The Cylc Suite Engine User Guide

7.0.0

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Abstract

Cylc ("silk") is a metascheduler for cycling environmental forecasting suites containing many forecast models and associated processing tasks. Cylc has a novel self-organising scheduling algorithm: a pool of task proxy objects, that each know just their own inputs and outputs, negotiate dependencies so that correct scheduling emerges naturally at run time. Cylc does not group tasks artificially by forecast cycle² (each task has a private cycle time and is self-spawning - there is no suite-wide cycle time) and handles dependencies within and between cycles equally so that tasks from multiple cycles can run at once to the maximum possible extent. This matters in particular whenever the external driving data ³ for upcoming cycles are available in advance: cylc suites can catch up from delays very quickly, parallel test suites can be started behind the main operation to catch up quickly, and one can likewise achieve greater throughput in historical case studies; the usual sequence of distinct forecast cycles emerges naturally if a suite catches up to real time operation. Cylc can easily use existing tasks and can run suites distributed across a heterogenous network. Suites can be stopped and restarted in any state of operation, and they dynamically adapt to insertion and removal of tasks, and to delays or failures in particular tasks or in the external environment: tasks not directly affected will carry on cycling as normal while the problem is addressed, and then the affected tasks will catch up as quickly as possible. Cylc has comprehensive command line and graphical interfaces, including a dependency graph based suite control GUI. Other notable features include suite databases; a fast simulation mode; a structured, validated suite definition file format; dependency graph plotting; task event hooks for centralized alerting; and cryptographic suite security.

¹A metascheduler determines when dependent jobs are *ready to run* and then submits them to run by other means, usually a batch queue scheduler. The term can also refer to an aggregate view of multiple distributed resource managers, but that is not the topic of this document. We drop the "meta" prefix from here on because a metascheduler is also a type of scheduler.

²A forecast cycle comprises all tasks with a common cycle time (later referred to here as cycle point) i.e. the analysis time or nominal start time of a forecast model, or that of the associated forecast model(s) for other tasks.

 $^{^3}$ Forecast suites are typically driven by real time observational data or timely model fields from an external forecasting system.

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1 Introduction: How Cylc Works

1.1 Scheduling Forecast Suites

Environmental forecasting suites generate forecast products from a potentially large group of interdependent scientific models and associated data processing tasks. They are constrained by availability of external driving data: typically one or more tasks will wait on real time observations and/or model data from an external system, and these will drive other downstream tasks, and so on. The dependency diagram for a single forecast cycle point in such a system is a *Directed Acyclic Graph* as shown in Figure 1 (in our terminology, a *forecast cycle point* is comprised of all tasks with a common cycle point, which is the nominal analysis time or start time of the forecast models in the group). In real time operation processing will consist of a series of distinct forecast cycle points that are each initiated, after a gap, by arrival of the new cycle point's external driving data.

From a job scheduling perspective task execution order in such a system must be carefully controlled in order to avoid dependency violations. Ideally, each task should be queued for execution at the instant its last prerequisite is satisfied; this is the best that can be done even if queued tasks are not able to execute immediately because of resource contention.

1.2 EcoConnect

Cylc was developed for the EcoConnect Forecasting System at NIWA (National Institute of Water and Atmospheric Research, New Zealand). EcoConnect takes real time atmospheric and stream flow observations, and operational global weather forecasts from the Met Office (UK), and uses these to drive global sea state and regional data assimilating weather models, which in turn drive regional sea state, storm surge, and catchment river models, plus tide prediction, and a large number of associated data collection, quality control, preprocessing, post-processing, product generation, and archiving tasks.⁴ The global sea state forecast runs once daily. The regional weather forecast runs four times daily but it supplies surface winds and pressure to several downstream models that run only twice daily, and precipitation accumulations to catchment river models that run on an hourly cycle assimilating real time stream flow observations and using the most recently available regional weather forecast. EcoConnect runs on heterogeneous distributed hardware, including a massively parallel supercomputer and several Linux servers.

1.3 Dependence Between Tasks

1.3.1 Intra-cycle Dependence

Most dependence between tasks applies within a single forecast cycle point. Figure 1 shows the dependency diagram for a single forecast cycle point of a simple example suite of three forecast models (a, b, and c) and three post processing or product generation tasks (d, e and f). A scheduler capable of handling this must manage, within a single forecast cycle point, multiple parallel streams of execution that branch when one task generates output for several downstream tasks, and merge when one task takes input from several upstream tasks.

Figure 2 shows the optimal job schedule for two consecutive cycle points of the example suite in real time operation, given execution times represented by the horizontal extent of the task bars. There is a time gap between cycle points as the suite waits on new external driving data. Each task in the example suite happens to trigger off upstream tasks *finishing*, rather

 $^{^4}$ Future plans for EcoConnect include additional deterministic regional weather forecasts and a statistical ensemble.

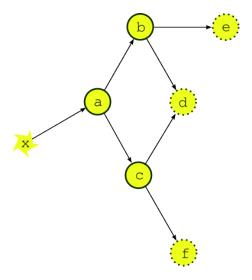


Figure 1: The dependency graph for a single forecast cycle point of a simple example suite. Tasks a, b, and c represent forecast models, d, e and f are post processing or product generation tasks, and x represents external data that the upstream forecast model depends on.

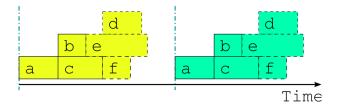


Figure 2: The optimal job schedule for two consecutive cycle points of our example suite during real time operation, assuming that all tasks trigger off upstream tasks finishing completely. The horizontal extent of a task bar represents its execution time, and the vertical blue lines show when the external driving data becomes available.

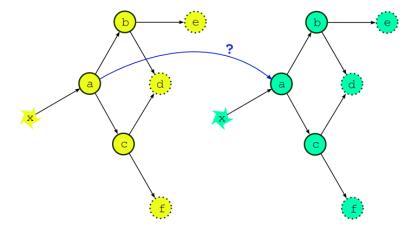


Figure 3: If the external driving data is available in advance, can we start running the next cycle point early?

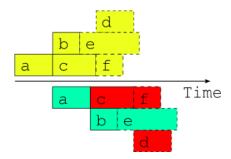


Figure 4: A naive attempt to overlap two consecutive cycle points using the single-cycle-point dependency graph. The red shaded tasks will fail because of dependency violations (or will not be able to run because of upstream dependency violations).

than off any intermediate output or event; this is merely a simplification that makes for clearer diagrams.

Now the question arises, what happens if the external driving data for upcoming cycle points is available in advance, as it would be after a significant delay in operations, or when running a historical case study? While the forecast model a appears to depend only on the external data x at this stage of the discussion, in fact it would typically also depend on its own previous instance for the model background state used in initializing the new forecast. Thus, as alluded to in Figure 3, task a could in principle start as soon as its predecessor has finished. Figure 4 shows, however, that starting a whole new cycle point at this point is dangerous - it results in dependency violations in half of the tasks in the example suite. In fact the situation could be even worse than this - imagine that task b in the first cycle point is delayed for some reason

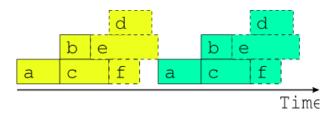


Figure 5: The best that can be done in general when inter-cycle dependence is ignored.

after the second cycle point has been launched. Clearly we must consider handling inter-cycle dependence explicitly or else agree not to start the next cycle point early, as is illustrated in Figure 5.

1.3.2 Inter-Cycle Dependence

Forecast models typically depend on their own most recent previous forecast for background state or restart files of some kind (this is called $warm\ cycling$) but there can also be inter-cycle dependence between different tasks. In an atmospheric forecast analysis suite, for instance, the weather model may generate background states for observation processing and data-assimilation tasks in the next cycle point as well as for the next forecast model run. In real time operation inter-cycle dependence can be ignored because it is automatically satisfied when one cycle point finishes before the next begins. If it is not ignored it drastically complicates the dependency graph by blurring the clean boundary between cycle points. Figure 6 illustrates the problem for our simple example suite assuming minimal inter-cycle dependence: the warm cycled models $(a, b, and\ c)$ each depend on their own previous instances.

For this reason, and because we tend to see forecasting suites in terms of their real time characteristics, other metaschedulers have ignored inter-cycle dependence and are thus restricted to running entire cycle points in sequence at all times. This does not affect normal real time operation but it can be a serious impediment when advance availability of external driving data makes it possible, in principle, to run some tasks from upcoming cycle points before the current cycle point is finished - as was suggested at the end of the previous section. This can occur, for instance, after operational delays (late arrival of external data, system maintenance, etc.) and to an even greater extent in historical case studies and parallel test suites started behind a real time operation. It can be a serious problem for suites that have little downtime between forecast cycle points and therefore take many cycle points to catch up after a delay. Without taking account of inter-cycle dependence, the best that can be done, in general, is to reduce the gap between cycle points to zero as shown in Figure 5. A limited crude overlap of the single cycle point job schedule may be possible for specific task sets but the allowable overlap may change if new tasks are added, and it is still dangerous: it amounts to running different parts of a dependent system as if they were not dependent and as such it cannot be guaranteed that some unforeseen delay in one cycle point, after the next cycle point has begun, (e.g. due to resource contention or task failures) won't result in dependency violations.

Figure 7 shows, in contrast to Figure 4, the optimal two cycle point job schedule obtained by respecting all inter-cycle dependence. This assumes no delays due to resource contention or otherwise - i.e. every task runs as soon as it is ready to run. The scheduler running this suite must be able to adapt dynamically to external conditions that impact on multi-cycle-point scheduling in the presence of inter-cycle dependence or else, again, risk bringing the system down with dependency violations.

To further illustrate the potential benefits of proper inter-cycle dependency handling, Figure 8 shows an operational delay of almost one whole cycle point in a suite with little downtime between cycle points. Above the time axis is the optimal schedule that is possible in principle when inter-cycle dependence is taken into account, and below it is the only safe schedule possible in general when it is ignored. In the former case, even the cycle point immediately after the delay is hardly affected, and subsequent cycle points are all on time, whilst in the latter case it takes five full cycle points to catch up to normal real time operation.

Similarly, Figure 9 shows example suite job schedules for an historical case study, or when catching up after a very long delay; i.e. when the external driving data are available many cycle points in advance. Task a, which as the most upstream forecast model is likely to be

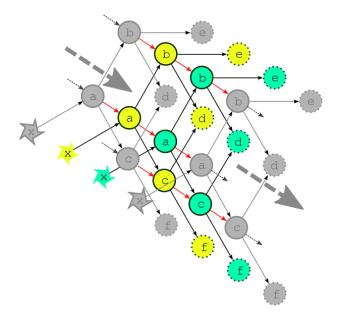


Figure 6: The complete dependency graph for the example suite, assuming the least possible inter-cycle dependence: the forecast models (a, b, and c) depend on their own previous instances. The dashed arrows show connections to previous and subsequent forecast cycle points.

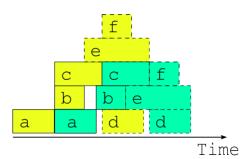


Figure 7: The optimal two cycle job schedule when the next cycle's driving data is available in advance, possible in principle when inter-cycle dependence is handled explicitly.

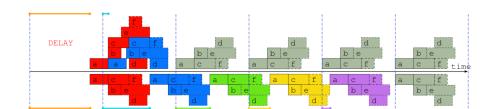


Figure 8: Job schedules for the example suite after a delay of almost one whole forecast cycle point, when inter-cycle dependence is taken into account (above the time axis), and when it is not (below the time axis). The colored lines indicate the time that each cycle point is delayed, and normal "caught up" cycle points are shaded gray.

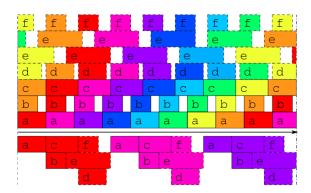


Figure 9: Job schedules for the example suite in case study mode, or after a long delay, when the external driving data are available many cycle points in advance. Above the time axis is the optimal schedule obtained when the suite is constrained only by its true dependencies, as in Figure 3, and underneath is the best that can be done, in general, when inter-cycle dependence is ignored.

a resource intensive atmosphere or ocean model, has no upstream dependence on co-temporal tasks and can therefore run continuously, regardless of how much downstream processing is yet to be completed in its own, or any previous, forecast cycle point (actually, task a does depend on co-temporal task x which waits on the external driving data, but that returns immediately when the data is available in advance, so the result stands). The other forecast models can also cycle continuously or with a short gap between, and some post processing tasks, which have no previous-instance dependence, can run continuously or even overlap (e.g. e in this case). Thus, even for this very simple example suite, tasks from three or four different cycle points can in principle run simultaneously at any given time.

In fact, if our tasks are able to trigger off internal outputs of upstream tasks (message triggers) rather than waiting on full completion, then successive instances of the forecast models could overlap as well (because model restart outputs are generally completed early in the forecast) for an even more efficient job schedule.

1.4 The Cylc Scheduling Algorithm

Cylc manages a pool of proxy objects that represent the real tasks in a suite. Task proxies know how to run the real tasks that they represent, and they receive progress messages from the tasks as they run (usually reports of completed outputs). There is no global cycling mechanism to advance the suite; instead individual task proxies have their own private cycle point and spawn their own successors when the time is right. Task proxies are self-contained - they know their own prerequisites and outputs but are not aware of the wider suite. Inter-cycle dependence is not treated as special, and the task pool can be populated with tasks with many different cycle points. The task pool is illustrated in Figure 10. Whenever any task changes state due to completion of an output, every task checks to see if its own prerequisites have been satisfied. In effect, cylc gets a pool of tasks to self-organize by negotiating their own dependencies so that optimal scheduling, as described in the previous section, emerges naturally at run time.

2 Cylc Screenshots

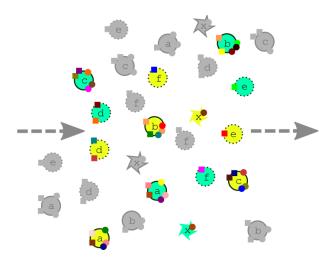


Figure 10: How cylc sees a suite, in contrast to the multi-cycle-point dependency graph of Figure 6. Task colors represent different cycle points, and the small squares and circles represent different prerequisites and outputs. A task can run when its prerequisites are satisfied by the outputs of other tasks in the pool.

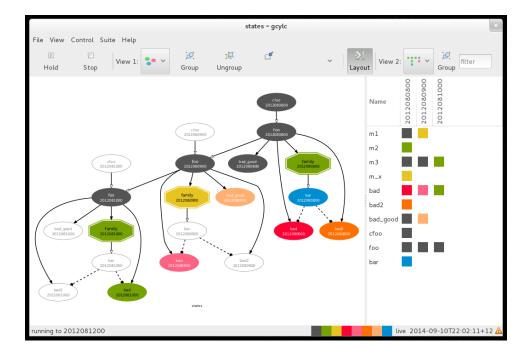


Figure 11: gcylc graph and dot views.

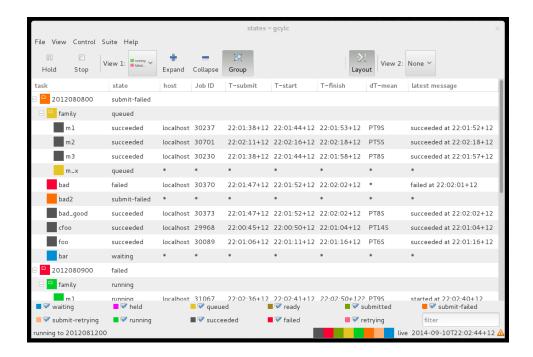


Figure 12: gcylc text view.

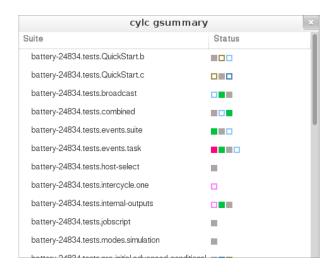
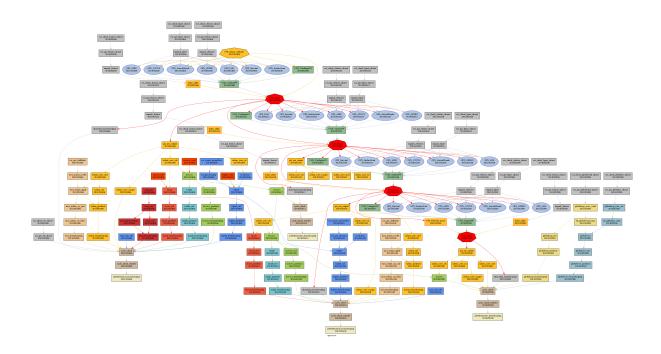


Figure 13: gscan multi-suite state summary GUI.



 $Figure \ 14: \ {\rm A \ large-ish \ suite \ graphed \ by \ cylc.}$

3 Required Software

- Cylc, the version associated with this document is: 7.0.0.

 Cylc can be downloaded from from GitHub: https://cylc.github.com/cylc
- OS: A Linux or Unix variant (including, reportedly, Apple OS X).
- The Python Language, version 2.6 or later, but not 3.x yet. https://python.org

```
• sqlite (a server-less, zero-configuration, SQL database engine). The Python API to sqlite is part of the Python standard library. The command line interface is likely included in your Linux distribution already. Cylc generates an sqlite database for each suite as it runs, to record task events and status.
```

```
http://sqlite.org
```

The following packages are technically optional as you can construct and run cylc suites without dependency graphing and the gcylc GUI:

• **PyGTK**, a Python wrapper for the GTK+ GUI toolkit, required for the gcylc GUI. PyGTK is included in most Linux Distributions.

```
http://www.pygtk.org
```

• Graphviz (latest tested 2.28.0) and Pygraphviz (latest tested 1.1), a graph layout engine and a Python interface to it.

```
http://www.graphviz.org
http://pygraphviz.github.io/
```

If you use a binary package manager to install graphviz you may also need a couple of *devel* packages for the pygraphviz build:

- python-devel
- graphviz-devel

This user guide can be generated from the LATEX source by running make in the top level cylc directory after download. The following TeXpackages are required (but note that the exact packages required may be somewhat OS or distribution-dependent):

- texlive
- texlive-tocloft
- texlive-framed
- texlive-preprint (for fullpage.sty, formerly in tetex)

And for HTML versions of the User Guide:

- texlive-tex4ht
- ImageMagick (for image scaling)

Cylc includes a slightly modified version of cherrypy 6.0.2, a pure Python HTTP framework that we use as a web server for communication between server processes (cylc suites) and client programs (running tasks, the gcylc GUI, user commands). Client communication is done via the Python requests library if available (recommended) or via pure Python via urllib2.

```
http://www.cherrypy.org/
http://docs.python-requests.org/
```

Cylc includes Jinja2 2.8, a full featured template engine for Python and its dependency MarkupSafe 0.23, both BSD licensed.

```
http://jinja.pocoo.org/
http://www.pocoo.org/projects/markupsafe/
```

Finally, cylc makes heavy use of Python *ordered dictionary* data structures. Significant speedup in parsing large suites can be had by installing the fast C-coded ordereddict module by Anthon van der Neut:

• ordereddict (latest tested 0.4.5) https://anthon.home.xs4all.nl/Python/ordereddict/

This module is currently included with cylc under \$CYLC_DIR/ext, and is built by the top level cylc Makefile. If you install the resulting library appropriately cylc will automatically use it in place of a slower Python implementation of the ordered dictionary structure.

3.1 Known Version Compatibility Issues

Cylc should run "out of the box" on recent Linux distributions.

3.1.1 Apple Mac OSX

</arrav>

It has been reported that cylc runs fine on OSX 10.6 SnowLeopard, but on OSX 10.7 Lion there is an issue with constructing proper FQDNs (Fully Qualified Domain Names) that requires a change to the DNS service. Here's how to solve the problem:

```
• Now unload and reload the mDNSResponder service:
```

```
% sudo launchctl unload -w
/System/Library/LaunchDaemons/com.apple.mDNSResponder.plist
% sudo launchctl load -w
/System/Library/LaunchDaemons/com.apple.mDNSResponder.plist
```

<string>-AlwaysAppendSearchDomains</string>

3.2 Other Software Used Internally By Cylc

Cylc has incorporated a custom-modified version the *xdot* graph viewer (https://github.com/jrfonseca/xdot.py, LGPL license).

4 Installation

4.1 Install The External Dependencies

First install graphviz, Pygraphviz, TEX, and ImageMagick using the package manager on your system if possible; otherwise download the packages manually and follow their native installation documentation. On a modern Linux system, this is very easy. For example, to install cylc-5.1.0 on the Fedora 18 Linux distribution:

4 INSTALLATION 4.2 Install Cylc

```
$ yum install graphviz  # (2.28)
$ yum install graphviz-devel # (for pgraphviz build)
$ yum install python-devel # (ditto)

# TeX packages, and ImageMagick, for generating the Cylc User Guide:
$ yum install texlive
$ yum install texlive-tex4ht
$ yum install texlive-tocloft
$ yum install texlive-framed
$ yum install texlive-preprint
$ yum install ImageMagick

# Python packages:
$ easy_install pygraphviz

# (sqlite 3.7.13 already installed on the system)
```

If you do not have root access on your intended cylc host machine and cannot get a sysadmin to do this at system level, see 4.4 for tips on installing everything to a local user account.

Now check that everything other than the LATEX packages is installed properly:

```
$ cylc check-software
Checking for Python >= 2.6 ... found 2.7.3 ... ok
Checking for non-Python packages:
    + Graphviz ... ok
    + sqlite ... ok
Checking for Python packages:
    + pygraphviz ... ok
    + pygraphviz ... ok
    + pygtk ... ok
```

If this command reports any errors then the packages concerned are not installed, not in the system Python search path, or (for a local install) not present in your \$PYTHONPATH variable.

4.2 Install Cylc

Cylc installs into a normal user account, as an unpacked release tarball or a git repository clone. See the INSTALL file in the source tree for instructions (also listed in H).

4.2.1 Create A Site Config File

Site and user global config files define some important parameters that affect all suites, some of which may need to be customized for your site. See 7 for how to generate an initial site file and where to install it. All legal site and user global config items are defined in B.

4.2.2 Configure Site Environment on Job Hosts

If your users submit task jobs to hosts other than the hosts they use to run their suites, you should ensure that the job hosts have the correct environment for running cylc. A cylc suite generates task job scripts that normally invoke bash. The job will attempt to source the first of these files it finds to set up its environment:

• \${HOME}/.cylc/job-init-env.sh

• \${CYLC_DIR}/conf/job-init-env.sh

• \${CYLC DIR}/conf/job-init-env-default.sh

• \${CYLC_DIR}/conf/job-init-env-default.sh

The \${CYLC_DIR}/conf/job-init-env-default.sh file is provided in the cylc distribution, and will attempt to source /etc/profile and \${HOME}/.profile. If this behaviour is not desirable, you should override it by adding a \${CYLC_DIR}/conf/job-init-env.sh file and populate it with the appropriate contents.

4.3 Automated Tests

The cylc test battery is primarily intended for developers to check that changes to the source code don't break existing functionality. Note that some test failures can be expected to result from suites timing out, even if nothing is wrong, if you run too many tests in parallel. See cylc test-battery --help.

4.4 Local User Installation

It is possible to install cylc and all of its software prerequisites under your own user account. Cylc itself is already designed to be installed into a normal user account, just follow the instructions above in 4.2. For the other packages, depending on the installation method used for each, it is just a matter of learning how to change the default install path prefix from, for example, \(\text{\userline} \) \(\text{\underline} \) \(\text{\userline} \) \(\text{\userline} \) \(\text{\userline} \) \(\text{\underline} \) \(\text{\userline} \) \(\text{\underline} \) \(\text{\userline} \) \(\text{\underline} \) \

4.4.1 Some Guidelines

• For python setup.py install installation:

```
$ python setup.py install --prefix=/my/local/install/path
```

• For building graphviz from source:

```
$ ./configure --prefix=/my/local/install/path --with-qt=no
$ make
$ make install
```

The graphviz build reportedly may fail on systems that do not have QT installed, hence the ./configure --with-qt=no option above. The graphviz lib and include locations are required when installing Pygraphviz.

 The pygraphviz setup.py file may need to be edited to point at your local graphviz library and include directories:

```
# setup.py lines 31 and 32
library_path='/path/to/local/graphviz/lib'
include_path='/path/to/local/graphviz/include'
```

• Note that when using python setup.py or easy_install the local install location may need to exist and it may be need to be present in PYTHONPATH before you initiate the install process.

Finally, check that everything (other than LATEX for document processing) is installed:

```
$ cylc check-software
Checking for Python >= 2.6 ... found 2.7.3 ... ok
Checking for non-Python packages:
+ Graphviz ... ok
+ sqlite ... ok
Checking for Python packages:
+ pygraphviz ... ok
+ pygtk ... ok
```

If this command reports any errors then the packages concerned are not installed, not in the system Python search path, or (for a local install) not present in your \$PYTHONPATH variable.

4.5 Upgrading To New Cylc Versions

Upgrading is just a matter of unpacking the new cylc release. Successive cylc releases can be installed in parallel as suggested in the INSTALL file (H).

5 Cylc Terminology

5.1 Jobs and Tasks

A job is a program or script that runs on a computer, and a task is a workflow abstraction - a node in the suite dependency graph - that represents a job.

5.2 Cycle Points

A cycle point is a particular date-time (or integer) point in a sequence of date-time (or integer) points. Each cylc task has a private cycle point and can advance independently to subsequent cycle points. It may sometimes be convenient, however, to refer to the "current cycle point" of a suite (or the previous or next one, etc.) with reference to a particular task, or in the sense of all tasks instances that "belong to" a particular cycle point. But keep in mind that different tasks may pass through the "current cycle point" (etc.) at different times as the suite evolves.

6 Workflows For Cycling Systems

A model run and associated processing may need to be cycled for the following reasons:

- In real time forecasting systems, a new forecast may be initiated at regular intervals when new real time data comes in.
- Batch scheduler queue limits may require that long single runs be split into many smaller runs with incremental processing of associated inputs and outputs.

Cylc provides two ways of constructing workflows for cycling systems: cycling workflows and parameterized tasks.

6.1 Cycling Workflows

This is cylc's classic cycling mode as described in the Introduction. Each instance of a cycling job is represented by a new instance of the same task, with a new cycle point. The suite configuration defines patterns for extending the workflow on the fly, so it can keep running indefinitely if necessary. For example, to cycle model.exe on a monthly sequence we could define a single task model, an initial cycle point, and a monthly sequence. Cylc then generates the date-time sequence and creates a new task instance for each cycle point as it comes up. Workflow dependencies are defined generically with respect to the "current cycle point" of the tasks involved.

This is the only sensible way to run very large suites or operational suites that need to continue cycling indefinitely. The cycling is configured with standards-based ISO 8601 date-time recurrence expressions. Multiple cycling sequences can be used at once in the same suite. See Section 10.3.

6.2 Parameterized Tasks as a Proxy for Cycling

It is also possible to run cycling jobs with a pre-defined static workflow in which each instance of a cycling job is represented by a different task: as far as the abstract workflow is concerned there is no cycling. The sequence of tasks can be constructed efficiently, however, using cylc's built-in suite parameters (10.6.7) or explicit Jinja2 loops (10.7).

For example, to run model.exe 12 times on a monthly cycle we could loop over an integer parameter R = 0, 1, 2, ..., 11 to define tasks model-R0, model-R1, model-R2, ...model-R11, and

the parameter values could be multiplied by the interval P1M (one month) to get the start point point for the corresponding model run.

This method is only good for smaller workflows of finite duration because every single task has to be mapped out in advance, and cylc has to be aware of all of them throughout the entire run. Additionally Cylc's cycling workflow capabilities (above) are more powerful, more flexible, and generally easier to use (Cylc will do the date-time arithmetic for you, for instance), so that is the recommended way to drive most cycling systems.

The primary use for parameterized tasks in cylc is to generate ensembles and other groups of related tasks at the same cycle point, not as a proxy for cycling.

6.3 Mixed Cycling Workflows

For completeness we note that parameterized cycling can be used within a cycling workflow. For example, in a daily cycling workflow long (daily) model runs could be split into four shorter runs by parameterized cycling. A simpler six-hourly cycling workflow should be considered first, however.

7 Global (Site, User) Configuration Files

Cylc site and user global configuration files contain settings that affect all suites. Some of these, such as the range of network ports used by cylc, should be set at site level,

```
# cylc site global config file
/path/to/cylc/conf/global.rc
# Deprecated path to cylc site global config file
/path/to/cylc/conf/siterc/site.rc
```

Others, such as the preferred text editor for suite definitions, can be overridden by users,

```
# cylc user global config file
~/.cylc/global.rc
# Deprecated cylc user global config file
~/.cylc/user.rc
```

The cylc get-site-config command retrieves current global settings consisting of cylc defaults overridden by site settings, if any, overridden by user settings, if any. To generate an initial site or user global config file:

```
$ cylc get-site-config > $HOME/.cylc/global.rc
```

Settings that do not need to be changed should be deleted or commented out of user global config files so that they don't override future changes to the site file.

Legal items, values, and system defaults are documented in (B).

8 Tutorial

This section provides a hands-on tutorial introduction to basic cycle functionality.

8.1 User Config File

Some settings affecting cylc's behaviour can be defined in site and user *global config files*. For example, to choose the text editor invoked by cylc on suite definitions:

```
# $HOME/.cylc/global.rc
[editors]
    terminal = vim
    gui = gvim -f
```

• For more on site and user global config files see 7 and B.

8 TUTORIAL 8.2 User Interfaces

8.1.1 Configure Environment on Job Hosts

If you submit task jobs to hosts other than the hosts you use to run your suites, you may need to customise the environment for running cylc. A cylc suite generates task job scripts that normally invoke bash. The job will attempt to source the first of these files it finds to set up its environment:

- \${HOME}/.cylc/job-init-env.sh
- \${CYLC_DIR}/conf/job-init-env.sh
- \${CYLC_DIR}/conf/job-init-env-default.sh

The \${CYLC_DIR}/conf/job-init-env-default.sh file is provided in the cylc distribution, and will attempt to source /etc/profile and \${HOME}/.profile. If this behaviour is not desirable, your site administrator should have overridden it by adding a \${CYLC_DIR}/conf/job-init-env.sh file and populate it with the appropriate contents. If customisation is still required, you can add your own \${HOME}/.cylc/job-init-env.sh file and populate it with the appropriate contents.

8.2 User Interfaces

You should have access to the cylc command line (CLI) and graphical (GUI) user interfaces once cylc has been installed as described in Section 4.2.

8.2.1 Command Line Interface (CLI)

The command line interface is unified under a single top level cylc command that provides access to many sub-commands and their help documentation.

```
$ cylc help  # Top level command help.
$ cylc run --help # Example command-specific help.
```

Command help transcripts are printed in E and are available from the GUI Help menu. Cylc is *scriptable* - the error status returned by commands can be relied on.

8.2.2 Graphical User Interface (GUI)

The cylc GUI covers the same functionality as the CLI, but it has more sophisticated suite monitoring capability. It can start and stop suites, or connect to suites that are already running; in either case, shutting down the GUI does not affect the suite itself.

```
$ gcylc & # or:
$ cylc gui & # Single suite control GUI.
$ cylc gscan & # Multi-suite monitor GUI.
```

Clicking on a suite in gscan, shown in Figure 13, opens a gcylc instance for it.

8.3 Suite Definitions

Cylc suites are defined by extended-INI format suite.rc files (the main file format extension is section nesting). These reside in *suite definition directories* that may also contain a bin directory and any other suite-related files.

• For more on the suite definition file format, see 10 and A.

8.4 Suite Registration

Suite registration creates a run directory (under ~/cylc-run/ by default) and populates it with authentication files and a symbolic link to a suite definition directory. Cylc commands that parse suite definitions can take the file path or the suite name as input. Commands that interact with running suites have to target the suite by name.

```
# Target a suite by file path:
$ cylc validate /path/to/my/suite/suite.rc
$ cylc graph /path/to/my/suite/suite.rc

# Register a suite:
$ cylc register my.suite /path/to/my/suite/

# Target a suite by name:
$ cylc graph my.suite
$ cylc validate my.suite
$ cylc validate my.suite
$ cylc run my.suite
$ cylc stop my.suite
# cylc stop my.suite
# etc.
```

8.5 Suite Passphrases

Registration (above) also generates a suite-specific passphrase file under .service/ in the suite run directory. It is loaded by the suite daemon at start-up and used to authenticate connections from client programs.

Possession of a suite's passphrase file gives full control over it. Without it, the information avaiable to a client is determined by the suite's public access privilege level.

For more on connection authentication, suite passphrases, and public access, see 13.6.

8.6 Import The Example Suites

Run the following command to copy cylc's example suites and register them for your own use: \$ cylc import-examples /tmp

```
8.7 Rename The Imported Tutorial Suites
```

Suites can be renames by simply renaming (i.e. moving) their run directories. Make the tutorial suite names shorter, and print their locations with cylc print:

```
$ mv ~/cylc-run/$(cylc --version)/examples/tutorial ~/cylc-run/tut
$ cylc print -ya tut
tut/oneoff/jinja2 | /tmp/cylc-examples/7.0.0/tutorial/oneoff/jinja2
tut/cycling/two | /tmp/cylc-examples/7.0.0/tutorial/cycling/two
tut/cycling/three | /tmp/cylc-examples/7.0.0/tutorial/cycling/three
#
```

See cylc print --help for other display options.

8.8 Suite Validation

Suite definitions can be validated to detect syntax (and other) errors:

```
# pass:
$ cylc validate tut/oneoff/basic
Valid for cylc-6.0.0
$ echo $?
0
# fail:
$ cylc validate my/bad/suite
Illegal item: [scheduling]special tusks
```

```
$ echo $?
```

8.9 Hello World in Cylc

suite: tut/oneoff/basic

Here's the traditional *Hello World* program rendered as a cylc suite:

```
title = "The cylc Hello World! suite"
[scheduling]
        [[dependencies]]
            graph = "hello"
[runtime]
        [[hello]]
            script = "sleep 10; echo Hello World!"
```

Cylc suites feature a clean separation of scheduling configuration, which determines when tasks are ready to run; and runtime configuration, which determines what to run (and where and how to run it) when a task is ready. In this example the [scheduling] section defines a single task called hello that triggers immediately when the suite starts up. When the task finishes the suite shuts down. That this is a dependency graph will be more obvious when more tasks are added. Under the [runtime] section the script item defines a simple inlined implementation for hello: it sleeps for ten seconds, then prints Hello World!, and exits. This ends up in a job script generated by cylc to encapsulate the task (below) and, thanks to some defaults designed to allow quick prototyping of new suites, it is submitted to run as a background job on the suite host. In fact cylc even provides a default task implementation that makes the entire [runtime] section technically optional:

```
title = "The minimal complete runnable cylc suite"
[scheduling]
    [[dependencies]]
        graph = "foo"
# (actually, 'title' is optional too ... and so is this comment)
```

(the resulting dummy task just prints out some identifying information and exits).

8.10 Editing Suites

The text editor invoked by cylc on suite definitions is determined by cylc site and user global config files, as shown above in 8.2. Check that you have renamed the tutorial examples suites as described just above and open the *Hello World* suite definition in your text editor:

```
$ cylc edit tut/oneoff/basic # in-terminal
$ cylc edit -g tut/oneoff/basic & # or GUI
```

Alternatively, start gcylc on the suite:

```
$ gcylc tut/oneoff/basic &
```

and choose $Suite \rightarrow Edit$ from the menu.

The editor will be invoked from within the suite definition directory for easy access to other suite files (in this case there are none). There are syntax highlighting control files for several text editors under /path/to/cylc/conf/; see in-file comments for installation instructions.

8.11 Running Suites

8.11.1 CLI

Run tut/oneoff/basic using the cylc run command. As a suite runs detailed timestamped information is written to a *suite log* and progress can be followed with cylc's suite monitoring tools

(below). By default a running suite daemonizes after printing a short message so that you can exit the terminal or even log out without killing the suite:

ssh nwp-1 "pgrep -a -P 1 -fu \$USER 'cylc-r.* \btut/oneoff/basic\b'"

If you're quick enough (this example only takes 10-15 seconds to run) the cylc scan command will detect the running suite:

```
$ cylc scan
tut/oneoff/basic oliverh@nwp-1:43027
```

Note you can use the --no-detach and --debug options to cylc-run to prevent the suite from daemonizing (i.e. to make it stay attached to your terminal until it exits).

When a task is ready cylc generates a *job script* to run it, by default as a background jobs on the suite host. The job process ID is captured, and job output is directed to log files in standard locations under the suite run directory.

Log file locations relative to the suite run directory look like job/1/hello/01/ where the first digit is the *cycle point* of the task hello (for non-cycling tasks this is just '1'); and the final 01 is the *submit number* (tasks can be made to retry on failure or manually retriggered - each time a new log directory is used to avoid overwriting previous output).

The suite shuts down automatically once all tasks have succeeded.

8.11.2 GUI

The cylc GUI can start and stop suites, or (re)connect to suites that are already running:

```
$ cylc gui tut/oneoff/basic &
```

Use the tool bar Play button, or the $Control \rightarrow Run$ menu item, to run the suite again. You may want to alter the suite definition slightly to make the task take longer to run. Try right-clicking on the hello task to view its output logs. The relative merits of the three $suite\ views$ - dot, text, and graph - will be more apparent later when we have more tasks. Closing the GUI does not affect the suite itself.

8.12 Discovering Running Suites

Suites that are currently running can be detected with command line or GUI tools:

```
# list currently running suites and their port numbers:
$ cylc scan
tut/oneoff/basic oliverh oliverh-34403DL 7766
# GUI summary view of running suites:
$ cylc gscan &
```

The scan GUI is shown in Figure 13; clicking on a suite in it opens gcylc.

8 TUTORIAL 8.13 Task Identifiers

8.13 Task Identifiers

At run time, task instances are identified by *name*, which is determined entirely by the suite definition, and a *cycle point* which is usually a date-time or an integer:

```
foo.20100808T00Z  # a task with a date-time cycle point
bar.1  # a task with an integer cycle point (could be non-cycling)
```

Non-cycling tasks usually just have the cycle point 1, but this still has to be used to target the task instance with cylc commands.

8.14 Job Submission: How Tasks Are Executed

```
suite: tut/oneoff/jobsub
```

Task job scripts are generated by cylc to wrap the task implementation specified in the suite definition (environment, script, etc.) in error trapping code, messaging calls to report task progress back to the suite daemon, and so forth. Job scripts are written to the suite job log directory where they can be viewed alongside the job output logs. They can be accessed at run time by right-clicking on the task in the cylc GUI, or printed to the terminal:

```
$ cylc cat-log tut/oneoff/basic hello.1
```

This command can also print the suite log (and stdout and stderr for suites in daemon mode) and task stdout and stderr logs (see cylc cat-log --help). A new job script can also be generated on the fly for inspection:

```
$ cylc jobscript tut/oneoff/basic hello.1
```

Take a look at the job script generated for hello.1 during the suite run above. The custom scripting should be clearly visible toward the bottom of the file.

The hello task in the first tutorial suite defaults to running as a background job on the suite host. To submit it to the Unix at scheduler instead, configure its job submission settings as in tut/oneoff/jobsub:

```
[runtime]
    [[hello]]
        script = "sleep 10; echo Hello World!"
        [[[job]]]
        batch system = at
```

Run the suite again after checking that atd is running on your system.

Cylc supports a number of different job submission methods. Tasks submitted to external batch queuing systems like at, PBS, SLURM, Moab, or LoadLeveler, are displayed as *submitted* in the cylc GUI until they start executing.

- For more on task job scripts, see 12.1.
- For more on job submission methods, see 12.2.

8.15 Locating Suite And Task Output

If the --no-detach option is not used, suite stdout and stderr will be directed to the suite run directory along with the time-stamped suite log file, and task job scripts and job logs (task stdout and stderr). The default suite run directory location is \$HOME/cylc-run:

8 TUTORIAL 8.16 Remote Tasks

```
|-- ssl.cert
                         # SSL certificate for the suite server
    '-- ssl.pem
                         # SSL private key
   cylc-suite.db
                         # back compat symlink to public suite run database
-- share
                         # suite share directory (not used in this example)
                           task work space (sub-dirs are deleted if not used)
  work
                            # task cycle point directory (or 1)
        '-- hello
                               # task work directory (deleted if not used)
  log
                           suite log directory
   1-- db
                            # public suite run database
       job
                              task job log directory
                                # task cycle point directory (or 1)
           '-- hello
                                   # task name
                                     # task submission number
                   01
                       job
                   I - -
                                         # task job script
                    · _ _
                       job-activity.log # task job activity
                   |-- job.err
                                         # task stderr log
                                        # task stdout log
                       job.out
                    '-- job.status
                                        # task status file
                   NN -> 01
                                     # symlink to latest submission number
                              suite daemon log directory
      suite
       |-- err
                               # suite daemon stderr log
                                                          (daemon mode only)
       |-- out
                                 suite daemon stdout log (damon mode only)
       '-- log
                                 suite daemon event log (timestamped info)
```

The suite run database files, suite environment file, and task status files are used internally by cylc. Tasks execute in private work/ directories that are deleted automatically if empty when the task finishes. The suite share/ directory is made available to all tasks (by \$CYLC_SUITE_SHARE_DIR) as a common share space. The task submission number increments from 1 if a task retries on failure; this is used a sub-directory of the log tree to avoid overwriting log files from earlier job submissions.

The top level run directory location can be changed in site and user config files if necessary, and the suite share and work locations can be configured separately because of the potentially larger disk space requirement.

Task job logs can be viewed by right-clicking on tasks in the gcylc GUI (so long as the task proxy is live in the suite), manually accessed from the log directory (of course), or printed to the terminal with the cylc cat-log command:

```
# suite logs:
  cylc cat-log
                  tut/oneoff/basic
                                             # suite event log
 cylc cat-log -o tut/oneoff/basic
                                             # suite stdout log
 cylc cat-log -e tut/oneoff/basic
$
                                             # suite stderr log
  task logs:
 cylc cat-log
                  tut/oneoff/basic hello.1
                                           # task job script
 cylc cat-log -o tut/oneoff/basic hello.1
                                             # task stdout log
  cylc cat-log -e tut/oneoff/basic hello.1
                                            # task stderr log
```

- For a web-based interface to suite and task logs (and much more), see *Rose* in 15.
- For more on environment variables supplied to tasks, such as \$CYLC_SUITE_SHARE_DIR, see 10.4.7.

8.16 Remote Tasks

```
suite: tut/oneoff/remote
```

The hello task in the first two tutorial suites defaults to running on the suite host. To make it run on a remote host instead change its runtime configuration as in tut/oneoff/remote:

```
[runtime]
    [[hello]]
        script = "sleep 10; echo Hello World!"
        [[[remote]]]
        host = server1.niwa.co.nz
```

For remote task hosting to work several requirements must be satisfied:

8 TUTORIAL 8.16 Remote Tasks

• Non-interactive ssh must be enabled from the suite host account to the task host account, for task job submission.

- Your shell initialization (.profile, .bashrc, .cshrc, etc) on the remote host must not produce any standard output as it may confuse commands such as scp. See http://www.openssh.com/faq.html#2.9 for more information.
- Network settings must allow communication *back* from the task host to the suite host, either by network ports or ssh, unless the last-resort one way *task polling* communication method is used.
- Cylc must be installed on the task host. Other software dependencies like graphviz are not required there.
- Any files needed by a remote task must be installed on the task host. In this example there is nothing to install because the implementation of hello is inlined in the suite definition and thus ends up entirely contained within the task job script.

If your username is different on the task host the [[[remote]]] section also supports an owner=username item, or your \$HOME/.ssh/config file can be configured for username translation.

If you configure a task host according to the requirements cylc will create remote log directories, source login scripts on the remote host to ensure cylc is visible there, send the task job script over, and submit it to run there by the configured job submission method:

Remote task job logs are saved to the suite run directory on the task host, not on the suite host. They can be retrieved by right-clicking on the task in the GUI, or to have cylc pull them back to the suite host automatically do this:

```
[runtime]
    [[hello]]
        script = "sleep 10; echo Hello World!"
        [[[remote]]]
        host = server1.niwa.co.nz
        retrieve job logs = True
```

This suite will attempt to rsync job logs from the remote host each time a task job completes. Some batch systems have considerable delays between the time when the job completes and when it writes the job logs in its normal location. If this is the case, you can configure an initial delay and retry delays for job log retrieval by setting some delays. E.g.:

```
[runtime]
    [[hello]]
        script = "sleep 10; echo Hello World!"
        [[[remote]]]
        host = server1.niwa.co.nz
        retrieve job logs = True
        # Retry after 10 seconds, 1 minute and 3 minutes
        retrieve job logs retry delays = PT10S, PT1M, PT3M
```

Finally, if the disk space of the suite host is limited, you may want to set [[[remote]]]retrieve job logs max siz The value of SIZE can be anything that is accepted by the --max-size=SIZE option of the rsync command. E.g.:

```
[runtime]
    [[hello]]
        script = "sleep 10; echo Hello World!"
        [[[remote]]]
        host = server1.niwa.co.nz
        retrieve job logs = True
        # Don't get anything bigger than 10MB
        retrieve job logs max size = 10M
```

It is worth noting that cylc uses the existence of a job's job.out or job.err in the local file system to indicate a successful job log retrieval. If retrieve job logs max sizeSIZE= is set and both job.out and job.err are bigger than SIZE then cylc will consider the retrieval as failed. If

retry delays are specified, this will trigger some useless (but harmless) retries. If this occurs regularly, you should try the following:

- Reduce the verbosity of STDOUT or STDERR from the task.
- Redirect the verbosity from STDOUT or STDERR to an alternate log file.
- Adjust the size limit with tolerance to the expected size of STDOUT or STDERR.
- For more on remote tasks see 10.4.9
- For more on task communications, see 13.2.
- For more on suite passphrases and authentication, see 8.5 and 13.6.

