

Dezyne IDE Manual

Component based, formally verified.

The Dezyne developers

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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 Dezyne IDE.

The Dezyne IDE provides two graphical views: a structural overview (see Section 5.1 [System View], page 21) that helps navigating the system architecture, and a dynamic view (see Section 5.2 [Trace View], page 22) that helps understanding your system's behavior.

The 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 (preferably) user-customizable integration between all these.

2 Installation

In order to install Dezyne IDE on your system, you can use a binary installation that we prepared especially for you. In case you are interested in building Dezyne IDE from source yourself, watch this space!

2.1 Binary Installation

This section describes how to install Dezyne IDE on an arbitrary system from a self-contained tarball providing binaries for Dezyne IDE 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://dezyne.org/download/dezyne-ide/dezyne-ide-2.14.0-x86_64-linux.tar.gz, e.g.:

```
$ wget https://dezyne.org/download/dezyne-ide/dezyne-ide-2.14.0-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://dezyne.org/download/dezyne-ide/dezyne-ide-2.14.0-x86_64-linux.tar.gz
$ gpg --verify dezyne-ide-2.14.0-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 \
-q0 - | 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/dezyne-ide-2.14.0-x86_64-linux.tar.gz
```

Then try:

```
$ cd dezyne-ide-2.14.0
$ ./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-command¹ 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://dezyne.org/download/dezyne-ide/dezyne-ide-2.14.0-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-2.14.0`.

...

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 10) 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 12) and stopped with `ide bye` (see Section 4.2.4 [Invoking `ide bye`], page 12).

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 4.2.9 [Invoking `ide system`], page 16) 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 11):

```
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 4.2.8 [Invoking `ide state`], page 14) 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 11):

```
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 using the `dzn simulate` (see Section 4.2.7 [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 11):

```
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 4.2.10 [Invoking `ide verify`], page 18) 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 the Dezyne IDE

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 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 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 -abilities for this Dezyne mode in VSCode `dzn-lsp`. `dzn-lps` can be downloaded here <https://dezyne.org/download/dezyne-ide/dzn-lsp-1.1.0.vsix>.

In the extension settings for `dzn-lsp` you can configure where the `ide` is located e.g., `C:/dezyne-ide-2.14.0` or `/home/user/bin/dezyne-ide-2.14.0`; 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 performing 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 command 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 corresponding settings of the extension.

4.1.2 A GNU Emacs-based 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

```

// WITHOUT ANY WARRANTY; without even the implied warranty of
// MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the GNU
// Affero General Public License for more details.
//
// You should have received a copy of the GNU Affero General Public
// License along with Dezyne. If not, see <http://www.gnu.org/licenses/>.
//
// Commentary:
//
// Code:

interface ihello
{
    in void hello();

    behaviour
    {
        on hello: {}
    }
}

component hello
{
    provides ihello h;
    behaviour
    {
        on h.hello(): {}
    }
}

```

```

U:--- hello.dzn|daemon Bot (42,0) Git-daemon [#gna,#guile,#e,#b,#h,#tcc,#gnu,#fsf,w
[*- mode: compilation; default-directory: "~/src/verum/ide/daemon/" *-
Compilation started at Mon Mar 23 19:37:06

```

```
dzn code hello.dzn
```

```
Compilation finished at Mon Mar 23 19:37:06
```

```

U:%*- *compilation*daemon* All (1,0) [#gna,#guile,#e,#b,#h,#tcc,#gnu,#fsf,w,#debia
M-x dzn-verify-region

