "There are $curr_ct current files."
echo "There are $em_ct current density files."
echo "There are $volt_ct IR drop files."
```

The `switch` command also has three options, `-exact`, `-glob`, and `-regexp`, that affect how pattern matching is handled. For more information about these options, see the `switch` man page.

---

## Basic File Commands

This section provides an overview of Tcl commands you can use when working with files. You use these commands to work with directories, retrieve information about files, and read from and write to files.

---

### cd and pwd

The `cd` and `pwd` commands are equivalent to the operating system commands with the same name. You use the `cd` command to change the current working directory and the `pwd` command to print the full path name of the current working directory.

---

## file and glob

You use the `file` and `glob` commands to retrieve information about file names and to generate lists of file names.

You use the `file` command to retrieve information about a file. The `file` command has the following form:

```
file option arg arg ...
```

[Table 2-4](#) provides a sample of `file` command options.

*Table 2-4 File Command Option Samples*

File command and option	Description
<code>file dirname <i>fname</i></code>	Returns the directory name part of a file name.
<code>file exists <i>fname</i></code>	Returns 1 if the file name exists, 0 otherwise.
<code>file extension <i>fname</i></code>	Returns the extension part of a file name.
<code>file isdirectory <i>fname</i></code>	Returns 1 if the file name is a directory, 0 otherwise.
<code>file isfile <i>fname</i></code>	Returns 1 if the file name is a file, 0 otherwise.
<code>file readable <i>fname</i></code>	Returns 1 if the file is readable, 0 otherwise.
<code>file rootname <i>fname</i></code>	Returns the name part of a file name.
<code>file size <i>fname</i></code>	Returns the size, in bytes, of a file.
<code>file tail <i>fname</i></code>	Returns the file name from a file path string.
<code>file writable <i>fname</i></code>	Returns 1 if the file is writable, 0 otherwise.

You use the `glob` command to generate a list of file names that match one or more patterns. The `glob` command has the following form:

```
glob pattern1 pattern2 pattern3 ...
```

The following example generates a list of `.em` and `.volt` files located in the current directory:

```
set flist [glob *.em *.volt]
```

---

## open, close, and flush

You use the `open`, `close`, and `flush` commands to set up file access.

The `open` command syntax is as follows:

```
open fname access_mode
```

The *access\_mode* argument specifies how you want the file opened; the default access mode is read only. Typical access modes include read only, write only, read/write, and append. (For a complete list of all access modes, see the `open` man page.) [Table 2-5](#) lists some commonly used access modes.

*Table 2-5 Commonly Used Access Modes*

Access mode	Description
r	Opens the file for reading only; the file must already exist. This is the default access mode.
r+	Opens the file for reading and writing; the file must already exist.
w	Opens the file for writing only. If the file exists, truncates it. If the file does not exist, creates it.
w+	Opens the file for reading and writing. If the file exists, truncates it. If the file does not exist, creates it.
a	Opens the file for writing only; new data is appended to the file. The file must already exist.
a+	Opens the file for reading and writing. If the file does not exist, creates it. New data is appended to the file.

The `open` command returns a string (a file ID) that is used to identify the file for further interaction with it.

You use the `close` command to close a file; it has the following syntax:

```
close $fid
```

The *\$fid* argument is the file ID of the file that was obtained from an `open` command.

The following example demonstrates the use of the `open` and `close` commands:

```
set f [open VDD.em w+]
close $f
```

You use the `flush` command to force buffered output to be written to a file. Data written to a file does not always immediately appear in the file when a buffered output scheme is used. Instead, the data is queued in memory by the system and is written to the file later; the `flush` command overrides this behavior.

The `flush` command has the following syntax:

```
flush $fid
```

---

## gets and puts

You use the `gets` command to read a single line from a file and the `puts` commands to write a single line to a file.

The `gets` command has the following syntax:

```
gets $fid var
```

The `$fid` argument is the file ID of the file that was obtained from an `open` command; the `var` argument is the variable that is to receive the line of data.

After the line is read, the file is positioned to its next line. The `gets` command returns a count of the number of characters actually read. If no characters are read, `gets` returns -1 and places an empty string into `var`.

The `puts` command has the following syntax:

```
puts $fid var
```

The `$fid` argument is the file ID of the file that was obtained from an `open` command; the `var` argument contains the data that is to be written. The `puts` command adds a new-line character to the data before it is outputted.

If you leave out the file ID, the data is written to the standard output. For more information about this use of `puts`, see [“Using the echo and puts Commands to Output Data” on page 1-9](#).

The following example demonstrates the use of `gets` and `puts`:

```
# Write out a line of text, then read it back and print it
set fname "mytext.txt"
# Open file, then write to it
set fid [open $fname w+]
puts $fid "This is my line of text."
close $fid
#
# Open file, then read from it
set fid [open $fname r]
set data_in [gets $fid]
close $fid
#
# Print out data read
echo $data_in
```

---

## Nonsequential File Access

By default, the `gets` and `puts` commands access files sequentially. You can use the `seek`, `tell`, and `eof` commands to manage nonsequential file access.

You use the `seek` command to move the *access position* of the file by a specified number of bytes. The access position is the point where the next read or write occurs in the file. By default, the access point is where the last read or write ended.

The simplest form of the `seek` command is

```
seek $fid offset
```

The `$fid` argument is the file ID of the file that was obtained from an `open` command; the `offset` argument is the number of bytes to move the access position.

You use the `tell` command to obtain the current access position of a file.

The basic syntax of the command is

```
tell $fid
```

You use the `eof` command to test whether the access position of a file is at the end of the file. The command returns 1 if true, 0 otherwise.

# 3

## Working With Procedures

---

A procedure is a named block of commands that performs a particular task or function. With procedures, you create new commands by using existing Tcl and Synopsys commands. This chapter shows you how to create procedures, and it describes how to use Synopsys procedure extensions.

This chapter contains the following sections:

- [Creating Procedures](#)
- [Extending Procedures](#)
- [Displaying Procedure Body and Arguments](#)

---

## Creating Procedures

You use the Tcl `proc` command to create a procedure. The general form of the `proc` command is

```
proc name args body
```

The *name* argument names your procedure. You cannot use the name of an existing Tcl or Synopsys command. You can, however, use the name of an existing procedure, and if a procedure with the name you specify exists, your procedure replaces the existing procedure.

The arguments to a procedure are specified in *args*, and the script that makes up a procedure is contained in *body*. You can create procedures without arguments also. Arguments to a procedure must be scalar variables; consequently you cannot use arrays as arguments to a procedure. (For a technique to overcome this limitation, see [“Using Arrays With Procedures” on page 3-5.](#))

The following is a procedure example:

```
# procedure max
# returns the greater of two values
proc max {a b} {
    if {$a > $b} {
        return $a
    }
    return $b
}
```

You invoke this procedure as follows:

```
dc_shell> max 10 5
```

To save the result of the procedure, set a variable to its result. For example,

