labgrid Documentation

Release 0.2.0

Jan Luebbe, Rouven Czerwinski

May 06, 2020

Contents

Labgrid is a embedded board control python library with a focus on testing, development and general automation. It includes a remote control layer to control boards connected to other hosts.

The idea behind labgrid is to create an abstraction of the hardware control layer needed for testing of embedded systems, automatic software installation and automation during development. Labgrid itself is *not* a testing framework, but is intended to be combined with pytest (and additional pytest plugins). Please see *Design Decisions* for more background information.

It currently supports:

- pytest plugin to write tests for embedded systems connecting serial console or SSH
- remote client-exporter-coordinator infrastructure to make boards available from different computers on a network
- power/reset management via drivers for power switches or onewire PIOs
- upload of binaries via USB: imxusbloader/mxsusbloader (bootloader) or fastboot (kernel)
- functions to control external services such as emulated USB-Sticks and the hawkBit deployment service

While labgrid is currently used for daily development on embedded boards and for automated testing, several planned features are not yet implemented and the APIs may be changed as more use-cases appear. We appreciate code contributions and feedback on using labgrid on other environments (see *Contributing* for details). Please consider contacting us (via a GitHub issue) before starting larger changes, so we can discuss design trade-offs early and avoid redundant work. You can also look at *Ideas* for enhancements which are not yet implemented.

CHAPTER 1

Getting Started

This section of the manual contains introductory tutorials for installing labgrid, running your first test and setting up the distributed infrastructure.

1.1 Installation

Depending on your distribution you need some dependencies. On Debian stretch these usually are:

```
$ apt-get install python3 python3-virtualenv python3-pip virtualenv
```

In many cases, the easiest way is to install labgrid into a virtualenv:

```
$ virtualenv -p python3 labgrid-venv
$ source labgrid-venv/bin/activate
```

Start installing labgrid by cloning the repository and installing the requirements from the *requirements.txt* file:

```
$ git clone https://github.com/labgrid-project/labgrid
$ cd labgrid && pip install -r requirements.txt
$ python3 setup.py install
```

Note: Previous documentation recommended the installation as via pip (*pip3 install labgrid*). This lead to broken installations due to unexpected incompatibilities with new releases of the dependencies. Consequently we now recommend using pinned versions from the *requirements.txt* file for most use cases.

Labgrid also supports the installation as a library via pip, but we only test against library versions specified in the requirements.txt file. Thus when installing directly from pip you have to test compatibility yourself.

Note: If you are installing via pip and intend to use Serial over IP (RFC2217), it is highly recommended to uninstall pyserial after installation and replace it with the pyserial version from the labgrid project:

```
$ pip uninstall pyserial
$ pip install https://github.com/labgrid-project/pyserial/archive/v3.4.0.1.
↪zip#egg=pyserial
```

This pyserial version has two fixes for an Issue we found with Serial over IP multiplexers. Additionally it reduces the Serial over IP traffic considerably since the port is not reconfigured when labgrid changes the timeout (which is done inside the library a lot).

Test your installation by running:

```
$ labgrid-client --help
usage: labgrid-client [-h] [-x URL] [-c CONFIG] [-p PLACE] [-d] COMMAND ...
...
```

If the help for labgrid-client does not show up, open an Issue. If everything was successful so far, proceed to the next section:

1.1.1 Optional Requirements

Labgrid provides optional features which are not included in the default *requirements.txt*. The tested library version for each feature is included in a seperate requirements file. An example for snmp support is:

```
$ pip install -r snmp-requirements.txt
```

Onewire

Onewire support requires the *libow* library with headers, installable on debian via the *libow-dev* package. Use the *onewire-requirements.txt* file to install the correct onewire library version in addition to the normal installation.

SNMP

SNMP support requires to additional packages, *pysnmp* and *pysnmpmibs*. They are included in the *snmp-requirements.txt* file.

Modbus

Modbus support requires an additional package *pyModbusTCP*. It is included in the *modbus-requirements.txt* file.

1.2 Running Your First Test

Start by copying the initial example:

```
$ mkdir ../first_test/
$ cp examples/shell/* ../first_test/
$ cd ../first_test/
```

Connect your embedded board (raspberry pi, riotboard, ...) to your computer and adjust the `port` parameter of the `RawSerialPort` resource and `username` and `password` of the ShellDriver driver in `local.yaml`:

```
targets:
  main:
    resources:
      RawSerialPort:
        port: "/dev/ttyUSB0"
    drivers:
      ManualPowerDriver:
        name: "example"
      SerialDriver: {}
      ShellDriver:
        prompt: 'root@\w+:[^ ]+ '
        login_prompt: ' login: '
        username: 'root'
```

You can check which device name gets assigned to your USB-Serial converter by unplugging the converter, running `dmesg -w` and plugging it back in. Boot up your board (manually) and run your first test:

```
$ pytest --lg-env local.yaml test_shell.py
```

It should return successfully, in case it does not, open an Issue.

If you want to build documentation you need some more dependencies:

```
$ pip3 install -r doc-requirements.txt
```

The documentation is inside `doc/`. HTML-Documentation is build using:

```
$ cd doc/
$ make html
```

The HTML documentation is written to `doc/.build/html/`.

1.3 Setting Up the Distributed Infrastructure

The labgrid distributed infrastructure consists of three components:

1. Coordinator
2. Exporter
3. Client

The system needs at least one coordinator and exporter, these can run on the same machine. The client is used to access functionality provided by an exporter. Over the course of this tutorial we will set up a coordinator and exporter, and learn how to access the exporter via the client.

1.3.1 Coordinator

To start the coordinator, we will download the labgrid repository, create an extra virtualenv and install the dependencies via the requirements file.

```
$ git clone https://github.com/labgrid-project/labgrid
$ cd labgrid && virtualenv -p python3 crossbar_venv
$ source crossbar_venv/bin/activate
$ pip install -r crossbar-requirements.txt
$ python setup.py install
```

All necessary dependencies should be installed now, we can start the coordinator by running `crossbar start` inside of the repository.

Note: This is possible because the labgrid repository contains the crossbar configuration the coordinator in the `.crossbar` folder. crossbar is a network messaging framework for building distributed applications, which labgrid plugs into.

1.3.2 Exporter

The exporter needs a configuration file written in YAML syntax, listing the resources to be exported from the local machine. The config file contains one or more named resource groups. Each group contains one or more resource declarations and optionally a location string (see the *configuration reference* for details).

For example, to export a `RawSerialPort` with the group name *example-port* and the location *example-location*:

```
example-group:
  location: example-location
  RawSerialPort:
    port: /dev/ttyUSB0
```

The exporter can now be started by running:

```
$ labgrid-exporter configuration.yaml
```

Additional groups and resources can be added:

```
example-group:
  location: example-location
  RawSerialPort:
    port: /dev/ttyUSB0
  NetworkPowerPort:
    model: netio
    host: netio1
    index: 3
example-group-2:
  RawSerialPort:
    port: /dev/ttyUSB1
```

Restart the exporter to activate the new configuration.

Attention: The *ManagedFile* will create temporary uploads in the exporters `/tmp` filesystem. It is recommended to install a cron job or systemd timer to remove old temporary files. All uploads done by labgrid are stored in the `/tmp/labgrid` directory.

1.3.3 Client

Finally we can test the client functionality, run:

```
$ labgrid-client resources
kiwi/example-group/NetworkPowerPort
kiwi/example-group/RawSerialPort
kiwi/example-group-2/RawSerialPort
```

You can see the available resources listed by the coordinator. The groups *example-group* and *example-group-2* should be available there.

To show more details on the exported resources, use `-v` (or `-vv`):

```
$ labgrid-client -v resources
Exporter 'kiwi':
  Group 'example-group' (kiwi/example-group/*):
    Resource 'NetworkPowerPort' (kiwi/example-group/NetworkPowerPort[/
↪NetworkPowerPort]):
      {'acquired': None,
       'avail': True,
       'cls': 'NetworkPowerPort',
       'params': {'host': 'netio1', 'index': 3, 'model': 'netio'}}
...
```

You can now add a place with:

```
$ labgrid-client --place example-place create
```

And add resources to this place (`-p` is short for `--place`):

```
$ labgrid-client -p example-place add-match */example-port/*
```

Which adds the previously defined resource from the exporter to the place. To interact with this place, it needs to be acquired first, this is done by

```
$ labgrid-client -p example-place acquire
```

Now we can connect to the serial console:

```
$ labgrid-client -p example-place console
```

For a complete reference have a look at the *labgrid-client(1)* man page.

1.4 udev Matching

Labgrid allows the exporter (or the client-side environment) to match resources via udev rules. The udev resources become available to the test/exporter as soon es they are plugged into the computer, e.g. allowing an exporter to export all USB ports on a specific hub and making a `NetworkSerialPort` available as soon as it is plugged into one of the hub's ports. The information udev has on a device can be viewed by executing:

```
$ udevadm info /dev/ttyUSB0
...
E: ID_MODEL_FROM_DATABASE=CP210x UART Bridge / myAVR mySmartUSB light
E: ID_MODEL_ID=ea60
E: ID_PATH=pci-0000:00:14.0-usb-0:5:1.0
E: ID_PATH_TAG=pci-0000_00_14_0-usb-0_5_1_0
E: ID_REVISION=0100
E: ID_SERIAL=Silicon_Labs_CP2102_USB_to_UART_Bridge_Controller_P-00-00682
E: ID_SERIAL_SHORT=P-00-00682
E: ID_TYPE=generic
...
```

In this case the device has an `ID_SERIAL_SHORT` key with a unique ID embedded in the USB-serial converter. The resource match configuration for this USB serial converter is:

```
USBSerialPort:
  match:
    'ID_SERIAL_SHORT': 'P-00-00682'
```

This section can now be added under the resource key in an environment configuration or under its own entry in an exporter configuration file.

As the USB bus number can change depending on the kernel driver initialization order, it is better to use the `@ID_PATH` instead of `@sys_name` for USB devices. In the default udev configuration, the path is not available for all USB devices, but that can be changed by creating a udev rules file:

```
SUBSYSTEMS=="usb", IMPORT{builtin}="path_id"
```

1.5 Using a Strategy

Strategies allow the labgrid library to automatically bring the board into a defined state, e.g. boot through the bootloader into the Linux kernel and log in to a shell. They have a few requirements:

- A driver implementing the `PowerProtocol`, if no controllable infrastructure is available a `ManualPowerDriver` can be used.
- A driver implementing the `LinuxBootProtocol`, usually a specific driver for the board's bootloader
- A driver implementing the `CommandProtocol`, usually a `ShellDriver` with a `SerialDriver` below it.

Labgrid ships with two builtin strategies, `BareboxStrategy` and `UBootStrategy`. These can be used as a reference example for simple strategies, more complex tests usually require the implementation of your own strategies.

To use a strategy, add it and its dependencies to your configuration YAML, retrieve it in your test and call the `transition(status)` function.

```
>>> strategy = target.get_driver(strategy)
>>> strategy.transition("barebox")
```

An example using the pytest plugin is provided under *examples/strategy*.

CHAPTER 2

Overview

2.1 Architecture

Labgrid can be used in several ways:

- on the command line to control individual embedded systems during development ("board farm")
- via a pytest plugin to automate testing of embedded systems
- as a python library in other programs

In the labgrid library, a controllable embedded system is represented as a `Target`. *Targets* normally have several `Resource` and `Driver` objects, which are used to store the board-specific information and to implement actions on different abstraction levels. For cases where a board needs to be transitioned to specific states (such as *off*, *in bootloader*, *in Linux shell*), a `Strategy` (a special kind of *Driver*) can be added to the *Target*.

While labgrid comes with implementations for some resources, drivers and strategies, custom implementations for these can be registered at runtime. It is expected that for complex use-cases, the user would implement and register a custom *Strategy* and possibly some higher-level *Drivers*.

2.1.1 Resources

Resources are passive and only store the information to access the corresponding part of the *Target*. Typical examples of resources are `RawSerialPort`, `NetworkPowerPort` and `AndroidFastboot`.

An important type of *Resources* are `ManagedResources`. While normal *Resources* are always considered available for use and have fixed properties (such as the `/dev/ttyUSB0` device name for a `RawSerialPort`), the *ManagedResources* are used to represent interfaces which are discoverable in some way. They can appear/disappear at runtime and have different properties each time they are discovered. The most common examples of *ManagedResources* are the various USB resources discovered using udev, such as `USBSerialPort`, `IMXUSBLoader` or `AndroidFastboot`.

2.1.2 Drivers and Protocols

A labgrid `Driver` uses one (or more) *Resources* and/or other, lower-level *Drivers* to perform a set of actions on a *Target*. For example, the `NetworkPowerDriver` uses a `NetworkPowerPort` resource to control the *Target's* power supply. In this case, the actions are "on", "off", "cycle" and "get".

As another example, the `ShellDriver` uses any driver implementing the `ConsoleProtocol` (such as a `SerialDriver`, see below). The *ConsoleProtocol* allows the *ShellDriver* to work with any specific method of accessing the board's console (locally via USB, over the network using a console server or even an external program). At the *ConsoleProtocol* level, characters are sent to and received from the target, but they are not yet interpreted as specific commands or their output.

The *ShellDriver* implements the higher-level `CommandProtocol`, providing actions such as "run" or "run_check". Internally, it interacts with the Linux shell on the target board. For example, it:

- waits for the login prompt
- enters user name and password
- runs the requested shell command (delimited by marker strings)
- parses the output
- retrieves the exit status

Other drivers, such as the `SSHDriver`, also implement the *CommandProtocol*. This way, higher-level code (such as a test suite), can be independent of the concrete control method on a given board.

