apio Documentation

Release 0.4.0

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Contents

Open source **ecosystem for open FPGA boards**. It was inspired by PlatformIO.

Apio (pronounced [a.pjo]) is a **multiplatform toolbox**, with static pre-built packages, project configuration tools and easy command interface to verify, synthesize, simulate and upload your **verilog** designs.

Apio is used by Icestudio.

Source code: https://github.com/FPGAwars/apio

CHAPTER 1

Contents

1.1 Installation

Apio is written in Python and works on Linux (+ARM), Mac OS X, Windows.

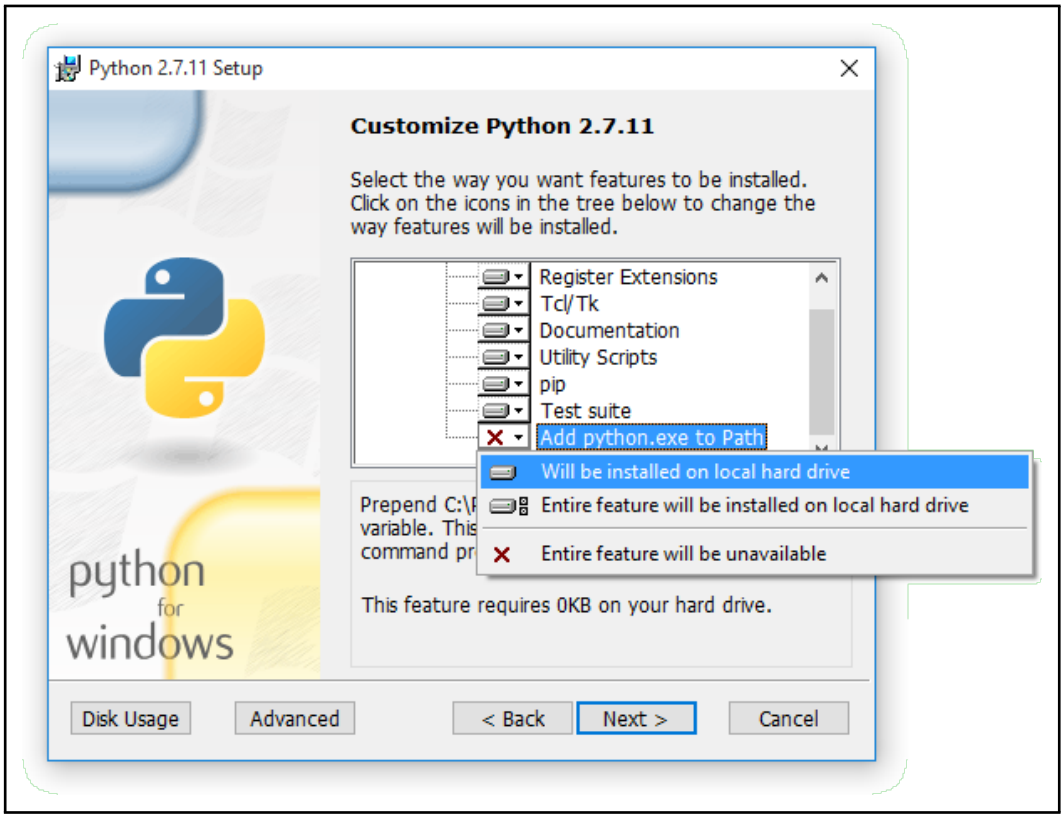
Contents

1.1.1 System requirements

Operating System Linux (+ARM), Mac OS X or Windows

Python Interpreter Python 2.7, Python 3.5+

> **Attention: Windows Users**: Please Download the latest Python and install it. **DON'T FORGET** to select `Add python.exe to Path` feature on the "Customize" stage, otherwise Python Package Manager `pip` command will not be available.



Terminal Application All commands below should be executed in Command-line application (Terminal). For Mac OS X and Linux OS - *Terminal* application, for Windows OS – `cmd.exe` application.

Access to Serial Ports (USB/UART) Windows Users: Please check that you have correctly installed USB driver from board manufacturer.

Linux Users: Ubuntu/Debian users may need to add own "username" to the "dialout" group if they are not "root", doing this issuing a `sudo usermod -a -G dialout $USER`.

1.1.2 Install Apio

The latest stable version of Apio may be installed or upgraded via Python Package Manager (pip) as follows:

```
$ pip install -U apio
```

If `pip` command is not available run `easy_install pip`.

Note that you may run into permissions issues running these commands. You have a few options here:

- Run with `sudo` to install Apio and dependencies globally
- Specify the pip install –user option to install local to your user
- Run the command in a virtualenv local to a specific project working set.

Note: Debian users can also install the application and its packages by executing the following commands. (These packages may not be updated).

```
$ curl -sSL http://fpgalibre.sf.net/debian/go | sudo sh
$ sudo apt-get install apio
$ sudo apt-get install apio-scons apio-icestorm apio-iverilog apio-examples apio-
↪system
```

1.1.3 Install FTDI drivers

For boards with a FTDI interface.

```
$ apio drivers --ftdi-enable
```

To revert the FTDI drivers configuration.

```
$ apio drivers --ftdi-disable
```

1.1.4 Install Serial drivers

For boards with a Serial interface.

```
$ apio drivers --serial-enable
```

To revert the Serial drivers configuration.

```
$ apio drivers --serial-disable
```

1.2 Quick Start

Once apio has been installed and the drivers have been correctly configured is time to start playing with your FPGA!

