

# Introducing Svlint

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## Background and Motivation

# What is SystemVerilog?

- SystemVerilog is (arguably) 2 languages.
  - The preprocessor language describes text transformation, vaguely specified in IEEE Std. 1800-2017 Clause 22 Compiler directives.
  - The main language aims to unify hardware design, specification, and verification, formally specified with Backus-Naur Form notation in IEEE Std. 1800-2017 Annex A.
- Annex A only describes the syntax (valid sequences of characters), not the semantics (what the text actually means); semantics are described in the rest of the LRM.
- Anybody working with code can tell you there is better/good code, and there is worse/bad code, and everybody's opinion is slightly different.
  - Either may synthesize to a correct circuit.
  - Sometimes difficult to pin down exactly what makes you classify code as better/good or worse/bad.

# What is svlint?

- Command-line tool to analyse SystemVerilog source code.
- Open source SystemVerilog linter, developed on [GitHub](#).
  - Initially written by Naoya Hatta at [PEZY Computing](#), a Japanese company producing supercomputer chips.
  - Many contributions by myself and several private [contributors](#), both professional and individual.
- Written in Rust, adhering to modern best-practices in software development.
  - Released versions, SemVer compatibility, easy installation on Linux, MacOS, and Windows, testing with continuous integration, printable manual etc.
- Contributions welcome in whatever form you can!
- Faster than commercial linters, but be aware of limitations.

# What is a linter?

*A linter is a tool which classifies pieces of code as allowed or forbidden according to a set of precise rules.*

- By default (without lint checks), every language feature is allowed - but tools vary widely in their levels of support and compliance.
- You can't avoid pinning down of what's allowed/good vs forbidden/bad.
- What is good vs bad depends on who is deciding and context, e.g. design teams vs verif teams.
- Rules can be applied at different levels of analysis (before preprocessor, parsing, compilation, elaboration, etc.).

# Operation

# How svlint works

1. Iterate over source lines, applying text rules to each in turn.
  2. Preprocess source then parse into a `SyntaxTree` (Rust data structure).
  3. Iterate over nodes of the `SyntaxTree`, applying syntax rules to each in turn.
- Uses a preprocessor and parser from a related project [sv-parser](#) which adhere very closely to IEEE Std. 1800-2017 Clause 22 and Annex A, respectively.
  - Each rule operates independently and can maintain state.
  - Only violations are reported.
  - Rules are pass/fail, i.e. no levels like warning, low, etc.

# Levels of SystemVerilog Analysis

- Text, before the preprocessor.
  - E.g. lines longer than 80 characters, lines with trailing whitespace, indented preprocessor directives, etc.
  - Called “text rules” in svlint.
- Syntax, i.e. after parsing.
  - E.g. blocking assignment under `always_ff`, identifier that violates naming conventions, `if` without matching `else`.
  - Called “syntax rules” in svlint.

————— svlint stops here —————

- Semantics of a single `module/package/etc.`, i.e. compilation.
  - E.g. variable undeclared before use, constants unresolved, etc.
  - Analogous to compiled object files.
- Semantics of combined `modules/packages/etc.`, i.e. elaboration.
  - E.g. unconnected ports, hierarchy too deep, etc.
  - Analogous to linked executables.



# Examples of Text and Syntax Rules

- Text
  - `style_textwidth`
  - `header_copyright`
- Syntax
  - `blocking_assignment_in_always_ff`
  - `localparam_type_twostate`
  - `style_operator_boolean`
  - `re_forbidden_port_input`
  - `re_required_port_input`
  - `prefix_input`

# TOML Configuration 1of2

- A TOML file defines which set of rules are enabled, i.e. a *ruleset*, together with the values of any options they use.
- The file is given by environment variable `SVLINT_CONFIG`.
  - Ideal for large projects distributed across a filesystem.
  - Ideal for teams using [Environment Modules](#).
- Alternatively found by searching up the hierarchy (from the current working directory) for a file called `.svlint.toml`.
  - Ideal for small projects contained in one git repository.
- In the [MANUAL](#), syntax rules are (loosely) divided between functional, naming, and style/whitespace.

