

## PU-OR1K WIKI

A Processing Unit (PU) is an electronic system within a computer that carries out instructions of a program by performing the basic arithmetic, logic, controlling, and I/O operations specified by instructions. Instruction-level parallelism is a measure of how many instructions in a computer can be executed simultaneously. The PU is contained on a single Metal Oxide Semiconductor (MOS) Integrated Circuit (IC).

The OpenRISC implementation has a 32/64 bit Microarchitecture, 5 stages data pipeline and an Instruction Set Architecture based on Reduced Instruction Set Computer. Compatible with Wishbone Bus. Only For Researching.

## FRONT-END Open Source Tools

### Verilator

SystemVerilog System Description Language Simulator

*A System Description Language Simulator (translator) is a computer program that translates computer code written in a Programming Language (the source language) into a Hardware Design Language (the target language). The compiler is primarily used for programs that translate source code from a high-level programming language to a low-level language to create an executable program.*

```
git clone http://git.veripool.org/git/verilator
```

```
cd verilator
autoconf
./configure
make
sudo make install

cd sim/verilog/regression/wb/vtor
source SIMULATE-IT

cd sim/verilog/regression/ahb3/vtor
source SIMULATE-IT
```

### Icarus Verilog

Verilog Hardware Description Language Simulator

*A Hardware Description Language Simulator uses mathematical models to replicate the behavior of an actual hardware device. Simulation software allows for modeling of circuit operation and is an invaluable analysis tool. Simulating a circuit's behavior before actually building it can greatly improve design efficiency*

*by making faulty designs known as such, and providing insight into the behavior of electronics circuit designs.*

```
git clone https://github.com/steveicarus/iverilog
```

```
cd iverilog
./configure
make
sh autoconf.sh
sudo make install

cd sim/verilog/regression/wb/iverilog
source SIMULATE-IT

cd sim/verilog/regression/ahb3/iverilog
source SIMULATE-IT
```

## **GHDL**

VHDL Hardware Description Language Simulator

*A Hardware Description Language Simulator uses mathematical models to replicate the behavior of an actual hardware device. Simulation software allows for modeling of circuit operation and is an invaluable analysis tool. Simulating a circuit's behavior before actually building it can greatly improve design efficiency by making faulty designs known as such, and providing insight into the behavior of electronics circuit designs.*

```
git clone https://github.com/ghdl/ghdl
```

```
cd ghdl
./configure --prefix=/usr/local
make
sudo make install

cd sim/vhdl/regression/wb/ghdl
source SIMULATE-IT

cd sim/vhdl/regression/ahb3/ghdl
source SIMULATE-IT
```

## **Yosys-ABC**

Verilog Hardware Description Language Synthesizer

*A Hardware Description Language Synthesizer turns a RTL implementation into a Logical Gate Level implementation. Logical design is a step in the standard design cycle in which the functional design of an electronic circuit is converted*

*into the representation which captures logic operations, arithmetic operations, control flow, etc. In EDA parts of the logical design is automated using synthesis tools based on the behavioral description of the circuit.*

#### Hardware Description Language Optimizer

*A Hardware Description Language Optimizer finds an equivalent representation of the specified logic circuit under specified constraints (minimum area, pre-specified delay). This tool combines scalable logic optimization based on And-Inverter Graphs (AIGs), optimal-delay DAG-based technology mapping for look-up tables and standard cells, and innovative algorithms for sequential synthesis and verification.*

```
git clone https://github.com/YosysHQ/yosys
```

```
cd yosys
make
sudo make install

cd synthesis/yosys
source SYNTHESIZE-IT
```

## BACK-END Open Source Tools

```
mkdir qflow
cd qflow
```

### Magic

#### Floor-Planner

*A Floor-Planner of an Integrated Circuit (IC) is a schematic representation of tentative placement of its major functional blocks. In modern electronic design process floor-plans are created during the floor-planning design stage, an early stage in the hierarchical approach to Integrated Circuit design. Depending on the design methodology being followed, the actual definition of a floor-plan may differ.*

