
colcon Documentation

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Apr 22, 2021

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colcon is a command line tool to improve the workflow of building, testing and using multiple software packages. It automates the process, handles the ordering and sets up the environment to use the packages.

The code is open source, and [available on GitHub](#).

The documentation exists in two version:

- **released**: matching the latest released version of all packages
- **latest**: matching the latest state on the default branch of all packages

The documentation is organized into a few sections:

- *User Documentation*
- *Migrate from other build tools*

Information about development is also available:

- *Developer Documentation*

The functionality of `colcon` is split over multiple Python packages. The package `colcon-core` provides the command line tool `colcon` itself as well as a few fundamental extensions. Additional functionality is provided by separate packages, e.g. `colcon-cmake` adds support for packages which use `CMake`. The following instructions install a set of common `colcon` packages.

1.1 Using Debian packages

On platforms which support Debian packages using those is preferred since they will be updated using `apt` together with other system packages.

1.1.1 In the context of the ROS project

The `ROS` project hosts copies of the Debian packages in their `apt` repositories. You can choose either of the two following `apt` repositories.

- ROS 1 repository

```
$ sudo sh -c 'echo "deb http://packages.ros.org/ros/ubuntu `lsb_release -cs` main
↳" > /etc/apt/sources.list.d/ros-latest.list'
$ sudo apt-key adv --keyserver 'hkp://keyserver.ubuntu.com:80' --recv-key
↳C1CF6E31E6BADE8868B172B4F42ED6FBAB17C654
```

- ROS 2 repository

```
$ sudo sh -c 'echo "deb [arch=amd64,arm64] http://repo.ros2.org/ubuntu/main `lsb_
↳release -cs` main" > /etc/apt/sources.list.d/ros2-latest.list'
$ curl -s https://raw.githubusercontent.com/ros/rosdistro/master/ros.asc | sudo
↳apt-key add -
```

After that you can install the Debian package which depends on `colcon-core` as well as commonly used extension packages (see `setup.cfg`).

```
$ sudo apt update
$ sudo apt install python3-colcon-common-extensions
```

1.1.2 Outside the ROS project

The Debian packages are also hosted in an apt repository provided by [packagecloud](#):

You can add the GPG key as well as the apt repository using the following command (which is described [here](#)).

```
$ curl -s https://packagecloud.io/install/repositories/dirk-thomas/colcon/
↳script.deb.sh | sudo bash
```

After that you can install the Debian package which depends on `colcon-core` as well as commonly used extension packages (see [setup.cfg](#)).

```
$ sudo apt install python3-colcon-common-extensions
```

1.2 Using pip on any platform

On all non-Debian platforms the most common way of installation is the Python package manager `pip`. The following assumes that you are using a virtual environment with Python 3.5 or higher. If you want to install the packages globally it might be necessary to invoke `pip3` instead of `pip` and require `sudo`.

```
$ pip install -U colcon-common-extensions
```

Note: The package `colcon-common-extensions` doesn't contain any functionality itself but only depends on a set of other packages (see [setup.cfg](#)).

Note: You can find a list of released packages on [PyPI](#) using the keyword `colcon`.

1.3 Installing from source

Note: This approach is commonly only used by advanced users.

Commonly this is the case when you want to try or leverage new features or bug fixes which have been committed already but are not available in a released version yet. In order to use the latest state of any of the above packages you can invoke `pip` with a URL of the GitHub repository:

```
$ pip install -U git+https://github.com/colcon/colcon-common-extensions.git
```

1.4 Installing custom branches from source

To try a patch proposed in a pull request you can install the sources of that specific branch by appending the branch name to the URL:

```
$ pip install -U git+https://github.com/colcon/colcon-core.git@branch_name
```

Note: Make sure to uninstall that custom version again using `pip uninstall <name>` to revert back to the previously used version. Otherwise if you use the Debian packages this pip installed package will overlay even newer Debian packages.

1.5 Building from source

Since this is not a common use case for users you will find the documentation in the *developer section*.

1.6 Quick directory changes

1.6.1 Sh (and compatible shells)

On Linux / macOS the above instructions install the package `colcon-cd` which offers a command to change to the directory a package specified by its name is in. To enable this feature you need to source the shell script provided by that package. The script is named `colcon_cd.sh`. For convenience you might want to source it in the user configuration, e.g. `~/.bashrc`:

Depending on which instructions you followed to install the packages the location will vary:

- Debian package: `/usr/share/colcon_cd/function`
- PIP - user specific: `$HOME/.local/share/colcon_cd/function`
- PIP - global: `/usr/local/share/colcon_cd/function`

When building `colcon` from source the generated setup files will automatically include this hook.

1.7 Enable completion

1.7.1 Bash / zsh

On Linux / macOS the above instructions install the package `colcon-argcomplete` which offers command completion for bash and bash-like shells. To enable this feature you need to source the shell-specific script provided by that package. These scripts are named `colcon-argcomplete.bash` / `colcon-argcomplete.zsh`. For convenience you might want to source the one matching your shell in the user configuration, e.g. `~/.bashrc`:

Depending on which instructions you followed to install the packages the location will vary:

- Debian package: `/usr/share/colcon_argcomplete/hook`
- PIP - user specific: `$HOME/.local/share/colcon_argcomplete/hook`
- PIP - global: `/usr/local/share/colcon_argcomplete/hook`

When building `colcon` from source the generated setup files will automatically include this hook.

This section gives a high-level overview of how to use the `colcon` command.

2.1 TL;DR

The following is an example workflow and sequence of commands using default settings:

```
$ mkdir -p /tmp/workspace/src      # Make a workspace directory with a src subdirectory
$ cd /tmp/workspace                # Change directory to the workspace root
$ <...>                            # Populate the `src` directory with packages
$ colcon list                      # List all packages in the workspace
$ colcon graph                    # List all packages in the workspace in topological_
→order                             # and visualize their dependencies
$ colcon build                    # Build all packages in the workspace
$ colcon test                     # Test all packages in the workspace
$ colcon test-result --all        # Enumerate all test results
$ . install/local_setup.bash      # Setup the environment to use the built packages
$ <...>                            # Use the built packages
```

The most commonly used arguments for the `build` and `test` verbs are to only process a specific package or a specific package including all the recursive dependencies it needs.

```
$ colcon build --packages-select <name-of-pkg>
$ colcon build --packages-up-to <name-of-pkg>
```

Note: The log files of the latest invocation can be found in the log directory which is by default in `~/ .colcon/ log/latest`.

Note: If you want to see the output of each package after it finished you can pass the argument `--event-handlers`

```
console_cohesion+.
```

2.2 Build ROS 2 packages

The process of building ROS 2 packages is described in the [ROS 2 building from source](#) instructions. Using `colcon` instead of the recommended tool `ament_tools` only changes a couple of the steps.

Instead of invoking `ament build` you can invoke `colcon`.

```
$ colcon build
```

In order to use the built packages you need to source the `install/local_setup.<ext>` script mentioned in the instructions.

For detailed information how command line arguments of `ament_tools` are mapped to `colcon` please see the [ament_tools migration guide](#).

2.3 Build ROS 1 packages

The process of building ROS 1 packages is described in the [distro specific building from source](#) instructions. Using `colcon` instead of the recommended tool `catkin_make_isolated` only changes a couple of the steps.

Note: `colcon-ros` requires at least version 0.7.13 of `catkin` which provides a new CMake option the tool uses.

Instead of invoking `catkin_make_isolated --install` you can invoke `colcon`.

```
$ colcon build
```

Note: `colcon` does by design not support the concept of a “devel space” as it exists in ROS 1. Instead it requires each package to be installed so each package must declare an install step in order to work with `colcon`.

In order to use the built packages you need to source the `install/local_setup.<ext>` rather than the `setup.<ext>` script mentioned in the instructions. For `bash` the command would be:

```
$ source install/local_setup.bash
```

For detailed information how command line arguments of `catkin_make_isolated` are mapped to `colcon` please see the [catkin_make_isolated migration guide](#). For detailed information how command line arguments of `catkin_tools` are mapped to `colcon` please see the [catkin_tools migration guide](#).

2.3.1 Test ROS 1 packages

As of `colcon-ros` version 0.3.6 the `build` verb builds the test targets for ROS 1 packages implicitly (when available).

In earlier versions you must build the custom `tests` target explicitly:

```
$ colcon build --cmake-target tests
```

2.4 Build Gazebo and the ignition packages

In more recent versions `Gazebo` has been refactored to split out a lot of the functionality into `ignition` libraries. While that makes the project more modular it also increases the effort necessary to build all these packages from source. `colcon` can make this process easy again.

In order to build a specific Gazebo version you need the right versions of the ignition libraries. At the time of writing Gazebo 9 is the latest release so we will use that for the purpose of this example. The following steps use a `.repos` to specify the various repositories with specific branches.

```
$ mkdir -p /tmp/gazebo/src && cd /tmp/gazebo
$ wget https://gist.githubusercontent.com/dirk-thomas/
↳6c1ca2a7f5f8c70ce7d3e1ef10a9f678/raw/490aaba72321284af956c9db12f9ef1550ef88cf/
↳Gazebo9.repos
$ vcs import src < Gazebo9.repos
```

Note: The Gist containing the repository list should be replaced with an “official” URL coming from the Gazebo project.