## TOML Configuration 2of2

```
# Rules without options.  
textrules.style_semicolon = true  
syntaxrules.blocking_assignment_in_always_ff = true  
  
# Text rule which uses an option.  
# Require all text to fit on a screen.  
option.textwidth = 80  
textrules.style_textwidth = true  
  
# Syntax rule which uses an option.  
# Require output ports to have a prefix.  
option.prefix_output = "o_"  
syntaxrules.prefix_output = true
```

# Rulesets

- Considering the effects of combining different rules is non-trivial (in terms of the code quality that's allowed to pass).
- Some example rulesets are bundled with svlint:
  - `parseonly`: No rules enabled, but syntax must be valid.
  - `style`: Basic set of whitespace checks.
  - `simsynth`: Find obvious risks of simulation/synthesis mismatch.
  - `designintent`: Extends `simsynth` to require code that means (to a simulator/synthesizer) what you (probably) mean.
  - `verifintent`: Like `designintent`, but for verification code.
  - `DaveMcEwan-*`: My personally preferred configurations.
- You don't need to use these, but you can build from them.
- Yes, I'll happily assist get your's included in future releases :)

# Wrapper Scripts

- Typing `SVLINT_CONFIG=.../foo.toml svlint myfile.sv` can be cumbersome.
- Instead, all bundled rulesets also have wrapper scripts so you can do `svlint-foo` or `svls-foo`.
- If you want additional functionality in a wrapper script, this can be added as part of a ruleset definition.

# Text-Editor Integration

- Most modern editors support the [Language Server Protocol](#) to show diagnostic messages from an external tool.
  - [Vim](#), [Neovim](#), [Emacs](#), [VSCode](#), [Notepad++](#).
- Svls is svlint built as a LSP server.
  - Diagnostic messages, i.e. the hints and reasons you would see running svlint on the command line, are supported.
  - Other features, e.g. go-to-definition, are not supported.

## Illustrations

# Sources

```
module M; // BadSyntax
  woops @(posedge clk) z = z - 1;
endmodule

module M; // Fail
  always_ff @(posedge clk) z = z - 1;
endmodule

module M; // Pass
  always_ff @(posedge clk) z <= z - 1;
endmodule
```



## Command Line `svlint-simsynth`

```
$ svlint-simsynth exampleBadSyntax.sv ; echo $?
Error: parse error
--> exampleBadSyntax.sv:2:9
1 |
2 |   woops @(posedge clk) z = z - 1;
  |         ^
1
$ svlint-simsynth exampleFail.sv ; echo $?
Fail: blocking_assignment_in_always_ff
--> exampleFail.sv:2:3
1 |
2 |   always ff @(posedge clk) z = z - 1;
  |   ^^^^^^^^^ hint : Do not use blocking assignments within `always_ff`.
  |              reason: Blocking assignment in `always_ff` may cause undefined event ordering.
1
$ svlint-simsynth examplePass.sv ; echo $?
0
$
```

## Vim with vim-lsp Plugin

```
1 module M;  
E> 2   woops @(posedge clk) z = z - 1;  
    parse error  
3 endmodule
```

~  
exampleBadSyntax.sv

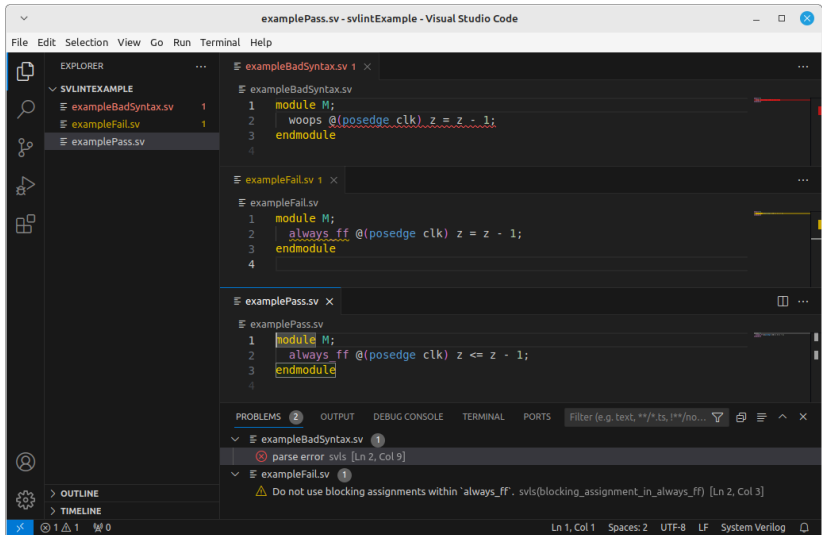
```
1 module M;  
W> 2   always_ff @(posedge clk) z = z - 1;  
    Do not use blocking assignments within `always_ff`.  
3 endmodule
```