#### Standard Cell Checker

*A Standard Cell Checker is a geometric constraint imposed on Printed Circuit Board (PCB) and Integrated Circuit (IC) designers to ensure their designs function properly, reliably, and can be produced with acceptable yield. Design Rules for production are developed by hardware engineers based on the capability of their processes to realize design intent. Design Rule Checking (DRC) is used to ensure that designers do not violate design rules.*

#### Standard Cell Editor

*A Standard Cell Editor allows to print a set of standard cells. The standard cell methodology is an abstraction, whereby a low-level VLSI layout is encapsulated into a logical representation. A standard cell is a group of transistor and interconnect structures that provides a boolean logic function (AND, OR, XOR, XNOR, inverters) or a storage function (flipflop or latch).*

```
git clone https://github.com/RTimothyEdwards/magic
```

```
cd magic
./configure
make
sudo make install
```

## Graywolf

Standard Cell Placer

*A Standard Cell Placer takes a given synthesized circuit netlist together with a technology library and produces a valid placement layout. The layout is optimized according to the aforementioned objectives and ready for cell resizing and buffering, a step essential for timing and signal integrity satisfaction. Physical design flow are iterated a number of times until design closure is achieved.*

```
git clone https://github.com/rubund/graywolf
cd graywolf
mkdir build
cd build
cmake ..
make
sudo make install
```

## OpenSTA

Standard Cell Timing-Analizer

*A Standard Cell Timing-Analizer is a simulation method of computing the expected timing of a digital circuit without requiring a simulation of the full circuit. High-performance integrated circuits have traditionally been characterized by the clock frequency at which they operate. Measuring the ability of a circuit to operate at the specified speed requires an ability to measure, during the design process, its delay at numerous steps.*

```
git clone https://github.com/The-OpenROAD-Project/OpenSTA
cd OpenSTA
mkdir build
cd build
cmake ..
```

```
make
sudo make install
```

## Qrouter

### Standard Cell Router

*A Standard Cell Router takes pre-existing polygons consisting of pins on cells, and pre-existing wiring called pre-routes. Each of these polygons are associated with a net. The primary task of the router is to create geometries such that all terminals assigned to the same net are connected, no terminals assigned to different nets are connected, and all design rules are obeyed.*

```
git clone https://github.com/RTimothyEdwards/qrouter
cd qrouter
./configure
make
sudo make install
```

## Irsim

### Standard Cell Simulator

*A Standard Cell Simulator treats transistors as ideal switches. Extracted capacitance and lumped resistance values are used to make the switch a little bit more realistic than the ideal, using the RC time constants to predict the relative timing of events. This simulator represents a circuit in terms of its exact transistor structure but describes the electrical behavior in a highly idealized way.*

```
git clone https://github.com/RTimothyEdwards/irsim
cd irsim
./configure
make
sudo make install
```

## Netgen

### Standard Cell Verifier

*A Standard Cell Verifier compares netlists, a process known as LVS (Layout vs. Schematic). This step ensures that the geometry that has been laid out matches the expected circuit. The greatest need for LVS is in large analog or mixed-signal circuits that cannot be simulated in reasonable time. LVS can be done faster than simulation, and provides feedback that makes it easier to find errors.*

```
git clone https://github.com/RTimothyEdwards/netgen
cd netgen
./configure
make
sudo make install
```

## **Qflow**

Back-End Workflow

```
git clone https://github.com/RTimothyEdwards/qflow
cd qflow
./configure
make
sudo make install

cd synthesis/qflow
source FLOW-IT
```

## **for WINDOWS users!**

open Microsoft Store and install Ubuntu

type:

```
sudo apt update
sudo apt upgrade
```

```
sudo apt install bison cmake flex freeglut3-dev libcairo2-dev libgsl-dev \
libncurses-dev libx11-dev m4 python-tk python3-tk swig tcl tcl-dev tk-dev tcsh
```