Before building the workspace with `colcon` the steps also fetch some additional metadata for Gazebo from a public repository.

```
$ colcon metadata add default https://raw.githubusercontent.com/colcon/colcon-
↳metadata-repository/master/index.yaml
$ colcon metadata update
$ colcon build
```

To run Gazebo, which requires environment variables for e.g., the model paths, the same commands as for other packages can be used. Using the additional metadata the source script will also automatically source the Gazebo specific file `share/gazebo/setup.sh` which defines these environment variables.

```
$ . install/local_setup.bash
$ gazebo
```


Configuration files can provide additional metadata for packages as well as define default command line arguments. All files described below are using the [YAML](#) format. Note that all strings are case sensitive.

3.1 colcon.pkg files

A `colcon.pkg` file must be placed in the root directory of a package.

The first level of the configuration file is a dictionary. The key can contain any of the following:

- `name` (string) to declare the package name
- `type` (string) to explicitly declare which colcon extension should process the package.
- `dependencies` (list of strings) to declare additional dependencies on other packages. For more fine grain control it is also possible to set `build-dependencies`, `run-dependencies`, and `test-dependencies`.
- `hooks` (list of relative paths within the install prefix) to declare additional scripts to be sourced.
- Any command line argument. The leading single or double dash must be omitted.

3.1.1 Values for command line arguments

The value type depends on the kind of command line argument:

- For flags which are not followed by a value the value can be either `true` or `false`.
- For options followed by a single decimal / float the value must be a decimal / float.
- For options followed by a single value the value must be a string.
- For options followed by one or more values the value must be a list where each item can be any of the mentioned types.

An example declaring an environment hook which should be sourced for a package:

```
{
  "hooks": ["share/pkgname/hook/something.sh"]
}
```

3.2 .meta files

The first level of the configuration file is a dictionary. The only two supported keys are:

- `names` to provide settings based on the package name.
- `paths` to provide settings based on the package path.

3.2.1 By package name

Note: Providing metadata based on the package name only works if the package can be identified and the name can be determined. Otherwise using a *colcon.pkg* file or the *By package path* configuration is necessary.

The value under the `names` key is again a dictionary.

The key is the name of the package. The value can contain the same package specific settings as described in the *colcon.pkg files* section above. The only exception is that specifying a package name is not supported.

3.2.2 By package path

The value under the `paths` key is again a dictionary.

The key is the path of the package. It can be either absolute or relative to the `.meta` file. The value can contain the same package specific settings as described in the *colcon.pkg files* section above. This can be used if the package name can't be determined automatically and placing a `colcon.pkg` file into the package directory is undesired.

3.2.3 Package specific configuration

The package specific part under the package name or package path has the same content as the package specific configuration files described in the *colcon.pkg files* section above.

3.2.4 Using .meta files

Some configuration files are being picked up by default. The following are a few examples (see e.g. `colcon build --help`):

- When `--ignore-user-meta` is not passed any file ending with `.meta` in any recursive subdirectory of `$COLCON_HOME/metadata` is being used.
- When `--metas` is not passed and a file `./colcon.meta` exists it is being used.
- Any file passed with `--metas <path/to/file>` is being used.

Note: The default value for the environment variable `COLCON_HOME` is pointing to the directory `.colcon` within the users home directory.

3.3 defaults.yaml

If the configuration file `$COLCON_HOME/defaults.yaml` exists it is used to customize the default behavior of the CLI. The location can also be modified using the environment variable `COLCON_DEFAULTS_FILE` (see `colcon --help`).

The first level of the configuration file is a dictionary. The key is the `verb` name. In the case of more than one nested verbs the key is the names separated by dots. To specify configuration options *before* the first verb use an empty string key. The value is another dictionary containing the verb specific configuration.

3.3.1 Verb specific configuration

The key can contain any command line argument. The leading single or double dash must be omitted. The value type depends on the command line argument as mentioned in the *Values for command line arguments* section above.

An example to use the symlink install option by default:

```
{
  "build": {
    "symlink-install": true
  }
}
```


This section describe how to perform common tasks.

4.1 Show all output immediately on the console

```
$ colcon <verb> --event-handlers console_direct+
```

Note: If you use the parallel executor (which is the default when that extension is installed) the output of packages processed in parallel will be interleaved.

4.2 Show all output on the console after a package has finished

```
$ colcon <verb> --event-handlers console_cohesion+
```

Note: While this delays the output until a package has finished, it avoids interleaving the output when using the parallel executor.

4.3 Build only a single package (or selected packages)

```
$ colcon build --packages-select <name-of-pkg>  
$ colcon build --packages-select <name-of-pkg> <name-of-another-pkg>
```

Note: This assumes that you have built dependencies of the selected packages within the workspace before.

4.4 Build selected packages including their dependencies

```
$ colcon build --packages-up-to <name-of-pkg>
```

4.5 Rebuild packages which depend on a specific package

Assuming you have built the whole workspace before and then made changes to one package. In order to rebuild this package as well as all packages which (recursively) depend on this package invoke:

```
$ colcon build --packages-above <name-of-pkg>
```

4.6 Build packages that create a Python C/C++ Extension

To be able to build a C/C++ extension when using the option `--symlink-install`, you must include the following lines in your package's `setup.py`:

```
sources = ['one.cpp', 'two.cpp'] # This will contain all C/C++ source files
headers = ['a.h', 'b.hpp', 'c.h'] # Any included header files must be listed here

setup(
    ...,
    data_files=[('.', sources + headers)] # Assuming that your source and header_
↳files are                               # on the same level as setup.py, this will_
↳copy                                     # all required files to the colcon build_
↳folder
)
```

Finally, run `colcon build --symlink-install` as usual.

4.7 Test selected packages as well as their dependents

If you have built the relevant packages before you can run the tests the same way as described in the *previous section*:

```
$ colcon test --packages-above <name-of-pkg>
```

If you haven't built the relevant packages before you can build the to-be-tested packages as well as their recursive dependencies with:

```
$ colcon build --packages-above-and-dependencies <name-of-pkg>
```

4.8 Run specific tests

Depending on the type of the package a different tool is being used to run tests.

4.8.1 Python packages using pytest

```
$ colcon test --packages-select <name-of-pkg> --pytest-args ...
```

Pytest provides multiple ways to select individual tests:

- Tests can be identified by their name:

```
$ ... --pytest-args -k name_of_the_test_function
```

- Tests can be identified using markers if the tests have been decorated with markers before:

```
$ ... --pytest-args -m marker_name
```

Both approaches also support logical expressions like `or` and `not`. For more information see the [pytest documentation](#).

4.8.2 CMake packages using CTest

```
$ colcon test --packages-select <name-of-pkg> --ctest-args ...
```

CTest provides multiple ways to select individual tests:

- Tests can be selected / excluded using a regular expression matching their name:

```
$ ... --ctest-args -R regex
$ ... --ctest-args -E regex
```

- Tests can be selected / excluded using a regular expression matching their label (which have to be assigned to each test when adding the test in the CMake code):

```
$ ... --ctest-args -L regex
$ ... --ctest-args -LE regex
```

For more information see the [CTest documentation](#).

4.9 Build CMake packages without configuring tests

For CMake packages which use the CMake option `BUILD_TESTING` (which is the standard in the [CTest module](#)) you can skip configuring and building tests to improve the build time:

```
$ colcon build --cmake-args -DBUILD_TESTING=OFF
```

4.10 CMake packages generating `compile_commands.json`

When the CMake option `CMAKE_EXPORT_COMPILE_COMMANDS` is enabled a `compile_commands.json` file is generated in the package specific build directory containing the exact compiler calls for all translation units of the project in machine-readable form:

```
$ colcon build --cmake-args -DCMAKE_EXPORT_COMPILE_COMMANDS=ON
```

`colcon-cmake` will additionally generate a workspace-level `compile_commands.json` in the build directory which aggregates the information from all package specific json files.

4.11 Enable additional output for debugging

Beside the output of the actually invoked commands to build or test packages the tool by default only outputs warning or error messages. For debugging purposes you can enable logging messages with other levels (e.g. `info`, `debug`).

```
$ colcon --log-level info <verb> ...
```

4.12 Log files of past invocations

By default the `log` directory is created as a sibling to the `src` directory. Some verbs (e.g. `build`, `test`, `test-result`) generate log files in a subdirectory which is named following the pattern `<verb>_<timestamp>`. For the latest invocation of a specific verb there is a symlink named `latest_<verb>` (on platforms which support symbolic links). For the latest invocation there is another symlink just named `latest` (on platforms which support symbolic links).

Each log directory contains a couple of files in the root:

- `events.log` contains all internal events dispatched. This file is mostly for debugging purposes.
- `logger_all.log` contains all logging messages even though the invocation didn't show them on the console. This is helpful to see log message with a different level after a command was run. The first line of this file contains the exact command line invocation including all the arguments passed.