```

The screenshot shows the Dezyne IDE interface. The menu bar includes File, Edit, Options, Buffers, Tools, Jabber, Dezyne, and Help. The Dezyne menu is open, showing options: Compile (C-c C-c), Goto index, Parse (C-c C-p), Register Emacs, Select view, Update views (C-c C-u), and Verify (C-c C-v). The Verify option is highlighted in blue.

```

optics.lens <=> lens.port;
optics.shutter <=> shutter.port;
optics.flash <=> flash.port;
flash_hardware.port <=> flash.hardware;
}
}
component Driver
{
  provides IControl control;
  requires IAcquisition acquisition;
  requires IOptics optics;

  behaviour
  {
    enum State {Idle, Setup, Ready, Acquire};
    enum Contrast {Down, Up, Max};
    enum Zoom {In, Out};

    State state = State.Idle;
    Contrast contrast = Contrast.Down;
    Zoom zoom = Zoom.In;
    bool ready = false;

    [state.Idle]
    {
      on control.setup(): {optics.prepare(); acquisition.contrast_gradient(); state = State.S
      on optics.ready(): {}
    }
    [state.Setup]
    {
      on acquisition.lower_contrast():
      {
        [contrast.Up]
        {
          if(zoom.In) {optics.focus_out(); zoom = Zoom.Out;}
          else      {optics.focus_in(); zoom = Zoom.In;}

          contrast = Contrast.Max;
        }
      }
    }
  }
}

```

```

U:--- Camera-Error.dzn 48% (230,27)  [*,#gna,#xr,#b,#guile,#lib,#gnu,#h,#lil,#tcc,#nix
-*- mode: compilation; default-directory: "~/src/verum/ide/wip/examples/" -*-
Compilation started at Fri Mar 27 08:41:33

-*- mode: compilation; default-directory: "~/src/verum/ide/wip/" -*-
Compilation started at Fri Mar 27 09:37:36

bash -c 'source .guix-env.sh; ~/src/verum/dzn/wip-release/pre-inst-env ./pre-inst-env dzn che
/Camera-Error.dzn'
verification error
ide_port: 1024
examples/Camera-Error.dzn:230:28:error: illegal
examples/Camera-Error.dzn:65:10:info: control.setup
examples/Camera-Error.dzn:64:5:info: control.state=State.Idle
examples/Camera-Error.dzn:65:10:info: control.setup
examples/Camera-Error.dzn:230:10:info: Driver.control.setup
examples/Camera-Error.dzn:228:5:info: Driver.receive.queue= state=State.Idle contrast=Contras
eady=false
examples/Camera-Error.dzn:230:10:info: Driver.control.setup
U:*** *dzn-compilation* Top (10,15)  [*,#gna,#xr,#b,#guile,#lib,#gnu,#h,#lil,#tcc,#ni

```

4.2 Dezyne IDE View Commands

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

Usually, your Dezyne 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 Dezyne-IDE extends the set of `dzn` core command-line with graphical `ide` view commands.

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

The *options* can be among the following:

```
--debug
-d      Enable debug output. 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.
```

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

```
Usage: ide [OPTION]... COMMAND [COMMAND-ARGUMENT...]
  -d, --debug          enable debug output
  -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
  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 automatically when issuing any `ide`-command, e.g. `ide`

`hello` (see Section 4.2.5 [Invoking `ide hello`], page 12), and it is stopped by running `ide bye` (see Section 4.2.4 [Invoking `ide bye`], page 12).

When started automatically, 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 *options* can be among the following:

```
--debug
-d          Enable debug output. 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 server 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 daemon 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 *views* must be the name of a view: `system` (the default) `state`, `trace` or an *URL*.

Running

```
ide browse trace
```

opens the trace view.

The *options* 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 Dezyne-IDE daemon. The start of a dezyne session can be marked with `ide hello` (see Section 4.2.5 [Invoking `ide hello`], page 12).

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

The *options* 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 Dezyne-IDE daemon. The end of a dezyne session can be marked with `ide bye` (see Section 4.2.4 [Invoking `ide bye`], page 12).