2.1.3 Binding and Activation

When a *Target* is configured, each driver is "bound" to the resources (or other drivers) required by it. Each *Driver* class has a "bindings" attribute, which declares which *Resources* or *Protocols* it needs and under which name they should be available to the *Driver* instance. The binding resolution is handled by the *Target* during the initial configuration and results in a directed, acyclic graph of resources and drivers. During the lifetime of a *Target*, the bindings are considered static.

In most non-trivial target configurations, some drivers are mutually exclusive. For example, a *Target* may have both a `ShellDriver` and a `BareboxDriver`. Both bind to a driver implementing the *ConsoleProtocol* and provide the *CommandProtocol*. Obviously, the board cannot be in the bootloader and in Linux at the same time, which is represented in labgrid via the `BindingState` (*bound*/*active*). If, during activation of a driver, any other driver in its bindings is not active, they will be activated as well.

Activating and deactivating *Drivers* is also used to handle *ManagedResources* becoming available/unavailable at runtime. If some resources bound to by the activating drivers are currently unavailable, the *Target* will wait for them to appear (with a per resource timeout). A realistic sequence of activation might look like this:

- enable power (`PowerProtocol.on`)
- activate the `IMXUSBDriver` driver on the target (this will wait for the `IMXUSBLoader` resource to be available)
- load the bootloader (`BootstrapProtocol.load`)
- activate the `AndroidFastbootDriver` driver on the target (this will wait for the `AndroidFastboot` resource to be available)
- boot the kernel (`AndroidFastbootDriver.boot`)
- activate the `ShellDriver` driver on the target (this will wait for the `USBSerialPort` resource to be available and log in)

Any *ManagedResources* which become unavailable at runtime will automatically deactivate the dependent drivers.

2.1.4 Multiple Drivers and Names

Each driver and resource can have an optional name. This parameter is required for all manual creations of drivers and resources. To manually bind to a specific driver set a binding mapping before creating the driver:

```
>>> t = Target("Test")
>>> SerialPort(t, "First")
SerialPort(target=Target(name='Test', env=None), name='First', state=<BindingState.
↪bound: 1>, avail=True, port=None, speed=115200)
>>> SerialPort(t, "Second")
SerialPort(target=Target(name='Test', env=None), name='Second', state=<BindingState.
↪bound: 1>, avail=True, port=None, speed=115200)
>>> t.set_binding_map({"port": "Second"})
>>> sd = SerialDriver(t, "Driver")
>>> sd
SerialDriver(target=Target(name='Test', env=None), name='Driver', state=<BindingState.
↪bound: 1>, txdelay=0.0)
>>> sd.port
SerialPort(target=Target(name='Test', env=None), name='Second', state=<BindingState.
↪bound: 1>, avail=True, port=None, speed=115200)
```

2.1.5 Priorities

Each driver supports a priorities class variable. This allows drivers which implement the same protocol to add a priority option to each of their protocols. This way a *NetworkPowerDriver* can implement the *ResetProtocol*, but if another *ResetProtocol* driver with a higher protocol is available, it will be selected instead.

Note: Priority resolution only takes place if you have multiple drivers which implement the same protocol and you are not fetching them by name.

The target resolves the driver priority via the Method Resolution Order (MRO) of the driver's base classes. If a base class has a *priorities* dictionary which contains the requested Protocol as a key, that priority is used. Otherwise, *0* is returned as the default priority.

To set the priority of a protocol for a driver, add a class variable with the name *priorities*, e.g.

```
@attr.s
class NetworkPowerDriver(Driver, PowerProtocol, ResetProtocol):
    priorities: {PowerProtocol: -10}
```

2.1.6 Strategies

Especially when using labgrid from pytest, explicitly controlling the board's boot process can distract from the individual test case. Each `Strategy` implements the board- or project-specific actions necessary to transition from one state to another. Labgrid includes the `BareboxStrategy` and the `UBootStrategy`, which can be used as-is for simple cases or serve as an example for implementing a custom strategy.

Strategies themselves are not activated/deactivated. Instead, they control the states of the other drivers explicitly and execute actions to bring the target into the requested state.

See the strategy example (`examples/strategy`) and the included strategies in `labgrid/strategy` for some more information.

For more information on the reasons behind labgrid's architecture, see *Design Decisions*.

2.2 Remote Resources and Places

Labgrid contains components for accessing resources which are not directly accessible on the local machine. The main parts of this are:

labgrid-coordinator (crossbar component) Clients and exporters connect to the coordinator to publish resources, manage place configuration and handle mutual exclusion.

labgrid-exporter **(CLI)** Exports explicitly configured local resources to the coordinator and monitors these for changes in availability or parameters.

labgrid-client **(CLI)** Configures places (consisting of exported resources) and allows command line access to some actions (such as power control, bootstrap, fastboot and the console).

RemotePlace (managed resource) When used in a *Target*, the RemotePlace expands to the resources configured for the named places.

These components communicate over the WAMP implementation Autobahn and the Crossbar WAMP router.

2.2.1 Coordinator

The *Coordinator* is implemented as a Crossbar component and is started by the router. It provides separate RPC methods for the exporters and clients.

The coordinator keeps a list of all resources for clients and notifies them of changes as they occur. The resource access from clients does not pass through the coordinator, but is instead done directly from client to exporter, avoiding the need to specify new interfaces for each resource type.

The coordinator also manages the registry of "places". These are used to configure which resources belong together from the user's point of view. A *place* can be a generic rack location, where different boards are connected to a static set of interfaces (resources such as power, network, serial console, ...).

Alternatively, a *place* can also be created for a specific board, for example when special interfaces such as GPIO buttons need to be controlled and they are not available in the generic locations.

Each place can have aliases to simplify accessing a specific board (which might be moved between generic places). It also has a comment, which is used to store a short description of the connected board.

Finally, a place is configured with one or more *resource matches*. A resource match pattern has the format `<exporter>/<group>/<class>`, where each component may be replaced with the wildcard `*`.

Some commonly used match patterns are:

/1001/ Matches all resources in groups named 1001 from all exporters.

***/1001/NetworkPowerPort** Matches only the NetworkPowerPort resource in groups named 1001 from all exporters. This is useful to exclude a NetworkSerialPort in group 1001 in cases where the serial console is connected somewhere else (such as via USB on a different exporter).

exporter1/hub1-port1/* Matches all resources exported from exporter1 in the group hub1-port1. This is an easy way to match several USB resources related to the same board (such as a USB ROM-Loader interface, Android fastboot and a USB serial gadget in Linux).

To avoid conflicting access to the same resources, a place must be *aquired* before it is used and the coordinator also keeps track of which user on which client host has currently acquired the place. The resource matches are only evaluated while a place is being acquired and cannot be changed until it is *released* again.

2.2.2 Exporter

An exporters registers all its configured resources when it connects to the router and updates the resource parameters when they change (such as (dis-)connection of USB devices). Internally, the exporter uses the normal `Resource` (and `ManagedResource`) classes as the rest of labgrid. By using *ManagedResources*, availability and parameters for resources such as USB serial ports are tracked and sent to the coordinator.

For some specific resources (such as `USBSerialPorts`), the exporter uses external tools to allow access by clients (`ser2net` in the serial port case).

Resources which do not need explicit support in the exporter, are just published as declared in the configuration file. This is useful to register externally configured resources such as network power switches or serial port servers with a labgrid coordinator.

2.2.3 Client

The client requests the current lists of resources and places from the coordinator when it connects to it and then registers for change events. Most of its functionality is exposed via the *labgrid-client* CLI tool. It is also used by the `RemotePlace` resource (see below).

Besides viewing the list of *resources*, the client is used to configure and access *places* on the coordinator. For more information on using the CLI, see the manual page for *labgrid-client*.

2.2.4 RemotePlace

To use the resources configured for a *place* to control the corresponding board (whether in pytest or directly with the labgrid library), the `RemotePlace` resource should be used. When a *RemotePlace* is configured for a *Target*, it will create a client connection to the coordinator, create additional resource objects for those configured for that place and keep them updated at runtime.

The additional resource objects can be bound to by drivers as normal and the drivers do not need to be aware that they were provided by the coordinator. For resource types which do not have an existing, network-transparent protocol (such as USB ROM loaders or JTAG interfaces), the driver needs to be aware of the mapping done by the exporter.

For generic USB resources, the exporter for example maps a `AndroidFastboot` resource to a `NetworkAndroidFastboot` resource and adds a hostname property which needs to be used by the client to connect to the exporter. To avoid the need for additional remote access protocols and authentication, labgrid currently expects that the hosts are accessible via SSH and that any file names refer to a shared filesystem (such as NFS or SMB).

Note: Using SSH's session sharing (`ControlMaster auto`, `ControlPersist`, ...) makes *RemotePlaces* easy to use even for exporters with require passwords or more complex login procedures.

For exporters which are not directly accessible via SSH, add the host to your .ssh/config file, with a ProxyCommand when need.

CHAPTER 3

Usage

3.1 Library

Labgrid can be used directly as a Python library, without the infrastructure provided by the pytest plugin.

3.1.1 Creating and Configuring Targets

The labgrid library provides two ways to configure targets with resources and drivers: either create the `Target` directly or use `Environment` to load a configuration file.

Targets

At the lower level, a `Target` can be created directly:

```
>>> from labgrid import Target
>>> t = Target('example')
```

Next, the required `Resources` can be created:

```
>>> from labgrid.resource import RawSerialPort
>>> rsp = RawSerialPort(t, name=None, port='/dev/ttyUSB0')
```

Note: Since we support multiple drivers of the same type, resources and drivers have a required name attribute. If you don't require support for this functionality set the name to *None*.

Then, a `Driver` needs to be created on the *Target*:

```
>>> from labgrid.driver import SerialDriver
>>> sd = SerialDriver(t, name=None)
```

As the *SerialDriver* declares a binding to a SerialPort, the target binds it to the resource created above:

```
>>> sd.port
RawSerialPort(target=Target(name='example', env=None), name=None, state=<BindingState.
↪bound: 1>, avail=True, port='/dev/ttyUSB0', speed=115200)
>>> sd.port is rsp
True
```

Before the driver can be used, it needs to be activated:

```
>>> t.activate(sd)
>>> sd.write(b'test')
```

Active drivers can be accessed by class (any *Driver* or *Protocol*) using some syntactic sugar:

```
>>> target = Target('main')
>>> console = FakeConsoleDriver(target, 'console')
>>> target.activate(console)
>>> target[FakeConsoleDriver]
FakeConsoleDriver(target=Target(name='main', ...), name='console', ...)
>>> target[FakeConsoleDriver, 'console']
FakeConsoleDriver(target=Target(name='main', ...), name='console', ...)
```

Environments

In practice, is is often useful to separate the *Target* configuration from the code which needs to control the board (such as a test case or installation script). For this use-case, labgrid can construct targets from a configuration file in YAML format:

```
targets:
  example:
    resources:
      RawSerialPort:
        port: '/dev/ttyUSB0'
    drivers:
      SerialDriver: {}
```

To parse this configuration file, use the `Environment` class:

```
>>> from labgrid import Environment
>>> env = Environment('example-env.yaml')
```

Using `Environment.get_target`, the configured *Targets* can be retrieved by name. Without an argument, *get_target* would default to 'main':

```
>>> t = env.get_target('example')
```

To access the target's console, the correct driver object can be found by using `Target.get_driver`:

```
>>> from labgrid.protocol import ConsoleProtocol
>>> cp = t.get_driver(ConsoleProtocol)
>>> cp
SerialDriver(target=Target(name='example', env=Environment(config_file='example.yaml
↪')), name=None, state=<BindingState.active: 2>, txdelay=0.0)
>>> cp.write(b'test')
```

When using the `get_driver` method, the driver is automatically activated. The driver activation will also wait for unavailable resources when needed.

For more information on the environment configuration files and the usage of multiple drivers, see *Environment Configuration*.

3.2 pytest Plugin

Labgrid includes a pytest plugin to simplify writing tests which involve embedded boards. The plugin is configured by providing an environment config file (via the –lg-env pytest option, or the LG_ENV environment variable) and automatically creates the targets described in the environment.

Two pytest fixtures are provided:

env (session scope) Used to access the `Environment` object created from the configuration file. This is mostly used for defining custom fixtures at the test suite level.

target (session scope) Used to access the 'main' `Target` defined in the configuration file.

3.2.1 Command-Line Options

The pytest plugin also supports the verbosity argument of pytest:

- `-vv`: activates the step reporting feature, showing function parameters and/or results
- `-vvv`: activates debug logging

This allows debugging during the writing of tests and inspection during test runs.

Other labgrid-related pytest plugin options are:

`--lg-env=LG_ENV` (was `--env-config=ENV_CONFIG`) Specify a labgrid environment config file. This is equivalent to labgrid-client's `-c`/`--config`.

`--lg-coordinator=CROSSBAR_URL` Specify labgrid coordinator websocket URL. Defaults to `ws://127.0.0.1:20408/ws`. This is equivalent to labgrid-client's `-x`/`--crossbar`.

`--lg-log=[path to logfiles]` Path to store console log file. If option is specified without path the current working directory is used.

`--lg-colored-steps` Enables the ColoredStepReporter. Different events have different colors. The more colorful, the more important. In order to make less important output "blend into the background" different color schemes are available. See *LG_COLOR_SCHEME*.

`pytest --help` shows these options in a separate *labgrid* section.

3.2.2 Environment Variables

LG_ENV

Behaves like `LG_ENV` for *labgrid-client*.

LG_COLOR_SCHEME

Influences the color scheme used for the Colored Step Reporter. `dark` (default) is meant for dark terminal background. `light` is optimized for light terminal background. Takes effect only when used with `--lg-colored-steps`.