For each package additional files are being created in a subdirectory named after the package:

- `command.log` contains the commands which have been invoked for the package, e.g. calls to `python setup.py`.
- `stdout.log` contains all the output the invoked commands printed to `stdout`.
- `stderr.log` contains all the output the invoked commands printed to `stderr`.
- `stdout_stderr.log` contains all the output the invoked commands printed to either of the two pipes in the order they appeared.
- `streams.log` combines the output of all the other log files in the order they appeared.

Note: While `colcon` is doing its best to read concurrently from the `stdout` and `stderr` pipes to preserve the order of output it can't guarantee the correctness of the order in all cases.

The `build` verb is building a set of packages. It is provided by the `colcon-core` package.

5.1 Command line arguments

These common arguments can be used:

- *executor* arguments
- *event handler* arguments
- *discovery* arguments
- *package selection* arguments
- *mixin* arguments

Additionally, the following specific command line arguments can be used:

-build-base BUILD_BASE The base path for all build directories. The default value is `./build`. Each package uses a subdirectory in that base path as its package specific build directory.

-install-base INSTALL_BASE The base path for all install prefixes. The default value is `./install`.

-merge-install Use the `--install-base` as the install prefix for all packages instead of a package specific subdirectory in the install base.

Without this option each package will contribute its own paths to environment variables which leads to very long environment variable values.

With this option most of the paths added to environment variables will be the same, resulting in shorter environment variable values.

The disadvantage of using this option is that it doesn't provide proper isolation between packages. For example declaring a dependency on one package also allows access to resources from other packages installed in the same install prefix (without requiring a declared dependency).

Note: on Windows using `cmd` this argument should be used for workspaces with many packages otherwise the environment variables might exceed the supported maximum length.

- `--symlink-install`** Use symlinks instead of copying files from the source and build directories where possible.
- `--test-result-base TEST_RESULT_BASE`** The base path for all test results. The default value is the `--build-base` argument. Each package uses a subdirectory in that base path as its package specific test result directory.
- `--continue-on-error`** Continue building other packages when a package fails to build. Packages recursively depending on the failed package are skipped.

5.1.1 CMake specific arguments

The following arguments are provided by the `colcon-cmake` package:

- `--cmake-args [* [* ...]]`** Pass arbitrary arguments to CMake projects. Arguments matching other options must be prefixed by a space, e.g. `--cmake-args " --help"`.
- `--cmake-target CMAKE_TARGET`** Build a specific target instead of the default target. To avoid packages which don't have that target causing the build to fail, also pass `--cmake-target-skip-unavailable`.
- `--cmake-target-skip-unavailable`** Skip building packages which don't have the target passed to `--cmake-target`.
- `--cmake-clean-cache`** Remove the CMake cache file `CMakeCache.txt` from the build directory before proceeding with the build. This implicitly forces a CMake configure step.
- `--cmake-clean-first`** Build the target `clean` first, then proceed with a regular build. To only invoke the clean target use `--cmake-target clean`.
- `--cmake-force-configure`** Force CMake configure step.

5.1.2 ROS ament_cmake specific arguments

The following arguments are provided by the `colcon-ros` package:

- `--ament-cmake-args [* [* ...]]`** Pass arbitrary arguments to ROS packages with the build type `ament_cmake`. Arguments matching other options must be prefixed by a space, e.g. `--ament-cmake-args " --help"`.

5.1.3 ROS catkin specific arguments

The following arguments are provided by the `colcon-ros` package:

- `--catkin-cmake-args [* [* ...]]`** Pass arbitrary arguments to ROS packages with the build type `catkin`. Arguments matching other options must be prefixed by a space, e.g. `--catkin-cmake-args " --help"`.
- `--catkin-skip-building-tests`** By default the `tests` target building the tests in `catkin` packages is invoked. If running `colcon test` later isn't intended this can be skipped.

CHAPTER 6

edit - Edit File

The `edit` search and edit a file inside a package using command line. It is provided by the `colcon-ed` package. When a correct package name and file name is provided, it will open that file with an editor.

```
$ colcon edit <package_name> <file_name>
```

Note: To enable auto-complete, check out the [installation guide](#).

Hidden files and `.pyc` files are ignored. If multiple files under the same name are present, they will all be listed and you can type in the index number to select which file to edit.

By default, `vim` is the editor that will be used, but you can also use other editors by specifying `$EDITOR` environment variable to the ones preferred. For example, to use **Visual Studio Code**, simply run

```
$ export EDITOR=code
```

6.1 Command line arguments

These common arguments can be used:

- *discovery* arguments
- *mixin* arguments

The following specific positional arguments are used:

PKG_NAME Explicit package name to specify which package the file is in.

FILE_NAME File name to specify which file to edit.

graph - Visualize Dependencies

The `graph` verb generates a visual representation of the package dependency graph. It is provided by the `colcon-package-information` package.

For each package, the path, name and type is shown. By default it outputs a topologically ordered list of packages using ASCII art to indicate direct as well as transitive dependencies.

Optionally the verb can generate `DOT` code to render a graphical representation.

7.1 Command line arguments

These common arguments can be used:

- *discovery* arguments
- *package selection* arguments
- *mixin* arguments

Additionally, the following specific command line arguments can be used:

-density Output the density of the dependency graph. This option is only supported without `--dot`.

-legend Output a legend for the dependency graph.

-dot Output topological graph in DOT. Commonly the output should be piped to `dot`, e.g. `| dot -Tpng -o graph.png`.

The differently colored edges represent the dependency types: blue=build, red=run, tan=test. Dashed edges are indirect dependencies which only appear if some packages are being skipped.

-dot-cluster Cluster packages by their file system path. This option only affects `--dot`.

-dot-include-skipped Include skipped packages in the rendered graph with a gray color. This option only affects `--dot`.

7.2 Example Output

7.2.1 ASCII

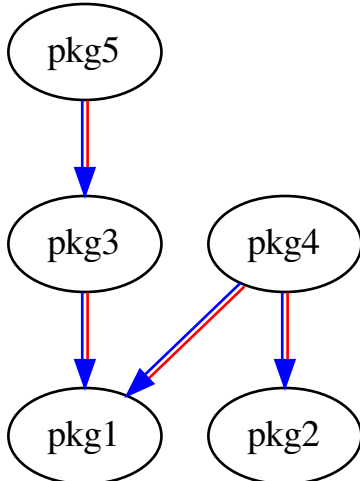
Example output of invoking `colcon graph` with `--legend` (which adds the first paragraph describing the symbols).

```
+ marks when the package in this row can be processed
* marks a direct dependency from the package indicated
  by the + in the same column to the package in this row
. marks a transitive dependency

pkg1 + **
pkg2 + *
pkg3 + *
pkg4 +
pkg5 +
```

7.2.2 DOT

Example output of invoking `colcon graph` with `--dot` rendered into an image. In this example the packages have the same build (blue edges) and run (red edges) dependencies.



info - Show Package Information

The `info` verb shows detailed information about packages. It is provided by the `colcon-package-information` package.

For each package a set of lines is shown starting with the path of the package. Additionally the package type, name, build/run/test dependencies and metadata like the package version are enumerated.

By default the information for all packages is shown. Optionally, single or multiple package names can be passed to only show their information.

8.1 Command line arguments

These common arguments can be used:

- *discovery* arguments
- *package selection* arguments
- *mixin* arguments

Additionally, the following specific command line arguments can be used:

PKG_NAME [PKG_NAME ...] Explicit package names to only show their information. This positional argument is redundant with the package selection argument `--packages-select` and only exists for ease of use.

`list` - List Packages

The `list` verb enumerates a set of packages. It is provided by the `colcon-package-information` package.

For each package a line is shown containing the path, name and type separated by tabs. By default the list is ordered alphabetically by the package name. Optionally, it can order the packages topologically based on their dependencies.

9.1 Command line arguments

These common arguments can be used:

- *discovery* arguments
- *package selection* arguments
- *mixin* arguments

Additionally, the following specific command line arguments can be used:

-topological-order, -t Order output based on topological ordering (breadth-first). For more detailed visualizations of dependencies see the *graph* verb.

-names-only, -n Output only the name of each package but not the path and type

-paths-only, -p Output only the path of each package but not the name and type

The `metadata` verb offers multiple subverbs to manage the registration, introspection and update of metadata repositories.

10.1 `metadata add`

Add the URL of a metadata repository. Afterwards, the metadata information needs to be fetched at least once by invoking `colcon metadata update <name>`.

name The name to identify the to-be-added repository.

url The URL pointing to a yaml file containing an index enumerating `.meta` files.

10.2 `metadata list`

Enumerate the name and URL of the registered metadata repositories as well as their metadata files.

[name] An optional name to only enumerate the metadata files of a specific repository.

10.3 `metadata remove`

Remove the URL of a metadata repository and all its metadata files.

name The name to identify the to-be-removed repository.

10.4 `metadata update`

Fetch the metadata files from a specific repository. The output indicates which metadata files have been added, updated, are unchanged or are obsolete. Obsolete metadata files are not deleted but renamed (changing the `.meta` extension to

.obsolete).

