Verum-Dezyne Manual

Component based, formally verified.

The Dezyne developers

Edition 2.18.3
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1 Introduction

While the component-based approach of Dezyne (see *Dezyne Reference Manual*) helps to create an understandable, modular system architecture, working on a software system is not always easy. When the problem at hand gets more difficult, then all help, e.g., help from tooling, is welcome.

Working with the Dezyne Language, we think, is best done using the Verum-Dezyne IDE.

Verum-Dezyne provides two graphical views: a structural overview (see Section 5.1 [System View], page 18) that helps navigating the system architecture, and a dynamic view (see Section 5.2 [Trace View], page 19) that helps understanding your system's behavior.

The Verum-Dezyne IDE consists of these elements:

- A Dezyne Language-Aware editor,
- An HTML renderer,
- A shell to run:
- The `dzn` command-line tools,
- And a (preferrably) user-customizable integration between all these.

2 Installation

In order to install Verum-Dezyne on your system, you can use a binary installation that we prepared especially for you.

> **Note:** The Verum-Dezyne IDE is a *commercial* product by verum.com (`https://verum.com`). You should make sure to contact (or having contacted) Verum for a license.

2.1 Binary Installation

> **Note:** The Verum-Dezyne IDE is a *commercial* product by verum.com (`https://verum.com`). You should make sure to contact (or having contacted) Verum for a license.

This section describes how to install Verum-Dezyne on an arbitrary system from a self-contained tarball providing binaries for Verum-Dezyne and for all its dependencies. This is often quicker than installing from source, which is described in the next sections. The only requirement is to have GNU tar and gzip, or 7zip for the Microsoft Windows inclined.

2.1.1 Generic GNU/Linux Binary

Installing goes along these lines:

1. Download the binary tarball from `https://download.verum.com/download/verum-dezyne/verum-dezyne-2.18.3-x86_64-linux.tar.gz`, e.g.:

   ```
   $ wget https://download.verum.com/download/verum-dezyne/\
   verum-dezyne-2.18.3-x86_64-linux.tar.gz
   ```

   Make sure to download the associated `.sig` file and to verify the authenticity of the tarball against it, do something like:

   ```
   $ wget https://download.verum.com/download/verum-dezyne/\
   verum-dezyne-2.18.3-x86_64-linux.tar.gz.sig
   $ gpg --verify verum-dezyne-2.18.3-x86_64-linux.tar.gz.sig
   ```

   If that command fails because you do not have the required public key, then run this command to import it:

   ```
   $ wget https://savannah.gnu.org/people/viewgpg.php?user_id=4348 \
         -qO - | gpg --import -
   ```

   and rerun the `gpg --verify` command.

   Take note that a warning like "This key is not certified with a trusted signature!" is normal.

   Now, you can unpack the tarball; do something like:

   ```
   $ tar --warning=no-timestamp -xf /path/to/\
   verum-dezyne-2.18.3-x86_64-linux.tar.gz
   ```

   Then try:

   ```
   $ cd dezyne-2.18.3
   $ ./ide --help
   $ ./dzn --help
   ```

2. Make the `dzn` command available from other locations or to other users on the machine, for instance with:

```
$ ln -s $PWD/dzn ~/bin/dzn
$ ln -s $PWD/ide ~/bin/ide
or
# ln -s $PWD/dzn /usr/local/bin/dzn
# ln -s $PWD/ide /usr/local/bin/ide
```

3. And optionally, make the `dzn-env` prefix-command[1] available:

```
$ ln -s $PWD/dzn-env ~/bin/dzn-env
or
# ln -s $PWD/dzn-env /usr/local/bin/dzn-env
```

4. Test your installation

```
$ ide hello
$ dzn-env info dezyne
```

and get busy Dezyne'ing, see Chapter 3 [Getting Started], page 4!

2.1.2 Generic Microsoft Windows Binary

Installing goes along these lines:

1. Download the binary zip archive from `https://download.verum.com/download/verum-dezyne/verum-dezyne-2.18.3-x86_64-windows.zip`,

after which you can extract the archive by using 7zip `https://www.7-zip.org`. Please do not use the built-in Windows archive extraction tool: It does not honor the time stamps of the files in the archive and thus produces a faulty installation.

If your system comes with a virus scanner, consider creating an exception for dezyne-2.18.3.

. . .

and get busy Dezyne'ing, see Chapter 3 [Getting Started], page 4!

[1] `dzn-env` can be used as a prefix for using programs from your operating system, such as `info`, `man`, or `emacs`; so that they may find and use the documentation and extensions that are provided in the binary release.

3 Getting Started

The dezyne core functionality delivers tool support for the dezyne language in parsing, verification and code generation. Results are delivered in text format only.

In order to gain more insight graphical feedback is delivered in the following cases:

- System view: a visual representation of the system composition of dezyne components.
- State view: a state diagram of component, system or interface.
- Sequence view: a message sequence chart showing the result of a simulation or verification trace. The sequence view is interactive, and allows the displayed trace to be extended and shortened.

All views are initiated by the user from the command-line, and are presented in a web page.

3.1 Set-up

In order to use the web views a dedicated `ide daemon`(see Section 4.2.2 [Invoking ide daemon], page 9) needs to be running. This daemon mediates between the command line and the web pages, and also stores the traces that are presented and modified in the sequence view.

The `ide daemon` is started by running `ide hello` (see Section 4.2.5 [Invoking ide hello], page 11) and stopped with `ide bye` (see Section 4.2.4 [Invoking ide bye], page 11).