3.2.3 Simple Example

As a minimal example, we have a target connected via a USB serial converter ('/dev/ttyUSB0') and booted to the Linux shell. The following environment config file (`shell-example.yaml`) describes how to access this board:

```
targets:
  main:
    resources:
      RawSerialPort:
        port: '/dev/ttyUSB0'
    drivers:
      SerialDriver: {}
      ShellDriver:
        prompt: 'root@\w+:[^ ]+ '
        login_prompt: ' login: '
        username: 'root'
```

We then add the following test in a file called `test_example.py`:

```
from labgrid.protocol import CommandProtocol

def test_echo(target):
    command = target.get_driver(CommandProtocol)
    result = command.run_check('echo OK')
    assert 'OK' in result
```

To run this test, we simply execute pytest in the same directory with the environment config:

```
$ pytest --lg-env shell-example.yaml --verbose
============================= test session starts ==============================
platform linux -- Python 3.5.3, pytest-3.0.6, py-1.4.32, pluggy-0.4.0
...
collected 1 items

test_example.py::test_echo PASSED
=========================== 1 passed in 0.51 seconds ===========================
```

pytest has automatically found the test case and executed it on the target.

3.2.4 Custom Fixture Example

When writing many test cases which use the same driver, we can get rid of some common code by wrapping the *CommandProtocol* in a fixture. As pytest always executes the `conftest.py` file in the test suite directory, we can define additional fixtures there:

```
import pytest

from labgrid.protocol import CommandProtocol

@pytest.fixture(scope='session')
def command(target):
    return target.get_driver(CommandProtocol)
```

With this fixture, we can simplify the `test_example.py` file to:

```
def test_echo(command):
    result = command.run_check('echo OK')
    assert 'OK' in result
```

3.2.5 Strategy Fixture Example

When using a `Strategy` to transition the target between states, it is useful to define a function scope fixture per state in `conftest.py`:

```
import pytest

from labgrid.protocol import CommandProtocol
from labgrid.strategy import BareboxStrategy

@pytest.fixture(scope='session')
def strategy(target):
    try:
        return target.get_driver(BareboxStrategy)
    except NoDriverFoundError:
        pytest.skip("strategy not found")

@pytest.fixture(scope='function')
def switch_off(target, strategy, capsys):
    with capsys.disabled():
        strategy.transition('off')

@pytest.fixture(scope='function')
def bootloader_command(target, strategy, capsys):
    with capsys.disabled():
        strategy.transition('barebox')
    return target.get_active_driver(CommandProtocol)

@pytest.fixture(scope='function')
def shell_command(target, strategy, capsys):
    with capsys.disabled():
        strategy.transition('shell')
    return target.get_active_driver(CommandProtocol)
```

Note: The `capsys.disabled()` context manager is only needed when using the `ManualPowerDriver`, as it will not be able to access the console otherwise. See the corresponding pytest documentation for details.

With the fixtures defined above, switching between bootloader and Linux shells is easy:

```
def test_barebox_initial(bootloader_command):
    stdout = bootloader_command.run_check('version')
    assert 'barebox' in '\n'.join(stdout)

def test_shell(shell_command):
    stdout = shell_command.run_check('cat /proc/version')
    assert 'Linux' in stdout[0]

def test_barebox_after_reboot(bootloader_command):
    bootloader_command.run_check('true')
```

Note: The *bootloader_command* and *shell_command* fixtures use `Target.get_active_driver` to get the currently active *CommandProtocol* driver (either `BareboxDriver` or `ShellDriver`). Activation and deactivation of drivers is handled by the `BareboxStrategy` in this example.

The *Strategy* needs additional drivers to control the target. Adapt the following environment config file (`strategy-example.yaml`) to your setup:

```
targets:
  main:
    resources:
      RawSerialPort:
        port: '/dev/ttyUSB0'
    drivers:
      ManualPowerDriver:
        name: 'example-board'
      SerialDriver: {}
      BareboxDriver:
        prompt: 'barebox@[^:]+:[^ ]+ '
      ShellDriver:
        prompt: 'root@\w+:[^ ]+ '
        login_prompt: ' login: '
        username: 'root'
      BareboxStrategy: {}
```

For this example, you should get a report similar to this:

```
$ pytest --lg-env strategy-example.yaml -v
============================= test session starts ==============================
platform linux -- Python 3.5.3, pytest-3.0.6, py-1.4.32, pluggy-0.4.0
...
collected 3 items

test_strategy.py::test_barebox_initial
main: CYCLE the target example-board and press enter
PASSED
test_strategy.py::test_shell PASSED
test_strategy.py::test_barebox_after_reboot
main: CYCLE the target example-board and press enter
PASSED

========================== 3 passed in 29.77 seconds ===========================
```

3.2.6 Feature Flags

Labgrid includes support for feature flags on a global and target scope. They will be concatenated and compared to a pytest mark on the test to decide whether the test can run with the available features.:

```
import pytest

@pytest.mark.lg_feature("camera")
def test_camera(target):
    [...]
```

together with an example environment configuration:

```
targets:
  main:
    features:
      - camera
    resources: {}
    drivers: {}
```

would run the above test, however the following configuration would skip the test because of the missing feature:

```
targets:
  main:
    features:
      - console
    resources: {}
    drivers: {}
```

This is also reported in the pytest execution as a skipped test with the reason being the missing feature.

For tests with multiple required features, pass them as a list to pytest::

```
import pytest

@pytest.mark.lg_feature(["camera", "console"])
def test_camera(target):
   [...]
```

Features do not have to be set per target, they can also be set via the global features key:

```
features:
  - camera
targets:
  main:
    features:
      - console
    resources: {}
    drivers: {}
```

This yaml would combine both the global and the target features.

3.2.7 Test Reports

pytest-html

With the pytest-html plugin, the test results can be converted directly to a single-page HTML report:

```
$ pip install pytest-html
$ pytest --lg-env shell-example.yaml --html=report.html
```

JUnit XML

JUnit XML reports can be generated directly by pytest and are especially useful for use in CI systems such as Jenkins with the JUnit Plugin.

They can also be converted to other formats, such as HTML with junit2html tool:

```
$ pip install junit2html
$ pytest --lg-env shell-example.yaml --junit-xml=report.xml
$ junit2html report.xml
```

Labgrid adds additional xml properties to a test run, these are:

- ENV_CONFIG: Name of the configuration file
- TARGETS: List of target names
- TARGET_{NAME}_REMOTE: optional, if the target uses a RemotePlace resource, its name is recorded here
- PATH_{NAME}: optional, labgrid records the name and path
- PATH_{NAME}_GIT_COMMIT: optional, labgrid tries to record git sha1 values for every path
- IMAGE_{NAME}: optional, labgrid records the name and path to the image
- IMAGE_{NAME}_GIT_COMMIT: optional, labgrid tries to record git sha1 values for every image

3.3 Command-Line

Labgrid contains some command line tools which are used for remote access to resources. See *labgrid-client*, *labgrid-device-config* and *labgrid-exporter* for more information.

3.4 USB stick emulation

Labgrid makes it posible to use a target as an emulated USB stick, allowing upload, modification, plug and unplug events. To use a target as an emulated USB stick, several requirements have to be met:

- OTG support on one of the device USB ports
- losetup from util-linux
- mount from util-linux
- A kernel build with *CONFIG_USB_GADGETFS=m*
- A network connection to the target to use the *SSHDriver* for file uploads

To use USB stick emulation, import `USBStick` from *labgrid.external* and bind it to the desired target:

```
from labgrid.external import USBStick

stick = USBStick(target, '/home/')
```

The above code block creates the stick and uses the */home* directory to store the device images. USBStick images can now be uploaded using the *upload_image* method. Once an image is selected, files can be uploaded and retrived using the *put_file* and *get_file* methods. The *plug_in* and *plug_out* functions plug the emulated USB stick in and out.

3.5 hawkBit management API

Labgrid provides an interface to the hawkbit management API. This allows a labgrid test to create targets, rollouts and manage deployments.

```
from labgrid.external import HawkbitTestClient

client = HawkbitTestClient('local', '8080', 'admin', 'admin')
```

The above code connects to a running hawkbit instance on the local computer and uses the default credentials to log in. The `HawkbitTestClient` provides various helper functions to add targets, define distribution sets and assign targets.

CHAPTER 4

Manual Pages

4.1 labgrid-client

4.1.1 labgrid-client interface to control boards

Author Rouven Czerwinski <r.czerwinski@pengutronix.de>

organization Labgrid-Project

Date 2017-04-15

Version 0.0.1

Manual section 1

Manual group embedded testing

SYNOPSIS

`labgrid-client --help`

`labgrid-client` -p <place> <command>

`labgrid-client places|resources`

DESCRIPTION

Labgrid is a scalable infrastructure and test architecture for embedded (linux) systems.

This is the client to control a boards status and interface with it on remote machines.

OPTIONS

-h, --help display command line help

-p PLACE, --place PLACE specify the place to operate on

-x, --crossbar-url the crossbar url of the coordinator

-c CONFIG, --config CONFIG set the configuration file

-s STATE, --state STATE set an initial state before executing a command, requires a configuration file and strategy

-d, --debug enable debugging

CONFIGURATION FILE

The configuration file follows the description in `labgrid-device-config`(1).

ENVIRONMENT VARIABLES

Various labgrid-client commands use the following environment variable:

PLACE

This variable can be used to specify a place without using the `-p` option, the `-p` option overrides it.

STATE

This variable can be used to specify a state which the device transitions into before executing a command. Requires a configuration file and a Strategy specified for the device.

LG_ENV

This variable can be used to specify the configuration file to use without using the `--config` option, the `--config` option overrides it.

LG_CROSSBAR

This variable can be used to set the default crossbar URL (instead of using the `-x` option).

LG_CROSSBAR_REALM

This variable can be used to set the default crossbar realm to use instead of `realm1`.

MATCHES

Match patterns are used to assign a resource to a specific place. The format is: exporter/group/cls/name, exporter is the name of the exporting machine, group is a name defined within the exporter, cls is the class of the exported resource and name is its name. Wild cards in match patterns are explicitly allowed, * matches anything.

LABGRID-CLIENT COMMANDS

`monitor` Monitor events from the coordinator

`resources (r)` List available resources

`places (p)` List available places

`show` Show a place and related resources

`create` Add a new place (name supplied by -p parameter)

`delete` Delete an existing place

`add-alias` Add an alias to a place

`del-alias` Delete an alias from a place

`set-comment` Update or set the place comment

`add-match` match Add a match pattern to a place, see MATCHES

`del-match` match Delete a match pattern from a place, see MATCHES

`acquire (lock)` Acquire a place

`release (unlock)` Release a place

`env` Generate a labgrid environment file for a place

`power (pw)` action Change (or get) a place's power status, where action is one of get, on, off, status

`console (con)` Connect to the console

`fastboot` Run fastboot

`bootstrap` Start a bootloader

`io` Interact with Onewire devices

EXAMPLES

To retrieve a list of places run:

```
$ labgrid-client places
```

To access a place, it needs to be acquired first, this can be done by running the `acquire command` and passing the placename as a -p parameter:

```
$ labgrid-client -p <placename> acquire
```

Open a console to the acquired place:

```
$ labgrid-client -p <placename> console
```

Add all resources with the group "example-group" to the place example-place:

```
$ labgrid-client -p example-place add-match */example-group/*/*
```

SEE ALSO

`labgrid-exporter`(1)

4.2 labgrid-device-config

4.2.1 labgrid test configuration files

Author Rouven Czerwinski <r.czerwinski@pengutronix.de>

organization Labgrid-Project

Date 2017-04-15

Version 0.0.1

Manual section 1

Manual group embedded testing

SYNOPSIS

`*.yaml`

DESCRIPTION

To integrate a device into a labgrid test, labgrid needs to have a description of the device and how to access it.

This manual page is divided into section, each describing one top-level yaml key.

TARGETS

The `targets:` top key configures a `target`, it's `drivers` and `resources`.

The top level key is the name of the target, it needs both a `resources` and `drivers` subkey. The order of instantiated `resources` and `drivers` is important, since they are parsed as an ordered dictionary and may depend on a previous driver.

For a list of available resources and drivers refer to https://labgrid.readthedocs.io/en/latest/configuration.html.

OPTIONS

The `options:` top key configures various options such as the crossbar_url.

OPTIONS KEYS

`crossbar_url` takes as parameter the URL of the crossbar (coordinator) to connect to. Defaults to 'ws://127.0.0.1:20408'.

`crossbar_realm` takes as parameter the realm of the crossbar (coordinator) to connect to. Defaults to 'realm1'.

IMAGES

The `images:` top key provides paths to access preconfigured images to flash onto the board.

IMAGE KEYS

The subkeys consist of image names as keys and their paths as values. The corresponding name can than be used with the appropriate tool found under TOOLS.

TOOLS

The `tools:` top key provides paths to binaries such as fastboot.

TOOLS KEYS

`fastboot` Path to the fastboot binary

`mxs-usb-loader` Path to the mxs-usb-loader binary

`imx-usb-loader` Path to the imx-usb-loader binary

IMPORTS

The `imports` key is a list of files or python modules which are imported by the environment after loading the configuration. Paths relative to the configuration file are also supported.

EXAMPLES

A sample configuration with one *main* target, accessible via SerialPort */dev/ttyUSB0*, allowing usage of the ShellDriver:

```
targets:
  main:
    resources:
      RawSerialPort:
        port: "/dev/ttyUSB0"
    drivers:
      SerialDriver: {}
      ShellDriver:
        prompt: 'root@\w+:[^ ]+ '
        login_prompt: ' login: '
        username: 'root'
```

SEE ALSO

`labgrid-client`(1), `labgrid-exporter`(1)

4.3 labgrid-exporter

4.3.1 labgrid-exporter interface to control boards

Author Rouven Czerwinski <r.czerwinski@pengutronix.de>

organization Labgrid-Project

Date 2017-04-15

Version 0.0.1

Manual section 1

Manual group embedded testing

SYNOPSIS

```
labgrid-exporter --help
labgrid-exporter *.yaml
```

DESCRIPTION

Labgrid is a scalable infrastructure and test architecture for embedded (linux) systems.