## **FRONT-END**

type:

```
sudo apt install verilator
sudo apt install iverilog
sudo apt install ghdl
```

```
sudo apt install yosys
```

## **BACK-END**

type:

```
mkdir qflow
cd qflow
```

```
git clone https://github.com/RTimothyEdwards/magic
git clone https://github.com/rubund/graywolf
git clone https://github.com/The-OpenROAD-Project/OpenSTA
git clone https://github.com/RTimothyEdwards/qrouter
git clone https://github.com/RTimothyEdwards/irsim
git clone https://github.com/RTimothyEdwards/netgen
git clone https://github.com/RTimothyEdwards/qflow
```

## Basic parameters

Parameter	Description	Default	Values
OPTION_OPERAND_WIDTH	CPU data and address widths	32	32, 64
OPTION_CPU0	CPU pipeline core	CAPPUCCINO	CAPPUCCINO
OPTION_RESET_PC	Program Counter upon reset	0x100	N

## Caching parameters

Parameter	Description	Default	Values
FEATURE_DATACACHE	Enable memory access data caching	NONE	ENABLED
OPTION_DCACHE_BLOCK_WIDTH	Address width of a cache block	5	n
OPTION_DCACHE_SET_WIDTH	Set address width	9	n
OPTION_DCACHE_WAYS	Number of blocks per set	2	n
OPTION_DCACHE_LIMIT_WIDTH	Maximum address width	32	n
OPTION_DCACHE_SNOOP	Bus snooping for cache coherency	NONE	ENABLED
FEATURE_INSTRUCTIONCACHE	Memory access instruction caching	NONE	ENABLED
OPTION_ICACHE_BLOCK_WIDTH	Address width of a cache block	5	n
OPTION_ICACHE_SET_WIDTH	Set address width	9	n
OPTION_ICACHE_WAYS	Number of blocks per set	2	n
OPTION_ICACHE_LIMIT_WIDTH	Maximum address width	32	n

## Memory Management Unit (MMU) parameters

Parameter	Description	Default	Values
FEATURE_DMMU	Enable the data bus MMU	NONE	ENABLED
FEATURE_DMMU_HW_TLB_RELOAD	Enable hardware TLB reload	NONE	ENABLED
OPTION_DMMU_SET_WIDTH	Set address width	6	n

Parameter	Description	Default	Values
OPTION_DMMU_WAYS	Number of ways per set	1	<b>n</b>
FEATURE_IMMU	Enable the instruction bus MMU	<b>NONE</b>	<b>ENABLED</b>
FEATURE_IMMU_HW_TLB_RELOAD	Enable hardware TLB reload	<b>NONE</b>	<b>ENABLED</b>
OPTION_IMMU_SET_WIDTH	Set address width	6	<b>n</b>
OPTION_IMMU_WAYS	Number of ways per set	1	<b>n</b>

## System bus parameters

Parameter	Description	Default
FEATURE_STORE_BUFFER	Load store unit store buffer	<b>ENABLED</b>
OPTION_STORE_BUFFER_DEPTH_WIDTH	Load store unit store buffer depth	8
BUS_IF_TYPE	Bus interface type	<b>WISHBONE32</b>
IBUS_WB_TYPE	Instruction bus interface	<b>B3_READ_BURSTING</b>
DBUS_WB_TYPE	Data bus interface type option	<b>CLASSIC</b>

