Simulation and Verification with ModelSim/Questasim
Code Coverage and Profiling

Universidad Nacional del Centro
de la Provincia de Buenos Aires

Elías Todorovich
etodorov@exa.unicen.edu.ar

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Introduction

- ModelSim **Code Coverage** gives you graphical and report file feedback on which
  - executable statements,
  - branches,
  - conditions, and
  - expressions in your source code have been executed.
- It also measures bits of logic that have been toggled during execution.
- Enabling Code Coverage is a two step process.
  1. Identify which coverage statistics you want and compile the design files.
  2. Load the design and tell ModelSim to produce those statistics.

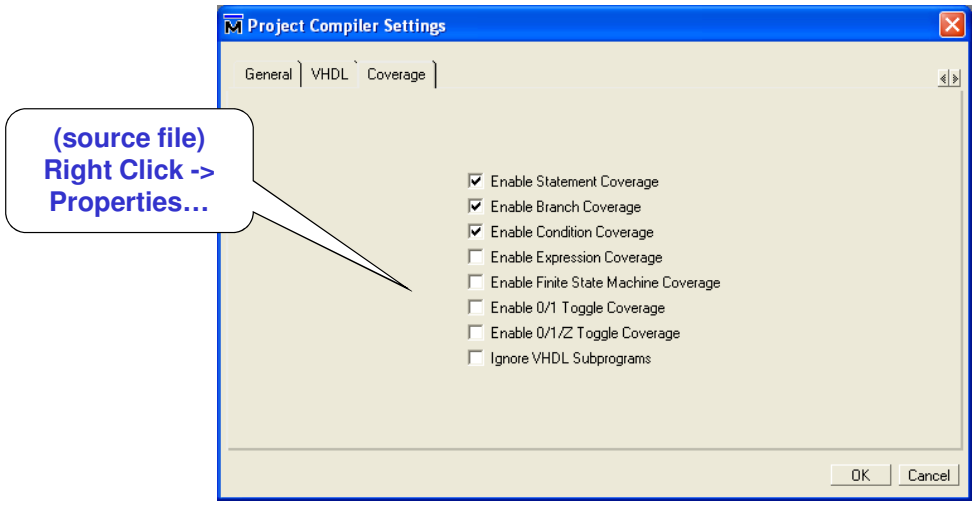
Compile for Code Coverage

- A) Command **vcom**. For VHDL type
  vcom -cover bcsxf alu.vhd regs.vhd pc.vhd

- The **-cover** argument instructs ModelSim to collect specific coverage statistics:
  - b branch**,**
  - c condition**,**
  - e expression,
  - s statement,
  - t toggle,
  - x extended toggle,
  - f and finite state machine
- Refer to the section Enabling Code Coverage in the User's Manual for more information.

Compile for Code Coverage

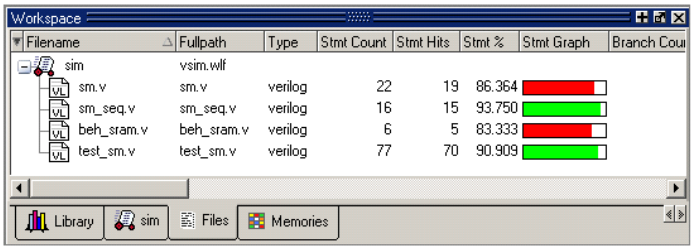
- B) GUI



Load a design for Code Coverage

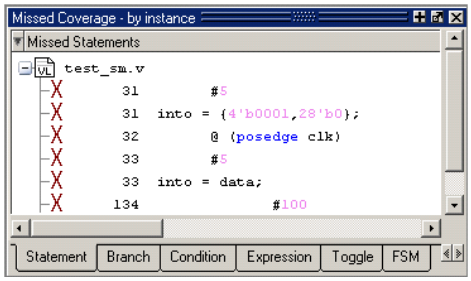
- A) Command vsim:
  vsim -voptargs="+acc" -coverage test_sm
- B) GUI

