

THE PROCESSOR VERIFICATION COMPANY





## OBSIDIAN SOFTWARE

Founded in 1997, Obsidian Software provides functional verification solutions for generating valid input stimuli in processor designs. Obsidian's patented random test generation technology can reach up to 98% coverage of even complex designs, virtually eliminating the need for directed tests.

### The Challenge of Processor Verification

Functional verification is an expensive and lengthy process that consumes on average 48% of the total development cost required to bring a new processor to market.<sup>1</sup> The added complexity of multi-threaded and multi-core processor designs compounds the verification problem. Time and resources needed to add these features increase the required investment exponentially. There are typically more lines of verification related code, including the testbench, correctness checkers, stimulus generators and coverage tools, than lines of RTL for the design itself.

#### Complex Processor Designs Cannot be Implemented without Error

Every experienced verification engineer knows this statement to be true. Since the absence of bugs cannot be assured, verification teams rely on proven methodologies, apply legacy test suites, and create sample applications to simulate real world conditions. In spite of these efforts, market research shows that 61% of new processor designs require a manufacturing respin, and chip design projects taking place in foundries require 2.5 respins on average. The cost of a 45nm mask set is on the order of \$3M. With the latest chip designs costing upwards of \$50M, companies can no longer afford to respin designs.<sup>2</sup>

#### The Danger of Functional Errors

Functional errors are one of the most common reasons for delayed time-to-market. If these errors find their way into the hands of consumers, the results can be disastrous. Mandatory firmware updates, additional manufacturing spins, product recalls and loss of market confidence in the product are all examples of the potentially damaging results of releasing products with undiscovered functional errors. Because functional errors are so costly, processor designers typically simulate the pre-silicon design logic with software and rigorously test functionality before the part is physically manufactured. Many large organizations spend untold hours of development time and millions of dollars creating random test generators to increase the amount of testing possible during the verification phase.

### Processor Verification Methodology

Obsidian's coverage-driven verification methodology utilizes functional coverage goals in conjunction with the RAVEN® random test generator to achieve optimal results. RAVEN may be used in a simulation, emulation or post-silicon environment to generate vast amounts of valid and interesting stimuli. Tests are typically generated using the customer's Instruction Set Simulator (ISS) with results compared against the RTL.

#### The Importance of Random Test Generation

Random test generators offer the advantage of automatically hitting coverage points without the need to directly author each test sequence. Modern generators automatically create valid sequences of processor instructions with associated data values, initial values for multilevel caches and initial processor register values. This saves time normally wasted on repetitive register setups and generating invalid test sequences.

<sup>1</sup> Source: 2007 IC Economics Report

<sup>2</sup> Source: 2009 IC Insights Report

## Hitting Coverage Goals

Coverage metrics are the dominant method for measuring verification progress in the industry today. Coverage points are normally designated by design engineers according to functional definitions and risk assessment. Obsidian's verification methodology begins by generating large numbers of purely random tests. Coverage monitors report the points hit by these tests and are used to identify regions which require further testing.

## Closing Coverage Gaps

As the number of coverage points hit by random tests begins to decline, generator templates are updated and constrained toward specific regions of the verification space. Some coverage points may require a long series of events before the targeted behavior takes place. In this case, directed tests and directed templates are used. Directed tests are used to target the most difficult coverage points while directed templates are written to allow as much random behavior around the coverage point as possible.

## The RAVEN software retains knowledge of how to reach key verification coverage points including:

- Every instruction executed following every other instruction
- FPU overflows and underflows
- All paths of state transitions throughout the memory hierarchy
- All possible load / store orderings and conflicts
- Using instructions to create all possible exceptions
- Accessing all possible paging modes and physical memory size boundaries
- Memory sharing with multiple bus masters or multiprocessor tests

## Introducing Obsidian's RAVEN

RAVEN (Random Architecture Verification Engine) is an intelligent verification tool used by processor design teams around the world. RAVEN provides value as a proven, mature random test generation technology for generating random and valid stimuli in standard and custom processor cores.