8.17 Task Triggering

```
suite: tut/oneoff/goodbye
```

To make a second task called goodbye trigger after hello finishes successfully, return to the original example, tut/oneoff/basic, and change the suite graph as in tut/oneoff/goodbye:

```
[scheduling]
    [[dependencies]]
        graph = "hello => goodbye"
or to trigger it at the same time as hello,
[scheduling]
    [[dependencies]]
        graph = "hello & goodbye"
and configure the new task's behaviour under [runtime]:
[runtime]
    [[goodbye]]
        script = "sleep 10; echo Goodbye World!"
   Run tut/oneoff/goodbye and check the output from the new task:
$ cat ~/cylc-run/tut/oneoff/goodbye/log/job/1/goodbye/01/job.out
  # or
 cylc cat-log -o tut/oneoff/goodbye goodbye.1
JOB SCRIPT STARTING
cylc (scheduler - 2014-08-14T15:09:30+12): goodbye.1 started at 2014-08-14T15:09:30+12 cylc Suite and Task Identity:
  Suite Name : tut/oneoff/goodbye
  Suite Host : oliverh-34403dl.niwa.local
               : 7766
  Suite Port
  Suite Owner : oliverh
               : goodbye.1
  Task ID
  Task Host
              : oliverh-34403DL
  Task Owner
              : oliverh
  Task Try No.:
Goodbye World!
cylc (scheduler - 2014-08-14T15:09:40+12): goodbye.1 succeeded at 2014-08-14T15:09:40+12
JOB SCRIPT EXITING (TASK SUCCEEDED)
```

8.17.1 Task Failure And Suicide Triggering

```
suite: tut/oneoff/suicide
```

Task names in the graph string can be qualified with a state indicator to trigger off task states other than success:

A common use of this is to automate recovery from known modes of failure:

```
graph = "goodbye:fail => really_goodbye"
```

i.e. if task goodbye fails, trigger another task that (presumably) really says goodbye.

Failure triggering generally requires use of *suicide triggers* as well, to remove the recovery task if it isn't required (otherwise it would hang about indefinitely in the waiting state):

This means if goodbye fails, trigger really_goodbye; and otherwise, if goodbye succeeds, remove really_goodbye from the suite.

Try running tut/oneoff/suicide, which also configures the hello task's runtime to make it fail, to see how this works.

- For more on suite dependency graphs see 10.3.
- For more on task triggering see 10.3.5.

8.18 Runtime Inheritance

suite: tut/oneoff/inherit

The [runtime] section is actually a multiple inheritance hierarchy. Each subsection is a namespace that represents a task, or if it is inherited by other namespaces, a family. This allows common configuration to be factored out of related tasks very efficiently.

```
title = "Simple runtime inheritance example"
[scheduling]
        [[dependencies]]
            graph = "hello => goodbye"
[runtime]
        [[root]]
            script = "sleep 10; echo $GREETING World!"
        [[hello]]
            [[fenvironment]]]
            GREETING = Hello
        [[goodbye]]
            [[environment]]]
            GREETING = Goodbye
```

The [root] namespace provides defaults for all tasks in the suite. Here both tasks inherit script from root, which they customize with different values of the environment variable \$GREETING. Note that inheritance from root is implicit; from other parents an explicit inherit = PARENT is required, as shown below.

• For more on runtime inheritance, see 10.4.

8.19 Triggering Families

suite: tut/oneoff/ftrigger1

Task families defined by runtime inheritance can also be used as shorthand in graph trigger expressions. To see this, consider two "greeter" tasks that trigger off another task foo:

```
[scheduling]
    [[dependencies]]
        graph = "foo => greeter_1 & greeter_2"
```

If we put the common greeting functionality of greeter_1 and greeter_2 into a special GREETERS family, the graph can be expressed more efficiently like this:

```
[scheduling]
    [[dependencies]]
        graph = "foo => GREETERS"
```

i.e. if foo succeeds, trigger all members of GREETERS at once. Here's the full suite with runtime hierarchy shown:

```
title = "Triggering a family of tasks"
[scheduling]
    [[dependencies]]
        graph = "foo => GREETERS"
[runtime]
    [[root]]
        pre-script = "sleep 10"
    [[foo]]
                (creates a dummy task)
        # emptv
    [[GREETERS]]
        script = "echo $GREETING World!"
    [[greeter_1]]
        inherit = GREETERS
        [[[environment]]]
            GREETING = Hello
    [[greeter_2]]
        inherit = GREETERS
        [[[environment]]]
            GREETING = Goodbye
```

(Note that we recommend given ALL-CAPS names to task families to help distinguish them from task names. However, this is just a convention).

Experiment with the tut/oneoff/ftrigger1 suite to see how this works.

8.20 Triggering Off Families

```
suite: tut/oneoff/ftrigger2
```

Tasks (or families) can also trigger *off* other families, but in this case we need to specify what the trigger means in terms of the upstream family members. Here's how to trigger another task bar if all members of GREETERS succeed:

```
[scheduling]
    [[dependencies]]
        graph = """foo => GREETERS
        GREETERS:succeed-all => bar"""
```

Verbose validation in this case reports:

```
$ cylc val -v tut/oneoff/ftrigger2
...
Graph line substitutions occurred:
   IN: GREETERS:succeed-all => bar
   OUT: greeter_1:succeed & greeter_2:succeed => bar
```

Cylc ignores family member qualifiers like succeed-all on the right side of a trigger arrow, where they don't make sense, to allow the two graph lines above to be combined in simple cases:

```
[scheduling]
     [[dependencies]]
          graph = "foo => GREETERS:succeed-all => bar"
```

Any task triggering status qualified by -all or -any, for the members, can be used with a family trigger. For example, here's how to trigger bar if all members of GREETERS finish (succeed or fail) and any of them them succeed:

```
[scheduling]
    [[dependencies]]
        graph = """foo => GREETERS
    GREETERS:finish-all & GREETERS:succeed-any => bar"""
```

(use of GREETERS: succeed-any by itself here would trigger bar as soon as any one member of GREETERS completed successfully). Verbose validation now begins to show how family triggers can simplify complex graphs, even for this tiny two-member family:

Experiment with tut/oneoff/ftrigger2 to see how this works.

• For more on family triggering, see 10.3.5.9.

8.21 Suite Visualization

You can style dependency graphs with an optional [visualization] section, as shown in tut/oneoff/ftrigger2:

```
[visualization]
  default node attributes = "style=filled"
  [[node attributes]]
    foo = "fillcolor=#6789ab", "color=magenta"
    GREETERS = "fillcolor=#ba9876"
    bar = "fillcolor=#89ab67"
```

To display the graph in an interactive viewer:

```
$ cylc graph tut/oneoff/ftrigger2 & # dependency graph
$ cylc graph -n tut/oneoff/ftrigger2 & # runtime inheritance graph
```

It should look like Figure 15 (with the GREETERS family node expanded on the right).

Graph styling can be applied to entire families at once, and custom "node groups" can also be defined for non-family groups.

8.22 External Task Scripts

```
suite: tut/oneoff/external
```

The tasks in our examples so far have all had inlined implementation, in the suite definition, but real tasks often need to call external commands, scripts, or executables. To try this, let's return to the basic Hello World suite and cut the implementation of the task hello out to a file hello.sh in the suite bin directory:

```
#!/bin/sh
set -e
GREETING=${GREETING:-Goodbye}
echo "$GREETING World! from $0"
```

Make the task script executable, and change the hello task runtime section to invoke it:

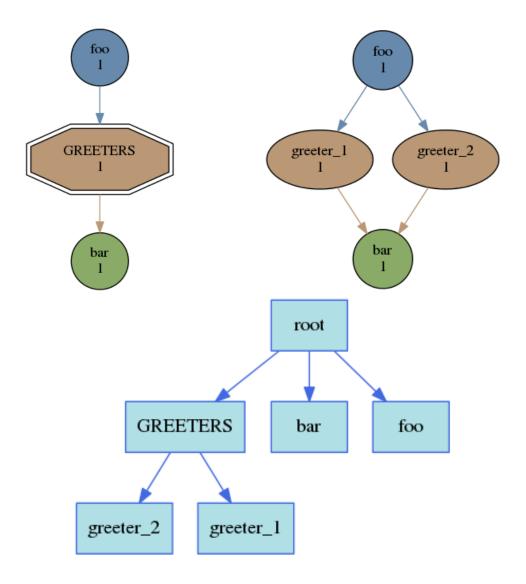


Figure 15: The tut/oneoff/ftrigger2 dependency and runtime inheritance graphs

If you run the suite now the new greeting from the external task script should appear in the hello task stdout log. This works because cylc automatically adds the suite bin directory to \$PATH in the environment passed to tasks via their job scripts. To execute scripts (etc.) located elsewhere you can refer to the file by its full file path, or set \$PATH appropriately yourself (this could be done via \$HOME/.profile, which is sourced at the top of the task job script, or in the suite definition itself).

Note the use of set -e above to make the script abort on error. This allows the error trapping code in the task job script to automatically detect unforeseen errors.

8.23 Cycling Tasks

suite: tut/cycling/one

So far we've considered non-cycling tasks, which finish without spawning a successor.

Cycling is based around iterating through date-time or integer sequences. A cycling task may run at each cycle point in a given sequence (cycle). For example, a sequence might be a set of date-times every 6 hours starting from a particular date-time. A cycling task may run for each date-time item (cycle point) in that sequence.

There may be multiple instances of this type of task running in parallel, if the opportunity arises and their dependencies allow it. Alternatively, a sequence can be defined with only one valid cycle point - in that case, a task belonging to that sequence may only run once.

Open the tut/cycling/one suite:

The difference between cycling and non-cycling suites is all in the [scheduling] section, so we will leave the [runtime] section alone for now (this will result in cycling dummy tasks). Note that the graph is now defined under a new section heading that makes each task under it have a succession of cycle points ending in 00 or 12 hours, between specified initial and final cycle points (or indefinitely if no final cycle point is given), as shown in Figure 16.

If you run this suite instances of foo will spawn in parallel out to the *runahead limit*, and each bar will trigger off the corresponding instance of foo at the same cycle point. The runahead limit, which defaults to a few cycles but is configurable, prevents uncontrolled spawning of cycling tasks in suites that are not constrained by clock triggers in real time operation.

Experiment with tut/cycling/one to see how cycling tasks work.



Figure 16: The tut/cycling/one suite

8.23.0.1 ISO 8601 Date-Time Syntax

The suite above is a very simple example of a cycling date-time workflow. More generally, cylc comprehensively supports the ISO 8601 standard for date-time instants, intervals, and sequences. Cycling graph sections can be specified using full ISO 8601 recurrence expressions, but these may be simplified by assuming context information from the suite - namely initial and final cycle points. One form of the recurrence syntax looks like Rn/start-date-time/period (Rn means run n times). In the example above, if the initial cycle point is always at 00 or 12 hours then [[[T00,T12]]] could be written as [[[PT12H]]], which is short for [[[R/initial-cycle-point/PT12H/]]] - i.e. run every 12 hours indefinitely starting at the initial cycle point. It is possible to add constraints to the suite to only allow initial cycle points at 00 or 12 hours e.g.

```
[scheduling]
  initial cycle point = 20130808T00
  initial cycle point constraints = T00, T12
```

- For a comprehensive description of ISO 8601 based date-time cycling, see 10.3.4.5
- For more on runahead limiting in cycling suites, see 13.12.

8.23.1 Inter-Cycle Triggers

```
suite: tut/cycling/two
```

The tut/cycling/two suite adds inter-cycle dependence to the previous example:

For any given cycle point in the sequence defined by the cycling graph section heading, bar triggers off foo as before, but now foo triggers off its own previous instance foo[-PT12H]. Date-time offsets in inter-cycle triggers are expressed as ISO 8601 intervals (12 hours in this case). Figure 17 shows how this connects the cycling graph sections together.

Experiment with this suite to see how inter-cycle triggers work. Note that the first instance of foo, at suite start-up, will trigger immediately in spite of its inter-cycle trigger, because cylc ignores dependence on points earlier than the initial cycle point. However, the presence of an inter-cycle trigger usually implies something special has to happen at start-up. If a model depends on its own previous instance for restart files, for example, then some special process has to generate the initial set of restart files when there is no previous cycle point to do it. The following section shows one way to handle this in cylc suites.

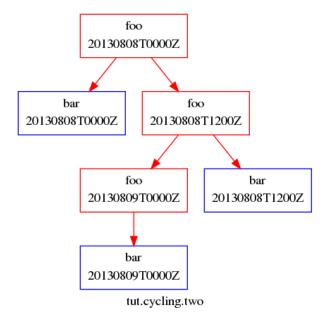


Figure 17: The tut/cycling/two suite

8.23.2 Initial Non-Repeating (R1) Tasks

suite: tut/cycling/three

Sometimes we want to be able to run a task at the initial cycle point, but refrain from running it in subsequent cycles. We can do this by writing an extra set of dependencies that are only valid at a single date-time cycle point. If we choose this to be the initial cycle point, these will only apply at the very start of the suite.

The cylc syntax for writing this single date-time cycle point occurrence is R1, which stands for R1/no-specified-date-time/no-specified-period. This is an adaptation of part of the ISO 8601 date-time standard's recurrence syntax (Rn/date-time/period) with some special context information supplied by cylc for the no-specified-* data.

The 1 in the R1 means run once. As we've specified no date-time, Cylc will use the initial cycle point date-time by default, which is what we want. We've also missed out specifying the period - this is set by cylc to a zero amount of time in this case (as it never repeats, this is not significant).

For example, in tut/cycling/three:

This is shown in Figure 18.

Note that the time zone has been set to ± 1300 in this case, instead of UTC (z) as before. If no time zone or UTC mode was set, the local time zone of your machine will be used in the cycle points.

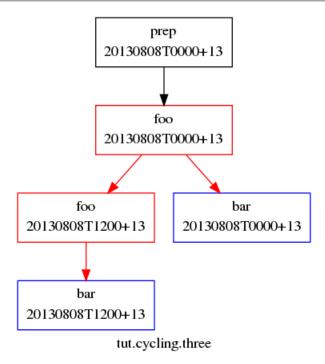


Figure 18: The tut/cycling/three suite

At the initial cycle point, foo will depend on foo[-PT12H] and also on prep:
prep.20130808T0000+13 & foo.20130807T1200+13 => foo.20130808T0000+13
Thereafter, it will just look like e.g.:
foo.20130808T0000+13 => foo.20130808T1200+13

However, in our initial cycle point example, the dependence on foo.20130807T1200+13 will be ignored, because that task's cycle point is earlier than the suite's initial cycle point and so it cannot run. This means that the initial cycle point dependencies for foo actually look like: $prep.20130808T0000+13 \Rightarrow foo.20130808T0000+13$

• R1 tasks can also be used to make something special happen at suite shutdown, or at any single cycle point throughout the suite run. For a full primer on cycling syntax, see 10.3.4.5.

8.23.3 Integer Cycling

suite: tut/cycling/integer

Cylc can do also do integer cycling for repeating workflows that are not date-time based. Open the tut/cycling/integer suite, which is plotted in Figure 19.

8 TUTORIAL 8.24 Jinja2

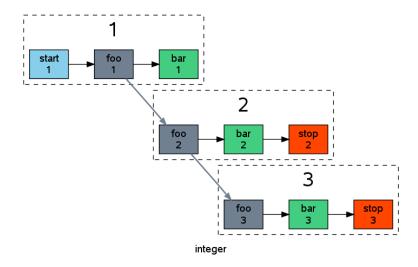


Figure 19: The tut/cycling/integer suite

The integer cycling notation is intended to look similar to the ISO 8601 date-time notation, but it is simpler for obvious reasons. The example suite illustrates two recurrence forms, Rn/start-point/period and Rn/period/stop-point, simplified somewhat using suite context information (namely the initial and final cycle points). The first form is used to run one special task called start at start-up, and for the main cycling body of the suite; and the second form to run another special task called stop in the final two cycles. The P character denotes period (interval) just like in the date-time notation. R/1/P2 would generate the sequence of points 1,3,5,....

• For more on integer cycling, including a more realistic usage example see 10.3.4.7.

8.24 Jinja2

suite: tut/oneoff/jinja2

Cylc has built in support for the Jinja2 template processor, which allows us to embed code in suite definitions to generate the final result seen by cylc.

The tut/oneoff/jinja2 suite illustrates two common uses of Jinja2: changing suite content or structure based on the value of a logical switch; and iteratively generating dependencies and runtime configuration for groups of related tasks:

```
#!jinja2
{% set MULTI = True %}
{% set N_GOODBYES = 3 %}
title = "A Jinja2 Hello World! suite"
```

```
[scheduling]
    [[dependencies]]
   if MULTI %}
graph = "hello"
{% endif %}
[runtime]
    [[hello]]
        script = "sleep 10; echo Hello World!"
{% if MULTI \( \) \( \) \\
    [[BYE]]
        script = "sleep 10; echo Goodbye World!"
    {% for I in range(0, N_GOODBYES) %}
    [[ goodbye_{{I}}]]
inherit = BYE
    {% endfor %}
{% endif %}
   To view the result of Jinja2 processing with the Jinja2 flag MULTI set to False:
$ cylc view --jinja2 --stdout tut/oneoff/jinja2
title = "A Jinja2 Hello World! suite"
[scheduling]
    [[dependencies]]
        graph = "hello"
[runtime]
    [[hello]]
        script = "sleep 10; echo Hello World!"
   And with MULTI set to True:
$ cylc view --jinja2 --stdout tut/oneoff/jinja2
title = "A Jinja2 Hello World! suite"
[scheduling]
graph = "hello => BYE"
[runtime]
    [[dependencies]]
    [[hello]]
        script = "sleep 10; echo Hello World!"
    [[BYE]]
        script = "sleep 10; echo Goodbye World!"
    [[ goodbye_0 ]]
        inherit =
    [[ goodbye_1 ]] inherit = BYE
    [[ goodbye_2 ]]
        inherit = BYE
```

8.25 Task Retry On Failure

suite: tut/oneoff/retry

Tasks can be configured to retry a number of times if they fail. An environment variable \$CYLC_TASK_TRY_NUMBER increments from 1 on each successive try, and is passed to the task to allow different behaviour on the retry:

```
title = "A task with automatic retry on failure"
[scheduling]
    [[dependencies]]
        graph = "hello"
[runtime]
    [[hello]]
        retry delays = 2*PT6S # retry twice after 6-second delays
        script = """
```

```
if [[ $CYLC_TASK_TRY_NUMBER < 3 ]]; then
    echo "Hello ... aborting!"
    exit 1
else
    echo "Hello World!"
fi"""</pre>
```

When a task with configured retries fails, its cylc task proxy goes into the *retrying* state until the next retry delay is up, then it resubmits. It only enters the *failed* state on a final definitive failure.

Experiment with tut/oneoff/retry to see how this works.

8.26 Other Users' Suites

If you have read access to another user's account (even on another host) it is possible to use cylc monitor to look at their suite's progress without full shell access to their account. To do this, you will need to copy their suite passphrase to

```
$HOME/.cylc/SUITE_OWNER@SUITE_HOST/SUITE_NAME/passphrase
```

(use of the host and owner names is optional here - see 13.6.1) and also retrieve the port number of the running suite from:

```
~SUITE_OWNER/.cylc/ports/SUITE_NAME
```

Once you have this information, you can run

```
$ cylc monitor --user=SUITE_OWNER --port=SUITE_PORT SUITE_NAME
```

to view the progress of their suite.

Other suite-connecting commands work in the same way; see 13.10.

8.27 Other Things To Try

Almost every feature of cylc can be tested quickly and easily with a simple dummy suite. You can write your own, or start from one of the example suites in /path/to/cylc/examples (see use of cylc import-examples above) - they all run "out the box" and can be copied and modified at will.

- Change the suite runahead limit in a cycling suite.
- Stop a suite mid-run with cylc stop, and restart it again with cylc restart.
- Hold (pause) a suite mid-run with cylc hold, then modify the suite definition and cylc reload it before using cylc release to continue (you can also reload without holding).
- Use the gcylc View menu to show the task state color key and watch tasks in the task-states example evolve as the suite runs.
- Manually re-run a task that has already completed or failed, with cylc trigger.
- Use an *internal queue* to prevent more than an alotted number of tasks from running at once even though they are ready see 13.13.
- Configure task event hooks to send an email, or shut the suite down, on task failure.

9 Suite Name Registration

Cylc commands target suites via their names, which are relative path names under the suite run directory (~/cylc-run/ by default). Suites can be grouped together under sub-directories. E.g.:

Suites can be pre-registered with a name using the cylc register command. The creates the essential directory structure for the suite, and generates some service files underneath it. Otherwise, cylc run will create these files on suite start up.

10 Suite Definition

Cylc suites are defined in structured, validated, *suite.rc* files that concisely specify the properties of, and the relationships between, the various tasks managed by the suite. This section of the User Guide deals with the format and content of the suite.rc file, including task definition. Task implementation - what's required of the real commands, scripts, or programs that do the processing that the tasks represent - is covered in 11; and task job submission - how tasks are submitted to run - is in 12.

10.1 Suite Definition Directories

A cylc suite definition directory contains:

- A suite.rc file: this is the suite definition.
 - And any include-files used in it (see below; may be kept in sub-directories).
- A bin/ sub-directory (optional)
 - For scripts and executables that implement, or are used by, suite tasks.
 - Automatically added to \$PATH in task execution environments.
 - Alternatively, tasks can call external commands, scripts, or programs; or they can be scripted entirely within the suite.rc file.
- A lib/python/ sub-directory (optional)
 - For custom job submission modules (see 12.8) and local Python modules imported by custom Jinja2 filters (see 10.7.2).
- Any other sub-directories and files documentation, control files, etc. (optional)
 - Holding everything in one place makes proper suite revision control possible.
 - Portable access to files here, for running tasks, is provided through \$CYLC_SUITE_DEF_PATH (see 10.4.7).
 - Ignored by cylc, but the entire suite definition directory tree is copied when you copy a suite using cylc commands.

A typical example:

```
/path/to/my/suite  # suite definition directory
   suite.rc  # THE SUITE DEFINITION FILE
  bin/  # scripts and executables used by tasks
   foo.sh
    bar.sh
   ...
  # (OPTIONAL) any other suite-related files, for example:
   inc/  # suite.rc include-files
      nwp-tasks.rc
      globals.rc
```

```
doc/ # documentation control/ # control files ancil/ # ancillary files
```

10.2 Suite.rc File Overview

Suite.rc files are an extended-INI format with section nesting.

Embedded template processor expressions may also be used in the file, to programatically generate the final suite definition seen by cylc. Currently the Jinja2 template processor is supported (http://jinja.pocoo.org/docs); see 10.7 for examples. In the future cylc may provide a plug-in interface to allow use of other template engines too.

10.2.1 Syntax

The following defines legal suite.rc syntax:

- Items are of the form item = value.
- [Section] headings are enclosed in square brackets.
- Sub-section [[nesting]] is defined by repeated square brackets.
- Sections are **closed** by the next section heading.
- Comments (line and trailing) follow a hash character: #
- List values are comma-separated.
- Single-line string values can be single-, double-, or un-quoted.
- Multi-line string values are triple-quoted (using single or double quote characters).
- Boolean values are capitalized: True, False.
- Leading and trailing whitespace is ignored.
- **Indentation** is optional but should be used for clarity.
- Continuation lines follow a trailing backslash: \
- Duplicate sections add their items to those previously defined under the same section.
- Duplicate items override, except for dependency graph strings, which are additive.
- Include-files %include inc/foo.rc can be used as a verbatim inlining mechanism.

Suites that embed Jinja2 code (see 10.7) must process to raw suite.rc syntax.

10.2.2 Include-Files

Cylc has native support for suite.rc include-files, which may help to organize large suites. Inclusion boundaries are completely arbitrary - you can think of include-files as chunks of the suite.rc file simply cut-and-pasted into another file. Include-files may be included multiple times in the same file, and even nested. Include-file paths can be specified portably relative to the suite definition directory, e.g.:

```
# include the file $CYLC_SUITE_DEF_PATH/inc/foo.rc:
%include inc/foo.rc
```

10.2.2.1 Editing Temporarily Inlined Suites

Cylc's native file inclusion mechanism supports optional inlined editing:

```
$ cylc edit --inline SUITE
```

The suite will be split back into its constituent include-files when you exit the edit session. While editing, the inlined file becomes the official suite definition so that changes take effect whenever you save the file. See cylc prep edit --help for more information.

10.2.2.2 Include-Files via Jinja2

Jinja2 (10.7) also has template inclusion functionality.

10.2.3 Syntax Highlighting For Suite Definitions

Cylc comes with syntax files for a number of text editors:

```
$CYLC_DIR/conf/cylc.vim  # vim
$CYLC_DIR/conf/cylc-mode.el  # emacs
$CYLC_DIR/conf/cylc.lang  # gedit (and other gtksourceview programs)
$CYLC_DIR/conf/cylc.xml  # kate
```

Refer to comments at the top of each file to see how to use them.

10.2.4 Gross File Structure

Cylc suite.rc files consist of a suite title and description followed by configuration items grouped under several top level section headings:

- [cylc] non task-specific suite configuration
- [scheduling] determines when tasks are ready to run
 - tasks with special behaviour, e.g. clock-trigger tasks
 - the dependency graph, which defines the relationships between tasks
- [runtime] determines how, where, and what to execute when tasks are ready
 - script, environment, job submission, remote hosting, etc.
 - suite-wide defaults in the *root* namespace
 - a nested family hierarchy with common properties inherited by related tasks
- [visualization] suite graph styling

10.2.5 Validation

Cylc suite.rc files are automatically validated against a specification that defines all legal entries, values, options, and defaults. This detects formatting errors, typographic errors, illegal items and illegal values prior to run time. Some values are complex strings that require further parsing by cylc to determine their correctness (this is also done during validation). All legal entries are documented in the *Suite.rc Reference* (A).

The validator reports the line numbers of detected errors. Here's an example showing a section heading with a missing right bracket:

```
$ cylc validate my.suite
    [[special tasks]
'Section bracket mismatch, line 19'
```

If the suite.rc file uses include-files cylc view will show an inlined copy of the suite with correct line numbers (you can also edit suites in a temporarily inlined state with cylc edit --inline).

Validation does not check the validity of chosen job submission methods.

```
title = "Dependency Example 1"
[cylc]
    UTC mode = True
[scheduling]
                                                                  Α
    initial cycle point = 20200401
                                                             20200401T0000Z
    final cycle point = 20200405
    [[dependencies]]
         [[[T00,T06,T12,T18]]]  # validity
             graph = """
                                                20200401T0000Z
                                                             20200401T0000Z
                                                                           20200401T0600Z
               # B and C trigger off A
A => B & C
A[-PT6H] => A
# Model A restart trigger
                                                                        C
                                                                                      R
         [[[T06,T18]]] # hours
                                                                    20200401T0600Z
                                                                                  20200401T0600Z
                       "C => X"
              graph =
[visualization]
     initial cycle point = 20200401
                                                                        X
    final cycle point =
                           20200401T06
                                                                    20200401T0600Z
    [[node attributes]]
         X = "color=red'
                                                                  den-example l
```

Figure 20: Example Suite

10.3 Scheduling - Dependency Graphs

The [scheduling] section of a suite.rc file defines the relationships between tasks in a suite - the information that allows cylc to determine when tasks are ready to run. The most important component of this is the suite dependency graph. Cylc graph notation makes clear textual graph representations that are very concise because sections of the graph that repeat at different hours of the day, say, only have to be defined once. Here's an example with dependencies that vary depending on the particular cycle point:

Figure 20 shows the complete suite.rc listing alongside the suite graph. This is a complete, valid, runnable suite (it will use default task runtime properties such as script).

10.3.1 Graph String Syntax

Multiline graph strings may contain:

- blank lines
- arbitrary white space
- internal comments: following the # character
- conditional task trigger expressions see below.

10.3.2 Interpreting Graph Strings

Suite dependency graphs can be broken down into pairs in which the left side (which may be a single task or family, or several that are conditionally related) defines a trigger for the task or family on the right. For instance the "word graph" C triggers off B which triggers off A can be

deconstructed into pairs C triggers off B and B triggers off A. In this section we use only the default trigger type, which is to trigger off the upstream task succeeding; see 10.3.5 for other available triggers.

In the case of cycling tasks, the triggers defined by a graph string are valid for cycle points matching the list of hours specified for the graph section. For example this graph:

```
[scheduling]
    [[dependencies]]
    [[[T00,T12]]]
         graph = "A => B"
```

implies that B triggers off A for cycle points in which the hour matches 00 or 12.

To define inter-cycle dependencies, attach an offset indicator to the left side of a pair:

This means B[time] triggers off A[time-PT12H] (12 hours before) for cycle points with hours matching 00 or 12. time is implicit because this keeps graphs clean and concise, given that the majority of tasks will typically depend only on others with the same cycle point. Cycle point offsets can only appear on the left of a pair, because a pairs define triggers for the right task at cycle point time. However, A => B[-PT6H], which is illegal, can be reformulated as a future trigger A[+PT6H] => B (see 10.3.5.11). It is also possible to combine multiple offsets within a cycle point offset e.g.

```
[scheduling]
    [[dependencies]]
    [[[T00,T12]]]
         graph = "A[-P1D-PT12H] => B"
```

This means that B[Time] triggers off A[time-P1D-PT12H] (1 day and 12 hours before).

Triggers can be chained together. This graph:

is equivalent to this:

```
graph = "A => B => C"
```

Each trigger in the graph must be unique but the same task can appear in multiple pairs or chains. Separately defined triggers for the same task have an AND relationship. So this:

```
graph = """A => X # X triggers off A
B => X # X also triggers off B"""
```

is equivalent to this:

```
graph = "A & B => X" # X triggers off A AND B
```

In summary, the branching tree structure of a dependency graph can be partitioned into lines (in the suite.rc graph string) of pairs or chains, in any way you like, with liberal use of internal white space and comments to make the graph structure as clear as possible.

```
title = some one-off tasks
[scheduling]
   [[dependencies]]
        graph = "foo => bar & baz => qux"
```

Figure 21: One-off (Non-Cycling) Tasks.

```
B => D"""
# and it can even be written like this:
    graph = """A => B # blank line follows:

B => C # comment ...
B => D"""
```

10.3.2.1 Handling Long Graph Lines

Long chains of dependencies can be split into pairs:

```
graph = "A => B => C"
# is equivalent to this:
    graph = """A => B
    B => C"""
# BUT THIS IS AN ERROR:
    graph = """A => B => # WRONG!
    C""" # WRONG!
```

If you have very long task names, or long conditional trigger expressions (below) then you can use the suite.rc line continuation marker:

```
graph = "A => B \
=> C" # OK
```

Note that a line continuation marker must be the final character on the line; it cannot be followed by trailing spaces or a comment.

10.3.3 Graph Types

A suite definition can contain multiple graph strings that are combined to generate the final graph.

10.3.3.1 One-off (Non-Cycling)

Figure 21 shows a small suite of one-off non-cycling tasks; these all share a single cycle point (1) and don't spawn successors (once they're all finished the suite just exits). The integer 1 attached to each graph node is just an arbitrary label here.

10.3.3.2 Cycling Graphs

For cycling tasks the graph section heading defines a sequence of cycle points for which the subsequent graph section is valid. Figure 22 shows a small suite of cycling tasks.

10.3.4 Graph Section Headings

Graph section headings define recurrence expressions, the graph within a graph section heading defines a workflow at each point of the recurrence. For example in the following scenario:

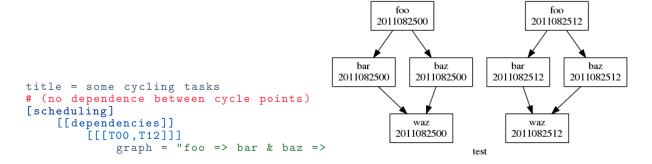


Figure 22: Cycling Tasks.

```
[scheduling]
    [[dependencies]]
        [[[ T06 ]]] # A graph section heading
        graph = foo => bar
```

Too means "Run every day starting at 06:00 after the initial cycle point". Cylc allows you to start (or end) at any particular time, repeat at whatever frequency you like, and even optionally limit the number of repetitions.

Graph section heading can also be used with integer cycling see 10.3.4.7.

10.3.4.1 Syntax Rules

Date-time cycling information is made up of a starting date-time, an interval, and an optional limit.

The time is assumed to be in the local time zone unless you set [cylc]cycle point time zone or [cylc]UTC mode. The calendar is assumed to be the proleptic Gregorian calendar unless you set [scheduling]cycling mode.

The syntax for representations is based on the ISO 8601 date-time standard. This includes the representation of *date-time*, *interval*. What we define for cylc's cycling syntax is our own optionally-heavily-condensed form of ISO 8601 recurrence syntax. The most common full form is: R[limit?]/[date-time]/[interval]. However, we allow omitting information that can be guessed from the context (rules below). This means that it can be written as:

```
R[limit?]/[date-time]
R[limit?]//[interval]
[date-time]/[interval]
R[limit?] # Special limit of 1 case
[date-time]
[interval]
```

with example graph headings for each form being:

Note that TOO is an example of [date-time], with an inferred 1 day period and no limit.

Where some or all *date-time* information is omitted, it is inferred to be relative to the initial date-time cycle point. For example, TOO by itself would mean the next occurrence of midnight that follows, or is, the initial cycle point. Entering +PT6H would mean 6 hours after the initial cycle point. Entering -P1D would mean 1 day before the initial cycle point. Entering no information for the *date-time* implies the initial cycle point date-time itself.

Where the *interval* is omitted and some (but not all) *date-time* information is omitted, it is inferred to be a single unit above the largest given specific *date-time* unit. For example, the largest given specific unit in TOO is hours, so the inferred interval is 1 day (daily), PID.

Where the *limit* is omitted, unlimited cycling is assumed. This will be bounded by the final cycle point's date-time if given.

Another supported form of ISO 8601 recurrence is: R[limit?]/[interval]/[date-time]. This form uses the *date-time* as the end of the cycling sequence rather than the start. For example, R3/P5D/20140430T06 means:

```
20140420T06
20140425T06
20140430T06
```

This kind of form can be used for specifying special behaviour near the end of the suite, at the final cycle point's date-time. We can also represent this in cycle with a collapsed form:

```
R[limit?]/[interval]
R[limit?]//[date-time]
[interval]/[date-time]
```

So, for example, you can write:

10.3.4.2 Referencing The Initial And Final Cycle Points

For convenience the caret and dollar symbols may be used as shorthand for the initial and final cycle points. Using this shorthand you can write:

Note that there can be multiple ways to write the same headings, for instance the following all run once at the final cycle point:

10.3.4.3 Excluding Dates

Datetimes can be excluded from a recurrence by an exclamation mark for example [[[PT1D!20000101]]] means run daily except on the first of January 2000.

This syntax can only be used to exclude one datetime from a recurrence. Note that the ^ and \$ symbols (shorthand for the initial and final cycle points) are both datetimes so [[[T12!\$-PT1D]]] is valid.

If using a run limit in combination with an exclusion, the heading might not run the number of times specified in the limit. For example in the following suite foo will only run once as its second run has been excluded.

```
[scheduling]
   initial cycle point = 20000101T00Z
   final cycle point = 20000105T00Z
   [[dependencies]]
        [[[ R2/P1D!20000102 ]]]
        graph = foo
```

10.3.4.4 How Multiple Graph Strings Combine

For a cycling graph with multiple validity sections for different hours of the day, the different sections *add* to generate the complete graph. Different graph sections can overlap (i.e. the same hours may appear in multiple section headings) and the same tasks may appear in multiple sections, but individual dependencies should be unique across the entire graph. For example, the following graph defines a duplicate prerequisite for task C:

This does not affect scheduling, but for the sake of clarity and brevity the graph should be written like this:

10.3.4.5 Advanced Examples

The following examples show the various ways of writing graph headings in cylc.

```
[[[ R1 ]]]
                      # Run once at the initial cycle point
[[[ P1D ]]]
                     # Run every day starting at the initial cycle point
[[[ PT5M ]]]
                     # Run every 5 minutes starting at the initial cycle
                        point
[[[ T00/P2W ]]]
                      # Run every 2 weeks starting at 00:00 after the
                      # initial cycle point
[[[ +P5D/P1M ]]]
                     # Run every month, starting 5 days after the initial
                      # cycle point
[[[ R1/T06 ]]]
[[[ R1/P0Y ]]]
                      # Run once at 06:00 after the initial cycle point
                     # Run once at the final cycle point
[[[ R1/$ ]]]
                      # Run once at the final cycle point (alternative
                        form)
[[[ R1/$-P3D ]]]
                     # Run once three days before the final cycle point
[[[ R3/T0830 ]]]
                     # Run 3 times, every day at 08:30 after the initial
                        cycle point
                      # Run 3 times, every month at 00:00 on the first
[[[ R3/01T00 ]]]
                      # of the month after the initial cycle point
[[[ R5/W-1/P1M ]]]
                     # Run 5 times, every month starting on Monday
                      # following the initial cycle point
[[[ T00!^ ]]]
                      # Run at the first occurrence of TOO that isn't the
                       initial cycle point
[[[ PT1D!20000101 ]]]  # Run every day days excluding 1st Jan 2000 [[[ 20140201T06/P1D ]]]  # Run every day starting at 20140201T06 [[[ R1/min(T00,T06,T12,T18) ]]]  # Run once at the first instance
                                      # of either T00, T06, T12 or T18
                                      # starting at the initial cycle
                                      # point
```

10.3.4.6 Advanced Starting Up

Dependencies that are only valid at the initial cycle point can be written using the R1 notation (e.g. as in 8.23.2. For example:

In the example above, R1 implies R1/20130808T00, so prep only runs once at that cycle point (the initial cycle point). At that cycle point, foo will have a dependence on prep - but not at subsequent cycle points.

However, it is possible to have a suite that has multiple effective initial cycles - for example, one starting at T00 and another starting at T12. What if they need to share an initial task?

Let's suppose that we add the following section to the suite example above:

We'll also say that there should be a starting dependence between prep and our new task baz - but we still want to have a single prep task, at a single cycle.

We can write this using a special case of the task[-interval] syntax - if the interval is null, this implies the task at the initial cycle point.

For example, we can write our suite like 23.

This neatly expresses what we want - a task running at the initial cycle point that has one-off dependencies with other task sets at different cycles.

A different kind of requirement is displayed in Figure 24. Usually, we want to specify additional tasks and dependencies at the initial cycle point. What if we want our first cycle point to be entirely special, with some tasks missing compared to subsequent cycle points?

In Figure 24, bar will not be run at the initial cycle point, but will still run at subsequent cycle points. [[[+PT6H/PT6H]]] means start at +PT6H (6 hours after the initial cycle point) and then repeat every PT6H (6 hours).

Some suites may have staggered start-up sequences where different tasks need running once but only at specific cycle points, potentially due to differing data sources at different cycle points with different possible initial cycle points. To allow this cylc provides a $\min(\)$ function that can be used as follows:

```
[cylc]
     UTC mode = True
[scheduling]
     initial cycle point = 20130808T00
     final cycle point = 20130812T00
     [[dependencies]]
          [[[R1]]]
          graph = "prep"
[[[R1/T00]]]
                                                                               prep
                                                                           20130808T0000Z
    implies the initial cycle point:
  graph = "prep[^] => foo"
          [[[R1/T12]]]
                                                                        baz
                                                                                      foo
  is initial cycle point, as above:
  graph = "prep[^] => baz"
  [[[T00]]]
                                                                    20130808T1200Z
                                                                                  20130808T0000Z
      graph = "foo[-P1D] => foo => bar"
      [[[T12]]]
graph = "baz[-P1D] => baz => qux"
                                                       20130808T1200Z
                                                                     20130809T1200Z
                                                                                  20130809T0000Z
                                                                                                20130808T0000Z
[visualization]
     initial cycle point = 20130808T00
                                                                                      foo
     final cycle point = 20130810T00
                                                                     20130809T1200Z
                                                                                  20130810T0000Z
                                                                                                20130809T0000Z
     [[node attributes]]
          foo = "color=red"
          bar = "color=orange"
          baz = "color=green'
                                                                                  20130810T0000Z
          qux = "color=blue"
                                                                               stag
```

Figure 23: Staggered Start Suite

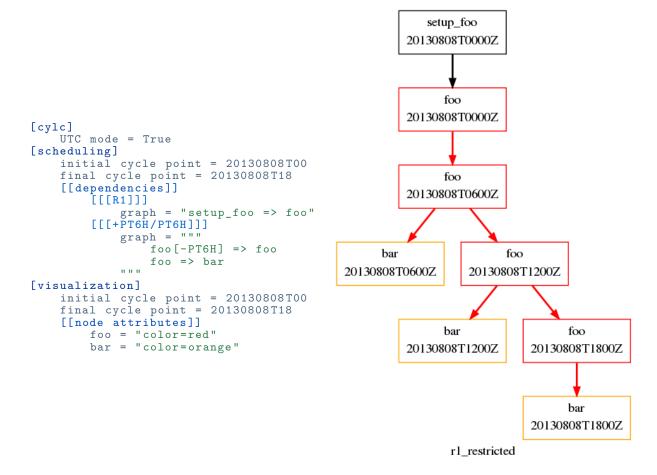


Figure 24: Restricted First Cycle Point Suite

```
[[[T00,T06,T12,T18]]]
graph = "foo => bar"
```

In this example the initial cycle point is 20100101T03, so the prep1 task will run once at 20100101T12 and the prep2 task will run once at 20100101T06 as these are the first cycle points after the initial cycle point in the respective min() entries.

10.3.4.7 Integer Cycling

In addition to non-repeating and date-time cycling workflows, cylc can do integer cycling for repeating workflows that are not date-time based.

To construct an integer cycling suite, set [scheduling]cycling mode = integer, and specify integer values for the initial and (optional) final cycle points. The notation for intervals, offsets, and recurrences (sequences) is similar to the date-time cycling notation, except for the simple integer values.

The full integer recurrence expressions supported are:

```
• Rn/start-point/interval #e.g. R3/1/P2
```

• Rn/interval/end-point #e.g. R3/P2/9

But, as for date-time cycling, sequence start and end points can be omitted where suite initial and final cycle points can be assumed. Some examples:

```
[[[ R1 ]]]
                  # Run once at the initial cycle point
                    (short for R1/initial-point/?)
[[[ P1 ]]]
                  # Repeat with step 1 from the initial cycle point
                    (short for R/initial-point/P1)
[[[ P5 ]]]
                    Repeat with step 5 from the initial cycle point
                    (short for R/initial-point/P5)
[[[ R2//P2 ]]]
                    Run twice with step 3 from the initial cycle point
                    (short for R2/initial-point/P2)
[[[ R/+P1/P2 ]]]
                  # Repeat with step 2, from 1 after the initial cycle point
[[[ R2/P2 ]]]
                  # Run twice with step 2, to the final cycle point
                    (short for R2/P2/final-point)
                  # Run once at the final cycle point
[[[ R1/P0 ]]]
                    (short for R1/P0/final-point)
```

10.3.4.7.1 Example

The tutorial illustrates integer cycling in 8.23.3, and \$CYLC_DIR/examples/satellite/ is a self-contained example of a realistic use for integer cycling. It simulates the processing of incoming satellite data: each new dataset arrives after a random (as far as the suite is concerned) interval, and is labeled by an arbitrary (as far as the suite is concerned) ID in the filename. A task called get_data at the top of the repeating workflow waits on the next dataset and, when it finds one, moves it to a cycle-point-specific shared workspace for processing by the downstream tasks. When get_data.1 finishes, get_data.2 triggers and begins waiting for the next dataset at the same time as the downstream tasks in cycle point 1 are processing the first one, and so on. In this way multiple datasets can be processed at once if they happen to come in quickly. A single shutdown task runs at the end of the final cycle to collate results. The suite graph is shown in Figure 25.