[name] An optional name to only update the metadata files of a specific repository.

The `mixin` verb offers multiple subverbs to manage the registration, introspection and update of mixin repositories.

11.1 `mixin add`

Add the URL of a mixin repository. Afterwards the mixin information needs to be fetched at least once by invoking `colcon mixin update <name>`.

name The name to identify the to-be-added repository.

url The URL pointing to a yaml file containing an index enumerating `.mixin` files.

11.2 `mixin list`

Enumerate the name and URL of the registered mixin repositories as well as their mixin files.

[name] An optional name to only enumerate the mixin files of a specific repository.

11.3 `mixin remove`

Remove the URL of a mixin repository and all its mixin files.

name The name to identify the to-be-removed repository.

11.4 `mixin update`

Fetch the mixin files from a specific repository. The output indicates which mixin files have been added, updated, are unchanged or are obsolete. Obsolete mixin files are not deleted but renamed (changing the `.mixin` extension to `.obsolete`).

[name] An optional name to only update the mixin files of a specific repository.

The `test` verb runs the tests for a set of packages. It is provided by the `colcon-core` package.

12.1 Command line arguments

These common arguments can be used:

- *executor* arguments
- *event handler* arguments
- *discovery* arguments
- *package selection* arguments
- *mixin* arguments

Additionally, the following specific command line arguments can be used:

-build-base BUILD_BASE The base path for all build directories. The default value is `./build`. Each package uses a subdirectory in that base path as its package specific build directory.

-install-base INSTALL_BASE The base path for all install prefixes. The default value is `./install`.

-merge-install Use the `--install-base` as the install prefix for all packages instead of a package specific subdirectory in the install base. See [here](#) for more information.

-test-result-base TEST_RESULT_BASE The base path for all test results. The default value is the `--build-base` argument. Each package uses a subdirectory in that base path as its package specific test result directory.

-retest-until-fail N Rerun tests up to N times if they pass.

-retest-until-pass N Rerun failing tests up to N times.

-abort-on-error Abort after the first package with any errors. Failing tests are not considered errors in this context.

-return-code-on-test-failure Use a non-zero return code to indicate any test failure.

12.1.1 CMake specific arguments

-ctest-args [* [* ...]] [**colcon-cmake**] Pass arbitrary arguments to CTest projects. Arguments matching other options must be prefixed by a space, e.g. `--ctest-args " --help"`.

12.1.2 Python specific arguments

-python-testing {**pytest**,**setuppy_test**} Choose the Python testing framework to use. The default value is determined based on the packages `tests_require` option.

- `pytest`: Use `pytest` to test Python packages.
- `setuppy_test`: Use `setup.py test` to test Python packages.

-pytest-args [* [* ...]] Pass arbitrary arguments to Python packages using `pytest`. Arguments matching other options must be prefixed by a space, e.g. `--pytest-args " --help"`.

-pytest-with-coverage Generate coverage information in the package specific build directory. By default, coverage information is only generated for Python packages that declare a test dependency on `pytest-cov`.

test-result - Summarize Test Results

The `test-result` verb summarizes the results of previous run tests. It is provided by the `colcon-test-result` package.

13.1 Command line arguments

These common arguments can be used:

- *mixin* arguments

Additionally, the following specific command line arguments can be used:

- test-result-base TEST_RESULT_BASE** The base path for all test results. The default value is `./build`. Each package uses a subdirectory in that base path as its package specific test result directory.
- all** Show all test result files including the ones without errors / failures.
- verbose** Show additional information for each error / failure.
- result-files-only** Print only the paths of the result files. Use with `--all` to include files without errors / failures.
- delete** Delete all result files. This might include additional files beside what is listed by `--result-files-only`. An interactive prompt will ask for confirmation.
- delete-yes** Same as `--delete` without an interactive confirmation.

14.1 Command line arguments

The following command line arguments can be used *before* every verb. For each argument the name in brackets indicates which package contributes it.

-log-base LOG_BASE [colcon-core] The base path for all log directories. The default value is `./log`. To completely disable logging, pass `/dev/null` (on POSIX) / `nul` (on Windows).

Within the base path all log files from a specific invocation are placed in a subdirectory named `<verb>_<timestamp>` (in the following named `log-dir`). If the system supports creating symlinks, shortcuts with the names `latest_<verb>` and `latest` are created (overwriting previous symlinks).

Within the `log-dir` the following files are generated:

- `events.log` [colcon-output]: All generated events - only used for debugging.
- `logger_all.log` [colcon-core]: All log messages, independent of the chosen log level for the console output.
- For each processed package a subdirectory with the following files is generated:
 - `command.log` [colcon-output]: All invoked external commands including their return code.
 - `stderr.log` [colcon-output]: All output from external commands to `stdout`.
 - `stdout.log` [colcon-output]: All output from external commands to `stderr`.
 - `stdout_stderr.log` [colcon-output]: A combination of `stdout.log` and `stderr.log` in the order the two streams were processed. Since both streams are read concurrently the order is not fully deterministic.
 - `streams.log` [colcon-output]: A combination of the command log as well as both output logs. Each line is being prefixed with the elapsed time since the package started being processed.

-log-level LOG_LEVEL [colcon-core] Set the log level for the console output. The log file `<log-dir>/logger_all.log` always contains messages of all levels. The value can either be a numeric value or a string as defined in the [Python logging module](#) (the names are case insensitive). The default value is `warning`.

14.2 Environment variables

The following environment variables are supported. The name in brackets indicates which package contributes it.

CMAKE_COMMAND [**colcon-cmake**] The full path to the CMake executable. By default the executable `cmake` is being searched for on the `PATH`.

COLCON_ALL_SHELLS [**colcon-core**] Flag to enable all shell extensions. If the environment variable is set and not empty all shell extensions are being used even if they are supposed to be skipped based on the current platform.

COLCON_ANIMATION_PROGRESS [**colcon-graphviz-anim**] Flag to generate an animation of the task progress. If the environment variable is set and not empty the file `./graphviz_anim_build.gif` is generated.

COLCON_COMPLETION_LOGFILE [**colcon-argcomplete**] Set the path of a logfile to append the completion time to. If the environment variable is set and not empty a line is appended to the specified file. The line contains the duration it took to compute the completion choices as well as the value of the environment variable `COMP_LINE` which was passed to determine the completion choices.

COLCON_DEFAULTS_FILE [**colcon-defaults**] Set the path to the yaml file containing the default values. By default the path `$COLCON_HOME/defaults.yaml` is being used.

COLCON_DEFAULT_EXECUTOR [**colcon-core**] Select the default executor extension for verbs which support it. By default the executor with the highest priority is used. The executor can also be chosen using the `--executor` argument.

COLCON_EXTENSION_BLOCKLIST [**colcon-core**] Block extensions which should not be used. The value uses a path separator to enumerate entry point group names or full entry point names.

COLCON_HOME [**colcon-core**] Set the base path of configuration files. By default the path `~/.colcon` is being used.

COLCON_LOG_LEVEL [**colcon-core**] Set the log level for the console output. See the *`-log-level`* arguments for details about the possible values. Using the environment variable instead of the command line argument allows setting the log level *before* the argument parsing has been performed.

COLCON_WARNINGS [**colcon-core**] Set the warnings filter similar to `PYTHONWARNINGS` except that the module entry is implicitly set to `colcon.*`

CTEST_COMMAND [**colcon-cmake**] The full path to the CTest executable. By default the executable `ctest` is searched for on the `PATH`.

POWERSHELL_COMMAND [**colcon-powershell**] The full path to the PowerShell executable. By default the executable `PowerShell` (on Windows) / `pwsh` (on non-Windows) is searched for on the `PATH`.

Executor arguments

The executor is responsible for processing jobs in verbs which have more than one item of work. For each argument the name in brackets indicates which package contributes it.

-executor EXECUTOR [colcon-core] The executor to process all jobs. The default is chosen based on the priorities of all available executor extensions. To see a complete list invoke `colcon extensions colcon_core.executor --verbose`.

- `sequential [colcon-core]`
Process one package at a time.
- `parallel [colcon-parallel-executor]`
Process multiple jobs in parallel.

-parallel-workers NUMBER [colcon-parallel-executor] The maximum number of jobs to process in parallel. The default value is the number of logical CPU cores as reported by `os.cpu_count()`. This option only affects `--executor parallel`.

Event handler arguments

The event handlers are used by several verbs to generate any kind of output based on the progress of the invocation. For each argument the name in brackets indicates which package contributes it.

-event-handlers [name1+ [name2- ...]] [colcon-core] A list of event handlers to enable (trailing +) or disable (trailing -). The default is chosen by each available event handler (see `colcon <verb> --help`).