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

The *options* 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 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.
```

4.2.7 Invoking `ide simulate`

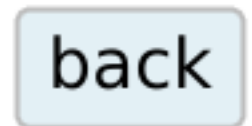
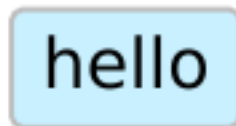
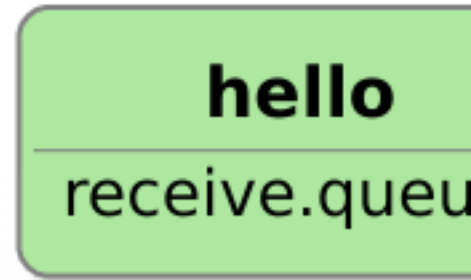
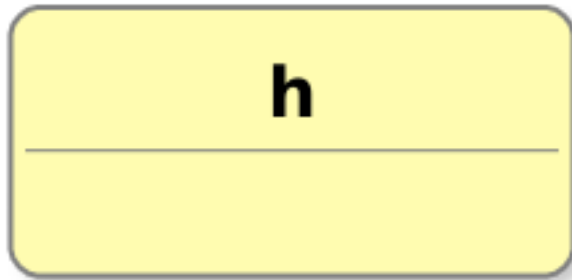
The `ide simulate` command runs the internal `simulate` command.

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

Running

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

will have the `trace.html` view show



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


4.2.8 Invoking `ide state`

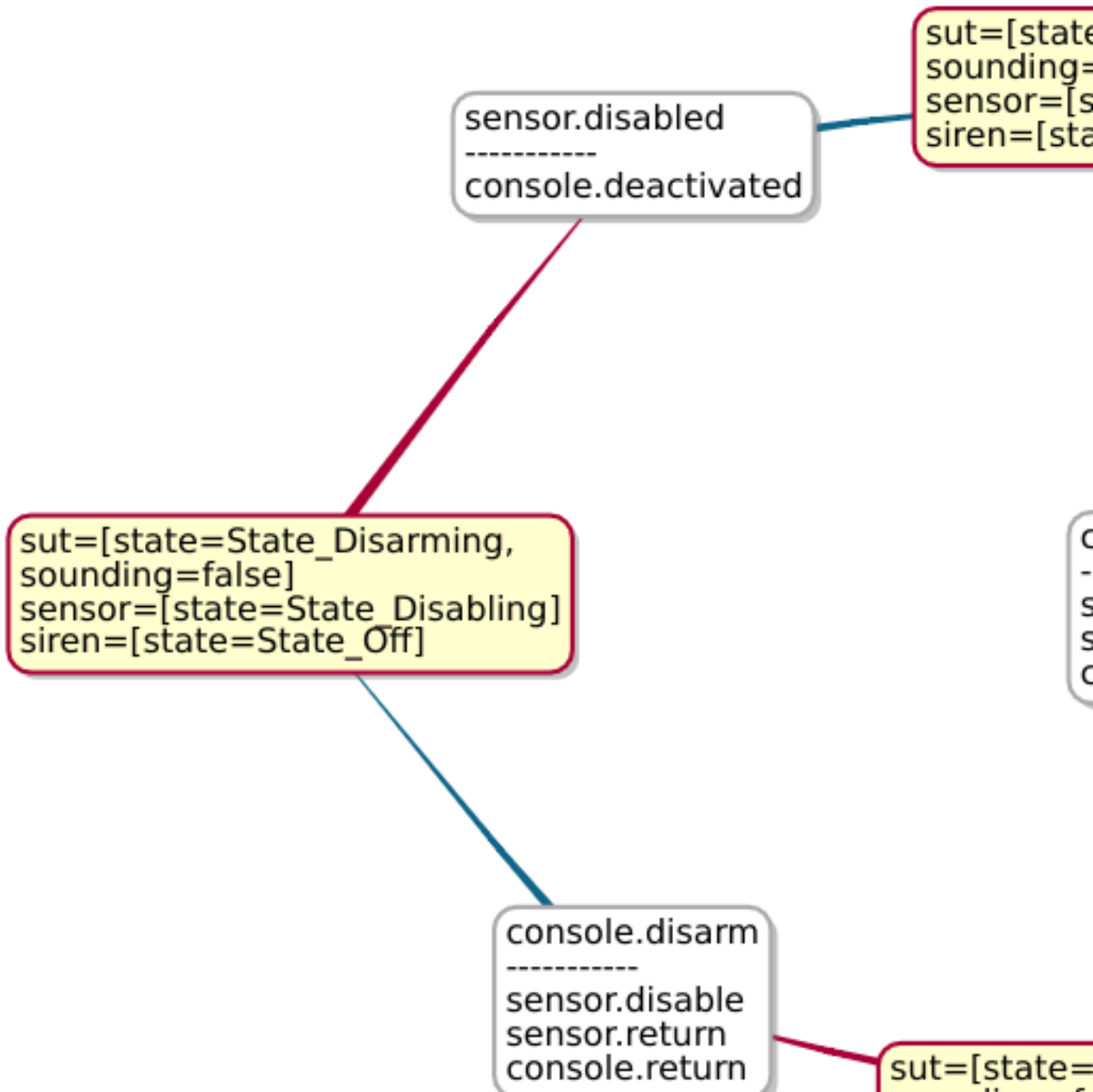
The `ide state` command runs the `dzn parse` command. It produces an AST to the `ide daemon` to provide a state view can be viewed with a browser.

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

Running

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

will have the `state.html` view show



The *options* 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.
```