```
dc_shell> set bigger [max 10 5]
```

When a procedure terminates, the return value is the value specified in a `return` command. If a procedure does not execute an explicit `return`, the return value is the value of the last command executed in the body of the procedure. If an error occurs while the body of the procedure is being executed, the procedure returns that error.

The `return` command causes the procedure to return immediately; commands that come after `return` are not executed.

---

## Variable Scope

Variable scope determines the accessibility of a variable when it is used in scripts and procedures. In Tcl, the scope of a variable can be either local or global. When working with scripts and procedures, you must be aware of a variable's scope to ensure that it is used properly.

When a procedure is invoked, a local variable is created for each argument of the procedure. Local variables are accessible only within the procedure from which they are created, and they are deleted when the procedure terminates. A variable created within the procedure body is also a local variable.

Variables created outside of procedures are called global variables. You can access a global variable from within a procedure by using the Tcl `global` command. The `global` command establishes a connection to the named global variable, and references are directed to that global variable until the procedure terminates. (For more information, see the `global` man page.)

You can also access variables that are outside the scope of a procedure by using the Tcl `upvar` command. This command is useful for linking to a procedure nonscalar variables (for example, arrays), which cannot be used as arguments for a procedure. For more information about this command, see the `upvar` man page.

It is possible to create a local variable with the same name as a global variable and to create local variables with the same name in different procedures. In each case, these are different variables, so changes to one do not affect the other.

For example,

```
# Variable scope example
set ga 5
set gb clock_ext

proc scope_ex1 {a b} {
    echo $a $b
    set gb 100
    echo $gb
}

proc scope_ex2 {a b} {
    echo $a $b
    set gb 4.25
    echo $gb
}
```

In this script example, `ga` and `gb` are global variables because they are created outside of procedures `scope_ex1` and `scope_ex2`. The variable name `gb` is also used within `scope_ex1` and `scope_ex2`. Within these procedures, `gb` is a local variable. All three

instances of `gb` exist as three different variables. A change to one instance of `gb` does not affect the others.

---

## Argument Defaults

You can specify default values for one or more of the arguments of a procedure.

To set up a default for an argument, you place the arguments of the procedure in a sublist that contains two elements: the name of the argument and its default. For example,

```
# procedure max
# returns the greater of two values
proc max {{a 0} {b 0}} {
    if {$a > $b} {
        return $a
    }
    return $b
}
```

In this example, you can invoke `max` with two or fewer arguments. If an argument is missing, its value is set to the specified default, 0 in this case.

With this procedure, the following invocations are all valid:

```
max
max arg1
max arg1 arg2
```

You do not have to surround nondefault arguments within braces. For example,

```
# procedure max
# returns the greater of two values
proc max {a {b 0}} {
    ...
}
```

You should also consider the following points when using default arguments:

- If you do not specify a particular argument with a default, you must supply that argument when the procedure is invoked.
- If you use default arguments, you must place them after all nondefault arguments.
- If you specify a default for a particular argument, you must specify a default for all arguments that follow.
- If you omit an argument, you must omit all arguments that follow.

---

## Variable Numbers of Arguments

You can create procedures with variable numbers of arguments if you use the special argument `args`. This argument must be positioned as the last argument in the argument list; arguments preceding `args` are handled as described in the previous sections.

Additional arguments are placed into `args` as a list. The following example shows how to use a varying number of arguments:

```
# print the square of at least one number
proc squares {num args} {
    set nlist $num
    append nlist " "
    append nlist $args
    foreach n $nlist {
        echo "Square of $n is [expr $n*$n]"
    }
}
```

---

## Using Arrays With Procedures

When using an array with a procedure, you can make the array a global variable, or you can use the `get` and `set` options of the `array` command to manipulate the array so that it can be used as an argument or as the return value of a procedure. [Example 3-1](#) demonstrates the latter technique.

### *Example 3-1 Passing an Array to a Procedure*

```
proc foo { bar_list } {
    # bar was an array in the main code
    array set bar_array $bar_list;
    # manipulate bar_array
    return [array get bar_array];
}
set george(one) {two};
set george(alpha) {green};
array set new_george [foo [array get george]];
```

---

## General Considerations for Using Procedures

Keep in mind the following points when using procedures:

- Procedures can use Tcl and Synopsys commands.
- Procedures can use other procedures provided that they contain supported Tcl and Synopsys commands.
- Procedures can be recursive.
- Procedures can contain local variables and can reference variables outside their scope (see [“Variable Scope” on page 3-3](#)).

---

## Extending Procedures

This section describes the Synopsys `define_proc_attributes` and `parse_proc_arguments` commands. These commands add extended functionality to the procedures you create. With these commands, you can create procedures with the same help and semantic attributes as Synopsys commands.

When you create a procedure, it has the following intrinsic attributes:

- The body of the procedure can be viewed with the Tcl `info body` command.
- The procedure can be modified.
- The procedure name can be abbreviated according to the value of the `sh_command_abbrev_mode` variable.
- The procedure is placed in the Procedures command group.

Note:

The procedure does not have help text.

By using the `define_proc_attributes` command, you can

- Specify help text for the command
- Specify rules for argument validation
- Prevent procedure view and modification
- Prevent procedure name abbreviation
- Specify the command group in which to place the procedure

You use the `parse_proc_arguments` command in conjunction with the `define_proc_attributes` command to enable the `-help` option for a procedure (see [“Getting Help on Commands” on page 1-7](#)) and to support procedure argument validation.

---

## Using the `define_proc_attributes` Command

You use the Synopsys `define_proc_attributes` command to define and change the attributes of a procedure.

The syntax is