Once the daemon is running, views can be initiated.

3.2 System View

The system view is started from the command-line with the `ide system` (see Section 4.2.10 [Invoking ide system], page 15) command:

```
ide system examples/Camera.dzn
```

If all is well, a browser will be presented showing the system view for the Camera system. A browser can also be started by running `ide browse` (see Section 4.2.3 [Invoking ide browse], page 10):

```
ide browse
```

It can also be viewed in a regular web browser that supports running non-free javascript by visiting `http://localhost:3000/system`.

3.3 State View

The state view is started from the command-line with the `ide state` (see Section 4.2.9 [Invoking ide state], page 13) command:

```
ide state examples/Camera.dzn
```

If all is well, a browser will be presented showing the state view for the Camera system. A browser can also be started by running `ide browse` (see Section 4.2.3 [Invoking ide browse], page 10):

```
ide browse state
```

It can also be viewed in a regular web browser that supports running non-free javascript by visiting `http://localhost:3000/state`.

3.4 Sequence view

The sequence view can be initiated from the command-line uing the `dzn simulate`(see Section 4.2.8 [Invoking ide simulate], page 12) command:

```
ide simulate -m Driver examples/Camera.dzn
```

If all is well, a browser will be presented showing an empty trace view for the Driver component. A browser can also be started by running `ide browse trace` (see Section 4.2.3 [Invoking ide browse], page 10):

```
ide browse trace
```

It can also be viewed by visiting `http://localhost:3000/trace`.

Optional input for the sequence view is a trace, which (among others) can be the result of a verification error. The `ide verify` (see Section 4.2.11 [Invoking ide verify], page 16) command supports this scenario. As first step verification is done. In case an error is found, the error trace is used as input for simulation, and presented in the web views:

```
ide verify examples/compliance_provides_bool.dzn
```

results in:

```
verify: ibool: check: deadlock: ok
verify: ibool: check: livelock: ok
verify: compliance_provides_bool: check: deterministic: ok
verify: compliance_provides_bool: check: illegal: ok
verify: compliance_provides_bool: check: deadlock: ok
verify: compliance_provides_bool: check: livelock: ok
verify: compliance_provides_bool: check: compliance: fail
verification error
```

4 Using Verum-Dezyne

While the letter I in IDE stands for *integrated*, the level and type of integration that makes a person productive is a matter of taste, habit and experience.

The Verum-Dezyne IDE offers these levels towards integration (or if you like, desintegration):

`Full` Integrated: Editor, Browser, Console, Window Management, Interpreter

An example is GNU Emacs with `exwm`

`External Browser, External Window Mangement`
Integrated: Editor, Console, Interpreter

Examples are `Electron`-derivatives, `emacs`, `vim`

`External, Console, Browser, Window Management and Interpreter`
Integrated: -

Examples are `nano`, `vi`.

4.1 Example IDEs

Dezyne Language-Awareness is provided through the `ide`. Currently, it provides the following

`Syntax coloring`
`Navigation`
Go to definition, Show usage

`Symbol completion`
`Lookup Documentation`

4.1.1 An Electron-based Verum-Dezyne IDE

There are several Electron (`https://github.com/Electron`)-based programmer's editors: Atom, VSCodium and Microsoft Visual Studio Code.

`ide lsp` provides Language-Awareness to the editor through the Language Server Protocol (LSP)(`https://langserver.org/`).

We provide a new VSCodium/Visual Studio Code extension `dzn-lsp` that adds rudimentary syntax highlighting, language recogniziton for `*.dzn` files and LSP -apabilities for this Dezyne mode in VSCode `dzn-lsp`. `dzn-lps` can be downloaded here `https://download.verum.com/download/verum-dezyne/dzn-lsp-1.2.2.vsix`.

In the extension settings for `dzn-lsp` you can configure where the `ide` is located e.g., `C:/dezyne-2.18.3` or `/home/user/bin/dezyne-2.18.3`; see field `Dzn>Ide:Path`. If this is not specified, the PATH environment variable of your system is used.