4.2.9 Invoking `ide system`

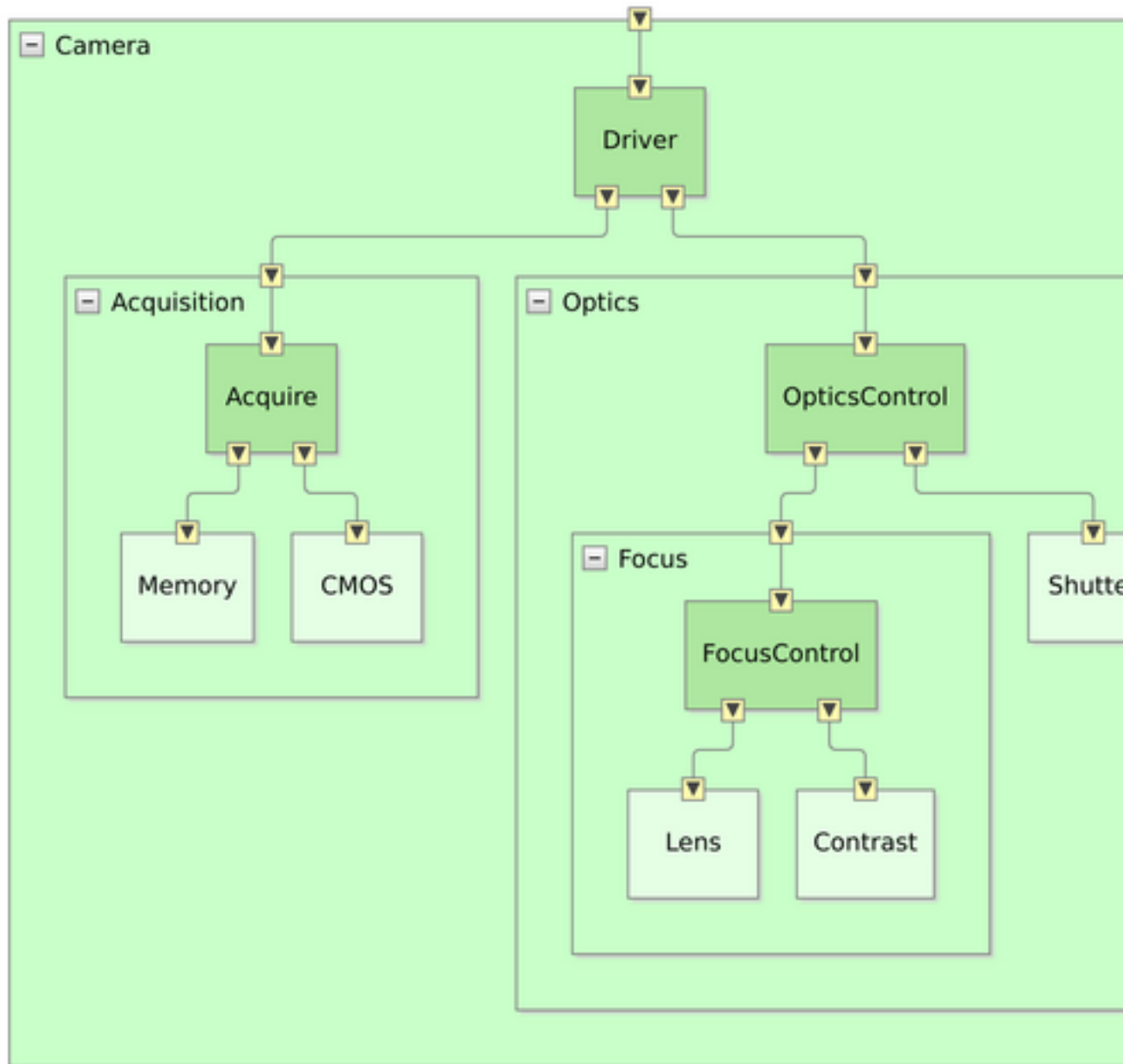
The `ide system` command runs the `dzn parse` command. It produces an AST to the `ide daemon` to provide a system view can be viewed with a browser.