```
define_proc_attributes proc_name
    [-info info_text]
    [-define_args arg_defs]
    [-command_group group_name]
    [-hide_body]
    [-hidden]
    [-permanent]
    [-dont_abbrev]
```

The arguments are defined as follows:

*proc\_name*

Specifies the name of the procedure to extend.

`-info info_text`

Specifies the quick-help text that is used in conjunction with the `help` command and the procedure's `-help` option. The text is limited to one line.

`-define_args arg_defs`

Specifies the help text for the procedure's arguments and defines the procedure arguments and their attributes.

`-command_group group_name`

Specifies the command group of the procedure. The default command group is Procedures. This attribute is used in conjunction with the `help` command (see [“Getting Help on Commands” on page 1-7](#)).

`-hide_body`

Hides the body of the procedure. The procedure body cannot be viewed by using the `body` option of the `info` command. This attribute does not affect the `info` command when the `args` option is used.

`-hidden`

Hides the procedure so the `help` command cannot access the help page, and the `info proc` command cannot access the body of the procedure.

`-permanent`

Prevents modifications to the procedure.

`-dont_abbrev`

Prevents name abbreviation for the procedure, regardless of the value of the `sh_command_abbrev_mode` variable.

You use the `-define_args` argument to specify quick-help text for the procedure's arguments and to define the data type and attributes of the procedure's arguments. The `-define_args` argument is a list of lists (see [“Lists” on page 2-8](#)). Each list element is used to specify attributes for each procedure argument.

For information about using the `-define_args` arguments within a procedure, see [“Using the parse\\_proc\\_arguments Command” on page 3-9](#). Each list element has the following format:

*arg\_name option\_help value\_help data\_type attributes*

*arg\_name*

Specifies the name of the argument.

*option\_help*

Specifies a short description of the argument for use with the procedure's `-help` option.

*value\_help*

For positional arguments, specifies the argument name; otherwise, is a one-word description for the value of a dash option. This parameter has no meaning for a Boolean option.

*data\_type*

Specifies the data type of an argument; the `data_type` parameter can be one of the following: `string` (the default), `list`, `boolean`, `int`, `float`, or `one_of_string`. This parameter is optional.

*attributes*

Specifies additional attributes for an argument. This parameter is optional. The additional attributes are described in [Table 3-1](#).

Table 3-1 Additional Argument Attributes

Attribute	Description
required	Specifies a required argument. You cannot use this attribute with the <code>optional</code> attribute.
optional	Specifies an optional argument. You cannot use this attribute with the <code>required</code> attribute.
value_help	Specifies that valid values for <code>one_of_string</code> arguments be shown when argument help is shown for a procedure. For data types other than <code>one_of_string</code> , this attribute is ignored.
values	Specifies the listing of allowable values for <code>one_of_string</code> arguments. This attribute is required if the argument type is <code>one_of_string</code> . If you use this attribute with other data types, an error is displayed.

## define\_proc\_attributes Command Example

The following procedure adds two numbers and returns the sum:

```
dc_shell> proc plus {a b} {return [expr $a + $b]}
dc_shell> define_proc_attributes plus \
  -info "Add two numbers" \
  -define_args {
    {a "first addend" a string required} \
    {b "second addend" b string required} \
    {"-verbose" "issue a message" "" boolean optional} }
dc_shell> help -verbose plus
Usage: plus      # Add two numbers
  [-verbose]      (issue a message)
  a              (first addend)
  b              (second addend)
dc_shell> plus 5 6
11
```

## Using the parse\_proc\_arguments Command

The Synopsys `parse_proc_arguments` command parses the arguments passed to a procedure that is defined with the `define_proc_attributes` command.

You use the `parse_proc_arguments` command within procedures to support argument validation and to enable the `-help` option. Typically, `parse_proc_arguments` is the first command called within a procedure. You cannot use the `parse_proc_arguments` command outside a procedure.

The syntax is

```
parse_proc_arguments -args arg_list result_array
```

```
-args arg_list
```

Specifies the list of arguments to be passed to the procedure.

```
result_array
```

Specifies the name of the array in which the parsed arguments are to be stored.

When a procedure that uses the `parse_proc_arguments` command is invoked with the `-help` option, `parse_proc_arguments` prints help information (in the same style as does the `-verbose` option of the Synopsys `help` command) and then causes the calling procedure to return. If any type of error exists with the arguments (missing required arguments, invalid value, and so forth), `parse_proc_arguments` returns an error, and the procedure terminates.

If you do not specify `-help` and the specified arguments are valid, the `result_array` array will contain each of the argument values subscripted with the argument name. The argument names are not the names of the arguments in the procedure definition; the argument names are the names of the arguments as defined with the `define_proc_attributes` command.

### Example

In [Example 3-2](#), the `argHandler` procedure shows how the `parse_proc_arguments` command is used. The `argHandler` procedure accepts an optional argument of each type supported by `define_proc_attributes`, then prints the options and values received.

#### Example 3-2 *argHandler Procedure*

```
proc argHandler {args} {
  parse_proc_arguments -args $args results
  foreach argname [array names results] {
    echo " $argname = $results($argname)"
  }
}

define_proc_attributes argHandler -info "argument processor" \
  -define_args {
    {-Oos "oos help" AnOos one_of_string {required value_help
      {values {a b}}}}
    {-Int "int help" AnInt int optional}
    {-Float "float help" AFloat float optional}
    {-Bool "bool help" "" boolean optional}
    {-String "string help" AString string optional}
    {-List "list help" AList list optional} }
```

Invoking the `argHandler` procedure with the `-help` option generates the following output:

```
dc_shell> argHandler -help
Usage: argHandler      # argument processor
      -Oos AnOos      (oos help:
                      Values: a, b)
      [-Int AnInt]    (int help)
      [-Float AFloat] (float help)
      [-Bool]         (bool help)
      [-String AString] (string help)
      [-List AList]   (list help)
```

Invoking the `argHandler` procedure with an invalid option generates the following output and causes an error:

```
dc_shell> argHandler -Int z
Error: value 'z' for option '-Int' not of type 'integer' (CMD-009)
Error: Required argument '-Oos' was not found (CMD-007)
```

Invoking the `argHandler` procedure with valid arguments generates the following output:

```
dc_shell> argHandler -Int 6 -Oos a
-Oos = a
-Int = 6
```

---

## Considerations for Extending Procedures

When using the extended procedure features, keep in mind the following points:

- The `define_proc_attributes` command does not validate the arguments you define by using its `-define_args` argument.
- Whenever possible, use the Tcl variable numbers of arguments feature (see [“Variable Numbers of Arguments” on page 3-5](#)) to facilitate the passing of arguments to the `parse_proc_arguments` command.
- If you do not use `parse_proc_arguments`, procedures cannot respond to the `-help` option. However, you can always use the `help` command. For example,
 

```
help procedure_name -verbose
```

---

## Displaying Procedure Body and Arguments

This section describes the commands you can use to display the body and the arguments of a procedure: the Tcl `info` command and the Synopsys `proc_body` and `proc_args` commands.

You use the `body` option of the `info` command to display the body of a procedure and the `args` option to display the arguments.

You can use the `proc_body` command as an alternative to `info body` and `proc_args` as an alternative to `info args`.

If you define a procedure with the `-hide_body` attribute (see “[-hide\\_body](#)” in “[Using the define\\_proc\\_attributes Command](#)” on page 3-7), you cannot use the `info body` or `proc_body` commands to view the contents of the procedure.

These commands have the following form:

```
info body procedure_name  
info args procedure_name
```

```
proc_body procedure_name  
proc_args procedure_name
```

# 4

## Working With Collections

---

A collection is a set of design objects such as libraries, ports, and cells. You create, view, and manipulate collections by using Synopsys commands provided specifically for working with collections. This chapter describes how to use Synopsys commands in conjunction with Tcl for working with collections.

This chapter contains the following sections:

- [Creating Collections](#)
- [Displaying Objects in a Collection](#)
- [Selecting Objects From a Collection Using Filter Expressions](#)
- [Adding Objects to a Collection](#)
- [Removing Objects From a Collection](#)
- [Comparing Collections](#)
- [Iterating Over a Collection](#)
- [Copying Collections](#)

Note:

For more information about design object types, enter `man collections`, which will open the `Collections_and_Querying` man page or see any Synopsys tool user guide.

---

## Creating Collections

You create collections with the Synopsys `get_*` and `all_*` commands. The following example creates a collection of all ports in a design:

```
dc_shell> get_ports
```

You can create collections that persist throughout a session or only within the scope of a command. A collection persists if you set the result of a collection command to a variable. For example,

```
dc_shell> set myports [get_ports]
```

When using `dc_shell`, the result of the collection command is the collection of objects.

---

## Pattern Matching

Most of the commands that create collections allow you to use a list of patterns. The patterns can contain the following wildcard characters:

Wildcard character	Description
*	Matches any sequence of characters
?	Matches any single character

For restrictions on pattern matching, see [Appendix A, “Tcl Implementation Differences and Limitations.”](#)

---

## Displaying Objects in a Collection

All commands that create collections implicitly query the collection when the command is used at the command prompt; however, for more flexibility, you can use the `query_objects` command to display objects in a collection. The `query_objects` command generates output that is similar to the output of a report command. The query results are formatted as a Tcl list (for example, `{a b c ...}`), so that you can directly use the results.

For example, to display all of the ports that start with the string `in`, enter the following command:

```
dc_shell> query_objects [get_ports in*]  
{in0 in1 in2}
```

The `query_objects` command also allows you to search the design database directly. For example, the following command returns the same information as the previous `query_objects` command:

```
dc_shell> query_objects -class port in*
{in0 in1 in2}
```

To control the number of elements displayed, use the `-truncate` option. If the display is truncated, you see an ellipsis (...) as the last element. If default truncation occurs, a message appears showing the total number of elements that would have been displayed.

You can change the default truncation by setting the `collection_result_display_limit` variable to a different value; the default is 100. For more information, see the `collection_result_display_limit` man page.

You must use the `query_objects` command to display objects created by one of the collection commands because collections do not return objects directly. Collection commands generate a collection handle, which is an identifier that points to the collection and is used for subsequent access to the collection objects. By contrast, variables return the actual object rather than a pointer.

In the following example, the `echo $collection_of_ports` command returns a pointer to the collection handle, `_sel1`, rather than the names of the ports created by the `set collection_of_ports` command. However, the `echo $name_of_ports` command returns the actual port names.

```
dc_shell> set collection_of_ports [get_ports IN*]
{IN1 IN2 IN3}
dc_shell> set name_of_ports "IN1 IN2 IN3"
dc_shell> echo $collection_of_ports
_sel1
dc_shell> echo $name_of_ports
{IN1 IN2 IN3}
```

The following example shows that when you use the `query_objects` command, the tool returns the names of the ports created by the `set collection_of_ports` command.

```
dc_shell> set collection_of_ports [get_ports IN*]
{IN1 IN2 IN3}
dc_shell> set name_of_ports "IN1 IN2 IN3"
dc_shell> query_objects $collection_of_ports
{IN1 IN2 IN3}
```

---

## Selecting Objects From a Collection Using Filter Expressions

A filter expression is a set of logical expressions describing the constraints you want to place on a collection. A filter expression compares an attribute name, such as `area` or `direction`, with a value, such as `43` or `input`, by means of a relational operator.

Attributes are defined for specific objects, such as designs, cells, nets, pins, and so on. Attributes are either built in to the tool for each object type, such as the `area` attribute for designs and the `direction` attribute for pins, or you can create them by using the Synopsys `define_user_attribute` and `set_user_attribute` commands.

In the following example, the filter expression selects all hierarchical objects whose `area` attribute is less than 12 units:

```
"is_hierarchical==true && area<12"
```

You can combine relational expressions by using logical AND (AND or `&&`) or logical OR (OR or `||`). You can group logical expressions with parentheses to enforce order; otherwise the order is left to right.

When using a filter expression as an argument to a command, you must enclose the entire filter expression in quotation marks or braces. However, if you use a string value as an argument in a logical expression, you do not need to enclose the string in quotation marks. For example,

```
"is_hierarchical == true && dont_touch == true"
```

A filter expression can fail to parse due to the following problems:

- Invalid syntax
- Invalid attribute name
- A type mismatch between an attribute and its compare value

---

## Using the `-filter` Option and the `filter_collection` Command

Many commands that create collections accept the `-filter` option. This option specifies a filter expression. For example, the following command gets cells that have the hierarchical attribute:

```
dc_shell> set hc [get_cells -filter is_hierarchical==true]
```

To select specific objects from a collection, use the `-filter` option with a collection command, when available, or use the `filter_collection` command. Both the `-filter` option and the `filter_collection` command use filter expressions to restrict the resulting collection. The `filter_collection` command takes a collection and a filter expression as

arguments. The result of the `filter_collection` command is a new collection, or an empty string if no objects match the criteria.

For example,

```
dc_shell> filter_collection [get_cells] is_hierarchical==true
```

[Table 4-1](#) shows the relational operators that you can use in filter expressions.

*Table 4-1 Relational Operators*

Syntax	Description	Supported types
<code>a&lt;b</code>	1 if a is less than b, 0 otherwise	numeric, string
<code>a&gt;b</code>	1 if a is greater than b, 0 otherwise	numeric, string
<code>a&lt;=b</code>	1 if a is less than or equal to b, 0 otherwise	numeric, string
<code>a&gt;=b</code>	1 if a is greater than or equal to b, 0 otherwise	numeric, string
<code>a==b</code>	1 if a is equal to b, 0 otherwise	numeric, string, Boolean
<code>a!=b</code>	1 if a is not equal to b, 0 otherwise	numeric, string, Boolean

## Adding Objects to a Collection

You use the `add_to_collection` command to add objects to a collection. The `add_to_collection` command creates a new collection that includes the objects in the original collection, plus the additional objects. You must define a new variable to store the new collection. For information about working with variables, see [“Variables” on page 2-2](#).

For example, to create a collection of ports that have names starting with I, enter the following command:

```
dc_shell> set ports [get_ports I*]
```

If you want to create a collection containing ports starting with I and add the CLOCK port to this collection, enter the following command:

```
dc_shell> set new_ports [add_to_collection $ports [get_ports CLOCK]]
```

You can add collections only if they have the same object class. For example, you cannot add a port collection to a cell collection.

---

## Removing Objects From a Collection

You use the `remove_from_collection` command to remove objects from a collection. The `remove_from_collection` command creates a new collection that includes the objects in the original collection minus the specified objects. If the operation results in zero elements, the command returns an empty string. The original collection is not modified.

For example, you can use the following command to create a collection containing all ports except for CLOCK:

```
dc_shell> set cPorts [remove_from_collection \  
    [all_inputs] CLOCK]  
{in1 in2}
```

You can specify a list of objects or collections to remove. The object class of each element you specify must be the same as in the original collection. For example, you cannot remove a port collection from a cell collection.

You can also remove objects from a collection by using a filter expression that limits the objects in the collection. For more information, see [“Selecting Objects From a Collection Using Filter Expressions” on page 4-4](#).

---

## Comparing Collections

You use the `compare_collections` command to compare the contents of two collections. If the two collections are the same, the `compare_collections` command returns zero; otherwise it returns a nonzero value.

For example,