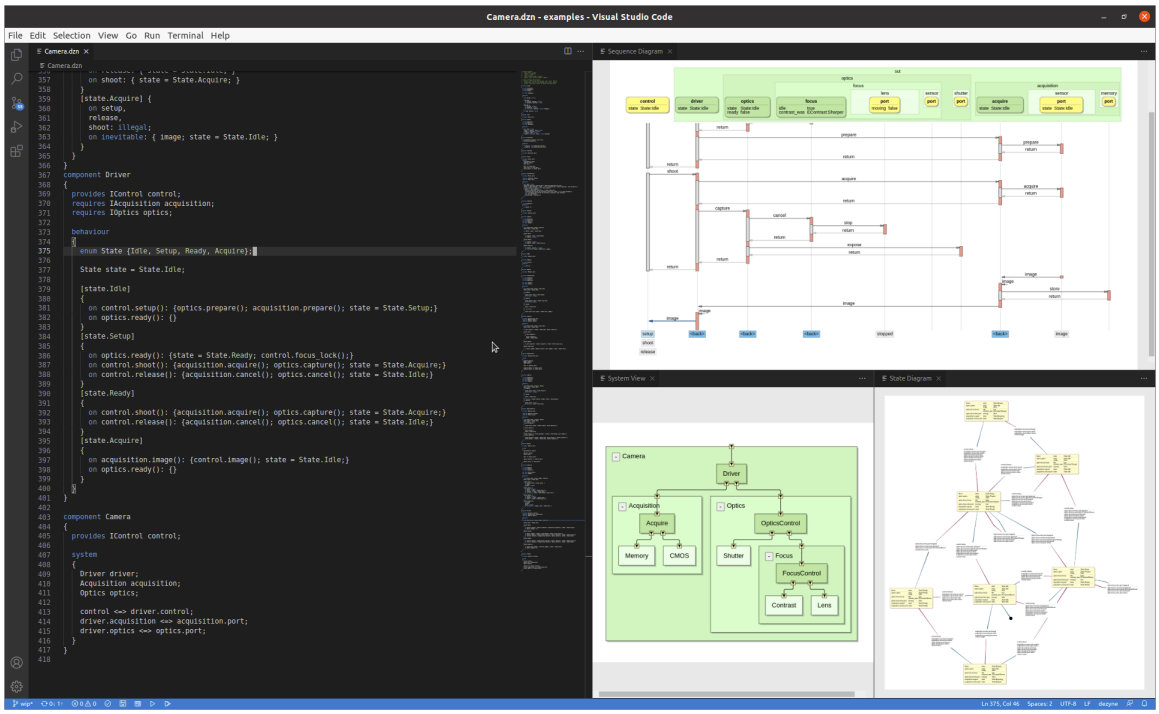
Furthermore, all commands for stopping an already running dzn daemon, starting a dzn daemon, starting the Dezyne LSP server, and preforming a verification can be configured. If your project needs include directories in order to resolve any imports, you can append `-I dir...` to the command for starting the LSP server such that the LSP server can resolve import locations.

The extension `dzn-lsp` also provides the `goto-click` functionality: when the user clicks on an element in one of the webviews, the editor jumps to the location in the code relating to that element. If needed, a new editor tab is opened for showing the corresponding file.

The extension `dzn-lsp` also starts the dzn daemon. The commmand for starting the daemon is executed in a dedicated terminal with the name `dzn-daemon`. By selecting that terminal you can see the output of the running dzn daemon.

The extension also offers a `verify` command. When the active editor contains a dzn file, the `verify` command can be executed by opening the `Command Palette: View -> Command Palette...` or `Ctrl+Shift+P` and typing `verify` and then selecting `"Dzn: Verify"`. Inside a dedicated terminal with the name `dzn-verify`, the verification command is executed for verifying the dzn file of the active editor.

The auto starting of the daemon and the goto-click functionality can be disabled using the correspondings settings of the extension.



4.1.2 A GNU Emacs-based Verum-Dezyne IDE

Emacs can be used in Full mode or External Browser mode, and with or without LSP.

