

Learn RISC-V CPU Implementation and BSV

(BSV: a High-Level Hardware Design Language)

Rishiyur S. Nikhil

L3: Structure of BSV Programs



Reminders

Please git clone or git pull: https://github.com/rsnikhil/Learn_Bluespec_and_RISCV_Design

```
./Book_BLang_RISCV.pdf
  Slides/
    Slides_01_Intro.pdf
    Slides_02_ISA.pdf
    ...
  Doc/Installing_bsc_Verilator_etc.{adoc,html}
  Exercises/
    Ex_03_B_Top_and_DUT/
    Ex_03_A_Hello_World/
    ...
  Code/
    src_Common/
    src_Drum/
    src_Fife/
    src_Top/
    ...
```

To compile and run the code for exercises, Drum and Fife, please make sure you have installed:

- *bsc* compiler (see <https://github.com/B-Lang-org/bsc>)
- Verilator compiler (see <https://www.verilator.org/>)

Chapter Roadmap



Strategy

We start learning **BSV** “from the outside in”, and with simple exercises, so that:

- you are very quickly able to start *reading* Drum and Fife code;
- you are very quickly able to run the codes and to get in the habit of compiling-and-running; and
- you are very quickly make small modifications,

even though it will take a little longer before you are able to code things yourself from scratch.

BSV language, compiler and libraries documents

From the book, Appendix A.6.5:

- The “**BSV** Language Reference Guide”. This document describes the syntax and semantics of **BSV**.
PDF: https://github.com/B-Lang-org/bsc/releases/latest/download/BSV_lang_ref_guide.pdf
- The “BSC Libraries Reference Guide”. This document describes the extensive set of libraries and IP (Intellectual Property blocks) available to the **BSV** user.
PDF: https://github.com/B-Lang-org/bsc/releases/latest/download/bsc_libraries_ref_guide.pdf
- The “BSC User Guide”. This document describes how to use the *bsc* compiler, which compiles our hardware descriptions written in **BSV** into Verilog (which can then be simulated or synthesizes using standard Verilog tools).
PDF: https://github.com/B-Lang-org/bsc/releases/latest/download/bsc_user_guide.pdf

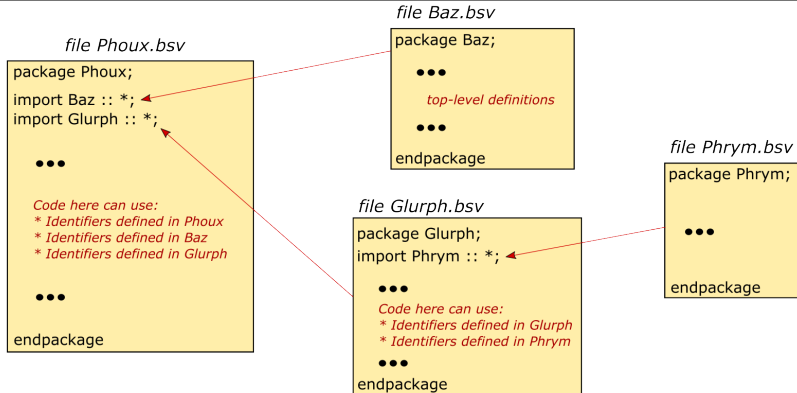
We will be using the Language Reference Guide and Librares Reference Guide extensively, so you may wish to download a copy for your laptop.



