Chapter 5 : Additional Reading Materials

- DC-Tcl

DC-Tcl

Tcl = Tool Command Language (tickle):

- DC-Tcl is the command interface for DC in XG mode
- Built on the “open” industry-standard shell programming language Tcl
- DC-Tcl an interpreted scripting language

- Many Synopsys tools support Tcl for consistency, e.g. Design Compiler, Formality, PrimeTime, Physical Compiler and more.
- Tcl was originally developed by John K. Ousterhout at UC Berkeley.
- There are many books on the topic of Tcl programming, here are a few:
  - Tcl and the Tk Toolkit, John K. Ousterhout
  - Practical Programming in Tcl and Tk, Brent B. Welch
- Some Tcl web sites for reference and further information:
  - www.tcl.tk (documentation and advanced packages for Tcl, same as www.scriptics.com)
  - www.tclforeda.net (many DC script examples and other useful tools for Logic Designers)

Converting from dcsh to DC-Tcl

A program is avilable for users to migrate from “old” dcsh to DC-Tcl.

```
UNIX% dc-transcript  my_script.scr  my_script.tcl
```

- Will convert most commands in existing scripts to Tcl
- Only goes from DCSH to DC-Tcl
- Called from the UNIX prompt

- The dc-transcript utility accurately translates most existing dcsh mode scripts.
- The dc-transcript does not do the following:
  - Does not check the syntax of your dcsh mode scripts, although serious syntax errors will stop the translation
  - Does not, in general, check the semantics of your commands
  - Does not optimize your scripts
  - Does not, in general, teach you how to write Tcl scripts
  - Does not always update your dcsh mode commands to the most
    current and preferred Tcl mode commands

Executing DC-Tcl Scripts

- Commands can be typed:
  - Interactively in DC Tcl

```
dc_shell-xg-t> echo "Running my.tcl..."
dc_shell-xg-t> source –echo –verbose my.tcl
```

  - Executed in batch mode

```
UNIX% dc_shell-xg-t -f my.tcl | tee –i my.log
```

The tee command displays the results on the screen and writes them into the specified log file.

Tcl Basics

- Tcl command =
  - One or more words separated by white space
  - First word is command name, others are arguments
  - Returns string result
- Tcl script =
  - Sequence of commands
  - Commands are separated by newlines and/or semi-colons

Examples:

`set a 22`	set the variable ‘a’ to 22
`echo "Hello World!“`	world’s most common program

Variable Substitution

- Syntax: *$varName*
- Variable name is letters, digits, underscores
- Substitution may occur anywhere within a word:

Sample commands	Results
`set b 66`	`66`
`set a b`	`b`
`set a $b`	`66`
`set a $b+$b+$b`	`66+66+66`
`set a $b.3`	`66.3`
`set a $b4`	`no such variable`

- To remove a variable, use the command unset, example:
  - `unset b`
- Variables can be concatenated with strings in many ways, e.g. to get the contents of the variable b concatenated with the string “test”, you type:
  - `set a ${b}test` -> “66test”
- Variables do not need declaration as in languages like C, Pascal, etc., since there is only one “type” of variable – a string. The string may be interpreted in different ways by the command itself, e.g. the `expr` command (shown later) may interpret the string as an integer or as a floating point number.

Nested Commands

- Syntax: [***commands…***]
- Evaluate command, return result
- May occur anywhere within a word:

Sample command	Result
`set b 8`	`8`
`set a [expr $b+2]`	`10`
`set a "b-3 is [expr $b-3]"`	`b-3 is 5`

Command substitution produces:
`set a "b-3 is 5"`
Then, the command “set” is executed

Note: “expr” is a Tcl function that performs math operations.

Defining Words

- Words end or break at *white space* and *semi-colons*, except:
  - Double-quotes prevent breaks
    `set a "x is $x; y is $y"`
  - Curly braces prevent breaks and substitutions
    `set a {[expr $b*$c]}`
  - Backslashes escape special characters
    `set a word\ with\ \$\ and\ space`
  - Backslashes can escape newline (line-continuation)

```
report_constraint \
   -all_violators
```

- `set x 3`
- `set y 5`
- `set a “x is $x; y is $y”;` #Sets the variable a to “`x is 3; y is 5`”
- `set a {[expr $b*$c]} ;` #Sets the variable a to “`[expr $b*$c]`”

- `set a word\ with\ \$\ and\ space;` #Sets variable a to “`word with $ and space`”

- `report_constraint \`
  `all_violators`
  Make sure that there is no space after the backslash. “Line-continuation” means “backslash – newline.”

- Notice that a \+newline is evaluated as a space. e.g.
- `set a "1 2\`
  `3 4“`
  sets a to “`1 2 3 4`” – with a space between the 2 and the 3!