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

Running

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

will have the `system.html` view show



The *options* 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.
```

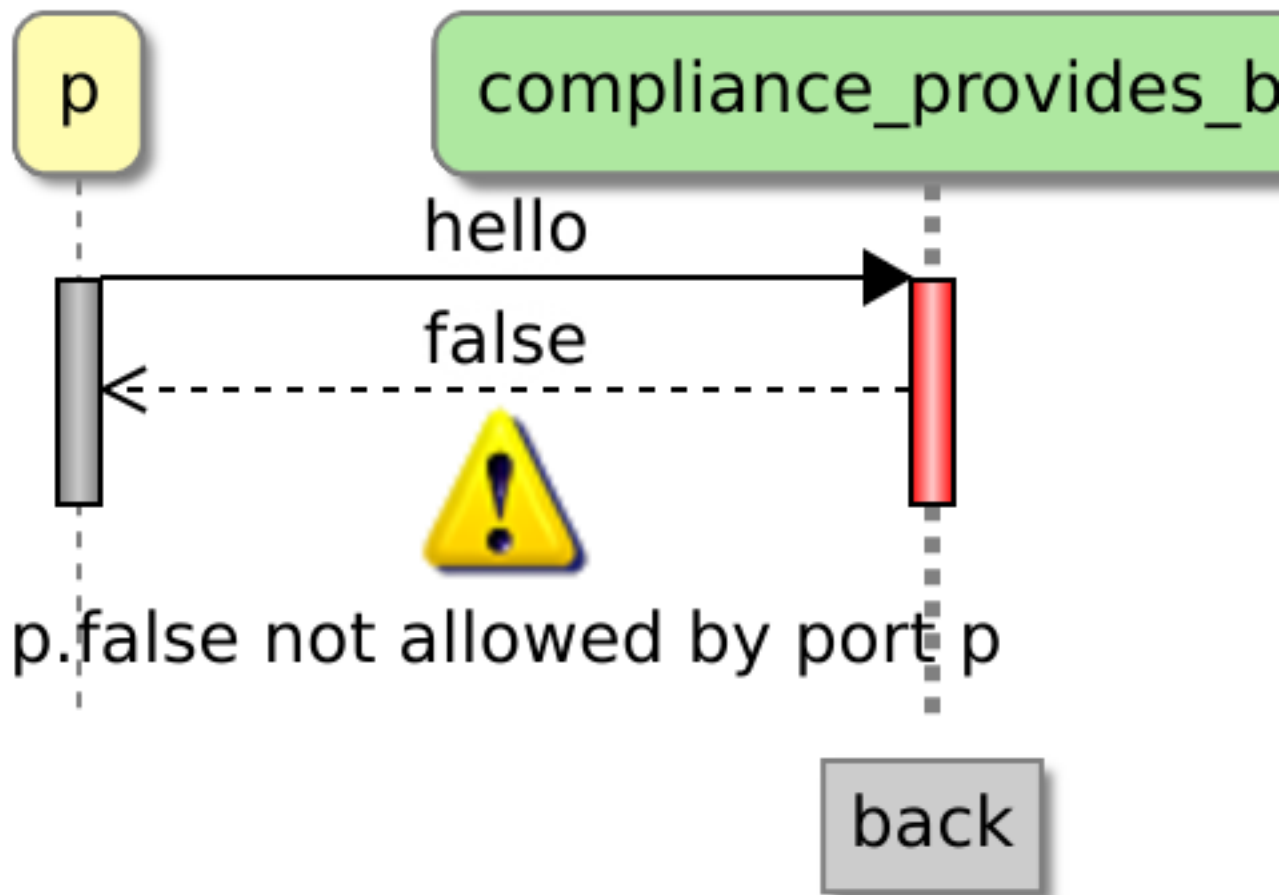
4.2.10 Invoking `ide verify`

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
```



