### Installation instructions

for tutorial: "A Tour of the RISC-V ISA Formal Specification"

RISC-V Foundation ISA Formal Spec Technical Committee

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### Outline

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### About this slide deck

This is a standalone slide deck that accompanies the main slide deck for the tutorial: "A Tour of the RISC-V ISA Formal Specification", first presented at the RISC-V Summit, December 12, 2019, San Jose.

We recommend taking either Step A, or Steps A and B, depending on your objectives, in advance of the tutorial.

Step A: If you just want to learn how to read and consult the spec

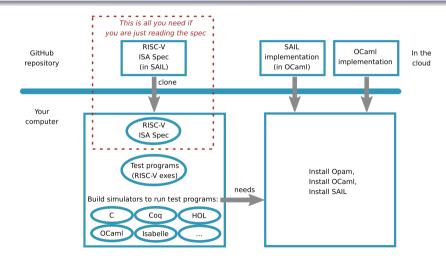
This merely git-clones a certain repo which contains the SAIL source code for the RISC-V ISA Formal Spec.

#### Step B: If you also want to learn how to execute the spec

This will compile a RISC-V ISA simulator from the SAIL formal spec, which you can use to execute:

- The standard suite of RISC-V ISA tests
- The standard RISC-V Compliance Test suite
- RISC-V ELF binaries that you create from other source codes

### Installation Overview



# Step A Installation: Cloning the SAIL RISC-V ISA Formal Spec

```
Just one step:
```

\$ git clone https://github.com/rems-project/sail-riscv

#### What you get:

```
$ sail-riscv
```

\$ tree -d

1-- ...

I-- model/ This directory contains all the spec files

I-- ...

That's all you need, for just reading and consulting (not executing) the spec!

# Step B Installation: to create an executable version of the spec

#### Safety net, in case things go wrong:

The instructions in these slides are collected here from various sources for your convenience. In case of trouble, the original full instructions can be found at:

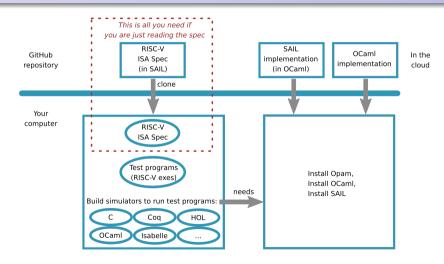
- Installing Opam: https://opam.ocaml.org/doc/Install.html
- Installing Ocaml for SAIL, and installing SAIL: https://github.com/rems-project/sail/wiki/OPAMInstall

#### OS requirements

These instructions are given for Debian/Ubuntu Linux. Alternatives:

- You could install a virtual machine running Debian/Linux and follow these instructions
- OCaml and SAIL will also install on other OSes. Wherever you see "apt get" here, which is the standard
  package manager for Debian/Ubuntu, please substitute the package manager for your OS. The websites
  mentioned under "Safety net" above may also have more information for other OSes.

### Installation Overview



Installing Opam
Installing OCamI using Opam
Installing SAIL using Opam
Building RISC-V simulator(s) from the SAIL spec

# Step B.1: Installing Opam, the package manager for OCaml

Reminder: Step B is not necessary if you're only reading and consulting the spec. It's necessary to build simulator(s) from the SAIL RISC-V ISA Formal Spec that can execute RISC-V binaries.

Use either of the following methods to install Opam:

### Step B.1 Method 1: Use curl to get an install script and run it directly:

Install curl if you don't already have it:

```
$ sudo apt-get install curl
```

### Install Opam:

\$ sudo sh <(curl -sL https://raw.githubusercontent.com/ocaml/opam/master/shell/install.sh)

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# Installing Opam (contd.)

#### Step B.1 Method 2: Download the install script and run it explicitly

```
Download install.sh from the above web link, and run it:
```

```
$ ... download https://raw.githubusercontent.com/ocaml/opam/master/shell/install.sh $ sudo sh install.sh ## Downloading opam 2.0.5 for linux on x86_64... ## Downloaded. ## Where should it be installed ? [/usr/local/bin] ## opam 2.0.5 installed to /usr/local/bin ## Run this script again with '--restore ' to revert.
```

### Step B.1: Verify successful opam installation (after using either method above)

```
$ which opam
/usr/local/bin/opam
$ opam --version
2 0 5
```

# Step B.2: Installing OCaml using Opam

Once Opam is installed, you can use it to install OCaml and SAIL. First, OCaml:

```
Step B.2: Installing OCaml, and verifying we've got it
 # Environment setup
 $ opam init
 $ eval 'opam env'
 # Install specific version of OCaml
 $ opam switch create ocaml-base-compiler.4.06.1
 $ eval 'opam config env'
 # Verify we've got it
 $ which ocaml
 /home/nikhil/.opam/ocaml-base-compiler.4.06.1/bin/ocaml
 $ ocaml -version
 The OCaml toplevel, version 4.06.1
```

Note: 4.06.1 is not the latest version of OCaml, but it is known to be suitable for SAIL (it is the version used during CI of SAIL).

Installing Opam Installing OCaml using Opam Installing SAIL using Opam Building RISC-V simulator(s) from the SAIL spec

# Step B.3: Installing SAIL using Opam

Some prerequisites: install certain libraries needed by SAIL (if not already installed on your system)

```
On Linux (Debian, Ubuntu, ...)
```

```
$ sudo apt-get install build-essential libgmp-dev z3 m4 pkg-config zlib1g-dev
```

## Homebrew (Mac OS)

\$ brew install gmp z3

# Step B.3 (contd.): Installing SAIL using Opam

### Set up opam so it knows where to get SAIL

\$ opam repository add rems https://github.com/rems-project/opam-repository.git

### Install SAIL, and verify we've got it

```
$ opam install sail

# Verify we've got it
$ which sail
/home/nikhil/.opam/ocaml-base-compiler.4.06.1/bin/sail
$ sail --help
Sail 0.11 (sail2 @ opam)
usage: sail <options> <file1.sail> ... <fileN.sail>
-o <prefix> select output filename prefix
-i start interactive interpreter
...
```

# Step B.4: Building RISC-V simulator(s) from the SAIL spec

A simulator can be used to execute RISC-V binaries.

### Step B.4: Building RISC-V simulator(s):

\$ cd sail-riscv i.e., be in the git-cloned directory

\$ make

### Creates the following (RV64 is the default):

```
c_emulator/riscv_sim_RV64 Generates a C simulator and compiles it ocaml_emulator/riscv_ocaml_sim_RV64 Generates an OCaml simulator and compiles it ... and Coq, Isabelle and HOL4 models in other directories ...
```

### You can also create corresponding RV32 simulators:

\$ ARCH=RV32 make