This is the man page for the exporter, supporting the export of serial ports, USB devices and various other controllers.

OPTIONS

-h, --help	display command line help
-x, --crossbar-url	the crossbar url of the coordinator
-i, --isolated	enable isolated mode (always request SSH forwards)
-n, --name	the public name of the exporter
--hostname	hostname (or IP) published for accessing resources

-i / –isolated

This option enables isolated mode, which causes all exported resources marked as requiring SSH connection forwarding. Isolated mode is useful when resources (such as NetworkSerialPorts) are not directly accessible from the clients. The client will then use SSH to create a port forward to the resource when needed.

-n / –name

This option is used to configure the exporter name under which resources are registered with the coordinator, which is useful when running multiple exporters on the same host. It defaults to the system hostname.

–hostname

For resources like USBSerialPort, USBGenericExport or USBSigrokExport, the exporter needs to provide a host name to set the exported value of the “host” key. If the system hostname is not resolvable via DNS, this option can be used to override this default with another name (or an IP address).

CONFIGURATION

The exporter uses a YAML configuration file which defines groups of releated resources. Furthermore the exporter can start helper binaries such as `ser2net` to export local serial ports over the network.

ENVIRONMENT VARIABLES

The following environment variable can be used to configure labgrid-exporter.

LG_CROSSBAR

This variable can be used to set the default crossbar URL (instead of using the `-x` option).

LG_CROSSBAR_REALM

This variable can be used to set the default crossbar realm to use instead of `realm1`.

EXAMPLES

Start the exporter with the configuration file *my-config.yaml*:

```
$ labgrid-exporter my-config.yaml
```

Same as above, but with name `myname`:

```
$ labgrid-exporter -n myname my-config.yaml
```

SEE ALSO

`labgrid-client`(1), `labgrid-device-config`(1)

CHAPTER 5

Configuration

This chapter describes the individual drivers and resources used in a device configuration. Drivers can depend on resources or other drivers, whereas resources have no dependencies.

Here the resource *RawSerialPort* provides the information for the *SerialDriver*, which in turn is needed by the *ShellDriver*. Driver dependency resolution is done by searching for the driver which implements the dependent protocol, all drivers implement one or more protocols.

5.1 Resources

5.1.1 Serial Ports

RawSerialPort

A RawSerialPort is a serial port which is identified via the device path on the local computer. Take note that re-plugging USB serial converters can result in a different enumeration order.

```
RawSerialPort:
  port: /dev/ttyUSB0
  speed: 115200
```

The example would access the serial port /dev/ttyUSB0 on the local computer with a baud rate of 115200.

- port (str): path to the serial device
- speed (int): desired baud rate

Used by:

- *SerialDriver*

NetworkSerialPort

A NetworkSerialPort describes a serial port which is exported over the network, usually using RFC2217 or raw tcp.

```
NetworkSerialPort:
  host: remote.example.computer
  port: 53867
  speed: 115200
```

The example would access the serial port on computer remote.example.computer via port 53867 and use a baud rate of 115200 with the RFC2217 protocol.

- host (str): hostname of the remote host
- port (str): TCP port on the remote host to connect to
- speed (int): baud rate of the serial port
- protocol (str): optional, protocol used for connection: raw or rfc2217

Used by:

- *SerialDriver*

USBSerialPort

A USBSerialPort describes a serial port which is connected via USB and is identified by matching udev properties. This allows identification through hot-plugging or rebooting.

```
USBSerialPort:
  match:
    'ID_SERIAL_SHORT': 'P-00-00682'
  speed: 115200
```

The example would search for a USB serial converter with the key *ID_SERIAL_SHORT* and the value *P-00-00682* and use it with a baud rate of 115200.

- match (str): key and value for a udev match, see *udev Matching*
- speed (int): baud rate of the serial port

Used by:

- *SerialDriver*

5.1.2 Power Ports

NetworkPowerPort

A NetworkPowerPort describes a remotely switchable power port.

```
NetworkPowerPort:
  model: gude
  host: powerswitch.example.computer
  index: 0
```

The example describes port 0 on the remote power switch *powerswitch.example.computer*, which is a *gude* model.

- model (str): model of the power switch

- host (str): hostname of the power switch
- index (int): number of the port to switch

Used by:

- *NetworkPowerDriver*

YKUSHPowerPort

A YKUSHPowerPort describes a YEPKIT YKUSH USB (HID) switchable USB hub.

```
YKUSHPowerPort:
  serial: YK12345
  index: 1
```

The example describes port 1 on the YKUSH USB hub with the serial "YK12345". (use "pykush -l" to get your serial...)

- serial (str): serial number of the YKUSH hub
- index (int): number of the port to switch

Used by:

- *YKUSHPowerDriver*

USBPowerPort

A USBPowerPort describes a generic switchable USB hub as supported by uhubctl.

```
USBPowerPort:
  match:
    ID_PATH: pci-0000:00:14.0-usb-0:2:1.0
  index: 1
```

The example describes port 1 on the hub with the ID_PATH "pci-0000:00:14.0-usb-0:2:1.0". (use `udevadm info /sys/bus/usb/devices/...` to find the ID_PATH value)

- index (int): number of the port to switch

Used by:

- *USBPowerDriver*

5.1.3 ModbusTCPCoil

A ModbusTCPCoil describes a coil accessible via ModbusTCP.

```
ModbusTCPCoil:
  host: "192.168.23.42"
  coil: 1
```

The example describes the coil with the address 1 on the ModbusTCP device *192.168.23.42*.

- host (str): hostname of the Modbus TCP server e.g. "192.168.23.42:502"
- coil (int): index of the coil e.g. 3
- invert (bool): optional, whether the logic level is be inverted (active-low)

Used by:

- *ModbusCoilDriver*

5.1.4 NetworkService

A NetworkService describes a remote SSH connection.

```
NetworkService:
  address: example.computer
  username: root
```

The example describes a remote SSH connection to the computer *example.computer* with the username *root*. Set the optional password password property to make SSH login with a password instead of the key file (needs sshpass to be installed)

- address (str): hostname of the remote system
- username (str): username used by SSH
- password (str): password used by SSH
- port (int): optional, port used by SSH (default 22)

Used by:

- *SSHDriver*

5.1.5 OneWirePIO

A OneWirePIO describes a onewire programmable I/O pin.

```
OneWirePIO:
  host: example.computer
  path: /29.7D6913000000/PIO.0
  invert: false
```

The example describes a *PIO.0* at device address *29.7D6913000000* via the onewire server on *example.computer*.

- host (str): hostname of the remote system running the onewire server
- path (str): path on the server to the programmable I/O pin
- invert (bool): optional, whether the logic level is be inverted (active-low)

Used by:

- *OneWirePIODriver*

5.1.6 USBMassStorage

A USBMassStorage resource describes a USB memory stick or similar device.

```
USBMassStorage:
  match:
    'ID_PATH': 'pci-0000:06:00.0-usb-0:1.3.2:1.0-scsi-0:0:0:3'
```

- match (str): key and value for a udev match, see *udev Matching*

Used by:

- *USBStorageDriver*
- *NetworkUSBStorageDriver*

5.1.7 NetworkUSBMassStorage

A NetworkUSBMassStorage resource describes a USB memory stick or similar device available on a remote computer.

Used by:

- *NetworkUSBStorageDriver*

The NetworkUSBMassStorage can be used in test cases by calling the *write_image()*, and *get_size()* functions.

5.1.8 SigrokDevice

A SigrokDevice resource describes a sigrok device. To select a specific device from all connected supported devices use the *SigrokUSBDevice*.

```
SigrokUSBDevice:
  driver: fx2lafw
  channel: "D0=CLK,D1=DATA"
```

- driver (str): name of the sigrok driver to use
- channel (str): channel mapping as described in the sigrok-cli man page

Used by:

- *SigrokDriver*

5.1.9 IMXUSBLoader

An IMXUSBLoader resource describes a USB device in the imx loader state.

```
IMXUSBLoader:
  match:
    'ID_PATH': 'pci-0000:06:00.0-usb-0:1.3.2:1.0'
```

- match (str): key and value for a udev match, see *udev Matching*

Used by:

- *IMXUSBDriver*

5.1.10 MXSUSBLoader

An MXSUSBLoader resource describes a USB device in the mxs loader state.

```
MXSUSBLoader:
  match:
    'ID_PATH': 'pci-0000:06:00.0-usb-0:1.3.2:1.0'
```

- match (str): key and value for a udev match, see *udev Matching*

Used by:

- *MXSUSBDriver*

5.1.11 NetworkMXSUSBLoader

A NetworkMXSUSBLoader descibes an *MXSUSBLoader* available on a remote computer.

5.1.12 NetworkIMXUSBLoader

A NetworkIMXUSBLoader descibes an *IMXUSBLoader* available on a remote computer.

5.1.13 AndroidFastboot

An AndroidFastboot resource describes a USB device in the fastboot state.

```
AndroidFastboot:
  match:
    'ID_PATH': 'pci-0000:06:00.0-usb-0:1.3.2:1.0'
```

- match (str): key and value for a udev match, see *udev Matching*

Used by:

- *AndroidFastbootDriver*

5.1.14 USBEthernetInterface

A USBEthernetInterface resource describes a USB device Ethernet adapter.

```
USBEthernetInterface:
  match:
    'ID_PATH': 'pci-0000:06:00.0-usb-0:1.3.2:1.0'
```

- match (str): key and value for a udev match, see *udev Matching*

5.1.15 AlteraUSBBlaster

An AlteraUSBBlaster resource describes an Altera USB blaster.

```
AlteraUSBBlaster:
  match:
    'ID_PATH': 'pci-0000:06:00.0-usb-0:1.3.2:1.0'
```

- match (dict): key and value for a udev match, see *udev Matching*

Used by:

- *OpenOCDDriver*
- *QuartusHPSDriver*

5.1.16 SNMPEthernetPort

A SNMPEthernetPort resource describes a port on an Ethernet switch, which is accessible via SNMP.

```
SNMPEthernetPort:
  switch: "switch-012"
  interface: "17"
```

- switch (str): host name of the Ethernet switch
- interface (str): interface name

5.1.17 SigrokUSBDevice

A SigrokUSBDevice resource describes a sigrok USB device.

```
SigrokUSBDevice:
  driver: fx2lafw
  channel: "D0=CLK,D1=DATA"
  match:
    'ID_PATH': 'pci-0000:06:00.0-usb-0:1.3.2:1.0'
```

- driver (str): name of the sigrok driver to use
- channel (str): channel mapping as described in the sigrok-cli man page
- match (str): key and value for a udev match, see *udev Matching*

Used by:

- *SigrokDriver*

5.1.18 NetworkSigrokUSBDevice

A NetworkSigrokUSBDevice resource describes a sigrok USB device connected to a host which is exported over the network. The SigrokDriver will access it via SSH.

```
NetworkSigrokUSBDevice:
  driver: fx2lafw
  channel: "D0=CLK,D1=DATA"
  match:
    'ID_PATH': 'pci-0000:06:00.0-usb-0:1.3.2:1.0'
  host: remote.example.computer
```

- driver (str): name of the sigrok driver to use
- channel (str): channel mapping as described in the sigrok-cli man page
- match (str): key and value for a udev match, see *udev Matching*

Used by:

- *SigrokDriver*

5.1.19 USBSDMuxDevice

A `USBSDMuxDevice` resource describes a Pengutronix USB-SD-Mux device.

```
USBSDMuxDevice:
  match:
    '@ID_PATH': 'pci-0000:00:14.0-usb-0:1.2'
```

- match (str): key and value for a udev match, see *udev Matching*

Used by:

- *USBSDMUXDriver*

5.1.20 NetworkUSBSDMuxDevice

A `NetworkUSBSDMuxDevice` resource describes a *USBSDMuxDevice* available on a remote computer.

5.1.21 USBVideo

A `USBVideo` resource describes a USB video camera which is supported by a Video4Linux2 kernel driver.

```
USBVideo:
  match:
    '@ID_PATH': 'pci-0000:00:14.0-usb-0:1.2'
```

Used by:

- *USBVideoDriver*

5.1.22 NetworkUSBVideo

A `NetworkUSBVideo` resource describes a `USBVideo` resource available on a remote computer.

5.1.23 USBTMC

A `USBTMC` resource describes an oscilloscope connected via the USB TMC protocol. The low-level communication is handled by the `usbtmc` kernel driver.

```
USBTMC:
  match:
    '@ID_PATH': 'pci-0000:00:14.0-usb-0:1.2'
```

A udev rules file may be needed to allow access for non-root users:

```
DRIVERS=="usbtmc", MODE="0660", GROUP="plugdev"
```

Used by:

- *USBTMCDriver*

5.1.24 NetworkUSBTMC

A `NetworkUSBTMC` resource describes a `USBTMC` resource available on a remote computer.

5.1.25 XenaManager

A XenaManager resource describe a Xena Manager instance which is the instance the Xena Driver must connect to in order to configure a Xena chassis.

```
XenaManager:
  hostname: "example.computer"
```

Used by:

- *XenaDriver*

5.1.26 RemotePlace

A RemotePlace describes a set of resources attached to a labgrid remote place.

```
RemotePlace:
  name: example-place
```

The example describes the remote place *example-place*. It will connect to the labgrid remote coordinator, wait until the resources become available and expose them to the internal environment.