RAVEN is built upon pre-developed and custom made modules that can be included to expand functionality. Common processor features can be quickly added to RAVEN as well as custom requirements and architectural improvements in future processor revisions.

### Functional Verification with Processor Intelligence

RAVEN contains valuable information about common errors found in other processors and applies rules to the selection of random values. As developers create new instructions, the RAVEN tool gains intelligence about the custom core and adds rules that make the tool more efficient.

RAVEN tracks the processor state at all time and uses the current state to influence the selection of instructions and operands for newly generated instructions. The result is better verification coverage in less time, producing large numbers of interesting test sequences. Tests from RAVEN can find 5-7x more errors per cycle than other methods. The advanced constraint engine allows users to supply behavioral models capable of directing tests into difficult to reach corner cases. The intelligent selection of values is more likely to uncover functional errors and is a primary advantage of choosing RAVEN.

If you currently use directed testing for functional verification, RAVEN can greatly increase the productivity of your team by automating much of the work now being done manually. RAVEN templates can be written based on your existing test sequences and can generate tens of thousands of tests from a single XML file.

### Supported Architectures

RAVEN can be used in functional verification of any processor architecture, whether proprietary or licensable IP.

- ARMv9-11
- MIPS 32/64
- PowerPC
- X86
- Custom Architectures including RISC, CISC and VLIW

## Obsidian's Verification Solutions

Obsidian has verification IP bundles available to fit the needs of any project. Our accessible entry level RAVEN packages are ideal for those looking to maintain their project budget while enhancing the effectiveness of their existing verification methodologies. All software packages include licensing, support, architectural layer development and regular software updates.

### Software Packages

#### RAVEN Core Package

- Adds “intelligence” for one standard or custom processor core
- Includes essential development support package

#### RAVEN Project Partnership Package

Includes Core package plus:

- “Processor Intelligence” for specific project
- Extensive RAVEN development included
- Support for multiple processor revisions



### Verification Consulting

Let Obsidian Software apply years of processor verification expertise to the planning and implementation of a complete verification strategy for your project. Our career verification engineers can provide a variety of services including:

- Verification Methodology Planning
- Hardware Verification Training
- RAVEN Deployment and Training
- Test Creation Services

### Integrating RAVEN into your Current Verification Flow

Obsidian provides workflow integration services and ongoing RAVEN development including feature deployment, and software updates throughout the span of the project.

We can assist with:

- ISS Integration
- Architectural Layer Development
- Coverage Analysis Tools
- Interface RAVEN with existing tools

### Verification Jump-Start Consulting and Training

Obsidian offers initial consulting services to get your team up-to-speed with RAVEN and successfully started verifying your project. Includes on-site application assistance.



## Obsidian Solution Value

### Experience Productivity Gains

Design productivity is tied to the ability to quickly generate large numbers of tests. RAVEN can be implemented in nightly test suites to continually generate hundreds of thousands of tests. Processor designs are verified with less time and effort than with alternative verification methodologies.

### Fewer Respins

Obsidian can help clients eliminate costly manufacturing respins due to functional errors. Using a dynamic random test generator ensures that more of the design will be tested with better coverage, specifically around difficult to reach corner-cases. With proper deployment and training of RAVEN, verification teams can save the equivalent of one full respin for each design project.

### Time-to-Market Advantage

Fully, 55% of embedded processor designs do not meet their scheduled release dates. Being first-to-market among competitors can be extremely advantageous for processor designers as revenues are typically doubled during the extra time period.

### Cutting Verification Costs

If Obsidian can cut verification time by a modest 10%, the end user can claim a 5% reduction in total design costs. Based on the \$50M cost of a 45nm processor, this element alone would result in a savings of \$2.5M for the design project. These numbers will be higher for more complex processors and with better time savings.

## Obsidian Corporate Background

Obsidian Software has been providing processor verification products, verification consulting and training services to processor designers since 1997. Obsidian's RAVEN software has been used to successfully verify dozens of processor implementations by many of the world's leading semiconductor companies.

### Contacting Obsidian

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Visit our website for more information on RAVEN, including product datasheets and whitepapers, or contact us to arrange for a product demo.

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