```
dc_shell> compare_collections [get_cells *] [get_cells *]
```

Empty collections can be used in the comparison. By default, the order of the objects in each collection does not matter. You can make the comparison order-dependent by using the `-order_dependent` option.

---

## Iterating Over a Collection

To iterate over a collection, use the `foreach_in_collection` command. This command can be nested within other control structures, including another `foreach_in_collection` command.

During each iteration, the iteration variable is set to a collection of exactly one object. Any command that accepts a collection accepts the iteration variable. Do not use the `foreach_in_collection` command to directly iterate over a collection.

[Example 4-1](#) shows how the `foreach_in_collection` command is used.

### Example 4-1 `foreach_in_collection` Example Script

```
dc_shell> foreach_in_collection itr [get_cell *] {
    if {[get_attribute $itr is_hierarchical] == "true"} {
        echo "[get_object_name $itr] is a hierarchical cell"
    }
}
I_SUB1 is a hierarchical cell
I_SUB2 is a hierarchical cell
I_SUB3 is a hierarchical cell
```

---

## Copying Collections

The `copy_collection` command duplicates a collection, resulting in a new collection. The base collection remains unchanged. Issuing the `copy_collection` command is an efficient mechanism for duplicating an existing collection. Copying a collection is different from multiple references to the same collection.

For example, if you create a collection and save a reference to it in variable `collection1`, assigning the value of `collection1` to another variable `collection2` creates a second reference to the same collection.

```
dc_shell> set collection1 [get_cells "U1*"]
{U10 U11 U12 U13 U14 U15}
dc_shell> set collection2 $collection1
{U10 U11 U12 U13 U14 U15}
dc_shell> printvar collection1
collection1 = "_sel2"
dc_shell> printvar collection2
collection2 = "_sel2"
```

Note that the output of the `printvar` command shows the same collection handle as the value of both variables. A collection handle is an identifier that is generated by the `collection` command. The collection handle points to the collection and is used for subsequent access to the collection objects. The previous commands do not copy the

collection; only the `copy_collection` command creates a new collection that is a duplicate of the original.

The following command sequence shows the results of copying a collection:

```
dc_shell> set collection1 [get_cells "U1*"]
{U10 U11 U12 U13 U14 U15}
dc_shell> printvar collection1
collection1 = "_sel4"
dc_shell> set collection2 [copy_collection $collection1]
{U10 U11 U12 U13 U14 U15}
dc_shell> printvar collection2
collection1 = "_sel5"
```

---

## Extracting Objects From a Collection

The `index_collection` command creates a collection of one object that is the  $n$ th object in another collection. The objects in a collection are numbers 0 through  $n-1$ .

Although collections that result from commands such as `get_cells` are not really ordered, each has a predictable, repeatable order: The same command executed  $n$  times (such as `get_cells *`) creates the same collection.

For example, to extract the first object in a collection,

```
dc_shell> set c1 [get_cells {u1 u2}]
{u1 u2}
dc_shell> query_objects [index_collection $c1 0]
{u1}
```

# 5

## A Tcl Script Example

---

This chapter contains a sample script that demonstrates how to use many of the Tcl and Synopsys commands and topics covered in previous chapters. The various aspects of the sample script are described in detail.

The sample script contains the `DC_rpt_cell` procedure and the `define_proc_attributes` command, which is used to extend the attributes of `DC_rpt_cell`.

This chapter contains the following sections:

- [DC\\_rpt\\_cell Overview](#)
- [DC\\_rpt\\_cell Listing and Sample Output](#)
- [DC\\_rpt\\_cell Details](#)

---

## DC\_rpt\_cell Overview

The `DC_rpt_cell` script has two components. The first is the `DC_rpt_cell` procedure; the second is the `define_proc_attributes` command. The `define_proc_attributes` command extends the attributes of the `DC_rpt_cell` procedure.

The `DC_rpt_cell` procedure lists all cells in a design and reports if a cell has the following properties:

- Is a black box (unknown)
- Has a don't touch attribute
- Has a DesignWare attribute
- Is hierarchical
- Is combinational
- Is a test cell

The `DC_rpt_cell` procedure takes one argument. The argument is treated as an option that specifies a desired report type. The options are

- `-all_cells` – Reports one line per cell, and it generates a summary of the cell count.
- `-hier_only` – Reports only the hierarchical blocks, including DesignWare parts, and it generates a summary of the cell count.
- `-total_only` – Displays only a summary of the cell count.

The `define_proc_attributes` command is placed after the `DC_rpt_cell` procedure in the `DC_rpt_cell` script file. This command is used to provide help information about the `DC_rpt_cell` procedure. The help information is used in conjunction with the Synopsys `help` command and includes a short description of the `DC_rpt_cell` procedure and its options.

A full listing of the `DC_rpt_cell` script is shown in [Example 5-1](#) starting on [page 5-3](#), and a sample output from `DC_rpt_cell` is shown in [Example 5-2](#) on [page 5-6](#).

To use the `DC_rpt_cell` script, enter or copy it into a text file named `DC_rpt_cell.tcl`, load it into the Synopsys shell by using the `source` command, then load a design database. The syntax for `DC_rpt_cell` is

```
DC_rpt_cell arg
```

For example,

```
dc_shell> source DC_rpt_cell.tcl
dc_shell> read_file -format ddc TLE_mapped.ddc
dc_shell> DC_rpt_cell -total_only
```

---

## DC\_rpt\_cell Listing and Sample Output

[Example 5-1](#) shows the full listing of the DC\_rpt\_cell sample script file.

### Example 5-1 DC\_rpt\_cell.tcl Listing

```
#Title:      DC_rpt_cell.tcl
#
#Description: This Design Compiler Tcl procedure generates a cell
#             report of a design.
#             It reports all cells and the following attributes:
#             b - black box (unknown)
#             d - has dont_touch attribute
#             dw - DesignWare part
#             h - hierarchy
#             n - noncombinational
#             t - test cell
#
#Options:    -all_cells    one line per cell plus summary
#            -hier_only    every hierarchy cell and summary
#            -total_only   generate summary only
#
#Usage:      dc_shell> source DC_rpt_cell.tcl
#            dc_shell> DC_rpt_cell -t
#
proc DC_rpt_cell args {
    suppress_message UID-101

    set option [lindex $args 0]
    if {[string match -a* $option]} {
        echo " "
        echo "Attributes:"
        echo " b - black-box (unknown)"
        echo " d - dont_touch"
        echo " dw - DesignWare"
        echo " h - hier"
        echo " n - noncombo"
        echo " t - test cell"
        echo " "
        echo [format "%-32s %-14s %5s %11s" "Cell" "Reference" "Area" "Attributes"]
        echo "-----"
    } elseif {[string match -t* $option]} {
        set option "-total_only"
        echo " "
        set cd [current_design]
        echo "Performing cell count on [get_object $cd] . . ."
        echo " "
    } elseif {[string match -h* $option]} {
        set option "h"; # hierarchical only
```