10.3.4.7.2 Advanced Integer Cycling Syntax

The same syntax used to reference the initial and final cycle points introduced in 10.3.4.2) for use with datetime cycling can also be used for integer cycling. For example you can write:

```
[[[ R1/^ ]]]  # Run once at the initial cycle point
[[[ R1/$ ]]]  # Run once at the final cycle point
```

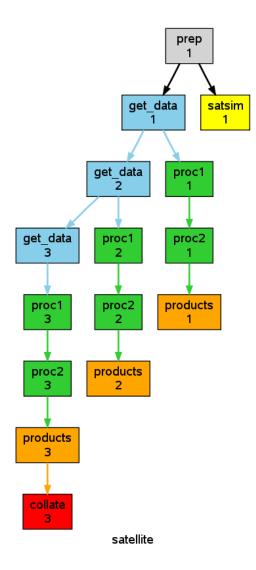


Figure 25: The examples/satellite integer suite

Likewise the syntax introduced in 10.3.4.3 for excluding a particular point from a recurrence also works for integer cycling. For example:

10.3.5 Trigger Types

Trigger type, indicated by *:type* after the upstream task (or family) name, determines what kind of event results in the downstream task (or family) triggering.

10.3.5.1 Success Triggers

The default, with no trigger type specified, is to trigger off the upstream task succeeding:

```
# B triggers if A SUCCEEDS:
    graph = "A => B"
```

For consistency and completeness, however, the success trigger can be explicit:

```
# B triggers if A SUCCEEDS:
    graph = "A => B"
# or:
    graph = "A:succeed => B"
```

10.3.5.2 Failure Triggers

To trigger off the upstream task reporting failure:

```
# B triggers if A FAILS:
    graph = "A:fail => B"
```

Suicide triggers can be used to remove task B here if A does not fail, see 10.3.5.8.

10.3.5.3 Start Triggers

To trigger off the upstream task starting to execute:

```
# B triggers if A STARTS EXECUTING:
    graph = "A:start => B"
```

This can be used to trigger tasks that monitor other tasks once they (the target tasks) start executing. Consider a long-running forecast model, for instance, that generates a sequence of output files as it runs. A postprocessing task could be launched with a start trigger on the model (model:start => post) to process the model output as it becomes available. Note, however, that there are several alternative ways of handling this scenario: both tasks could be triggered at the same time (foo => model & post), but depending on external queue delays this could result in the monitoring task starting to execute first; or a different postprocessing task could be triggered off a message output for each data file (model:out1 => post1 etc.; see 10.3.5.5), but this may not be practical if the number of output files is large or if it is difficult to add cylc messaging calls to the model.

10.3.5.4 Finish Triggers

To trigger off the upstream task succeeding or failing, i.e. finishing one way or the other:

```
# B triggers if A either SUCCEEDS or FAILS:
    graph = "A | A:fail => B"
# or
    graph = "A:finish => B"
```

10.3.5.5 Message Triggers

Tasks can also trigger off custom output messages. These must be registered in the [runtime] section of the emitting task, and reported using the cylc message command in task scripting. The graph trigger notation refers to the item name of the registered output message. The example suite \$CYLC_DIR/examples/message-triggers illustrates message triggering.

```
title = "test suite for cylc-6 message triggers"
[scheduling]
    initial cycle point = 20140801T00
    final cycle point = 20141201T00
    [[dependencies]]
        [[[P2M]]]
           graph = """foo:out1 => bar
                      foo[-P2M]:out2 => baz"""
[runtime]
    [[foo]]
        script = """
sleep 5
cylc message "file 1 done"
sleep 10
cylc message "file 2 done"
sleep 10"""
        [[[outputs]]]
            out1 = "file 1 done"
            out2 = "file 2 done"
    [[bar, baz]]
        script = sleep 10
```

10.3.5.6 Job Submission Triggers

It is also possible to trigger off a task submitting, or failing to submit:

```
# B triggers if A submits successfully:
    graph = "A:submit => B"
# D triggers if C fails to submit successfully:
    graph = "C:submit-fail => D"
```

A possible use case for submit-fail triggers: if a task goes into the submit-failed state, possibly after several job submission retries, another task that inherits the same runtime but sets a different job submission method and/or host could be triggered to, in effect, run the same job on a different platform.

10.3.5.7 Conditional Triggers

AND operators (a) can appear on both sides of an arrow. They provide a concise alternative to defining multiple triggers separately:

```
graph = """

# D triggers if A or (B and C) succeed
A | B & C => D

# just to align the two graph sections
D => W

# Z triggers if (W or X) and Y succeed
(W|X) & Y => Z
```

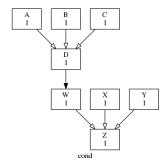


Figure 26: Conditional triggers are plotted with open arrow heads.

OR operators (1) which result in true conditional triggers, can only appear on the left,⁵

```
# C triggers when either A or B finishes:
    graph = "A | B => C"
```

Forecasting suites typically have simple conditional triggering requirements, but any valid conditional expression can be used, as shown in Figure 26 (conditional triggers are plotted with open arrow heads).

10.3.5.8 Suicide Triggers

Suicide triggers take tasks out of the suite. This can be used for automated failure recovery. The suite.rc listing and accompanying graph in Figure 27 show how to define a chain of failure recovery tasks that trigger if they're needed but otherwise remove themselves from the suite (you can run the *AutoRecover.async* example suite to see how this works). The dashed graph edges ending in solid dots indicate suicide triggers, and the open arrowheads indicate conditional triggers as usual. Suicide triggers are ignored by default in the graph view, unless you toggle them on with *View -> Options -> Ignore Suicide Triggers*.

Note that multiple suicide triggers combine in the same way as other triggers, so this:

```
foo => !baz
bar => !baz
is equivalent to this:
```

foo & bar => !baz

```
. 1 .1
```

i.e. both foo and bar must succeed for baz to be taken out of the suite. If you really want a task to be taken out if any one of several events occurs then be careful to write it that way:

```
foo | bar => !baz
```

A word of warning on the meaning of "bare suicide triggers". Consider the following suite:

```
[scheduling]
     [[dependencies]]
        graph = "foo => !bar"
```

 $^{^5}$ An OR operator on the right doesn't make much sense: if "B or C" triggers off A, what exactly should cylc do when A finishes?

```
1
title = automated failure recovery
description = """
Model task failure triggers diagnosis
                                                                         model
and recovery tasks, which take themselves out of the suite if model succeeds. Model
                                                                           1
post processing triggers off model OR
recovery tasks.
                                                                 diagnose
[scheduling]
     [[dependencies]]
         graph =
pre => model
model:fail => diagnose => recover
                                                                      recover
model => !diagnose & !recover
                                                                         1
model | recover => post
[runtime]
     [[model]]
                                                                           post
         # UNCOMMENT TO TEST FAILURE:
         # script = /bin/false
                                                             cylc-x:y:z.AutoRecover.async
```

Figure 27: Automated failure recovery via suicide triggers.

Task bar has a suicide trigger but no normal prerequisites (a suicide trigger is not a task triggering prerequisite, it is a task removal prerequisite) so this is entirely equivalent to:

```
[scheduling]
    [[dependencies]]
        graph = """
        foo & bar
        foo => !bar
```

In other words both tasks will trigger immediately, at the same time, and then bar will be removed if foo succeeds.

If an active task proxy (currently in the submitted or running states) is removed from the suite by a suicide trigger, a warning will be logged.

10.3.5.9 Family Triggers

Families defined by the namespace inheritance hierarchy (10.4) can be used in the graph trigger whole groups of tasks at the same time (e.g. forecast model ensembles and groups of tasks for processing different observation types at the same time) and for triggering downstream tasks off families as a whole. Higher level families, i.e. families of families, can also be used, and are reduced to the lowest level member tasks. Note that tasks can also trigger off individual family members if necessary.

To trigger an entire task family at once:

```
[scheduling]
    [[dependencies]]
        graph = "foo => FAM"
[runtime]
    [[FAM]]  # a family (because others inherit from it)
    [[m1,m2]]  # family members (inherit from namespace FAM)
        inherit = FAM

This is equivalent to:
[scheduling]
    [[dependencies]]
        graph = "foo => m1 & m2"
[runtime]
```

```
[[FAM]]
[[m1,m2]]
    inherit = FAM
```

To trigger other tasks off families we have to specify whether to triggering off *all members* starting, succeeding, failing, or finishing, or off *any* members (doing the same). Legal family triggers are thus:

```
[scheduling]
    [[dependencies]]
        graph = """
    # all-member triggers:
    FAM:start-all => one
    FAM:succeed-all => one
    FAM:fail-all => one
    FAM:finish-all => one
    # any-member triggers:
    FAM:start-any => one
    FAM:succeed-any => one
    FAM:fail-any => one
    FAM:finish-any => one
```

Here's how to trigger downstream processing after if one or more family members succeed, but only after all members have finished (succeeded or failed):

```
[scheduling]
    [[dependencies]]
        graph = """
    FAM:finish-all & FAM:succeed-any => foo
```

10.3.5.10 Writing Efficient Inter-Family Triggering

While cylc allows writing dependencies between two families it is important to consider the number of dependencies this will generate. In the following example, each member of FAM2 has dependencies pointing at all the members of FAM1.

```
[scheduling]
    [[dependencies]]
        graph = """
    FAM1:succeed-any => FAM2
```

Expanding this out, you generate N * M dependencies, where N is the number of members of FAM1 and M is the number of members of FAM2. This can result in high memory use as the number of members of these families grows, potentially rendering the suite impractical for running on some systems.

You can greatly reduce the number of dependencies generated in these situations by putting dummy tasks in the graphing to represent the state of the family you want to trigger off. For example, if FAM2 should trigger off any member of FAM1 succeeding you can create a dummy task FAM1 succeed any marker and place a dependency on it as follows:

```
[scheduling]
    [[dependencies]]
        graph = """
    FAM1:succeed_any => FAM1_succeed_any_marker => FAM2
[runtime]
...
    [[FAM1_succeed_any_marker]]
        script = true
```

This graph generates only $\mathbb{N}+\mathbb{M}$ dependencies, which takes significantly less memory and CPU to store and evaluate.

10.3.5.11 Inter-Cycle Triggers

Typically most tasks in a suite will trigger off others in the same cycle point, but some may depend on others with other cycle points. This notably applies to warm-cycled forecast models, which depend on their own previous instances (see below); but other kinds of inter-cycle dependence are possible too. Here's how to express this kind of relationship in cycle:

```
[dependencies]
    [[PT6H]]
    # B triggers off A in the previous cycle point
    graph = "A[-PT6H] => B"
```

inter-cycle and trigger type (or message trigger) notation can be combined:

```
# B triggers if A in the previous cycle point fails:
graph = "A[-PT6H]:fail => B"
```

At suite start-up inter-cycle triggers refer to a previous cycle point that does not exist. This does not cause the dependent task to wait indefinitely, however, because cylc ignores triggers that reach back beyond the initial cycle point. That said, the presence of an inter-cycle trigger does normally imply that something special has to happen at start-up. If a model depends on its own previous instance for restart files, for instance, then an initial set of restart files has to be generated somehow or the first model task will presumably fail with missing input files. There are several ways to handle this in cylc using different kinds of one-off (non-cycling) tasks that run at suite start-up. They are illustrated in the Tutorial (8.23.1); to summarize here briefly:

• R1 tasks (recommended):

R1, or R1/date-time tasks are the recommended way to specify unusual start up conditions. They allow you to specify a clean distinction between the dependencies of initial cycles and the dependencies of the subsequent cycles.

Initial tasks can be used for real model cold-start processes, whereby a warm-cycled model at any given cycle point can in principle have its inputs satisfied by a previous instance of itself, or by an initial task with (nominally) the same cycle point.

In effect, the R1 task masquerades as the previous-cycle-point trigger of its associated cycling task. At suite start-up initial tasks will trigger the first cycling tasks, and thereafter the intercycle trigger will take effect.

If a task has a dependency on another task in a different cycle point, the dependency can be written using the <code>[offset]</code> syntax such as <code>[-PT12H]</code> in <code>foo[-PT12H]</code> => <code>foo</code>. This means that <code>foo</code> at the current cycle point depends on a previous instance of <code>foo</code> at 12 hours before the current cycle point. Unlike the cycling section headings (e.g. <code>[[[T00,T12]]]]</code>), dependencies assume that relative times are relative to the current cycle point, not the initial cycle point.

However, it can be useful to have specific dependencies on tasks at or near the initial cycle point. You can switch the context of the offset to be the initial cycle point by using the caret symbol: ^.

⁶In NWP forecast analysis suites parts of the observation processing and data assimilation subsystem will typically also depend on model background fields generated by the previous forecast.

For example, you can write foo[^] to mean foo at the initial cycle point, and foo[^+PT6H] to mean foo 6 hours after the initial cycle point. Usually, this kind of dependency will only apply in a limited number of cycle points near the start of the suite, so you may want to write it in R1-based cycling sections. Here's the example inter-cycle R1 suite from above again.

You can see there is a dependence on the initial R1 task prep for foo at the first T00 cycle point, and at the first T12 cycle point. Thereafter, foo just depends on its previous (12 hours ago) instance.

Finally, it is also possible to have a dependency on a task at a specific cycle point.

However, in a long running suite, a repeating cycle should avoid having a dependency on a task with a specific cycle point (including the initial cycle point) - as it can currently cause performance issue. In the following example, all instances of qux will depend on baz.20200101, which will never be removed from the task pool.:

```
[scheduling]
  initial cycle point = 2010
  [[dependencies]]
    # Can cause performance issue!
    [[[P1D]]]
        graph = "baz[20200101] => qux"
```

10.3.5.12 Special Sequential Tasks

If a cycling task does not generate files required by its own successor, then successive instances can run in parallel if the opportunity arises. However, if such a task would interfere with its own siblings for internal reasons (e.g. use of a hardwired non cycle dependent temporary file or similar) then it can be forced to run sequentially. This can be done with explicit inter-cycle triggers in the graph:

```
[scheduling]
    [[dependencies]]
        [[[T00,T12]]]
            graph = "foo[-PT12H] => foo => bar"

or by declaring the task to be sequential:

[scheduling]
    [[special tasks]]
        sequential = foo
    [[dependencies]]
        [[[T00,T12]]]
            graph = "foo => bar"
```

The sequential declaration also results in each instance of foo triggering off its own predecessor, exactly as in the explicit version. The only difference is that implicit triggers will not appear in graph visualizations. The implicit version can also be considerably simpler when the task appears in multiple graph sections or in a non-uniform cycling sequence: this suite:

```
[scheduling]
     [[special tasks]]
```

```
sequential = foo
    [[dependencies]]
         [[[T00,T03,T11]]]
            graph = "foo => bar"
is equivalent to this one:
[scheduling]
    [[dependencies]]
        [[[T00,T03,T11]]]
             graph = "foo => bar"
         [[[TOO]]]]
             graph = "foo[-PT13H] => foo"
         [[[EŎT]]]
                   = "foo[-PT3H] => foo"
             graph
         [[[Tī1]]]
             graph = "foo[-PT8H] => foo"
```

10.3.5.13 Future Triggers

Cylc also supports inter-cycle triggering off tasks "in the future" (with respect to cycle point):

(Recall that A[t+PT6H] can run before B[t] because tasks in cylc have private cycle points). Future triggers present a problem at the suite shutdown rather than at start-up. Here, B at the final cycle point wants to trigger off an instance of A that will never exist because it is beyond the suite stop point. Consequently cylc prevents tasks from spawning successors that depend on other tasks beyond the stop point.

10.3.5.14 Clock Triggers

In addition to depending on other tasks (and on external events - see 10.3.5.16) tasks can depend on the wall clock: specifically, they can trigger off a wall clock time expressed as an offset from their own cycle point:

```
[scheduling]
    [[special tasks]]
        clock-trigger = foo(PT2H)
    [[dependencies]]
        [[[T00]]]
        graph = foo
```

Here, foo [2015-08-23T00] would trigger (other dependencies allowing) when the wall clock time reaches 2015-08-23T02. Clock-trigger offsets are normally positive, to trigger some time *after* the wall-clock time is equal to task cycle point.

Clock-triggers have no effect on scheduling if the suite is running sufficiently far behind the clock (e.g. after a delay, or because it is processing archived historical data) that the trigger times, which are relative to task cycle point, have already passed.

10.3.5.15 Clock-Expire Triggers

Tasks can be configured to *expire* - i.e. to skip job submission and enter the *expired* state - if they are too far behind the wall clock when they become ready to run, and other tasks can trigger off this. As a possible use case, consider a cycling task that copies the latest of a set of files to overwrite the previous set: if the task is delayed by more than one cycle there may be

no point in running it because the freshly copied files will just be overwritten immediately by the next task instance as the suite catches back up to real time operation. Clock-expire tasks are configured like clock-trigger tasks, with a date-time offset relative to cycle point (A.3.11.2). The offset should be positive to make the task expire if the wall-clock time has gone beyond the cycle point. Triggering off an expired task typically requires suicide triggers to remove the workflow that runs if the task has not expired. Here a task called copy expires, and its downstream workflow is skipped, if it is more than one day behind the wall-clock (see also examples/clock-expire):

```
[cylc]
  cycle point format = %Y-%m-%dT%H
[scheduling]
  initial cycle point = 2015-08-15T00
  [[special tasks]]
     clock-expire = copy(-P1D)
  [[dependencies]]
     [[[P1D]]]
        graph = """
  model[-P1D] => model => copy => proccepy:expired => !proc"""
```

10.3.5.16 External Triggers

In addition to depending on other tasks (and on the wall clock - see 10.3.5.14) tasks can trigger off events reported by an external system. For example, an external process could detect incoming data on an ftp server, and then notify a suite containing a task to retrieve the new data for processing. This is an alternative to long-running tasks that poll for external events.

Note that cylc does not currently support triggering off "filesystem events" (e.g. inotify on Linux). However, external watcher processes can use filesystem events to detect triggering conditions, if that is appropriate, before notifying a suite with our general external event system.

The external triggering process must call cylc ext-trigger with the name of the target suite, the message that identifies this type of event to the suite, and an ID that distinguishes this particular event instance from others (the name of the target task or its current cycle point is not required). The event ID is just an arbitary string to cylc, but it typically identifies the filename(s) of the latest dataset in some way. When the suite daemon receives the external event notification it will trigger the next instance of any task waiting on that trigger (whatever its cycle point) and then broadcast (see 13.19) the event ID to the cycle point of the triggered task as \$CYLC_EXT_TRIGGER_ID. Downstream tasks with the same cycle point therefore know the new event ID too and can use it, if they need to, to identify the same new dataset. In this way a whole workflow can be associated with each new dataset, and multiple datasets can be processed in parallel if they happen to arrive in quick succession.

An externally-triggered task must register the event it waits on in the suite scheduling section:

```
# suite "sat-proc"
[scheduling]
    cycling mode = integer
    initial cycle point = 1
    [[special tasks]]
        external-trigger = get-data("new sat X data avail")
    [[dependencies]]
        [[[P1]]]]
        graph = get-data => conv-data => products
```

Then, each time a new dataset arrives the external detection system should notify the suite like this:

```
$ cylc ext-trigger sat-proc "new sat X data avail" passX12334a
```

where "sat-proc" is the suite name and "passX12334a" is the ID string for the new event. The suite passphrase must be installed on triggering account.

Note that only one task in a suite can trigger off a particular external message. Other tasks can trigger off the externally triggered task as required, of course.

\$CYLC_DIR/examples/satellite/ext-triggers/suite.rc is a working example of a simulated satellite processing suite.

External triggers are not normally needed in date-time cycling suites driven by real time data that comes in at regular intervals. In these cases a data retrieval task can be clock-triggered (and have appropriate retry intervals supplied) to submit at the expected data arrival time, so little time if any is wasted in polling. However, if the arrival time of the cycle-point-specific data is highly variable, external triggering may be used with the cycle point embedded in the message:

Once the variable-length waiting is finished, an external detection system should notify the suite like this:

```
$ cylc ext-trigger data-proc "data arrived for 20150126T00" passX12334a
```

where "data-proc" is the suite name, the cycle point has replaced the variable in the trigger string, and "passX12334a" is the ID string for the new event. The suite passphrase must be installed on the triggering account. In this case, the event will trigger for the second cycle point but not the first because of the cycle-point matching.

10.3.6 Model Restart Dependencies

Warm-cycled forecast models generate *restart files*, e.g. model background fields, to initialize the next forecast. This kind of dependence requires an inter-cycle trigger:

If your model is configured to write out additional restart files to allow one or more cycle points to be skipped in an emergency do not represent these potential dependencies in the suite graph as they should not be used under normal circumstances. For example, the following graph would result in task A erroneously triggering off A[T-24] as a matter of course, instead of off A[T-6], because A[T-24] will always be finished first:

```
[scheduling]
    [[dependencies]]
        [[[T00,T06,T12,T18]]]
        # DO NOT DO THIS (SEE ACCOMPANYING TEXT):
        graph = "A[-PT24H] | A[-PT18H] | A[-PT12H] | A[-PT6H] => A"
```

10.4 Runtime - Task Configuration

The [runtime] section of a suite definition configures what to execute (and where and how to execute it) when each task is ready to run, in a multiple inheritance hierarchy of namespaces

culminating in individual tasks. This allows all common configuration detail to be factored out and defined in one place.

Any namespace can configure any or all of the items defined in the Suite.rc Reference (A).

Namespaces that do not explicitly inherit from others automatically inherit from the *root* namespace (below).

Nested namespaces define *task families* that can be used in the graph as convenient shorthand for triggering all member tasks at once, or for triggering other tasks off all members at once see 10.3.5.9. Nested namespaces can be progressively expanded and collapsed in the dependency graph viewer, and in the gcylc graph and text views. Only the first parent of each namespace (as for single-inheritance) is used for suite visualization purposes.

10.4.1 Namespace Names

Namespace names may contain letters, digits, underscores, and hyphens.

Note that task names need not be hardwired into task implementations because task and suite identity can be extracted portably from the task execution environment supplied by the suite daemon (10.4.7) - then to rename a task you can just change its name in the suite definition.

10.4.2 Root - Runtime Defaults

The root namespace, at the base of the inheritance hierarchy, provides default configuration for all tasks in the suite. Most root items are unset by default, but some have default values sufficient to allow test suites to be defined by dependency graph alone. The *script* item, for example, defaults to code that prints a message then sleeps for between 1 and 15 seconds and exits. Default values are documented with each item in A. You can override the defaults or provide your own defaults by explicitly configuring the root namespace.

10.4.3 Defining Multiple Namespaces At Once

If a namespace section heading is a comma-separated list of names then the subsequent configuration applies to each list member. Particular tasks can be singled out at run time using the \$CYLC_TASK_NAME variable.

As an example, consider a suite containing an ensemble of closely related tasks that each invokes the same script but with a unique argument that identifies the calling task name:

```
[runtime]
    [[ENSEMBLE]]
        script = "run-model.sh $CYLC_TASK_NAME"
    [[m1, m2, m3]]
        inherit = ENSEMBLE
```

For large ensembles Jinja2 template processing can be used to automatically generate the member names and associated dependencies (see 10.7).

10.4.4 Runtime Inheritance - Single

The following listing of the *inherit.single.one* example suite illustrates basic runtime inheritance with single parents.

```
# SUITE.RC
title = "User Guide [runtime] example."
[cylc]
    required run mode = simulation # (no task implementations)
[scheduling]
    initial cycle point = 20110101T06
    final cycle point = 20110102T00
```

```
[[dependencies]]
        [[[00T]]]
            graph = """foo => OBS
                  OBS:succeed-all => bar"""
[runtime]
    [[root]] # base namespace for all tasks (defines suite-wide defaults)
        [[[job]]]
            batch system = at
        [[[environment]]]
            COLOR = red
    [[OBS]] # family (inherited by land, ship); implicitly inherits root
        script = run-${CYLC_TASK_NAME}.sh
        [[[environment]]]
            RUNNING_DIR = $HOME/running/$CYLC_TASK_NAME
    [[land]] # a task (a leaf on the inheritance tree) in the OBS family
        inherit = OBS
        description = land obs processing
    [[ship]] # a task (a leaf on the inheritance tree) in the OBS family
        inherit = OBS
        description = ship obs processing
        [[[job]]]
            batch system = loadleveler
        [[[environment]]]
            RUNNING_DIR = $HOME/running/ship # override OBS environment
OUTPUT_DIR = $HOME/output/ship # add to OBS environment
    [[foo]]
        # (just inherits from root)
    # The task [[bar]] is implicitly defined by its presence in the
    # graph; it is also a dummy task that just inherits from root.
```

10.4.5 Runtime Inheritance - Multiple

If a namespace inherits from multiple parents the linear order of precedence (which namespace overrides which) is determined by the so-called *C3 algorithm* used to find the linear *method resolution order* for class hierarchies in Python and several other object oriented programming languages. The result of this should be fairly obvious for typical use of multiple inheritance in cylc suites, but for detailed documentation of how the algorithm works refer to the official Python documentation here: http://www.python.org/download/releases/2.3/mro/.

The *inherit.multi.one* example suite, listed here, makes use of multiple inheritance:

```
title = "multiple inheritance example"
description = """To see how multiple inheritance works:
% cylc list -tb[m] SUITE # list namespaces
% cylc graph -n SUITE # graph namespaces
% cylc graph SUITE # dependencies, collapse on first-parent namespaces
  % cylc get-config --sparse --item [runtime]ops_s1 SUITE
  % cylc get-config --sparse --item [runtime]var_p2 foo"""
[scheduling]
    [[dependencies]]
        graph = "OPS:finish-all => VAR"
[runtime]
    [[root]]
    [[OPS]]
        script = echo "RUN: run-ops.sh"
    [[VAR]]
        script = echo "RUN: run-var.sh"
    [[SERIAL]]
        [[[directives]]]
            job_type = serial
    [[PARALLEL]]
        [[[directives]]]
```

```
job_type = parallel
     [[ops_s1, ops_s2]]
          inherit = OPS,
                               SERTAL.
     [[ops_p1, ops_p2]]
           inherit = OPS, PARALLEL
     [[var_s1, var_s2]]
          inherit = VAR, SERIAL
     [[var_p1, var_p2]]
           inherit = VAR, PARALLEL
[visualization]
     # NOTE ON VISUALIZATION AND MULTIPLE INHERITANCE: overlapping
     # family groups can have overlapping attributes, so long as
# non-conflictling attributes are used to style each group. Below,
# for example, OPS tasks are filled green and SERIAL tasks are
     # outlined blue, so that ops_s1 and ops_s2 are green with a blue
     # outline. But if the SERIAL tasks are explicitly styled as "not
# filled" (by setting "style=") this will override the fill setting
     # in the (previously defined and therefore lower precedence) OPS
# group, making ops_s1 and ops_s2 unfilled with a blue outline.
     # Alternatively you can just create a manual node group for ops_s1
# and ops_s2 and style them separately.
     [[node groups]]
          #(see comment above:)
          #serial_ops = ops_s1, ops_s2
     [[node attributes]]
          OPS = "style=filled", "fillcolor=green"
          SERIAL = "color=blue" #(see comment above:), "style="
          #(see comment above:)
#serial_ops = "color=blue", "style=filled", "fillcolor=green"
```

cylc get-suite-config provides an easy way to check the result of inheritance in a suite. You can extract specific items, e.g.:

```
$ cylc get-suite-config --item '[runtime][var_p2]script' \
    inherit.multi.one
echo ''RUN: run-var.sh''
```

or use the --sparse option to print entire namespaces without obscuring the result with the dense runtime structure obtained from the root namespace:

```
$ cylc get-suite-config --sparse --item '[runtime]ops_s1' inherit.multi.one
script = echo ''RUN: run-ops.sh''
inherit = ['OPS', 'SERIAL']
[directives]
    job_type = serial
```

10.4.5.1 Suite Visualization And Multiple Inheritance

The first parent inherited by a namespace is also used as the collapsible family group when visualizing the suite. If this is not what you want, you can demote the first parent for visualization purposes, without affecting the order of inheritance of runtime properties:

```
[runtime]
    [[BAR]]
    # ...
[[foo]]
    # inherit properties from BAR, but stay under root for visualization:
    inherit = None, BAR
```

10.4.6 How Runtime Inheritance Works

The linear precedence order of ancestors is computed for each namespace using the C3 algorithm. Then any runtime items that are explicitly configured in the suite definition are "inherited" up

the linearized hierarchy for each task, starting at the root namespace: if a particular item is defined at multiple levels in the hierarchy, the level nearest the final task namespace takes precedence. Finally, root namespace defaults are applied for every item that has not been configured in the inheritance process (this is more efficient than carrying the full dense namespace structure through from root from the beginning).

10.4.7 Task Execution Environment

The task execution environment contains suite and task identity variables provided by the suite daemon, and user-defined environment variables. The environment is explicitly exported (by the task job script) prior to executing the task script (see 12).

Suite and task identity are exported first, so that user-defined variables can refer to them. Order of definition is preserved throughout so that variable assignment expressions can safely refer to previously defined variables.

Additionally, access to cylc itself is configured prior to the user-defined environment, so that variable assignment expressions can make use of cylc utility commands:

10.4.7.1 User Environment Variables

A task's user-defined environment results from its inherited [[[environment]]] sections:

This results in a task foo with SHAPE=circle, COLOR=blue, and TEXTURE=rough in its environment.

10.4.7.2 Overriding Environment Variables

When you override inherited namespace items the original parent item definition is *replaced* by the new definition. This applies to all items including those in the environment sub-sections which, strictly speaking, are not "environment variables" until they are written, post inheritance processing, to the task job script that executes the associated task. Consequently, if you override an environment variable you cannot also access the original parent value:

The compressed variant of this, COLOR = dark-\$COLOR, is also in error for the same reason. To achieve the desired result you must use a different name for the parent variable:

```
[runtime]
    [[F00]]
    [[[environment]]]
```

10.4.7.3 Suite And Task Identity Variables

The task identity variables provided to tasks by the suite daemon include:

```
$CYLC_TASK_ID  # X.20110511T1800Z (e.g.)
$CYLC_TASK_NAME  # X
$CYLC_TASK_CYCLE_POINT  # 20110511T1800Z
$CYLC_TASK_LOG_ROOT  # ~/cylc-run/foo.bar.baz/log/job/20110511T1800Z/X/01/job
$CYLC_TASK_NAMESPACE_HIERARCHY  # "root postproc X" (e.g.)
$CYLC_TASK_SUBMIT_NUMBER  # increments with every submit
$CYLC_TASK_TRY_NUMBER  # increments with automatic retry-on-fail
$CYLC_TASK_WORK_DIR  # task work directory (see below)
$CYLC_SUITE_SHARE_DIR  # suite (or task!) shared directory (see below)
```

And the suite identity variables are:

```
$CYLC_SUITE_DEF_PATH  # $HOME/mysuites/baz (e.g.)
$CYLC_SUITE_NAME  # foo.bar.baz (e.g.)
$CYLC_SUITE_REG_PATH  # name translate to path: foo/bar/baz
$CYLC_SUITE_HOST  # orca.niwa.co.nz (e.g.)
$CYLC_SUITE_PORT  # 7766 (e.g.)
$CYLC_SUITE_OWNER  # oliverh (e.g.)
```

Some of these variables are also used by cylc task messaging commands in order to target the right task proxy object in the right suite.

10.4.7.4 Suite Share Directories

A *suite share directory* is created automatically under the suite run directory as a share space for tasks. The location is available to tasks as \$CYLC_SUITE_SHARE_DIR. In a cycling suite, output files are typically held in cycle point sub-directories of the suite share directory.

The top level share and work directory (below) location can be changed (e.g. to a large data area) by a global config setting (see B.9.1.2).

10.4.7.5 Task Work Directories

Task job scripts are executed from within work directories created automatically under the suite run directory. A task can get its own work directory from \$CYLC_TASK_WORK_DIR (or simply \$PWD if it does not cd elsewhere at runtime). By default the location contains task name and cycle point, to provide a unique workspace for every instance of every task. This can be overridden in the suite definition, however, to get several tasks to share the same work directory (see A.4.1.10).

The top level work and share directory (above) location can be changed (e.g. to a large data area) by a global config setting (see B.9.1.2).

10.4.7.6 Other Cylc-Defined Environment Variables

Initial and final cycle points, if supplied via the suite.rc file or the command line, are passed to task execution environments as:

```
$CYLC_SUITE_INITIAL_CYCLE_POINT
$CYLC_SUITE_FINAL_CYCLE_POINT
```

Tasks can use these to determine whether or not they are running in the first or final cycles. Note however that R1 graph sections are now the preferred way to get different behaviour at suite start-up or shutdown.

10.4.7.7 Environment Variable Evaluation

Variables in the task execution environment are not evaluated in the shell in which the suite is running prior to submitting the task. They are written in unevaluated form to the job script that is submitted by cylc to run the task (12.1) and are therefore evaluated when the task begins executing under the task owner account on the task host. Thus \$HOME, for instance, evaluates at run time to the home directory of task owner on the task host.

10.4.8 How Tasks Get Access To The Suite Directory

Tasks can use \$CYLC_SUITE_DEF_PATH to access suite files on the task host, and the suite bin directory is automatically added \$PATH. If a remote suite definition directory is not specified the local (suite host) path will be assumed with the local home directory, if present, swapped for literal \$HOME for evaluation on the task host.

10.4.9 Remote Task Hosting

If a task declares an owner other than the suite owner and/or a host other than the suite host, cylc will use non-interactive ssh to execute the task on the owner@host account by the configured job submission method:

```
[runtime]
    [[foo]]
        [[[remote]]]
            host = orca.niwa.co.nz
            owner = bob
        [[[job]]]
            batch system = pbs
```

For this to work:

- non-interactive ssh/scp is required from the suite host to the task host accounts. Note: Your shell initialization (.profile, .bashrc, .cshrc, etc) on the remote host must not produce any standard output as it may confuse commands such as scp. See http://www.openssh.com/faq.html#2.9 for more information.
- cylc must be installed on task hosts.
 - Optional software dependencies such as graphviz and Jinja2 are not needed on task hosts.
 - If polling task communication is used, there is no other requirement.
 - If SSH task communication is configured, non-interactive ssh is required from the task host to the suite host.
 - If (default) task communication is configured, the task host should have access to the port on the suite host.
- the suite definition directory, or some fraction of its content, can be installed on the task host, if needed.

To learn how to give remote tasks access to cylc, see 13.7.

Tasks running on the suite host under another user account are treated as remote tasks.

Remote hosting, like all namespace settings, can be declared globally in the root namespace, or per family, or for individual tasks.

10.4.9.1 Dynamic Host Selection

Instead of hardwiring host names into the suite definition you can specify a shell command that prints a hostname, or an environment variable that holds a hostname, as the value of the host config item. See A.4.1.16.1.

10.4.9.2 Remote Task Log Directories

Task stdout and stderr streams are written to log files in a suite-specific sub-directory of the *suite run directory*, as explained in 12.3. For remote tasks the same directory is used, but *on the task host*. Remote task log directories, like local ones, are created on the fly, if necessary, during job submission.

10.5 Visualization

The visualization section of a suite definition is used to configure suite graphing, principally graph node (task) and edge (dependency arrow) style attributes. Tasks can be grouped for the purpose of applying common style attributes. See A for details.

10.5.1 Collapsible Families In Suite Graphs

```
[visualization]
    collapsed families = family1, family2
```

Nested families from the runtime inheritance hierarchy can be expanded and collapsed in suite graphs and the gcylc graph view. All families are displayed in the collapsed state at first, unless [visualization]collapsed families is used to single out specific families for initial collapsing.

In the gcylc graph view, nodes outside of the main graph (such as the members of collapsed families) are plotted as rectangular nodes to the right if they are doing anything interesting (submitted, running, failed).

Figure 28 illustrates successive expansion of nested task families in the *namespaces* example suite.

10.6 Parameterized Tasks

Cylc can automatically generate tasks and dependencies by expanding parameterized task names over lists of parameter values. Uses for this include:

- generating an ensemble of similar model runs
- generating chains of tasks to process similar datasets
- replicating an entire workflow, or part thereof, over several runs
- splitting a long model run into smaller steps or "chunks" (parameterized cycling)

Note that this can be done with Jinja2 loops too (Section 10.7) but parameterization is much cleaner (nested loops can seriously reduce the clarity of a suite definition).

10.6.1 Parameter Expansion

Parameter values can be lists of strings, or integer ranges (with inclusive bounds):

```
[cylc]
    [[parameters]]
        obs = ship, buoy, plane
        run = 1..5 # 1, 2, 3, 4, 5
```

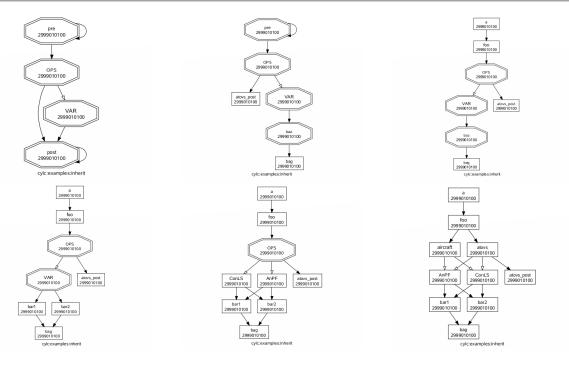


Figure 28: Graphs of the *namespaces* example suite showing various states of expansion of the nested namespace family hierarchy, from all families collapsed (top left) through to all expanded (bottom right). This can also be done by right-clicking on tasks in the gcylc graph view.

Then angle brackets denote use of these parameters throughout the suite definition. For the values above, this parameterized name:

```
model < run > # for run = 1..2
expands to these concrete task names:
    model_run1, model_run2
and this parameterized name:
    proc < obs > # for obs = ship, buoy, plane
expands to these concrete task names:
    proc_ship, proc_buoy, proc_plane
```

By default, to avoid any ambiguity, the parameter name appears in the expanded task names for integer values, but not for string values. For example, model_run1 for run = 1, but proc_ship for obs = ship. However, the default expansion templates can be overridden if need be:

```
[cylc]
    [[parameters]]
      obs = ship, buoy, plane
      run = 1..5
    [[parameter templates]]
      run = -R%(run)s # Make foo<run> expand to foo-R1 etc.
```

(See A.2.11 for more on the string template syntax.)

Any number of parameters can be used at once. This parameterization:

```
model<run,obs> # for run = 1..2 and obs = ship, buoy, plane
```

expands to these tasks names:

```
model_run1_ship, model_run1_buoy, model_run1_plane,
model_run2_ship, model_run2_buoy, model_run2_plane
```

Here's a simple but complete example suite:

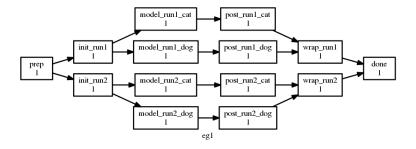


Figure 29: Parameter expansion example.

```
[cylc]
    [[parameters]]
        run = 1..2
[scheduling]
    [[dependencies]]
        graph = "prep => model<run>"
[runtime]
    [[model<run>]]
    # ...
```

The result, post parameter expansion, is this:

```
[scheduling]
    [[dependencies]]
        graph = "prep => model_run1 & model_run2"
[runtime]
    [[model_run1]]
        # ...
    [[model_run2]]
        # ...
```

Here's a more complex graph using two parameters ([runtime] omitted):

Figure 29 shows the result as visualized by cylc graph.

10.6.1.1 Zero-Padded Integer Values

Integer parameter values are zero-padded according to the size of their largest value, so foo for p = 9..10 expands to foo_p09, foo_p10.

To get thicker padding, prepend extra zeroes to the upper range value: foo for p = 9..010 expands to foo_p009, foo_p010.

10.6.2 Passing Parameter Values To Tasks

Parameter values are passed as environment variables to tasks generated by parameter expansion. For the example above, task model_run2_ship would get the following environment variables:

```
$CYLC_TASK_PARAM_run # value "2" etc.
$CYLC_TASK_PARAM_obs # value "ship" etc.
```

These variables allow tasks to determine which member of a parameterized group they are, and so to vary their behaviour accordingly.

10.6.3 Selecting Specific Parameter Values

Specific parameter values can be singled out in the graph and under [runtime] with the notation <p=5> (for example). Here's how to make a special task trigger off just the first of a set of model runs:

10.6.4 Selecting Partial Parameter Ranges

The parameter notation does not currently support partial range selection such as foo<p=5..10>, but you can achieve the same result by defining a second parameter that covers the partial range and giving it the same expansion template as the full-range parameter. For example:

10.6.5 Parameter Offsets In The Graph

A negative offset notation <NAME-1> is interpreted as the previous value in the ordered list of parameter values. For example, to split a model run into multiple steps with each step depending on the previous one, this graph:

10.6.6 Task Families And Parameterization

Task family members can be generated by parameter expansion:

```
[runtime]
    [[FAM]]
    [[member < r > ]]
        inherit = FAM
# Result: family FAM contains member_r1, member_r2, etc.
```

Family names can be parameterized too, just like task names:

```
[runtime]
    [[RUN<r>]]
    [[model<r>]]
        inherit = RUN<r>
    [[post_proc<r>]]
        inherit = RUN<r>
# Result: family RUN_r1 contains model_r1 and post_proc_r1,
# family RUN_r2 contains model_r2 and post_proc_r1, etc.
```

As described in Section 10.3.5.9 family names can be used to trigger all members at once:

```
graph = "foo => FAMILY"
```

or to trigger off all members:

```
graph = "FAMILY:succeed-all => bar"
```

or to trigger off any members:

```
graph = "FAMILY:succeed-any => bar"
```

If the members of FAMILY were generated with parameters, you can also trigger them all at once with parameter notation:

```
graph = "foo => member <m>"
```

Similarly, to trigger off all members:

```
graph = "member < m > => bar"
# (member < m >: fail etc., for other trigger types)
```

Family names are still needed in the graph, however, to succinctly express "succeed-any" triggering semantics, and all-to-all or any-to-all triggering:

```
graph = "FAM1:succeed-any => FAM2"
```

(Direct all-to-all and any-to-all family triggering is not recommended for efficiency reasons though - see Section 10.3.5.10).

For family *member-to-member* triggering use parameterized members. For example, if family OBS_GET has members get<obs> and family OBS_PROC has members proc<obs> then this graph:

```
graph = "get < obs > => proc < obs > " # for obs = ship, buoy, plane
expands to:
    get_ship => proc_ship
    get_buoy => proc_buoy
    get_plane => proc_plane
```

10.6.7 Parameterized Cycling

Two ways of constructing cycling systems are described and contrasted in Section 6. For most purposes use of a proper *cycling workflow* is recommended, wherein cylc incrementally generates the date-time sequence and extends the workflow, potentially indefinitely, at run time. For smaller systems of finite duration, however, parameter expansion can be used to generate a sequence of pre-defined tasks as a proxy for cycling.

Here's a cycling workflow of two-monthly model runs for one year, with previous-instance model dependence (e.g. for model restart files):

[scheduling]

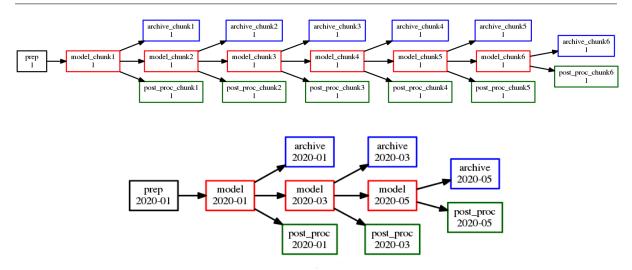


Figure 30: parameterized and cycling versions of the same workflow. The first three cycle points are shown in the cycling case. The parameterized case does not have "cycle points".

```
initial cycle point = 2020-01
     final cycle point = 2020-12
     [[dependencies]]
          [[[R1]]] # Run once, at the initial point.
    graph = "prep => model"
           [[[P2M]]] # Run^{2} at 2-month intervals between the initial and final points.
               graph = "model[-P2M] => model => post_proc & archive'
[runtime]
     [[model]]
          script = "run-model $CYLC_TASK_CYCLE_POINT"
    And here's how to do the same thing with parameterized tasks:
     [[parameters]]
          chunk = 1...6
[scheduling]
     [[dependencies]]
          graph = """prep => model < chunk=1>
                           model < chunk -1> => model < chunk > =>
                             post_proc<chunk> & archive<chunk>"""
[runtime]
     [[model < chunk >]]
          script =
# Compute start date from chunk index and interval, then run the model.
INITIAL_POINT=2020-01
INTERVAL_MONTHS=2
OFFSET_MONTHS=(( (CYLC_TASK_PARAM_chunk - 1)*INTERVAL_MONTHS ))
OFFSET=P${OFFSET_MONTHS}M # e.g. P4M for chunk=3
run-model $(cylc cyclepoint --offset=$OFFSET $INITIAL_POINT)""
```

The two workflows are shown together in Figure 30. They both achieve the same result, and both can include special tasks at the start, end, or anywhere in between. But as noted earlier the parameterized version has several disadvantages: it must be finite in extent and not too large; the date-time arithmetic has to be done by the user; and the full extent of the workflow will be visible at all times as the suite runs.