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

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

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

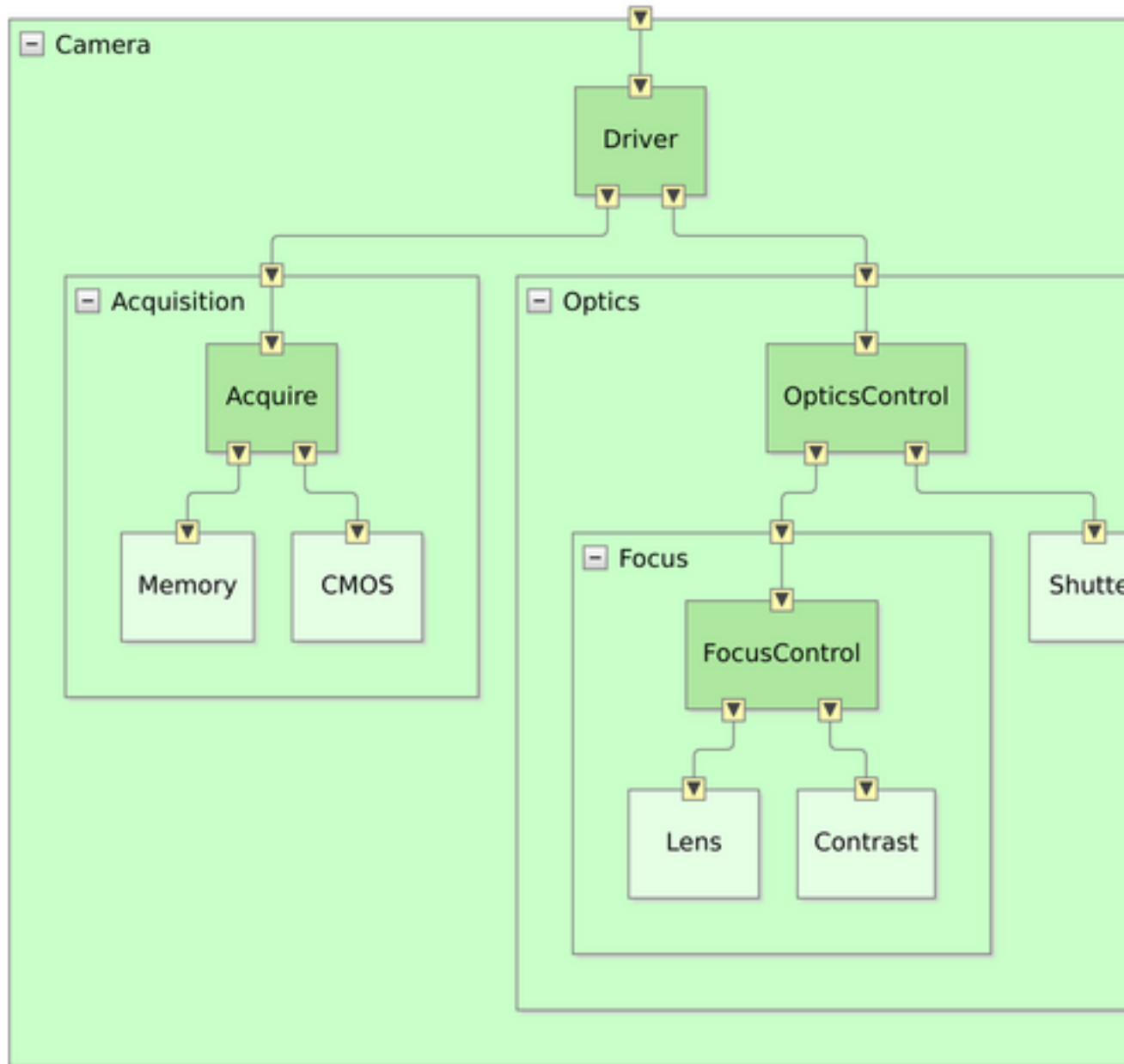
4.3 Component Simulator

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.