1.2.1 Install packages

```
$ apio install --all
```

1.2.2 Create a project

Go to your project's directory or try the examples

```
$ apio examples -d leds
$ cd leds
```

Configure your board

Find your board in the list

```
$ apio boards --list

Supported boards:

-------------------------------------------------------
Board            FPGA                 Type  Size  Pack
-------------------------------------------------------
Cat-board        iCE40-HX8K-CT256     hx    8k    ct256
TinyFPGA-B2      iCE40-LP8K-CM81      lp    8k    cm81
TinyFPGA-BX      iCE40-LP8K-CM81      lp    8k    cm81
alhambra-ii      iCE40-HX4K-TQ144     hx    8k    tq144:4k
blackice         iCE40-HX4K-TQ144     hx    8k    tq144:4k
blackice-ii      iCE40-HX4K-TQ144     hx    8k    tq144:4k
fpga101          iCE40-UP5K-SG48      up    5k    sg48
go-board         iCE40-HX1K-VQ100     hx    1k    vq100
iCE40-HX8K       iCE40-HX8K-CT256     hx    8k    ct256
iCE40-UP5K       iCE40-UP5K-SG48      up    5k    sg48
iCEBreaker       iCE40-UP5K-SG48      up    5k    sg48
iCEBreaker-bitsy iCE40-UP5K-SG48      up    5k    sg48
iceblink40-hx1k  iCE40-HX1K-VQ100     hx    1k    vq100
icestick         iCE40-HX1K-TQ144     hx    1k    tq144
icezum           iCE40-HX1K-TQ144     hx    1k    tq144
icoboard         iCE40-HX8K-CT256     hx    8k    ct256
kefir            iCE40-HX4K-TQ144     hx    8k    tq144:4k
upduino          iCE40-UP5K-SG48      up    5k    sg48
upduino2         iCE40-UP5K-SG48      up    5k    sg48
```

Create an apio.ini file with your board

```
$ apio init --board icestick
```

1.2.3 Process the project

Verify

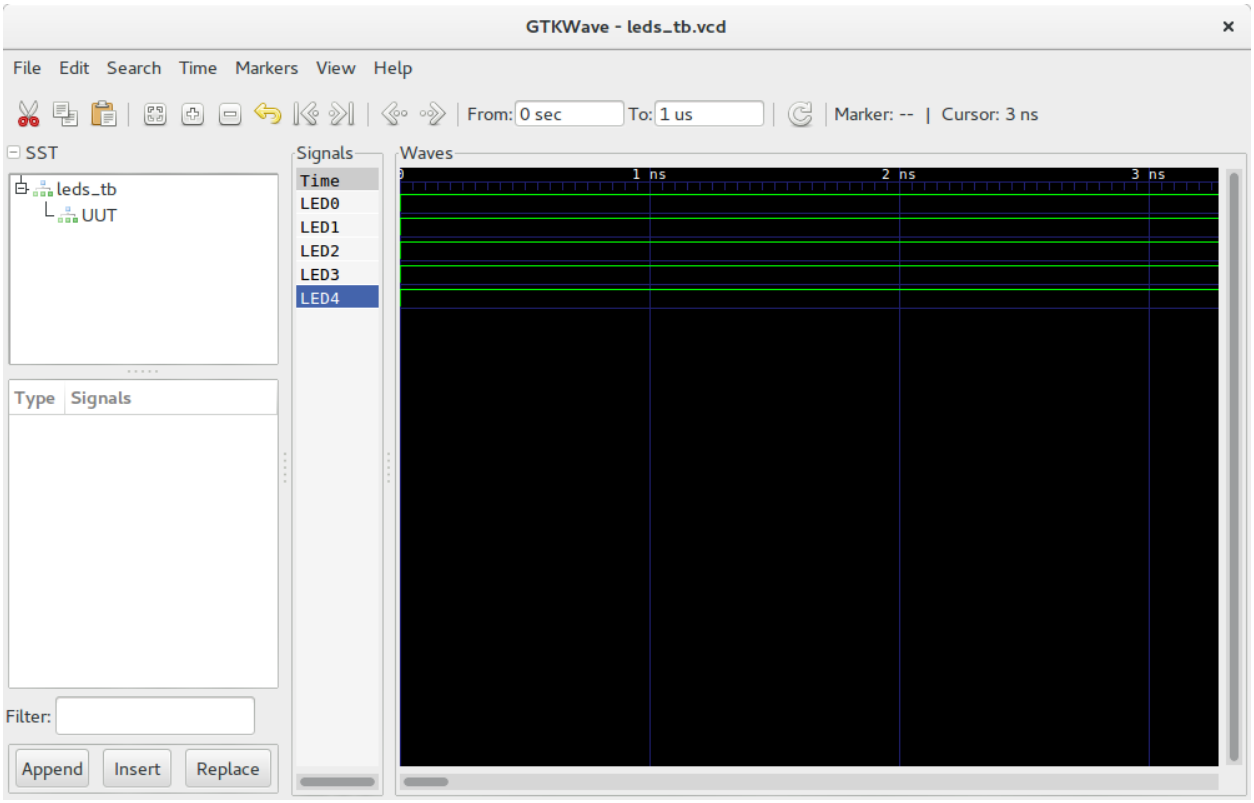
Check your verilog code using Icarus Verilog

```
$ apio verify
```

Simulate

Simulate your test bench using Icarus Verilog and GTKWave

```
$ apio sim
```



Note: GTKWave must be installed.

Debian	apt-get install gtkwave
Mac OSX	brew install gtkwave
Windows	apio install gtkwave

Build

Syntesize your project using Icestorm Tools

```
$ apio build
```

Upload

Connect your FPGA board and upload the bitstream using Icestorm Tools

```
$ apio upload
```

All the leds should turn on after 3 seconds

Congrats! Now You have your fully open source FPGA toolchain ready!