- Use `dzn-env` to start Emacs

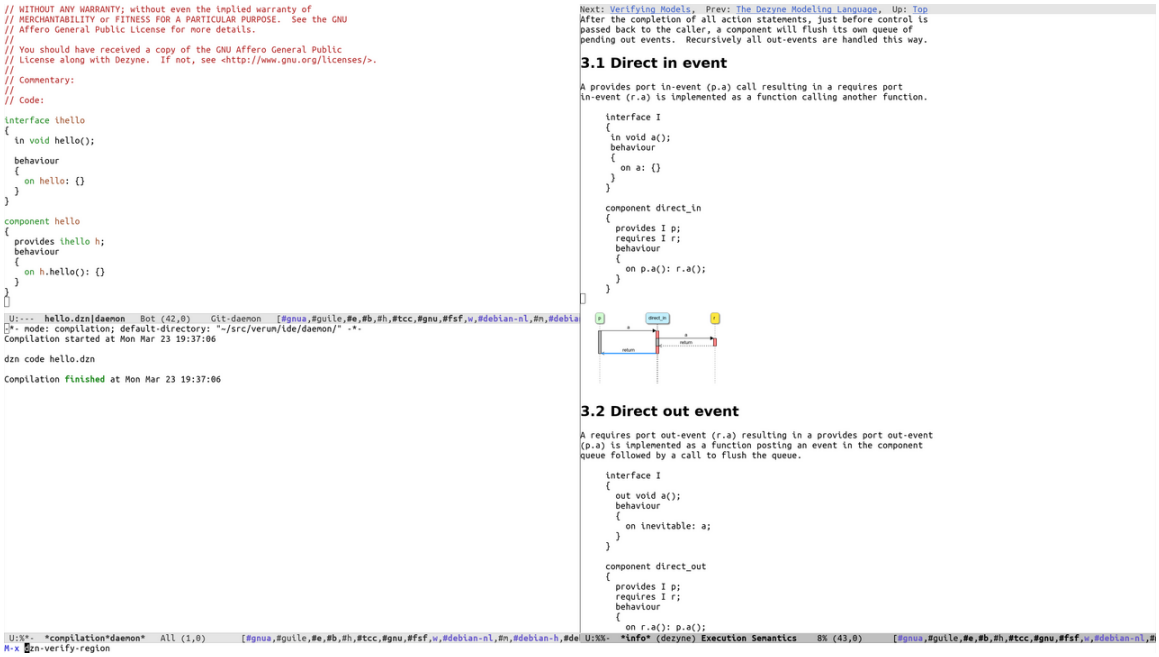
  ```
  ./dzn-env emacs
  ```

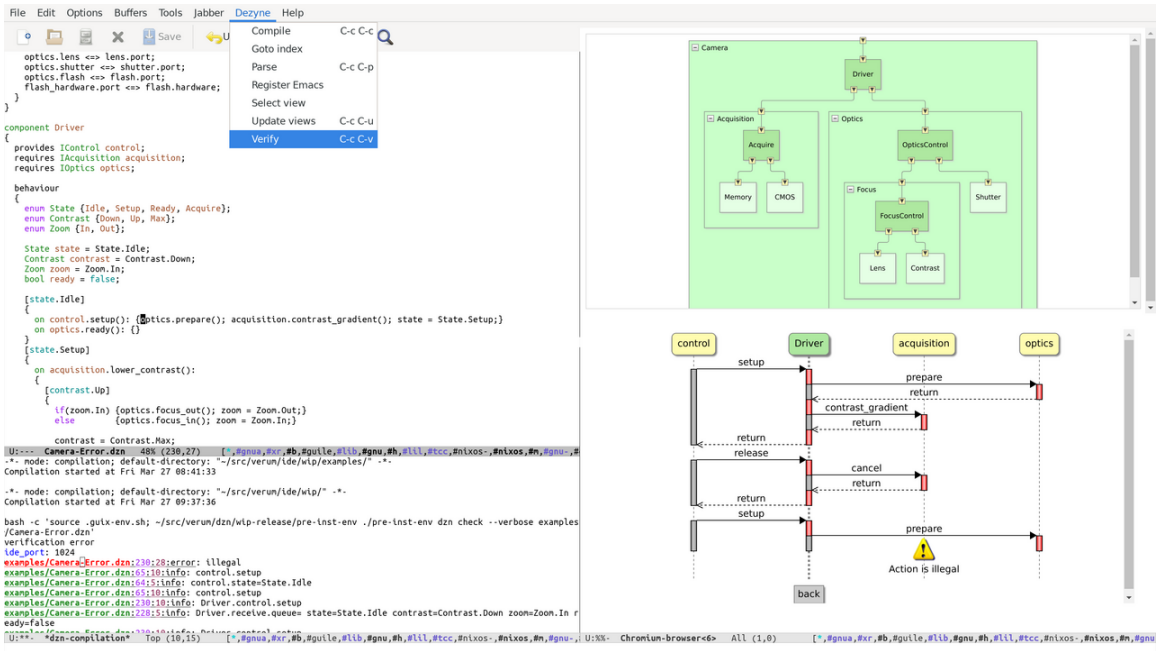
- Install the websocket package, select: Options/Manage Emacs Packages, or use M-x list-packages
- Optionally, install the lsp-mode package, select: Options/Manage Emacs Packages, or use M-x list-packages
- Add to your ~/.config/emacs/init.el:

  ```
  (when (require 'dzn-mode nil t)
  ```

```
(push '("\\.dzn\\'" . dzn-mode) auto-mode-alist))
```

- Evaluate `~/.config/emacs/init.el` or restart Emacs





4.2 Verum-Dezyne View Commands

The View experience of Verum-Dezyne is achieved through a the `dzn daemon` and three sub-commands `ide verify`, `ide system`, and `dzn simulate`.

Usually, your Dezyze IDE takes care of running these commands; so if you are planning on using an IDE you can safely skip this section.

4.2.1 Invoking `ide`

The Verum-Dezyne IDE extends the set of `dzn` core command-line with graphical `ide` view commands.

`ide` *`ide-option...`* [*`command`*]

The *option*s can be among the following:

`--debug`
`-d` Enable debug ouput. Careful, this can produce a lot of text!

`--help`
`-h` Display help on invoking `ide daemon`, and then exit.

`--skip-wfc`
`-p` Use plain *peg* parser, skip Well-formedness (See Section "Well-formedness" in *Well-formedness*) checking.

`--verbose`
`-v` Be more verbose, show progress.

`--version`
`-V` Display the current version of `ide`, and then exit.

Running `ide` without *command* shows a list of available ide commands:

```
Usage: ide [OPTION]... COMMAND [COMMAND-ARGUMENT...]
  -d, --debug            enable debug ouput
  -h, --help             display this help
  -p, --skip-wfc         use plain PEG, skip well-formedness checking
  -v, --verbose          be more verbose, show progress
  -V, --version          display version

Commands:
  browse
  bye
  daemon
  hello
  info
  lsp
  simulate
  state
  system
  verify

Use "ide COMMAND --help" for command-specific information.
```

4.2.2 Invoking `ide daemon`

All Dezyne View commands communicate with the Views and Editor through the `ide daemon`. The daemon is started automagically when issuing any `ide`-command, e.g. `ide`

`hello` (see Section 4.2.5 [Invoking ide hello], page 11), and it is stopped by running `ide bye` (see Section 4.2.4 [Invoking ide bye], page 11).

When started automagically, the daemon writes its log file to `$XDG_CACHE_HOME/dzn/daemon.log`. If the `XDG_CACHE_HOME` environment variable is not defined, `$HOME/.cache/dzn/daemon.log` is used instead.

```
ide ide-option... daemon option... FILE
```

The *option*s can be among the following:

`--debug`
`-d` Enable debug ouput. Careful, this can produce a lot of text!

`--editor-port=`*EDITOR-PORT*
`-i` *EDITOR-PORT*
Listen to editor port *EDITOR-PORT*, the default is `3003`.

`--help`
`-h` Display help on invoking `ide daemon`, and then exit.

`--http-port=`*HTTP-PORT*
`-b` *HTTP-PORT*
Start web serever on http port *HTTP-PORT*, the default is `3000`.

`--ide-port=`*IDE-PORT*
`-i` *IDE-PORT*
Listen to ide command port *IDE-PORT*, the default is `3001`.