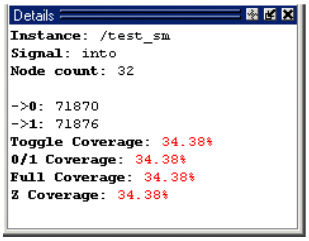
- ModelSim adds several columns to the Files and sim tabs in the Workspace:

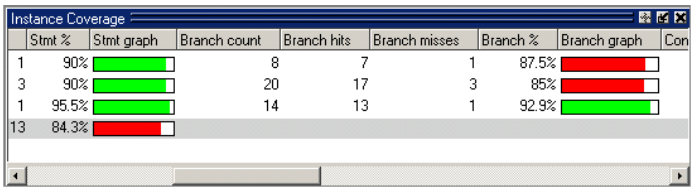


Run a design for Code Coverage

- By default, ModelSim also displays three Code Coverage panes in the Main window:

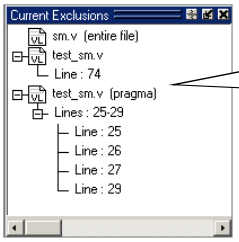






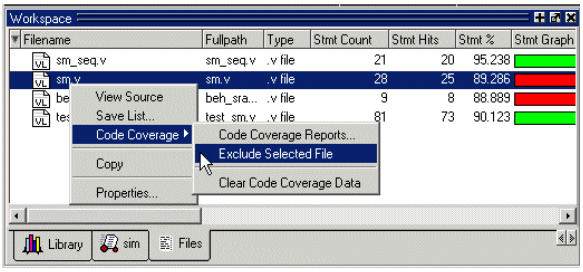
Run a design for Code Coverage

- For advanced users, you can list all files and lines that are excluded from coverage statistics.



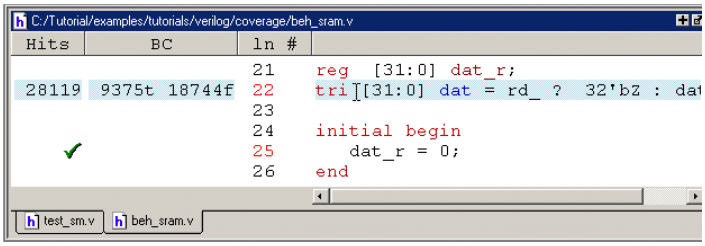
View -> Coverage -> Current Exclusions

- You can exclude lines and files (You can also exclude the selection for the current instance only)



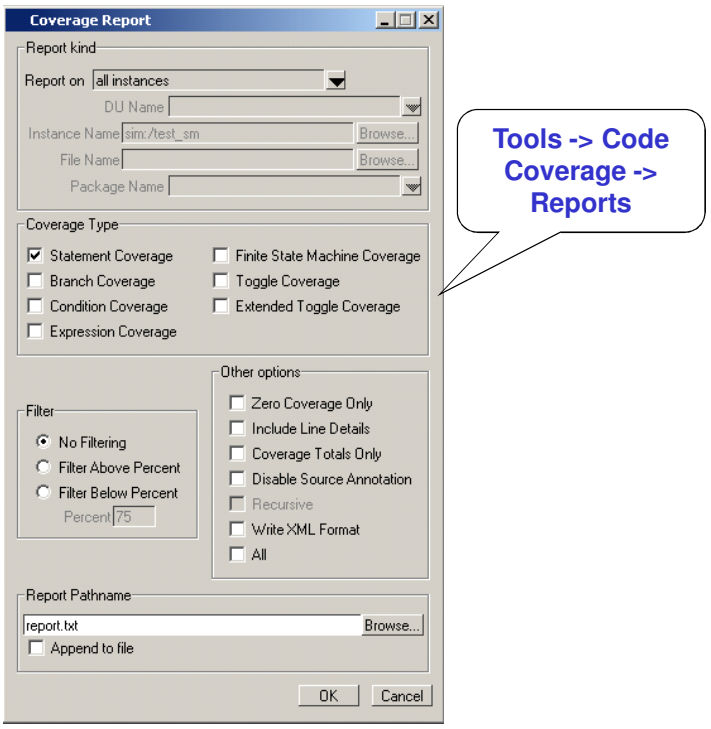
More Analysis…

- Coverage Statistics in the Source Window
  - If you hover the mouse pointer over a line of executable code with a green checkmark in the Hits or BC columns, the icons change to numbers that indicate how many times the statements and branches in that line were executed.