```

        echo ""
        set cd [current_design]
        echo "Performing hierarchical cell report on [get_object $cd] . . ."
        echo " "
        echo [format "%-36s %-14s %11s" "Cell" "Reference" "Attributes"]
        echo "-----"
    } else {
        echo " "
        echo "  Message: Option Required"
        echo "  Usage: DC_rpt_cell \[-all_cells\] \[-hier_only\] \[-total_only\]"
        echo " "
        return
    }
}

# initialize summary vars
set total_cells 0
set dt_cells 0
set hier_cells 0
set hier_dt_cells 0
set dw_cells 0
set seq_cells 0
set seq_dt_cells 0
set test_cells 0
set total_area 0

# initialize other vars
set hdt ""
set tc_atr ""
set xcell_area 0

# create a collection of all cell objects
set all_cells [get_cells -h *]

foreach_in_collection cell $all_cells {
    incr total_cells

    set cell_name [get_attribute $cell full_name]
    set dt [get_attribute $cell dont_touch]

    if {$dt=="true"} {
        set dt_atr "d"
        incr dt_cells
    } else {
        set dt_atr ""
    }

    set ref_name [get_attribute $cell ref_name]
    set cell_area [get_attribute $cell area]

    if {$cell_area > 0} {
        set xcell_area $cell_area
    } else {
        set cell_area 0
    }

    set t_cell [get_attribute $cell is_a_test_cell]
    if {$t_cell=="true"} {
        set tc_atr "t"
    }
}

```

```

        incr test_cells
    } else {
        set tc_atr ""
    }
}
set hier [get_attribute $cell is_hierarchical]
set combo [get_attribute $cell is_combinational]
set seq [get_attribute $cell is_sequential]
set dwb [get_attribute $cell DesignWare]
set dw_atr ""

if {$hier} {
    set attribute "h"
    incr hier_cells
    set hdt [concat $option $hier]
    if {$dt_atr=="d"} {
        incr hier_dt_cells
    }
    if {$dwb=="true"} {
        set dw_atr "dw"
        incr dw_cells
    }
} elseif {$seq} {
    set attribute "n"
    incr seq_cells
    if {$dt_atr=="d"} {
        incr seq_dt_cells
    }
}
set total_area [expr $total_area + $xcell_area]
} elseif {$combo} {
    set attribute ""
    set total_area [expr $total_area + $xcell_area]
} else {
    set attribute "b"
}
}

if {[string match -a* $option]} {
    echo [format "%-32s %-14s %5.2f %2s %1s %1s %2s" $cell_name $ref_name \
        $cell_area $attribute $dt_atr $tc_atr $dw_atr]
} elseif {$hdt=="h true"} {
    echo [format "%-36s %-14s %2s %2s" $cell_name $ref_name $attribute \
        $dt_atr $dw_atr]
    set hdt ""
}
} ; # close foreach_in_collection

echo "-----"
echo [format "%10s Total Cells" $total_cells]
echo [format "%10s Cells with dont_touch" $dt_cells]
echo ""
echo [format "%10s Hierarchical Cells (incl DesignWare)" $hier_cells]
echo [format "%10s Hierarchical Cells with dont_touch" $hier_dt_cells]
echo ""
echo [format "%10s DesignWare Cells" $dw_cells]
echo ""
echo [format "%10s Sequential Cells (incl Test Cells)" $seq_cells]
echo [format "%10s Sequential Cells with dont_touch" $seq_dt_cells]
echo ""
echo [format "%10s Test Cells" $test_cells]

```

```

echo ""
echo [format "%10.2f Total Cell Area" $total_area]
echo "-----"
echo ""
}

define_proc_attributes DC_rpt_cell \
  -info "Report all cells in the design" \
  -define_args {
    {-a "report every cell and the summary"}
    {-h "report only hierarchy cells and the summary"}
    {-t "report the summary only"} }

```

**Example 5-2** shows sample output from `DC_rpt_cell`, using the `-h` (`-hier_only`) option.

### Example 5-2 `DC_rpt_cell` Sample Output

```

Current design is 'TLE'.
Performing hierarchical cell report on TLE . . .

```

Cell	Reference	Attributes
datapath	fast_add8	h
Multiplicand_reg	reg8	h
control_unit	control	h
Op_register	super_reg17	h
datapath/CLA_0	CLA_4bit_1	h
datapath/CLA_1	CLA_4bit_0	h
datapath/CLA_0/FA_0	full_adder_7	h
datapath/CLA_0/FA_1	full_adder_6	h
datapath/CLA_0/FA_2	full_adder_5	h
datapath/CLA_0/FA_3	full_adder_4	h
datapath/CLA_1/FA_0	full_adder_3	h
datapath/CLA_1/FA_1	full_adder_2	h
datapath/CLA_1/FA_2	full_adder_1	h
datapath/CLA_1/FA_3	full_adder_0	h

```

-----
247 Total Cells
  0 Cells with dont_touch
 14 Hierarchical Cells (incl DesignWare)
  0 Hierarchical Cells with dont_touch
  0 DesignWare Cells
 32 Sequential Cells (incl Test Cells)
  0 Sequential Cells with dont_touch
  0 Test Cells
663.00 Total Cell Area
-----

```

---

## DC\_rpt\_cell Details

The DC\_rpt\_cell script is described sequentially in the following sections:

- [Defining the Procedure](#)
- [Suppressing Warning Messages](#)
- [Examining the args Argument](#)
- [Initializing Variables](#)
- [Creating and Iterating Over a Collection](#)
- [Collecting the Report Data](#)
- [Formatting the Output](#)

---

### Defining the Procedure

The DC\_rpt\_cell procedure requires only one argument, so its definition is simple.

[Example 5-3](#) shows how DC\_rpt\_cell is defined.

#### *Example 5-3 DC\_rpt\_cell proc Definition*

```
proc DC_rpt_cell args {  
    procedure body ...  
}
```

You use the Tcl `proc` command to define the procedure; `DC_rpt_cell` names the procedure, and `args` is the variable that receives the argument when the procedure is invoked. The value of `args` is used later within the body of the procedure, as described in [“Examining the args Argument” on page 5-9](#).

The Synopsys `define_proc_attributes` command provides additional (extended) information about a procedure (see [“Using the define\\_proc\\_attributes Command” on page 3-7](#)). For `DC_rpt_cell`, the `define_proc_attributes` command is used to specify extended help information about `DC_rpt_cell`. This information is used in conjunction with the Synopsys `help` command. [Example 5-4](#) show how `define_proc_attributes` is used with `DC_rpt_cell`.

**Example 5-4** *define\_proc\_attributes Command*

```
define_proc_attributes DC_rpt_cell \
  -info "Procedure to report all cells in ..." \
  -define_args {
    {-a "report every cell and the summary"}
    {-h "report only hierarchy cells and the summary"}
    {-t "report the summary only"} } }
```

The additional information consists of a one-line description of `DC_rpt_cell` and descriptions of the options it expects. [Example 5-5](#) shows a sample display of help for `DC_rpt_cell` (to see argument information with the `help` command, you use its `-verbose` option).

**Example 5-5** *DC\_rpt\_cell Help Usage*