## Hardware unit configuration parameters

Parameter	Description	Default
FEATURE_TRACEPORT_EXEC	Traceport hardware interface	<b>NONE</b>
FEATURE_DEBUGUNIT	Hardware breakpoints and debug unit	<b>NONE</b>
FEATURE_PERFCOUNTERS	Performance counters unit	<b>NONE</b>
OPTION_PERFCOUNTERS_NUM	Performance counters to generate	0
FEATURE_TIMER	Internal OpenRISC timer	<b>ENABLED</b>
FEATURE_PIC	Internal OpenRISC PIC	<b>ENABLED</b>
OPTION_PIC_TRIGGER	PIC trigger mode	<b>LEVEL</b>
OPTION_PIC_NMI_WIDTH	Non maskable interrupts width	0
OPTION_RF_CLEAR_ON_INIT	clearing all registers on initialization	0
OPTION_RF_NUM_SHADOW_GPR	Number of shadow register files	0
OPTION_RF_ADDR_WIDTH	Address width of the register file	5
OPTION_RF_WORDS	Number of registers in the register file	32
FEATURE_FASTCONTEXTS	Fast context switching of register sets	<b>NONE</b>
FEATURE_MULTICORE	<b>coreid</b> and <b>numcores</b> SPR registers	<b>NONE</b>
FEATURE_FPU	FPU, for cappuccino pipeline only	<b>NONE</b>
OPTION_FTOI_ROUNDING	Rounding behavior for <b>lf.ftoi.s</b>	<b>CPP</b>
FEATURE_BRANCH_PREDICTOR	Branch predictor implementation	<b>SIMPLE</b>

**Note:** *C/C++ double to integer conversion assumes truncation (rounding toward zero). The default (CPP) value of OPTION\_FTOI\_ROUNDING forces toward zero rounding mode exclusively for lf.ftoi.s instruction regardless*



of *rounding mode* bits of *FPCSR*. While with *IEEE* value *lf.ftoi.s* performs conversion in according with *rounding mode* bits of *FPCSR*. And these bits are *nearest-even* rounding mode by default. All other floating point instructions always perform rounding in according with *rounding mode* bits of *FPCSR*.

## Exception handling options

Parameter	Description	Default
FEATURE_DSX	Enable setting the <code>SR[DSX]</code> flag	ENABLED
FEATURE_RANGE	Enable checking and raising range exceptions	ENABLED
FEATURE_OVERFLOW	Enable checking and raising overflow exceptions	ENABLED

## ALU configuration options

Parameter	Description	Default
FEATURE_MULTIPLIER	Specify the multiplier implementation	THREESTAGE
FEATURE_DIVIDER	Specify the divider implementation	SERIAL
OPTION_SHIFTER	Specify the shifter implementation	BARREL
FEATURE_CARRY_FLAG	Enable checking and setting the carry flag	ENABLED

## Instruction enabling options

Parameter	Description	Default
FEATURE_MAC	<code>1.mac*</code> multiply accumulate instructions	NONE
FEATURE_SYSCALL	<code>1.sys</code> OS syscall instruction	ENABLED
FEATURE_TRAP	<code>1.trap</code> instruction	ENABLED
FEATURE_ADDC	<code>1.addc</code> add with <code>carry</code> flag instruction	ENABLED
FEATURE_SRA	<code>1.sra</code> shift right arithmetic instruction	ENABLED
FEATURE_ROR	<code>1.ror*</code> rotate right instructions	NONE
FEATURE_EXT	<code>1.ext*</code> sign extend instructions	NONE
FEATURE_CMOV	<code>1.cmov</code> conditional move instruction	ENABLED
FEATURE_FFL1	<code>1.f[f1]</code> find first/last set bit instructions	ENABLED
FEATURE_ATOMIC	<code>1.lwa</code> and <code>1.swa</code> atomic instructions	ENABLED
FEATURE_CUST1	<code>1.cust*</code> custom instruction	NONE
FEATURE_CUST2	<code>1.cust*</code> custom instruction	NONE
FEATURE_CUST3	<code>1.cust*</code> custom instruction	NONE
FEATURE_CUST4	<code>1.cust*</code> custom instruction	NONE
FEATURE_CUST5	<code>1.cust*</code> custom instruction	NONE
FEATURE_CUST6	<code>1.cust*</code> custom instruction	NONE

Parameter	Description	Default
FEATURE_CUST7	<b>1.cust*</b> custom instruction	NONE
FEATURE_CUST8	<b>1.cust*</b> custom instruction	NONE