`--view-port=`*VIEW-PORT*
`-b` *VIEW-PORT*
Listen to browser view port *VIEW-PORT*, the default is `3002`.

`--verbose`
`-v` Be more verbose, show progress.

When overriding a port setting, the daemo saves this configuration to `$XDG_CONFIG_HOME/dzn/daemon.scm`. If the `XDG_CONFIG_HOME` environment variable is not defined, `$HOME/.config/dzn/daemon.scm` is used instead.

4.2.3 Invoking `ide browse`

The `ide browse` command opens a graphical browser view.

```
ide ide-option... browse option... view
```

The `view`s must be the name of a view: `system` (the default) `state`, `trace` or an *URL*.

Running

```
ide browse trace
```

opens the trace view.

The *option*s can be among the following:

`--help`
`-h` Display help on invoking `ide browse`, and then exit.

`--import=`*dir*
`-I` *dir* Add directory *dir* to import path.

4.2.4 Invoking `ide bye`

The `ide bye` command runs the `dzn bye` command. It marks the end of a dezyne session and kills the Verum-Dezyne daemon. The start of a dezyne session can be marked with `ide hello` (see Section 4.2.5 [Invoking ide hello], page 11).

```
ide ide-option... bye option...
```

The *option*s can be among the following:

`--force`
`-f` Kill the daemon without connecting or sending `dzn bye`.

`--help`
`-h` Display help on invoking `ide bye`, and then exit.

4.2.5 Invoking `ide hello`

The `ide hello` command runs the `dzn hello` command. It marks the start of a dezyne session and starts the Verum-Dezyne daemon. The end of a dezyne session can be marked with `ide bye` (see Section 4.2.4 [Invoking ide bye], page 11).

```
ide ide-option... hello option...
```

The *option*s can be among the following:

`--force`
`-f` Assume the `daemon.pid` file is stale and forcibly start the daemon, writing a fresh `daemon.pid` file.

`--help`
`-h` Display help on invoking `ide hello`, and then exit.

`--verbose`
`-v` Show the editors and browsers connections with the daemon.

4.2.6 Invoking `ide info`

The `ide info` command is used to query the state of the daemon (see Section 4.2.2 [Invoking ide daemon], page 9).

```
ide ide-option... info option...
```

The *option*s can be among the following:

`--help`
`-h` Display help on invoking `ide info`, and then exit.

`--trail`
`-t` Show the current trail on standard output. This is the default.

`--verbose`
`-v` Show the editors and browsers connections with the daemon.

4.2.7 Invoking `ide lsp`

The `ide lsp` command runs a Dezyne Language Server Protocol (LSP) server reading and writing *json*-rpc over stdio.

```
ide ide-option... lsp option...
```

Running

```
ide lsp
```

starts the Dezyne Language Protocol Server.

`--help`
`-h` Display help on invoking `ide lsp`, and then exit.

`--import=`*`dir`*
`-I` *`dir`* Add directory *dir* to import path.

4.2.8 Invoking `ide simulate`

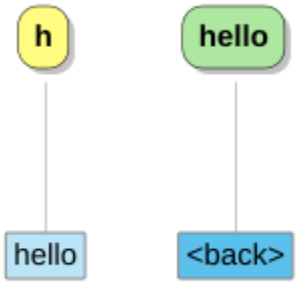
The `ide simulate` command runs the internal `simulate` command.

```
ide ide-option... simulate option... FILE
```

Running

```
ide simulate examples/hello.dzn
```

will have the `trace.html` view show



The *option*s can be among the following:

`--help`
`-h` Display help on invoking `ide simulate`, and then exit.

`--import=`*`dir`*
`-I` *`dir`* Add directory *dir* to import path.

`--model=`*`model`*
`-m` *`model`* Start simulation of model *model*.

`--no-compliance`
`-C` Do not run the compliance check.

`--no-deadlock`
`-D` Do not run the deadlock check at the end of the trail (EOT).

`--no-interface-livelock`
Do not run the interface livelock check at the end of the trail (EOT).

`--no-queue-full`
`-Q` Do not run the external queue-full check at the end of the trail (EOT).

`--no-refusals`
`-R` Do not run the compliance check for the failures model refusals check at the end of the trail (EOT).

`--no-strict`
`-S` Do not use strict matching of trail.

`--queue-size=`*`size`*
`-q` *`size`* Use component queue size *size* for simulation, the default is `3`.

`--queue-size-defer=`*`size`*
Use defer queue size *size* for simulation, the default is `2`.

`--queue-size-external=`*`size`*
Use external queue size *size* for simulation, the default is `1`.

`--strict`
`-s` Use strict matching of trail, i.e., the trail must contain all observable events.

`--trail=`*`trail`*
`-t` *`trail`* Start simulation by feeding initial trail *trail*.

`--trail-file=`*`trail-file`*
`-T` *`trail-file`*
Start simulation by feeding initial trail from *trail-file*.