```
dc_shell> help -verbose DC_rpt_cell
DC_rpt_cell    # Report all cells in the design (v12/2002)
-a            (report every cell and the summary)
-h            (report only hierarchy cells and the summary)
-t            (report the summary only)
```

---

## Suppressing Warning Messages

The first line within the body of `DC_rpt_cell`, shown in [Example 5-6](#), is used to suppress UID-101 warning messages that occur when an attribute-related command does not find a given attribute.

**Example 5-6** *suppress\_message Command*

```
proc DC_rpt_cell args {
  suppress_message UID-101
  ...
}
```

The `DC_rpt_cell` procedure reports information about specific cell attributes; however, some of the cells within the design might not have one of these specific attributes. If this situation occurs repeatedly, a large number of warning messages will be generated and outputted to the screen, or if you redirect the output to a log file, the log file might become undesirably large. Because a UID-101 warning message does not affect the meaning of the report and is likely to occur frequently within `DC_rpt_cell`, it is being suppressed.

You use the Synopsys `suppress_message` command to disable the printing of a specific warning or informational message. For more information, see the `suppress_message` man page.

---

## Examining the args Argument

The section of script shown in [Example 5-7](#) extracts the report type option from `args` and uses this value to determine what the report header will look like; furthermore, this section is used to handle the entry of invalid options.

### Example 5-7 Examining args

```
...
set option [lindex $args 0]
if {[string match -a* $option]} {
    ...
} elseif {[string match -t* $option]} {
    ...
} elseif {[string match -h* $option]} {
    ...
} else {
    ...
}
...
```

The argument to `DC_rpt_cell` is used to specify what type of report to generate. The Tcl `lindex` command is used to extract the option from `args`, and the result is placed into the `option` variable. The Tcl `string` command with its `match` option is then used to conditionally determine what the report header will look like.

The report options are `-all_cells`, `-hier_only`, or `-total_only`; however, the values `-a`, `-h`, and `-t` are all that are required because the wildcard character (`*`) is used in the `string match` command. (For more information, see the `string` man page.)

The Synopsys `echo` command is used to output information, and the Tcl `format` command is used in conjunction with `echo` to generate formatted output (see [Example 5-8](#)).

### Example 5-8 echo and format Commands

```
...
echo "Performing hierarchical cell report on [get_object $cd] . . ."
echo " "
echo [format "%-36s %-14s %11s" "Cell" "Reference" "Attributes"]
...
```

You use the `format` command to format lines of output in the same manner as the C `sprintf` procedure. The use of `format` within `DC_rpt_cell` is described in more detail in [“Formatting the Output” on page 5-16](#).

The Synopsys `current_design` and `get_object` commands are used to display the name of the current design (see [Example 5-9](#)).

*Example 5-9 current\_design and get\_object Commands*

```

...
} elseif {[string match -t* $option]} {
    set option "-total_only"
    ...
    set cd [current_design]
    echo "Performing cell count on [get_object $cd] . . ."
    ...
} elseif {[string match -h* $option]} {
    set option "h"; # hierarchical only
    echo ""
    set cd [current_design]
    echo "Performing hierarchical cell report on [get_object $cd] . . ."
    ...
}

```

You use `current_design` to set the working design; however, if used without arguments, `current_design` returns a collection handle to the current working design (see [Chapter 4, “Working With Collections”](#)). This collection handle is then passed to the `get_object` command to obtain the name of the current design.

Note how the following line of script (from [Example 5-9](#)) is constructed:

```
set option "h"; # hierarchical only
```

In Tcl, you can place multiple commands on one line by using a semicolon to separate the commands. You can use this feature as a way to form inline comments.

The `else` block (see [Example 5-10](#)) handles an invalid option condition. If no option or an invalid option is specified, the procedure prints out a message that shows proper argument usage and then exits.

*Example 5-10 Invalid Option Message*

```

...
} else {
    echo " "
    echo " Message: Option Required (Version - December 2002)"
    echo " Usage: DC_rpt_cell \[-all_cells\] \[-hier_only\] \[-total_only\]"
    echo " "
    return
}
...

```

---

## Initializing Variables

The section of script shown in [Example 5-11](#) uses the Tcl `set` command to initialize some of the variables used by `DC_rpt_cell`.

### *Example 5-11 Variable Initialization*

```
...
# initialize summary vars
set total_cells 0
set dt_cells 0
set hier_cells 0
set hier_dt_cells 0
set dw_cells 0
set seq_cells 0
set seq_dt_cells 0
set test_cells 0
set total_area 0

# initialize other vars
set hdt ""
set tc_atr ""
set xcell_area 0
...
```

The values for these particular variables are expected to change within the `foreach_in_collection` loop and within `if` blocks that might not be executed, so these variables are set to 0 here to prevent a “no such variable error” should the loop or `if` blocks not be executed.

---

## Creating and Iterating Over a Collection

A collection is used to hold the list of all cells in the design. Then, a `foreach_in_collection` loop is used to obtain the attribute information about each cell and to cumulate results for the summary section of the report. (Collections and the `foreach_in_collection` command are covered in more detail in [Chapter 4, “Working With Collections.”](#)) [Example 5-12](#) shows the command used to create the collection and the `foreach_in_collection` loop.

### *Example 5-12 Collection Iteration*

```
...
set all_cells [get_cells -h *]

foreach_in_collection cell $all_cells {
    ...
}; # close foreach_in_collection
...
```

The Synopsys `get_cells` command creates a collection of cells from the current design relative to the current instance. The `-h` option tells `get_cells` to search for cells level by level relative to the current instance. The wildcard character (`*`) is used as the pattern name to match—in this case, all cell names.

The result of `get_cells` is a collection handle that is placed into `all_cells`. The collection handle is then used by the `foreach_in_collection` command to iterate over all the objects in the collection. For each iteration, an object is placed into `cell`; then `cell` is used in the body of the `foreach_in_collection` block to derive information about that object (cell name, reference name, cell area, and cell attributes).

---

## Collecting the Report Data

The report data is collected into a set of variables by the `foreach_in_collection` loop shown in [Example 5-12](#). Cell information is obtained from the design database by the Synopsys `get_attribute` command, and the summary data is cumulated inside of `if` blocks at various locations within the `foreach_in_collection` loop. [Table 5-1](#) lists the variables used for the report.

*Table 5-1 DC\_rpt\_cell Report Variables*

Variable	Description
Variables used in main body of the report	
<code>cell_name</code>	Cell name
<code>ref_name</code>	Reference name
<code>cell_area</code>	Cell area
<code>attribute</code>	Cell's attribute
<code>dt_atr</code>	Don't touch attribute
<code>tc_atr</code>	Test cell attribute
<code>dw_atr</code>	DesignWare attribute
Variables used in summary section of the report	
<code>total_cell</code>	Total number of cells
<code>dont_touch</code>	Number of cells with don't touch attribute
<code>hier_cells</code>	Number of hierarchical cells (includes DesignWare cells)
<code>hier_dt_cells</code>	Number of hierarchical cells with don't touch attribute
<code>dw_cells</code>	Number of DesignWare cells
<code>seq_cells</code>	Number of sequential cells (includes test cells)
<code>seq_dt_cells</code>	Number of sequential cells with don't touch attribute
<code>test_cells</code>	Number of test cells
<code>total_area</code>	Total cell area

---

The body of the `foreach_in_collection` loop looks complex, but the pseudo code shown in [Example 5-13](#) shows how straightforward it really is.

**Example 5-13** *Body of `foreach_in_collection` Loop*