Here's a yearly-cycling suite with four parameterized chunks in each cycle point:

```
[cylc]
    [[parameters]]
    chunk = 1..4
[scheduling]
```

Note the inter-cycle trigger that connects the first chunk in each cycle point to the last chunk in the previous cycle point. Of course it would be simpler to just use 3-monthly cycling:

Here's a possible valid use-case for mixed cycling: consider a portable date-time cycling workflow of model jobs that can each take too long to run on some supported platforms. This could be handled without changing the cycling structure of the suite by splitting the run (at each cycle point) into a variable number of shorter steps, using more steps on less powerful hosts.

10.6.7.1 Cycle Point And Parameter Offsets At Start-Up

In cycling workflows cylc ignores anything earlier than the suite initial cycle point. So this graph:

```
graph = "model[-P1D] => model"
simplifies at the initial cycle point to this:
    graph = "model"
```

Similarly, parameter offsets are ignored if they extend beyond the start of the parameter value list. So this graph:

```
graph = "model < chunk - 1 > = > model < chunk > "
simplifies for chunk = 1 to this:
    graph = "model_chunk 1"
```

Note however that the initial cut-off applies to every parameter list, but only to cycle point sequences that start at the suite initial cycle point. Therefore it may be somewhat easier to use parameterized cycling if you need multiple date-time sequences with different start points in the same suite. We plan to allow this sequence-start simplification for any date-time sequence in the future, not just at the suite initial point, but it needs to be optional because delayed-start cycling tasks sometimes need to trigger off earlier cycling tasks.

10.7 Jinja2

This section needs to be revised - the Parameterized Task feature introduced in cylc-6.11.0 (see Section 10.6) provides a cleaner way to auto-generate tasks without coding messy Jinja2 loops.

Cylc has built in support for the Jinja2 template processor in suite definitions. Jinja2 variables, mathematical expressions, loop control structures, conditional logic, etc., are automatically processed to generate the final suite definition seen by cylc.

The need for Jinja2 processing must be declared with a hash-bang comment as the first line of the suite.rc file:

```
#!jinja2
# ...
```

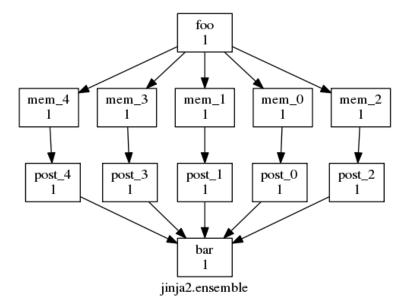


Figure 31: The Jinja2 ensemble example suite graph.

Potential uses for this include automatic generation of repeated groups of similar tasks and dependencies, and inclusion or exclusion of entire suite sections according to the value of a single flag. Consider a large complicated operational suite and several related parallel test suites with slightly different task content and structure (the parallel suites, for instance, might take certain large input files from the operation or the archive rather than downloading them again) - these can now be maintained as a single master suite definition that reconfigures itself according to the value of a flag variable indicating the intended use.

Template processing is the first thing done on parsing a suite definition so Jinja2 expressions can appear anywhere in the file (inside strings and namespace headings, for example).

Jinja2 is well documented at http://jinja.pocoo.org/docs, so here we just provide an example suite that uses it. The meaning of the embedded Jinja2 code should be reasonably self-evident to anyone familiar with standard programming techniques.

The jinja2.ensemble example, graphed in Figure 31, shows an ensemble of similar tasks generated using Jinja2:

```
#!jinja2
{% set N_MEMBERS = 5 %}
[scheduling]
    [[dependencies]]
        graph = """{# generate ensemble dependencies #}
        {% for I in range( 0, N_MEMBERS ) %}
            foo => mem_{{ I }} => post_{{ I }} => bar
        {% endfor %}"""
```

Here is the generated suite definition, after Jinja2 processing:

```
#!jinja2
[scheduling]
    [[dependencies]]
        graph = """
        foo => mem_0 => post_0 => bar
        foo => mem_1 => post_1 => bar
        foo => mem_2 => post_2 => bar
        foo => mem_3 => post_3 => bar
        foo => mem_4 => post_4 => bar
```

And finally, the jinja2.cities example uses variables, includes or excludes special cleanup tasks according to the value of a logical flag, and it automatically generates all dependencies and family relationships for a group of tasks that is repeated for each city in the suite. To add a new city and associated tasks and dependencies simply add the city name to list at the top of the file. The suite is graphed, with the New York City task family expanded, in Figure 32.

```
#!Jinja2
```

```
title = "Jinja2 city suite example."
description = """
description =
Illustrates use of variables and math expressions, and programmatic
generation of groups of related dependencies and runtime properties."""
{% set HOST = "SuperComputer" %}
{% set CITIES = 'NewYork', 'Philadelphia', 'Newark', 'Houston', 'SantaFe', 'Chicago' %}
{% set CITYJOBS = 'one', 'two', 'three', 'four' %}
{\% \text{ set LIMIT\_MINS} = 20 \%}
{% set CLEANUP = True %}
[scheduling]
    initial cycle point = 2011-08-08T12
     [[ dependencies ]]
{% if CLEANUP %}
         [[[T23]]]
              graph = "clean"
{% endif %}
         [[[T00,T12]]]
              graph =
setup => get_lbc & get_ic # foo
{% for CITY in CITIES %} {# comment #}
                       get_lbc => {{ CITY }}_one
                       get_ic => {{ CITY }}_two
{{ CITY }}_one & {{ CITY }}_two => {{ CITY }}_three & {{ CITY }}_four
{% if CLEANUP %}
                       {{ CITY }}_three & {{ CITY }}_four => cleanup
{% endif %}
{% endfor %}
[runtime]
     [[on_{{ HOST }}]]
          [[[remote]]]
              host = \{\{ HOST \}\}
              # (remote cylc directory is set in site/user config for this host)
         [[[directives]]]
              wall_clock_limit = "00:{{ LIMIT_MINS|int() + 2 }}:00,00:{{ LIMIT_MINS }}:00"
{% for CITY in CITIES %}
     [[ {{ CITY }} ]]
         inherit = on_{{ HOST }}
{% for JOB in CITYJOBS %}
    [[ {{ CITY }}_{{ JOB }} ]]
inherit = {{ CITY }}
{% endfor %}
{% endfor %}
[visualization]
     initial cycle point = 2011-08-08T12
    final cycle point = 2011-08-08T23
     [[node groups]]
         cleaning = clean, cleanup
     [[node attributes]]
         cleaning = 'style=filled', 'fillcolor=yellow'
NewYork = 'style=filled', 'fillcolor=lightblue'
```

10.7.1 Accessing Environment Variables With Jinja2

This functionality is not provided by Jinja2 by default, but cylc automatically imports the user environment to the template in a dictionary structure called *environ*. A usage example:

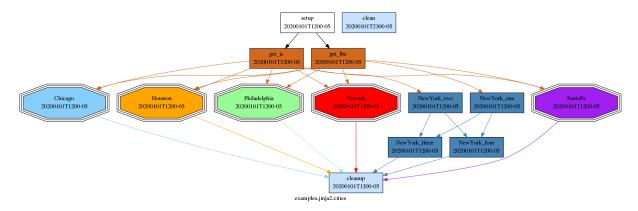


Figure 32: The Jinja2 cities example suite graph, with the New York City task family expanded.

```
#!Jinja2
#...
[runtime]
       [[root]]
       [[[environment]]]
       SUITE_OWNER_HOME_DIR_ON_SUITE_HOST = {{environ['HOME']}}}
```

This example is emphasizes that the environment is read on the suite host at the time the suite definition is parsed - it is not, for instance, read at task run time on the task host.

10.7.2 Custom Jinja2 Filters

Jinja2 variable values can be modified by "filters", using pipe notation. For example, the built-in trim filter strips leading and trailing white space from a string:

```
{% set MyString = " dog " %}
{{ MyString | trim() }} # "dog"
```

(See official Jinja2 documentation for available built-in filters.)

Cylc also supports custom Jinja2 filters. A custom filter is a single Python function in a source file with the same name as the function (plus ".py" extension) and stored in one of the following locations:

- \$CYLC_DIR/lib/Jinja2Filters/
- [suite definition directory]/Jinja2Filters/
- \$HOME/.cylc/Jinja2Filters/

In the filter function argument list, the first argument is the variable value to be "filtered", and subsequent arguments can be whatever is needed. Currently there is one custom filter called "pad" in the central cylc Jinja2 filter directory, for padding string values to some constant length with a fill character - useful for generating task names and related values in ensemble suites:

```
{% for i in range(0,100) %} # 0, 1, ..., 99
    {% set j = i | pad(2,'0') %}
    A_{{{j}}} # A_00, A_01, ..., A_99
{% endfor %}
```

10.7.3 Associative Arrays In Jinja2

Associative arrays (*dicts* in Python) can be very useful. Here's an example, from \$CYLC_DIR/examples/jinja2/dict:

```
#!Jinja2
{% set obs_types = ['airs', 'iasi'] %}
{% set resource = { 'airs':'ncpus=9', 'iasi':'ncpus=20' } %}
[scheduling]
     [[dependencies]]
graph = OBS
[runtime]
    [[OBS]]
         [[[job]]]
              batch system = pbs
     {% for i in obs_types %}
     [[ {{i}} ]]
         inherit = OBS
         [[[directives]]]
               -I = {{ resource[i] }}
     {% endfor %}
   Here's the result:
$ cylc get-suite-config -i [runtime][airs]directives SUITE
-I = ncpus = 9
```

10.7.4 Jinja2 Default Values And Template Inputs

The values of Jinja2 variables can be passed in from the cylc command line rather than hardwired in the suite definition. Here's an example, from

\$CYLC_DIR/examples/jinja2/defaults:

```
#!Jinja2
title = "Jinja2 example: use of defaults and external input"
description = """
The template variable FIRST_TASK must be given on the cylc command line using --set or --set-file=FILE; two other variables, LAST_TASK and
N_MEMBERS can be set similarly, but if not they have default values."""
{% set LAST_TASK = LAST_TASK | default( 'baz') %}
{% set N_MEMBERS = N_MEMBERS | default( 3 ) | int %}
{# input of FIRST_TASK is required - no default #}
[scheduling]
    initial cycle point = 20100808T00
     final cycle point
                           = 20100816T00
     [[dependencies]]
          [[[0]]]
              graph = """{{ FIRST_TASK }} => ENS
                   ENS:succeed-all => {{ LAST TASK }}"""
[runtime]
     [[ENS]]
   for I in range( 0, N_MEMBERS ) %}
    [[ mem_{{ I }} ]]
inherit = ENS
{% endfor %}
   Here's the result:
$ cylc list SUITE
Jinja2 Template Error
'FIRST_TASK' is undefined
cylc-list foo failed:
$ cylc list --set FIRST_TASK=bob foo
bob
baz
mem_2
mem_1
mem_0
```

```
$ cylc list --set FIRST_TASK=bob --set LAST_TASK=alice foo
bob
alice
mem_2
mem 1
mem_0
$ cylc list --set FIRST_TASK=bob --set N_MEMBERS=10 foo
mem_9
mem_8
mem_{2}
mem_6
mem_5
mem_4
mem_3
mem_2
mem_1
mem_0
baz
bob
```

Note also that cylc view --set FIRST_TASK=bob --jinja2 SUITE will show the suite with the Jinja2 variables as set.

Note: suites started with template variables set on the command line will *restart* with the same settings. However, you can set them again on the cylc restart command line if they need to be overridden.

10.7.5 Jinja2 Variable Scope

Jinja2 variable scoping rules may be surprising. Variables set inside a *for loop* block, for instance, are not accessible outside of the block, so the following will print # F00 is 0, not # F00 is 9:

```
{% set COUNT = 0 %}
{% for I in range(10) %}
    {% set F00 = I %}
{% endfor %}
# F00 is {{F00}}
```

10.8 Omitting Tasks At Runtime

It is sometimes convenient to omit certain tasks from the suite at runtime without actually deleting their definitions from the suite.

Defining [runtime] properties for tasks that do not appear in the suite graph results in verbose-mode validation warnings that the tasks are disabled. They cannot be used because the suite graph is what defines their dependencies and valid cycle points. Nevertheless, it is legal to leave these orphaned runtime sections in the suite definition because it allows you to temporarily remove tasks from the suite by simply commenting them out of the graph.

To omit a task from the suite at runtime but still leave it fully defined and available for use (by insertion or cylc submit) use one or both of [scheduling][[special task]] lists, include at start-up or exclude at start-up (documented in A.3.11.6 and A.3.11.5). Then the graph still defines the validity of the tasks and their dependencies, but they are not actually loaded into the suite at start-up. Other tasks that depend on the omitted ones, if any, will have to wait on their insertion at a later time or otherwise be triggered manually.

Finally, with Jinja2 (10.7) you can radically alter suite structure by including or excluding tasks from the [scheduling] and [runtime] sections according to the value of a single logical flag defined at the top of the suite.

10.9 Naked Dummy Tasks And Strict Validation

A naked dummy task appears in the suite graph but has no explicit runtime configuration section. Such tasks automatically inherit the default "dummy task" configuration from the root namespace. This is very useful because it allows functional suites to be mocked up quickly for test and demonstration purposes by simply defining the graph. It is somewhat dangerous, however, because there is no way to distinguish an intentional naked dummy task from one generated by typographic error: misspelling a task name in the graph results in a new naked dummy task replacing the intended task in the affected trigger expression; and misspelling a task name in a runtime section heading results in the intended task becoming a dummy task itself (by divorcing it from its intended runtime config section).

To avoid this problem any dummy task used in a real suite should not be naked - i.e. it should have an explicit entry in under the runtime section of the suite definition, even if the section is empty. This results in exactly the same dummy task behaviour, via implicit inheritance from root, but it allows use of cylc validate --strict to catch errors in task names by failing the suite if any naked dummy tasks are detected.

11 Task Implementation

Existing scripts or executables can be used as cylc tasks without any modification so long as they return standard exit status on success or failure, and do not internally spawn detaching processes (see 11.4).

11.1 Inlined Tasks

Simple tasks can be entirely implemented within the suite.rc file, as the task script items can be multi-line strings.

11.2 Returning Proper Error Status

Tasks should abort with non-zero exit status if a fatal error occurs (this is just good coding practice anyway). This allows cylc's task job scripts to automatically trap errors and send cylc task message "failed" back to the suite. The shell set -e option can be used in lieu of explicit error checks for every command:

```
#!/bin/bash
set -e # abort on error
mkdir /illegal/dir # this will abort the script with error status
```

11.3 Other Task Messages

General (non-output) messages can also be sent to report progress, warnings, and so on, e.g.:

```
#!/bin/bash
# a warning message (this will be logged by the suite):
cylc task message -p WARNING "oops, something's fishy here"
# information (this will also be logged by the suite):
cylc task message "Hello from task foo"
```

Explanatory messages can be sent before aborting on error:

```
#!/bin/bash
set -e # abort on error
if ! mkdir /illegal/dir; then
    # (use inline error checking to avoid triggering the above 'set -e')
    cylc task message -p CRITICAL "Failed to create directory /illegal/dir"
    exit 1 # now abort non-zero exit status to trigger the task failed message
fi
```

Or equivalently, with different syntax:

```
#!/bin/bash
set -e
mkdir /illegal/dir || {  # inline error checking using OR operator
        cylc task message -p CRITICAL "Failed to create directory /illegal/dir"
        exit 1
}

But not this:
#!/bin/bash
set -e
mkdir /illegal/dir # aborted via 'set -e'
if [[ $? != 0 ]]; then # so this will never be reached.
        cylc task message -p CRITICAL "Failed to create directory /illegal/dir"
        exit 1
fi
```

If critical errors are not reported in this way task failures will still be detected and logged by the suite daemon, but you may have to examine task logs to determine what the problem was.

11.4 Avoid Detaching Processes

If a task script starts background sub-processes and does not wait on them, or internally submits jobs to a batch scheduler and then exits immediately, the detached processes will not be visible to cylc and the task will appear to finish when the top-level script finishes. You will need to modify scripts like this to make them execute all sub-processes in the foreground (or use the shell wait command to wait on them before exiting) and to prevent job submission commands from returning before the job completes (e.g. llsubmit -s for Loadleveler, qsub -sync yes for Sun Grid Engine, and qsub -W block=true for PBS).

If this is not possible - perhaps you don't have control over the script or can't work out how to fix it - one alternative approach is to use another task to repeatedly poll for the results of the detached processes:

```
[scheduling]
    [[dependencies]]
        graph = "model => checker => post-proc"
[runtime]
    [[model]]
        # Uh-oh, this script does an internal job submission to run model.exe:
        script = "run-model.sh"
    [[checker]]
        # Fail and retry every minute (for 10 tries at the most) if the model's
        # job.done indicator file does not exist yet.
        retry delays = 10 * PT1M
        script = "[[ ! -f $RUN_DIR/job.done ]] && exit 1"
```

12 Task Job Submission and Management

For the requirements a command, script, or program, must fulfill in order to function as a cylc task, see 11. This section explains how tasks are submitted by the suite daemon when they are ready to run, and how to define new task job submission methods.

12.1 Task Job Scripts

When a task is ready cylc generates a *task job script* that encapsulates the runtime settings (environment and scripting) defined for it in the suite.rc file. The job script is submitted to run by the *job submission method* chosen for the task. Different tasks can have different job submission methods. Like other runtime properties, you can set a suite default job submission method and override it for specific tasks or families:

As shown in the Tutorial (8.11) job scripts are saved to the suite run directory; the commands used to submit them are printed to stdout by cylc in debug mode; and they can be printed with the cylc cat-log command or new ones generated and printed with the cylc jobscript command. Take a look at one to see exactly how cylc wraps and runs your tasks.

12.2 Supported Job Submission Methods

Cylc supports a number of commonly used job submission methods. See 12.8 for how to add new job submission methods.

12.2.1 background

Runs tasks as Unix background processes.

If an execution time limit is specified for a task, its job will be wrapped by the timeout command.

12.2.2 at

Submits tasks to the rudimentary Unix at scheduler. The atd daemon must be running.

If an execution time limit is specified for a task, its job will be wrapped by the timeout command.

12.2.3 loadleveler

Submits tasks to loadleveler by the llsubmit command. Loadleveler directives can be provided in the suite.rc file:

These are written to the top of the task job script like this:

```
#!/bin/bash
# DIRECTIVES
# @ foo = bar
# @ baz = qux
# @ wall_clock_limit = 660,600
# @ queue
```

If restart=yes is specified as a directive for loadleveler, the job will automatically trap SIGUSR1, which loadleveler may use to preempt the job. On trapping SIGUSR1, the job will inform the suite that it has been vacated by loadleveler. This will put it back to the submitted state, until it starts running again.

If execution time limit is specified, it is used to generate the wall_clock_limit directive. The setting is assumed to be the soft limit. The hard limit will be set by adding an extra minute to the soft limit. Do not specify the wall_clock_limit directive explicitly if execution time limit

is specified. Otherwise, the execution time limit known by the suite may be out of sync with what is submitted to the batch system.

12.2.4 lsf

Submits tasks to IBM Platform LSF by the bsub command. LSF directives can be provided in the suite.rc file:

These are written to the top of the task job script like this:

```
#!/bin/bash
# DIRECTIVES
#BSUB -q = foo
#BSUB -W = 10
```

If execution time limit is specified, it is used to generate the -W directive. Do not specify the -W directive explicitly if execution time limit is specified. Otherwise, the execution time limit known by the suite may be out of sync with what is submitted to the batch system.

12.2.5 pbs

Submits tasks to PBS (or Torque) by the qsub command. PBS directives can be provided in the suite.rc file:

These are written to the top of the task job script like this:

```
#!/bin/bash
# DIRECTIVES
#PBS -V
#PBS -q foo
#PBS -l nodes=1
#PBS -l walltime=60
```

If execution time limit is specified, it is used to generate the -1 walltime directive. Do not specify the -1 walltime directive explicitly if execution time limit is specified. Otherwise, the execution time limit known by the suite may be out of sync with what is submitted to the batch system.

12.2.6 moab

Submits tasks to the Moab workload manager by the msub command. Moab directives can be provided in the suite.rc file; the syntax is very similar to PBS:

```
[runtime]
    [[my_task]]
         [[[job]]]
               batch system = moab
```

```
execution time limit = PT1M
[[[directives]]]
   -V =
   -q = foo
   -l nodes = 1
```

These are written to the top of the task job script like this:

```
#!/bin/bash
# DIRECTIVES
#PBS -V
#PBS -q foo
#PBS -l nodes=1
#PBS -l walltime=60
```

(Moab understands #PBS directives).

If execution time limit is specified, it is used to generate the -1 walltime directive. Do not specify the -1 walltime directive explicitly if execution time limit is specified. Otherwise, the execution time limit known by the suite may be out of sync with what is submitted to the batch system.

12.2.7 sge

Submits tasks to Sun/Oracle Grid Engine by the qsub command. SGE directives can be provided in the suite.rc file:

These are written to the top of the task job script like this:

```
#!/bin/bash
# DIRECTIVES
#$ -cwd
#$ -q foo
#$ -1 h_data=1024M
#$ -1 h_rt=24:00:00
```

If execution time limit is specified, it is used to generate the -1 h_rt directive. Do not specify the -1 h_rt directive explicitly if execution time limit is specified. Otherwise, the execution time limit known by the suite may be out of sync with what is submitted to the batch system.

12.2.8 slurm

Submits tasks to Simple Linux Utility for Resource Management by the sbatch command. SLURM directives can be provided in the suite.rc file (note that since not all SLURM commands have a short form, cylc requires the long form directives):

These are written to the top of the task job script like this:

```
#!/bin/bash
#SBATCH --nodes=5
#SBATCH --time=60:00
#SBATCH --account=QXZ5W2
```

If execution time limit is specified, it is used to generate the --time directive. Do not specify the --time directive explicitly if execution time limit is specified. Otherwise, the execution time limit known by the suite may be out of sync with what is submitted to the batch system.

12.2.9 Default Directives Provided

For job submission methods that use job file directives (PBS, Loadleveler, etc.) default directives are provided to set the job name, stdout and stderr file paths, and the execution time limit (if specified).

Cylc constructs the job name string using a combination of the task ID and the suite name. PBS fails a job submit if the job name in -N name is too long. For version 12 or below, this is 15 characters. For version 13, this is 236 characters. The default setting will truncate the job name string to 15 characters. If you have PBS 13 at your site, you should modify your site's global configuration file to allow the job name to be longer. (See also Section B.9.1.17.5.) For example:

12.2.10 Directives Section Quirks (PBS, SGE, ...)

As shown in the example above, to get a naked option flag such as -v in PBS or -cwd in SGE you must give a null string as the directive value in the suite.rc file.

12.3 Task stdout And stderr Logs

When a task is ready to run cylc generates a filename root to be used for the task job script and log files. The filename containing the task name, cycle point, and a submit number that increments if the same task is re-triggered multiple times:

How the stdout and stderr streams are directed into these files depends on the job submission method. The background method just uses appropriate output redirection on the command line, as shown above. The loadleveler method writes appropriate directives to the job script that is submitted to loadleveler.

Cylc obviously has no control over the stdout and stderr output from tasks that do their own internal output management (e.g. tasks that submit internal jobs and direct the associated output to other files). For less internally complex tasks, however, the files referred to here will be complete task job logs.

Some job submission methods, such as pbs, redirect a job's stdout and stderr streams to a separate cache area while the job is running. The contents are only copied to the normal locations when the job completes. This means that cylc cat-log or the gcylc GUI will be unable

to find the job's stdout and stderr streams while the job is running. Some sites with these job submission methods are known to provide commands for viewing and/or tail-follow a job's stdout and stderr streams that are redirected to these cache areas. If this is the case at your site, you can configure cylc to make use of the provided commands by adding some settings to the global site/user config. E.g.:

12.4 Overriding The Job Submission Command

To change the form of the actual command used to submit a job you do not need to define a new job submission method; just override the command template in the relevant job submission sections of your suite.rc file:

As explained in A the template's %(job)s will be substituted by the job file path.

12.5 Job Polling

For supported job submission methods, one-way polling can be used to determine actual job status: the suite daemon executes a process on the task host, by non-interactive ssh, to interrogate the batch queueing system there, and to read a *status file* that is automatically generated by the task job script as it runs.

Polling may be required to update the suite state correctly after unusual events such as a machine being rebooted with tasks running on it, or network problems that prevent task messages from getting back to the suite host.

Tasks can be polled on demand by right-clicking on them in gcylc or using the cylc poll command.

Tasks are polled automatically, once, if they timeout while queueing in a batch scheduler and submission timeout is set. (See A.4.1.17 for how to configure timeouts).

Tasks are polled multiple times, where necessary, when they exceed their execution time limits. These are normally set with some initial delays to allow the batch systems to kill the jobs. (See B.9.1.17.6 for how to configure the polling intervals).

Any tasks recorded in the *submitted* or *running* states at suite restart are automatically polled to determine what happened to them while the suite was down.

Regular polling can also be configured as a health check on tasks submitted to hosts that are known to be flaky, or as the sole method of determining task status on hosts that do not allow task messages to be routed back to the suite host.

To use polling instead of task-to-suite messaging set task communication method = poll in cylc site and user global config (see B.9.1.3). The default polling intervals can be overridden for all suites there too (see B.1.7 and B.1.6), or in specific suite definitions (in which case polling will

be done regardless of the task communication method configured for the host; see A.4.1.15.7 and A.4.1.15.8).

Note that regular polling is not as efficient as task messaging in updating task status, and it should be used sparingly in large suites.

Note that for polling to work correctly, the batch queueing system must have a job listing command for listing your jobs, and that the job listing must display job IDs as they are returned by the batch queueing system submit command. For example, for pbs, moab and sge, the qstat command should list jobs with their IDs displayed in exactly the same format as they are returned by the qsub command.

12.6 Job Killing

For supported job submission methods, the suite daemon can execute a process on the task host, by non-interactive ssh, to kill a submitted or running job according to its job submission method

Tasks can be killed on demand by right-clicking on them in gcylc or using the cylc kill command.

12.7 Execution Time Limit

You can specify an execution time limit for all supported job submission methods. E.g.:

For tasks running with background or at, their jobs will be wrapped using the timeout command. For all other methods, the relevant time limit directive will be added to their job files.

The execution time limit setting will also inform the suite when a a task job should complete by. If a task job has not reported completing within the specified time, the suite will poll the task job. (The default setting is PT1M, PT2M, PT7M. The accumulated times for these intervals will be roughly 1 minute, 1 + 2 = 3 minutes and 1 + 2 + 7 = 10 minutes after a task job exceeds its execution time limit.)

12.7.1 Execution Time Limit and Execution Timeout

If you specify an execution time limit the execution timeout event handler will only be called if the job has not completed after the final poll (by default, 10 min after the time limit). This should only happen if the submission method you are using is not enforcing wallclock limits (unlikely) or you are unable to contact the machine to confirm the job status.

If you specify an execution timeout and not an execution time limit then the execution timeout event handler will be called as soon as the specified time is reached. The job will also be polled to check its latest status (possibly resulting in an update in its status and the calling of the relevant event handler). This behaviour is deprecated, which users should avoid using.

If you specify an execution timeout and an execution time limit then the execution timeout setting will be ignored.

12.8 Custom Job Submission Methods

Defining a new job submission method requires a little Python programming. You can use one of the built-in methods as an example, and read the documentation in the header of the cylc.batch_sys_manager module.

12.8.1 An Example

The following user-defined job submission class, called qsub, overrides the built-in pbs class to change the directive prefix from #PBS to #QSUB:

```
#!/usr/bin/env python
from cylc.batch_sys_handlers.pbs import PBSHandler
class QSUBHandler(PBSHandler):
    """A user defined batch system handler."""
    DIRECTIVE_PREFIX = "#QSUB"

BATCH_SYSTEM_HANDLER = QSUBHandler()
```

To check that this works correctly save the new source file to qsub.py in one of the allowed locations (see just below), use it in a suite definition:

```
# SUITE.rc
# $HOME/test/suite.rc
[scheduling]
        [[dependencies]]
            graph = "a"
[runtime]
        [[[job]]]
            batch system = qsub
            execution time limit = PT1M
        [[[directives]]]
            -1 nodes = 1
            -q = long
            -V =
```

and generate a job script to see the resulting directives:

```
$ cylc register test $HOME/test
$ cylc jobscript test a.1 | grep QSUB
#QSUB -e /home/oliverh/cylc-run/my.suite/log/job/1/a/01/job.err
#QSUB -l nodes=1
#QSUB -l walltime=60
#QSUB -o /home/oliverh/cylc-run/my.suite/log/job/1/a/01/job.out
#QSUB -N a.1
#QSUB -Q long
#QSUB -V
```

12.8.2 Where To Put New Job Submission Modules

You new job submission class code should be saved to a file with the same name as the class (plus ".py" extension). It can reside in any of the following locations, depending on how generally useful the new method is and whether or not you have write-access to the cylc source tree:

- a lib/python sub-directory of your suite definition directory.
- any directory in your \$PYTHONPATH.
- in the lib/cylc/batch_sys_handlers directory of the cylc source tree.

13 Running Suites

This chapter currently features a diverse collection of topics related to running suites. Please also see the Tutorial (8) and command documentation (E), and experiment with plenty of examples.

13.1 Suite Start-up

There are three ways to start a suite running: *cold start* and *warm start*, which start from scratch; and *restart*, which loads a prior suite state. There is no difference between cold and warm start, except that the latter starts from a point beyond the suite initial cycle point.

Once a suite is up and running it is typically a restart that is needed most often (but see also cylc reload). Be aware that cold and warm starts wipe out any prior suite state, which prevents returning to a restart if you decide that's what you really intended.

13.1.1 Cold Start

A cold start is the primary way to start a suite run from scratch:

```
$ cylc run SUITE [INITIAL_CYCLE_POINT]
```

The initial cycle point may be specified on the command line or in the suite.rc file. The scheduler starts by loading the first instance of each task at the suite initial cycle point, or at the next valid point for the task.

13.1.2 Restart

A restart starts a suite run from the state recorded at a checkpoint, which is normally the end of a previous run. This allows restarting a suite that was shut down or killed, without rerunning tasks that were already completed, or which were already submitted or running when the suite went down.

```
$ cylc restart SUITE
```

For a restart, the scheduler starts by loading each task in its recorded state. Any tasks recorded as 'submitted' or 'running' will be polled automatically to determine what happened to them while the suite was down.

See Section 13.8 for more detail.

13.1.3 Warm Start

A warm start runs a suite from scratch like a cold start, but from a given cycle point that is later than the suite's initial cycle point. All tasks from the given cycle point will run. It can be considered an inferior alternative to a restart because it may result in some tasks rerunning. A warm start may be required if a restart is not possible because the suite run databases were accidentally deleted (for instance). The warm start cycle point must be given on the command line:

```
$ cylc run --warm SUITE [START_CYCLE_POINT]
```

The original suite initial cycle point is preserved, but all tasks and dependencies before the given start cycle point are ignored.

The scheduler starts by loading a first instance of each task at the warm start cycle point, or at the next valid point for the task. R1-type tasks behave exactly the same as other tasks - if their cycle point is at or later than the given start cycle point, they will run; if not, they will be ignored.

13.2 How Tasks Interact With Running Suites

Cylc has three ways of tracking the progress of tasks, configured per task host in the site and user global config files (7). All three methods can be used on different task hosts within the same suite if necessary.

- 1. **task-to-suite messaging:** cylc job scripts encapsulate task scripting in a wrapper that automatically invokes messaging commands to report progress back to the suite. The messaging commands can be configured to work in two different ways:
 - (a) **default:** direct messaging via network sockets using HTTPS.
 - (b) **ssh:** for tasks hosts that block access to the network ports required, cylc can use non-interactive ssh to re-invoke task messaging commands on the suite host (where ultimately HTTPS is still used to connect to the server process).
- 2. **polling:** for task hosts that do not allow return routing to the suite host or ssh, cylc can poll tasks at configurable intervals, using non-interactive ssh.

The remote HTTPS communication method is the default because it is the most direct and efficient; the ssh method inserts an extra step in the process (command re-invocation on the suite host); and task polling is the least efficient because results are checked at predetermined intervals, not when task events actually occur.

13.2.1 Task Polling

Be careful to avoid spamming task hosts with polling commands. Each poll opens (and then closes) a new ssh connection.

Polling intervals are configurable under [runtime] because they should may depend on the expected execution time. For instance, a task that typically takes an hour to run might be polled every 10 minutes initially, and then every minute toward the end of its run. Interval values are used in turn until the last value, which is used repeatedly until finished:

A list of intervals with optional multipliers can be used for both submission and execution polling, although a single value is probably sufficient for submission polling. If these items are not configured default values from site and user global config will be used for the polling task communication method; polling is not done by default under the other task communications methods (but it can still be used if you like).

Polling is also done automatically once on job submission timeout, and multiple times on exceeding the execution time limit, to see if the timed-out task has failed or not; and on suite restarts, to see what happened to any tasks that were orphaned when the suite went down.

13.3 Alternatives To Polling When Routing Is Blocked

If remote ports are blocked and non-interactive ssh doesn't work, but you don't want to use polling from the suite host:

- it has been suggested that network *port forwarding* may provide a solution;
- you may be able to persuade system administrators to provide network routing to one or more dedicated cylc servers;
- it is possible to run cylc itself on HPC login nodes, but depending on what software is installed there this may preclude use of the gcylc GUI and suite visualization tools.

13.4 Task Host Communications Configuration

Here are the default site and user global config items relevant to task state tracking (see these with cylc get-site-config):

```
# SITE AND USER CONFIG
# Task messaging settings affect task-to-suite communications.
[task messaging]
    # If a message send fails, retry after this delay:
    retry interval in seconds = 5
    # If send fails after this many tries, give up trying:
    maximum number of tries = 7
    # This timeout is the same as --comms-timeout for user commands. If
    # set to None (no timeout) messages to non-responsive suites
    # (e.g. suspended with Ctrl-Z) could hang indefinitely.
    connection timeout in seconds = 30
# Setup the communication method details. This is required for
# communications between cylc clients and servers (i.e. between
# suite-connecting commands and guis, and running suite server processes).
[communications]
    # Configure the choice of communication method. Only https is supported
    # at the moment.
# SITE ONLY
    method = https
    # Each suite listens on a dedicated network port. The port to bind to is
    # selected randomly from the allowed range of ports.
# SITE ONLY
    base port = 43001
    # This sets the maximum number of suites that can run at once.
# SITE ONLY
    maximum number of ports = 100
[hosts]
    # The default task host is the suite host, i.e. localhost:
    # Add task host sections if local defaults are not sufficient.
    [[HOST]]
       \mbox{\tt\#} Method of communication of task progress back to the suite:
            1) default - HTTPS via network ports
             2) ssh - re-invoke messaging commands on suite server
             3) poll - the suite polls for status of passive tasks
        # HTTPS comms are still required in all cases *on the suite host*
        # for cylc clients (commands etc.) to communicate with suites.
task communication method = "default" # or "ssh" or "poll"
        # The "poll" method sets a default interval here to ensure no
        # tasks are accidentally left unpolled. You can override this
        # with run-length appropriate intervals under task [runtime]
        # (however this will also result in routine polling under the
        # default or ssh communications).
        default polling interval in minutes = 1.0
```

13.5 How Commands Interact With Running Suites

User-invoked commands that connect to running suites can also choose between direct communication across network sockets (HTTPS) and re-invocation of commands on the suite host using non-interactive ssh (there is a --use-ssh command option for this purpose).

The gcylc GUI requires direct HTTPS connections to its target suite. If that is not possible, run gcylc on the suite host.

13.6 Client Authentication and Passphrases

Suite daemons listen on dedicated network ports for incoming client requests - task messages and user-invoked commands (CLI or GUI). The cylc scan command reveals which suites are running on scanned hosts, and what ports they are listening on.

Client programs have to authenticate with the target suite daemon before issuing commands or requesting information. Cylc has two authentication levels: full control via a suite-specific passphrase (see 13.6.1); and configurable free "public" access (see 13.6.2).

13.6.1 Full Control - Suite Passphrases

A file called passphrase with owner-only permissions is generated under .server/ in the suite run directory at registration time. It is loaded by the suite daemon at start-up and used to authenticate connections from client programs. Suite passphrases are used in an encrypted challenge-response scheme; they are never sent raw over the network.

On submission of the first job on another task host cylc will attempt to install the passphrase to the run directory there to enable task jobs to connect to the suite, using non-interactive ssh.

Client programs on other accounts will attempt to read the passphrase via non-interactive SSH and install it to \$home/.cylc/auth/OWNER@HOST/SUITE/passphrase. Alternatively, if the suite owner gives you the passphrase you can install it yourself to the same location.

13.6.2 Public Access - No Passphrase

Possession of a suite passphrase gives full read and control access to the suite. Without the passphrase the amount of information revealed by a suite daemon is determined by the public access privilege level set in global site/user config (B.15) and optionally overidden in suites (A.2.15):

- identity only suite and owner names revealed
- description identity plus suite title and description
- state-totals identity, description, and task state totals
- full-read full read-only access for monitor and GUI
- shutdown full read access plus shutdown, but no other control.

The default public access level is *state-totals*. The cylc scan command can print descriptions and task state totals in addition to basic suite identity, if you have the right passphrases or if the requested information is revealed publicly.

13.7 How Tasks Get Access To Cylc

Running tasks need access to cylc via \$PATH, principally for the task messaging commands. To allow this, the first thing a task job script does is set \$CYLC_VERSION to the cylc version number of the running suite. If you need to run several suites at once under different incompatible versions of cylc, check that your site is using the cylc version wrapper (see INSTALL and admin/cylc-wrapper in a cylc installation) then set \$CYLC_VERSION to the desired version. In the case of developers wishing to run their own copy of cylc rather than a centrally installed one, set \$CYLC_HOME to point to your cylc copy.

Access to the cylc executable for different hosts can be configured using the site and user global configuration files. If the environment for running the cylc executable is only set up correctly in a login shell for a given host, you can set [hosts][HOST]use login shell = True for the relevant host (this is the default behaviour). If the environment is already correct without the

login shell, but the cylc executable is not in \$PATH, then [hosts][HOST]cylc executable can be used to specify the path to the cylc executable.

To customize the environment more generally for cylc on jobs hosts, use of job-init-env.sh is described in 8.1.1.

13.8 Restarting Suites

A restarted suite (see cylc restart --help) is initialized from a previous recorded checkpoint, which is normally the end of a previous run, so that it can carry on from wherever it got to before being shut down or killed.

13.8.1 Restart From Latest

A normal restart is easy. Simply invoke the cylc restart command with the suite name:

```
$ cylc restart SUITE
```

It will restart the suite from the latest checkpoint.

13.8.2 Restart From Checkpoint

You can use the cylc ls-checkpoints command to identify the checkpoint to use to restart a suite. (See also cylc ls-checkpoints --help.)

The checkpoint ID 0 (zero) is always used for latest state of the suite, which is updated continuously as the suite progresses. The checkpoint IDs of earlier states are positive integers starting from 1, and incremented each time a new checkpoint is stored. Currently suites automatically store checkpoints before and after reloads, and on restarts (using the latest checkpoints before the restarts).

Once you have identified the checkpoint to restart from, invoke the cylc restart command with the suite name and the --checkpoint=CHECKPOINT option:

```
$ cylc restart --checkpoint=CHECKPOINT-ID SUITE
```

13.8.3 Behaviour of Tasks on Restart

All tasks are reloaded in exactly their former states as recorded in checkpoint. Failed tasks, for instance, are not automatically resubmitted at restart in case the underlying problem has not been addressed yet.

Tasks recorded in the submitted or running states are automatically polled on restart, to see if they are still waiting in a batch queue, still running, or if they succeeded or failed while the suite was down.

13.9 Task States

As a suite runs its task proxies may pass through the following states:

- waiting prerequisites not satisfied yet (note that clock-trigger tasks also wait on their trigger time).
- **queued** ready to run (prerequisites satisfied) but temporarily held back by an *internal* cylc queue (see 13.13).
- **held** will not be submitted even if ready to run. Tasks that spawn past the final cycle point are held automatically.

- **ready** ready to run (prerequisites satisfied) and handed to cylc's job submission subsystem.
- **submitted** submitted to run, but not executing yet (could be waiting in an external batch scheduler queue).
- **submit-failed** job submission failed *or* submitted job killed before commencing execution
- **submit-retrying** job submission failed, but a submission retry was configured. Will only enter the *submit-failed* state if all configured submission retries are exhausted.
- **running** currently executing (a *task started* message was received, or the task polled as running).
- **succeeded** finished executing successfully (a *task succeeded* message was received, or the task polled as succeeded).
- **failed** aborted execution due to some error condition (a *task failed* message was received, or the task polled as failed).
- **retrying** job execution failed, but an execution retry was configured. Will only enter the *failed* state if all configured execution retries are exhausted.

Note that greyed-out "base graph nodes" in the gcylc graph view do not represent task states; they are displayed to fill out the graph structure where corresponding task proxies do not currently exist in the live task pool.

For manual task state reset purposes **ready** is a pseudo-state that means waiting with all prerequisites satisfied.

13.10 Remote Control - Passphrases and Network Ports

Connecting to a running suite requires knowing the *network port* it is listening on, and the *suite passphrase* to authenticate with once a connection is made to the port.

Suites write their port number to \$HOME/.cylc/ports/<SUITE> at start-up, and suite-connecting commands read this file to get the number. An exception to this is the messaging commands called by tasks. Running tasks know the port number from the execution environment provided by the suite (via the task job script).

So, to connect to a suite running on another account you must install the suite passphrase (13.6.1), and configure non-interactive ssh so that the port number can be retrieved from the remote port file. Then use the --user and --host command options to connect:

```
$ cylc monitor --user=USER --host=HOST SUITE
```

Alternatively, you can determine suite port numbers using cylc scan, and use them explicitly on the command line:

```
$ cylc monitor --user=USER --host=HOST --port=PORT SUITE
```

Possession of a suite passphrase gives full control over the suite, and ssh access to the port file also implies full access to the suite host account, so it is recommended that this only be used to interact with your own suites running on other hosts. We plan to implement finer-grained authentication in the future to allow suite owners to grant read-only access to others.

13.11 Network Connection Timeouts

A connection timeout can be set in site and user global config files (see 7) so that messaging commands cannot hang indefinitely if the suite is not responding (this can be caused by sus-

⁷If you accidentally delete a port file while a suite is running, use cylc scan to determine the port number then use it on the command line (--port) or rewrite the port file manually.

pending a suite with Ctrl-Z) thereby preventing the task from completing. The same can be done on the command line for other suite-connecting user commands, with the --comms-timeout option.

13.12 Runahead Limiting

Runahead limiting prevents the fastest tasks in a suite from getting too far ahead of the slowest ones. Newly spawned tasks are released to the task pool only when they fall below the runahead limit. A low runhead limit can prevent cylc from interleaving cycles, but it will not stall a suite unless it fails to extend out past a future trigger (see 10.3.5.11). A high runahead limit may allow fast tasks that are not constrained by dependencies or clock-triggers to spawn far ahead of the pack, which could have performance implications for the suite daemon when running very large suites. Succeeded and failed tasks are ignored when computing the runahead limit.

The preferred runahead limiting mechanism restricts the number of consecutive active cycle points. The default value is three active cycle points; see A.3.8. Alternatively the interval between the slowest and fastest tasks can be specified as hard limit; see A.3.7.

13.13 Limiting Active Tasks With Internal Queues

Large suites can potentially overwhelm task hosts by submitting too many tasks at once. You can prevent this with *internal queues*, which limit the number of tasks that can be active (submitted or running) at the some time.

A queue is defined by a *name*; a *limit*, which is the maximum number of active tasks allowed for the queue; and a list of *members*, assigned by task or family name.

Queue configuration is done under the [scheduling] section of the suite.rc file (like dependencies, internal queues constrain when a task runs).

By default every task is assigned to the *default* queue, which by default has a zero limit (interpreted by cylc as no limit). To use a single queue for the whole suite just set the default queue limit:

To use additional queues just name each one, set their limits, and assign members:

```
[scheduling]
        [[ queues]]
              [[[q_foo]]]
              limit = 5
              members = foo, bar, baz
```

Any tasks not assigned to a particular queue will remain in the default queue. The *queues* example suite illustrates how queues work by running two task trees side by side (as seen in the graph GUI) each limited to 2 and 3 tasks respectively:

```
members = n, o, p, FAM2, u, v, w, x, y, z
[[dependencies]]
    graph = """
    a => b & c => FAM1
    n => o & p => FAM2
    FAM1:succeed-all => h & i & j & k & l & m
    FAM2:succeed-all => u & v & w & x & y & z

[runtime]
    [[FAM1, FAM2]]
    [[d,e,f,g]]
        inherit = FAM1
    [[q,r,s,t]]
        inherit = FAM2
```

13.14 Automatic Task Retry On Failure

See also A.4.1.15.6 in the Suite.rc Reference.