1.3 User Guide

Contents

1.3.1 Usage

```
apio [OPTIONS] COMMAND [ARGS]
```

You can execute just *apio* to see the help:

```
$ apio
Usage: apio [OPTIONS] COMMAND [ARGS]...

Options:
  --version  Show the version and exit.
  --help     Show this message and exit.

Project commands:
  build      Synthesize the bitstream.
  clean      Clean the previous generated files.
```

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```
  lint       Lint the verilog code.
  sim        Launch the verilog simulation.
  time       Bitstream timing analysis.
  upload     Upload the bitstream to the FPGA.
  verify     Verify the verilog code.

Setup commands:
  drivers    Manage FPGA boards drivers.
  init       Manage apio projects.
  install    Install packages.
  uninstall  Uninstall packages.

Utility commands:
  boards     Manage FPGA boards.
  config     Apio configuration.
  examples   Manage verilog examples.
  raw        Execute commands using Apio packages.
  system     System tools.
  upgrade    Check the latest Apio version.
```

1.3.2 Options

`--version`

Show the version of Apio.

1.3.3 Project Commands

apio build

Contents

Usage

```
apio build [OPTIONS]
```

Description

Synthesize the bitstream: generates a **bin** file from a **verilog** and a **pcf** files.

Required packages: `scons`, `icestorm`.

Options

`-b, --board`

Select a specific board.

`--fpga`

Select a specific FPGA.

`--size` `--type --pack`

Select a specific FPGA size, type and pack.

`-p, --project-dir`

Set the target directory for the project.

`-v, --verbose`

Show the entire output of the command.

`--verbose-yosys`

Show the yosys output of the command.

`--verbose-arachne`

Show the arachne output of the command.

Note: All available boards, FPGAs, sizes, types and packs are showed in *apio boards*

Examples

1. Process the *leds example*

```
$ apio build
[] Processing icezum
--------------------------------------------------------------------------------
↪-------
yosys -p "synth_ice40 -blif hardware.blif" -q leds.v
arachne-pnr -d 1k -P tq144 -p leds.pcf -o hardware.asc -q hardware.blif
icepack hardware.asc hardware.bin
================================== [SUCCESS] Took 0.72 seconds␣
↪==============================
```

apio clean

Contents

Usage

```
apio clean [OPTIONS]
```

Description

Clean the previous generated files: **blif**, **asc**, **bin**, **rpt** and **out**.

Required packages: `scons`.

Options

`-p, --project-dir`

Set the target directory for the project.

Examples

1. Clean the *leds example*

```
$ apio clean
Removed hardware.blif
Removed hardware.asc
Removed hardware.bin
Removed hardware.out
================================== [SUCCESS] Took 0.17 seconds␣
↪==============================
```

apio lint

Contents

Usage

```
apio lint [OPTIONS]
```

Description

Lint the **verilog** code. It is agnostic of the FPGA. It does not use the *pcf* file.

Required packages: `scons`, `verilator`.

Options

`-a, --all`

Enable all warnings, including code style warnings.

`-t, --top`

Set top module.

`--nostyle`

Disable all style warnings.

`--nowarn`

Disable specific warning(s).

`--warn`

Enable specific warning(s).

`-p, --project-dir`

Set the target directory for the project.

Examples

1. Lint the *leds example*

```
$ apio lint
verilator --lint-only -I/path/to/share leds.v
================================== [SUCCESS] Took 0.20 seconds␣
↪==============================
```

2. Lint the *leds example* with all the options

```
$ apio lint --all --top leds --nostyle --nowarn PINMISSING,WIDTH --warn DECLFILENAME,
↪DEFPARAM
verilator --lint-only -I/path/to/share -Wall -Wno-style -Wno-PINMISSING -Wno-WIDTH -
↪Wwarn-DECLFILENAME -Wwarn-DEFPARAM --top-module leds leds.v
================================== [SUCCESS] Took 0.20 seconds␣
↪==============================
```

apio sim

Contents

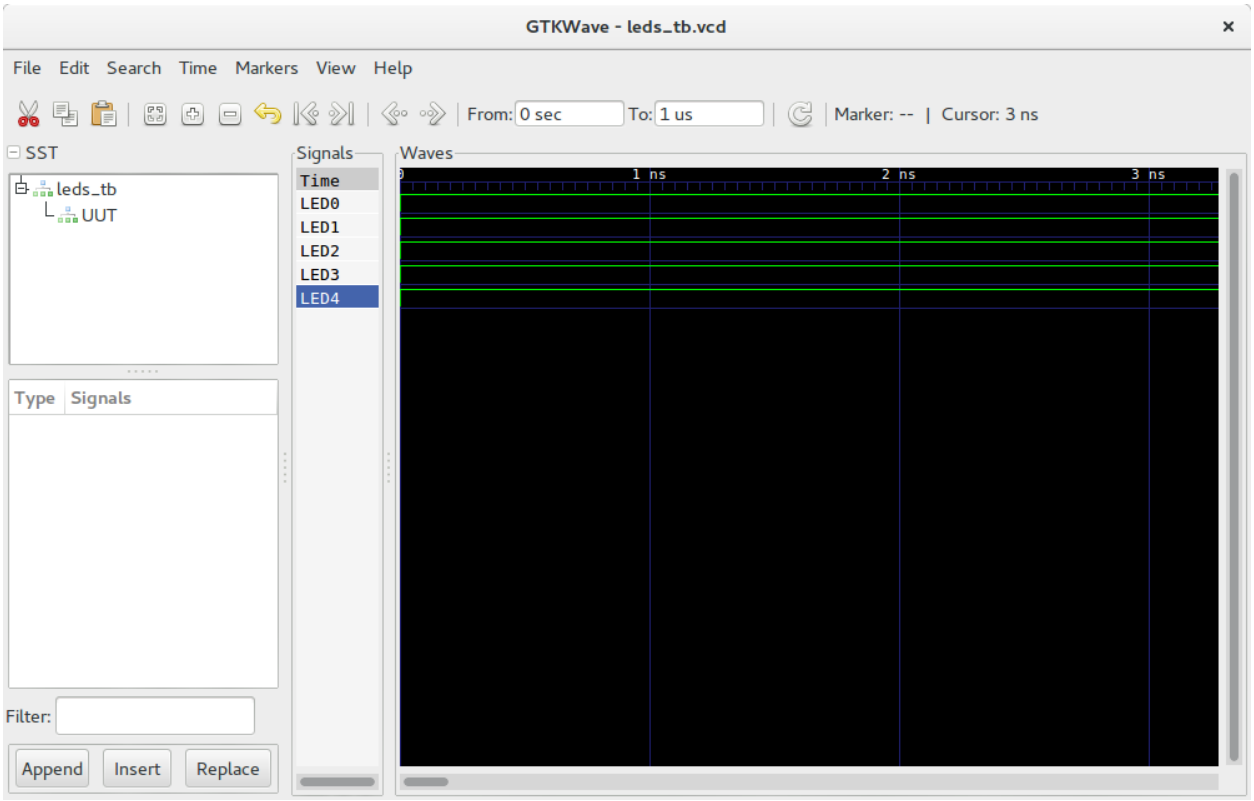
Usage