Comments in DC-Tcl

```
# Comments in Tcl

# If you want to comment on the same line, be sure
# to use a semicolon before the comment:

set header_str “Output Header” ; # Same line comment
```

This semicolon is required!

Comment a line in a DC-Tcl script using the ‘#’ character

Using Wildcards

- DC-Tcl supports two wildcard characters:
  - ***** will match zero to ‘n’ characters
  - **?** matches exactly 1 character

Examples:

```
dc_shell-xg-t> help create*
dc_shell-xg-t> set_input_delay 5 -clock CLK \
                    [get_ports BUS*]
```

Arithmetic Expressions

To evaluate arithmetic expressions use the `expr` command.

```
dc_shell-xg-t> set period 10.0
10.0

dc_shell-xg-t> set freq [expr  1 / $period]
0.1

dc_shell-xg-t> echo "Freq = " [expr $freq * 1000] "MHz"
Freq = 100.0 MHz

dc_shell-xg-t> set_load [expr [load_of \
                 ssc_core_slow/and2a0/A] * 5] [all_outputs]
```

- To have the result of `expr` represented as a floating point number, at least one of the numbers involved in the calculation has to be a float. The number 7 becomes 7.0 if floating point is required.
- e.g. the command:
  - `expr 5/2`
  - will return 2.
- If a floating point answer is required, use:
  - `expr 5.0/2`
  - This will return 2.5

Using Lists in DC-Tcl

Arrange *your* data as lists, example:

```
dc_shell-xg-t> set colors {red green blue}
red green blue
dc_shell-xg-t> echo $colors
red green blue
dc_shell-xg-t> set Num_of_Elements [llength $colors]
3
dc_shell-xg-t> set colors [lsort $colors]
blue green red
```

```
dc_shell-xg-t> set link_library {*}
*
dc_shell-xg-t> lappend link_library tc6a.db opcon.db
* tc6a.db opcon.db
dc_shell-xg-t> echo $link_library
* tc6a.db opcon.db
```

- To manipulate lists, use Tcl built-in list commands:

• `concat`	Concatenates two lists and returns a new list
• `join`	Joins elements of a list into a string
• `lappend`	Creates a new list by appending elements to a list
• `lindex`	Returns a specific element from a list
• `linsert`	Creates a new list by inserting elements into a list
• `list`	Returns a list formed from its argument
• `llength`	Returns the number of elements in a list
• `lrange`	Extracts elements from a list
• `lreplace`	Replaces a specific range of elements in a list
• `lsearch`	Searches a list for a regular expression
• `lsort`	Sorts a list
• `split`	Splits a string into a list

Iterate through Lists

The following example iterates over a list:

```
set all_colors "red green blue"

foreach color $all_colors {
  echo $color is a nice color...
}
```

```
red is a nice color…
green is a nice color…
blue is a nice color…
```

Objects and Attributes

- Recall that designs consist of objects:
  - Designs, cells, ports, pins, clocks, and nets
- In order to keep track of circuit functionality and timing, DC attaches many attributes to each of these objects:
  - Ports can have the following attributes

`direction`	**`driving_cell`**
`max_capacitance`	others. . .

  - Designs can have the following attributes

`area`	**`operating_conditions_max`**
`max_area`	others…

Accessing the Synopsys Database

- Access to DC *objects* in DC-Tcl is achieved through collections - a DC extension to standard Tcl
- Collections are generally created by `get_` or `all_` commands:

Example:

```
get_ports clk*
set myclocks [all_clocks]
set hi_cap_pins [get_pins
busdriver/tristate*]
```

- Partial list of get_* and all_* commands:

```
get_cells          # Create a collection of cells
get_clocks         # Create a collection of clocks
get_designs        # Create a collection of designs
get_libs           # Create a collection of libraries
get_nets           # Create a collection of nets
get_pins           # Create a collection of pins
get_ports          # Create a collection of ports

all_clocks         # Create a collection of all_clocks
all_designs        # Create a collection of all_designs
all_inputs         # Create a collection of all_inputs
all_outputs        # Create a collection of all_outputs
all_registers      # Create a collection of all_registers
```

- When these commands are issued, DC **internally** creates a group of objects, along with all their attributes.

Collections Are Referenced by a Handle

Just like lists, collections have special access commands.

```
dc_shell-xg-t> set foo [get_ports p*]
{"pclk", "pframe_n", "pidsel", "pad[31]"...}
dc_shell-xg-t> sizeof_collection $foo
50
dc_shell-xg-t> query_objects $foo
{"pclk", "pframe_n", "pidsel", "pad[31]"...}
```

Collection commands return a collection handle, NOT a list!
A list, containing the names of all the objects returned by the **get_** or **all_** command is echoed to the screen.

Standard Tcl list commands (concat, llength, etc) will not work with the output of a collection command!