- `console_cohesion [colcon-output]:`
Pass job output at once to `stdout` after it has finished.
- `console_direct [colcon-core]:`
Pass output directly to `stdout` / `stderr`. When processing multiple jobs in parallel the output will likely interleave.
- `console_package_list [colcon-output]:`
Output a list of queued job names.
- `console_start_end [colcon-core]:`
Output each job name when starting / ending.
- `console_stderr [colcon-output]:`
Output all `stderr` of a job at once after it has finished.
- `desktop_notification [colcon-notification]:`
Enable desktop notification of the summary indicating the result of the invocation.
- `event_log [colcon-output]:`
Log all events to a global log file `events.log`. See [here](#) for more information about the location of that log file.
- `graphviz_anim [colcon-graphviz-anim]:`
Generate a `.gif` file of the job progress after the invocation has finished. See [here](#) for more details.

- `log [colcon-output]`:
Output job specific log files containing all the output of invoked commands. See [here](#) for more information about the location of these log files.
- `log_command [colcon-colcon]`:
Log a debug message for each invoked command. Either *set a custom log level* to show debug messages or check the generated log files.
- `status [colcon-notification]`:
Show a status line at the current cursor in the terminal title and update it continuously.
- `store_result [colcon-package-select]`:
Persist the result of a job in a file in its build directory which allows the information to be used in subsequent invocation to select packages based on the previous result.
- `summary [colcon-output]`:
Output a single line summarizing the result of all jobs after the invocation has finished.
- `terminal_title [colcon-notification]`:
Show the ongoing status in the terminal title.

Discovery arguments

Discovery arguments determine which locations should be checked if they contain packages. For each argument the name in brackets indicates which package contributes it.

- paths** [PATH [PATH ...]] [**colcon-core**] The (non recursive) paths to check for a package. Use shell wildcards (e.g. `src/*`) to select all direct subdirectories of `src`.
- base-paths** [PATH [PATH ...]] [**colcon-recursive-crawl**] The base paths to recursively crawl for packages. The default value is `..`. In a workspace root the subdirectories other than `src` (commonly `build`, `install`, `log`) contain a `COLCON_IGNORE` marker file which causes them to be ignored.
- metas** [PATH [PATH ...]] [**colcon-metadata**] The directories containing a `colcon.meta` file or paths to arbitrary files containing the same meta information. The default value is `./colcon.meta`.
- ignore-user-meta** [**colcon-metadata**] Ignore `*.meta` files in the configuration directory `$COLCON_HOME/metadata/`.
- packages-ignore** [PKG_NAME [PKG_NAME ...]] [**colcon-package-selection**] Ignore packages by name as if they were not discovered. In contrast to being skipped using *package selection* arguments, ignored packages aren't considered in the dependency graph.
- packages-ignore-regex** [PATTERN [PATTERN ...]] [**colcon-package-selection**] Ignore packages where any of the patterns match the package name. In contrast to being skipped using *package selection* arguments, ignored packages aren't considered in the dependency graph.

Package selection arguments

Package selection arguments determine the set of packages which should be processed by a given verb. If multiple arguments are passed the resulting set is a logical AND combination. For each argument the name in brackets indicates which package contributes it.

-build-base BUILD_BASE The base path for all build directories. The default value is `./build`. Each package uses a subdirectory in that base path as its package specific build directory.

For some verbs this argument only exists since some of the package selection arguments use state information from previous builds to select / skip packages.

-packages-up-to [PKG_NAME [PKG_NAME ...]] Select the packages with the passed names as well as their recursive dependencies.

-packages-up-to-regex [PATTERN [PATTERN ...]] Select the packages that match any of the passed patterns as well as their recursive dependencies.

-packages-above [PKG_NAME [PKG_NAME ...]] Select the packages with the passed names as well as packages which recursively depend on them.

-packages-above-and-dependencies [PKG_NAME [PKG_NAME ...]] Select the packages with the passed names, packages which recursively depend on them as well as their recursive dependencies.

-packages-above-depth DEPTH [PKG_NAME ...] Select the packages with the passed names as well as packages which recursively depend on them up to the given depth.

-packages-select-by-dep [DEP_NAME [DEP_NAME ...]] Select packages which (recursively) depend on the given packages.

-packages-skip-by-dep [DEP_NAME [DEP_NAME ...]] Skip packages which (recursively) depend on the given packages.

-packages-skip-up-to [PKG_NAME [PKG_NAME ...]] Skip the packages with the passed names as well as their recursive dependencies.

-packages-select-build-failed Select packages which have failed to build previously. Packages which have been aborted previously are not included.

-packages-skip-build-finished Skip packages which have finished to build previously.

- packages-select-test-failures** Select packages which had test failures previously.
- packages-skip-test-passed** Skip packages which had no test failures previously.
- packages-select [PKG_NAME [PKG_NAME ...]]** Select the packages with the passed names.
- packages-skip [PKG_NAME [PKG_NAME ...]]** Skip the packages with the passed names.
- packages-select-regex [PATTERN [PATTERN ...]]** Select the packages where any of the patterns match the package name.
- packages-skip-regex [PATTERN [PATTERN ...]]** Skip the packages where any of the patterns match the package name.
- packages-start PKG_NAME** Skip packages before the given package name in flat topological ordering. This option only makes sense when using the *sequential executor*.
- packages-end PKG_NAME** Skip packages after the given package name in flat topological ordering. This option only makes sense when using the *sequential executor*.

Mixin arguments

Mixins can be used by several verbs to contribute command line arguments defined in external files.

The following arguments are provided by the `colcon-mixin` package:

- **-mixin-files** [**FILE** [**FILE ...**]] Read additional mixin files and make the mixin names specified in them available in the `--mixin` argument.
- **-mixin** [**mixin1** [**mixin2 ...**]] The names of mixins to be used. The list of mixin names and their command line arguments depends on which ones are available. To enumerate the available verb specific mixins and their command line arguments invoke `colcon mixin show <verb>`.

An example mixin provided in the `colcon-mixin-repository` repository:

- **debug:**
 - `cmake-args: ['-DCMAKE_BUILD_TYPE=Debug']`

When multiple mixins are used they are interpreted in order with later mixin values replacing or extending previous values. In case of lists the items are being concatenated. In all other cases the latter value replaces the former value.

Warning: At the moment the logic concatenating lists has no semantic knowledge of the data. Therefore the joined list might not have the desired semantic meaning. E.g. for the following two lists:

- `cmake-args: ['-DCMAKE_C_FLAGS=-fpic']`
- `cmake-args: ['-DCMAKE_C_FLAGS=-g']`

the joined list will be just a concatenation:

- `cmake-args: ['-DCMAKE_C_FLAGS=-fpic', '-DCMAKE_C_FLAGS=-g']`

But passing these arguments to CMake would result in the latter value of `CMAKE_C_FLAGS` overwriting the former even though the user likely wanted both compiler options to be used.

20.1 Goals for colcon

A few high level goals are used to guide the overall development.

- The tool should make building, testing and using multiple packages easy.
- It should be possible to add support for any kind of build system using extensions. `colcon-core` only bundles Python support in order to bootstrap itself.
- It should be possible to build any set of packages without requiring changes to their sources. If necessary missing information can be provided externally.
- After building packages they must be immediately usable which includes setting up necessary environment variables etc.

20.1.1 Explicitly out of scope

The tool does not aim to address any of the following tasks. Those should be left for other tools to take care of them.

- Fetch the source of the packages which should be processed by `colcon`.
- Install dependencies of the packages which should be processed by `colcon`.
- Perform packaging tasks like creating Debian packages.

Note: While these items are specifically not targeted by `colcon` it is still possible to implement support for any of these features (or helpful functionality to integration with existing tools) in an extension.

20.2 Software design

Additionally some software design goals are stated:

- All the functionality provided should be exposed in a way that it can be reused by other extensions.
- The separation into multiple Python packages is being used to encourage modularity and loose coupling ([Law of Demeter](#)). It is also used to demonstrate extensibility and show that certain features are not “special” but can be contributed externally.
- Each component should have responsibility over a single part of the software ([Single responsibility principle](#)).
- Each functionality added should follow the principle “you don’t pay for what you don’t use”.

Bootstrap from source

When developing `colcon` you want to have a local checkout of all involved packages.

Note: The following steps use the command line tool `vcstool` to fetch a set of repositories. You can e.g. install it using `pip install vcstool`.

Note: While the following instructions use a Linux shell the same can be done on other platforms like Windows with slightly adjusted commands.

21.1 Virtual environment

While not strictly necessary it is recommended to use a virtual environment for developing Python packages.

```
$ mkdir colcon-venv
$ python3 -m venv colcon-venv
$ . colcon-venv/bin/activate
```

Note: On Windows the Python 3 executable is likely named `python` and the activation script is invoked with `colcon-venv\Scripts\activate`

You might want to make sure that the `venv` is using up-to-date versions of the some foundational packages.

```
$ pip install -U pip setuptools
```

21.2 Fetch the sources

```
$ mkdir colcon-from-source && cd colcon-from-source
$ curl --output colcon.repos https://raw.githubusercontent.com/colcon/colcon.
→readthedocs.org/main/colcon.repos
$ mkdir src
$ vcs import src < colcon.repos
```

Note: Depending on your platform you might not want to use all cloned packages. On Windows you must ignore or remove `colcon-argcomplete`, and may want to do the same for `colcon-bash`. If you don't use PowerShell you might want to ignore / remove the package `colcon-powershell`. To ignore a package add an empty file named `COLCON_IGNORE` to the folder.