```
apio sim [OPTIONS]
```

Description

Launch the verilog simulation using GTKWave from a **verilog test bench**.

Required packages: `scons`, `iverilog`.



Note: GTKWave must be installed.

Debian	apt-get install gtkwave
Mac OSX	brew install gtkwave
Windows	apio install gtkwave

Options

`-p, --project-dir`

Set the target directory for the project.

Examples

1. Simulate the *leds example*

```
$ apio sim
iverilog -B /path/to/lib/ivl -o leds_tb.out -D VCD_OUTPUT=leds_tb /path/to/vlib/
↪system.v leds.v leds_tb.v
vvp -M /path/to/lib/ivl leds_tb.out
VCD info: dumpfile leds_tb.vcd opened for output.
End of simulation
gtkwave leds_tb.vcd leds_tb.gtkw

GTKWave Analyzer v3.3.66 (w)1999-2015 BSI

[0] start time.
[1000] end time.
WM Destroy
================================== [SUCCESS] Took 1.96 seconds␣
↪==============================
```

apio time

Contents

Usage

```
apio time [OPTIONS]
```

Description

Bitstream timing analysis: generates a **rpt** file with a topological timing analysis report, from a **verilog** and a **pcf** files.

Required packages: `scons`, `icestorm`.

Options

`-b, --board`

Select a specific board.

`--fpga`

Select a specific FPGA.

`--size` `--type --pack`

Select a specific FPGA size, type and pack.

`-p, --project-dir`

Set the target directory for the project.

`-v, --verbose`

Show the entire output of the command.

`--verbose-yosys`

Show the yosys output of the command.

`--verbose-arachne`

Show the arachne output of the command.

Note: All available boards, FPGAs, sizes, types and packs are showed in *apio boards*

Examples

1. Timing analysis for the *leds example*

```
$ apio time
[] Processing icezum
------------------------------------------------------------------------------------
 ↪-------
[...]
// Reading input .asc file..
// Reading 1k chipdb file..
// Creating timing netlist..
// Timing estimate: 0.24 ns (4161.98 MHz)
================================== [SUCCESS] Took 1.10 seconds␣
 ↪==============================

$ cat hardware.rpt

icetime topological timing analysis report
==========================================
```

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```
Warning: This timing analysis report is an estimate!
Info: max_span_hack is enabled: estimate is conservative.

Report for critical path:
-------------------------

        pre_io_13_11_0 (PRE_IO) [clk] -> PADOUT: 0.240 ns
     0.240 ns io_pad_13_11_0_din

Total number of logic levels: 0
Total path delay: 0.24 ns (4161.98 MHz)
```

apio upload

Contents

Usage

```
apio upload [OPTIONS]
```

Description

Upload the bitstream to the FPGA. It builds the project if required.

It also performs an automatic discovery and validation of the FTDI chip depending on the selected board.

Required packages: `scons`, `system`, `icestorm`.

Note: FTDI driver configuration must be done before upload. More information in *apio drivers*.

Options

`-b, --board`

Select a specific board.

`--serial-port`

Select a specific serial port. You can check the available serial devices with the command `apio system --lsserial`.

`--ftdi-id`

Select a specific FTDI index. You can check the available FTDI indexes with the command `apio system --lsftdi`. This numerical index is provided by **libftdi1**, that is different from *libftdi0*.

`-s, --sram`

Perform SRAM programming. Only available for *iceprog* compatible boards.

`-p, --project-dir`

Set the target directory for the project.

`-v, --verbose`

Show the entire output of the command.

`--verbose-yosys`

Show the yosys output of the command.

`--verbose-arachne`

Show the arachne output of the command.

Note: All available boards, FPGAs, sizes, types and packs are showed in *apio boards*

Examples

1. Upload the *leds example*

```
$ apio upload
[] Processing icezum
--------------------------------------------------------------------------------
↪-------
[...]
iceprog -d i:0x0403:0x6010:0 hardware.bin
init..
cdone: high
reset..
cdone: low
flash ID: 0x20 0xBA 0x16 0x10 0x00 0x00 0x23 0x51 0x85 0x32 0x13 0x00 0x54 0x00 0x29␣
↪0x10 0x06 0x15 0x51 0x62
file size: 32220
erase 64kB sector at 0x000000..
programming..
reading..
VERIFY OK
cdone: high
Bye.
================================= [SUCCESS] Took 1.96 seconds␣
↪==============================
```

apio verify

Contents

Usage

```
apio verify [OPTIONS]
```

Description

Verify the **verilog** code. It is agnostic of the FPGA. It does not use the *pcf* file.

Required packages: `scons`, `iverilog`.

Options

`-p, --project-dir`

Set the target directory for the project.