Tasks can be configured with a list of "retry delay" periods, as ISO 8601 durations, such that if a task fails it will go into a temporary *retrying* state and then automatically resubmit itself after the next specified delay period expires. A usage example is shown in the suite listed below under 13.15.

13.15 Suite And Task Event Handling

See also A.2.12 and A.4.1.17 in the Suite.rc Reference.

Cylc can call nominated event handlers when certain suite or task events occur. This is intended to facilitate centralized alerting and automated handling of critical events. Event handlers can be used to send a message, call a pager, and so on; or intervene in the operation of their own suite using cylc commands.

To send an email, you can use the built-in setting [[[events]]]mail events to specify a list of events for which notifications should be sent. E.g. to send an email on (submission) failed and retry:

```
[runtime]
    [[foo]]
        retry delays = PTOS, PT30S
        script = "test ${CYLC_TASK_TRY_NUMBER} -eq 3"
        [[[events]]]
        mail events = submission failed, submission retry, failed, retry
```

By default, the emails will be sent to the current user with:

- to: set as \$USER
- from: set as notifications@\$(hostname)
- SMTP server at localhost:25

These can be configured using the settings:

- [[[events]]]mail to (list of email addresses),
- [[[events]]]mail from
- [[[events]]]mail smtp.

Event handler commands can be located in the suite bin/ directory, otherwise it is up to you to ensure their location is in \$PATH (in the shell in which cylc runs, on the suite host). The commands should require very little resource to run and should return quickly. (Each event handler is invoked by a child process in a finite process pool that is also used to submit, poll and kill jobs. The child process will wait for the event handler to complete before moving on to

the next item in the queue. If the process pool is saturated with long running event handlers, the suite will appear to hang.)

Task event handlers can be specified using the [[[events]]] < event > handler settings, where < event > is one of:

- 'submitted' the job submit command was successful
- 'submission failed' the job submit command failed
- 'submission timeout' task job submission timed out
- 'submission retry' task job submission failed, but will retry after a configured delay
- 'started' the task reported commencement of execution
- 'succeeded' the task reported successful completion
- 'warning' the task reported a warning message
- 'failed' the task failed
- 'retry' the task failed but will retry
- 'execution timeout' task execution timed out

The value of each setting should be a list of command lines or command line templates (see below).

Alternatively, task event handlers can be specified using the [[[events]]]handlers and the [[[events]]]handler events settings, where the former is a list of command lines or command line templates (see below) and the latter is a list of events for which these commands should be invoked.

A command line template may have any or all of these patterns which will be substituted with actual values:

- %(event)s: event name
- %(suite)s: suite name
- %(point)s: cycle point
- %(name)s: task name
- %(submit num)s: submit number
- %(id)s: task ID (i.e. %(name)s.%(point)s)
- %(message)s: event message, if any

Otherwise, the command line will be called with the following command line arguments:

```
<task-event-handler> %(event)s %(suite)s %(id)s %(message)s
```

For an explanation of the substitution syntax, see String Formatting Operations in the Python documentation.

The retry event occurs if a task fails and has any remaining retries configured (see 13.14). The event handler will be called as soon as the task fails, not after the retry delay period when it is resubmitted.

Note that event handlers are called by cylc itself, not by the running tasks so if you wish to pass them additional information via the environment you must use [cylc] \rightarrow [[environment]], not task runtime environments.

The following 2 suite.rc snippets are examples on how to specify event handlers using the alternate methods:

```
[runtime]
    [[foo]]
      retry delays = PTOS, PT30S
      script = "test ${CYLC_TASK_TRY_NUMBER} -eq 2"
      [[[events]]]
      retry handler = "echo '!!!!!EVENT!!!!!' "
      failed handler = "echo '!!!!!EVENT!!!!!' "
```

```
[runtime]
    [[foo]]
        retry delays = PTOS, PT30S
        script = "test ${CYLC_TASK_TRY_NUMBER} -eq 2"
        [[[events]]]
        handlers = "echo '!!!!!EVENT!!!!!' "
        handler events = retry, failed

Note: The handler command is called like this:
echo '!!!!!EVENT!!!!!' %(event)s %(suite)s %(id)s %(message)s
```

13.16 Reloading The Suite Definition At Runtime

The cylc reload command reloads the suite definition at run time. This allows: (a) changing task config items such as script or environment; (b) adding tasks to, or removing them from, the suite definition, at run time - without shutting the suite down and restarting it. (It is easy to shut down and restart cylc suites, but reloading may be useful if you don't want to wait for long-running tasks to finish first).

Note that defined tasks can be already be added to or removed from a running suite with the cylc insert and cylc remove commands; the reload command allows addition and removal of task definitions. If a new task is definition is added (and used in the graph) you will still need to manually insert an instance of it (with a particular cycle point) into the running suite. If a task definition (and its use in the graph) is deleted, existing task proxies of the of the deleted type will run their course after the reload but new instances will not be spawned. Changes to a task definition will only take effect when the next task instance is spawned (existing instances will not be affected).

13.17 Handling Job Preemption

Some HPC facilities allow job preemption: the resource manager can kill or suspend running low priority jobs in order to make way for high priority jobs. The preempted jobs may then be automatically restarted by the resource manager, from the same point (if suspended) or requeued to run again from the start (if killed). If a running cylc task gets suspended or hard-killed (kill -9 <PID> is not a trappable signal so cylc cannot detect task failure in this case) and then later restarted, it will just appear to cylc as if it takes longer than normal to run. If the job is soft-killed the signal will be trapped by the task job script and a failure message sent, resulting in cylc putting the task into the failed state. When the preempted task restarts and sends its started message cylc would normally treat this as an error condition (a dead task is not supposed to be sending messages) - a warning will be logged and the task will remain in the failed state. However, if you know that preemption is possible on your system you can tell cylc that affected tasks should be resurrected from the dead, to carry on as normal if progress messages start coming in again after a failure:

```
# ...
[runtime]
    [[HPC]]
        enable resurrection = True
    [[TaskFoo]]
        inherit = HPC
# ...
```

To test this in any suite, manually kill a running task then, after cylc registers the task failed, resubmit the killed job manually by cutting-and-pasting the original job submission command from the suite stdout stream.

13.18 Manual Task Triggering and Edit-Run

Any task proxy currently present in the suite can be manually triggered at any time using the cylc trigger command, or from the right-click task menu in gcylc. If the task belongs to a limited internal queue (see 13.13), this will queue it; if not, or if it is already queued, it will submit immediately.

With cylc trigger --edit (also in the gcylc right-click task menu) you can edit the generated task job script to make one-off changes before the task submits.

13.19 Runtime Settings Broadcast and Communication Between Tasks

The cylc broadcast command overrides [runtime] settings in a running suite. This can be used to communicate information to downstream tasks by broadcasting environment variables (communication of information from one task to another normally takes place via the filesystem, i.e. the input/output file relationships embodied in inter-task dependencies). Variables (and any other runtime settings) may be broadcast to all subsequent tasks, or targeted specifically at a specific task, all subsequent tasks with a given name, or all tasks with a given cycle point; see broadcast command help for details.

Broadcast settings targeted at a specific task ID or cycle point expire and are forgotten as the suite moves on. Un-targeted variables and those targeted at a task name persist throughout the suite run, even across restarts, unless manually cleared using the broadcast command - and so should be used sparingly.

13.20 The Meaning And Use Of Initial Cycle Point

When a suite is started with the cylc run command (cold or warm start) the cycle point at which it starts can be given on the command line or hardwired into the suite.rc file:

```
cylc run foo 20120808T06Z

or:
[scheduling]
   initial cycle point = 20100808T06Z
```

An initial cycle given on the command line will override one in the suite.rc file.

13.20.1 The Environment Variable CYLC_SUITE_INITIAL_CYCLE_POINT

In the case of a *cold start only* the initial cycle point is passed through to task execution environments as \$CYLC_SUITE_INITIAL_CYCLE_POINT. The value is then stored in suite database files and persists across restarts, but it does get wiped out (set to None) after a warm start, because a warm start is really an implicit restart in which all state information is lost (except that the previous cycle is assumed to have completed).

The \$CYLC_SUITE_INITIAL_CYCLE_POINT variable allows tasks to determine if they are running in the initial cold-start cycle point, when different behaviour may be required, or in a normal mid-run cycle point. Note however that an initial R1 graph section is now the preferred way to get different behaviour at suite start-up.

13.21 The Simulation And Dummy Run Modes

Since cylc-4.6.0 any cylc suite can run in *live*, *simulation*, or *dummy* mode. Prior to that release simulation mode was a hybrid mode that replaced real tasks with local dummy tasks. This allowed local simulation testing of any suite, to get the scheduling right without running real

tasks, but running dummy tasks locally does not add much value over a pure simulation (in which no tasks are submitted at all) because all job submission configuration has to be ignored and most task job script sections have to be cut out to avoid any code that could potentially be specific to the intended task host. So at 4.6.0 we replaced this with a pure simulation mode (task proxies go through the *running* state automatically within cylc, and no dummy tasks are submitted to run) and a new dummy mode in which only the real task scripting is dummied out - each dummy task is submitted exactly as the task it represents on the correct host and in the same execution environment. A successful dummy run confirms not only that the scheduling works correctly but also tests real job submission, communication from remote task hosts, and the real task job scripts (in which errors such as use of undefined variables will cause a task to fail).

The run mode, which defaults to *live*, is set on the command line (for run and restart):

```
$ cylc run --mode=dummy SUITE
```

but you can configure the suite to force a particular run mode:

```
[cylc]
    force run mode = simulation
```

This can be used, for example, for demo suites that necessarily run out of their original context; or to temporarily prevent accidental execution of expensive real tasks during suite development.

Dummy mode task scripting just prints a message and sleeps for ten seconds by default, but you can override this behaviour for particular tasks or task groups if you like. Here's how to make a task sleep for twenty seconds and then fail in dummy mode:

```
[runtime]
    [[foo]]
        script = "run-real-task.sh"
        [[[dummy mode]]]
        script = """
echo "hello from dummy task $CYLC_TASK_ID"
sleep 20
echo "ABORTING"
/bin/false"""
```

Finally, in simulation mode each task takes between 1 and 15 seconds to "run" by default, but you can also alter this for particular tasks or groups of tasks:

```
[runtime]
    [[foo]]
        [[[simulation mode]]]
        run time range = PT20S,PT31S # (between 20 and 30 seconds)
```

Note that to get a failed simulation or dummy mode task to succeed on re-triggering, just change the suite.rc file appropriately and reload the suite definition at run time with cylc reload SUITE before re-triggering the task.

Dummy mode is equivalent to removing all user-defined task scripting to expose the default scripting.

13.21.1 Restarting Suites With A Different Run Mode?

The run mode is recorded in the suite run database files. Cylc will not let you restart a non-live mode suite in live mode, or vice versa - any attempt to do the former would certainly be a mistake (because the simulation mode dummy tasks do not generate any of the real outputs depended on by downstream live tasks), and the latter, while feasible, would corrupt the task pool by turning it over to simulation mode. The easiest way to test a live suite in simulation mode, if you don't want to obliterate the current suite run database files by doing a cold or warm start (as opposed to a restart from the previous state) is to take a quick copy of the suite

and run the copy in simulation mode. However, if you really want to run a live suite forward in simulation mode without copying it, do this:

- 1. Back up the live mode suite database files.
- 2. Using the sqlite3 command or otherwise, update the value of run_mode in the suite_params table in the cylc-suite-private.db file.
- 3. Later, restart the live suite from the restored back up.

13.22 Automated Reference Test Suites

Reference tests are finite-duration suite runs that abort with non-zero exit status if any of the following conditions occur (by default):

- cylc fails
- any task fails
- the suite times out (e.g. a task dies without reporting failure)
- a nominated shutdown event handler exits with error status

The default shutdown event handler for reference tests is cylc hook check-triggering which compares task triggering information (what triggers off what at run time) in the test run suite log to that from an earlier reference run, disregarding the timing and order of events - which can vary according to the external queueing conditions, runahead limit, and so on.

To prepare a reference log for a suite, run it with the --reference-log option, and manually verify the correctness of the reference run.

To reference test a suite, just run it (in dummy mode for the most comprehensive test without running real tasks) with the --reference-test option.

A battery of automated reference tests is used to test cylc before posting a new release version. Reference tests can also be used to check that a cylc upgrade will not break your own complex suites - the triggering check will catch any bug that causes a task to run when it shouldn't, for instance; even in a dummy mode reference test the full task job script (sans script items) executes on the proper task host by the proper job submission method.

Reference tests can be configured with the following settings:

```
[cylc]
    [[reference test]]
    suite shutdown event handler = cylc check-triggering
    required run mode = dummy
    allow task failures = False
    live mode suite timeout = PT5M
    dummy mode suite timeout = PT2M
    simulation mode suite timeout = PT2M
```

13.22.1 Roll-your-own Reference Tests

If the default reference test is not sufficient for your needs, firstly note that you can override the default shutdown event handler, and secondly that the --reference-test option is merely a short cut to the following suite.rc settings which can also be set manually if you wish:

```
[cylc]
  abort if any task fails = True
  [[events]]
     shutdown handler = cylc check-triggering
     timeout = PT5M
     abort if shutdown handler fails = True
     abort on timeout = True
```

13.23 Inter-suite Dependence: Triggering Off Task States In Other Suites

The cylc suite-state command interrogates suite run databases. It has a polling mode that waits for a given task in the target suite to achieve a given state. This can be used to make task scripting wait for a remote task to succeed (for example). The suite graph notation also provides a way to define automatic suite-state polling tasks, which use the same polling command under the hood. Note that cylc suite-state can only trigger off task *states* in remote suites and does not support triggering off task messages.

Here's how to trigger a task bar off a task foo in a remote suite called other.suite:

Local task my-foo will poll for the success of foo in suite other suite, at the same cycle point, succeeding only when or if it succeeds. Other task states can also be polled:

```
graph = "my-foo<other.suite::foo:fail> => bar"
```

The default polling parameters (e.g. maximum number of polls and the interval between them) are printed by cylc suite-state --help and can be configured if necessary under the local polling task runtime section:

For suites owned by others, or those with run databases in non-standard locations, use the --run-dir option, or in-suite:

```
[runtime]
     [[my-foo]]
          [[[suite state polling]]]
          run-dir = /path/to/top/level/cylc/run-directory
```

If the remote task has a different cycling sequence, just arrange for the local polling task to be on the same sequence as the remote task that it represents. For instance, if local task cat cycles 6-hourly at 0,6,12,18 but needs to trigger off a remote task dog at 3,9,15,21:

For suite-state polling the cycle point of the target task is treated as a literal string so the polling command has to be told if the remote suite has a different cycle point format. Use the --template option for this, or in-suite:

```
[runtime]
    [[my-foo]]
    [[[suite state polling]]]
        template = %Y-%m-%dT%H
```

Note that the remote suite does not have to be running when polling commences because the command interrogates the suite run database, not the suite server process.

14 Other Topics In Brief

The following topics have yet to be documented in detail.

- Intervening in suites, e.g. stopping, removing, inserting tasks: see cylc control help.
- Interrogating suites and tasks: see cylc info help, cylc show help, and cylc discovery help.
- Understanding suite evolution, particularly in delayed/catchup operation: the Tutorial helps here (8), along with running the example suites.
- Task insertion (add a new task proxy instance to a running suite): see cylc insert --help.
- Sub-suites: to run another suite inside a task, just invoke the sub-suite, with appropriate start and end cycle points (probably a single cycle point), via the host task's script item:

```
[runtime]
    [[foo]]
        script = \
"cylc run SUITE $CYLC_TASK_CYCLE_POINT --until=$CYLC_TASK_CYCLE_POINT"
```

15 Suite Storage, Discovery, Revision Control, and Deployment

Small groups of cylc users can of course share suites by manual copying, and generic revision control tools can be used on cylc suites as for any collection of files. Beyond this cylc does not have a built-in solution for suite storage and discovery, revision control, and deployment, on a network. That is not cylc's core purpose, and large sites may have preferred revision control systems and suite meta-data requirements that are difficult to anticipate. We can, however, recommend the use of *Rose* to do all of this very easily and elegantly with cylc suites.

15.1 Rose

Rose is a framework for managing and running suites of scientific applications, developed at the UK Met Office for use with cylc. It is available under the open source GPL license.

- Rose documentation: http://metomi.github.io/rose/doc/rose.html
- Rose source repository: https://github.com/metomi/rose

16 Suite Design Principles

16.1 Make Fine-Grained Suites

A suite can contain a small number of large, internally complex tasks; a large number of small, simple tasks; or anything in between. Cylc can easily handle a large number of tasks, however, so there are definite advantages to fine-graining:

- A more modular and transparent suite.
- More functional parallelism (multiple tasks running at once).
- Faster debugging and failure recovery: rerun just the tasks(s) that failed.
- More code reuse: similar tasks may be able to call the same underlying script or command with differing input parameters.

16.2 Make Tasks Re-runnable

It should be possible to rerun a task by simply resubmitting it for the same cycle point. In other words, failure at any point during execution of a task should not render a rerun impossible by corrupting the state of some internal-use file, or whatever. It is difficult to overstate the usefulness of being able to rerun the same task multiple times, either outside of the suite with cylc submit, or by re-triggering it within the running suite, when debugging a problem.

16.3 Make Models Re-runnable

If a warm-cycled model uses the exact same file names for its restart files regardless of current cycle point, the only cycle point that can subsequently run successfully is the next one. Instead, restart files should be labelled with current cycle point and maintained in a simple rolling archive. Then you can easily rerun the task for any cycle point still in the archive.

16.4 Avoid False Dependence

If a task does not depend on files generated by another task then generally speaking it should not trigger off that task in the suite scheduling graph. Unnecessary dependence between tasks restricts functional parallelism at run time, and it makes the suite more difficult to understand. If you need to restrict the number of tasks that are active at once, use runahead limiting (13.12) and internal queues (13.13).

16.5 Put Task Cycle Point In Output File Paths

Putting task cycle point in output file or directory names makes archiving and cleanup easier, and it facilitates re-runnability by ensuring that important files do not get overwritten from one cycle to the next.

The cycle cycle-point command computes offsets from a given or current cycle point, and can insert the resulting computed date-time into a filename template string.

16.6 Managing Input/Output File Dependencies

Dependence between tasks usually, although not always, take the form of files generated by one task and used by others. It is possible to manage these files across a suite without compromising suite flexibility and portability with hard wired I/O locations.

16.6.1 Common I/O Workspaces

You may be able to have all tasks, or groups of tasks that need to cooperate, read and write from a common workspace, thereby avoiding the need to explicitly move files around. The suite share directory (\$CYLC_SUITE_SHARE_DIR) is provided for this purpose. Similarly, task work directories are private to each task by default but they can be shared to allow multiple tasks to simply read and write from their current working directory. Even if you use other custom I/O directories, define their locations in the suite.rc file rather than hard wiring them into task implementation. Shared workspace locations can be passed to tasks as needed without modifying the task implementation, like this:

```
script = generate-data.exe
[[[environment]]]
    MY_OUTPUT_DIR = $WORKDIR
[[bar]]
    inherit = SHARE
    script = use-data.exe
[[[environment]]]
        MY_INPUT_DIR = $WORKDIR
```

16.6.2 Connector Tasks

Special tasks can be used to move files around, from one task's output directory to another's input directory. This should only be necessary across host or filesystem boundaries, however; otherwise simply reference shared locations as shown above.

16.7 Reuse Task Implementation

If your suite contains multiple logically distinct tasks that have similar functionality (e.g. tasks that move files around or generate similar products from different datasets) just have them all call the same underlying command, script, or executable, but provide different input parameters as required.

16.8 Make Suites Portable

If all I/O is automatically done in suite-specific locations, such as the under suite share and work directories (\$CYLC_SUITE_SHARE_DIRECTORY and \$CYLC_TASK_WORK_DIRECTORY), you should be able to run multiple copies of the same suite without interference between them, and other users should be able to copy and run your suites with minimal modification.

16.9 Make Tasks As Independent As Possible

Where possible a task should not rely on the action of another task, except for the inputs embodied in the suite dependency graph that it has no choice but to depend on. This makes it as easy as possible to run single tasks alone during suite development and debugging. For example, tasks should create their own output directories if necessary rather than assuming their existence due to the action of another task. Note that if the existing task implementation does not handle output directory creation you can do it in suite pre-script or similar.

16.10 Make Suites As Self-Contained As Possible

Tasks can (of course) run external commands, scripts, and executables; and they can read or otherwise make use of external files. In some cases this may be necessary, but it does leave suites vulnerable to external breakages. Alternatively, suites can be more or less completely self-contained (aside from exposure to network, filesystem, and OS problems) if they have private copies of every file they need at run time. Tasks can access files stored under their suite definition directory via \$CYLC_SUITE_DEF_PATH, and the suite bin directory is automatically added to \$PATH in the task execution environment. If you have multiple suites there may be a tradeoff between self-containment and duplication of files, but this does not particularly matter if you can automatically extract, build, and install suite files from external repositories prior to, or at the start of, a suite run.

16.10.1 Distinguish Between Source and Installed Suites

A suite definition and any files stored with it should be version controlled, and a particular revision extracted before a run. The extracted source suite will be a repository clone or working copy, depending on your choice of revision control software, and can be used for further development. The source files should then be *installed* to another location where the suite will actually be executed (the cylc suite run directory is ideal for this). External files may also be installed into the suite at this time, prior to the run, or by special deployment tasks that run at suite start-up. This makes self-containment easier to achieve, and the clean separation of source and installed suite allows further development without breaking a running suite. Rose (15.1) supports this mode of working with cylc suites.

16.11 Orderly Product Generation?

Correct scheduling is not necessarily equivalent to orderly generation of products in strict datetime order. Under cylc a product generation task will trigger as soon as its private prerequisites are satisfied regardless of whether other tasks at the same cycle point have finished or have yet to run. If your product presentation system demands that all products are uploaded in order, then be aware that this may be quite inefficient if your suite ever has to catch up from a delay or run over historical data, but if necessary you can force tasks to run in the right order even if their true dependencies do not require that. One way to do this is to declare the product upload task to be *sequential*, which is equivalent to making it depend on its own previous instance (see 10.3.5.12).

16.12 Use Of Clock-Trigger Tasks

Tasks that wait on external real time data should have a clock-trigger to delay submission until roughly the expected time of data availability (see 10.3.5.14), otherwise they could clutter up your batch scheduler queue by submitting hours earlier. Similarly, suite polling tasks (for intersuite dependence in real time operation) should use a clock-trigger to delay their submission until the expected time of the remote suite event.

16.13 Tasks That Wait On Something

Some tasks wait on external events and therefore need to repeatedly check and wait for the event before reporting eventual success (or perhaps failure after a timeout). For example, a task that waits for a file to appear on an ftp server. Typically these should be clock-trigger tasks (see above), but once triggered there are two ways to handle the repeated checking: the task itself could implement a check-and-wait loop; or you could just configure multiple retries for the task (see 13.14).

16.14 Do Not Treat Real Time Operation As Special

Cylc suites, without modification, can handle real time and delayed operation equally well. In caught-up real time operation, clock-trigger tasks constrain the behaviour of the whole suite, or at least of any tasks downstream of them in the dependency graph. In delayed or historical operation clock-trigger tasks will not constrain the suite at all, and cylc's cycle point interleaving abilities come to the fore, because the clock-trigger times have already passed. But if a clock-trigger task catches up to the wall clock, it will automatically wait again. In this way cylc suites naturally transition between delayed and real time operation as required.

16.15 Factor Out Common Configuration

To help avoid suite maintenance errors in the future, properties shared by multiple tasks (job submission settings, environment variables, scripting, etc.) should be defined only once, using runtime inheritance (10.4) or Jinja2 variables (10.7).

Multiple inheritance is efficient when tasks share many properties, but Jinja2 variables may be preferred when a small number of properties are shared by tasks that don't have anything else in common (e.g. a single environment variable for the location of a shared file).

For environment variables in particular it may be tempting to define all variables for all tasks once under [root], but this is analogous to overuse of global variables in programming and it can make it difficult to determine which variables matter to which tasks. Environment filters (A.4.1.19) can be used to make this safer, but generally it is best to provide each task with only the variables that it needs. It is difficult to be sure if a task really needs a variable that is passed to it, but you can be sure that it does not use a variable that is not passed to it.

Finally, Jinja2 can also be used to avoid polluting task environments with variables used for the sole purpose of deriving other variables at task run time. Instead of this:

If the values of these Jinja2 variables are needed in external scripts, just translate them directly in environment sections:

```
[[[environment]]]
   OUTPUT_DIR = {{ OUTPUT_DIR }}
```

16.16 Use The Graph For Scheduling

If you find yourself writing runtime scripting to change a task's behaviour in some cycle points, consider that the graph is usually the proper place to express this sort of thing. Use different task names, but have them inherit common properties to avoid duplication. Instead of this:

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do this:

```
[scheduling]
    [[dependencies]]
        [[[T00,T12]]]
            graph = "foo => shout_dog => baz"
        [[[T06,T18]]]
            graph = "foo => shout_fox => baz"
[runtime]
    [[SHOUT]]
        # (... other config...)
        script = "echo $SENTENCE"
    [[shout_fox]]
        inherit = SHOUT
        [[[environment]]]
            SENTENCE =
                        "the quick brown fox"
    [[shout_dog]]
        inherit = SHOUT
        [[[environment]]]
            SENTENCE = "the lazy dog"
```

Similarly, if your task has a different behaviour at the initial or final cycle point, consider using an R1 syntax to separate out the functionality.

16.17 Use Suite Visualization

Effective visualization can make complex suites easier to understand. Collapsible task families for visualization are defined by the *first parents* in the runtime namespace hierarchy. Tasks should generally be grouped into visualization families that reflect their purpose within the structure of the suite rather than technical detail such as common job submission method or task host. This often coincides nicely with common configuration inheritance requirements, but if it doesn't you can use an empty namespace as a first parent for visualization:

17 Style Guide

[runtime]

Good style is to some extent a matter of taste. That said, for collaborative development of complex systems it is important to settle on a clear and consistent style, and you may find the following suggestions useful. Note that the boundary between this section (style) and the previous (design) is somewhat arbitrary.

17.1 Indentation

The suite.rc file format consists of item = value pairs under nested section headings. Clear indentation is the best way to show local nesting level inside large blocks.

• Indent suite.rc syntax four spaces per nesting level.

```
[SECTION]
    title = the quick brown fox
    [[SUBSECTION]]
        a short item = value1
        a very very long item = value2
```

17 STYLE GUIDE 17.1 Indentation

Don't align item = value pairs on the = character - this does not show nesting level clearly and it pushes everything off to the right:

The following layout does preserve proper indentation on the left, but the whole block may need reformatting after changing one line, which pollutes your revision history with spurious changes:

- Set your text editor to convert *TAB characters* to spaces tabs may be displayed differently in different editors, so a mixture of space and tab indentations can render to a mess.
- *Line comments* should be indented to the same level as the section or item they refer to. Consistent local indentation makes block re-indentation operations easier in text editors.
- *script strings* are interpreted by the associated task job script, not by cylc, so strictly speaking their internal lines should not be indented as if part of the suite.rc syntax. This, for example:

```
[runtime]
    [[foo]]
        script = \
"""echo Hello World!
echo Goodbye World!"""

is preferred over this (or similar):

[runtime]
    [[foo]]
        script ="""
        echo Hello World!
        echo Goodbye World!
```

The extra whitespace here translates directly to spurious indentation in the task job script. As it happens this is just an aesthetic problem in bash scripts, but for Python job scripts (which cylc may support in the future) it would be a technical error.

• The positioning of string-delimiting triple quotes is of no practical consequence either, but the following forms are suggested for the same reason - to avoid including spurious whitespace in the string:

• Multiline dependency graph strings have no meaning outside of the suite definition, so they can be free-form in order to most clearly present the structure of the suite:

```
[scheduling]
    [[dependencies]]
        graph = """
    foo => bar => baz => qux
```

17 STYLE GUIDE 17.2 Comments

```
# failure recovery:
qux:fail => recover
```

• Embedded *Jinja2* code is not part of the suite.rc syntax, so it should be indented from the left margin on its own terms.

```
[[OPS]]
{% for T in OPS_TASKS %}
    [[ops_{{T}}]]
         inherit = OPS
         # ...
{% endfor %}
```

17.2 Comments

Comments should be *minimal*, but not too minimal. If context and clear item names will do, leave it at that. Extremely verbose comments tend to be neglected and eventually get out of sync with the code, a result that may be worse than having no comments at all.

- Indent line comments to section or item level, as described above.
- Avoid *numbered comments* future changes can create a renumbering nightmare.
- Avoid full page width "section divider" comments these assume a particular line width, which can be a problem for text editors that auto line break on a smaller line width.
- Use the title and description items instead of comments to describe tasks and families under [runtime] these get displayed by mouse hover in gcylc.

17.3 Line Length

Keep to the standard maximum line length of 79 characters where possible. Very long lines affect readability, may pose a problem for auto-line-breaking in text editors, and make side-by-side diff display less effective.

• Line continuation markers can be used anywhere to break up long lines:

Graph lines can also be split up without line breaks, like this:

17.4 Task Naming Convention

Use UPPERCASE_NAMES for families and lowercase_names for tasks, so that you can tell which is which at a glance.

• Put the most general components of task names first, for natural grouping in the GUI (under alphanumeric sorting) and in listings, e.g. obsproc_sonde, obsproc_radar.

17.5 Inlined Task Scripting

Trivial task scripting may be inlined in the suite definition but anything more should be written to a script file. This keeps the suite definition tidy, it allows proper shell-mode text editing, and it allows separate command line testing of the script during development or debugging.

A Suite.rc Reference

This appendix defines all legal suite definition config items. Embedded Jinja2 code (see 10.7) must process to a valid raw suite.rc file. See also 10.2 for a descriptive overview of suite.rc files, including syntax (10.2.1).

A.1 Top Level Items

The only top level configuration items at present are the suite title and description.

A.1.1 title

A single line description of the suite. It is displayed in the db viewer window and can be retrieved at run time with the cylc show command.

• *type:* single line string

• default: (none)

A.1.2 description

A multi-line description of the suite. It can be retrieved by the db viewer right-click menu, or at run time with the cylc show command.

• type: multi-line string

• default: (none)

A.1.3 group

A single line group name for a suite. It is displayed in the gscan window and can be used as a way of grouping related suites together. cylc show command.

• type: single line string

• default: (none)

A.1.4 URL

A web URL to suite documentation. If present it can be browsed with the cylc doc command, or from the gcylc Suite menu. The variable \${CYLC_SUITE_NAME} will be replaced with the actual suite name (note this is not a shell environment variable in this context). See also task URLs (A.4.1.4).

• type: string (URL)

• default: (none)

• example: http://suites/\${CYLC_SUITE_NAME}/index.html

A.2 [cylc]

This section is for configuration that is not specifically task-related.

A.2.1 [cylc] \rightarrow required run mode

If this item is set cylc will abort if the suite is not started in the specified mode. This can be used for demo suites that have to be run in simulation mode, for example, because they have been taken out of their normal operational context; or to prevent accidental submission of expensive real tasks during suite development.

• type: string

• legal values: live, dummy, simulation

• default: None

A.2.2 [cylc] \rightarrow UTC mode

Cylc runs off the suite host's system clock by default. This item allows you to run the suite in UTC even if the system clock is set to local time. Clock-trigger tasks will trigger when the current UTC time is equal to their cycle point date-time plus offset; other time values used, reported, or logged by the suite daemon will usually also be in UTC. The default for this can be set at the site level (see B.14.1).

• type: boolean

• default: False, unless overridden at site level.

A.2.3 [cylc] \rightarrow cycle point format

To just alter the timezone used in the date/time cycle point format, see A.2.5. To just alter the number of expanded year digits (for years below 0 or above 9999), see A.2.4.

Cylc usually uses a CCYYMMDDThhmmZ (z in the special case of UTC) or CCYYMMDDThhmm+hhmm format (+ standing for + or - here) for writing down date/time cycle points, which follows one of the basic formats outlined in the ISO 8601 standard. For example, a cycle point on the 3rd of February 2001 at 4:50 in the morning, UTC (+0000 timezone), would be written 20010203T0450Z. Similarly, for the the 3rd of February 2001 at 4:50 in the morning, +1300 timezone, cylc would write 20010203T0450+1300.

You may use the isodatetime library's syntax to write dates and times in ISO 8601 formats - cc for century, YY for decade and decadal year, +X for expanded year digits and their positive or negative sign, thereafter following the ISO 8601 standard example notation except for fractional digits, which are represented as ,ii for hh, ,nn for mm, etc. For example, to write date/times as week dates with fractional hours, set cycle point format to CCYYWwwDThh,iiZ e.g. 1987W041T08,5Z for 08:30 UTC on Monday on the fourth ISO week of 1987.

You can also use a subset of the strptime/strftime POSIX standard - supported tokens are %F, %H, %M, %S, %Y, %d, %j, %m, %s, %z.

To use the old cylc date-time format (e.g. 2014020106 for 06:00 on the 1st of February 2014), set cycle point format to \%Y\%m\%d\%H.

Please note that using characters like "/" is not allowed, as it will break task output files ("/" is a reserved character in POSIX file and directory naming). Using ":" is also not allowed, as it is likely to interfere with usage of commands like "rsync" when applied to task output files.

A.2.4 $[cylc] \rightarrow cycle$ point num expanded year digits

For years below 0 or above 9999, the ISO 8601 standard specifies that an extra number of year digits and a sign should be used. This extra number needs to be written down somewhere (here).

For example, if this extra number is set to 2, 00Z on the 1st of January in the year 10040 will be represented as +0100400101T0000Z (2 extra year digits used). With this number set to 3, 06Z on the 4th of May 1985 would be written as +00019850504T0600Z.

This number defaults to 0 (no sign or extra digits used).

A.2.5 [cylc] \rightarrow cycle point time zone

If you set UTC mode to True (A.2.2) then this will default to z. If you use a custom cycle point format (A.2.3), you should specify the timezone choice (or null timezone choice) here as well.

You may set your own time zone choice here, which will be used for all date/time cycle point dumping. Time zones should be expressed as ISO 8601 time zone offsets from UTC, such as +13, +1300, -0500 or +0645, with z representing the special +0000 case. Cycle points will be converted to the time zone you give and will be represented with this string at the end.

Cycle points that are input without time zones (e.g. as an initial cycle point setting) will use this time zone if set. If this isn't set (and UTC mode is also not set), then they will default to the current local time zone.

Note that the ISO standard also allows writing the hour and minute separated by a ":" (e.g. +13:00) - however, this is not recommended, given that the time zone is used as part of task output filenames.

A.2.6 [cylc] \rightarrow abort if any task fails

Cylc does not normally abort if tasks fail, but if this item is turned on it will abort with exit status 1 if any task fails.

type: boolean default: False

A.2.7 [cylc] \rightarrow health check interval

Specify an time interval when a running cylc suite will attempt to check that its run directory and port file exist, and that the port file contains the expected information. If the suite run directory is not found or if the port file is removed or modified, the suite will shut itself down automatically.

- type: ISO 8601 duration/interval representation (e.g. PT5M, 5 minutes (note: by contrast, P5M means 5 months, so remember the T!)).
- default: PT10M

A.2.8 [cylc] \rightarrow disable automatic shutdown

This has the same effect as the --no-auto-shutdown flag for the suite run commands: it prevents the suite daemon from shutting down normally when all tasks have finished (a suite timeout can still be used to stop the daemon after a period of inactivity, however). This option can make it easier to re-trigger tasks manually near the end of a suite run, during suite development and debugging.

type: boolean default: False

A.2.9 [cylc] \rightarrow log resolved dependencies

If this is turned on cylc will write the resolved dependencies of each task to the suite log as it becomes ready to run (a list of the IDs of the tasks that actually satisfied its prerequisites at run time). Mainly used for cylc testing and development.

type: boolean default: False

A.2.10 [cylc] \rightarrow parameters

Define parameter values here for use in expanding parameterized tasks - see Section 10.6.

- type: list of strings, or an integer range LOWER..UPPER (two dots, inclusive bounds)
- default: (none)
- examples:

```
- run = control, test1, test2

- mem = 1..5 (equivalent to 1, 2, 3, 4, 5).
```

A.2.11 [cylc] \rightarrow parameter templates

Parameterized task names (see previous item, and Section 10.6) are expanded, for each parameter value, using string templates. You can assign templates to parameter names here, to override the default templates.

- type: a Python-style string template
- default for an integer-valued parameter p: _p%(p)s e.g. foo<run> becomes foo_run3 for run value 3.
- default for a non integer-valued parameter p: _%(p)s e.g. foo<run> becomes foo_top for run value top.
- example: run = -R%(run)s e.g. foo<run> becomes foo-R3 for run value 3.

Note that the values of a parameter named p are substituted for %(p)s. The s indicates a string value and should be used even for integer-valued parameters, because cylc converts integer parameter values to strings, with (depending on size) zero-padding. In _run%(run)s the first "run" is a string literal, and the second gets substituted with each value of the parameter.

A.2.12 [cylc] \rightarrow [[events]]

Cylc has internal "hooks" to which you can attach handlers that are called by the suite daemon whenever certain events occur. This section configures suite event hooks; see A.4.1.17 for task event hooks.

Event handler commands can send an email or an SMS, call a pager, intervene in the operation of their own suite, or whatever. They can be held in the suite bin directory, otherwise it is up to you to ensure their location is in \$PATH (in the shell in which cylc runs, on the suite host). The commands should require very little resource to run and should return quickly.

Each event handler can be specified as a list of command lines or command line templates. A command line template may have any or all of these patterns which will be substituted with actual values:

- %(event)s: event name (see below)
- %(suite)s: suite name
- %(message)s: event message, if any

Otherwise, the command line will be called with the following command line arguments:

```
<suite-event-handler> %(event)s %(suite)s '%(message)s'
```

Additional information can be passed to event handlers via $[cylc] \rightarrow [[environment]]$.

A.2.12.1 [cylc] \rightarrow [[events]] \rightarrow EVENT handler

A comma-separated list of one or more event handlers to call when one of the following EVENTs occurs:

- startup the suite has started running
- shutdown the suite is shutting down
- timeout the suite has timed out
- stalled the suite has stalled
- inactivity the suite is inactive

Default values for these can be set at the site level via the siterc file (see B.14.3). Item details:

- type: string (event handler script name)
- default: None, unless defined at the site level.
- example: startup handler = my-handler.sh

A.2.12.2 [cylc] \rightarrow [[[events]]] \rightarrow handlers

Specify the general event handlers as a list of command lines or command line templates.

- type: Comma-separated list of strings (event handler command line or command line templates).
- default: (none)
- example: handlers = my-handler.sh

A.2.12.3 [cylc] \rightarrow [[events]] \rightarrow handler events

Specify the events for which the general event handlers should be invoked.

- type: Comma-separated list of events
- default: (none)
- example: handler events = timeout, shutdown

A.2.12.4 [cylc] \rightarrow [[events]] \rightarrow mail events

Specify the suite events for which notification emails should be sent.

- type: Comma-separated list of events
- default: (none)
- example: handler = startup, shutdown, timeout

A.2.12.5 [cylc] \rightarrow [[events]] \rightarrow mail footer

Specify a string or string template to insert to footers of notification emails for both suite events and task events.

A template string may have any or all of these patterns which will be substituted with actual values:

- %(host)s: suite host name
- %(port)s: suite port number
- %(owner)s: suite owner name
- %(suite)s: suite name
- type:
- default: (none)
- example: mail footer = see: http://localhost/%(owner)s/notes-on/%(suite)s/

A.2.12.6 [cylc] \rightarrow [[events]] \rightarrow mail from

Specify an alternate from: email address for suite event notifications.

- type: string
- default: None, (notifications@HOSTNAME)
- example: mail from = no-reply@your-org

$A.2.12.7 \quad [cylc] \rightarrow [[events]] \rightarrow mail \ smtp$

Specify the SMTP server for sending suite event email notifications.

- type: string
- default: None, (localhost:25)
- example: mail smtp = smtp.yourorg

A.2.12.8 [cylc] \rightarrow [[events]] \rightarrow mail to

A list of email addresses to send suite event notifications. The list can be anything accepted by the mail command.

- type: string
- default: None, (USER@HOSTNAME)
- example: mail to = your.colleague

A.2.12.9 [cylc] \rightarrow [[events]] \rightarrow timeout

If a timeout is set and the timeout event is handled, the timeout event handler(s) will be called if the suite stays in a stalled state for some period of time. The timer is set initially at suite start up. It is possible to set a default for this at the site level (see B.14.3).

- type: ISO 8601 duration/interval representation (e.g. PT5S, 5 seconds, PT1S, 1 second) minimum 0 seconds.
- default: (none), unless set at the site level.

A.2.12.10 [cylc] \rightarrow [[events]] \rightarrow inactivity

If inactivity is set and the inactivity event is handled, the inactivity event handler(s) will be called if there is no activity in the suite for some period of time. The timer is set initially at suite start up. It is possible to set a default for this at the site level (see B.14.3).

- type: ISO 8601 duration/interval representation (e.g. PT5S, 5 seconds, PT1S, 1 second) minimum 0 seconds.
- default: (none), unless set at the site level.

A.2.12.11 [cylc] \rightarrow [[events]] \rightarrow reset timer

If True (the default) the suite timer will continually reset after any task changes state, so you can time out after some interval since the last activity occured rather than on absolute suite execution time.

type: boolean default: True

A.2.12.12 [cylc] \rightarrow [[events]] \rightarrow abort on stalled

If this is set to True it will cause the suite to abort with error status if it stalls. A suite is considered "stalled" if there are no active, queued or submitting tasks or tasks waiting for clock triggers to be met. It is possible to set a default for this at the site level (see B.14.3).

- type: boolean
- default: False, unless set at the site level.

A.2.12.13 [cylc] \rightarrow [[events]] \rightarrow abort on timeout

If a suite timer is set (above) this will cause the suite to abort with error status if the suite times out while still running. It is possible to set a default for this at the site level (see B.14.3).

- type: boolean
- default: False, unless set at the site level.

A.2.12.14 [cylc] \rightarrow [[events]] \rightarrow abort on inactivity

If a suite inactivity timer is set (above) this will cause the suite to abort with error status if the suite is inactive for some period while still running. It is possible to set a default for this at the site level (see B.14.3).

- type: boolean
- default: False, unless set at the site level.

A.2.12.15 [cylc] \rightarrow [[events]] \rightarrow abort if EVENT handler fails

Cylc does not normally care whether an event handler succeeds or fails, but if this is turned on the EVENT handler will be executed in the foreground (which will block the suite while it is running) and the suite will abort if the handler fails.

type: boolean default: False

A.2.13 [cylc] \rightarrow [[environment]]

Environment variables defined in this section are passed to suite and task event handlers.

- These variables are not passed to tasks use task runtime variables for that. Similarly, task runtime variables are not available to event handlers which are executed by the suite daemon, (not by running tasks) in response to task events.
- Cylc-defined environment variables such as \$CYLC_SUITE_RUN_DIR are not passed to task event handlers by default, but you can make them available by extracting them to the cylc environment like this:

```
[cylc]
    [[environment]]
        CYLC_SUITE_RUN_DIR = $CYLC_SUITE_RUN_DIR
```

• These variables - unlike task execution environment variables which are written to job scripts and interpreted by the shell at task run time - are not interpreted by the shell prior to use so shell variable expansion expressions cannot be used here.

$A.2.13.1 \quad [cylc] \rightarrow [[environment]] \rightarrow __VARIABLE__$

Replace ___VARIABLE___ with any number of environment variable assignment expressions. Values may refer to other local environment variables (order of definition is preserved) and are not evaluated or manipulated by cylc, so any variable assignment expression that is legal in the shell in which cylc is running can be used (but see the warning above on variable expansions, which will not be evaluated). White space around the '=' is allowed (as far as cylc's file parser is concerned these are just suite configuration items).

```
type: string
default: (none)
examples:
FOO = $HOME/foo
```

A.2.14 [cylc] \rightarrow [[reference test]]

Reference tests are finite-duration suite runs that abort with non-zero exit status if cylc fails, if any task fails, if the suite times out, or if a shutdown event handler that (by default) compares the test run with a reference run reports failure. See 13.22.

A.2.14.1 [cylc] \rightarrow [[reference test]] \rightarrow suite shutdown event handler

A shutdown event handler that should compare the test run with the reference run, exiting with zero exit status only if the test run verifies.

- type: string (event handler command name or path)
- default: cylc hook check-triggering

As for any event handler, the full path can be ommitted if the script is located somewhere in \$PATH or in the suite bin directory.

A.2.14.2 [cylc] \rightarrow [[reference test]] \rightarrow required run mode

If your reference test is only valid for a particular run mode, this setting will cause cylc to abort if a reference test is attempted in another run mode.