Ignore `colcon-argcomplete` and `colcon-bash` on Windows.

```
> type nul > src\colcon-argcomplete\COLCON_IGNORE
> type nul > src\colcon-bash\COLCON_IGNORE
```

21.3 Dependencies

Make sure the dependencies are available:

```
$ curl --output requirements.txt https://raw.githubusercontent.com/colcon/colcon.
→readthedocs.org/main/requirements.txt
$ pip install -r requirements.txt
```

21.4 Build the sources - first time

In the first build we will use the minimal features provided by `colcon-core` to build the set of cloned packages.

```
$ ./src/colcon-core/bin/colcon build --paths src/*
```

Note: On Windows the command needs to be prefixed with `python`.

The build of the packages will run sequentially and for each package the output will be printed directly to the console. The install directory will contain a `local_setup.sh` (or `.bat` on Windows).

In order to generate scripts for additional shells the set of packages have to be built a second time but this time using all extension provided by the various cloned packages.

21.5 Build the sources - second time

```
$ . install/local_setup.sh
$ colcon build
```

Note: On Windows the setup file ends with `.bat` and is just being called. Also the `colcon` executable can't be invoked directly here since while it is being used it can't be overwritten by the build. Instead invoke the following command: `python install\colcon-core\Scripts\colcon-script.py build`.

Note: The second build will process packages in parallel as long as their dependencies are finished. Also the output of all packages is not shown on the console (until there are errors) but is being redirected to log files. Depending on the platform you might also notice a status line during the build, a continuously updated title of the shell windows, and a desktop notification at the end of the build.

To use the full functionality you can source the generated script for your shell:

```
$ . install/local_setup.bash
```

Note: With bash you should now also have completion for all arguments if you have the Python package `argcomplete` installed. Try typing `colcon <tab>` to see the completion of global options and verbs.

Environment setup

Using a package after it has been built or building a package on top of its dependencies might require updating environment variables. For the former, the best option for the user is to have a script perform the environment update for ease of use. In the latter case, automating the process is necessary to build packages in topological order without user interaction. E.g. if a package installs an executable which should be invocable by name, the directory containing the executable needs to be part of the `PATH` environment variable.

22.1 Entry points

To update environment variables:

- On non-Windows platforms a shell script needs to be `source-ed` (e.g. `.sh`, `.bash`, `.zsh`)
- On Windows a shell script needs to be `call-ed` (e.g. `.bat`, `.ps1`)

Note: Executables are unable to change the environment of the current shell. Therefore this needs to be done from a shell script.

22.1.1 Package-level

Note: Each package installs its files under its install prefix. This corresponds to `install/<package_name>` except when `colcon build --merge-install` is used. In that case, the install prefix is `install/`.

For each built package `colcon` generates a set of package-level scripts (one for each supported shell type): `share/<package_name>/package.<ext>`. These script files update the environment with information specific to this package.

`colcon` supports multiple different approaches to update environment variables:

- A heuristic checking the installed files for known file types or known destinations. A few of the supported heuristics:
 - An executable under `bin` adds that directory to the `PATH`
 - An existing Python library directory adds that directory to the `PYTHONPATH`
 - A file ending in `-config.cmake` or `Config.cmake` adds the directory to the `CMAKE_PREFIX_PATH` (provided by `colcon-cmake`)
 - A file starting with `Find` and ending in `.cmake` adds the directory to the `CMAKE_MODULE_PATH` (provided by `colcon-cmake`)
 - A shared library adds the directory to one of the following environment variables (depending on the platform): `LD_LIBRARY_PATH`, `DYLD_LIBRARY_PATH`, `PATH` (provided by `colcon-library-path`)
 - A file ending in `.pc` in a directory `lib/pkgconfig` adds the directory to the `PKG_CONFIG_PATH` (provided by `colcon-pkg-config`)
- Specific package types providing their own scripts to setup the package specific environment. E.g. `ament_cmake` packages (supported by `colcon-ros`) provide a file named `share/<package_name>/local_setup.<ext>`.

22.1.2 Workspace-level

In the root of the install prefix path, `colcon` generates two kinds of scripts:

- `local_setup.<ext>`: updates the environment with information from all packages installed under this prefix path. Since package-level scripts rely on information from their dependencies the package-level scripts must be invoked in topological order. In order to determine the topological order of all packages under the prefix path, `colcon` stores all run dependencies of a package in a file named `share/colcon-core/packages/<package_name>`.
- `setup.<ext>`: first invokes the `local_setup.<ext>` files from all parent prefix paths and then invokes the sibling `local_setup.<ext>` file.

22.2 Different shells

Each shell has a potentially different syntax and supports a different set of features. Some environment changes like extending the `PATH` are applicable to all shells while others like providing completion functionality are only applicable to some. If one shell (e.g. `bash`) provides a superset of functionality and syntax of another shell (e.g. `sh`) the logic of the `.sh` scripts doesn't have to be duplicated for `bash` but can be invoked from the package-level setup files. The latter shell is called a *primary shell*.

22.2.1 Primary shells

All environment changes necessary to use a package should be expressed in script with the extension of a primary shell. Primary shell extensions are:

- `.sh`: plain shell
- `.bat`: Windows cmd
- `.ps1`: PowerShell

22.2.2 Non-primary / additional shells

Other shells which are able to invoke primary shell scripts within their context commonly don't duplicate their content and logic. Instead they first invoke the primary shell script and then add additional logic to provide specific functionalities like completion.

22.3 Avoid duplicate entries

Several environment variables store multiple values separated by a delimiter. Commonly, duplicate values are not useful and only increase length and decrease readability. Therefore, shell scripts try to avoid adding duplicate values where applicable.

With the number of values in such an environment variable the cost to check if a given value is already in the collection increases. This significantly affects the time it takes to `source / call` the workspace-level setup file since for each attempt to update an environment variable the collection needs to be split and each existing value compared to the to-be-added value.

Therefore `colcon` provides an alternative way to update the environment.

22.3.1 .dsv files

Since shell scripts can contain arbitrary logic it is opaque from the outside how they affect the environment. That makes it impossible to optimize their execution.

Most scripts perform one of the following common operations:

- Set an environment variable to a value.
- Add a value to an environment variable (using a platform specific delimiter) if the value is not already in the collection.
- Source / call another script file.

A `.dsv` file contains the descriptive information about the intended environment change (instead of shell specific logic). The content of such a file uses a semicolon as the delimiter and contains a single line. The first value is the `type` of the operation followed by a variable number of arguments specific to the operation.

The following list enumerates the supported types and their arguments:

- `prepend-non-duplicate;<name>;<value>`: Prepend a value `<value>` to an environment variable `<name>` (using a platform specific delimiter) if the value is not already in the collection. The value is considered to be a path. If the value is not an absolute path the prefix path of the `.dsv` file is prepended to the value. An empty value therefore represents the prefix path.
- `prepend-non-duplicate-if-exists;<name>;<value>`: Same as `prepend-non-duplicate` but only if the path described by the value exists.
- `set;<name>;<value>`: Set an environment variable `<name>` to a value `<value>`. If the value is an existing relative path in the install prefix the install prefix is prepended to the value. Otherwise the value is used as is.
- `set-if-unset;<name>;<value>`: Same as `set` but only if the environment variable is not yet set (or empty).
- `source;<path>`: Source / call another script file `<path>`. If the value is not an absolute path the prefix path of the `.dsv` file is prepended.

22.4 Implementation

Implementing the logic to determine the topological order of packages in every primary shell would be a lot of effort and (depending on the shell) cumbersome. Also parsing and interpreting `.dsv` files would likely not be much faster than invoking the native scripts.

Therefore both parts are implemented in a Python script located in the root of the install prefix: `_local_setup_util_<ext>.py`. The Python script itself can't change the environment. However, it is able to efficiently interpret the operations described by the `.dsv` files and generate the shell specific commands necessary to update the environment. The Python file is templated with information specific to the primary shell it's used from, hence the `<ext>` in the filename.