- name (str): name or pattern of the remote place

Used by:

- potentially all drivers

5.1.27 udev Matching

udev matching allows labgrid to identify resources via their udev properties. Any udev property key and value can be used, path matching USB devices is allowed as well. This allows exporting a specific USB hub port or the correct identification of a USB serial converter across computers.

The initial matching and monitoring for udev events is handled by the `UdevManager` class. This manager is automatically created when a resource derived from `USBResource` (such as `USBSerialPort`, `IMXUSBLoader` or `AndroidFastboot`) is instantiated.

To identify the kernel device which corresponds to a configured *USBResource*, each existing (and subsequently added) kernel device is matched against the configured resources. This is based on a list of *match entries* which must all be tested successfully against the potential kernel device. Match entries starting with an `@` are checked against the device's parents instead of itself; here one matching parent causes the check to be successful.

A given *USBResource* class has builtin match entries that are checked first, for example that the `SUBSYSTEM` is `tty` as in the case of the `USBSerialPort`. Only if these succeed, match entries provided by the user for the resource instance are considered.

In addition to the properties reported by `udevadm monitor --udev --property`, elements of the `ATTR(S){}` dictionary (as shown by `udevadm info <device> -a`) are useable as match keys. Finally `sys_name` allows matching against the name of the directory in sysfs. All match entries must succeed for the device to be accepted.

The following examples show how to use the udev matches for some common use-cases.

Matching a USB Serial Converter on a Hub Port

This will match any USB serial converter connected below the hub port 1.2.5.5 on bus 1. The *sys_name* value corresponds to the hierarchy of buses and ports as shown with `lsusb -t` and is also usually displayed in the kernel log messages when new devices are detected.

```
USBSerialPort:
  match:
    '@sys_name': '1-1.2.5.5'
```

Note the `@` in the `@sys_name` match, which applies this match to the device's parents instead of directly to itself. This is necessary for the *USBSerialPort* because we actually want to find the `ttyUSB?` device below the USB serial converter device.

Matching an Android Fastboot Device

In this case, we want to match the USB device on that port directly, so we don't use a parent match.

```
AndroidFastboot:
  match:
    'sys_name': '1-1.2.3'
```

Matching a Specific UART in a Dual-Port Adapter

On this board, the serial console is connected to the second port of an on-board dual-port USB-UART. The board itself is connected to the bus 3 and port path 10.2.2.2. The correct value can be shown by running `udevadm info /dev/ttyUSB9` in our case:

```
$ udevadm info /dev/ttyUSB9
P: /devices/pci0000:00/0000:00:14.0/usb3/3-10/3-10.2/3-10.2.2/3-10.2.2.2/3-10.2.2.2:1.
↪1/ttyUSB9/tty/ttyUSB9
N: ttyUSB9
S: serial/by-id/usb-FTDI_Dual_RS232-HS-if01-port0
S: serial/by-path/pci-0000:00:14.0-usb-0:10.2.2.2:1.1-port0
E: DEVLINKS=/dev/serial/by-id/usb-FTDI_Dual_RS232-HS-if01-port0 /dev/serial/by-path/
↪pci-0000:00:14.0-usb-0:10.2.2.2:1.1-port0
E: DEVNAME=/dev/ttyUSB9
E: DEVPATH=/devices/pci0000:00/0000:00:14.0/usb3/3-10/3-10.2/3-10.2.2/3-10.2.2.2/3-10.
↪2.2.2:1.1/ttyUSB9/tty/ttyUSB9
E: ID_BUS=usb
E: ID_MODEL=Dual_RS232-HS
E: ID_MODEL_ENC=Dual\x20RS232-HS
E: ID_MODEL_FROM_DATABASE=FT2232C Dual USB-UART/FIFO IC
E: ID_MODEL_ID=6010
E: ID_PATH=pci-0000:00:14.0-usb-0:10.2.2.2:1.1
E: ID_PATH_TAG=pci-0000_00_14_0-usb-0_10_2_2_2_1_1
E: ID_REVISION=0700
E: ID_SERIAL=FTDI_Dual_RS232-HS
E: ID_TYPE=generic
E: ID_USB_DRIVER=ftdi_sio
E: ID_USB_INTERFACES=:ffffff:
E: ID_USB_INTERFACE_NUM=01
E: ID_VENDOR=FTDI
E: ID_VENDOR_ENC=FTDI
E: ID_VENDOR_FROM_DATABASE=Future Technology Devices International, Ltd
```

```
E: ID_VENDOR_ID=0403
E: MAJOR=188
E: MINOR=9
E: SUBSYSTEM=tty
E: TAGS=:systemd:
E: USEC_INITIALIZED=9129609697
```

We use the `ID_USB_INTERFACE_NUM` to distinguish between the two ports:

```
USBSerialPort:
  match:
    '@sys_name': '3-10.2.2.2'
    'ID_USB_INTERFACE_NUM': '01'
```

Matching a USB UART by Serial Number

Most of the USB serial converters in our lab have been programmed with unique serial numbers. This makes it easy to always match the same one even if the USB topology changes or a board has been moved between host systems.

```
USBSerialPort:
  match:
    'ID_SERIAL_SHORT': 'P-00-00679'
```

To check if your device has a serial number, you can use `udevadm info`:

```
$ udevadm info /dev/ttyUSB5 | grep SERIAL_SHORT
E: ID_SERIAL_SHORT=P-00-00679
```

5.2 Drivers

5.2.1 SerialDriver

A SerialDriver connects to a serial port. It requires one of the serial port resources.

Binds to:

port:

- *NetworkSerialPort*
- *RawSerialPort*
- *USBSerialPort*

```
SerialDriver:
  txdelay: 0.05
```

Implements:

- `ConsoleProtocol`

Arguments:

- txdelay (float): time in seconds to wait before sending each byte

5.2.2 ShellDriver

A ShellDriver binds on top of a *ConsoleProtocol* and is designed to interact with a login prompt and a Linux shell.

Binds to:

console:

- `ConsoleProtocol`

Implements:

- `CommandProtocol`

```
ShellDriver:
  prompt: 'root@\w+:[^ ]+ '
  login_prompt: ' login: '
  username: 'root'
```

Arguments:

- prompt (regex): shell prompt to match after logging in
- login_prompt (regex): match for the login prompt
- username (str): username to use during login
- password (str): password to use during login
- keyfile (str): optional keyfile to upload after login, making the *SSHDriver* usable
- login_timeout (int): optional, timeout for login prompt detection in seconds (default 60)
- await_login_timeout (int): optional, time in seconds of silence that needs to pass before sending a newline to device.
- console_ready (regex): optional, pattern used by the kernel to inform the user that a console can be activated by pressing enter.

5.2.3 SSHDriver

A SSHDriver requires a *NetworkService* resource and allows the execution of commands and file upload via network. It uses SSH's ServerAliveInterval option to detect failed connections.

If a shared SSH connection to the target is already open, it will reuse it when running commands. In that case, ServerAliveInterval should be set outside of labgrid, as it cannot be enabled for an existing connection.

Binds to:

networkservice:

- *NetworkService*

Implements:

- `CommandProtocol`
- `FileTransferProtocol`

```
SSHDriver:
  keyfile: example.key
```

Arguments:

- keyfile (str): filename of private key to login into the remote system (only used if password is not set)
- **stderr_merge (bool): set to True to make *run()* return stderr merged with** stdout, and an empty list as second element.

5.2.4 InfoDriver

An InfoDriver provides an interface to retrieve system settings and state. It requires a *CommandProtocol*.

Binds to:

command:

- `CommandProtocol`

Implements:

- `InfoProtocol`

```
InfoDriver: {}
```

Arguments:

- None

5.2.5 UBootDriver

A UBootDriver interfaces with a u-boot boot loader via a *ConsoleProtocol*.

Binds to:

console:

- `ConsoleProtocol`

Implements:

- `CommandProtocol`

```
UBootDriver:
  prompt: 'Uboot> '
```

Arguments:

- prompt (regex): u-boot prompt to match
- password (str): optional, u-boot unlock password
- interrupt (str, default="\n"): string to interrupt autoboot (use "\x03" for CTRL-C)
- init_commands (tuple): tuple of commands to execute after matching the prompt
- password_prompt (str): optional, regex to match the uboot password prompt, defaults to "enter Password: "
- boot_expression (str): optional, regex to match the uboot start string defaults to "U-Boot 20d+"
- bootstring (str): optional, regex to match on Linux Kernel boot
- login_timeout (int): optional, timeout for login prompt detection in seconds (default 60)

5.2.6 SmallUBootDriver

A SmallUBootDriver interfaces with stripped-down UBoot variants that are sometimes used in cheap consumer electronics.

SmallUBootDriver is meant as a driver for UBoot with only little functionality compared to standard a standard UBoot. Especially is copes with the following limitations:

- The UBoot does not have a real password-prompt but can be activated by entering a "secret" after a message was displayed.
- The command line is does not have a build-in echo command. Thus this driver uses 'Unknown Command' messages as marker before and after the output of a command.
- Since there is no echo we can not return the exit code of the command. Commands will always return 0 unless the command was not found.

This driver needs the following features activated in UBoot to work:

- The UBoot must not have real password prompt. Instead it must be keyword activated. For example it should be activated by a dialog like the following:
  - UBoot: "Autobooting in 1s..."
  - Labgrid: "secret"
  - UBoot: <switching to console>
- The UBoot must be able to parse multiple commands in a single line separated by ";".
- The UBoot must support the "bootm" command to boot from a memory location.

Binds to:

- `ConsoleProtocol` (see *SerialDriver*)

Implements:

- `CommandProtocol`

```
SmallUBootDriver:
  prompt: 'ap143-2\.0> '
  boot_expression: 'Autobooting in 1 seconds'
  boot_secret: "tpl"
```

Arguments:

- prompt (regex): u-boot prompt to match
- init_commands (tuple): tuple of commands to execute after matching the prompt
- boot_expression (str): optional, regex to match the uboot start string defaults to "U-Boot 20d+"
- login_timeout (str): optional, timeout for the password/login detection

5.2.7 BareboxDriver

A BareboxDriver interfaces with a barebox bootloader via a *ConsoleProtocol*.

Binds to:

console:

- `ConsoleProtocol`

Implements:

- `CommandProtocol`

```
BareboxDriver:
  prompt: 'barebox@[^:]+:[^ ]+ '
```

Arguments:

- prompt (regex): barebox prompt to match
- autoboot (regex, default="stop autoboot"): autoboot message to match
- interrupt (str, default="\n"): string to interrupt autoboot (use "\x03" for CTRL-C)
- startstring (regex, default="[n]barebox 20d+"): string that indicates that Barebox is starting
- bootstring (regex, default="Linux version d"): succesfully jumped into the kernel
- password (str): optional, password to use for access to the shell
- login_timeout (int): optional, timeout for access to the shell

5.2.8 ExternalConsoleDriver

An ExternalConsoleDriver implements the *ConsoleProtocol* on top of a command executed on the local computer.

Implements:

- `ConsoleProtocol`

```
ExternalConsoleDriver:
  cmd: 'microcom /dev/ttyUSB2'
  txdelay: 0.05
```

Arguments:

- cmd (str): command to execute and then bind to.
- txdelay (float): time in seconds to wait before sending each byte

5.2.9 AndroidFastbootDriver

An AndroidFastbootDriver allows the upload of images to a device in the USB fastboot state.

Binds to:

fastboot:

- *AndroidFastboot*

Implements:

- None (yet)

```
AndroidFastbootDriver:
  image: mylocal.image
```

Arguments:

- image (str): filename of the image to upload to the device

5.2.10 OpenOCDDriver

An OpenOCDDriver controls OpenOCD to bootstrap a target with a bootloader.

Binds to:

interface:

- *AlteraUSBBlaster*

Implements:

- `BootstrapProtocol`

Arguments:

- config (str): OpenOCD configuration file
- search (str): include search path for scripts
- image (str): filename of image to bootstrap onto the device

5.2.11 QuartusHPSDriver

A QuartusHPSDriver controls the "Quartus Prime Programmer and Tools" to flash a target's QSPI.

Binds to:

- *AlteraUSBBlaster*

Implements:

- None

Arguments:

- image (str): filename of image to flash QSPI

The driver can be used in test cases by calling the *flash* function. An example strategy is included in Labgrid.

5.2.12 ManualPowerDriver

A ManualPowerDriver requires the user to control the target power states. This is required if a strategy is used with the target, but no automatic power control is available.

Implements:

- `PowerProtocol`

```
ManualPowerDriver:
  name: 'example-board'
```

Arguments:

- name (str): name of the driver (will be displayed during interaction)

5.2.13 ExternalPowerDriver

An ExternalPowerDriver is used to control a target power state via an external command.

Implements:

- PowerProtocol

```
ExternalPowerDriver:
  cmd_on: example_command on
  cmd_off: example_command off
  cmd_cycle: example_command cycle
```

Arguments:

- cmd_on (str): command to turn power to the board on
- cmd_off (str): command to turn power to the board off
- cycle (str): optional command to switch the board off and on
- delay (float): configurable delay in seconds between off and on if cycle is not set

5.2.14 NetworkPowerDriver

A NetworkPowerDriver controls a *NetworkPowerPort*, allowing control of the target power state without user interaction.

Binds to:

port:

- *NetworkPowerPort*

Implements:

- PowerProtocol

```
NetworkPowerDriver:
  delay: 5.0
```

Arguments:

- delay (float): optional delay in seconds between off and on

5.2.15 YKUSHPowerDriver

A YKUSHPowerDriver controls a *YKUSHPowerPort*, allowing control of the target power state without user interaction.