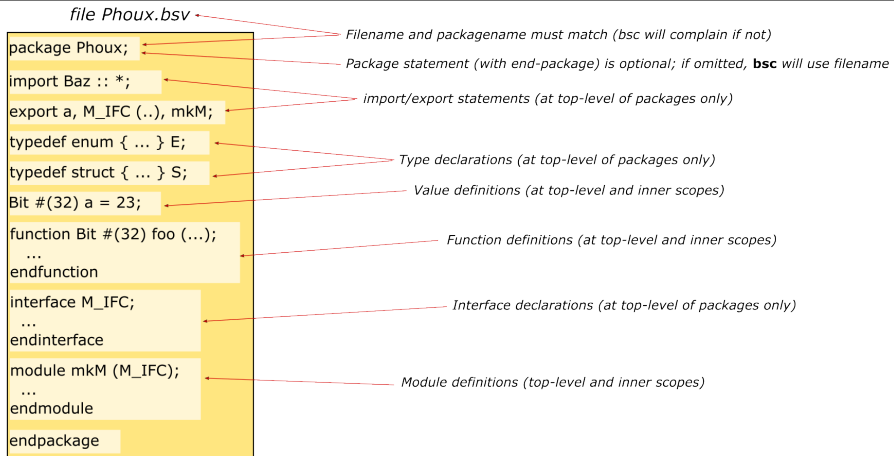
Exercise break

Please see directory: `Exercises/Ex_03_A_Hello_World/`
and its README.

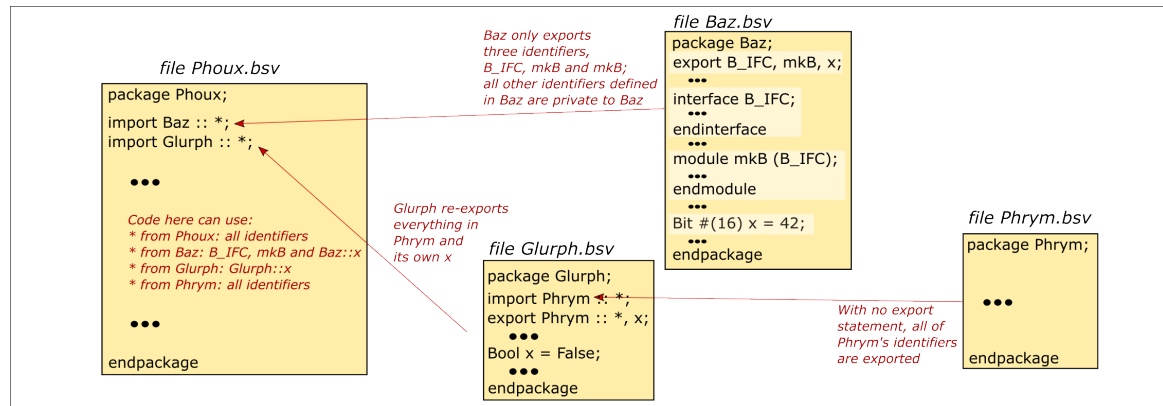
File-level view of a BSV program



What's in a BSV package/file?



Namespace control with package imports and exports





Exercise break

Please see directory: `Exercises/Ex_03_B_Top_and_DUT/`
and its README.

What's in an Interface Declaration?

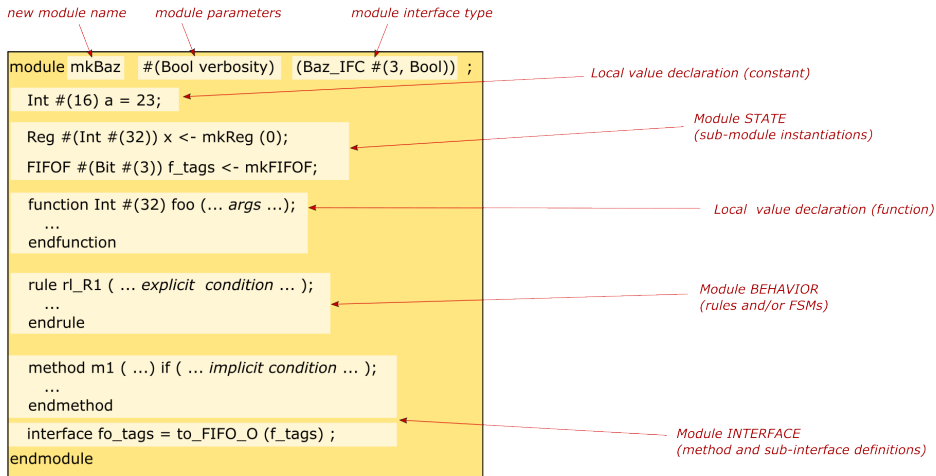
The diagram shows an interface declaration for `Baz_IFC` with several annotations pointing to its components:

- `interface`: new interface type
- `Baz_IFC`: numeric type parameter declaration
- `numeric type n`: value type parameter declaration
- `type t`: value type parameter declaration
- `method Action m1 (Int #(32) x, Bool y, t z);`: Action method declaration (methods can have arguments)
- `method ActionValue #(Bit #(16)) m2 (... args ...);`: ActionValue method declaration
- `method Bit #(16) m3 (... args ...);`: Value method declaration (return type is not Action or ActionValue)
- `interface FIFO_O #(Bit #(n)) fo_tags;`: Nested sub-interface declaration
- `endinterface`: Existing interface type

```
interface Baz_IFC #( numeric type n, type t );
  method Action m1 (Int #(32) x, Bool y, t z);
  method ActionValue #(Bit #(16)) m2 (... args ...);
  method Bit #(16) m3 (... args ...);

  interface FIFO_O #(Bit #(n)) fo_tags;
endinterface
```

What's in a Module Declaration?





Exercise break

Please see directory: `Exercises/Ex_03_C_Module_and_Interface/`
and its README.

What's in a Rule?

new rule name

rule condition ("explicit condition")

```
rule rl_Fetch_req ( rg_running  
                    && (! f_Fetch_from_Retire.notEmpty) );
```

```
let pred_pc = rg_pc + 4;  
let y       = fn_Fetch (rg_pc, pred_pc, rg_epoch, rg_inum);
```

```
f_Fetch_to_Decode.enq (y.to_D);  
f_Fetch_to_IMem.enq (y.mem_req);
```

```
rg_pc  <= pred_pc;  
rg_inum <= rg_inum + 1;
```

```
endrule
```

Two local variable definitions

*Two Actions
(invocations of FIFO ".enq" methods)*

*Two Actions
(invocations of register "._write" methods)*

What's in an Interface Definition?

The diagram shows two BSV method definitions within a yellow box. Red arrows point from text labels to specific parts of the code. The first method is 'init', an Action method with a condition. The second method is 'read_epc', a Value method with a return statement. Annotations explain that Action and ActionValue methods can contain Actions, while Value methods cannot. They also note that return statements are only used in Value and ActionValue methods.

```
method Action init ( Initial_Params initial_params ) if ( ! rg_running );  
  rg_pc      <= initial_params.pc_reset_value;  
  rg_running <= True;  
endmethod  
  
method Bit #(XLEN) read_epc;  
  return csr_mepc;  
endmethod
```

method name

method arguments

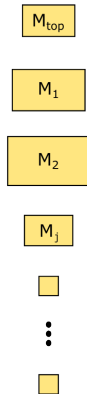
method condition ("implicit condition")

method body
(Action and ActionValue methods can contain Actions;
Value methods cannot contain Actions)

return statement
(in Value-methods and ActionValue methods
but not in Action methods)

Static elaboration

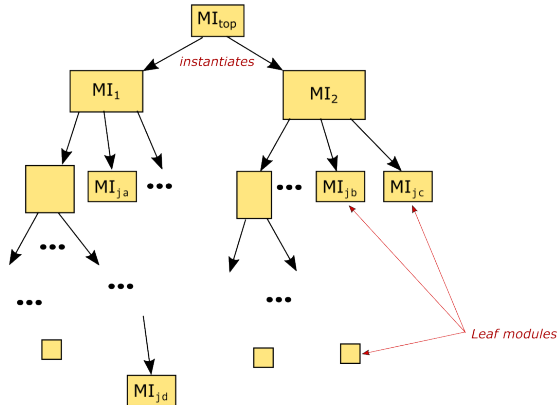
module definitions



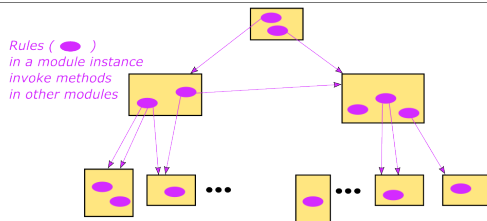
Static Elaboration



module instance hierarchy



Module interaction



End