- type: string
- legal values: live, dummy, simulation
- default: None

A.2.14.3 [cylc] \rightarrow [[reference test]] \rightarrow allow task failures

A reference test run will abort immediately if any task fails, unless this item is set, or a list of expected task failures is provided (below).

type: boolean default: False

A.2.14.4 [cylc] \rightarrow [[reference test]] \rightarrow expected task failures

A reference test run will abort immediately if any task fails, unless *allow task failures* is set (above) or the failed task is found in a list IDs of tasks that are expected to fail.

- type: Comma-separated list of strings (task IDs: name.cycle_point).
- default: (none)
- example: foo.20120808, bar.20120908

A.2.14.5 $[\text{cylc}] \rightarrow [[\text{reference test}]] \rightarrow \text{live mode suite timeout}$

The timeout value, expressed as an ISO 8601 duration/interval, after which the test run should be aborted if it has not finished, in live mode. Test runs cannot be done in live mode unless you define a value for this item, because it is not possible to arrive at a sensible default for all suites.

- type: ISO 8601 duration/interval representation, e.g. PT5M is 5 minutes (note: by contrast P5M means 5 months, so remember the T!).
- default: PT1M (1 minute)

A.2.14.6 [cylc] \rightarrow [[reference test]] \rightarrow simulation mode suite timeout

The timeout value in minutes after which the test run should be aborted if it has not finished, in simulation mode. Test runs cannot be done in simulation mode unless you define a value for this item, because it is not possible to arrive at a sensible default for all suites.

- type: ISO 8601 duration/interval representation (e.g. PT5M, 5 minutes (note: by contrast, P5M means 5 months, so remember the T!)).
- default: PT1M (1 minute)

A.2.14.7 $[\text{cylc}] \rightarrow [[\text{reference test}]] \rightarrow \text{dummy mode suite timeout}$

The timeout value, expressed as an ISO 8601 duration/interval, after which the test run should be aborted if it has not finished, in dummy mode. Test runs cannot be done in dummy mode unless you define a value for this item, because it is not possible to arrive at a sensible default for all suites.

- type: ISO 8601 duration/interval representation (e.g. PT5M, 5 minutes (note: by contrast, P5M means 5 months, so remember the T!)).
- default: PT1M (1 minute)

A.2.15 [cylc] \rightarrow [[authentication]]

Authentication of client programs with suite daemons can be set in the global site/user config files and overridden here if necessary. See B.15 for more information.

A.2.15.1 [cylc] \rightarrow [[authentication]] \rightarrow public

The client privilege level granted for public access - i.e. no suite passphrase required. See B.15 for legal values.

A.3 [scheduling]

This section allows cylc to determine when tasks are ready to run.

A.3.1 [scheduling] \rightarrow cycling mode

Cylc runs using the proleptic Gregorian calendar by default. This item allows you to either run the suite using the 360 day calendar (12 months of 30 days in a year) or using integer cycling.

- type: string
- legal values: gregorian, 360day, integer
- default: gregorian

A.3.2 [scheduling] \rightarrow initial cycle point

In a cold start each cycling task (unless specifically excluded under [special tasks]) will be loaded into the suite with this cycle point, or with the closest subsequent valid cycle point for the task. This item can be overridden on the command line or in the gcylc suite start panel.

In date-time cycling, if you do not provide time zone information for this, it will be assumed to be local time, or in UTC if A.2.2 is set, or in the time zone determined by A.2.5 if that is set.

- type: ISO 8601 date/time point representation (e.g. ccyymmddthhmm, 19951231T0630) or "now".
- default: (none)

The string "now" converts to the current date-time on the suite host (adjusted to UTC if the suite is in UTC mode but the host is not) to minute resolution. Minutes (or hours, etc.) may be ignored depending on your cycle point format (A.2.3).

A.3.3 [scheduling] \rightarrow final cycle point

Cycling tasks are held once they pass the final cycle point, if one is specified. Once all tasks have achieved this state the suite will shut down. If this item is provided you can override it on the command line or in the gcylc suite start panel.

In date-time cycling, if you do not provide time zone information for this, it will be assumed to be local time, or in UTC if A.2.2 is set, or in the A.2.5 if that is set.

- type: ISO 8601 date/time point representation (e.g. CCYYMMDDThhmm, 19951231T1230) or ISO 8601 date/time offset (e.g. +P1D+PT6H)
- default: (none)

A.3.4 [scheduling] \rightarrow initial cycle point constraints

In a cycling suite it is possible to restrict the initial cycle point by defining a list of truncated time points under the initial cycle point constraints.

- type: Comma-separated list of ISO 8601 truncated time point representations (e.g. T00, T06, T-30).
- default: (none)

A.3.5 [scheduling] \rightarrow final cycle point constraints

In a cycling suite it is possible to restrict the final cycle point by defining a list of truncated time points under the final cycle point constraints.

- type: Comma-separated list of ISO 8601 truncated time point representations (e.g. T00, T06, T-30).
- default: (none)

A.3.6 [scheduling] \rightarrow hold after point

Cycling tasks are held once they pass the hold after cycle point, if one is specified. Unlike the final cycle point suite will not shut down once all tasks have passed this point. If this item is provided you can override it on the command line or in the gcylc suite start panel.

A.3.7 [scheduling] \rightarrow runahead limit

Runahead limiting prevents the fastest tasks in a suite from getting too far ahead of the slowest ones, as documented in 13.12.

This config item specifies a hard limit as a cycle interval between the slowest and fastest tasks. It is deprecated in favour of the newer default limiting by max active cycle points (A.3.8).

- type: Cycle interval string e.g. PT12H for a 12 hour limit under ISO 8601 cycling.
- default: (none)

A.3.8 [scheduling] \rightarrow max active cycle points

Runahead limiting prevents the fastest tasks in a suite from getting too far ahead of the slowest ones, as documented in 13.12.

This config item supersedes the deprecated hard runahead limit (A.3.7). It allows up to N (default 3) consecutive cycle points to be active at any time, adjusted up if necessary for any future triggering.

type: integer default: 3

A.3.9 [scheduling] →spawn to max active cycle points

Allows tasks to spawn out to max active cycle points (A.3.8), removing restriction that a task has to have submitted before its successor can be spawned.

Important: This should be used with care given the potential impact of additional task proxies both in terms of memory and cpu for the cylc daemon as well as overheads in rendering all the additional tasks in gcylc. Also, use of the setting may highlight any issues with suite

design relying on the default behaviour where downstream tasks would otherwise be waiting on ones upstream submitting and the suite would have stalled e.g. a housekeeping task at a later cycle deleting an earlier cycle's data before that cycle has had chance to run where previously the task would not have been spawned until its predecessor had been submitted.

type: boolean default: False

A.3.10 [scheduling] \rightarrow [[queues]]

Configuration of internal queues, by which the number of simultaneously active tasks (submitted or running) can be limited, per queue. By default a single queue called *default* is defined, with all tasks assigned to it and no limit. To use a single queue for the whole suite just set the limit on the *default* queue as required. See also 13.13.

A.3.10.1 [scheduling] \rightarrow [[queues]] \rightarrow [[[__QUEUE__]]]

Section heading for configuration of a single queue. Replace ___QUEUE___ with a queue name, and repeat the section as required.

- type: string
- default: "default"

A.3.10.2 [scheduling] \rightarrow [[queues]] \rightarrow [[[__QUEUE__]]] \rightarrow limit

The maximum number of active tasks allowed at any one time, for this queue.

- type: integer
- default: 0 (i.e. no limit)

A.3.10.3 [scheduling] \rightarrow [[queues]] \rightarrow [[[___QUEUE___]]] \rightarrow members

A list of member tasks, or task family names, to assign to this queue (assigned tasks will automatically be removed from the default queue).

- type: Comma-separated list of strings (task or family names).
- default: none for user-defined queues; all tasks for the "default" queue

A.3.11 [scheduling] \rightarrow [[special tasks]]

This section is used to identify tasks with special behaviour. Family names can be used in special task lists as shorthand for listing all member tasks.

A.3.11.1 [scheduling] \rightarrow [[special tasks]] \rightarrow clock-trigger

Clock-trigger tasks (see 10.3.5.14) wait on a wall clock time specified as an offset from their own cycle point.

- type: Comma-separated list of task or family names with associated date-time offsets expressed as ISO8601 interval strings, positive or negative, e.g. PT1H for 1 hour. The offset specification may be omitted to trigger right on the cycle point.
- default: (none)
- example:

```
clock-trigger = foo(PT1H30M), bar(PT1.5H), baz
```

A.3.11.2 [scheduling] \rightarrow [[special tasks]] \rightarrow clock-expire

Clock-expire tasks enter the *expired* state and skip job submission if too far behind the wall clock when they become ready to run. The expiry time is specified as an offset from wall-clock time; typically it should be negative - see 10.3.5.15.

- type: Comma-separated list of task or family names with associated date-time offsets expressed as ISO8601 interval strings, positive or negative, e.g. PT1H for 1 hour. The offset may be omitted if it is zero.
- default: (none)
- example:

```
clock-expire = foo(-P1D)
```

A.3.11.3 [scheduling] \rightarrow [[special tasks]] \rightarrow external-trigger

Externally triggered tasks (see 10.3.5.16) wait on external events reported via the cylc ext-trigger command. To constrain triggers to a specific cycle point, include \$CYLC_TASK_CYCLE_POINT in the trigger message string and pass the cycle point to the cylc ext-trigger command.

- type: Comma-separated list of task names with associated external trigger message strings.
- default: (none)
- example: (note the comma and line-continuation character)

A.3.11.4 [scheduling] \rightarrow [[special tasks]] \rightarrow sequential

Sequential tasks are automatically given dependence on their own predecessor. This is equivalent to use of explicit inter-cycle triggers in the graph, except that the automatic version does not show in suite graph visualization. For more on sequential tasks see 10.3.5.12 and 16.4.

- type: Comma-separated list of task or family names.
- default: (none)
- example: sequential = foo, bar

A.3.11.5 [scheduling] \rightarrow [[special tasks]] \rightarrow exclude at start-up

Any task listed here will be excluded from the initial task pool (this goes for suite restarts too). If an *inclusion* list is also specified, the initial pool will contain only included tasks that have not been excluded. Excluded tasks can still be inserted at run time. Other tasks may still depend on excluded tasks if they have not been removed from the suite dependency graph, in which case some manual triggering, or insertion of excluded tasks, may be required.

- type: Comma-separated list of task or family names.
- default: (none)

A.3.11.6 [scheduling] \rightarrow [[special tasks]] \rightarrow include at start-up

If this list is not empty, any task *not* listed in it will be excluded from the initial task pool (this goes for suite restarts too). If an *exclusion* list is also specified, the initial pool will contain only included tasks that have not been excluded. Excluded tasks can still be inserted at run time.

Other tasks may still depend on excluded tasks if they have not been removed from the suite dependency graph, in which case some manual triggering, or insertion of excluded tasks, may be required.

- type: Comma-separated list of task or family names.
- default: (none)

A.3.12 [scheduling] \rightarrow [[dependencies]]

The suite dependency graph is defined under this section. You can plot the dependency graph as you work on it, with cylc graph or by right clicking on the suite in the db viewer. See also 10.3.

A.3.12.1 [scheduling] \rightarrow [[dependencies]] \rightarrow graph

The dependency graph for a completely non-cycling suites can go here. See also A.3.12.2.1 below and 10.3, for graph string syntax.

- type: string
- *example:* (see A.3.12.2.1 below)

A.3.12.2 [scheduling] \rightarrow [[dependencies]] \rightarrow [[[___RECURRENCE___]]]

__RECURRENCE__ section headings define the sequence of cycle points for which the subsequent graph section is valid. These should be specified in our ISO 8601 derived sequence syntax, or similar for integer cycling:

- examples:
 - date-time cycling: [[[T00,T06,T12,T18]]] or [[[PT6H]]]
 - integer cycling (stepped by 2): [[[P2]]]
- default: (none)

See 10.3.3 for more on recurrence expressions, and how multiple graph sections combine.

$\textbf{A.3.12.2.1} \quad [\textbf{scheduling}] \rightarrow [[\textbf{dependencies}]] \rightarrow [[[\underline{\phantom{\textbf{CURRENCE}}}]] \rightarrow \textbf{graph}$

The dependency graph for a given recurrence section goes here. Syntax examples follow; see also 10.3 and 10.3.5.

- type: string
- examples:

```
graph = """
  foo => bar => baz & waz  # baz and waz both trigger off bar
  foo[-P1D-PT6H] => bar  # bar triggers off foo[-P1D-PT6H]
  baz:out1 => faz  # faz triggers off a message output of baz
  X:start => Y  # Y triggers if X starts executing
  X:fail => Y  # Y triggers if X fails
  foo[-PT6H]:fail => bar  # bar triggers if foo[-PT6H] fails
  X => !Y  # Y suicides if X succeeds
  X | X:fail => Z  # Z triggers if X succeeds
  X | X:fail => Z  # Z triggers if X succeeds or fails
  (A | B & C ) | D => foo  # general conditional triggers
  foo:submit => bar  # bar triggers if foo is successfully submitted
  foo:submit-fail => bar  # bar triggers if submission of foo fails
  # comment
  """
```

• default: (none)

A.4 [runtime]

This section is used to specify how, where, and what to execute when tasks are ready to run. Common configuration can be factored out in a multiple-inheritance hierarchy of runtime namespaces that culminates in the tasks of the suite. Order of precedence is determined by the C3 linearization algorithm as used to find the *method resolution order* in Python language class hierarchies. For details and examples see 10.4.

$A.4.1 \quad [runtime] \rightarrow [[__NAME__]]$

Replace ___NAME__ with a namespace name, or a comma-separated list of names, and repeat as needed to define all tasks in the suite. Names may contain letters, digits, underscores, and hyphens. A namespace represents a group or family of tasks if other namespaces inherit from it, or a task if no others inherit from it.

- legal values:
 - [[foo]]
 - [[foo, bar, baz]]

If multiple names are listed the subsequent settings apply to each.

All namespaces inherit initially from *root*, which can be explicitly configured to provide or override default settings for all tasks in the suite.

A.4.1.1 [runtime] \rightarrow [[___NAME___]] \rightarrow inherit

A list of the immediate parent(s) this namespace inherits from. If no parents are listed root is assumed.

- type: Comma-separated list of strings (parent namespace names).
- default: root

A.4.1.2 [runtime] \rightarrow [[___NAME___]] \rightarrow title

A single line description of this namespace. It is displayed by the cylc list command and can be retrieved from running tasks with the cylc show command.

- type: single line string
- root default: (none)

$\textbf{A.4.1.3} \quad [\textbf{runtime}] \rightarrow [[\underline{\hspace{1cm}} \textbf{NAME}\underline{\hspace{1cm}}]] \rightarrow \textbf{description}$

A multi-line description of this namespace, retrievable from running tasks with the cylc show command.

- type: multi-line string
- root default: (none)

A.4.1.4 [runtime] \rightarrow [[___NAME___]] \rightarrow URL

A web URL to task documentation for this suite. If present it can be browsed with the cylc doc command, or by right-clicking on the task in gcylc. The variables \${CYLC_SUITE_NAME} and \${CYLC_TASK_NAME} will be replaced with the actual suite and task names (note that these are not environment variables in this context). See also suite URLs (A.1.4).

- type: string (URL)
- default: (none)
- example: you can set URLs to all tasks in a suite by putting something like the following in the root namespace:

```
[runtime]
    [[root]]
        URL = http://suites/${CYLC_SUITE_NAME}/${CYLC_TASK_NAME}.html
```

(Note that URLs containing the suite comment delimiter # must be protected by quotes).

$A.4.1.5 \quad [runtime] \rightarrow [[__NAME__]] \rightarrow init\text{-script}$

This is written to the top of the task job script before the task execution environment is configured, so it does not have access to any suite or task environment variables. It can be a single command or multiple lines of scripting. The original intention was to allow remote tasks to source login scripts to configure their access to cylc, but this should no longer be necessary (see 13.7). See also env-script, pre-script, script, and post-script.

```
type: string
default: (none)
example: init-script = "echo Hello World"
```

A.4.1.6 [runtime] \rightarrow [[___NAME___]] \rightarrow env-script

This is written to the task job script between the cylc-defined environment (suite and task identity, etc.) and the user-defined task runtime environment - i.e. it has access to the cylc environment, and the task environment has access to variables defined by this scripting. It can be a single command or multiple lines of scripting. See also init-script, pre-script, script, and post-script.

```
    type: string
    default: (none)
    example: env-script = "echo Hello World"
```

A.4.1.7 [runtime] \rightarrow [[___NAME___]] \rightarrow pre-script

This is written to the task job script immediately before the script item (just below). It can be a single command or multiple lines of scripting. See also init-script, env-script, script, and post-script.

```
type: string
default: (none)
example:

pre-script = """

$\text{$\text{$HOME}/.profile}$
echo Hello from suite $\text{$\text{CYLC_SUITE_NAME}}\!"""
```

A.4.1.8 [runtime] \rightarrow [[___NAME___]] \rightarrow script

The is the main user-defined scripting to run when the task is ready. It can be a single command or multiple lines of scripting. See also init-script, env-script, pre-script, and post-script.

```
type: stringroot default: echo "Dummy task"; $(cylc rnd 1 16)
```

A.4.1.9 [runtime] \rightarrow [[___NAME___]] \rightarrow post-script

This is written to the task job script immediately after the script item (just above). It can be a single command or multiple lines of scripting. See also init-script, env-script, pre-script, and script.

- type: string default: (none)
- A.4.1.10 [runtime] \rightarrow [[___NAME___]] \rightarrow work sub-directory

Task job scripts are executed from within work directories created automatically under the suite run directory. A task can get its own work directory from \$CYLC_TASK_WORK_DIR (or simply \$PWD if it does not cd elsewhere at runtime). The default directory path contains task name and cycle point, to provide a unique workspace for every instance of every task. If several tasks need to exchange files and simply read and write from their from current working directory, this item can be used to override the default to make them all use the same workspace.

The top level share and work directory location can be changed (e.g. to a large data area) by a global config setting (see B.9.1.2).

- type: string (directory path, can contain environment variables)
- default: \$CYLC_TASK_CYCLE_POINT/\$CYLC_TASK_NAME
- example: \$CYLC_TASK_CYCLE_POINT/shared/

Note that if you omit cycle point from the work sub-directory path successive instances of the task will share the same workspace. Consider the effect on cycle point offset housekeeping of work directories before doing this.

A.4.1.11 [runtime] \rightarrow [[___NAME___]] \rightarrow enable resurrection

If a message is received from a failed task cylc will normally treat this as an error condition, issue a warning, and leave the task in the "failed" state. But if "enable resurrection" is switched on failed tasks can come back from the dead: if the same task job script is executed again cylc will put the task back into the running state and continue as normal when the started message is received. This can be used to handle HPC-style job preemption wherein a resource manager may kill a running task and reschedule it to run again later, to make way for a job with higher immediate priority. See also 13.17

- type: boolean default: False
- $\textbf{A.4.1.12} \quad [\textbf{runtime}] \rightarrow [[\underline{} \textbf{NAME}\underline{}]] \rightarrow [[[\textbf{dummy mode}]]]$

Dummy mode configuration.

The main script item for tasks in dummy mode. See A.4.1.8 for documentation.

- type: string
- root default: echo "Dummy task"; sleep \$(cylc rnd 1 16)

A.4.1.12.2 [runtime] \rightarrow [[___NAME___]] \rightarrow [[[dummy mode]]] \rightarrow disable pre-script This disables the task pre-script in dummy mode.

- type: boolean
- root default: True

A.4.1.12.3 [runtime] \rightarrow [[___NAME___]] \rightarrow [[[dummy mode]]] \rightarrow disable post-script This disables the task post-script in dummy mode.

- type: boolean
- root default: True

$$A.4.1.13 \quad [runtime] \rightarrow [[__NAME__]] \rightarrow [[[simulation mode]]]$$

Simulation mode configuration.

$$\textbf{A.4.1.14} \quad [\textbf{runtime}] \rightarrow [[\underline{} \textbf{NAME}\underline{}]] \rightarrow [[[\textbf{simulation mode}]]] \rightarrow \textbf{run time range}$$

This defines a minimum and a maximum duration (expressed as ISO 8601 duration/intervals) which define a range from which the simulation mode task run length will be randomly chosen.

- type: Comma-separated list containing two ISO 8601 duration/interval representations.
- example: PT1S,PT20S a range of 1 second to 20 seconds
- default: (1, 16)

$$\textbf{A.4.1.15} \quad [\textbf{runtime}] \rightarrow [[\underline{\phantom{\textbf{c}}} \textbf{NAME}\underline{\phantom{\textbf{c}}}]] \rightarrow [[[\textbf{job}]]]$$

This section configures the means by which cylc submits task job scripts to run.

$$\textbf{A.4.1.15.1} \quad [\textbf{runtime}] \rightarrow [[\underline{\phantom{\textbf{c}}} \textbf{NAME}\underline{\phantom{\textbf{c}}}]] \rightarrow [[[\textbf{job}]]] \rightarrow \textbf{batch system}$$

See 12 for how job submission works, and how to define new handlers for different batch systems. Cylc has a number of built in batch system handlers:

- type: string
- legal values:
 - background invoke a child process
 - at the rudimentary Unix at scheduler
 - loadleveler IBM LoadLeveler llsubmit, with directives defined in the suite.rc file
 - 1sf IBM Platform LSF bsub, with directives defined in the suite.rc file
 - pbs PBS qsub, with directives defined in the suite.rc file
 - sge Sun Grid Engine qsub, with directives defined in the suite.rc file
 - slurm Simple Linux Utility for Resource Management sbatch, with directives defined in the suite.rc file
 - moab Moab workload manager msub, with directives defined in the suite.rc file
- default: background

$\textbf{A.4.1.15.2} \quad [\textbf{runtime}] \rightarrow [[\underline{} \textbf{NAME}\underline{}]] \rightarrow [[[\textbf{job}]]] \rightarrow \textbf{execution time limit}$

Specify the execution wall clock limit for a job of the task. For background and at, the job script will be invoked using the timeout command. For other batch systems, the specified time will be automatically translated into the equivalent directive for wall clock limit.

- type: ISO 8601 duration/interval representation
- example: PT5M, 5 minutes, PT1H, 1 hour
- default: (none)

A.4.1.15.3 [runtime] \rightarrow [[___NAME___]] \rightarrow [[[job]]] \rightarrow batch submit command template

This allows you to override the actual command used by the chosen batch system. The template's %(job)s will be substituted by the job file path.

- type: string
- legal values: a string template
- example: llsubmit \%(job)s

$\textbf{A.4.1.15.4} \quad [\textbf{runtime}] \rightarrow [[\underline{} \textbf{NAME}\underline{}]] \rightarrow [[[\textbf{job}]]] \rightarrow \textbf{shell}$

This is the shell used to interpret the job script submitted by the suite daemon when a task is ready to run. It has no bearing on the shell used in task implementations. Scripting and suite environment variable assignment expressions must be valid for this shell. The latter is currently hardwired into cylc as export item=value - valid for both bash and ksh because value is entirely user-defined - but cylc would have to be modified slightly to allow use of the C shell.

- type: string
- root default: /bin/bash

$\textbf{A.4.1.15.5} \quad [\textbf{runtime}] \rightarrow [[\underline{\phantom{\textbf{c}}} \textbf{NAME}\underline{\phantom{\textbf{c}}}]] \rightarrow [[[\textbf{job}]]] \rightarrow \textbf{submission retry delays}$

A list of duration (in ISO 8601 syntax), after which to resubmit if job submission fails.

- type: Comma-separated list of ISO 8601 duration/interval representations, optionally preceded by multipliers.
- example: PT1M,3*PT1H, P1D is equivalent to PT1M, PT1H, PT1H, PT1H, P1D 1 minute, 1 hour, 1 hour, 1 day.
- default: (none)

A.4.1.15.6 [runtime] \rightarrow [[___NAME___]] \rightarrow [[[job]]] \rightarrow execution retry delays

A list of ISO 8601 time duration/intervals after which to resubmit the task if it fails. The variable \$CYLC_TASK_TRY_NUMBER in the task execution environment is incremented each time, starting from 1 for the first try - this can be used to vary task behaviour by try number.

- type: Comma-separated list of ISO 8601 duration/interval representations, optionally preceded by multipliers.
- example: PT1.5M,3*PT10M is equivalent to PT1.5M, PT10M, PT10M, PT10M 1.5 minutes, 10 minutes, 10 minutes.
- default: (none)

$\textbf{A.4.1.15.7} \quad [\textbf{runtime}] \rightarrow [[\underline{\phantom{\textbf{c}}} \textbf{NAME}\underline{\phantom{\textbf{c}}}]] \rightarrow [[[\textbf{job}]]] \rightarrow \textbf{submission polling intervals}$

A list of intervals, expressed as ISO 8601 duration/intervals, with optional multipliers, after which cylc will poll for status while the task is in the submitted state.

For the polling task communication method this overrides the default submission polling interval in the site/user config files (7). For default and ssh task communications, polling is not done by default but it can still be configured here as a regular check on the health of submitted tasks.

Each list value is used in turn until the last, which is used repeatedly until finished.

- type: Comma-separated list of ISO 8601 duration/interval representations, optionally preceded by multipliers.
- example: PT1M,3*PT1H, PT1M is equivalent to PT1M, PT1H, PT1H, PT1H, PT1H-1 minute, 1 hour, 1 hour, 1 minute.
- default: (none)

A single interval value is probably appropriate for submission polling.

A.4.1.15.8 [runtime] \rightarrow [[__NAME___]] \rightarrow [[[job]]] \rightarrow execution polling intervals

A list of intervals, expressed as ISO 8601 duration/intervals, with optional multipliers, after which cylc will poll for status while the task is in the running state.

For the polling task communication method this overrides the default execution polling interval in the site/user config files (7). For default and ssh task communications, polling is not done by default but it can still be configured here as a regular check on the health of submitted tasks.

Each list value is used in turn until the last, which is used repeatedly until finished.

- type: Comma-separated list of ISO 8601 duration/interval representations, optionally preceded by multipliers.
- example: PT1M,3*PT1H, PT1M is equivalent to PT1M, PT1H, PT1H, PT1H, PT1H, PT1H-1 minute, 1 hour, 1 hour, 1 minute.
- default: (none)

A.4.1.16 [runtime] \rightarrow [[___NAME___]] \rightarrow [[[remote]]]

Configure host and username, for tasks that do not run on the suite host account. Non-interactive ssh is used to submit the task by the configured batch system, so you must distribute your ssh key to allow this. Cylc must be installed on remote task hosts, but no external software dependencies are required there.

$$\textbf{A.4.1.16.1} \quad [\textbf{runtime}] \rightarrow [[\underline{} \textbf{NAME}\underline{}]] \rightarrow [[[\textbf{remote}]]] \rightarrow \textbf{host}$$

The remote host for this namespace. This can be a static hostname, an environment variable that holds a hostname, or a command that prints a hostname to stdout. Host selection commands are executed just prior to job submission. The host (static or dynamic) may have an entry in the cylc site or user config file to specify parameters such as the location of cylc on the remote machine; if not, the corresponding local settings (on the suite host) will be assumed to apply on the remote host.

- type: string (a valid hostname on the network)
- default: (none)

- examples:
 - static host name: host = foo
 - fully qualified: host = foo.bar.baz
 - dynamic host selection:
 - * shell command (1): host = \$(host-selector.sh)
 - * shell command (2): host = 'host-selector.sh)'
 - * environment variable: host = \$MY_HOST

$A.4.1.16.2 \quad [runtime] \rightarrow [[\underline{\hspace{1cm}} NAME\underline{\hspace{1cm}}]] \rightarrow [[[remote]]] \rightarrow owner$

The username of the task host account. This is (only) used in the non-interactive ssh command invoked by the suite daemon to submit the remote task (consequently it may be defined using local environment variables (i.e. the shell in which cycle runs, and $[cyc] \rightarrow [[environment]]$).

If you use dynamic host selection and have different usernames on the different selectable hosts, you can configure your \$HOME/.ssh/config to handle username translation.

- type: string (a valid username on the remote host)
- default: (none)

$$A.4.1.16.3 \quad [runtime] \rightarrow [[__NAME__]] \rightarrow [[[remote]]] \rightarrow retrieve job logs$$

Remote task job logs are saved to the suite run directory on the task host, not on the suite host. If you want the job logs pulled back to the suite host automatically, you can set this item to True. The suite will then attempt to rsync the job logs once from the remote host each time a task job completes. E.g. if the job file is ~/cylc-run/tut.oneoff.remote/log/job/1/hello/01/job, anything under ~/cylc-run/tut.oneoff.remote/log/job/1/hello/01/ will be retrieved.

- type: boolean
- default: False

$\textbf{A.4.1.16.4} \quad [\textbf{runtime}] \rightarrow [[\underline{\phantom{\textbf{c}}} \textbf{NAME}\underline{\phantom{\textbf{c}}}]] \rightarrow [[[\textbf{remote}]]] \rightarrow \textbf{retrieve job logs max size}$

If the disk space of the suite host is limited, you may want to set the maximum sizes of the job log files to retrieve. The value can be anything that is accepted by the --max-size=SIZE option of the rsync command.

- type: string
- default: None

A.4.1.16.5 [runtime] \rightarrow [[___NAME___]] \rightarrow [[[remote]]] \rightarrow retrieve job logs retry delays

Some batch systems have considerable delays between the time when the job completes and when it writes the job logs in its normal location. If this is the case, you can configure an initial delay and some retry delays between subsequent attempts. The default behaviour is to attempt once without any delay.

- type: Comma-separated list of ISO 8601 duration/interval representations, optionally preceded by multipliers.
- default: (none)
- example: handler = PT10S, PT1M, PT5M

$\textbf{A.4.1.16.6} \quad [\textbf{runtime}] \rightarrow [[\underline{\phantom{\textbf{c}}} \textbf{NAME}\underline{\phantom{\textbf{c}}}]] \rightarrow [[[\textbf{remote}]]] \rightarrow \textbf{suite definition directory}$

The path to the suite definition directory on the remote host, needed if remote tasks require access to files stored there (via \$CYLC_SUITE_DEF_PATH) or in the suite bin directory (via \$PATH). If this item is not defined, the local suite definition directory path will be assumed, with the suite owner's home directory, if present, replaced by '\$HOME' for interpretation on the remote host.

- type: string (a valid directory path on the remote host)
- default: (local suite definition path with \$HOME replaced)

A.4.1.17 [runtime] \rightarrow [[___NAME___]] \rightarrow [[[events]]]

Cylc can call nominated event handlers when certain task events occur. This section configures specific task event handlers; see A.2.12 for suite event hooks.

Event handler commands can be located in the suite bin/ directory, otherwise it is up to you to ensure their location is in \$PATH (in the shell in which cylc runs, on the suite host). The commands should require very little resource to run and should return quickly.

Each task event handler can be specified as a list of command lines or command line templates.

A command line template may have any or all of these patterns which will be substituted with actual values:

- %(event)s: event name
- %(suite)s: suite name
- %(point)s: cycle point
- %(name)s: task name
- %(submit_num)s: submit number
- %(id)s: task ID (i.e. %(name)s.%(point)s)
- %(message)s: event message, if any

Otherwise, the command line will be called with the following arguments:

```
<task-event-handler> %(event)s %(suite)s %(id)s %(message)s
```

For an explanation of the substitution syntax, see String Formatting Operations in the Python documentation: https://docs.python.org/2/library/stdtypes.html#string-formatting.

Additional information can be passed to event handlers via the [cylc] \rightarrow [[environment]] (but not via task runtime environments - event handlers are not called by tasks).

$A.4.1.17.1 \quad [runtime] \rightarrow [[\underline{\hspace{1cm}} NAME\underline{\hspace{1cm}}]] \rightarrow [[[events]]] \rightarrow EVENT \ handler$

A list of one or more event handlers to call when one of the following EVENTs occurs:

- submitted the job submit command was successful
- submission failed the job submit command failed, or the submitted job was killed before it started executing
- submission retry job submit failed, but cylc will resubmit it after a configured delay
- submission timeout the submitted job timed out without commencing execution
- started the task reported commencement of execution
- succeeded the task reported that it completed successfully
- failed the task reported that if tailed to complete successfully
- retry the task failed, but cylc will resubmit it after a configured delay

- execution timeout the task timed out after execution commenced
- warning the task reported a warning priority message

Item details:

- type: Comma-separated list of strings (event handler scripts).
- default: None
- example: failed handler = my-failed-handler.sh

$A.4.1.17.2 \quad [runtime] \rightarrow [[__NAME__]] \rightarrow [[[events]]] \rightarrow submission \ timeout$

If a task has not started after the specified ISO 8601 duration/interval, the *submission timeout* event handler(s) will be called.

- type: ISO 8601 duration/interval representation (e.g. PT30M, 30 minutes or P1D, 1 day).
- default: (none)

$$A.4.1.17.3 \quad [runtime] \rightarrow [[__NAME__]] \rightarrow [[[events]]] \rightarrow execution \ timeout$$

If a task has not finished after the specified ISO 8601 duration/interval, the execution timeout event handler(s) will be called.

- type: ISO 8601 duration/interval representation (e.g. PT4H, 4 hours or P1D, 1 day).
- default: (none)

$$A.4.1.17.4 \quad [runtime] \rightarrow [[__NAME__]] \rightarrow [[[events]]] \rightarrow reset \ timer$$

If you set an execution timeout the timer can be reset to zero every time a message is received from the running task (which indicates the task is still alive). Otherwise, the task will timeout if it does not finish in the alotted time regardless of incoming messages.

- type: boolean
- default: False

A.4.1.17.5 [runtime]
$$\rightarrow$$
 [[___NAME___]] \rightarrow [[[events]]] \rightarrow handlers

Specify a list of command lines or command line templates as task event handlers.

- type: Comma-separated list of strings (event handler command line or command line templates).
- default: (none)
- example: handlers = my-handler.sh

$\textbf{A.4.1.17.6} \quad [\textbf{runtime}] \rightarrow [[\underline{\phantom{\textbf{c}}} \textbf{NAME}\underline{\phantom{\textbf{c}}}]] \rightarrow [[[\textbf{events}]]] \rightarrow \textbf{handler events}$

Specify the events for which the general task event handlers should be invoked.

- type: Comma-separated list of events
- default: (none)
- example: handler events = submission failed, failed

$\textbf{A.4.1.17.7} \quad [\textbf{runtime}] \rightarrow [[\underline{} \textbf{NAME}\underline{}]] \rightarrow [[[\textbf{events}]]] \rightarrow \textbf{handler retry delays}$

Specify an initial delay before running an event handler command and any retry delays in case the command returns a non-zero code. The default behaviour is to run an event handler command once without any delay.

- type: Comma-separated list of ISO 8601 duration/interval representations, optionally preceded by multipliers.
- default: (none)
- example: handler = PT10S, PT1M, PT5M

$A.4.1.17.8 \quad [runtime] \rightarrow [[__NAME__]] \rightarrow [[[events]]] \rightarrow mail\ events$

Specify the events for which notification emails should be sent.

- type: Comma-separated list of events
- default: (none)
- example: handler = submission failed, failed

$A.4.1.17.9 \quad [runtime] \rightarrow [[__NAME__]] \rightarrow [[[events]]] \rightarrow mail \ from$

Specify an alternate from: email address for event notifications.

- type: string
- default: None, (notifications@HOSTNAME)
- example: mail from = no-reply@your-org

$$\textbf{A.4.1.17.10} \quad [\textbf{runtime}] \rightarrow [[\underline{\phantom{\textbf{c}}} \textbf{NAME}\underline{\phantom{\textbf{c}}}]] \rightarrow [[[\textbf{events}]]] \rightarrow \textbf{mail retry delays}$$

Specify an initial delay before running the mail notification command and any retry delays in case the command returns a non-zero code. The default behaviour is to run the mail notification command once without any delay.

- type: Comma-separated list of ISO 8601 duration/interval representations, optionally preceded by multipliers.
- default: (none)
- example: handler = PT10S, PT1M, PT5M

A.4.1.17.11 [runtime] \rightarrow [[___NAME___]] \rightarrow [[[events]]] \rightarrow mail smtp

Specify the SMTP server for sending email notifications.

- type: string
- default: None, (localhost:25)
- example: mail smtp = smtp.yourorg

$A.4.1.17.12 \quad [runtime] \rightarrow [[__NAME__]] \rightarrow [[[events]]] \rightarrow mail \ to$

A list of email addresses to send task event notifications. The list can be anything accepted by the mail command.

- type: string
- default: None, (USER@HOSTNAME)
- example: mail to = your.colleague

A.4.1.18 [runtime] \rightarrow [[___NAME___]] \rightarrow [[[environment]]]

The user defined task execution environment. Variables defined here can refer to cylc suite and task identity variables, which are exported earlier in the task job script, and variable assignment expressions can use cylc utility commands because access to cylc is also configured earlier in the script. See also 10.4.7.

```
A.4.1.18.1 \quad [runtime] \rightarrow [[\_\_NAME\_\_]] \rightarrow [[[environment]]] \rightarrow \_\_VARIABLE\_\_
```

Replace ____VARIABLE___ with any number of environment variable assignment expressions. Order of definition is preserved so values can refer to previously defined variables. Values are passed through to the task job script without evaluation or manipulation by cylc, so any variable assignment expression that is legal in the job submission shell can be used. White space around the '=' is allowed (as far as cylc's suite.rc parser is concerned these are just normal configuration items).

- type: string
- default: (none)
- legal values: depends to some extent on the task job submission shell (A.4.1.15.4).
- examples, for the bash shell:

```
- F00 = $HOME/bar/baz
- BAR = ${F00}$GLOBALVAR
- BAZ = $( echo "hello world")
- WAZ = ${F00%.jpg}.png
- NEXT_CYCLE = $( cylc cycle-point --offset=PT6H )
- PREV_CYCLE = 'cylc cycle-point --offset=-PT6H'
- ZAZ = "${F00#bar}"#<-- QUOTED to escape the suite.rc comment character</pre>
```

A.4.1.19 [runtime] \rightarrow [[___NAME___]] \rightarrow [[[environment filter]]]

This section contains environment variable inclusion and exclusion lists that can be used to filter the inherited environment. This is not intended as an alternative to a well-designed inheritance hierarchy that provides each task with just the variables it needs. Filters can, however, improve suites with tasks that inherit a lot of environment they don't need, by making it clear which tasks use which variables. They can optionally be used routinely as explicit "task environment interfaces" too, at some cost to brevity, because they guarantee that variables filtered out of the inherited task environment are not used.

Note that environment filtering is done after inheritance is completely worked out, not at each level on the way, so filter lists in higher-level namespaces only have an effect if they are not overridden by descendants.

$\textbf{A.4.1.19.1} \quad [\textbf{runtime}] \rightarrow [[\underline{} \textbf{NAME}\underline{}]] \rightarrow [[[\textbf{environment filter}]]] \rightarrow \textbf{include}$

If given, only variables named in this list will be included from the inherited environment, others will be filtered out. Variables may also be explicitly excluded by an exclude list.

- type: Comma-separated list of strings (variable names).
- default: (none)

$\textbf{A.4.1.19.2} \quad [\textbf{runtime}] \rightarrow [[\underline{} \textbf{NAME}\underline{}]] \rightarrow [[[\textbf{environment filter}]]] \rightarrow \textbf{exclude}$

Variables named in this list will be filtered out of the inherited environment. Variables may also be implicitly excluded by omission from an include list.

- type: Comma-separated list of strings (variable names).
- default: (none)

A.4.1.20 [runtime] \rightarrow [[___NAME___]] \rightarrow [[[directives]]]

Batch queue scheduler directives. Whether or not these are used depends on the batch system. For the built-in methods that support directives (loadleveler, lsf, pbs, sge, slurm, moab), directives are written to the top of the task job script in the correct format for the method. Specifying directives individually like this allows use of default directives that can be individually overridden at lower levels of the runtime namespace hierarchy.

```
\textbf{A.4.1.20.1} \quad [\textbf{runtime}] \rightarrow [[\underline{\phantom{0}} \textbf{NAME}\underline{\phantom{0}}]] \rightarrow [[[\textbf{directives}]]] \rightarrow \underline{\phantom{0}} \textbf{DIRECTIVE}\underline{\phantom{0}}
```

Replace ___DIRECTIVE__ with each directive assignment, e.g. class = parallel

- type: string
- default: (none)

Example directives for the built-in batch system handlers are shown in 12.2.

A.4.1.21 [runtime]
$$\rightarrow$$
 [[___NAME___]] \rightarrow [[[outputs]]]

Register custom task outputs for use in message triggering in this section (10.3.5.5)

$$\textbf{A.4.1.21.1} \quad [\textbf{runtime}] \rightarrow [[\underline{} \textbf{NAME}\underline{}]] \rightarrow [[[\textbf{outputs}]]] \rightarrow \underline{} \textbf{OUTPUT}\underline{}$$

Replace __OUTPUT__ with one or more custom task output messages (10.3.5.5). The item name is used to select the custom output message in graph trigger notation.

- type: string
- default: (none)
- examples:

```
out1 = "sea state products ready"
out2 = "NWP restart files completed"
```

$\textbf{A.4.1.22} \quad [\textbf{runtime}] \rightarrow [[\underline{\phantom{\textbf{c}}} \textbf{NAME}\underline{\phantom{\textbf{c}}}]] \rightarrow [[[\textbf{suite state polling}]]]$

Configure automatic suite polling tasks as described in 13.23. The items in this section reflect the options and defaults of the cylc suite-state command, except that the target suite name and the --task, --cycle, and --status options are taken from the graph notation.

$$A.4.1.22.1$$
 [runtime] \rightarrow [[___NAME___]] \rightarrow [[[suite state polling]]] \rightarrow run-dir

For your own suites the run database location is determined by your site/user config. For other suites, e.g. those owned by others, or mirrored suite databases, use this item to specify the location of the top level cylc run directory (the database should be a suite-name sub-directory of this location).

- type: string (a directory path on the target suite host)
- default: as configured by site/user config (for your own suites)

$\textbf{A.4.1.22.2} \quad [\textbf{runtime}] \rightarrow [[\underline{} \textbf{NAME}\underline{}]] \rightarrow [[[\textbf{suite state polling}]]] \rightarrow \textbf{template}$

Cycle point template of the target suite, if different from that of the polling suite.

- type: string
- default: cycle point format of the polling suite
- *example:* \%Y-\%m-\%dT\%H

$\textbf{A.4.1.22.3} \quad [\textbf{runtime}] \rightarrow [[\underline{} \textbf{NAME}\underline{}]] \rightarrow [[[\textbf{suite state polling}]]] \rightarrow \textbf{interval}$

Polling interval expressed as an ISO 8601 duration/interval.

- type: ISO 8601 duration/interval representation (e.g. PT10S, 10 seconds, or PT1M, 1 minute).
- default: PT1M

$A.4.1.22.4 \quad [runtime] \rightarrow [[__NAME__]] \rightarrow [[[suite state polling]]] \rightarrow max-polls$

The maximum number of polls before timing out and entering the 'failed' state.

- type: integer
- default: 10

$$A.4.1.22.5 \quad [runtime] \rightarrow [[__NAME__]] \rightarrow [[[suite state polling]]] \rightarrow user$$

Username of an account on the suite host to which you have access. The polling cylc suite-state command will be invoked on the remote account.

- *type:* string (username)
- default: (none)

$\textbf{A.4.1.22.6} \quad [\textbf{runtime}] \rightarrow [[\underline{} \textbf{NAME}\underline{}]] \rightarrow [[[\textbf{suite state polling}]]] \rightarrow \textbf{host}$

The hostname of the target suite. The polling cylc suite-state command will be invoked on the remote account.

- type: string (hostname)
- default: (none)

$A.4.1.22.7 \quad [runtime] \rightarrow [[__NAME__]] \rightarrow [[[suite state polling]]] \rightarrow verbose$

Run the polling cylc suite-state command in verbose output mode.

- type: boolean
- default: False

A.5 [visualization]

Configuration of suite graphing for the cylc graph command (graph extent, styling, and initial family-collapsed state) and the gcylc graph view (initial family-collapsed state). Graphviz documentation of node shapes and so on can be found at http://www.graphviz.org/Documentation.php.

A.5.1 [visualization] \rightarrow initial cycle point

The initial cycle point for graph plotting.

- type: ISO 8601 date/time representation (e.g. CCYYMMDDThhmm)
- default: the suite initial cycle point

The visualization initial cycle point gets adjusted up if necessary to the suite initial cycling point.

A.5.2 [visualization] →final cycle point

An explicit final cycle point for graph plotting. If used, this overrides the preferred number of cycle points (below).

- type: ISO 8601 date/time representation (e.g. CCYYMMDDThhmm)
- default: (none)

The visualization final cycle point gets adjusted down if necessary to the suite final cycle point.

A.5.3 [visualization] \rightarrow number of cycle points

The number of cycle points to graph starting from the visualization initial cycle point. This is the preferred way of defining the graph end point, but it can be overridden by an explicit *final cycle point* (above).