Examples

1. Verify the *leds example*

```
$ apio verify
iverilog -B /path/to/lib/ivl -o hardware.out -D VCD_OUTPUT= /path/to/vlib/system.v␣
↪leds.v
================================== [SUCCESS] Took 0.17 seconds␣
↪==============================
```

1.3.4 Setup Commands

apio drivers

Contents

Usage

```
apio drivers [OPTIONS]
```

Description

Enable/Disable the FTDI drivers.

- Linux: add the rules file. It may require a reboot or to uplug and reconnect the board.
- Mac OSX: configure FTDIUSBSerialDriver and AppleUSBFTDI keys and install libftdi.
- Windows: open zadig to replace the current driver by libusbK. It requires to uplug and reconnect the board.

This command requires the `driver` package (only for Windows).

Note: More information in *Install FTDI drivers*

Options

`--ftdi-enable`

Enable FPGA drivers.

`--ftdi-disable`

Disable FPGA drivers.

`--serial-enable`

Enable Serial drivers.

`--serial-disable`

Disable Serial drivers.

Examples

1. Enable the FTDI drivers on Linux

```
$ apio drivers --ftdi-enable
Configure FTDI drivers for FPGA
[sudo] password for user:
FTDI drivers enabled
Unplug and reconnect your board
```

2. Disable the FTDI drivers on Linux

```
$ apio drivers --ftdi-disable
Revert FTDI drivers configuration
[sudo] password for user:
FTDI drivers disabled
Unplug and reconnect your board
```

3. Enable the Serial drivers on Linux

```
$ apio drivers --serial-enable
Configure Serial drivers for FPGA
[sudo] password for user:
Serial drivers enabled
Unplug and reconnect your board
```

4. Disable the Serial drivers on Linux

```
$ apio drivers --serial-disable
Revert Serial drivers configuration
[sudo] password for user:
Serial drivers disabled
Unplug and reconnect your board
```

apio init

Contents

Usage

```
apio init [OPTIONS]
```

Description

Manage apio projects. In addition to the code, an apio project may include a configuration file **apio.ini** and a Scons script **SConstruct**.

Options

-s, --scons

Create a default SConstruct file. This file can be modified and it will be used instead of the default script.

-b, --board

Create a configuration file with the selected board. This will be the default board used in *apio build*, *apio time* and *apio upload* commands.

-p, --project-dir

Set the target directory for the project.

-y, --sayyes

Automatically answer YES to all the questions.

Examples

1. Create a SConstruct file.

```
$ apio init --scons
Creating SConstruct file ...
File 'SConstruct' has been successfully created!
```

2. Create an apio.ini file with the icezum board

```
$ apio init --board icezum
Creating apio.ini file ...
File 'apio.ini' has been successfully created!
```

apio install

Contents

Usage

```
apio install [OPTIONS]
```

Description

Install packages. Automatically installs the latest version of the package. Also other versions can be installed using the following notation: **pacakge@version**.

Available packages

Package	Installation	Description
drivers	apio install drivers	Drivers tools (only for Windows)
examples	apio install examples	Verilog basic examples, pinouts, etc
gtkwave	apio install gtkwave	Simulation viewer. GTKWave project (only for Windows)
icestorm	apio install icestorm	iCE40 FPGA synthesis, place & route and configuration tools. Icestorm project
iverilog	apio install iverilog	Verilog simulation and synthesis tool. Icarus Verilog project
scons	apio install scons	A software construction tool. Scons project
system	apio install system	Tools for listing the USB devices and retrieving information from the FTDI chips
verilator	apio install verilator	Verilog HDL simulator. Verilator project

Options

-a, --all

Install all packages.

-l, --list

List all available packages.

-f, --force

Force the packages installation.

-p, --platform
Set the platform [linux, linux_x86_64, linux_i686, linux_armv7l, linux_aarch64, windows, windows_amd64, windows_x86, darwin] (Advanced).

Examples

1. Install `system` and `icestorm` packages:

```
$ apio install system icestorm
Installing system package:
Download tools-system-linux_x86_64-1.1.0.tar.gz
Downloading  [####################################]  100%
Unpacking  [####################################]  100%
Package 'system' has been successfully installed!
Installing icestorm package:
Download toolchain-icestorm-linux_x86_64-1.11.0.tar.gz
Downloading  [####################################]  100%
Unpacking  [####################################]  100%
Package 'icestorm' has been successfully installed!
```

2. Install `examples` package version 0.0.11

```
$ apio install examples@0.0.11
Installing examples package:
Download apio-examples-0.0.11.zip
Downloading  [####################################]  100%
Unpacking  [####################################]  100%
Package 'examples' has been successfully installed!
```

3. Show all available packages

```
$ apio install --list

Installed packages:

--------------------------------------------------------------------------------
Name        Description                   Version
--------------------------------------------------------------------------------
examples    Verilog examples              0.0.11
icestorm    Icestorm toolchain            1.11.0
system      System tools                  1.1.0

Not installed packages:

--------------------------------------------------------------------------------
Name        Description
--------------------------------------------------------------------------------
iverilog    Icarus Verilog toolchain
scons       Scons tool
verilator   Verilator toolchain
```

4. Install and update all packages

```
$ apio install --all
Installing examples package:
Already installed. Version 0.0.11
Installing icestorm package:
Already installed. Version 1.11.0
Installing iverilog package:
Download toolchain-iverilog-linux_x86_64-1.2.0.tar.gz
Downloading  [####################################]  100%
Unpacking  [####################################]  100%
Package 'iverilog' has been successfully installed!
Installing scons package:
Download scons-3.0.1.tar.gz
Downloading  [####################################]  100%
Unpacking  [####################################]  100%
Package 'scons' has been successfully installed!
Installing system package:
Already installed. Version 1.1.0
Installing verilator package:
Download toolchain-verilator-linux_x86_64-1.0.0.tar.gz
Downloading  [####################################]  100%
Unpacking  [####################################]  100%
Package 'verilator' has been successfully installed!
```

5. Install the `drivers` package for **windows** in a linux platform

```
$ apio install drivers --platform windows
Installing drivers package:
Download tools-drivers-windows-1.1.0.tar.gz
Downloading  [####################################]  100%
Unpacking  [####################################]  100%
Package 'drivers' has been successfully installed!
```

apio uninstall

Contents

Usage

```
apio uninstall [OPTIONS]
```

Description

Uninstall packages. Before uninstalling a package, a confirmation is requested.