```
...
foreach_in_collection cell $all_cells {
  - Cumulate total cell count
  - Get cell name
  - Collect don't touch attribute information
  - Get reference name of cell
  - Get cell area
  - Collect test cell attribute information
  - Collect hierarchical attribute information
  - Collect combinational attribute information
  - Collect sequential attribute information
  - Collect DesignWare attribute information
  - Cumulate total area
  - Output one line of cell information
  - Return to top of loop and process next cell object
}; # close foreach_in_collection
...
```

You obtain cell attributes from the design database by using the Synopsys `get_attribute` command, as shown in [Example 5-14](#).

**Example 5-14** *Obtaining Cell Attributes*

```
...
set dt [get_attribute $cell dont_touch]
...
set ref_name [get_attribute $cell ref_name]
set cell_area [get_attribute $cell area]
...
set t_cell [get_attribute $cell is_a_test_cell]
...
set hier [get_attribute $cell is_hierarchical]
set combo [get_attribute $cell is_combinational]
set seq [get_attribute $cell is_sequential]
set dwb [get_attribute $cell DesignWare]
...
```

Attributes are properties assigned to design objects, and they range in values. Some are predefined values, like `dont_touch`; others are user-defined, while still others can be logical in nature and have values such as `true` or `false`. You can find detailed information about object properties in the attributes man pages.

The `if` blocks are used to determine whether the cell has one or more of the properties: don't touch, test cell, hierarchical, DesignWare, sequential, or combinational. Along the way, the totals for the summary section of the report are cumulated. [Example 5-15](#) shows a sample `if` block.

*Example 5-15 if Block Example*

```

...
set dt [get_attribute $cell dont_touch]

if {$dt=="true"} {
    set dt_atr "d"
    incr dt_cells
} else {
    set dt_atr ""
}
...

```

This `if` block determines whether the cell has the `dont_touch` attribute, and if so, it sets the don't touch attribute variable `dt_atr` to `d` and increments the count of don't touch cells (`dt_cells`). If the cell does not have the `dont_touch` attribute, the `dt_atr` variable is set to null. The other `if` blocks in the body of the `foreach_in_collection` loop work in a similar way.

One line of cell information is outputted at the end of the `foreach_in_collection` loop. The script that handles this step is shown in [Example 5-16](#).

*Example 5-16 Cell Information Output*

```

if {[string match -a* $option]} {
    echo [format "%-32s %-14s %5.2f %2s %1s %1s %2s" \
        $cell_name $ref_name $cell_area $attribute $dt_atr $tc_atr $dw_atr]
} elseif {$hdt=="h true"} {
    echo [format "%-36s %-14s %2s %2s" \
        $cell_name $ref_name $attribute $dt_atr $dw_atr]
    ...
}

```

There are two possible formats for the line of output; an `if` block is used to handle the two possibilities. The line of output is formatted by the `format` command. How the `format` command is used by `DC_rpt_cell` is explained in the next section.

After a line of cell information is outputted, the next cell object is processed.

---

## Formatting the Output

This section provides an overview of the Tcl `format` command as it is used by `DC_rpt_cell`. The options to the `format` command are extensive; see the `format` man page for a complete description.

[Example 5-17](#) shows sample output from `DC_rpt_cell`.

### Example 5-17 `DC_rpt_cell` Sample Output

```
Current design is 'TLE'.
Performing hierarchical cell report on TLE . . .

Cell                                     Reference  Attributes
-----
datapath                                fast_add8   h
Multiplicand_reg                         reg8       h
...

datapath/CLA_1/FA_2                       full_adder_1  h
-----
      247 Total Cells
      0 Cells with dont_touch
...

      663.00 Total Cell Area
-----
```

Each line of output is generated by the Synopsys `echo` command. Formatted output is handled by the `format` command in conjunction with the `echo` command.

The basic form of the `format` command is

```
format format_string arg_list
```

The `format_string` parameter contains text and conversion specifiers. The `arg_list` parameter contains one or more variables that are to be substituted into the conversion specifiers. For example, the following script is used in the summary section of the `DC_rpt_cell` report:

```
echo [format "%10s Total Cells" $total_cells]
```

In this example, the value of `total_cells` is substituted into the conversion specifier, `%10s`, and is formatted according to the conversion specifier. In this case, the `total_cells` value is converted into a text string that is 10 characters wide.

There is a one-to-one correspondence between conversion specifiers and the variables placed in the argument list. For example,

```
echo [format "%-32s %-14s %5.2f %2s %1s %1s %2s" \  
    $cell_name $ref_name $cell_area $attribute $dt_atr $tc_atr $dw_atr]
```

In this example, the list of variables is paired with each of the `format` specifiers.

The components of the conversion specifier can be used to specify conversion properties such as data type, minimum field width, precision, and field justification. For example, `%5.2f` specifies conversion of a floating point number to a text string that has five characters to left of the decimal point and two characters to the right.



# A

## Tcl Implementation Differences and Limitations

---

This appendix describes differences in and limitations to the Synopsys implementation of Tcl commands.

This appendix contains the following sections:

- [Ways of Identifying Tcl Commands](#)
- [Tcl Command Variations](#)
- [Command Substitution Exception](#)
- [Milkyway Environment Tcl Usage](#)

---

## Ways of Identifying Tcl Commands

Tcl commands that do not vary from their base implementations are referred to as built-in commands by the Synopsys `help` command and as Tcl built-in commands by the Synopsys man pages. Tcl commands that vary from their base implementation are referred to as Synopsys commands by the `help` command and the Synopsys man pages.

---

## Tcl Command Variations

The following Tcl commands vary from their base implementation:

- `exit` – Returns additional session information.
- `history` – Supports additional arguments.
- `rename` – Cannot be used on application commands or permanent procedures.
- `source` – Supports additional arguments.

For a complete description of these commands, see the Synopsys man pages.

---

## Command Substitution Exception

Synopsys tools make one exception to the use of square brackets to indicate command nesting—you can use square brackets to indicate bus references. Synopsys tools accept a string, such as `data[63]`, as a name rather than as the word `data` followed by the result of the command `63`.

---

## Milkyway Environment Tcl Usage

The Milkyway Environment tool uses Tcl equivalents for Scheme commands. Although these commands provide many Tcl capabilities, they have some limitations, such as not supporting collections.

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