Binds to:

port:

- *YKUSHPowerPort*

Implements:

- PowerProtocol

```
YKUSHPowerDriver:
  delay: 5.0
```

Arguments:

- delay (float): optional delay in seconds between off and on

5.2.16 DigitalOutputPowerDriver

A DigitalOutputPowerDriver can be used to control the power of a Device using a DigitalOutputDriver.

Using this driver you probably want an external relay to switch the power of your DUT.

Binds to:

output:

- `DigitalOutputProtocol`

```
DigitalOutputPowerDriver:
  delay: Delay for a power cycle
```

Arguments:

- delay (float): configurable delay in seconds between off and on

5.2.17 USBPowerDriver

A USBPowerDriver controls a *USBPowerPort*, allowing control of the target power state without user interaction.

Binds to:

- *USBPowerPort*

Implements:

- `PowerProtocol`

```
USBPowerPort:
  delay: 5.0
```

Arguments:

- delay (float): optional delay in seconds between off and on

5.2.18 SerialPortDigitalOutputDriver

The SerialPortDigitalOutputDriver makes it possible to use a UART as a 1-Bit general-purpose digital output.

This driver sits on top of a SerialDriver and uses the it's pyserial- port to control the flow control lines.

Implements:

- `DigitalOutputProtocol`

```
SerialPortDigitalOutputDriver:
  signal: "DTR"
  bindings: { serial : "nameOfSerial" }
```

Arguments:

- signal (str): control signal to use: DTR or RTS
- bindings (dict): A named ressource of the type SerialDriver to bind against. This is only needed if you have multiple SerialDriver in your environment (what is likely to be the case if you are using this driver).

5.2.19 ModbusCoilDriver

A ModbusCoilDriver controls a *ModbusTCPCoil* resource. It can set and get the current state of the resource.

Binds to:

coil:

- *ModbusTCPCoil*

Implements:

- `DigitalOutputProtocol`

```
ModbusCoilDriver: {}
```

Arguments:

- None

5.2.20 MXSUSBDriver

A MXUSBDriver is used to upload an image into a device in the mxs USB loader state. This is useful to bootstrap a bootloader onto a device.

Binds to:

loader:

- *MXSUSBLoader*
- *NetworkMXSUSBLoader*

Implements:

- `BootstrapProtocol`

```
targets:
  main:
    drivers:
      MXSUSBDriver:
        image: mybootloaderkey

images:
  mybootloaderkey: path/to/mybootloader.img
```

Arguments:

- image (str): The key in *images* containing the path of an image to bootstrap onto the target

5.2.21 IMXUSBDriver

A IMXUSBDriver is used to upload an image into a device in the imx USB loader state. This is useful to bootstrap a bootloader onto a device.

Binds to:

loader:

- *IMXUSBLoader*
- *NetworkIMXUSBLoader*

Implements:

- `BootstrapProtocol`

```
targets:
  main:
    drivers:
      IMXUSBDriver:
        image: mybootloaderkey

images:
  mybootloaderkey: path/to/mybootloader.img
```

Arguments:

- image (str): The key in *images* containing the path of an image to bootstrap onto the target

5.2.22 USBStorageDriver

A USBStorageDriver allows access to a USB stick or similar device via the *USBMassStorage* resource.

Binds to:

storage:

- *USBMassStorage*

Implements:

- None (yet)

```
USBStorageDriver: {}
```

Arguments:

- None

5.2.23 NetworkUSBStorageDriver

A NetworkUSBStorageDriver allows access to a USB stick or similar local or remote device.

Binds to:

- *USBMassStorage*
- *NetworkUSBMassStorage*

Implements:

- None (yet)

```
NetworkUSBStorageDriver: {}
```

Arguments:

- None

5.2.24 OneWirePIODriver

A OneWirePIODriver controls a *OneWirePIO* resource. It can set and get the current state of the resource.

Binds to:

port:

- *OneWirePIO*

Implements:

- `DigitalOutputProtocol`

```
OneWirePIODriver: {}
```

Arguments:

- None

5.2.25 QEMUDriver

The QEMUDriver allows the usage of a qemu instance as a target. It requires several arguments, listed below. The kernel, flash, rootfs and dtb arguments refer to images and paths declared in the environment configuration.

Binds to:

- None

```
QEMUDriver:
  qemu_bin: qemu_arm
  machine: vexpress-a9
  cpu: cortex-a9
  memory: 512M
  boot_args: "root=/dev/root console=ttyAMA0,115200"
  extra_args: ""
  kernel: kernel
  rootfs: rootfs
  dtb: dtb
```

```
tools:
  qemu_arm: /bin/qemu-system-arm
paths:
  rootfs: ../images/root
images:
  dtb: ../images/mydtb.dtb
  kernel: ../images/vmlinuz
```

Implements:

- `ConsoleProtocol`
- `PowerProtocol`

Arguments:

- qemu_bin (str): reference to the tools key for the QEMU binary
- machine (str): QEMU machine type
- cpu (str): QEMU cpu type

- memory (str): QEMU memory size (ends with M or G)
- extra_args (str): extra QEMU arguments, they are passed directly to the QEMU binary
- boot_args (str): optional, additional kernel boot argument
- kernel (str): optional, reference to the images key for the kernel
- disk (str): optional, reference to the images key for the disk image
- flash (str): optional, reference to the images key for the flash image
- rootfs (str): optional, reference to the paths key for use as the virtio-9p filesystem
- dtb (str): optional, reference to the image key for the device tree

The qemudriver also requires the specification of:

- a tool key, this contains the path to the qemu binary
- an image key, the path to the kernel image and optionally the dtb key to specify the build device tree
- a path key, this is the path to the rootfs

5.2.26 SigrokDriver

The SigrokDriver uses a SigrokDevice Resource to record samples and provides them during test runs.

Binds to:

sigrok:

- *SigrokUSBDevice*
- *SigrokDevice*
- *NetworkSigrokUSBDevice*

Implements:

- None yet

The driver can be used in test cases by calling the *capture*, *stop* and *analyze* functions.

5.2.27 USBSDMuxDriver

The `USBSDMuxDriver` uses a USBSDMuxDevice resource to control a USB-SD-Mux device via usbsdmux tool.

Implements:

- None yet

The driver can be used in test cases by calling the *set_mode()* function with argument being *dut*, *host*, *off*, or *client*.

5.2.28 USBVideoDriver

The `USBVideoDriver` is used to show a video stream from a remote USB video camera in a local window. It uses the GStreamer command line utility `gst-launch` on both sides to stream the video via an SSH connection to the exporter.

Binds to:

video:

- *USBVideo*
- *NetworkUSBVideo*

Implements:

- None yet

Although the driver can be used from Python code by calling the *stream()* method, it is currenly mainly useful for the `video` subcommand of `labgrid-client`. It supports the *Logitech HD Pro Webcam C920* with the USB ID 046d:082d, but other cameras can be added to *get_caps()* in `labgrid/driver/usbvideodriver.py`.

5.2.29 USBTMCDriver

The `USBTMCDriver` is used to control a oscilloscope via the USB TMC protocol.

Binds to:

tmc:

- *USBTMC*
- *NetworkUSBTMC*

Implements:

- None yet

Currently, it can be used by the `labgrid-client tmc` subcommands to show (and save) a screenshot, to show per channel measurements and to execute raw TMC commands. It only supports the *Keysight DSO-X 2000* series (with the USB ID 0957:1798), but more devices can be added by extending *on_activate()* in `labgrid/driver/usbtmcdriver.py` and writing a corresponding backend in `labgrid/driver/usbtmc/`.

5.2.30 XenaDriver

The XenaDriver allows to use Xena networking tests equipment. Using the xenavalkyrie library a full API to control the tester is available.

Binds to:

xena_manager:

- *XenaManager*

The driver is supposed to work with all Xena products from the "Valkyrie Layer 2-3 Test platform" Currently tested on a *XenaCompact* chassis equipped with a *1 GE test module*.

5.3 Strategies

Strategies are used to ensure that the device is in a certain state during a test. Such a state could be the boot loader or a booted Linux kernel with shell.

5.3.1 BareboxStrategy

A BareboxStrategy has four states:

- unknown

- off
- barebox
- shell

to transition to the shell state:

```
t = get_target("main")
s = BareboxStrategy(t)
s.transition("shell")
```

this command would transition from the boot loader into a Linux shell and activate the shelldriver.

5.3.2 ShellStrategy

A ShellStrategy has three states:

- unknown
- off
- shell

to transition to the shell state:

```
t = get_target("main")
s = ShellStrategy(t)
s.transition("shell")
```

this command would transition directly into a Linux shell and activate the shelldriver.

5.3.3 UBootStrategy

A UBootStrategy has four states:

- unknown
- off
- uboot
- shell

to transition to the shell state:

```
t = get_target("main")
s = UBootStrategy(t)
s.transition("shell")
```

this command would transition from the boot loader into a Linux shell and activate the shelldriver.

5.4 Reporters

5.4.1 StepReporter

The StepReporter outputs individual labgrid steps to *STDOUT*.

```
from labgrid.stepreporter import StepReporter

StepReporter.start()
```

The Reporter can be stopped with a call to the stop function:

```
from labgrid.stepreporter import StepReporter

StepReporter.stop()
```

Stopping the StepReporter if it has not been started will raise an AssertionError, as will starting an already started StepReporter.

5.4.2 ColoredStepReporter

The ColoredStepReporter inherits from the StepReporter. The output is colored using ANSI color code sequences.

5.4.3 ConsoleLoggingReporter

The ConsoleLoggingReporter outputs read calls from the console transports into files. It takes the path as a parameter.

```
from labgrid.consoleloggingreporter import ConsoleLoggingReporter

ConsoleLoggingReporter.start(".")
```

The Reporter can be stopped with a call to the stop function:

```
from labgrid.consoleloggingreporter import ConsoleLoggingReporter

ConsoleLoggingReporter.stop()
```

Stopping the ConsoleLoggingReporter if it has not been started will raise an AssertionError, as will starting an already started StepReporter.

5.5 Environment Configuration

The environment configuration for a test environment consists of a YAML file which contains targets, drivers and resources. The invocation order of objects is important here since drivers may depend on other drivers or resources.

The skeleton for an environment consists of:

```
targets:
  <target-1>:
    resources:
      <resource-1>:
        <resource-1 parameters>
      <resource-2>:
        <resource-2 parameters>
    drivers:
      <driver-1>:
        <driver-1 parameters>
      <driver-2>: {} # no parameters for driver-2
  <target-2>:
```

```
    resources:
      <resources>
    drivers:
      <drivers>
  <more targets>
options:
  <option-1 name>: <value for option-1>
  <more options>
images:
  <image-1 name>: <absolute or relative path for image-1>
  <more images>
tools:
  <tool-1 name>: <absolute or relative path for tool-1>
  <more tools>
imports:
  - <import.py>
  - <python module>
```

If you have a single target in your environment, name it "main", as the `get_target` function defaults to "main".

All the resources and drivers in this chapter have a YAML example snippet which can simply be added (at the correct indentation level, one level deeper) to the environment configuration.

If you want to use multiple drivers of the same type, the resources and drivers need to be lists, e.g:

```
resources:
  RawSerialPort:
    port: '/dev/ttyS1'
drivers:
  SerialDriver: {}
```

becomes:

```
resources:
- RawSerialPort:
    port: '/dev/ttyS1'
- RawSerialPort:
    port: '/dev/ttyS2'
drivers:
- SerialDriver: {}
- SerialDriver: {}
```

This configuration doesn't specifiy which `RawSerialPort` to use for each `SerialDriver`, so it will cause an exception when instantiating the `Target`. To bind the correct driver to the correct resource, explicit `name` and `bindings` properties are used:

```
resources:
- RawSerialPort:
    name: 'foo'
    port: '/dev/ttyS1'
- RawSerialPort:
    name: 'bar'
    port: '/dev/ttyS2'
drivers:
- SerialDriver:
    name: 'foo_driver'
    bindings:
      port: 'foo'
```

```
- SerialDriver:
    name: 'bar_driver'
    bindings:
      port: 'bar'
```

The property name for the binding (e.g. *port* in the example above) is documented for each individual driver under this chapter.

The YAML configuration file also supports templating for some substitutions, these are:

- LG_* variables, are replaced with their respective LG_* environment variable
- BASE is substituted with the base directory of the YAML file.

As an example:

```
targets:
  main:
    resources:
      RemotePlace:
        name: !template $LG_PLACE
tools:
  qemu_bin: !template "$BASE/bin/qemu-bin"
```

would resolve the qemu_bin path relative to the BASE dir of the YAML file and try to use the RemotePlace with the name set in the LG_PLACE environment variable.

5.6 Exporter Configuration

The exporter is configured by using a YAML file (with a syntax similar to the environment configs used for pytest) or by instantiating the `Environment` object. To configure the exporter, you need to define one or more *resource groups*, each containing one or more *resources*. This allows the exporter to group resources for various usage scenarios, e.g. all resources of a specific place or for a specific test setup. For information on how the exporter fits into the rest of labgrid, see *Remote Resources and Places*.

The basic structure of an exporter configuration file is:

```
<group-1>:
  <resources>
<group-2>:
  <resources>
```

The simplest case is with one group called "group1" containing a single `USBSerialPort`:

```
group1:
  USBSerialPort:
    match:
      '@sys_name': '3-1.3'
```

To reduce the amount of repeated declarations when many similar resources need to be exported, the Jinja2 template engine is used as a preprocessor for the configuration file:

```
## Iterate from group 1001 to 1016
# for idx in range(1, 17)
{{ 1000 + idx }}:
  NetworkSerialPort:
    {host: rl1, port: {{ 4000 + idx }}}
```

```
  NetworkPowerPort:
    # if 1 <= idx <= 8
    {model: apc, host: apc1, index: {{ idx }}}
    # elif 9 <= idx <= 12
    {model: netio, host: netio4, index: {{ idx - 8 }}}
    # elif 13 <= idx <= 16
    {model: netio, host: netio5, index: {{ idx - 12 }}}
    # endif
# endfor
```

Use `#` for line statements (like the for loops in the example) and `##` for line comments. Statements like `{{ 4000 + idx }}` are expanded based on variables in the Jinja2 template.