Available packages

Package	Installation	Description
drivers	apio install drivers	Drivers tools (only for Windows)
examples	apio install examples	Verilog basic examples, pinouts, etc
gtkwave	apio install gtkwave	Simulation viewer. GTKWave project (only for Windows)
icestorm	apio install icestorm	iCE40 FPGA synthesis, place & route and configuration tools. Icestorm project
iverilog	apio install iverilog	Verilog simulation and synthesis tool. Icarus Verilog project
scons	apio install scons	A software construction tool. Scons project
system	apio install system	Tools for listing the USB devices and retrieving information from the FTDI chips
verilator	apio install verilator	Verilog HDL simulator. Verilator project

Options

-a, --all

Uninstall all packages.

-l, --list

List all installed packages.

-p, --platform
Set the platform [linux_x86_64, linux_i686, linux_armv7l, linux_aarch64, windows, darwin] (Advanced).

Examples

1. Uninstall `examples` package

```
$ apio uninstall examples
Do you want to continue? [y/N]: y
Uninstalling examples package:
Package 'examples' has been successfully uninstalled!
```

2. Uninstall the `drivers` package for **windows** in a linux platform

```
$ apio uninstall drivers --platform windows
Do you want to continue? [y/N]: y
Uninstalling drivers package:
Package 'drivers' has been successfully uninstalled!
```

1.3.5 Utility Commands

apio boards

Contents

Usage

```
apio boards [OPTIONS]
```

Description

Show FPGA boards information.

All supported boards:

HX1K

- IceZUM Alhambra
- Nandland Go board
- iCEstick Evaluation Kit

HX8K

- Alhambra II

- BlackIce
- BlackIce II
- CAT board
- icoBOARD 1.0
- Kéfir I
- iCE40-HX8K Breakout Board

LP8K

- TinyFPGA B2
- TinyFPGA BX

UP5K

- UPDuino v1.0
- UPDuino v2.0
- iCEBreaker
- iCEBreaker bitsy
- FPGA 101 Workshop Badge Board
- iCE40 UltraPlus Breakout Board

Note: All supported FPGAs are shown in Project IceStorm web page

Options

`-l, --list`

List all supported boards.

`-f, --fpga`

List all supported FPGAs.

Examples

1. Show all available boards

```
$ apio boards --list

Supported boards:

-------------------------------------------------------
Board            FPGA                 Type  Size  Pack
-------------------------------------------------------
Cat-board        iCE40-HX8K-CT256     hx    8k    ct256
TinyFPGA-B2      iCE40-LP8K-CM81      lp    8k    cm81
TinyFPGA-BX      iCE40-LP8K-CM81      lp    8k    cm81
alhambra-ii      iCE40-HX4K-TQ144     hx    8k    tq144:4k
blackice         iCE40-HX4K-TQ144     hx    8k    tq144:4k
```

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```
blackice-ii       iCE40-HX4K-TQ144     hx    8k    tq144:4k
fpga101           iCE40-UP5K-SG48      up    5k    sg48
go-board          iCE40-HX1K-VQ100     hx    1k    vq100
iCE40-HX8K        iCE40-HX8K-CT256     hx    8k    ct256
iCE40-UP5K        iCE40-UP5K-SG48      up    5k    sg48
iCEBreaker        iCE40-UP5K-SG48      up    5k    sg48
iCEBreaker-bitsy  iCE40-UP5K-SG48      up    5k    sg48
iceblink40-hx1k   iCE40-HX1K-VQ100     hx    1k    vq100
icestick          iCE40-HX1K-TQ144     hx    1k    tq144
icezum            iCE40-HX1K-TQ144     hx    1k    tq144
icoboard          iCE40-HX8K-CT256     hx    8k    ct256
kefir             iCE40-HX4K-TQ144     hx    8k    tq144:4k
upduino           iCE40-UP5K-SG48      up    5k    sg48
upduino2          iCE40-UP5K-SG48      up    5k    sg48
```

2. Show all available FPGAs

```
$ apio boards --fpga

Supported FPGAs:

-------------------------------------------
FPGA                   Type  Size  Pack
-------------------------------------------
iCE40-HX1K-CB132       hx    1k    cb132
iCE40-HX1K-TQ144       hx    1k    tq144
iCE40-HX1K-VQ100       hx    1k    vq100
iCE40-HX4K-BG121       hx    8k    bg121:4k
iCE40-HX4K-CB132       hx    8k    cb132:4k
iCE40-HX4K-TQ144       hx    8k    tq144:4k
iCE40-HX8K-BG121       hx    8k    bg121
iCE40-HX8K-CB132       hx    8k    cb132
iCE40-HX8K-CM225       hx    8k    cm225
iCE40-HX8K-CT256       hx    8k    ct256
iCE40-LP1K-CB121       lp    1k    cb121
iCE40-LP1K-CB81        lp    1k    cb81
iCE40-LP1K-CM121       lp    1k    cm121
iCE40-LP1K-CM36        lp    1k    cm36
iCE40-LP1K-CM49        lp    1k    cm49
iCE40-LP1K-CM81        lp    1k    cm81
iCE40-LP1K-QN84        lp    1k    qn84
iCE40-LP1K-SWG16TR     lp    1k    swg16tr
iCE40-LP384-CM36       lp    384   cm36
iCE40-LP384-CM49       lp    384   cm49
iCE40-LP384-QN32       lp    384   qn32
iCE40-LP4K-CM121       lp    8k    cm121:4k
iCE40-LP4K-CM225       lp    8k    cm225:4k
iCE40-LP4K-CM81        lp    8k    cm81:4k
iCE40-LP8K-CM121       lp    8k    cm121
iCE40-LP8K-CM225       lp    8k    cm225
iCE40-LP8K-CM81        lp    8k    cm81
iCE40-UP3K-UWG30       up    5k    uwg30
iCE40-UP5K-SG48        up    5k    sg48
iCE40-UP5K-UWG30       up    5k    uwg30
```

apio config

Contents

Usage