• type: integer

• default: 3

A.5.4 [visualization] \rightarrow collapsed families

A list of family (namespace) names to be shown in the collapsed state (i.e. the family members will be replaced by a single family node) when the suite is first plotted in the graph viewer or the gcylc graph view. If this item is not set, the default is to collapse all families at first. Interactive GUI controls can then be used to group and ungroup family nodes at will.

- type: Comma-separated list of family names.
- default: (none)

A.5.5 [visualization] \rightarrow use node color for edges

Plot graph edges (dependency arrows) with the same color as the upstream node, otherwise default to black.

type: boolean default: False

A.5.6 [visualization] \rightarrow use node fillcolor for edges

Plot graph edges (i.e. dependency arrows) with the same fillcolor as the upstream node, if it is filled, otherwise default to black.

type: boolean default: False

A.5.7 [visualization] \rightarrow node penwidth

Line width of node shape borders.

type: integer default: 2

A.5.8 [visualization] \rightarrow edge penwidth

Line width of graph edges (dependency arrows).

type: integer default: 2

A.5.9 [visualization] \rightarrow use node color for labels

Graph node labels can be printed in the same color as the node outline.

type: boolean default: False

A.5.10 [visualization] \rightarrow default node attributes

Set the default attributes (color and style etc.) of graph nodes (tasks and families). Attribute pairs must be quoted to hide the internal = character.

- type: Comma-separated list of quoted 'attribute=value' pairs.
- legal values: see graphviz or pygraphviz documentation
- default: 'style=filled', 'fillcolor=yellow', 'shape=box'

A.5.11 [visualization] \rightarrow default edge attributes

Set the default attributes (color and style etc.) of graph edges (dependency arrows). Attribute pairs must be quoted to hide the internal = character.

- type: Comma-separated list of quoted 'attribute=value' pairs.
- legal values: see graphviz or pygraphviz documentation
- default: 'color=black'

A.5.12 [visualization] \rightarrow [[node groups]]

Define named groups of graph nodes (tasks and families) which can styled en masse, by name, in [visualization] \rightarrow [[node attributes]]. Node groups are automatically defined for all task families, including root, so you can style family and member nodes at once by family name.

A.5.12.1 [visualization] \rightarrow [[node groups]] \rightarrow ___GROUP___

Replace GROUP with each named group of tasks or families.

- type: Comma-separated list of task or family names.
- default: (none)
- example:

```
PreProc = foo, bar
PostProc = baz, waz
```

A.5.13 [visualization] \rightarrow [[node attributes]]

Here you can assign graph node attributes to specific nodes, or to all members of named groups defined in [visualization] \rightarrow [[node groups]]. Task families are automatically node groups. Styling of a family node applies to all member nodes (tasks and sub-families), but precedence is determined by ordering in the suite definition. For example, if you style a family red and then one of its members green, cylc will plot a red family with one green member; but if you style one member green and then the family red, the red family styling will override the earlier green styling of the member.

A.5.13.1 [visualization] \rightarrow [[node attributes]] \rightarrow ___NAME___

Replace ___NAME___ with each node or node group for style attribute assignment.

- type: Comma-separated list of quoted 'attribute=value' pairs.
- legal values: see graphviz or pygraphviz documentation
- default: (none)
- example: (with reference to the node groups defined above)

```
PreProc = 'style=filled', 'fillcolor=orange'
PostProc = 'color=red'
foo = 'style=filled'
```

B Global (Site, User) Config File Reference

This section defines all legal items and values for cylc site and user config files. See *Site And User Config Files* (Section 7) for file locations, intended usage, and how to generate the files using the cylc get-site-config command.

As for suite definitions, Jinja2 expressions can be embedded in site and user config files to generate the final result parsed by cylc. Use of Jinja2 in suite definitions is documented in Section 10.7.

B.1 Top Level Items

B.1.1 temporary directory

A temporary directory is needed by a few cylc commands, and is cleaned automatically on exit. Leave unset for the default (usually \$TMPDIR).

• *type:* string (directory path)

• default: (none)

• example: temporary directory = /tmp/\$USER/cylc

B.1.2 process pool size

Number of process pool worker processes used to execute shell commands (job submission, event handlers, job poll and kill commands).

• type: integer

• default: None (number of processor cores on the suite host)

B.1.3 disable interactive command prompts

Commands that intervene in running suites can be made to ask for confirmation before acting. Some find this annoying and ineffective as a safety measure, however, so command prompts are disabled by default.

type: boolean default: True

B.1.4 enable run directory housekeeping

The suite run directory tree is created anew with every suite start (not restart) but output from the most recent previous runs can be retained in a rolling archive. Set length to 0 to keep no backups. **This is incompatible with current Rose suite housekeeping** (see Section 15 for more on Rose) so it is disabled by default, in which case new suite run files will overwrite existing ones in the same run directory tree. Rarely, this can result in incorrect polling results due to the presence of old task status files.

type: boolean default: False

B.1.5 run directory rolling archive length

The number of old run directory trees to retain if run directory housekeeping is enabled.

type: integer default: 2

B.1.6 execution polling intervals

Cylc can poll running jobs to catch problems that prevent task messages from being sent back to the suite, such as hard job kills, network outages, or unplanned task host shutdown. Routine polling is done only for the polling task communication method (below) unless suite-specific polling is configured in the suite definition. A list of interval values can be specified, with the last value used repeatedly until the task is finished - this allows more frequent polling near the beginning and end of the anticipated task run time. Multipliers can be used as shorthand as in the example below.

- type: ISO 8601 duration/interval representation (e.g. PT10S, 10 seconds, or PT1M, 1 minute).
- default:
- example: execution polling intervals = 5*PT1M, 10*PT5M, 5*PT1M

B.1.7 submission polling intervals

Cylc can also poll submitted jobs to catch problems that prevent the submitted job from executing at all, such as deletion from an external batch scheduler queue. Routine polling is done only for the polling task communication method (below) unless suite-specific polling is configured in the suite definition. A list of interval values can be specified as for execution polling (above) but a single value is probably sufficient for job submission polling.

- type: ISO 8601 duration/interval representation (e.g. PT10S, 10 seconds, or PT1M, 1 minute).
- default:
- example: (see the execution polling example above)

B.1.8 task host select command timeout

When a task host in a suite is a shell command string, cylc calls the shell to determine the task host. This call is invoked by the main process, and may cause the suite to hang while waiting for the command to finish. This setting sets a timeout for such a command to ensure that the suite can continue.

- type: ISO 8601 duration/interval representation (e.g. PT10S, 10 seconds, or PT1M, 1 minute).
- default: PT10S

B.2 [task messaging]

This section contains configuration items that affect task-to-suite communications.

B.2.1 [task messaging] \rightarrow retry interval

If a send fails, the messaging code will retry after a configured delay interval.

- type: ISO 8601 duration/interval representation (e.g. PT10S, 10 seconds, or PT1M, 1 minute).
- default: PT5S

B.2.2 [task messaging] →maximum number of tries

If successive sends fail, the messaging code will give up after a configured number of tries.

type: integer minimum: 1 default: 7

B.2.3 [task messaging] \rightarrow connection timeout

This is the same as the --comms-timeout option in cylc commands. Without a timeout remote connections to unresponsive suites can hang indefinitely (suites suspended with Ctrl-Z for instance).

• type: ISO 8601 duration/interval representation (e.g. PT10S, 10 seconds, or PT1M, 1 minute).

• default: PT30S

B.3 [suite logging]

The suite event log, held under the suite run directory, is maintained as a rolling archive. Logs are rolled over (backed up and started anew) when they reach a configurable limit size.

B.3.1 [suite logging] \rightarrow roll over at start-up

If True, a new suite log will be started for a new suite run.

type: boolean default: True

B.3.2 [suite logging] \rightarrow rolling archive length

How many rolled logs to retain in the archive.

type: integer minimum: 1 default: 5

B.3.3 [suite logging] \rightarrow maximum size in bytes

Suite event logs are rolled over when they reach this file size.

type: integer default: 1000000

B.4 [documentation]

Documentation locations for the cylc doc command and gcylc Help menus.

B.4.1 [documentation] \rightarrow [files]]

File locations of documentation held locally on the cylc host server.

B.4.1.1 [documentation] \rightarrow [[files]] \rightarrow html index

File location of the main cylc documentation index.

- type: string
- default: \$CYLC_DIR/doc/index.html

B.4.1.2 [documentation] \rightarrow [files]] \rightarrow pdf user guide

File location of the cylc User Guide, PDF version.

- type: string
- $default: \protect\p$

$\textbf{B.4.1.3} \quad [\textbf{documentation}] \rightarrow \!\! [[\textbf{files}]] \rightarrow \!\! \textbf{multi-page html user guide}$

File location of the cylc User Guide, multi-page HTML version.

- type: string
- default: \$CYLC_DIR/doc/html/multi/cug-html.html

B.4.1.4 [documentation] \rightarrow [files]] \rightarrow single-page html user guide

File location of the cylc User Guide, single-page HTML version.

- type: string
- default: \$CYLC_DIR/doc/html/single/cug-html.html

$\textbf{B.4.2} \quad [\textbf{documentation}] \rightarrow [[\textbf{urls}]]$

Online documentation URLs.

B.4.2.1 [documentation] \rightarrow [[urls]] \rightarrow internet homepage

URL of the cylc internet homepage, with links to documentation for the latest official release.

- type: string
- default: http://cylc.github.com/cylc/

B.4.2.2 [documentation] \rightarrow [[urls]] \rightarrow local index

Local intranet URL of the main cylc documentation index.

- type: string
- default: (none)

B.5 [document viewers]

PDF and HTML viewers can be launched by cylc to view the documentation.

B.5.1 [document viewers] \rightarrow pdf

Your preferred PDF viewer program.

- type: string
- default: evince

B.5.2 [document viewers] $\rightarrow html$

Your preferred web browser.

type: string default: firefox

B.6 [editors]

Choose your favourite text editor for editing suite definitions.

B.6.1 [editors] \rightarrow terminal

The editor to be invoked by the cylc command line interface.

```
type: string
default: vim
examples:

terminal = emacs -nw (emacs non-GUI)
terminal = emacs (emacs GUI)
terminal = gvim -f (vim GUI)
```

B.6.2 [editors] $\rightarrow gui$

The editor to be invoked by the cylc GUI.

```
type: string
default: gvim -f
examples:
gui = emacs
gui = xterm -e vim
```

B.7 [communication]

This section covers options for network communication between cylc clients (suite-connecting commands and guis) servers (running suites). Each suite listens on a dedicated network port, binding on the first available starting at the configured base port.

By default, the communication method is HTTPS secured with HTTP Digest Authentication. If the system does not support SSL, it will fall back to HTTP.

B.7.1 [communication] \rightarrow method

The choice of client-server communication method - currently only HTTPS is supported, although others could be developed and plugged in.

```
type: stringoptions:
        httpsdefault: https
```

B.7.2 [communication] \rightarrow base port

The first port that cylc is allowed to use.

type: integer default: 43001

B.7.3 [communication] → maximum number of ports

This determines the maximum number of suites that can run at once on the suite host.

type: integer default: 100

B.7.4 [communication] →ports directory

Each suite stores its port number, by suite name, under this directory.

type: string (directory path) default: \$HOME/.cylc/ports/

B.7.5 [communication] \rightarrow proxies on

Enable or disable proxy servers for HTTPS - disabled by default.

• type: boolean

• localhost default: False

B.7.6 [communication] \rightarrow options

Option flags for the communication method. Currently only 'SHA1' is supported for HTTPS, which alters HTTP Digest Auth to use the SHA1 hash algorithm rather than the standard MD5. This is more secure but is also less well supported by third party web clients including web browsers. You may need to add the 'SHA1' option if you are running on platforms where MD5 is discouraged (e.g. under FIPS).

• type: string_list

• *default:* []

• options:

- SHA1

B.8 [monitor]

Configurable settings for the command line cylc monitor tool.

B.8.1 $[monitor] \rightarrow sort order$

The sort order for tasks in the monitor view.

• type: string

• options:

- alphanumeric
- **definition** the order that tasks appear under [runtime] in the suite definition.
- default: definition

B.9 [hosts]

The [hosts] section configures some important host-specific settings for the suite host ('local-host') and remote task hosts. Note that remote task behaviour is determined by the site/user config on the suite host, not on the task host. Suites can specify task hosts that are not listed here, in which case local settings will be assumed, with the local home directory path, if present, replaced by \$home in items that configure directory locations.

$B.9.1 \text{ [hosts]} \rightarrow \text{[[HOST]]}$

The default task host is the suite host, **localhost**, with default values as listed below. Use an explicit [hosts][[localhost]] section if you need to override the defaults. Localhost settings are then also used as defaults for other hosts, with the local home directory path replaced as described above. This applies to items omitted from an explicit host section, and to hosts that are not listed at all in the site and user config files. Explicit host sections are only needed if the automatically modified local defaults are not sufficient.

Host section headings can also be regular expressions to match multiple hostnames. Note that the general regular expression wildcard is '.*' (zero or more of any character), not '*'. Hostname matching regular expressions are used as-is in the Python re.match() function. As such they match from the beginning of the hostname string (as specified in the suite definition) and they do not have to match through to the end of the string (use the string-end matching character '\$' in the expression to force this).

A hierarchy of host match expressions from specific to general can be used because config items are processed in the order specified in the file.

- type: string (hostname or regular expression)
- examples:
 - server1.niwa.co.nz explicit host name
 - server\d.niwa.co.nz regular expression

B.9.1.1 [hosts] \rightarrow [[HOST]] \rightarrow run directory

The top level of the directory tree that holds suite-specific output logs, run database, etc.

- type: string (directory path)
- default: \$HOME/cylc-run

B.9.1.2 [hosts] \rightarrow [[HOST]] \rightarrow work directory

The top level for suite work and share directories.

- type: string (directory path)
- localhost default: \$HOME/cylc-run

B.9.1.3 [hosts] \rightarrow [[HOST]] \rightarrow task communication method

The means by which task progress messages are reported back to the running suite. See above for default polling intervals for the poll method.

- type: string (must be one of the following three options)
- options:

- **default** direct client-server communication via network ports
- ssh use ssh to re-invoke the messaging commands on the suite server
- **poll** the suite polls for the status of tasks (no task messaging)
- ullet localhost default: default

B.9.1.4 [hosts] \rightarrow [[HOST]] \rightarrow remote copy template

A string for the command used to copy files to a remote host. This is not used on the suite host unless you run local tasks under another user account.

- type: string
- localhost default: scp -oBatchMode=yes -oConnectTimeout=10

$\textbf{B.9.1.5} \quad [\textbf{hosts}] \rightarrow [[\textbf{HOST}]] \rightarrow \textbf{remote shell template}$

A string for the command used to invoke commands on this host. This is not used on the suite host unless you run local tasks under another user account. (N.B. This setting used to be a string template with a %s being a placeholder for the name of the host. This is no longer the case. Any %s in the string will now be discarded.)

- type: string
- localhost default: ssh -oBatchMode=yes -oConnectTimeout=10

B.9.1.6 [hosts] \rightarrow [[HOST]] \rightarrow use login shell

Whether to use a login shell or not for remote command invocation. By default cylc runs remote ssh commands using a login shell:

```
ssh user@host 'bash --login cylc ...'
```

which will source /etc/profile and ~/.profile to set up the user environment. However, for security reasons some institutions do not allow unattended commands to start login shells, so you can turn off this behaviour to get:

```
ssh user@host 'cylc ...'
```

which will use the default shell on the remote machine, sourcing ~/.bashrc (or ~/.cshrc) to set up the environment.

- type: boolean
- localhost default: True

B.9.1.7 [hosts] \rightarrow [[HOST]] \rightarrow cylc executable

The cylc executable on a remote host. Note this should point to the cylc multi-version wrapper (see 8.2) on the host, not bin/cylc for a specific installed version. Specify a full path if cylc is not in \\$PATH when it is invoked via ssh on this host.

- type: string
- localhost default: cylc

B.9.1.8 [hosts] \rightarrow [[HOST]] \rightarrow global init-script

If specified, the value of this setting will be inserted to just before the init-script section of all job scripts that are to be submitted to the specified remote host.

- type: string
- localhost default: ""

B.9.1.9 [hosts] \rightarrow [[HOST]] \rightarrow copyable environment variables

A list containing the names of the environment variables that can and/or need to be copied from the suite daemon to a job.

- type: string_list
- localhost default: []

B.9.1.10 [hosts] \rightarrow [[HOST]] \rightarrow retrieve job logs

Global default for the A.4.1.16.3 setting for the specified host.

B.9.1.11 [hosts] \rightarrow [[HOST]] \rightarrow retrieve job logs command

If rsync -a is unavailable or insufficient to retrieve job logs from a remote host, you can use this setting to specify a suitable command.

- type: string
- default: rsync -a

B.9.1.12 [hosts] \rightarrow [[HOST]] \rightarrow retrieve job logs max size

Global default for the A.4.1.16.4 setting for the specified host.

B.9.1.13 [hosts] \rightarrow [[HOST]] \rightarrow retrieve job logs retry delays

Global default for the A.4.1.16.5 setting for the specified host.

B.9.1.14 [hosts] \rightarrow [[HOST]] \rightarrow task event handler retry delays

Host specific default for the A.4.1.17.7 setting.

B.9.1.15 [hosts] \rightarrow [[HOST]] \rightarrow local tail command template

A template (with %(filename)s substitution) for the command used to tail-follow local job logs, used by the gcylc log viewer and cylc cat-log --tail. You are unlikely to need to override this.

- type: string
- default: tail -n +1 -F %(filename)s

B.9.1.16 [hosts] \rightarrow [[HOST]] \rightarrow remote tail command template

A template (with %(filename)s substitution) for the command used to tail-follow remote job logs, used by the gcylc log viewer and cylc cat-log --tail. The remote tail command needs to be told to die when its parent process exits. You may need to override this command for task hosts where the default tail or ps commands are not equivalent to the Gnu Linux versions.

- type: string
- default: tail --pid=\$(ps h -o ppid \$\$ | sed -e 's/[[:space:]]//g') -n +1 -F %(filename)s
- example: for AIX hosts:
 /gnu/tail --pid=\$(ps -o ppid= -p \$\$ | sed -e 's/[[:space:]]//g') -n +1 -F %(filename)s

B.9.1.17 [hosts] \rightarrow [[HOST]] \rightarrow [[[batch systems]]]

Settings for particular batch systems on HOST. In the subsections below, SYSTEM should be replaced with the cylc job submission method name that represents the batch system (see A.4.1.15.1).

$\text{B.9.1.17.1} \quad [\text{hosts}] \rightarrow [[\text{HOST}]] \rightarrow [[[\text{batch systems}]]] \rightarrow [[[[\text{SYSTEM}]]]] \rightarrow \text{err tailer}$

A command template (with %(job_id)s substitution) that can be used to tail-follow the stderr stream of a running job if SYSTEM does not use the normal log file location while the job is running. This setting overrides B.9.1.15 and B.9.1.16 above.

- type: string
- default: (none)
- example: For PBS:

$\textbf{B.9.1.17.2} \quad [\textbf{hosts}] \rightarrow [[\textbf{HOST}]] \rightarrow [[[\textbf{batch systems}]]] \rightarrow [[[[\textbf{SYSTEM}]]]] \rightarrow \textbf{out tailer}$

A command template (with %(job_id)s substitution) that can be used to tail-follow the stdout stream of a running job if SYSTEM does not use the normal log file location while the job is running. This setting overrides B.9.1.15 and B.9.1.16 above.

- type: string default: (none)
- example: see B.9.1.17.1

$\textbf{B.9.1.17.3} \quad [\textbf{hosts}] \rightarrow [[\textbf{HOST}]] \rightarrow [[[\textbf{batch systems}]]] \rightarrow [[[[\textbf{SYSTEM}]]]] \rightarrow \textbf{err viewer}$

A command template (with %(job_id)s substitution) that can be used to view the stderr stream of a running job if SYSTEM does not use the normal log file location while the job is running.

```
 type: string default: (none) example: see B.9.1.17.1
```

$B.9.1.17.4 \quad [hosts] \rightarrow [[HOST]] \rightarrow [[[batch\ systems]]] \rightarrow [[[[SYSTEM]]]] \rightarrow out\ viewer$

A command template (with %(job_id)s substitution) that can be used to view the stdout stream of a running job if SYSTEM does not use the normal log file location while the job is running.

• type: string

```
 default: (none) example: see B.9.1.17.1
```

B.9.1.17.5 [hosts] \rightarrow [[HOST]] \rightarrow [[[batch systems]]] \rightarrow [[[[SYSTEM]]]] \rightarrow job name length maximum

The maximum length for job name acceptable by a batch system on a given host. Currently, this setting is only meaningful for PBS jobs. For example, PBS 12 or older will fail a job submit if the job name has more than 15 characters, which is the default setting. If you have PBS 13 or above, you may want to modify this setting to a larger value.

```
• type: integer
• default: (none)
• example: For PBS:
    [hosts]
        [[myhpc*]]
        [[[batch systems]]]
        [[[pbs]]]]
        # PBS 13
        job name length maximum = 236
```

B.9.1.17.6 [hosts] \rightarrow [[HOST]] \rightarrow [[[batch systems]]] \rightarrow [[[[SYSTEM]]]] \rightarrow execution time limit polling intervals

The intervals between polling after a task job (submitted to the relevant batch system on the relevant host) exceeds its execution time limit. The default setting is PT1M, PT2M, PT7M. The accumulated times (in minutes) for these intervals will be roughly 1, 1 + 2 = 3 and 1 + 2 + 7 = 10 after a task job exceeds its execution time limit.

- type: Comma-separated list of ISO 8601 duration/interval representations, optionally preceded by multipliers.
- default: PT1M, PT2M, PT7M
- example:

B.10 [suite host self-identification]

The suite host's identity must be determined locally by cylc and passed to running tasks (via \$CYLC_SUITE_HOST) so that task messages can target the right suite on the right host.

B.10.1 [suite host self-identification] \rightarrow method

This item determines how cylc finds the identity of the suite host. For the default *name* method cylc asks the suite host for its host name. This should resolve on remote task hosts to the IP address of the suite host; if it doesn't, adjust network settings or use one of the other methods. For the *address* method, cylc attempts to use a special external "target address" to determine the IP address of the suite host as seen by remote task hosts (in-source documentation in \$CYLC_DIR/lib/cylc/suite_host.py explains how this works). And finally, as a last resort, you can choose the *hardwired* method and manually specify the host name or IP address of the suite host.

- type: string
- options:
 - name self-identified host name
 - address automatically determined IP address (requires target, below)
 - hardwired manually specified host name or IP address (requires host, below)
- default: name

B.10.2 [suite host self-identification] \rightarrow target

This item is required for the *address* self-identification method. If your suite host sees the internet, a common address such as <code>google.com</code> will do; otherwise choose a host visible on your intranet.

- type: string (an inter- or intranet URL visible from the suite host)
- default: google.com

B.10.3 [suite host self-identification] \rightarrow host

Use this item to explicitly set the name or IP address of the suite host if you have to use the hardwired self-identification method.

- type: string (host name or IP address)
- default: (none)

B.11 [suite host scanning]

Utilities such as cylc gsummary need to scan hosts for running suites.

B.11.1 [suite host scanning] \rightarrow hosts

A list of hosts to scan for running suites.

- type: comma-separated list of host names or IP addresses.
- default: localhost

B.12 [task events]

Global site/user defaults for A.4.1.17.

B.13 [test battery]

Settings for the automated development tests.

B.13.1 [test battery] \rightarrow remote host with shared fs

The name of a remote host with shared HOME file system as the host running the test battery.

B.13.2 [test battery] \rightarrow remote host

The name of a remote host without shared HOME file system as the host running the test battery.

B.13.3 [test battery] \rightarrow [[batch systems]]

Settings for testing supported batch systems (job submission methods). The tests for a batch system are only performed if the batch system is available on the test host or a remote host accessible via SSH from the test host.

B.13.3.1 [test battery] \rightarrow [[batch systems]] \rightarrow [[[SYSTEM]]]

SYSTEM is the name of a supported batch system with automated tests. This can currently be "loadleveler", "lsf", "pbs", "sge" and/or "slurm".

$B.13.3.1.1 \quad [test\ battery] \rightarrow [[batch\ systems]] \rightarrow [[[SYSTEM]]] \rightarrow host$

The name of a host where commands for this batch system is available. Use "localhost" if the batch system is available on the host running the test battery. Any specified remote host should be accessible via SSH from the host running the test battery.

B.13.3.1.2 [test battery] \rightarrow [[batch systems]] \rightarrow [[[SYSTEM]]] \rightarrow err viewer

The command template (with \%(job_id)s substitution) for testing the run time stderr viewer functionality for this batch system.

B.13.3.1.3 [test battery] \rightarrow [[batch systems]] \rightarrow [[[SYSTEM]]] \rightarrow out viewer

The command template (with \%(job_id)s substitution) for testing the run time stdout viewer functionality for this batch system.

B.13.3.1.4 [test battery] \rightarrow [[batch systems]] \rightarrow [[[SYSTEM]]] \rightarrow [[[directives]]]]

The minimum set of directives that must be supplied to the batch system on the site to initiate jobs for the tests.

B.14 [cylc]

Default values for entries in the suite.rc [cylc] section.

B.14.1 [cylc] \rightarrow UTC mode

Allows you to set a default value for UTC mode in a suite at the site level. See A.2.2 for details.

B.14.2 $[cylc] \rightarrow health check interval$

Site default suite health check interval. See A.2.7 for details.

B.14.3 [cylc] \rightarrow [[events]]

You can define site defaults for each of the following options, details of which can be found under A.2.12:

```
[cylc] \rightarrow [[events]] \rightarrow handlers
B.14.3.0.5
B.14.3.0.6
                     [\text{cylc}] \rightarrow [[\text{events}]] \rightarrow \text{handler events}
                     [\text{cylc}] \rightarrow [[\text{events}]] \rightarrow \text{startup handler}
B.14.3.0.7
                     [cylc] \rightarrow [[events]] \rightarrow shutdown handler
B.14.3.0.8
                     [cylc] \rightarrow [[events]] \rightarrow mail events
B.14.3.0.9
                      [\text{cylc}] \rightarrow [[\text{events}]] \rightarrow \text{mail footer}
B.14.3.0.10
B.14.3.0.11
                      [\text{cylc}] \rightarrow [[\text{events}]] \rightarrow \text{mail from}
                      [\text{cylc}] \rightarrow [[\text{events}]] \rightarrow \text{mail smtp}
B.14.3.0.12
B.14.3.0.13
                       [\text{cylc}] \rightarrow [[\text{events}]] \rightarrow \text{mail to}
                       [\text{cylc}] \rightarrow [[\text{events}]] \rightarrow \text{timeout handler}
B.14.3.0.14
B.14.3.0.15
                       [\text{cylc}] \rightarrow [[\text{events}]] \rightarrow \text{timeout}
B.14.3.0.16
                      [cylc] \rightarrow [[events]] \rightarrow abort on timeout
                       [cylc] \rightarrow [[events]] \rightarrow stalled handler
B.14.3.0.17
B.14.3.0.18
                       [cylc] \rightarrow [[events]] \rightarrow abort on stalled
B.14.3.0.19
                       [cylc] \rightarrow [[events]] \rightarrow inactivity handler
                       [\text{cylc}] \rightarrow [[\text{events}]] \rightarrow \text{inactivity}
B.14.3.0.20
                       [\text{cylc}] \rightarrow [[\text{events}]] \rightarrow \text{abort on inactivity}
B.14.3.0.21
```

B.15 [authentication]

Authentication of client programs with suite daemons can be configured here, and overridden in suites if necessary (see A.2.15).

The suite-specific passphrase must be installed on a user's account to authorize full control privileges (see 8.5 and 13.6). In the future we plan to move to a more traditional user account model so that each authorized user can have their own password.

B.15.1 [authentication] \rightarrow public

This sets the client privilege level for public access - i.e. no suite passphrase required.

- type: string (must be one of the following options)
- options:
 - identity only suite and owner names revealed
 - description identity plus suite title and description
 - state-totals identity, description, and task state totals
 - full-read full read-only access for monitor and GUI
 - shutdown full read access plus shutdown, but no other control.
- default: state-totals

C Gcylc Config File Reference

This section defines all legal items and values for the gcylc user config file, which should be located in \$HOME/.cylc/gcylc.rc. Current settings can be printed with the cylc get-gui-config command.

C.1 Top Level Items

C.1.1 dot icon size

Set the size of the task state dot icons displayed in the text and dot views.

- type: string
- legal values: "small" (10px), "medium" (14px), "large" (20px), "extra large (30px)"
- default: "medium"

C.1.2 initial side-by-side views

Set the suite view panels initial orientation when the GUI starts. This can be changed later using the "View" menu "Toggle views side-by-side" option.

- type: boolean (False or True)
- default: "False"

C.1.3 initial views

Set the suite view panel(s) displayed initially, when the GUI starts. This can be changed later using the tool bar.

- type: string (a list of one or two view names)
- legal values: "text", "dot", "graph"
- default: "text"
- example: initial views = graph, dot

C.1.4 sort by definition order

If this is not turned off the default sort order for task names and families in the dot and text views will the order they appear in the suite definition. Clicking on the task name column in the treeview will toggle to alphanumeric sort, and a View menu item does the same for the dot view. If turned off, the default sort order is alphanumeric and definition order is not available at all.

type: boolean default: True

C.1.5 sort column

If "text" is in initial views then sort column sets the column that will be sorted initially when the GUI launches. Sorting can be changed later by clicking on the column headers.

• type: string

- legal values: "task", "state", "host", "job system", "job ID", "T-submit", "T-start", "T-finish", "dT-mean", "latest message", "none"
- default: "none"
- example: sort column = T-start

C.1.6 sort column ascending

For use in combination with sort column, sets whether the column will be sorted using ascending or descending order.

- type: boolean default: "True"
- example: sort column ascending = False

C.1.7 task filter highlight color

The color used to highlight active task filters in gcylc. It must be a name from the X11 rgb.txt file, e.g. SteelBlue; or a *quoted* hexadecimal color code, e.g. "#ff0000" for red (quotes are required to prevent the hex code being interpreted as a comment).

type: string default: PowderBlue

C.1.8 task states to filter out

Set the initial filtering options when the GUI starts. Later this can be changed by using the "View" menu "Task Filtering" option.

- type: string list
- legal values: waiting, held, queued, ready, expired, submitted, submit-failed, submit-retrying, running, succeeded, failed, retrying, runahead
- default: runahead

C.1.9 transpose dot

Transposes the content in dot view so that it displays from left to right rather than from top to bottom. Can be changed later using the options submenu available via the view menu.

- type: boolean default: "False" example: transpose dot = True
- 1

C.1.10 transpose graph

Transposes the content in graph view so that it displays from left to right rather than from top to bottom. Can be changed later using the options submenu via the view menu.

type: boolean default: "False" example: transpose graph = True

C.1.11 ungrouped views

List suite views, if any, that should be displayed initially in an ungrouped state. Namespace family grouping can be changed later using the tool bar.

- type: string (a list of zero or more view names)
- legal values: "text", "dot", "graph"
- default: (none)
- example: ungrouped views = text, dot

C.1.12 use theme

Set the task state color theme, common to all views, to use initially. The color theme can be changed later using the tool bar. See <code>gcylc.rc.eg</code> and <code>themes.rc</code> in <code>\$CYLC_DIR/conf/gcylcrc/</code> for how to modify existing color themes or define your own. Use <code>cylc get-gui-config</code> to list your available themes.

- *type:* string (theme name)
- legal values: "default", "solid", "high-contrast", "color-blind", and any custom or user-modified themes.
- default: "default"

C.1.13 window size

Sets the size (in pixels) of the cylc GUI at startup.

- type: integer list (x, y)
- legal values: positive integers
- default: 800, 500
- example: window size = 1000, 700

C.2 [themes]

This section may contain task state color theme definitions.

C.2.1 [themes] \rightarrow [[THEME]]

The name of the task state color-theme to be defined in this section.

• type: string

C.2.1.1 [themes] \rightarrow [[THEME]] \rightarrow inherit

You can inherit from another theme in order to avoid defining all states.

- type: string (parent theme name)
- default: "default"

C.2.1.2 [themes] \rightarrow [[THEME]] \rightarrow defaults

Set default icon attributes for all state icons in this theme.

- *type:* string list (icon attributes)
- legal values: "color=COLOR", "style=STYLE", "fontcolor=FONTCOLOR"
- default: (none)

For the attribute values, COLOR and FONTCOLOR can be color names from the X11 rgb.txt file, e.g. SteelBlue; or hexadecimal color codes, e.g. #ff0000 for red; and STYLE can be "filled" or "unfilled". See gcylc.rc.eg and themes.rc in \$CYLC_DIR/conf/gcylcrc/ for examples.

C.2.1.3 [themes] \rightarrow [[THEME]] \rightarrow STATE

Set icon attributes for all task states in THEME, or for a subset of them if you have used theme inheritance and/or defaults. Legal values of STATE are any of the cylc task proxy states: waiting, runahead, held, queued, ready, submitted, submit-failed, running, succeeded, failed, retrying, submit-retrying.

- type: string list (icon attributes)
- legal values: "color=COLOR", "style=STYLE", "fontcolor=FONTCOLOR"
- default: (none)

For the attribute values, COLOR and FONTCOLOR can be color names from the X11 rgb.txt file, e.g. SteelBlue; or hexadecimal color codes, e.g. #ff0000 for red; and STYLE can be "filled" or "unfilled". See gcylc.rc.eg and themes.rc in \$CYLC_DIR/conf/gcylcrc/ for examples.

D Cylc Gscan Config File Reference

This section defines all legal items and values for the gscan config file which should be located in \$HOME/.cylc/gscan.rc.

D.1 Top Level Items

D.1.1 activate on startup

Set whether cylc gpanel will activate automatically when the gui is loaded or not.

- type: boolean (True or False)
- legal values: "True", "False"
- default: "False"
- example: activate on startup = True

D.1.2 columns

Set the data fields displayed initially when the cylc gscan GUI starts. This can be changed later using the right click context menu.

Note that the order in which the fields are specified does not affect the order in which they are displayed.

- type: string (a list of one or more view names)
- legal values: "host", "status", "suite", "title", "updated"
- default: "status", "suite"
- example: columns = suite, title, status

E Command Reference

```
Cylc ("silk") is a suite engine and metascheduler that specializes in
cycling weather and climate forecasting suites and related processing
(but it can also be used for one-off workflows of non-cycling tasks).
For detailed documentation see the Cylc User Guide (cylc doc --help).
Version 7.0.0
The graphical user interface for cylc is "gcylc" (a.k.a. "cylc gui").
  % cylc -v,--version
                                            # print cylc version
  % cylc version
                                            # (ditto, by command)
  % cylc help, --help, -h,?
                                            # print this help page
  % cylc help CATEGORY
                                            # print help by category
  % cylc CATEGORY help
                                            # (ditto)
  % cylc help [CATEGORY] COMMAND
                                          # print command help
  % cylc [CATEGORY] COMMAND help, -- help # (ditto)
  % cylc [CATEGORY] COMMAND [options] SUITE [arguments]
  % cylc [CATEGORY] COMMAND [options] SUITE TASK [arguments]
Commands and categories can both be abbreviated. Use of categories is
optional, but they organize help and disambiguate abbreviated commands:
% cylc control trigger SUITE TASK # trigger TASK in SUITE
  % cylc trigger SUITE TASK
                                            # ditto
  % cylc con trig SUITE TASK
                                            # ditto
  % cylc c t SUITE TASK
TASK IDENTIFICATION IN CYLC SUITES
  Tasks are identified by NAME.CYCLE_POINT where POINT is either a
  date-time or an integer.
  Date-time cycle points are in an ISO 8601 date-time format, typically
  CCYYMMDDThhmm followed by a time zone - e.g. 20101225T0600Z.
  Integer cycle points (including those for one-off suites) are integers
- just '1' for one-off suites.
HOW TO DRILL DOWN TO COMMAND USAGE HELP:
  % cylc help  # list all available categories (this page)
% cylc help prep  # list commands in category 'preparation'
  % cylc help prep  # list commands in category 'preparation' % cylc help prep edit # command usage help for 'cylc [prep] edit'
Command CATEGORIES:
  all ...... The complete command set.
  preparation ... Suite editing, validation, visualization, etc.
  information ... Interrogate suite definitions and running suites.
  discovery ..... Detect running suites.
  control ...... Suite start u\bar{p}, monitoring, and control.
  utility ...... Cycle arithmetic and templating, etc.
  task ...... The task messaging interface.
  hook ..... Suite and task event hook scripts.
  admin ...... Cylc installation, testing, and example suites.
  license | GPL ... Software licensing information (GPL v3.0).
E.1 Command Categories
E.1.1 admin
CATEGORY: admin - Cylc installation, testing, and example suites.
HELP: cylc [admin] COMMAND help, --help
  You can abbreviate admin and COMMAND.
  The category admin may be omitted.
COMMANDS:
  check-software .... Check required software is installed. import-examples ... Import example suites your suite run directory
```

```
test-battery ..... Run a battery of self-diagnosing test suites upgrade-run-dir ... Upgrade a pre-cylc-6 suite run directory
```

E.1.2 all

```
CATEGORY: all - The complete command set.
HELP: cylc [all] COMMAND help, --help
  You can abbreviate all and COMMAND.
  The category all may be omitted.
COMMANDS:

      JMMANDS:
      Improve the cylc 6 compatibility of a cylc

      broadcast|bcast
      Change suite [runtime] settings on the fly

      cat-log|log
      Print various suite and task log files

      cat-state
      Print the state of tasks from the state dun

      check-software
      Check required software is installed

      check-triggering
      A suite shutdown event hook for cylc testing

      check-versions
      Compare cylc versions on task host accounts

  get-suite-contact/get-contact/print-contact ... Fint the contact information of a suite daged get-suite-version|get-cylc-version ... Print the cylc version of a suite dagemon gpanel ... Internal interface for GNOME 2 panel applet graph ... Plot suite dependency graphs and runtime higraph-diff ... Compare two suite dependencies or runtime higscan|gsummary ... Scan GUI for monitoring multiple suites
  jobscript ...... Generate a task job script and print it to kill ...... Kill submitted or running tasks
  kill submitted or running tasks
list|ls ... List suite tasks and family namespaces
ls-checkpoints ... Display task pool etc at given events
message|task-message ... (task messaging) Report task messages
monitor ... An in-terminal suite monitor (see also gcyl
nudge ... Cause the cylc task processing loop to be i
ping ... Check that a suite is running
poll ... Poll submitted or running tasks
print ... Print registered suites
random|rnd ... Generate a random integer within a given random|rnd ... Register a suite for use
```

The category control may be omitted.

COMMANDS:

broadcast|bcast Change suite [runtime] settings on the fly ext-trigger|external-trigger ... Report an external trigger event to a suite gui (a.k.a. gcylc) cylc GUI for suite control etc. hold Hold (pause) suites or individual tasks insert Insert tasks into a running suite kill Kill submitted or running tasks nudge Cause the cylc task processing loop to be invoked poll Poll submitted or running tasks release | unhold Release (unpause) suites or individual tasks remove Remove tasks from a running suite set-verbosity Change a running suite's logging verbosity spawn Force one or more tasks to spawn their successors. stop|shutdown Shut down running suites trigger Manually trigger or re-trigger a task

E.1.4 discovery

```
HELP: cylc [discovery] COMMAND help, --help
You can abbreviate discovery and COMMAND.
The category discovery may be omitted.

COMMANDS:
check-versions ... Compare cylc versions on task host accounts
ping .......... Check that a suite is running
scan ......... Scan a host for running suites

E.1.5 hook
```

CATEGORY: hook - Suite and task event hook scripts.

CATEGORY: discovery - Detect running suites.

HELP: cylc [hook] COMMAND help, --help
You can abbreviate hook and COMMAND.
The category hook may be omitted.

COMMANDS:

check-triggering A suite shutdown event hook for cylc testing email-suite A suite event hook script that sends email alerts email-task A task event hook script that sends email alerts job-logs-retrieve ... (Internal) Retrieve logs from a remote host for a task job

E.1.6 information

CATEGORY: information - Interrogate suite definitions and running suites.

```
HELP: cylc [information] COMMAND help,--help You can abbreviate information and COMMAND.
 The category information may be omitted.
COMMANDS:
 dump ..... Print the state of tasks in a running suite
 gpanel ...... Internal interface for GNOME 2 panel applet gscan|gsummary ..... Scan GUI for monitoring multiple suites
 version ...... Print the cylc release version
E.1.7 license
CATEGORY: license | GPL - Software licensing information (GPL v3.0).
HELP: cylc [license|GPL] COMMAND help, --help
  You can abbreviate license | GPL and COMMAND.
 The category license | GPL may be omitted.
COMMANDS:
  conditions ... Print the GNU General Public License v3.0
  warranty ..... Print the GPLv3 disclaimer of warranty
E.1.8 preparation
CATEGORY: preparation - Suite editing, validation, visualization, etc.
HELP: cylc [preparation] COMMAND help,--help
You can abbreviate preparation and COMMAND.
 The category preparation may be omitted.
 5to6 .......... Improve the cylc 6 compatibility of a cylc 5 suite file diff|compare .... Compare two suite definitions and print differences
 edit ..... Edit suite definitions, optionally inlined
 get-directory ... Retrieve suite source directory paths graph ...... Plot suite dependency graphs and runtime hierarchies
 graph-diff ..... Compare two suite dependencies or runtime hierarchies
 jobscript ...... Generate a task job script and print it to stdout list|ls ...... List suite tasks and family namespaces
 print ..... Print registered suites
 register ....... Register a suite for use search|grep ..... Search in suite definitions
 validate ....... Parse and validate suite definitions view ....... View suite definitions, inlined and Jinja2 processed
E.1.9 task
CATEGORY: task - The task messaging interface.
HELP: cylc [task] COMMAND help, --help
  You can abbreviate task and COMMAND.
 The category task may be omitted.
COMMANDS:
  job-submit ..... (Internal) Submit a job
```

```
message|task-message ... (task messaging) Report task messages
submit|single ..... Run a single task just as its parent suite would
```

E.1.10 utility

```
CATEGORY: utility - Cycle arithmetic and templating, etc.
```

```
HELP: cylc [utility] COMMAND help, --help
You can abbreviate utility and COMMAND.
The category utility may be omitted.
```

COMMANDS:

E.2 Commands

E.2.1 5to6

Usage: cylc [prep] 5to6 FILE

Suggest changes to a cylc 5 suite file to make it more cylc 6 compatible. This may be a suite.rc file, an include file, or a suite.rc.processed file.

By default, print the changed file to stdout. Lines that have been changed are marked with '# UPGRADE'. These marker comments are purely for your own information and should not be included in any changes you make. In particular, they may break continuation lines.

```
Lines with '# UPGRADE CHANGE' have been altered. Lines with '# UPGRADE \dots INFO' indicate that manual change is needed.
```

As of cylc 7, 'cylc validate' will no longer print out automatic dependency section translations. At cylc 6 versions of cylc, 'cylc validate' will show start-up/mixed async replacement R1* section(s). The validity of these can be highly dependent on the initial cycle point choice (e.g. whether it is T00 or T12).

This command works best for hour-based cycling - it will always convert e.g. 'foo[T-6]' to 'foo[-PT6H]', even where this is in a monthly or yearly cycling section graph.

This command is an aid, and is not an auto-upgrader or a substitute for reading the documentation. The suggested changes must be understood and checked by hand.

Example usage:

```
\mbox{\# Print} out a file path (FILE) with suggested changes to stdout.cylc 5to6 FILE
```

- # Replace the file with the suggested changes file. cylc 5to6 FILE > FILE
- # Save a copy of the changed file.
 cylc 5to6 FILE > FILE.5to6
- # Show the diff of the changed file vs the original file. diff <(cylc 5to6 FILE) <FILE

Options:

-h, --help Print this help message and exit.

E.2.2 broadcast

```
Usage: cylc [control] broadcast|bcast [OPTIONS] REG
```

Override [runtime] config in targeted namespaces in a running suite.

Uses for broadcast include making temporary changes to task behaviour, and task-to-downstream-task communication via environment variables.

A broadcast can target any [runtime] namespace for all cycles or for a specific cycle. If a task is affected by specific-cycle and all-cycle broadcasts at once, the specific takes precedence. If a task is affected by broadcasts to multiple ancestor namespaces, the result is determined by normal [runtime] inheritance. In other words, it follows this order:

all:root -> all:FAM -> all:task -> tag:root -> tag:FAM -> tag:task

Broadcasts persist, even across suite restarts, until they expire when their target cycle point is older than the oldest current in the suite, or until they are explicitly cancelled with this command. All-cycle broadcasts do not expire.

For each task the final effect of all broadcasts to all namespaces is computed on the fly just prior to job submission. The --cancel and --clear options simply cancel (remove) active broadcasts, they do not act directly on the final task-level result. Consequently, for example, you cannot broadcast to "all cycles except Tn" with an all-cycle broadcast followed by a cancel to Tn (there is no direct broadcast to Tn to cancel); and you cannot broadcast to "all members of FAMILY except member_n" with a general broadcast to FAMILY followed by a cancel to member_n (there is no direct broadcast to member_n to cancel).