CHAPTER 6

Development

The first step is to install labgrid into a local virtualenv.

6.1 Installation

Clone the git repository:

```
git clone https://github.com/labgrid-project/labgrid && cd labgrid
```

Create and activate a virtualenv for labgrid:

```
virtualenv -p python3 venv
source venv/bin/activate
```

Install required dependencies:

```
sudo apt install libow-dev
```

Install the development requirements:

```
pip install -r dev-requirements.txt
```

Install labgrid into the virtualenv in editable mode:

```
pip install -e .
```

Tests can now be run via:

```
python -m pytest --lg-env <config>
```

6.2 Writing a Driver

To develop a new driver for labgrid, you need to decide which protocol to implement, or implement your own protocol. If you are unsure about a new protocol's API, just use the driver directly from the client code, as deciding on a good API will be much easier when another similar driver is added.

Labgrid uses the attrs library for internal classes. First of all import attr, the protocol and the common driver class into your new driver file.

```
import attr

from labgrid.driver.common import Driver
from labgrid.protocol import ConsoleProtocol
```

Next, define your new class and list the protocols as subclasses of the new driver class. Try to avoid subclassing existing other drivers, as this limits the flexibility provided by connecting drivers and resources on a given target at runtime.

```
import attr

from labgrid.driver.common import Driver
from labgrid.protocol import ConsoleProtocol

@attr.s(cmp=False)
class ExampleDriver(Driver, ConsoleProtocol):
    pass
```

The ConsoleExpectMixin is a mixin class to add expect functionality to any class supporting the `ConsoleProtocol` and has to be the first item in the subclass list. Using the mixin class allows sharing common code, which would otherwise need to be added into multiple drivers.

```
import attr

from labgrid.driver.common import Driver
from labgrid.driver.consoleexpectmixin import ConsoleExpectMixin
from labgrid.protocol import ConsoleProtocol

@attr.s(cmp=False)
class ExampleDriver(ConsoleExpectMixin, Driver, ConsoleProtocol)
    pass
```

Additionally the driver needs to be registered with the `target_factory` and provide a bindings dictionary, so that the `Target` can resolve dependencies on other drivers or resources.

```
import attr

from labgrid.factory import target_factory
from labgrid.driver.common import Driver
from labgrid.driver.consoleexpectmixin import ConsoleExpectMixin
from labgrid.protocol import ConsoleProtocol

@target_factory.reg_driver
@attr.s(cmp=False)
class ExampleDriver(ConsoleExpectMixin, Driver, ConsoleProtocol)
    bindings = { "port": SerialPort }
    pass
```

The listed resource `SerialPort` will be bound to `self.port`, making it usable in the class. Checks are performed that the target which the driver binds to has a SerialPort, otherwise an error will be raised.

If your driver can support alternative resources, you can use a set of classes instead of a single class:

```
bindings = { "port": {SerialPort, NetworkSerialPort}}
```

Optional bindings can be declared by including `None` in the set:

```
bindings = { "port": {SerialPort, NetworkSerialPort, None}}
```

If you need to do something during instantiation, you need to add a `__attrs_post_init__` method (instead of the usual `__init__` used for non-attr-classes). The minimum requirement is a call to `super().__attrs_post_init__()`.

```
import attr

from labgrid.factory import target_factory
from labgrid.driver.common import Driver
from labgrid.driver.consoleexpectmixin import ConsoleExpectMixin
from labgrid.protocol import ConsoleProtocol

@target_factory.reg_driver
@attr.s(cmp=False)
class ExampleDriver(ConsoleExpectMixin, Driver, ConsoleProtocol)
    bindings = { "port": SerialPort }

    def __attrs_post_init__(self):
        super().__attrs_post_init__()
```

All that's left now is to implement the functionality described by the used protocol, by using the API of the bound drivers and resources.

6.3 Writing a Resource

To add a new resource to labgrid, we import attr into our new resource file. Additionally we need the `target_factory` and the common Resource class.

```
import attr

from labgrid.factory import target_factory
from labgrid.driver.common import Resource
```

Next we add our own resource with the `Resource` parent class and register it with the `target_factory`.

```
import attr

from labgrid.factory import target_factory
from labgrid.driver.common import Resource

@target_factory.reg_resource
@attr.s(cmp=False)
class ExampleResource(Resource):
    pass
```

All that is left now is to add attributes via `attr.ib()` member variables.

```
import attr

from labgrid.factory import target_factory
from labgrid.driver.common import Resource

@target_factory.reg_resource
@attr.s(cmp=False)
class ExampleResource(Resource):
    examplevar1 = attr.ib()
    examplevar2 = attr.ib()
```

The `attr.ib()` style of member definition also supports defaults and validators, see the attrs documentation.

6.4 Writing a Strategy

Labgrid only offers two basic strategies, for complex use cases a customized strategy is required. Start by creating a strategy skeleton:

```
import enum

import attr

from labgrid.step import step
from labgrid.driver.common import Strategy

class Status(enum.Enum):
    unknown = 0

class MyStrategy(Strategy):
    bindings = {
    }

    status = attr.ib(default=Status.unknown)

    @step
    def transition(self, status, *, step):
        if not isinstance(status, Status):
            status = Status[status]
        if status == Status.unknown:
            raise StrategyError("can not transition to {}".format(status))
        elif status == self.status:
            step.skip("nothing to do")
            return  # nothing to do
        else:
            raise StrategyError(
                "no transition found from {} to {}".
                format(self.status, status)
            )
        self.status = status
```

The `bindings` variable needs to declare the drivers necessary for the strategy, usually one for power, boot loader and shell. The `Status` class needs to be extended to cover the states of your strategy, then for each state an `elif` entry in the transition function needs to be added.

Lets take a look at the builtin *BareboxStrategy*. The Status enum for Barebox:

```
class Status(enum.Enum):
    unknown = 0
    off = 1
    barebox = 2
    shell = 3
```

defines 3 custom states and the *unknown* state as the start point. These three states are handled in the transition function:

```
elif status == Status.off:
    self.target.deactivate(self.barebox)
    self.target.deactivate(self.shell)
    self.target.activate(self.power)
    self.power.off()
elif status == Status.barebox:
    self.transition(Status.off)
    # cycle power
    self.power.cycle()
    # interrupt barebox
    self.target.activate(self.barebox)
elif status == Status.shell:
    # tansition to barebox
    self.transition(Status.barebox)
    self.barebox.boot("")
    self.barebox.await_boot()
    self.target.activate(self.shell)
```

Here the *barebox* state simply cycles the board and activates the driver, while the *shell* state uses the barebox state to cycle the board and than boot the linux kernel. The *off* states switch the power off.

6.5 Graph Strategies

Graph Strategies are made for more complex strategies, with multiple, on each other depending, states.

All states HAVE TO:

1. Be a method of a *GraphStrategy* subclass
2. Use this prototype: *def state_$STATENAME(self):*
3. Not call *transition()* in its state definition

Every Graph Strategy graph has to have exactly one root state. A root state is a state that has no dependencies. If *invalidate()* is overridden the super method must be called.

```
# conftest.py
from labgrid.strategy import GraphStrategy


class TestStrategy(GraphStrategy):
    def state_Root(self):
        pass

    @GraphStrategy.depends('Root')
    def state_A1(self):
        pass
```

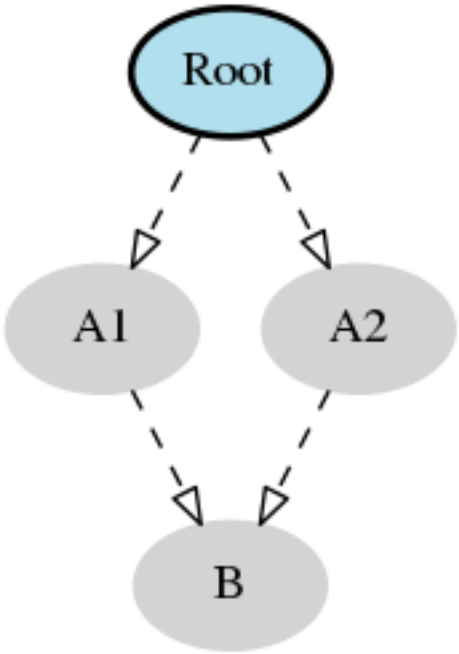
```
    @GraphStrategy.depends('Root')
    def state_A2(self):
        pass

    @GraphStrategy.depends('A1', 'A2')
    def state_B(self):
        pass
```

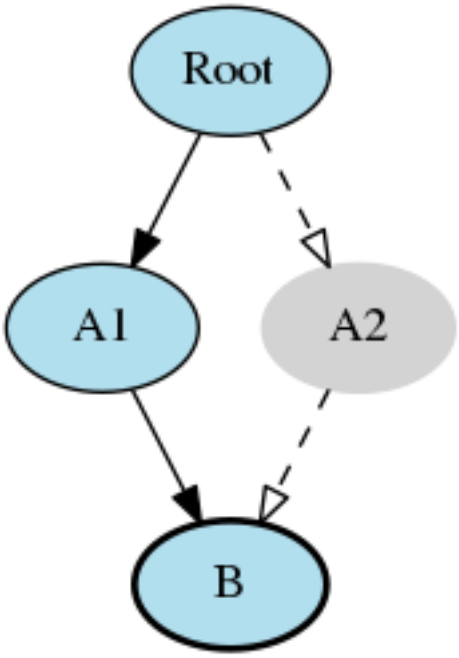
Graph Stategies allow to specify multiple paths to states. The first argument of *@GraphStrategy.depends()* becomes part of the default path. If a different path should be followed the keyword argument *via* can be used on *transition()*.

```
# test_feature.py
def test_feature(graph_strategy):
    graph_strategy.transition('B')  #  returns: ['A1', 'B']
    graph_strategy.transition('B')  #  returns: []
    graph_strategy.transition('B', via=['A2'])  #  returns: ['Root', 'A2', 'B']
```

pytest fixtures can be used to *transition()* into the designated state before a test is executed. Use *transition('my_state', via=...)* to follow a (non-default) path, e.g. an alternative boot method.

```
# render graph to png
>>> graph_strategy.graph.render('filename')
'filename.png'
```





6.6 SSHManager

Labgrid provides a SSHManager to allow connection reuse with control sockets. To use the SSHManager in your code, import it from *labgrid.util.ssh*:

```
from labgrid.util.ssh import sshmanager
```

you can now request or remove forwards:

```
from labgrid.util.ssh import sshmanager

localport = sshmanager.request_forward('somehost', 3000)

sshmanager.remove_forward('somehost', 3000)
```

or get and put files:

```
from labgrid.util.ssh import sshmanager

sshmanager.put_file('somehost', '/path/to/local/file', '/path/to/remote/file')
```

6.7 ManagedFile

While the *SSHManager* exposes a lower level interface to use SSH Connections, the ManagedFile provides a higher level interface for file upload to another host. It is meant to be used in conjunction with a remote resource, and store the file on the remote host with the following pattern:

```
/tmp/labgrid-<username>/<sha256sum>/<filename>
```

Additionally it provides *get_remote_path()* to retrieve the complete file path, to easily employ it for driver implementations. To use it in conjunction with a *Resource* and a file:

```
from labgrid.util.managedfile import ManagedFile

mf = ManagedFile(<your-file>, <your-resource>)
mf.sync_to_resource()
path = mf.get_remote_path()
```

6.8 ProxyManager

The proxymanager is used to open connections across proxies via an attribute in the resource. This allows gated testing networks by always using the exporter as an SSH gateway to proxy the connections using SSH Forwarding. Currently this is used in the *SerialDriver* for proxy connections.

Usage:

```
from labgrid.util.proxy import proxymanager

proxymanager.get_host_and_port(<resource>)
```

6.9 Contributing

Thank you for thinking about contributing to labgrid! Some different backgrounds and use-cases are essential for making labgrid work well for all users.

The following should help you with submitting your changes, but don't let these guidelines keep you from opening a pull request. If in doubt, we'd prefer to see the code earlier as a work-in-progress PR and help you with the submission process.

6.9.1 Workflow

- Changes should be submitted via a GitHub pull request.
- Try to limit each commit to a single conceptual change.
- Add a signed-of-by line to your commits according to the *Developer's Certificate of Origin* (see below).
- Check that the tests still work before submitting the pull request. Also check the CI's feedback on the pull request after submission.
- When adding new drivers or resources, please also add the corresponding documentation and test code.
- If your change affects backward compatibility, describe the necessary changes in the commit message and update the examples where needed.

6.9.2 Code

- Follow the **PEP 8** style.
- Use attr.ib attributes for public attributes of your drivers and resources.
- Use isort to sort the import statements.

6.9.3 Documentation

- Use semantic linefeeds in .rst files.

6.9.4 Run Tests

```
$ tox -r
```

6.9.5 Developer's Certificate of Origin

Labgrid uses the Developer's Certificate of Origin 1.1 with the same process as used for the Linux kernel:

> Developer's Certificate of Origin 1.1
>
> By making a contribution to this project, I certify that:
>
> 1. The contribution was created in whole or in part by me and I have the right to submit it under the open source license indicated in the file; or
> 2. The contribution is based upon previous work that, to the best of my knowledge, is covered under an appropriate open source license and I have the right under that license to submit that work with modifications, whether created in whole or in part by me, under the same open source license (unless I am permitted to submit under a different license), as indicated in the file; or
> 3. The contribution was provided directly to me by some other person who certified (a), (b) or (c) and I have not modified it.
> 4. I understand and agree that this project and the contribution are public and that a record of the contribution (including all personal information I submit with it, including my sign-off) is maintained indefinitely and may be redistributed consistent with this project or the open source license(s) involved.