~  
exampleFail.sv

```
1 module M;  
2   always_ff @(posedge clk) z <= z - 1;  
3 endmodule
```

~  
examplePass.sv

# VSCode with svls-vscode Extension



Thanks for Listening. Questions?

Extra

# Features for Debugging

- `svlint-parseonly`: The empty ruleset with no rules enabled. Useful to quickly check for (in)valid syntax.
- `-E`: Print output from preprocessor. Note that every preprocessor is different!
- `--dump-filelist=yaml`: Convert a filelist into YAML. Useful for working with other scripts.
- `--dump-filelist=files`: Print list of all files found in a filelist. Alternatively, `files` could be `incdirs` or `defines`. Useful for checking large filelists.
- `--dump-syntaxtree`: Print your code's syntax tree. Useful for working through obscure error messages from other tools.

# Shell Completion

- Generate shell completion scripts with the `--shell-completion` option.
- Also supports `zsh`, `fish`, `elvish`, and `powershell`.
- Save and source the output to get TAB-completions, e.g:

```
svlint --shell-completion=bash \  
  > ~/.bash_completion.d/svlint  
echo '. " ~/.bash_completion.d/svlint" ' \  
  >> ~/.bashrc
```

## Regex Naming Rules Are Powerful

```
# Require prefix on function names.  
option.re_required_function = "^f_[a-zA-Z0-9_]+$"  
syntaxrules.re_required_function = true
```

```
# Forbid any class from being declared.  
option.re_forbidden_class = ".*"  
syntaxrules.re_forbidden_class = true
```

Not only useful to enforce naming conventions. Forbidding certain types from being declared means they can't slip through unintended gaps in the ruleset.



# Simple Installation

- Download a [release](#) for your platform (Linux, Windows, MacOS) and unzip/extract.
  - `doc/` contains the PDF manual.
  - `bin/` contains the statically linked `svlint` binary, wrapper scripts (POSIX shell and Windows batch), and their TOML configurations.
- Add the `bin/` directory to your `PATH`, perhaps using an environment module like this:

```
##Module
```

```
module-whatis "SystemVerilog linter."
```

```
prepend-path PATH "/cad/tools/svlint-v0.9.1/bin"
```

# Live Demo: Syntax Checking a Collection of Files

- Show `svlint-parseonly` checking `example/*.sv`
- Commands:
  - `time svlint-parseonly -v *.sv`

# Live Demo: Examples of Ruleset Violations

- Show `svlint-designintent`.
- Re-show with `--github-actions` for CI compatibility.
- Re-show with `-1/--oneline` for compact output, compatible with `wc -l`.
- Commands:
  - `time svlint-designintent -v *.sv`
  - `svlint-designintent --github-actions Example.sv`
  - `svlint-designintent --oneline Example.sv`
  - `svlint-designintent --oneline Example.sv | wc -l`

# Vim Configuration

```
" ~/.vimrc
if executable('svls-simsynth')
  au User lsp_setup call lsp#register_server({
    \ 'name': 'svls-simsynth',
    \ 'cmd': {server_info->['svls-simsynth']},
    \ 'whitelist': ['systemverilog'],
    \ })
  let g:lsp_diagnostics_virtual_text_enabled = 1
  let g:lsp_diagnostics_signs_enabled = 1
  let g:lsp_log_file = expand('~/.vim-lsp.log')
endif
```

# VSCode Configuration