4.2.9 Invoking `ide state`

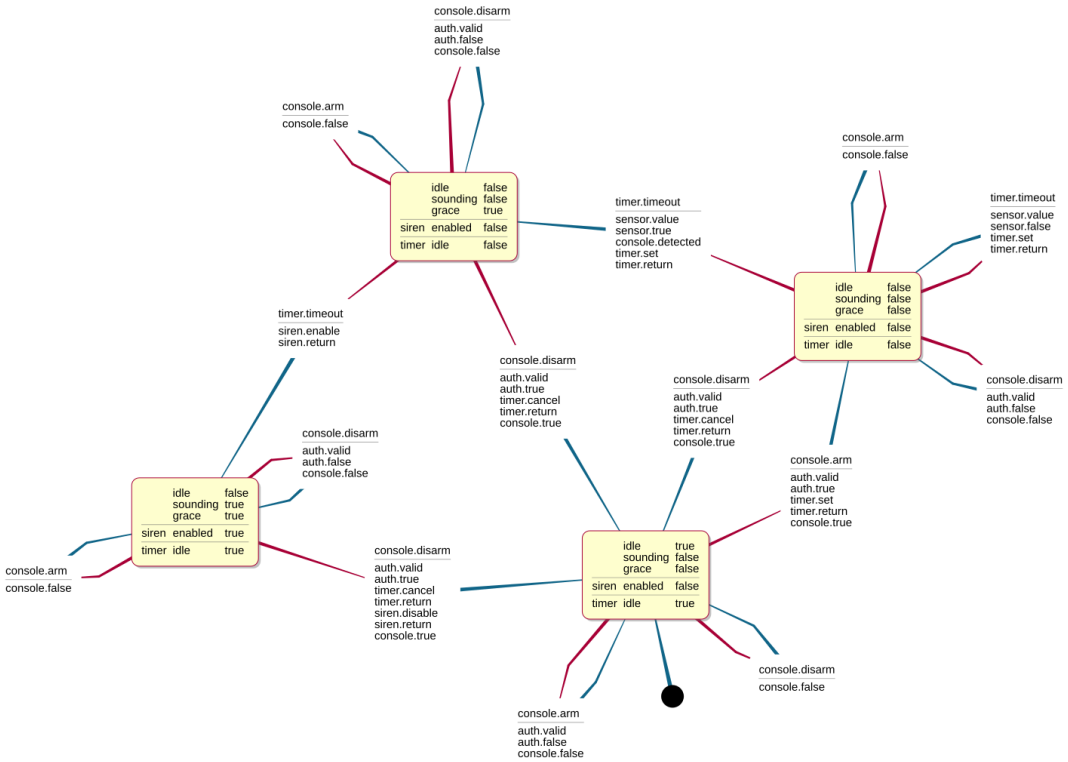
The `ide state` command runs the `dzn graph` command with the `--backend=state`. It produces graph data to the `ide daemon` to provide a state vew can be viewed with a browser.

```
ide ide-option... state option... FILE
```

Running

```
ide state examples/alarm.dzn
```

will have the `state.html` view show



The *option*s can be among the following:

`--help`
`-h` Display help on invoking `ide state`, and then exit.

`--hide=`*`hide`*
`-H` *`hide`* Generate a state diagram and hide *hide* from the transitions; one of `labels` (hide everything) or `actions`.

`--import=`*`dir`*
`-I` *`dir`* Add directory *dir* to import path.

`--model=`*`model`*
`-m` *`model`* Show state diagram for model *model*.

`--remove=`*`vars`*
`-R` *`vars`* Generate a state diagram and remove variables from nodes *remove*; one of `ports` or `extended`.

`ports` Hides the state of the component's or system's ports, `extended` hides the interface's or component's extended state, i.e., all but the main (first) state variable and implies `ports`.

4.2.10 Invoking `ide system`

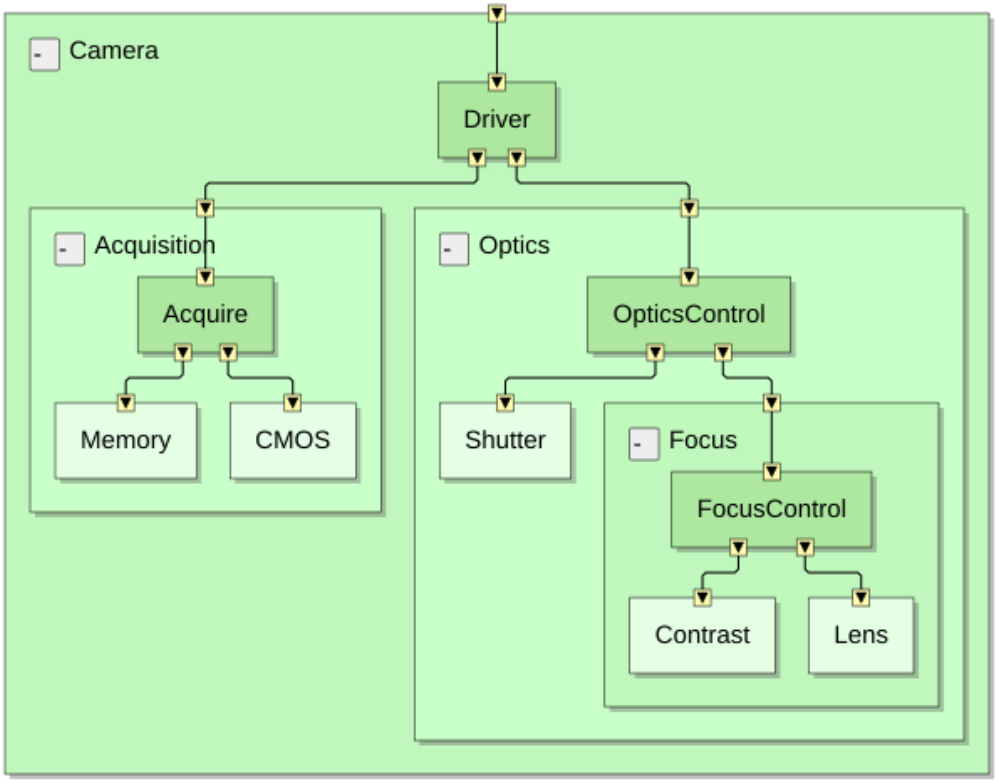
The `ide system` command runs the `dzn graph` command with the `--backend=system`. It produces a partial AST to the `ide daemon` to provide a system vew can be viewed with a browser. The well-formedness check (See Section "Well-formedness" in *Well-formedness*) is skipped so that incomplete systems can already be (partially) be displayed.

```
ide ide-option... system option... FILE
```

Running

```
ide system examples/Camera.dzn
```

will have the `system.html` view show



The *option*s can be among the following:

`--help`
`-h` Display help on invoking `ide system`, and then exit.