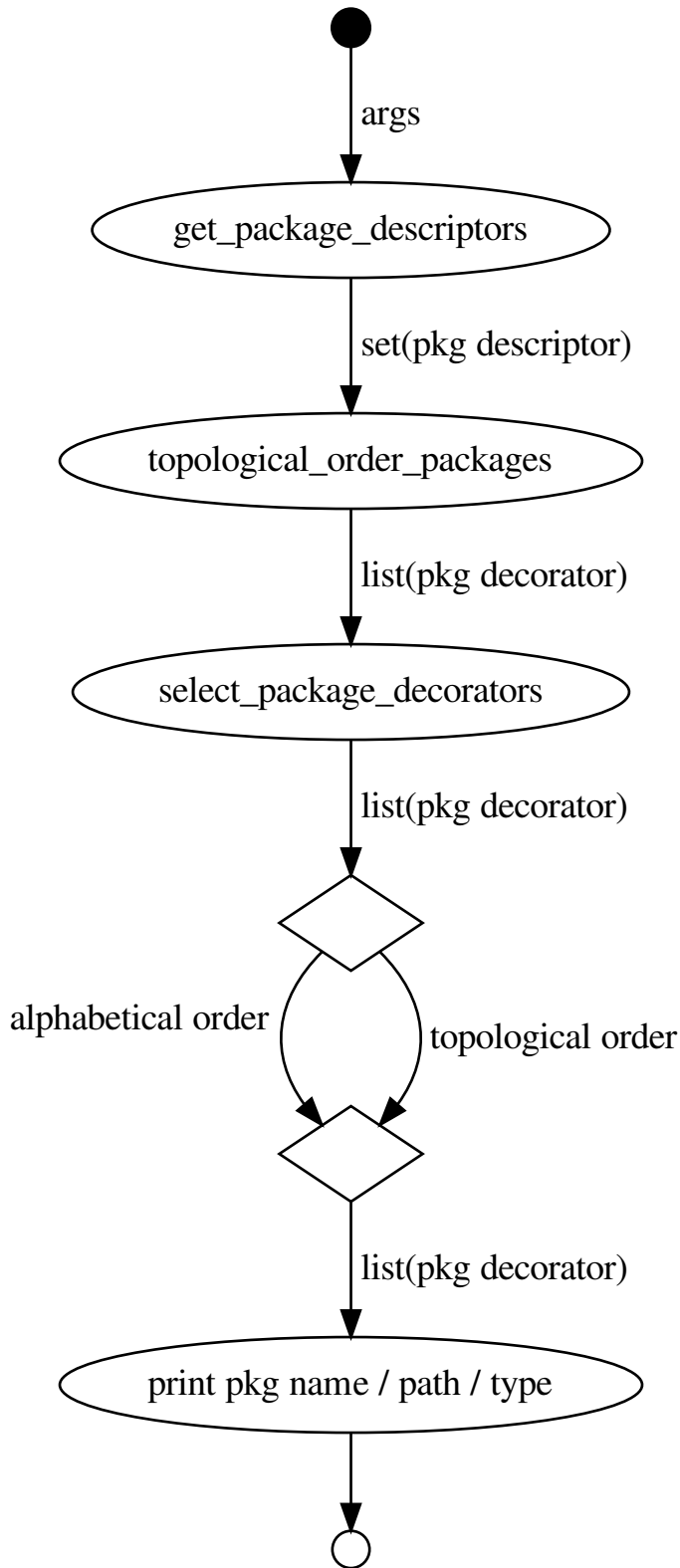
22.5 Tracing

When sourcing / calling a workspace-level setup file the number of evaluated scripts and / or interpreted `.dsv` files can be significant. To debug what files are being considered in which order and what environment changes are being performed you can prepend the invocation with `COLCON_TRACE=1`. As a result each recursively invoked script as well as every generated command will be printed to the terminal.

The following depicts the high level program flow of a couple of verbs.

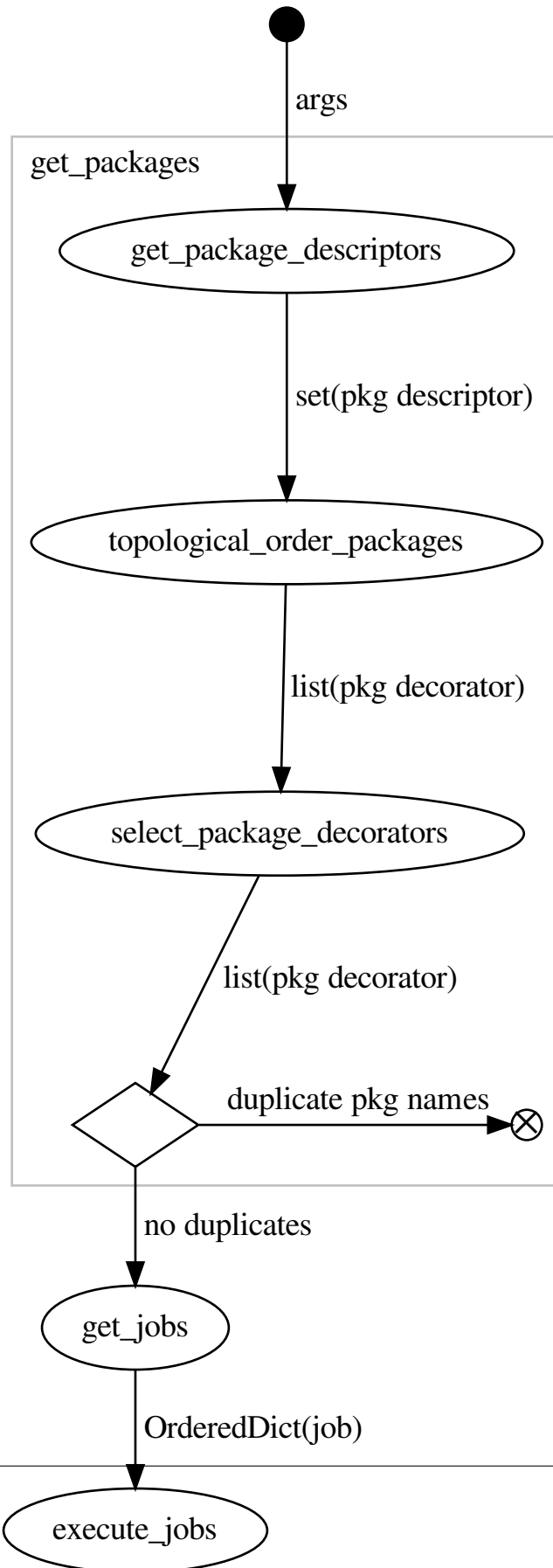
23.1 list

This verb is provided by the `colcon-package-information` package.



23.2 build

This verb is provided by the `colcon-core` package.



The following describes some of the extension points and how they are used.

24.1 VerbExtensionPoint

This extension point is used by the `colcon` command. Each verb extension defines custom logic which can be invoked by calling `colcon <verb>`. Each verb extension can add command line arguments to the verb specific subparser in `argparse`.

24.2 PackageDiscoveryExtensionPoint

This extension point is used by verb extensions. Each package discovery extension can add command line arguments which are grouped in the “Discovery arguments” section of the usage help. Each extension returns a set of package descriptors which identify a package with the tuple path, name, and type. While a package discovery extension only provides candidate paths it uses the package identification extension point to determine if a path contains a package.

If explicit arguments are provided for any package discovery extensions only those extension are being used. Otherwise the package discovery extensions which provide a default value are used.

24.3 PackageIdentificationExtensionPoint

This extension point is used by package discovery extensions. A package identification extension determines if a given path contains a package and returns the tuple path, name, and type.

Package identification extensions are grouped by their priority. The extensions are invoked in order of their priority and the first extension successfully identifying a package stops further extensions from being considered.

If multiple extensions have the same priority they are all invoked. If more than one extension within the priority group identifies the package in the given path the result must be identical or a warning is printed and the path is skipped.

24.4 PackageAugmentationExtensionPoint

This extension point is used by verb extensions after packages have been discovered and identified. A package augmentation extension can add arbitrary information to a package descriptor, like additional dependencies.

24.5 PackageSelectionExtensionPoint

This extension point is used by verb extensions after packages have been discovered, identified, and augmented. Each package selection extension adds command line arguments which are grouped in the “Package selection arguments” section of the usage help.

By default all packages are selected. Each extension can select / unselect matching package decorators based on the passed arguments. If arguments for multiple extensions are being passed the combined boolean flag is a logical AND combination.

24.6 TaskExtensionPoint

This extension point is used by verb extensions after packages have been discovered, identified, and augmented. Each task extension implements the logic for the combination of a `verb` and a `package type`, e.g. building a Python package.

In order to be invoked a task extension needs parameters provided by a context object. A job object brings those two together.

24.7 ExecutorExtensionPoint

This extension point is used by some verb extensions to execute a set of jobs. The executor extension with the highest priority is used by default.

24.8 ShellExtensionPoint

This extension point is used by some task extensions to generate shells scripts to setup the environment or create environment hooks for each supported shell. Each extension implements the logic for a specific shell. For the primary shells each extension also provides the environment to run commands.

24.9 EnvironmentExtensionPoint

This extension point is used by some task extensions as well as shell extensions to create environment hooks for each supported shell. Each extension creates environment hooks for a specific environment variable and uses the shell extensions to generate scripts for each supported shell.

24.10 EventHandlerExtensionPoint

This extension point defines how events are handled. An event can be any kind of object, like a line of output, a job starting, progressing or ending, or a command executing. Every event is dispatched to all extensions in order of their priority.

There are already many great contribution guidelines available online. Therefore only a few important bullets are enumerated here. Please read for example the Open Source Guide [How to contribute](#) for more detailed information which was created and is curated by GitHub.