```
apio config [OPTIONS]
```

Description

Apio configuration commands.

Options

`-l, --list`

List all configuration parameters.

`-v, --verbose` `[0|1]`

Verbose mode: *0* General, *1* Information.

`-e, --exe` `[default|native]`

Configure executables: *default* selects apio packages, *native* selects native binaries (except system package).

Note: In **debian** systems, if /etc/apio.json defines a new APIO_PKG_DIR, this new path will be used to load the packages.

Mode	default		native
/ect/apio.json	No	Yes	
Load installed packages	Yes	Yes *	No
Check installed packages	Yes	Yes **	No

* load APIO_PKG_DIR from /etc/apio.json

** Suggest message *apt-get install apio-[pkg]*

Examples

1. Show all configuration parameters

```
$ apio config --list
Executable mode: default
Verbose mode: 0
```

2. Enable native mode for executable binaries

```
$ apio config --exe native
Executable mode updated: native
```

3. Enable verbose mode 1

```
$ apio config --verbose 1
Verbose mode updated: 1
```

apio examples

Contents

Usage

```
apio examples [OPTIONS]
```

Description

Manage verilog examples: https://github.com/FPGAwars/apio-examples

This command requires the `examples` package.

Options

`-l, --list`

List all available examples.

`-d, --dir`

Copy the selected example directory.

-f, --files

Copy the selected example files.

-p, --project-dir

Set the target directory for the examples.

-n, --sayno

Automatically answer NO to all the questions.

Examples

1. Show all available examples

```
$ apio examples --list
[ ... ]

leds
-------------------------------------------------------------------------------
↪-------
Verilog example for Turning all the leds on (for the icestick/icezum boards)

wire
-------------------------------------------------------------------------------
↪-------
Verilog example on how to describe a simple wire

[ ...]
```

2. Copy the *leds example* files

```
$ apio examples --files leds
Copying leds example files ...
Example files 'leds' have been successfully created!

$ ls
leds.pcf  leds_tb.gtkw  leds_tb.v  leds.v
```

3. Copy the *leds example* directory

```
$ apio examples --dir leds
Creating leds directory ...
Example 'leds' has been successfully created!

$ tree leds
leds
├── info
├── leds.pcf
├── leds_tb.gtkw
├── leds_tb.v
└── leds.v
```

apio raw

Contents

Usage

```
apio raw '[CMD]'
apio raw "[CMD]"
```

Description

Execute commands using Apio packages.

Argument

cmd

Command to be executed using installed Apio packages.

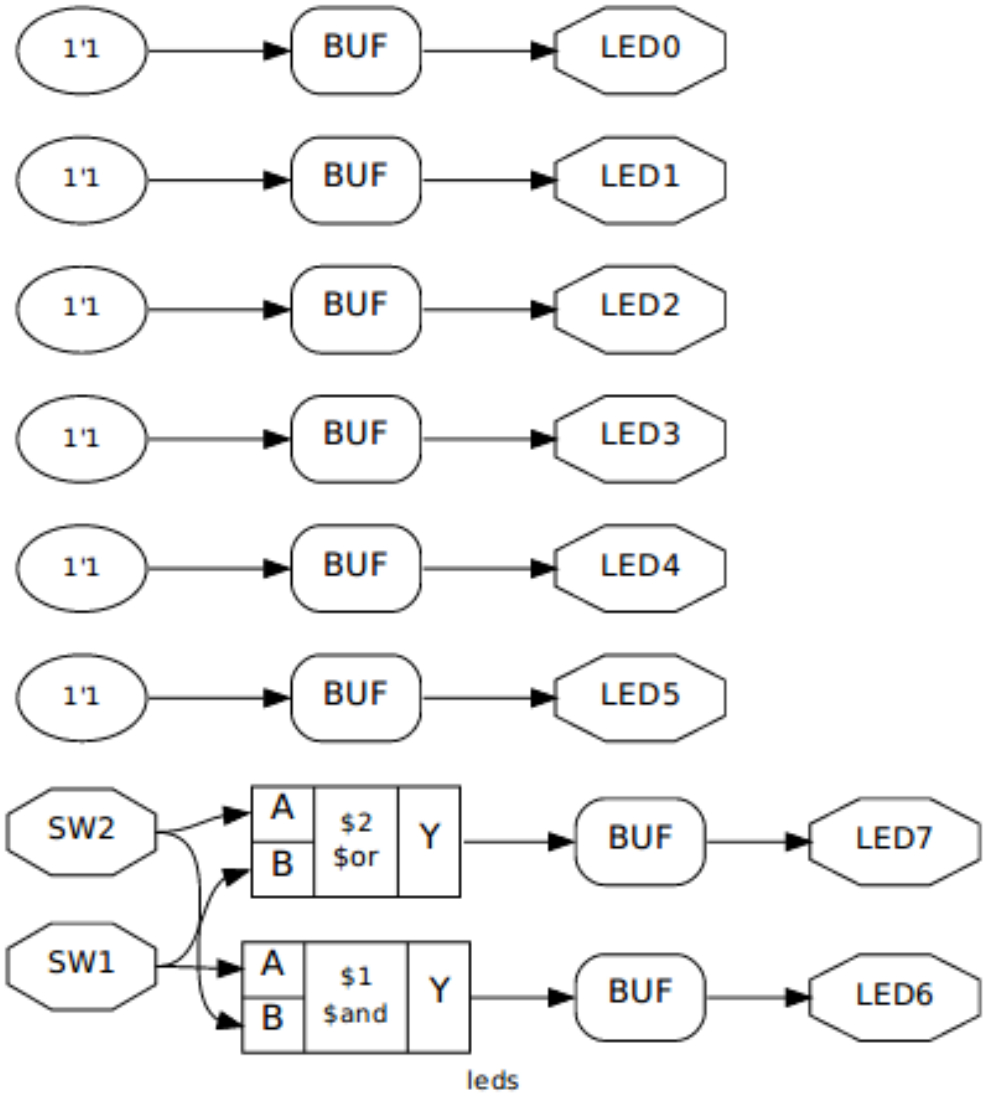
Examples

1. Run yosys (package installed with Apio)