`--import=`*`dir`*
`-I` *`dir`* Add directory *dir* to import path.

4.2.11 Invoking `ide verify`

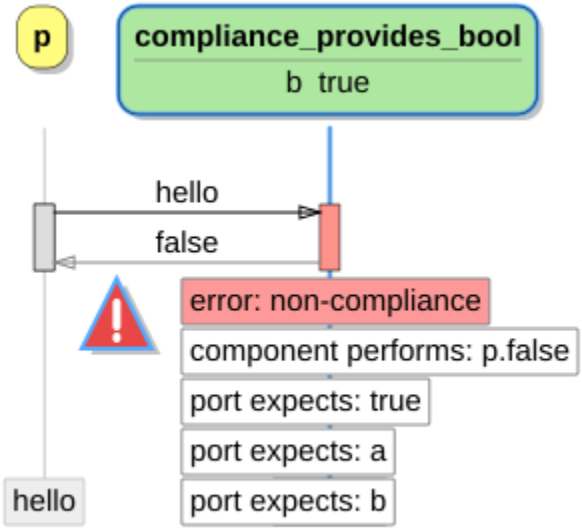
The `ide verify` command runs the `dzn verify` command. If verification errors are found, the `ide daemon` provides a sequence view that can be viewed with a browser.

```
ide ide-option... verify option... FILE
```

Running

```
ide verify examples/compliance_provides_bool.dzn
```

will have the `trace.html` view show



> **Note:** The trace view, which is generated by the simulator, will only show compliance errors when the verificator found a `compliance error`. This means that when the model has errors such as `deadlock`, `illegal`, `non-determinism`, `missing reply`, `second reply`, `queue full`, or `range error`, any `compliance error` is ignored.

The *option*s can be among the following:

`--help`
`-h` Display help on invoking `ide verify`, and then exit.

`--import=`*`dir`*
`-I` *`dir`* Add directory *dir* to import path.

`--model=`*`model`*
`-m` *`model`* Limit verification to *model*, and for behavioral component model, to its interfaces.

`--no-constraint`
`-C` Do not use a constraining process.

> **Note:** Verification cannot be applied to system components models; verifying a system model is a no-op.

`--no-interfaces`
: Do not verify a model's interfaces.

`--no-unreachable`
`-U`
: Disable the unreachable code check. For large models the unreachable code check may have a serious performance impact.

`--queue-size=`*size*
`-q` *size*
: Use component queue size *size* for verification, the default is `3`.

`--queue-size-defer=`*size*
: Use defer queue size *size* for verification, the default is `2`.

`--queue-size-external=`*size*
: Use external queue size *size* for verification, the default is `1`.

`--verbose`
`-v`
: Be more verbose, show progress.

4.3 Component Simulator

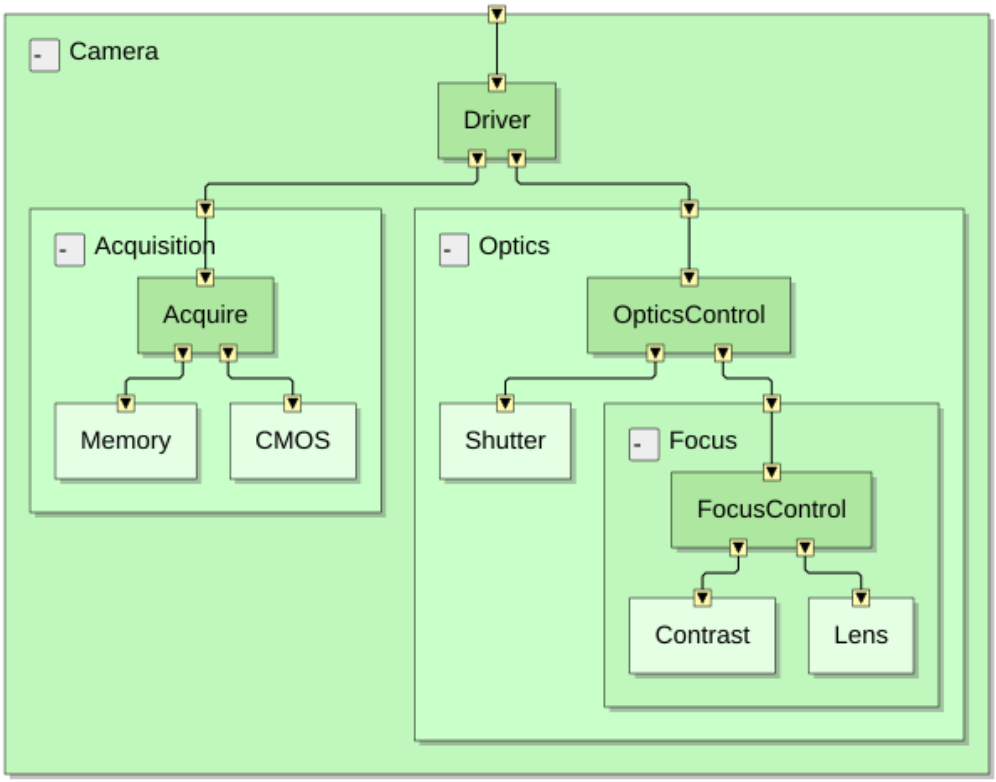
Input for the component simulator is a trace of events of a single component and its ports; such a trace is either a witness of a verification error, or a hand-crafted use case description. The simulator interprets the trace, using the Dezyne semantics, and outputs a more detailed trace, where the state of the component and its interfaces is included. It also outputs a list of 'eligible' events: events that are a valid extension of the input trace.