Manipulating Collections

```
dc_shell-xg-t> help *collection*
add_to_collection      # Add object(s)
remove_from_collection # Remove object(s) from a
                         collection
. . .
```

```
dc_shell-xg-t> set pci_ports [get_ports "DATA*"]

dc_shell-xg-t> set pci_ports [add_to_collection \
                     $pci_ports [get_ports CTRL*]]

dc_shell-xg-t> set all_inputs_except_clk \
              [remove_from_collection [all_inputs] \
               [get_ports CLK]]
```

```
• dc_shell-xg-t> help *collection*

• add_to_collection       # Add object(s)
• compare_collections     # compares two collections
• copy_collection         # Make a copy of a collection
• filter_collection       # Filter a collection, resulting
                            in a new collection
• foreach_in_collection   # Iterate over a collection
• index_collection        # Extract object from collection
• remove_from_collection  # Remove object(s) from a
                            collection
• sizeof_collection       # Number of objects in a
                            collection
• sort_collection         # Create a sorted copy of a
                            collection
• dc_shell-xg-t> help *object*
• more collection related commands…
```

Filtering Collections

- Use the `filter_collection` command to get only objects you are interested in:

```
filter_collection [get_cells *] "ref_name =~ AN*"
filter_collection [get_cells *] "is_mapped != true"
```

- The `-filter` option is a nice short-cut:

```
get_cells * -filter "dont_touch == true"
set fastclks [get_clocks * -filter "period < 10"]
```

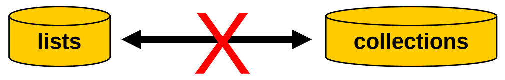
- Relational operators are:

```
==, !=, >, <, >=, <=, =~, !~
```

- Description of the examples in the previous slide:
  - 1. Returns all cells starting with the name “AN”
  - 2. Returns all unmapped cells
  - 3. Returns all cells with the “dont_touch” attribute
  - 4. Returns all clocks with a period smaller than 10
- `filter_collection` creates a new collection, or an empty string if no objects match the expression.
- The `-filter` option is more efficient, because the collection does not have to be read twice.
- Other examples:
- `get_cells -hier -filter “is_unmapped != true”`
- `get_cells -hier -filter “is_hierarchical == true”`
- To see all DC defined attributes:
- `dc_shell-xg-t> list_attributes -application`

Summary – Lists/Collections

- *Lists* are structures to store *YOUR* data
- *Collections* are used to access *DB* data
- List commands should not be used on collections and vise versa



The above is a strong recommendation. DC does allow some mixing of lists and collections, this does not mean that it should be done.
The following is allowed:
set port_col [list [get_ports a*] [get_ports b*]]
port_col: is a list with two collections. This list may be passed to other collection manipulation commands.
It is better to convert the command to this:
set port_col [get_ports "a* b*"]

Recommendations

- Avoid using aliases and abbreviating command names in scripts
- Use common extensions:
  `e.g. foo.tcl`
- Use full option names in commands:
  `create_clock -period 5 [get_ports clk]`
- Avoid "snake scripts"
  - "Snake scripts" are scripts that call scripts, that call scripts: Very hard to debug.
- Avoid sourcing scripts from your .synopsys_dc.setup file, since these scripts will be executed automatically every time you start the tool.

Need Help?

DC Tcl Help:

- Commands:

```
help create*
help -verbose create_clock
create_clock -help
man create_clock
```

- Variables:

```
printvar *_library
echo $target_library
man target_library
```

```
• dc_shell-xg-t> help *clock
•  clock                   # Builtin
•  create_clock            # create_clock
•  create_test_clock       # create_test_clock
•  remove_clock            # remove_clock
•  remove_propagated_clock #
 remove_propagated_clock
•  report_clock            # report_clock
•  set_propagated_clock    # set_propagated_clock

• dc_shell-xg-t> help -verbose create_clock
•  create_clock  # create_clock
     [-name clock_name]     (name for the clock)
     [-period period_value] (period of the clock)
     [-waveform edge_list]  (alternating rise,
     fall times for 1 period)
     [port_pin_list]  (list of ports and/or pins)
```

Command Summary (Lecture, Lab)

`dc-transcript`	UNIX utility used to translate DCSH script to DC-Tcl script
`set`	Read and write variables
`echo`	Display a value of a variable
`help`	Display command help information
`foreach`	Iterate through a list
`llength`	Returns the number of elements in a list
`sizeof_collection`	Returns the number of elements in a collection
`query_objects`	Returns object names of a collection
`add_to_collection`	Add objects to a collection
`remove_from_collection`	Remove objects from a collection
`get_attribute`	Returns the value of an attribute on a list of design or library objects
`filter_collection`	Filter an existing collection
`man`	Displays reference manual pages
`printvar`	Prints the values of one or more variables