```
$ apio raw 'yosys'
```

2. Generate a verilog diagram with yosys

```
$ apio raw 'yosys -p "read_verilog leds.v; show" -q'
```



apio system

Contents

Usage

```
apio system [OPTIONS]
```

Description

System tools: https://github.com/FPGAwars/tools-system

This command requires the `system` package.

Options

`--lsftdi`

List all connected FTDI devices.

`--lsusb`

List all connected USB devices.

`--lsserial`

List all connected Serial devices.

`-i, --info`

Show system information.

Examples

1. List connected FTDI devices

```
$ apio system --lsftdi
Number of FTDI devices found: 1
Checking device: 0
Manufacturer: Mareldem, Description: IceZUM Alhambra v1.1 - B01-020
```

2. List connected USB devices

```
$ apio system --lsusb
1d6b:0003 (bus 3, device 1)
04ca:7049 (bus 2, device 4) path: 8
8087:0a2a (bus 2, device 3) path: 7
138a:0017 (bus 2, device 2) path: 6
0403:6010 (bus 2, device 69) path: 2
1d6b:0002 (bus 2, device 1)
8087:8001 (bus 1, device 2) path: 1
1d6b:0002 (bus 1, device 1)
```

3. List connected Serial devices

```
$ apio system --lsserial
Number of Serial devices found: 2

/dev/ttyUSB1
```

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```
Description: IceZUM Alhambra v1.1 - B01-020
Hardware info: USB VID:PID=0403:6010 LOCATION=2-2:1.1

/dev/ttyUSB0
Description: IceZUM Alhambra v1.1 - B01-020
Hardware info: USB VID:PID=0403:6010 LOCATION=2-2:1.0
```

4. Show system information

```
$ apio system --info
Platform: linux_x86_64
```

apio upgrade

Contents

Usage

```
apio upgrade [OPTIONS]
```

Description

Check latest Apio version in https://pypi.python.org/pypi/apio.

Examples

1. Check the Apio version

```
$ apio upgrade
You're up-to-date!
Apio 0.4.0 is currently the newest version available.
```

1.4 Contribute

1.4.1 Support a new board

In order to support a new board based on FPGA Lattice iCE40 family, follow these steps:

1. **Find your FPGA name** in fpgas.json. This file contains all FPGAs supported by the Icestorm project.

```
"iCE40-HX1K-TQ144": {
  "type": "hx",
  "size": "1k",
  "pack": "tq144"
}
```

```
"iCE40-HX8K-CT256": {
  "type": "hx",
  "size": "8k",
  "pack": "ct256"
}
```

```
"iCE40-LP8K-CM81": {
  "type": "lp",
  "size": "8k",
  "pack": "cm81"
}
```

2. **Find or add your programmer** in programmers.json.

```
"iceprog": {
  "command": "iceprog",
  "args": "-d i:0x${VID}:0x${PID}:${FTDI_ID}"
}
```

```
"icoprog": {
  "command": "export WIRINGPI_GPIOMEM=1; icoprog",
  "args": "-p <"
}
```

```
"tinyprog": {
  "command": "tinyprog",
  "args": "--pyserial -c ${SERIAL_PORT} --program",
  "pip_packages": [ "tinyprog" ]
}
```

NOTE: if your programmer uses a python package, add this package and its version range to distribution.json.

```
"pip_packages": {
  "blackiceprog": ">=2.0.0,<3.0.0",
  "litterbox": ">=0.2.1,<0.3.0",
  "tinyfpgab": ">=1.1.0,<1.2.0",
  "tinyprog": ">=1.0.21,<1.1.0"
}
```

3. **Add your board** to boards.json with the following format:

```
"icezum": {
  "name": "IceZUM Alhambra",
  "fpga": "iCE40-HX1K-TQ144",
  "programmer": {
    "type": "iceprog"
  },
  "usb": {
    "vid": "0403",
```

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```
    "pid": "6010"
  },
  "ftdi": {
    "desc": "IceZUM Alhambra.*"
  }
}
```

```
"icoboard": {
  "name": "icoBOARD 1.0",
  "fpga": "iCE40-HX8K-CT256",
  "programmer": {
    "type": "icoprog"
  },
  "platform": "linux_armv7l"
}
```

```
"TinyFPGA-BX": {
  "name": "TinyFPGA BX",
  "fpga": "iCE40-LP8K-CM81",
  "programmer": {
    "type": "tinyprog"
  },
  "usb": {
    "vid": "1d50",
    "pid": "6130"
  },
  "tinyprog": {
    "desc": "TinyFPGA BX"
  }
}
```

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