5 Dezyne Views

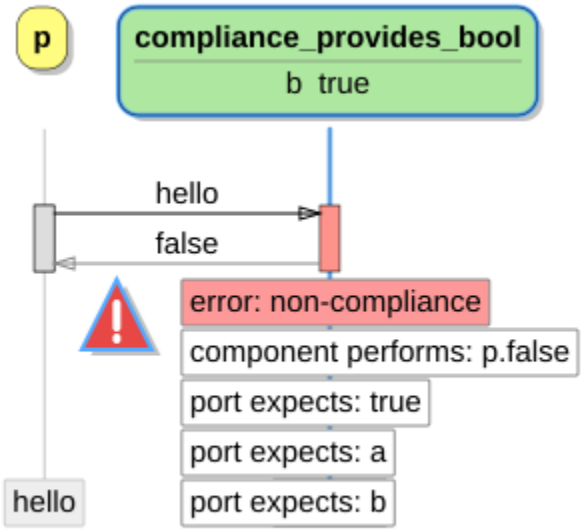
Each View in Dezyne is interactive and can be used to explore the different aspects of the design. By left clicking on different diagram elements using the mouse, a suitable connected editor will locate and highlight the corresponding text in the Dezyne model.

5.1 System View

The system view shows a structural view of a system component and its sub components.

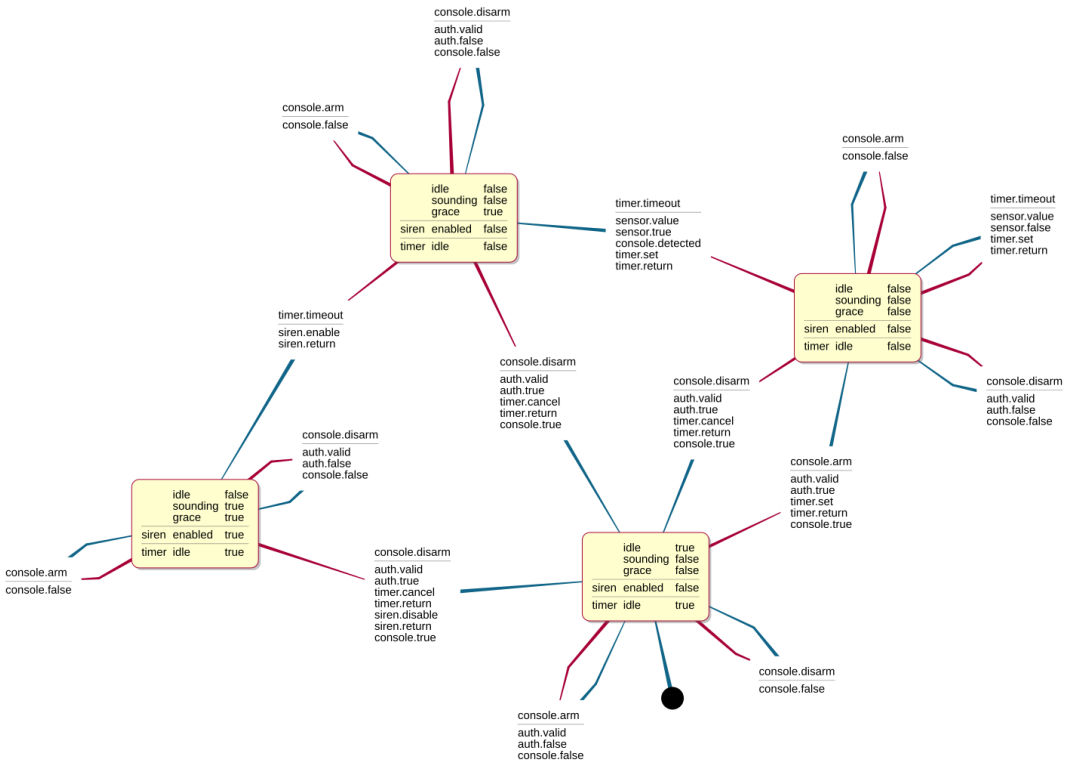


5.2 Trace View



The Trace View visualizes a detailed trace resulting from the component simulator; it displays all events that are communicated, the eligible events and the state. The Trace View can be used to extend the trace by selecting one of the eligible events.

5.3 State View



The State View visualizes the behavior of an interface, component or system as a state chart.

6 Working with Legacy Code

XXX: TODO

6.1 ASD Converter

The semantics of ASD and Dezyne largely overlap. This enables automatic conversion from ASD models to Dezyne models. Work has to be done for multi-threaded ASD models. Also the readability of the generated Dezyne models needs improvement.

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Version 1.3, 3 November 2008

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