- Toggle Statistics in the Objects Pane

Creating Code Coverage Reports



Modelsim Profiler

- The Profiler identifies
  - the percentage of simulation time spent in each section of your code and
  - the amount of memory allocated to each function and instance.
- With this information, you can identify bottlenecks and reduce simulation time by optimizing your code.
- For example, the statistical sampling profiler might show the following:
  - objects in the sensitivity list that are not required, resulting in a process that consumes more simulation time than necessary,
  - a testbench process that is active even though it is not needed, etc.
- With this information, you can make changes to the source code that will speed up the simulation.

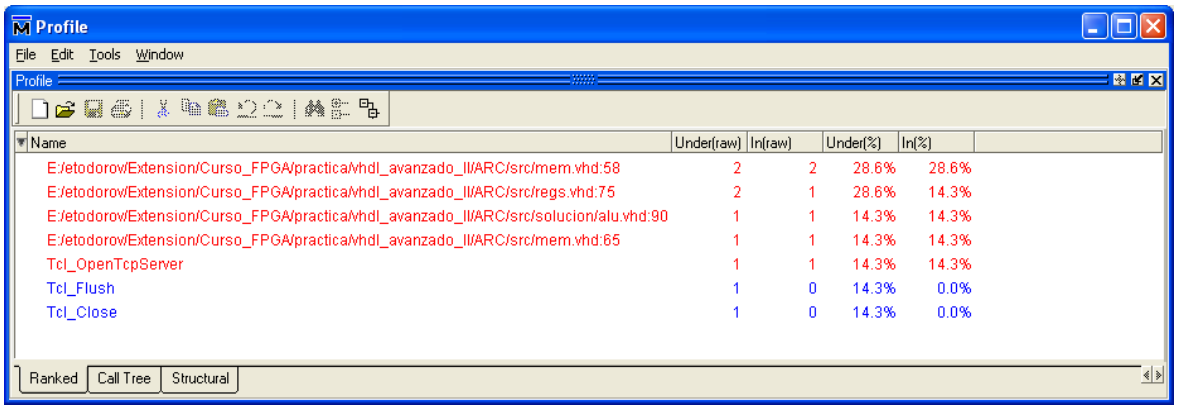
Modelsim Profiler

- The profiler's statistical sampling profiler samples the current simulation at a user-determined rate
  - every <n> milliseconds of real or "wall-clock" time, not simulation time
  - and records what is executing at each sample point.
- The `profile interval` command selects the frequency with which the profiler collects samples during a run command.
  - Example: `profile interval 2`
  - An integer value from 1 to 999 represents how many milliseconds to wait between each sample collected during a profiled simulation run.
  - Default is 10 ms.
- An entire simulation need not be run to get good information about what parts of your design are using the most simulation time.
  - A few thousand samples, for example, can be accumulated before pausing the simulation to see where simulation time is being spent.

Enabling the Performance Profiler

- After loading a design use 
- Run the simulation and observe the status bar:

- You can see the results: View -> Profiling -> Profile



Viewing Profiler Results

Column	Description
Under(raw)	the raw number of Profiler samples collected during the execution of a function, including all support routines under that function; or, the number of samples collected for an instance, including all instances beneath it in the structural hierarchy
In(raw)	the raw number of Profiler samples collected during a function or instance
Under(%)	the ratio (as a percentage) of the samples collected during the execution of a function and all support routines under that function to the total number of samples collected; or, the ratio of the samples collected during an instance, including all instances beneath it in the structural hierarchy, to the total number of samples collected
In(%)	the ratio (as a percentage) of the total samples collected during a function or instance
%Parent (not in the Ranked view)	the ratio (as a percentage) of the samples collected during the execution of a function or instance to the samples collected in the parent function or instance

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