25.1 Bug reports

- Make sure you are using the latest version.
- Search the project's issue tracker and/or the internet for similar reports.
- Perform basic troubleshooting steps:
 - Try to reproduce the problem “from scratch”.
 - If you are deviating from any instructions try to following the instructions and see if the problem persists.
 - If it seems to work for others ask yourself what is different in your case.
- Consider to provide a pull request if possible.
- And as a last step report a bug you can't solve yourself:
 - Describe the expected as well as the actual behavior.
 - Give enough context (e.g. platform, versions, environment).
 - Provide easily reproducible steps and/or a [SSCCE](#).

25.2 Pull requests

- Keep each pull request focused on one aspect, create separate ones for separate aspects.
- For bug fixes make sure to reproduce the problem before and after applying the patch ensure that the problem has been addressed.

- For larger patches consider to create a feature request ticket to discuss the proposal ahead of time.
- Ensure that new code is covered by tests to prevent regressions in the future.
- Make sure that the code changes pass the existing tests including the linters.
- And as a last step create a pull request.

25.3 Documentation

Since documentation is stored in a git repository any changes are made through pull requests and therefore the above bullets for pull requests apply.

The documentation follows the one-sentence-per-line style to minimize the diff (preventing reflow in a paragraph on changes).

25.4 New packages / extensions

Using Python entry points it is easy to contribute extensions in separate packages. To ease discoverability and ensure long term maintenance if individual maintainers move on it is encouraged to host the code in a repository under the *colcon* organization unit on GitHub. Please open a ticket to either ask for the creation of a repository which you will have *admin* level access to or for moving an existing repository to this organization unit.

25.4.1 Use keyword in package metadata

When creating a package containing `colcon` extensions please consider declaring a keyword to help discovering extensions through e.g. PyPI. When using a `setup.cfg` file for the metadata of the package it is as simple as including these lines:

```
[metadata]
keywords = colcon
```

If you are developing a Python package containing colcon extensions you might want to make a release of it. Commonly that involves bumping the version number and tagging the commit with that version.

Commonly Python packages are released to PyPI following the [packaging instructions for Python projects](#). For colcon packages the recommendation is to use [publish-python](#) which not only uploads a wheel to PyPI but also creates and uploads Debian packages.

26.1 First-time setup

Before using `publish-python` you need to do the following:

- Install the prerequisites of `publish-python`
- Configure credentials for `twine` / PyPI
- Configure credentials for `packagecloud.io` and request to be added as a contributor to the [colcon repository](#)
- Create a configuration file for your package

For details please see the [publish-python documentation](#).

Example configuration file `publish-python.yaml`:

```
artifacts:
- type: wheel
  uploads:
  - type: pypi
- type: stdeb
  uploads:
  - type: packagecloud
    config:
      repository: dirk-thomas/colcon
      distributions:
      - ubuntu:xenial
```

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```
- ubuntu:bionic
- ubuntu:focal
- debian:stretch
- debian:buster
```

The list of targeted distributions might need to be updated to match the configuration files mentioned in the following subsection.

26.2 Publishing a release

After having tagged the repository you only need to invoke `publish-python --upload` to create the configured artifacts as well as upload them to the configured destinations.

In the case the Debian package is used by the ROS community you need to open a ticket in the GitHub repository [ros-infrastructure/reprepo-updater](#). The pull request should update the two files `colcon.ubuntu.upstream.yaml` and `colcon.debian.upstream.yaml` file with a bumped version number for the package. Someone from the ROS team will then review and merge the pull request and import the latest artifacts into the apt repositories of ROS.

Most colcon repositories are hosted on GitHub and contain a single Python package. The following describes the process used to provide a detailed changelog for each release. The main goal is to keep the necessary effort minimal and reuse the information available in the GitHub tickets.

27.1 Milestone

For each upcoming release a milestone is being created with the tentative version number as the title. Every issue and pull request targeting that upcoming release should have that milestone set. That allows to list all open / closed tickets for a specific milestone using the GitHub interface.

27.2 Release

When making a release and tagging a new version the due date of the matching milestone should be edited to contain the date of the release. Afterwards the milestone should be closed and a new milestone with the next tentative version number should be created.

27.3 Link

To make the changelog information easily accessible the package manifest should provide a link like this in the `setup.cfg`:

```
[metadata]
project_urls =
    Changelog = https://github.com/colcon/<reponame>/milestones?direction=desc&
    ↪sort=due_date&state=closed
```


The following describes the mapping of some `ament_tools` options and arguments to the `colcon` command line interface.

28.1 ament build | test

```
[BASEPATH] --base-paths BASEPATH
--build-space PATH --build-base PATH
--install-space PATH --install-base PATH
--build-tests CMake configures tests by default. To skip configuring tests use --cmake-args
  -DBUILD_TESTING=OFF.
-s, --symlink-install --symlink-install
--isolated The colcon option --merge-install has the inverse logic.
--start-with PKGNAME --packages-start PKGNAME
--end-with PKGNAME --packages-end PKGNAME
--only-packages PKGNAME1 ... PKGNAMEn --packages-select PKGNAME1 ... PKGNAMEn
--skip-packages PKGNAME1 ... PKGNAMEn --packages-skip PKGNAME1 ... PKGNAMEn
--parallel colcon uses the parallel execution by default. To build packages sequentially use --executor
  sequential.
```

28.2 ament build

```
colcon build ...
```

--cmake-args -D... **--** `--cmake-args -D...` The closing double dash is not necessary anymore. Any CMake arguments which match colcon arguments need to be prefixed with a space. This can be done by quoting each argument with a leading space.

--force-cmake-configure `--cmake-force-configure`

--make-flags When using this option to pass a target name the substitution is: `--cmake-target TARGET`. When using this option to control the parallel execution with arguments like `-jN` the substitution is to use the environment variable `MAKEFLAGS`.

--use-ninja `--cmake-args -G Ninja`

28.3 ament test

`colcon test ...`

--ctest-args ... **--** `--ctest-args ...` Any CTest arguments which start with a dash need to be prefixed with a space (see `--cmake-args`).

--retest-until-fail N `--retest-until-fail N`

--retest-until-pass N `--retest-until-pass N`

--abort-on-test-error `--abort-on-error`

28.4 ament test_results

`colcon test-result ...`

[BASEPATH] `--build-base BASEPATH`

--verbose `--all`

28.5 Behavioral changes

The `colcon test` verb performs only the action of running tests. It does not build any packages.

`--retest-until-fail` with `colcon` uses `pytest-repeat` which runs individual tests of a package $N+1$ times each (the first test $N+1$ times, then the second test $N+1$ times, etc). With `ament_tools` the entire test suite of a package was run up to $N+1$ times. As a consequence `colcon` provides a more accurate result since each test that passed has actually run N times. Note that with `pytest-repeat`, `pytest` tests are repeated N times regardless of the result of the previous runs; if a test fails it will be repeated N times anyway. This is different from the behavior of a CTest test that will stop being repeated as soon as it fails once.

The location of JUnit test results file for `ament_python` packages tested with `colcon` is in `<pkg-build>/pytest.xml`, whereas with `ament_tools` it is in `<pkg-build>/test_results/<pkgname>/pytest.xunit.xml`.

catkin_make_isolated

The following describes the mapping of some `catkin_make_isolated` options and arguments to the `colcon` command line interface.

--source PATH --base-paths BASEPATH

--build PATH --build-base PATH

--devel PATH `colcon` doesn't support the concept of a "devel" space. Instead you can choose the path of the devel space as the install base and perform a normal installation.

--install-space PATH --install-base PATH

--merge --merge-install

--use-ninja --cmake-args -G Ninja

--use-nmake --cmake-args -G "NMake Makefiles"

--install `colcon` always performs an installation. It doesn't support the concept of a "devel" space.

--cmake-args ... --cmake-args ... The closing double dash is not necessary anymore. Any CMake arguments which match `colcon` arguments need to be prefixed with a space. This can be done by quoting each argument with a leading space.

--force-cmake --cmake-force-configure

--pkg PKGNAME1 ... PKGNAME_n --packages-select PKGNAME1 ... PKGNAME_n

--from-pkg PKGNAME --packages-start PKGNAME

--only-pkg-with-deps PKGNAME1 ... PKGNAME_n --packages-up-to PKGNAME1 ... PKGNAME_n

The following describes the mapping of some `catkin_tools` options and arguments to the `colcon` command line interface.

30.1 catkin build

```
[PKGNAME1 ... PKGNAMEn] --packages-up-to PKGNAME1 ... PKGNAMEn  
--no-deps --packages-select PKGNAME1 ... PKGNAMEn  
--start-with PKGNAME --packages-start PKGNAME  
--force-cmake --cmake-force-configure  
--cmake-args ... -- --cmake-args ... The closing double dash is not necessary anymore. Any CMake  
arguments which match colcon arguments need to be prefixed with a space. This can be done by quoting each  
argument with a leading space.  
-v, --verbose --event-handlers console_cohesion+  
-i, --interleave-output --event-handlers console_direct+  
--no-status --event-handlers status-  
--no-summarize, --no-summary --event-handlers summary-  
--no-notify --event-handlers desktop_notification-
```