Then you just add a line (using `git commit -s`) saying:

> Signed-off-by: Random J Developer <random@developer.example.org>

using your real name (sorry, no pseudonyms or anonymous contributions).

6.10 Ideas

6.10.1 Driver Preemption

To allow better handling of unexpected reboots or crashes, inactive Drivers could register callbacks on their providers (for example the BareboxDriver it's ConsoleProtocol). These callbacks would look for indications that the Target has changed state unexpectedly (by looking for the bootloader startup messages, in this case). The inactive Driver could then cause a preemption and would be activated. The current caller of the originally active driver would be notified via an exception.

6.10.2 Remote Target Reservation

For integration with CI systems (like Jenkins), it would help if the CI job could reserve and wait for a specific target. This could be done by managing a list of waiting users in the coordinator and notifying the current user on each

invocation of labgrid-client that another user is waiting. The reservation should expire after some time if it is not used to lock the target after it becomes available.

6.10.3 Step Tracing

The Step infrastructure already collects timing and nesting information on executed commands, but is currently only used for in pytest or via the standalone StepReporter. By writing these events to a file (or sqlite database) as a trace, we can collect data over multiple runs for later analysis. This would become more useful by passing recognized events (stack traces, crashes, . . .) and benchmark results via the Step infrastructure.

6.10.4 Target Feature Flags

It would be useful to support configuring feature flags in the target YAML definition. Then individual tests could be skipped if a required feature is unavailable on the current target without manually modifying the test suite.

6.10.5 CommandProtocol Support for Background Processes

Currently the CommandProtocol does not support long running processes well. An implementation should start a new process, return a handle and forbid running other processes in the foreground. The handle can be used to retrieve output from a command.

6.10.6 SSH Tunneling for Remote Infrastructure

Client and exporter require a direct HTTP(S) connection to the coordinator. Also, the clients connect directly to the exporters via SSH. However, often the clients are in an office network, while exporters run in separate lab networks, making it necessary to open holes in the firewall to connect to the coordinator or from client to exporter. In this case, it would be useful to use SSH as the authentication service and then use tunneling to connect to the coordinator or for the client to exporter connections.

6.10.7 Support for PDU-Daemon

The LAVA project developed their own daemon for power switching, the PDU Daemon. Add support for the daemon in the NetworkPowerDriver.

CHAPTER 7

Design Decisions

This document outlines the design decisions influencing the development of labgrid.

7.1 Out of Scope

Out of scope for labgrid are:

7.1.1 Integrated Build System

In contrast to some other tools, labgrid explicitly has no support for building target binaries or images.

Our reasons for this are:

- Several full-featured build systems already exist and work well.
- We want to test unmodified images produced by any build system (OE/Yocto, PTXdist, Buildroot, Debian, . . .).

7.1.2 Test Infrastructure

Labgrid does not include a test framework.

The main reason is that with pytest we already have a test framework which:

- makes it easy to write tests
- reduces boilerplate code with flexible fixtures
- is easy to extend and has many available plugins
- allows using any Python library for creating inputs or processing outputs
- supports test report generation

Furthermore, the hardware control functionality needed for testing is also very useful during development, provisioning and other areas, so we don't want to hide that behind another test framework.

7.2 In Scope

- usable as a library for hardware provisioning
- device control via:
  - serial console
  - SSH
  - file management
  - power and reset
- emulation of external services:
  - USB stick emulation
  - external update services (Hawkbit)
- bootstrap services:
  - fastboot
  - imxusbloader

7.3 Further Goals

- tests should be equivalent for workstations and servers
- discoverability of available boards
- distributed board access

CHAPTER 8

Changes

8.1 Release 0.2.0 (released Jan 4, 2019)

8.1.1 New Features

- A colored StepReporter was added and can be used with `pytest --lg-colored-steps`.
- `labgrid-client` can now use the last changed information to sort listed resources and places.
- `labgrid-client ssh` now uses ip/user/password from NetworkService resource if available
- The environement files can contain feature flags which can be used to control which tests are run in pytest.
- The new "managed file" support takes a local file and synchronizes it to a resource on a remote host. If the resource is not a `NetworkResource`, the local file is used instead.
- ProxyManager: a class to automatically create ssh forwardings to proxy connections over the exporter
- SSHManager: a global manager to multiplex connections to different exporters
- The target now saves it's attached drivers, resources and protocols in a lookup table, avoiding the need of importing many Drivers and Protocols (see *Syntactic sugar for Targets*)
- When multiple Drivers implement the same Protocol, the best one can be selected using a priority (see below).
- The new subcommand `labgrid-client monitor` shows resource or places changes as they happen, which is useful during development or debugging.
- The environment yaml file can now list Python files (under the 'imports' key). They are imported before constructing the Targets, which simplifies using custom Resources, Drivers or Strategies.
- The pytest plugin now stores metadata about the environment yaml file in the junit XML output.
- The `labgrid-client` tool now understands a `--state` option to transition to the provided state using a `Strategy`. This requires an environment yaml file with a `RemotePlace` Resources and matching Drivers.
- Resource matches for places configured in the coordinator can now have a name, allowing multiple resources with the same class.

- The new `Target.__getitem__` method makes writing using protocols less verbose.
- Experimental: The labgrid-autoinstall tool was added (see below).

8.1.2 New and Updated Drivers

- The new `DigitalOutputResetDriver` adapts a driver implementing the DigitalOutputProtocol to the ResetProtocol.
- The new `ModbusCoilDriver` support outputs on a ModbusTCP device.
- The new `NetworkUSBStorageDriver` allows writing to remote USB storage devices (such as SD cards or memory sticks connected to a mux).
- The new `QEMUDriver` runs a system image in QEmu and implements the `ConsoleProtocol` and `PowerProtocol`. This allows using labgrid without any real hardware.
- The new `QuartusHPSDriver` controls the "Quartus Prime Programmer and Tools" to flash a target's QSPI.
- The new `SerialPortDigitalOutputDriver` controls the state of a GPIO using the control lines of a serial port.
- The new `SigrokDriver` uses a (local or remote) device supported by sigrok to record samples.
- The new `SmallUBootDriver` supports the extremely limited U-Boot found in cheap WiFi routers.
- The new `USBSDMuxDriver` controls a Pengutronix USB-SD-Mux device.
- The new `USBTMCDriver` can fetch measurements and screenshots from the "Keysight DSOX2000 series" and the "Tektronix TDS 2000 series".
- The new `USBVideoDriver` can stream video from a remote H.264 UVC (USB Video Class) camera using gstreamer over SSH. Currently, configuration for the "Logitech HD Pro Webcam C920" exists.
- The new `XenaDriver` allows interacting with Xena network testing equipment.
- The new `YKUSHPowerDriver` and `USBPowerDriver` support software-controlled USB hubs.
- The bootloader drivers now have a `reset` method.
- The `BareboxDriver`'s boot string is now configurable, which allows it to work with the `quiet` Linux boot parameter.
- The `IMXUSBLoader` now recognizes more USB IDs.
- The `OpenOCDDriver` is now more flexible with loading configuration files.
- The `NetworkPowerDriver` now additionally supports:
  - 24 port "Gude Expert Power Control 8080"
  - 8 port "Gude Expert Power Control 8316"
  - NETIO 4 models (via telnet)
  - a simple REST interface
- The `SerialDriver` now supports using plain TCP instead of RFC 2217, which is needed from some console servers.
- The `ShellDriver` has been improved:
  - It supports configuring the various timeouts used during the login process.
  - It can use xmodem to transfer file from and to the target.

8.1.3 Incompatible Changes

- When using the coordinator, it must be upgrade together with the clients because of the newly introduce match names.
- Resources and Drivers now need to be created with an explicit name parameter. It can be `None` to keep the old behaviour. See below for details.
- Classes derived from `Resource` or `Driver` now need to use `@attr.s(cmp=False)` instead of `@attr.s` because of a change in the attrs module version 17.1.0.

8.1.4 Syntactic sugar for Targets

Targets are now able to retrieve requested drivers, resources or protocols by name instead of by class. This allows removing many imports, e.g.

```
from labgrid.driver import ShellDriver

shell = target.get_driver(ShellDriver)
```

becomes

```
shell = target.get_driver("ShellDriver")
```

Also take a look at the examples, they have been ported to the new syntax as well.

8.1.5 Multiple Driver Instances

For some Protocols, it is useful to allow multiple instances.

DigitalOutputProtocol: A board may have two jumpers to control the boot mode in addition to a reset GPIO. Previously, it was not possible to use these on a single target.

ConsoleProtocol: Some boards have multiple console interfaces or expose a login prompt via a USB serial gadget.

PowerProtocol: In some cases, multiple power ports need to be controlled for one Target.

To support these use cases, Resources and Drivers must be created with a name parameter. When updating your code to this version, you can either simply set the name to `None` to keep the previous behaviour. Alternatively, pass a string as the name.

Old:

```
>>> t = Target("MyTarget")
>>> SerialPort(t)
SerialPort(target=Target(name='MyTarget', env=None), state=<BindingState.bound: 1>,␣
↪avail=True, port=None, speed=115200)
>>> SerialDriver(t)
SerialDriver(target=Target(name='MyTarget', env=None), state=<BindingState.bound: 1>,␣
↪txdelay=0.0)
```

New (with name=None):

```
>>> t = Target("MyTarget")
>>> SerialPort(t, None)
SerialPort(target=Target(name='MyTarget', env=None), name=None, state=<BindingState.
↪bound: 1>, avail=True, port=None, speed=115200)
```

```
>>> SerialDriver(t, None)
SerialDriver(target=Target(name='MyTarget', env=None), name=None, state=<BindingState.
↪bound: 1>, txdelay=0.0)
```

New (with real names):

```
>>> t = Target("MyTarget")
>>> SerialPort(t, "MyPort")
SerialPort(target=Target(name='MyTarget', env=None), name='MyPort', state=
↪<BindingState.bound: 1>, avail=True, port=None, speed=115200)
>>> SerialDriver(t, "MyDriver")
SerialDriver(target=Target(name='MyTarget', env=None), name='MyDriver', state=
↪<BindingState.bound: 1>, txdelay=0.0)
```

8.1.6 Priorities

Each driver supports a priorities class variable. This allows drivers which implement the same protocol to add a priority option to each of their protocols. This way a `NetworkPowerDriver` can implement the `ResetProtocol`, but if another `ResetProtocol` driver with a higher protocol is available, it will be selected instead. See the documentation for details.

8.1.7 Auto-Installer Tool

To simplify using labgrid for provisioning several boards in parallel, the `labgrid-autoinstall` tool was added. It reads a YAML file defining several targets and a Python script to be run for each board. Interally, it spawns a child process for each target, which waits until a matching resource becomes available and then executes the script.

For example, this makes it simple to load a bootloader via the `BootstrapProtocol`, use the `AndroidFastbootDriver` to upload a kernel with initramfs and then write the target's eMMC over a USB Mass Storage gadget.

Note: `labgrid-autoinstall` is still experimental and no documentation has been written.

Contributions from: Ahmad Fatoum, Bastian Krause, Björn Lässig, Chris Fiege, Enrico Joerns, Esben Haabendal, Felix Lampe, Florian Scherf, Georg Hofmann, Jan Lübbe, Jan Remmet, Johannes Nau, Kasper Revsbech, Kjeld Flarup, Laurentiu Palcu, Oleksij Rempel, Roland Hieber, Rouven Czerwinski, Stanley Phoong Cheong Kwan, Steffen Trumtrar, Tobi Gschwendtner, Vincent Prince

8.2 Release 0.1.0 (released May 11, 2017)

This is the initial release of labgrid.

CHAPTER 9

Modules

9.1 labgrid package

9.1.1 Subpackages

labgrid.autoinstall package

Submodules

labgrid.autoinstall.main module

labgrid.driver package

Subpackages

labgrid.driver.power package

Submodules

labgrid.driver.power.apc module

labgrid.driver.power.digipower module

labgrid.driver.power.gude module

labgrid.driver.power.gude24 module

labgrid.driver.power.gude8316 module

labgrid.driver.power.netio module

labgrid.driver.power.netio_kshell module

labgrid.driver.power.simplerest module

labgrid.driver.usbtmc package

Submodules

labgrid.driver.usbtmc.keysight_dsox2000 module

labgrid.driver.usbtmc.tektronix_tds2000 module

Submodules

labgrid.driver.bareboxdriver module

labgrid.driver.commandmixin module

labgrid.driver.common module

labgrid.driver.consoleexpectmixin module

labgrid.driver.exception module

labgrid.driver.externalconsoledriver module

labgrid.driver.fake module

labgrid.driver.fastbootdriver module

labgrid.driver.infodriver module

labgrid.driver.modbusdriver module

labgrid.driver.networkusbstoragedriver module

labgrid.driver.onewiredriver module

labgrid.driver.openocddriver module

labgrid.driver.powerdriver module

labgrid.driver.qemudriver module

labgrid.util.yaml module

9.1.2 Submodules

9.1.3 labgrid.binding module

9.1.4 labgrid.config module

9.1.5 labgrid.consoleloggingreporter module

9.1.6 labgrid.environment module

9.1.7 labgrid.exceptions module

9.1.8 labgrid.factory module

9.1.9 labgrid.step module

9.1.10 labgrid.stepreporter module

9.1.11 labgrid.target module

CHAPTER 10

Indices and Tables

- genindex
- modindex
- search

Index

P