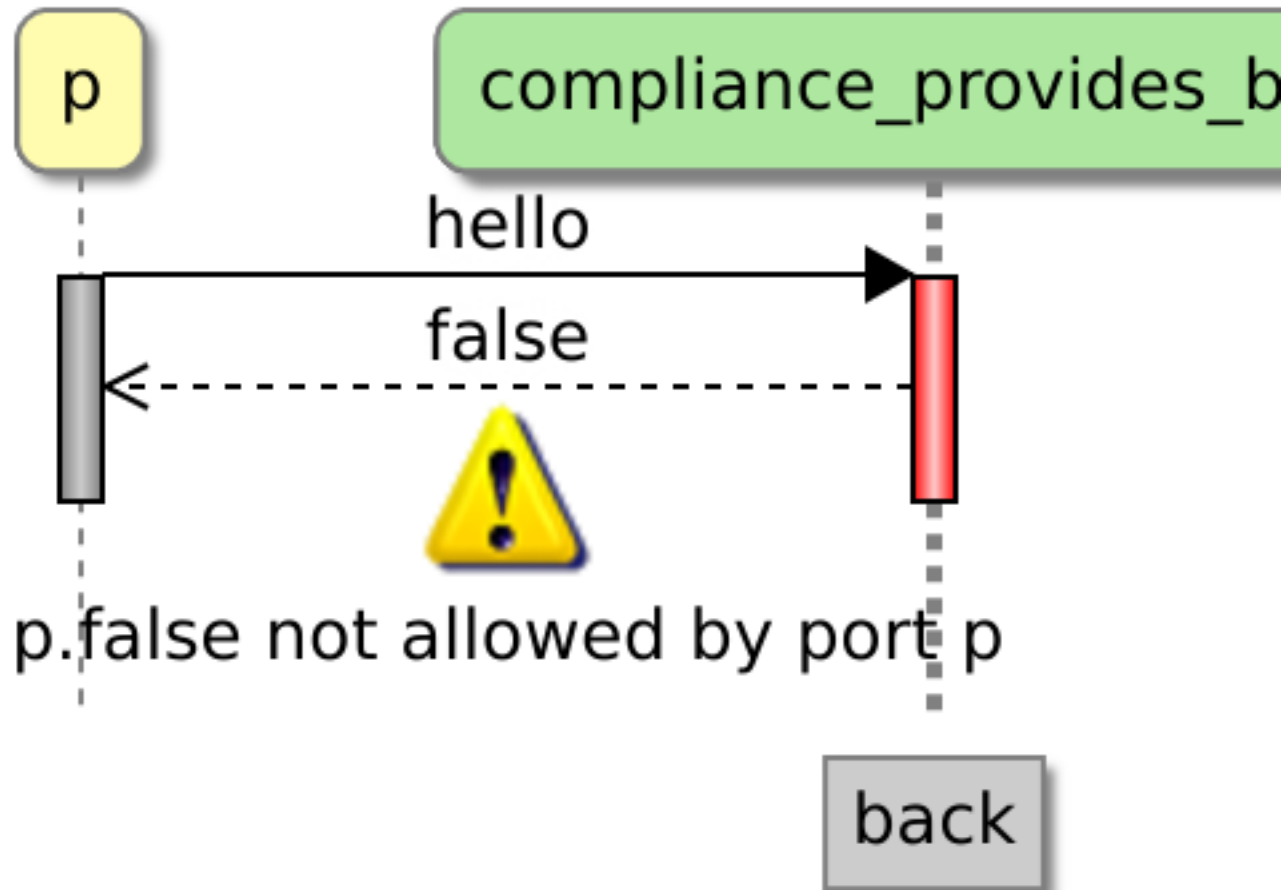
5 Dezyne Views

5.1 System View

The system view shows a static view of a system component and all 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.

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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