To broadcast a variable to all tasks (quote items with internal spaces):
 % cylc broadcast -s "[environment]VERSE = the quick brown fox" REG
To cancel the same broadcast:
 % cylc broadcast --cancel "[environment]VERSE" REG

Use -d/--display to see active broadcasts. Multiple set or cancel options can be used on the same command line. Broadcast cannot change [runtime] inheritance.

See also 'cylc reload' - reload a modified suite definition at run time.

Arguments:

REG Suite name

Options:

```
-h, --help
                         show this help message and exit
-p CYCLE_POINT, --point=CYCLE_POINT
                         Target cycle point. More than one can be added.
Defaults to '*' with --set and --cancel, and nothing
                         with --clear.
-n NAME, --namespace=NAME
                         Target namespace. Defaults to 'root' with --set and
-- cancel, and nothing with -- clear.
-s [SEC]ITEM=VALUE, -- set=[SEC]ITEM=VALUE
                         A [runtime] config item and value to broadcast.
-c [SEC]ITEM, --cancel=[SEC]ITEM
                         An item-specific broadcast to cancel.
                         Cancel all broadcasts, or with -p/--point, -n/--namespace, cancel all broadcasts to targeted
-C. --clear
                         namespaces and/or cycle points. Use "-C -p '*' to
                         cancel all all-cycle broadcasts without canceling all
                          specific-cycle broadcasts.
-e CYCLE_POINT, --expire=CYCLE_POINT
                         Cancel any broadcasts that target cycle points earlier
                         than, but not inclusive of, CYCLE_POINT.
-d, --display
                         Display active broadcasts.
-k TASKID, --display-task=TASKID
                         Print active broadcasts for a given task (NAME.CYCLE_POINT).
```

Use unicode box characters with -d, -k.

reinvocation on the remote account.

With -d/--display or -k/--display-task, write out the

Other host name. This results in command reinvocation

broadcast config structure in raw Python form. Other user account name. This results in command

-b, --box

-r, --raw

--user=USER

--host=HOST

```
on the remote account.
-v, --verbose
                         Verbose output mode.
--debug
                         Run suites in non-daemon mode, and show exception
                          tracebacks.
--port=INT
                         Suite port number on the suite host. NOTE: this is
                         retrieved automatically if non-interactive ssh is
                          configured to the suite host.
--use-ssh
                          Use ssh to re-invoke the command on the suite host.
--no-login
                         Do not use a login shell to run remote ssh commands.
                         The default is to use a login shell.
--comms-timeout=SEC, --pyro-timeout=SEC
                         Set a timeout for network connections to the running
                          suite. The default is no timeout. For task messaging
                         connections see site/user config file documentation. Print the client UUID to stderr. This can be matched
--print-uuid
                         to information logged by the receiving suite daemon. Set the client UUID manually (e.g. from prior use of
--set-unid=UUID
                          --print-uuid). This can be used to log multiple
                          commands under the same UUID (but note that only the
                         first [info] command from the same client ID will be
                         logged unless the suite is running in debug mode).
                         Do not ask for confirmation before acting. Note that it is not necessary to use this option if interactive
-f, --force
                          command prompts have been disabled in the site/user
                          config files.
```

E.2.3 cat-log

Usage: cylc [info] cat-log|log [OPTIONS] REG [TASK-ID]

Print the location or content of any suite or task log file, or a listing of a task log directory on the suite or task host. By default the suite event log or task job script is printed. For task logs you must use the same cycle point format as the suite (list the log directory to see what it is).

```
Arguments:
```

```
REG Suite name [TASK-ID] Task ID
```

Options:

```
show this help message and exit
-h, --help
-1, --location
                              Print location of the log file, exit 0 if it exists,
                               exit 1 otherwise
-o, --stdout
-e, --stderr
                               Suite log: out, task job log: job.out
Suite log: err, task job log: job.err
-r INT, --rotation=INT
                               Suite logs log rotation number
                               Task job log only: Short for --filename=job-
-a, --activity
                               activity.log
-d, --diff
                               Task job log only: Short for --filename=job-edit.diff
(file present after an edit-run).

-u, --status Task job log only: Short for --filename=job.status
-f FILENAME, -c FILENAME, --filename=FILENAME, --custom=FILENAME

Name of log file (e.g. 'job.stats').

--tail Tail the job log, if the task is running.
-s INT, -t INT, --submit-number=INT, --try-number=INT
                               Task job log only: submit number (default=NN).
                               List a log directory on the suite host
-x, --list-local
-y, --list-remote
                               Task job log only: List log directory on the job host Other user account name. This results in command
 --user=USER
                               reinvocation on the remote account.
--host=HOST
                               Other host name. This results in command reinvocation
                               on the remote account.
-v, --verbose
                               Verbose output mode.
                               Run suites in non-daemon mode, and show exception
--debug
                               tracebacks.
```

E.2.4 cat-state

```
Usage: cylc [info] cat-state [OPTIONS] REG
```

Print the suite state in the old state dump file format to stdout. This command is deprecated; use "cylc ls-checkpoints" instead.

REG Suite name

Options:

-h, --help show this help message and exit -d, --dump Use the same display format as the 'cylc dump' command. --user=USER Other user account name. This results in command reinvocation on the remote account. --host=HOST Other host name. This results in command reinvocation on the remote account. -v, --verbose Verbose output mode. --debug Run suites in non-daemon mode, and show exception tracebacks.

E.2.5 check-software

Usage: cylc [admin] check-software

Check that the external software required by cylc is installed.

Minimum versions are not checked, except in the case of Python.

Options:

-h, --help Print this help message and exit.

E.2.6 check-triggering

cylc [hook] check-triggering ARGS

This is a cylc shutdown event handler that compares the newly generated suite log with a previously generated reference log "reference.log" stored in the suite definition directory. Currently it just compares runtime triggering information, disregarding event order and timing, and fails the suite if there is any difference. This should be sufficient to verify correct scheduling of any suite that is not affected by different run-to-run conditional triggering.

1) run your suite with "cylc run --generate-reference-log" to generate the reference log with resolved triggering information. Check manually that the reference run was correct. 2) run reference tests with "cylc run --reference-test" - this automatically sets the shutdown event handler along with a suite timeout and "abort if shutdown handler fails", "abort on timeout", and "abort if any task fails".

- Reference tests can use any run mode:
 * simulation mode tests that scheduling is equivalent to the reference * dummy mode - also tests that task hosting, job submission, job script
 - evaluation, and cylc messaging are not broken.
 * live mode tests everything (but takes longer with real tasks!)

If any task fails, or if cylc itself fails, or if triggering is not equivalent to the reference run, the test will abort with non-zero exit status - so reference tests can be used as automated tests to check

that changes to cylc have not broken your suites.

E.2.7 check-versions

Usage: cylc [discovery] check-versions [OPTIONS] SUITE

Check the version of cylc invoked on each of SUITE's task host accounts when CYLC_VERSION is set to *the version running this command line tool*. Different versions are reported but are not considered an error unless the -e|--error option is specified, because different cylc versions from 6.0.0 onward should at least be backward compatible.

It is recommended that cylc versions be installed in parallel and ${\tt access}$ configured via the cylc version wrapper as described in the cylc INSTALL file and User Guide. This must be done on suite and task hosts. Users then get the latest installed version by default, or (like tasks) a particular version if \$CYLC_VERSION is defined.

User -v/--verbose to see the command invoked to determine the remote version (all remote cylc command invocations will be of the same form, which may be site dependent -- see cylc global config documentation.

Arguments:

SUITE Suite name or path Options: -h, --help show this help message and exit -e, --error Exit with error status if 7.0.0 is not available on all remote accounts. Verbose output mode. -v, --verbose --debug Run suites in non-daemon mode, and show exception tracebacks. --suite-owner=OWNER Specify suite owner -s NAME=VALUE, --set=NAME=VALUE Set the value of a Jinja2 template variable in the suite definition. This option can be used multiple times on the command line. NOTE: these settings persist across suite restarts, but can be set again on the "cylc restart" command line if they need to be

overridden. Set the value of Jinja2 template variables in the suite definition from a file containing NAME=VALUE pairs (one per line). NOTE: these settings persist across suite restarts, but can be set again on the "cylc restart" command line if they need to be overridden.

E.2.8 conditions

--set-file=FILE

```
Usage: cylc [license] warranty [--help]
Cylc is release under the GNU General Public License v3.0
This command prints the GPL v3.0 license in full.
Options:
             Print this usage message.
   --help
```

```
E.2.9 cycle-point
Usage: cylc [util] cycle-point [OPTIONS] [POINT]
Cycle point date-time offset computation, and filename templating.
Filename templating replaces elements of a template string with corresponding
elements of the current or given cycle point.
Use ISO 8601 or posix date-time format elements:
  % cylc cyclepoint 2010080T00 --template foo-CCYY-MM-DD-Thh.nc
  foo-2010-08-08-T00.nc
  % cylc cyclepoint 2010080T00 --template foo-%Y-%m-%d-Thh.nc
  foo-2010-08-08-T00.nc
Other examples:
1) print offset from an explicit cycle point:
    % cylc [util] cycle-point --offset-hours=6 20100823T1800Z
  20100824T0000Z
2) print offset from $CYLC_TASK_CYCLE_POINT (as in suite tasks):
  % export CYLC_TASK_CYCLE_POINT=20100823T1800Z
  % cylc cycle-point --offset-hours=-6
  20100823T1200Z
3) cycle point filename templating, explicit template:
  % export CYLC_TASK_CYCLE_POINT=2010-08
% cylc cycle-point --offset-years=2 --template=foo-CCYY-MM.nc
  foo-2012-08.nc
```

```
4) cycle point filename templating, template in a variable: \% export CYLC_TASK_CYCLE_POINT=2010-08
  % export MYTEMPLATE=foo-CCYY-MM.nc
  % cylc cycle-point --offset-years=2 --template=MYTEMPLATE
  foo-2012-08.nc
Arguments:
   [POINT] ISO 8601 date-time, e.g. 20140201T0000Z, default
       $CYLC_TASK_CYCLE_POINT
Options:
  -h, --help
                           show this help message and exit
                          Add N hours to CYCLE (may be negative)
Add N days to CYCLE (N may be negative)
  --offset-hours=HOURS
  --offset-days=DAYS
  --offset-months=MONTHS
                           Add N months to CYCLE (N may be negative)
  --offset-years=YEARS
--offset=ISO_OFFSET
                          Add N years to CYCLE (N may be negative)
                           Add an ISO 8601-based interval representation to CYCLE
  --template=TEMPLATE
                           Filename template string or variable
                          Control the formatting of the result's timezone e.g.
  --time-zone=TEMPLATE
                           (Z, +13:00, -hh
  --num-expanded-year-digits=NUMBER
                           Specify a number of expanded year digits to print in
                           the result
  --print-year
                           Print only CCYY of result
                          Print only MM of result
Print only DD of result
  --print-month
  --print-day
  --print-hour
                           Print only hh of result
```

E.2.10 diff

Usage: cylc [prep] diff|compare [OPTIONS] SUITE1 SUITE2

Compare two suite definitions and display any differences.

Differencing is done after parsing the suite.rc files so it takes account of default values that are not explicitly defined, it disregards the order of configuration items, and it sees any include-file content after inlining has occurred.

Note that seemingly identical suites normally differ due to inherited default configuration values (e.g. the default job submission log directory.

Files in the suite bin directory and other sub-directories of the suite definition directory are not currently differenced.

```
Arguments:
```

Suite name or path SUITE1 SUITE2 Suite name or path

Options:

-h, --help print suite.rc section headings in nested form. -n, --nested --user=USER Other user account name. This results in command reinvocation on the remote account. --host=HOST Other host name. This results in command reinvocation on the remote account. -v, --verbose Verbose output mode. --debug Run suites in non-daemon mode, and show exception tracebacks. --suite-owner=OWNER Specify suite owner -s NAME=VALUE, --set=NAME=VALUE Set the value of a Jinja2 template variable in the suite definition. This option can be used multiple times on the command line. NOTE: these settings persist across suite restarts, but can be set again on the "cylc restart" command line if they need to be overridden. Set the value of Jinja2 template variables in the --set-file=FILE

suite definition from a file containing NAME=VALUE

show this help message and exit

pairs (one per line). NOTE: these settings persist across suite restarts, but can be set again on the "cylc restart" command line if they need to be overridden.

E.2.11 documentation

```
Usage: cylc [info] documentation|browse [OPTIONS] [SUITE]
Open cylc or suite documentation in your browser or PDF viewer (as defined
in cylc global config files).
% cylc doc [OPTIONS]
   Open local or internet [--www] cylc documentation (locations must be
specified in cylc global config files).
% cylc doc -u [-t TASK] SUITE
    Open suite or task documentation if corresponding URL items are specified
in the suite definition.
Arguments:
               File, URL, or suite name
   [TARGET]
Options:
  -h, --help
-p, --pdf
-w, --www
                           show this help message and exit
                           Open the PDF User Guide directly.
                           Open the cylc internet homepage
  -t TASK_NAME, --task=TASK_NAME
                           Browse task documentation URLs.
  -s, --stdout
                           Just print the URL to stdout.
  --user=USER
                           Other user account name. This results in command
                           reinvocation on the remote account.
  --host = HOST
                           Other host name. This results in command reinvocation
                           on the remote account.
E.2.12 dump
Usage: cylc [info] dump [OPTIONS] REG
Print state information (e.g. the state of each task) from a running suite. For small suites 'watch cylc [info] dump SUITE' is an effective
non-GUI real time monitor (but see also 'cylc monitor').
For more information about a specific task, such as the current state of
its prerequisites and outputs, see 'cylc [info] show'.
 Display the state of all running tasks, sorted by cycle point: % cylc [info] dump --tasks --sort SUITE | grep running
 Display the state of all tasks in a particular cycle point:
 % cylc [info] dump -t SUITE | grep 2010082406
Arguments:
                        Suite name
   REG
Options:
  -h, --help
-g, --global
                           show this help message and exit
                           Global information only.
  -t, --tasks
                           Task states only.
  -r, --raw, --raw-format
                           Display raw format.
  -s, --sort
                           Task states only; sort by cycle point instead of name. Other user account name. This results in command
  --user=USER
                           reinvocation on the remote account.
  --host=HOST
                           Other host name. This results in command reinvocation
                           on the remote account. Verbose output mode.
  -v, --verbose
  --debug
                           Run suites in non-daemon mode, and show exception
                           tracebacks.
```

Suite port number on the suite host. NOTE: this is

--port=INT

retrieved automatically if non-interactive ssh is configured to the suite host. --use-ssh Use ssh to re-invoke the command on the suite host. --no-login Do not use a login shell to run remote ssh commands. The default is to use a login shell. --comms-timeout=SEC, --pyro-timeout=SEC Set a timeout for network connections to the running suite. The default is no timeout. For task messaging connections see site/user config file documentation. Print the client UUID to stderr. This can be matched --print-uuid to information logged by the receiving suite daemon. Set the client UUID manually (e.g. from prior use of --set-uuid=UUID --print-uuid). This can be used to log multiple commands under the same UUID (but note that only the first [info] command from the same client ID will be logged unless the suite is running in debug mode).

E.2.13 edit

Usage: cylc [prep] edit [OPTIONS] SUITE

Edit suite definitions without having to move to their directory locations, and with optional reversible inlining of include-files. Note that Jinja2 suites can only be edited in raw form but the processed version can be viewed with 'cylc [prep] view -p'.

1/cylc [prep] edit SUITE Change to the suite definition directory and edit the suite.rc file.

2/ cylc [prep] edit -i,--inline SUITE
Edit the suite with include-files inlined between special markers. The
original suite.rc file is temporarily replaced so that the inlined
version is "live" during editing (i.e. you can run suites during
editing and cylc will pick up changes to the suite definition). The
inlined file is then split into its constituent include-files
again when you exit the editor. Include-files can be nested or
multiply-included; in the latter case only the first inclusion is
inlined (this prevents conflicting changes made to the same file).

3/ cylc [prep] edit --cleanup SUITE Remove backup files left by previous INLINED edit sessions.

INLINED EDITING SAFETY: The suite.rc file and its include-files are automatically backed up prior to an inlined editing session. If the editor dies mid-session just invoke 'cylc edit -i' again to recover from the last saved inlined file. On exiting the editor, if any of the original include-files are found to have changed due to external intervention during editing you will be warned and the affected files will be written to new backups instead of overwriting the originals. Finally, the inlined suite.rc file is also backed up on exiting the editor, to allow recovery in case of accidental corruption of the include-file boundary markers in the inlined file.

The edit process is spawned in the foreground as follows: % <editor> suite.rc Where <editor> is defined in the cylc site/user config files.

See also 'cylc [prep] view'.

Arguments:

SUITE Suite name or path

Options:

-h, --help show this help message and exit
-i, --inline Edit with include-files inlined as described above.
--cleanup Remove backup files left by previous inlined edit sessions.
-g, --gui Force use of the configured GUI editor.
--user=USER Other user account name. This results in command reinvocation on the remote account.
--host=HOST Other host name. This results in command reinvocation

on the remote account.

```
-v, --verbose Verbose output mode.
--debug Run suites in non-daemon mode, and show exception tracebacks.
--suite-owner=OWNER Specify suite owner
```

E.2.14 email-suite

```
Usage: cylc [hook] email-suite EVENT SUITE MESSAGE
```

```
This is a simple suite event hook script that sends an email.

The command line arguments are supplied automatically by cylc.

For example, to get an email alert when a suite shuts down:

# SUITE.RC

[cylc]

   [[environment]]

     MAIL_ADDRESS = foo@bar.baz.waz

   [[events]]

     shutdown handler = cylc email-suite
```

See the Suite.rc Reference (Cylc User Guide) for more information on suite and task event hooks and event handler scripts.

E.2.15 email-task

Usage: cylc [hook] email-task EVENT SUITE TASKID MESSAGE

This is a simple task event hook handler script that sends an email. The command line arguments are supplied automatically by ${\tt cylc}$.

For example, to get an email alert whenever any task fails:

See the Suite.rc Reference (Cylc User Guide) for more information on suite and task event hooks and event handler scripts.

E.2.16 ext-trigger

Usage: cylc [control] ext-trigger [OPTIONS] REG MSG ID

Report an external event message to a suite daemon. It is expected that a task in the suite has registered the same message as an external trigger – a special prerequisite to be satisifed by an external system, via this command, rather than by triggering off other tasks.

The ID argument should uniquely distinguish one external trigger event from the next. When a task's external trigger is satisfied by an incoming message, the message ID is broadcast to all downstream tasks in the cycle point as \$CYLC_EXT_TRIGGER_ID so that they can use it - e.g. to identify a new data file that the external triggering system is responding to.

Use the retry options in case the target suite is down or out of contact.

The suite passphrase must be installed in \$HOME/.cylc/<SUITE>/.

Note: to manually trigger a task use 'cylc trigger', not this command.

Arguments:

```
REG Suite name
MSG External trigger message
ID Unique trigger ID
```

```
Options:
                            show this help message and exit Maximum number of send attempts (default 5).
  -h, --help
  --max-tries=INT
  --retry-interval=SEC Delay in seconds before retrying (default 10.0).
  --user=USER
                            Other user account name. This results in command
                            reinvocation on the remote account.
  --host = HOST
                            Other host name. This results in command reinvocation
                            on the remote account.
  -v, --verbose
                            Verbose output mode.
  --debug
                            Run suites in non-daemon mode, and show exception
                            tracebacks.
                            Suite port number on the suite host. NOTE: this is
  --port = INT
                            retrieved automatically if non-interactive ssh is configured to the suite host.
  --use-ssh
                            Use ssh to re-invoke the command on the suite host.
                            Do not use a login shell to run remote ssh commands.
  --no-login
                            The default is to use a login shell.
  --comms-timeout=SEC, --pyro-timeout=SEC
                            Set a timeout for network connections to the running
                            suite. The default is no timeout. For task messaging
                            connections see site/user config file documentation. Print the client UUID to stderr. This can be matched
  --print-uuid
                            to information logged by the receiving suite daemon.
                            Set the client UUID manually (e.g. from prior use of --print-uuid). This can be used to log multiple
  --set-uuid=UUID
                            commands under the same UUID (but note that only the
                            first [info] command from the same client ID will be
                            logged unless the suite is running in debug mode).
                            Do not ask for confirmation before acting. Note that it is not necessary to use this option if interactive
  -f. --force
                            command prompts have been disabled in the site/user
                            config files.
```

E.2.17 get-directory

```
Usage: cylc [prep] get-directory REG
Retrieve and print the source directory location of suite REG.
Here's an easy way to move to a suite source directory:
  $ cd $(cylc get-dir REG).
Arguments:
   SUITE
                       Suite name or path
Options:
  -h, --help
                       show this help message and exit
  --user=USER
                       Other user account name. This results in command
                       reinvocation on the remote account.
  --host=HOST
                       Other host name. This results in command reinvocation
                       on the remote account.
                       Verbose output mode.
  -v, --verbose
                       Run suites in non-daemon mode, and show exception
  --debug
                       tracebacks.
  --suite-owner=OWNER
                       Specify suite owner
```

E.2.18 get-gui-config

```
Usage: cylc [admin] get-gui-config [OPTIONS]

Print gcylc configuration settings.

By default all settings are printed. For specific sections or items use -i/--item and wrap parent sections in square brackets: cylc get-gui-config --item '[themes][default]succeeded' Multiple items can be specified at once.

Options:
-h, --help show this help message and exit -v, --verbose Print extra information.
--debug Show exception tracebacks.
-i [SEC...]ITEM, --item=[SEC...]ITEM
```

```
Item or section to print (multiple use allowed).
                           Only print items explicitly set in the config files.
  --sparse
  -p, --python
                           Print native Python format.
E.2.19 get-site-config
Usage: cylc [admin] get-site-config [OPTIONS]
Print cylc site/user configuration settings.
By default all settings are printed. For specific sections or items
use -i/--item and wrap parent sections in square brackets:
   cylc get-site-config --item '[editors]terminal'
Multiple items can be specified at once.
  -h, --help
                          show this help message and exit
  -i [SEC...] ITEM, --item=[SEC...] ITEM
                           Item or section to print (multiple use allowed).
                           Only print items explicitly set in the config files.
                           Print native Python format.
Print the configured cylc run directory.
  -p, --python
--print-run-dir
  --print-site-dir
                           Print the cylc site configuration directory location.
                           Print extra information.
  -v, --verbose
  --debug
                           Show exception tracebacks.
E.2.20 get-suite-config
Usage: cylc [info] get-suite-config [OPTIONS] SUITE
Print parsed suite configuration items, after runtime inheritance.
By default all settings are printed. For specific sections or items
use -i/--item and wrap sections in square brackets, e.g.:

cylc get-suite-config --item '[scheduling]initial cycle point'
Multiple items can be retrieved at once.
By default, unset values are printed as an empty string, or (for historical reasons) as "None" with -\text{o}/--\text{one}-\text{line}. These defaults
can be changed with the -n/--null-value option.
Example:
  |# SUITE.RC
   [runtime]
        [[modelX]]
            [[[environment]]]
                 F00 = foo
                 BAR = bar
$ cylc get-suite-config --item=[runtime][modelX][environment]F00 SUITE
$ cylc get-suite-config --item=[runtime][modelX][environment] SUITE
F00 = foo
BAR = bar
$ cylc get-suite-config --item=[runtime][modelX] SUITE
[[[environment]]]
    FOO = foo
    BAR = bar
Arguments:
   SUITE
                          Suite name or path
Options:
```

show this help message and exit

Item or section to print (multiple use allowed).

Only print items explicitly set in the config files.

-i [SEC...] ITEM, --item=[SEC...] ITEM

-h, --help

-r, --sparse

```
-p, --python
                       Print native Python format.
                       For [runtime] items (e.g. --item='script') report
-a, --all-tasks
                       values for all tasks prefixed by task name.
-n STRING, --null-value=STRING
                       The string to print for unset values (default
                       nothing).
-m, --mark-up
                       Prefix each line with '!cylc!'.
-o, --one-line
                       Print multiple single-value items at once.
-t, --tasks
                      Print the suite task list [DEPRECATED: use 'cylc list
                       SUITE'].
--user=USER
                       Other user account name. This results in command
                      reinvocation on the remote account.
--host=HOST
                       Other host name. This results in command reinvocation
                       on the remote account.
-v, --verbose
                       Verbose output mode.
--debug
                       Run suites in non-daemon mode, and show exception
                       tracebacks.
--suite-owner=OWNER
                      Specify suite owner
-s NAME=VALUE, --set=NAME=VALUE
                      Set the value of a Jinja2 template variable in the
                       suite definition. This option can be used multiple
                       times on the command line. NOTE: these settings
                       persist across suite restarts, but can be set again on
                       the "cylc restart" command line if they need to be
                       overridden.
--set-file=FILE
                       Set the value of Jinja2 template variables in the
                       suite definition from a file containing NAME=VALUE
                       pairs (one per line). NOTE: these settings persist
                       across suite restarts, but can be set again on the "cylc restart" command line if they need to be
                       overridden.
```

E.2.21 get-suite-contact

```
Usage: cylc [info] get-suite-contact [OPTIONS] REG
```

Print contact information of running suite REG.

Arguments:

REG Suite name

Options:

-h, --help show this help message and exit Other user account name. This results in command reinvocation --user=USER on the remote account. --host=HOST Other host name. This results in command reinvocation on the remote account. -v, --verbose Verbose output mode. Run suites in non-daemon mode, and show exception tracebacks. --debug

E.2.22 get-suite-version

Usage: cylc [info] get-suite-version [OPTIONS] REG

Interrogate running suite REG to find what version of cylc is running it.

To find the version you've invoked at the command line see "cylc version".

Arguments:

REG Suite name

Options:

-h, --help show this help message and exit --user=USER Other user account name. This results in command reinvocation on the remote account. --host=HOST Other host name. This results in command reinvocation on the remote account. -v, --verbose Verbose output mode. --debug Run suites in non-daemon mode, and show exception tracebacks. --port=INTSuite port number on the suite host. NOTE: this is

```
retrieved automatically if non-interactive ssh is
                            configured to the suite host.
--use-ssh
                            Use ssh to re-invoke the command on the suite host.
--no-login
                            Do not use a login shell to run remote ssh commands.
                            The default is to use a login shell.
--comms-timeout=SEC, --pyro-timeout=SEC
                            Set a timeout for network connections to the running
                            suite. The default is no timeout. For task messaging
                           connections see site/user config file documentation. Print the client UUID to stderr. This can be matched
--print-uuid
                            to information logged by the receiving suite daemon.
                            Set the client UUID manually (e.g. from prior use of
--set-uuid=UUID
                            --print-uuid). This can be used to log multiple commands under the same UUID (but note that only the
                            first [info] command from the same client ID will be
                           logged unless the suite is running in debug mode). Do not ask for confirmation before acting. Note that it is not necessary to use this option if interactive
-f. --force
                            command prompts have been disabled in the site/user
                            config files.
```

E.2.23 gpanel

Usage: cylc gpanel [OPTIONS]

This is a cylc scan panel applet for monitoring running suites on a set of hosts in ${\tt GNOME}$ 2.

To install this applet, run "cylc gpanel --install" and follow the instructions that it gives you.

This applet can be tested using the --test option.

To customize themes, copy $CYLC_DIR/conf/gcylcrc/gcylc.rc.eg$ to HOME/.cylc/gcylc.rc and follow the instructions in the file.

To configure default suite hosts, edit the [suite host scanning]hosts entry in your global.rc file.

Options:

```
-h, --help show this help message and exit
--compact Switch on compact mode at runtime.
--install Install the panel applet.
--test Run in a standalone window.
```

E.2.24 graph

Usage: 1/ cylc [prep] graph [OPTIONS] SUITE [START[STOP]] Plot the suite.rc dependency graph for SUITE. 2/ cylc [prep] graph [OPTIONS] -f,--file FILE Plot the specified dot-language graph file. 3/ cylc [prep] graph [OPTIONS] --reference SUITE [START[STOP]] Print out a reference format for the dependencies in SUITE. 4/ cylc [prep] graph [OPTIONS] --output-file FILE SUITE Plot SUITE dependencies to a file FILE with a extension-derived format. If FILE endswith ".png", output in PNG format, etc.

Plot suite dependency graphs in an interactive graph viewer.

If START is given it overrides "[visualization] initial cycle point" to determine the start point of the graph, which defaults to the suite initial cycle point. If STOP is given it overrides "[visualization] final cycle point" to determine the end point of the graph, which defaults to the graph start point plus "[visualization] number of cycle points" (which defaults to 3). The graph start and end points are adjusted up and down to the suite initial and final cycle points, respectively, if necessary.

The "Save" button generates an image of the current view, of format (e.g. png, svg, jpg, eps) determined by the filename extension. If the chosen format is not available a dialog box will show those that are available.

```
If the optional output filename is specified, the viewer will not open and a
graph will be written directly to the file.
GRAPH VIEWER CONTROLS:
    * Center on a node: left-click.
* Pan view: left-drag.
    * Zoom: +/- buttons, mouse-wheel, or ctrl-left-drag.
    * Box zoom: shift-left-drag.
* "Best Fit" and "Normal Size" buttons.
    * Left-to-right graphing mode toggle button.
    * "Ignore suicide triggers" button.
    * "Save" button: save an image of the view.
  Family (namespace) grouping controls:
    Toolbar:
    * "group" - group all families up to root.
* "ungroup" - recursively ungroup all families.
    Right-click menu:
    * "group" - close this node's parent family.
* "ungroup" - open this family node.
    * "recursive ungroup" - ungroup all families below this node.
Arguments:
                              Suite name or path
    [SUITE]
                             Initial cycle point (default: suite initial point)
Final cycle point (default: initial + 3 points)
    [START]
   [STOP]
Options:
  -h, --help
                             show this help message and exit
  -u, --ungrouped
                            Start with task families ungrouped (the default is
                             grouped).
  -n, --namespaces
                             Plot the suite namespace inheritance hierarchy (task
                            run time properties).
  -f FILE, --file=FILE
                            View a specific dot-language graphfile.
  --filter=NODE_NAME_PATTERN
                            Filter out one or many nodes.
  -O FILE, --output-file=FILE
                            Output to a specific file, with a format given by
                            --output-format or extrapolated from the extension. '-' implies stdout in plain format.
  --output-format=FORMAT
                            Specify a format for writing out the graph to
                            --output-file e.g. png, svg, jpg, eps, dot. 'ref' is a special sorted plain text format for comparison and
                             reference purposes.
  -r, --reference
                             Output in a sorted plain text format for comparison
                            purposes. If not given, assume --output-file=-. Show suicide triggers. They are not shown by default,
  --show-suicide
                             unless toggled on with the tool bar button.
  --user=USER
                             Other user account name. This results in command
                            reinvocation on the remote account.
  --host = HOST
                            Other host name. This results in command reinvocation
                            on the remote account.
  -v, --verbose
                            Verbose output mode.
  --debug
                            Run suites in non-daemon mode, and show exception
                            tracebacks.
  --suite-owner=OWNER
                            Specify suite owner
  -s NAME=VALUE, --set=NAME=VALUE
                            Set the value of a Jinja2 template variable in the
                             suite definition. This option can be used multiple
                             times on the command line. NOTE: these settings
                            persist across suite restarts, but can be set again on
                             the "cylc restart" command line if they need to be
                             overridden.
  --set-file=FILE
                            Set the value of Jinja2 template variables in the
                            suite definition from a file containing NAME=VALUE pairs (one per line). NOTE: these settings persist
                            across suite restarts, but can be set again on the "cylc restart" command line if they need to be
                             overridden.
```

E.2.25 graph-diff

```
Usage: cylc graph-diff [OPTIONS] SUITE1 SUITE2 -- [GRAPH_OPTIONS_ARGS]
Difference 'cylc graph --reference' output for SUITE1 and SUITE2.
OPTIONS: Use '-g' to launch a graphical diff utility. Use '--diff-cmd=MY_DIFF_CMD' to use a custom diff tool.
SUITE1, SUITE2: Suite names to compare.
GRAPH_OPTIONS_ARGS: Options and arguments passed directly to cylc graph.
E.2.26 gscan
Usage: cylc gscan [OPTIONS]
This is the cylc scan gui for monitoring running suites on a set of
hosts.
To customize themes copy $CYLC_DIR/conf/gcylcrc/gcylc.rc.eg to
$HOME/.cylc/gcylc.rc and follow the instructions in the file.
Arguments:
Options:
  -h, --help
                           show this help message and exit
                           Host names to monitor (override site default).
  --host=HOST
  --poll-interval=SECONDS
                           Polling interval (time between updates) in seconds
  -n PATTERN, --name=PATTERN
                           List suites with name matching PATTERN (regular
                           expression). Defaults to any name. Can be used
                           multiple times.
                           Other user account name. This results in command reinvocation on the remote account.
  --user=USER
  -v, --verbose
                           Verbose output mode.
  --debug
                           Run suites in non-daemon mode, and show exception
                           tracebacks.
E.2.27 gui
Usage: cylc gui [OPTIONS] [REG]
gcylc [OPTIONS] [REG]
This is the cylc Graphical User Interface.
Local suites can be opened and switched between from within gcylc. To connect
to running remote suites (whose passphrase you have installed) you must
currently use --host and/or --user on the gcylc command line.
Available task state color themes are shown under the View menu. To customize
themes copy $CYLC_DIR/conf/gcylcrc/gcylc.rc.eg to $HOME/.cylc/gcylc.rc and
follow the instructions in the file.
To see current configuration settings use "cylc get-gui-config".
In the graph view, View -> Options -> "Write Graph Frames" writes .dot graph
files to the suite share directory (locally, for a remote suite). These can be processed into a movie by \$CYLC_DIR/dev/bin/live-graph-movie.sh=.
Arguments:
   [REG]
                          Suite name
Options:
  -h, --help
                           show this help message and exit
  -r, --restricted
                           Restrict display to 'active' task states: submitted,
                           submit-failed, submit-retrying, running, failed, retrying; and disable the graph view. This may be needed for very large suites. The state summary icons
                           in the status bar still represent all task proxies.
  --user=USER
                           Other user account name. This results in command
                           reinvocation on the remote account.
```

Other host name. This results in command reinvocation

--host = HOST

```
on the remote account.
-v, --verbose
                         Verbose output mode.
--debug
                         Run suites in non-daemon mode, and show exception
                         tracebacks.
                         Suite port number on the suite host. NOTE: this is retrieved automatically if non-interactive ssh is
--port=INT
                         configured to the suite host.
--use-ssh
                         Use ssh to re-invoke the command on the suite host.
--no-login
                         Do not use a login shell to run remote ssh commands.
                         The default is to use a login shell.
--comms-timeout=SEC, --pyro-timeout=SEC
                         Set a timeout for network connections to the running
                         suite. The default is no timeout. For task messaging
                         connections see site/user config file documentation. Print the client UUID to stderr. This can be matched
--print-uuid
                         to information logged by the receiving suite daemon. Set the client UUID manually (e.g. from prior use of
--set-unid=UUID
                         --print-uuid). This can be used to log multiple
                         commands under the same UUID (but note that only the
                         first [info] command from the same client ID will be
                         logged unless the suite is running in debug mode).
-s NAME=VALUE, --set=NAME=VALUE
                         Set the value of a Jinja2 template variable in the
                         suite definition. This option can be used multiple
                         times on the command line. NOTE: these settings
                         persist across suite restarts, but can be set again on
                         the "cylc restart" command line if they need to be
                         overridden.
--set-file=FILE
                         Set the value of Jinja2 template variables in the
                         suite definition from a file containing NAME=VALUE
                         pairs (one per line). NOTE: these settings persist
                         across suite restarts, but can be set again on the "cylc restart" command line if they need to be
                         overridden.
```

E.2.28 hold

```
Usage: cylc [control] hold [OPTIONS] REG [TASKID ...]
Hold one or more waiting tasks (cylc hold REG TASKID \dots), or
a whole suite (cylc hold REG).
Held tasks do not submit even if they are ready to run.
See also 'cylc [control] release'.
A TASKID is an identifier for matching individual task proxies and/or families
of them. It can be written in these syntaxes:
* [CYCLE-POINT-GLOB/] TASK-NAME-GLOB[:TASK-STATE]
* [CYCLE-POINT-GLOB/] FAMILY-NAME-GLOB[:TASK-STATE]
* TASK-NAME-GLOB[.CYCLE-POINT-GLOB][:TASK-STATE]
* FAMILY-NAME-GLOB[.CYCLE-POINT-GLOB][:TASK-STATE]
For example, to match:
* all tasks in a cycle: '20200202T0000Z/*' or '*.20200202T0000Z'
* all tasks in the submitted status: ':submitted'
* retrying 'foo*' tasks in 0000Z cycles: 'foo*.*0000Z:retrying' or
   '*0000Z/foo*:retrying'
* retrying tasks in 'BAR' family: '*/BAR:retrying' or 'BAR.*:retrying' * retrying tasks in 'BAR' or 'BAZ' families: '*/BA[RZ]:retrying' or
   'BA[RZ].*:retrying'
The old 'MATCH POINT' syntax will be automatically detected and supported. To avoid this, use the '--no-multitask-compat' option, or use the new syntax (with a '/' or a '.') when specifying 2 TASKID arguments.
Arguments:
    REG
                                        Suite name
    [TASKID ...]
                                        Task identifiers
Options:
  -h, --help
                                show this help message and exit
```

```
--after=CYCLE_POINT
                           Hold whole suite AFTER this cycle point.
--user=USER
                           Other user account name. This results in command
                           reinvocation on the remote account.
--host=HOST
                           Other host name. This results in command reinvocation
                           on the remote account.
-v, --verbose
                           Verbose output mode.
--debug
                           Run suites in non-daemon mode, and show exception
                            tracebacks.
                           Suite port number on the suite host. NOTE: this is
--port = INT
                           retrieved automatically if non-interactive ssh is configured to the suite host.
                           Use ssh to re-invoke the command on the suite host.
--use-ssh
--no-login
                           Do not use a login shell to run remote ssh commands.
                           The default is to use a login shell.
--comms-timeout=SEC, --pyro-timeout=SEC
                           Set a timeout for network connections to the running suite. The default is no timeout. For task messaging
                           connections see site/user config file documentation. Print the client UUID to stderr. This can be matched
--print-uuid
                           to information logged by the receiving suite daemon.
                           Set the client UUID manually (e.g. from prior use of --print-uuid). This can be used to log multiple
--set-unid=UUID
                            commands under the same UUID (but note that only the
                           first [info] command from the same client ID will be logged unless the suite is running in debug mode).
                           Do not ask for confirmation before acting. Note that it is not necessary to use this option if interactive
-f. --force
                            command prompts have been disabled in the site/user
                            config files.
-m, --family
                            (Obsolete) This option is now ignored and is retained
                           for backward compatibility only. TASKID in the argument list can be used to match task and family
                            names regardless of this option.
--no-multitask-compat
                            Disallow backward compatible multitask interface.
```

E.2.29import-examples

Usage: cylc [admin] import-examples DIR

Copy the cylc example suites to DIR and register them for use under the GROUP suite name group.

Arguments:

destination directory DTR

E.2.30 insert

Usage: cylc [control] insert [OPTIONS] REG TASKID [...]

Insert task proxies into a running suite. Uses of insertion include: 1) insert a task that was excluded by the suite definition at start-up. 2) reinstate a task that was previously removed from a running suite.

3) re-run an old task that cannot be retriggered because its task proxy is no longer live in the a suite.

Be aware that inserted cycling tasks keep on cycling as normal, even if another instance of the same task exists at a later cycle (instances of the same task at different cycles can coexist, but a newly spawned task will not be added to the pool if it catches up to another task with the same ID).

See also 'cylc submit', for running tasks without the scheduler.

A TASKID is an identifier for matching individual task proxies and/or families of them. It can be written in these syntaxes:

- * [CYCLE-POINT-GLOB/] TASK-NAME-GLOB[:TASK-STATE]
 * [CYCLE-POINT-GLOB/] FAMILY-NAME-GLOB[:TASK-STATE]
- * TASK-NAME-GLOB[.CYCLE-POINT-GLOB][:TASK-STATE]
- * FAMILY-NAME-GLOB[.CYCLE-POINT-GLOB][:TASK-STATE]

```
For example, to match:
* all tasks in a cycle: '20200202T0000Z/*' or '*.20200202T0000Z'
* all tasks in the submitted status: ':submitted'
* retrying 'foo*' tasks in 0000Z cycles: 'foo*.*0000Z:retrying' or
   '*0000Z/foo*:retrying'
* retrying tasks in 'BAR' family: '*/BAR:retrying' or 'BAR.*:retrying' 
* retrying tasks in 'BAR' or 'BAZ' families: '*/BA[RZ]:retrying' or
  'BA[RZ].*:retrying'
The old 'MATCH POINT' syntax will be automatically detected and supported. To avoid this, use the '--no-multitask-compat' option, or use the new syntax (with a '/' or a '.') when specifying 2 TASKID arguments.
Arguments:
    REG
                                      Suite name
    TASKID [...]
                                     Task identifier
Options:
   -h, --help
                             show this help message and exit
   --stop-point=POINT, --remove-point=POINT
                              Optional hold/stop cycle point for inserted task. Other user account name. This results in command
  --user=USER
                              reinvocation on the remote account.
   --host=HOST
                              Other host name. This results in command reinvocation
                              on the remote account.
  -v, --verbose
                              Verbose output mode.
                              Run suites in non-daemon mode, and show exception
   --debug
                              tracebacks.
                              Suite port number on the suite host. NOTE: this is
  --port=INT
                              retrieved automatically if non-interactive ssh is
                              configured to the suite host.
                              Use ssh to re-invoke the command on the suite host. Do not use a login shell to run remote ssh commands.
   --use-ssh
  --no-login
                              The default is to use a login shell.
   --comms-timeout=SEC, --pyro-timeout=SEC
                              Set a timeout for network connections to the running
                              suite. The default is no timeout. For task messaging
                              connections see site/user config file documentation. Print the client UUID to stderr. This can be matched
  --print-uuid
                              to information logged by the receiving suite daemon.
   --set-uuid=UUID
                              Set the client UUID manually (e.g. from prior use of
                              --print-uuid). This can be used to log multiple
                              commands under the same UUID (but note that only the
                              first [info] command from the same client ID will be
                              logged unless the suite is running in debug mode).
                              Do not ask for confirmation before acting. Note that it is not necessary to use this option if interactive command prompts have been disabled in the site/user
  -f, --force
                              config files.
                              (Obsolete) This option is now ignored and is retained
  -m, --family
                              for backward compatibility only. TASKID in the argument list can be used to match task and family
                              names regardless of this option.
   --no-multitask-compat
                              Disallow backward compatible multitask interface.
E.2.31 job-logs-retrieve
Usage: cylc [hook] job-logs-retrieve [OPTIONS] HOST:HOST-PATH LOCALHOST-PATH
(This command is for internal use.)
Retrieve logs from a remote host for a task job.
```

```
Arguments:
   HOST: HOST-PATH
                                      Path to remote job logs directory Path to local job logs directory
   LOCALHOST - PATH
Options:
                      show this help message and exit
  -h, --help
  --max-size=SIZE Don't transfer any file larger than SIZE.
```

```
--user=USER
                   Other user account name. This results in command
                   reinvocation on the remote account.
  --host=HOST
                   Other host name. This results in command reinvocation on
                   the remote account.
  -v, --verbose
                   Verbose output mode.
                   Run suites in non-daemon mode, and show exception
  --debug
                   tracebacks.
E.2.32 job-submit
Usage: cylc [task] job-submit [--remote-mode] JOB-FILE-PATH
(This command is for internal use. Users should use "cylc submit".)
Submit a job file.
Arguments:
   JOB-FILE-PATH
                               the path of the job file
Options:
                 show this help message and exit
  -h, --help
  --remote-mode Is this being run on a remote job host?
  --user=USER
                 Other user account name. This results in command reinvocation
                 on the remote account.
  --host=HOST
                 Other host name. This results in command reinvocation on the
                 remote account.
  -v, --verbose
                Verbose output mode.
  --debug
                 Run suites in non-daemon mode, and show exception tracebacks.
E.2.33 jobs-kill
Usage: cylc [control] jobs-kill JOB-LOG-ROOT [JOB-LOG-DIR ...]
(This command is for internal use. Users should use "cylc kill".) Read job
status files to obtain the names of the batch systems and the job IDs in the
systems. Invoke the relevant batch system commands to ask the batch systems to
terminate the jobs.
Arguments:
   JOB-LOG-ROOT
                                   The log/job sub-directory for the suite
   [JOB-LOG-DIR ...]
                                   A point/name/submit_num sub-directory
Options:
 -h, --help
                show this help message and exit
  --user=USER
                 Other user account name. This results in command reinvocation
                 on the remote account.
  --host = HOST
                 Other host name. This results in command reinvocation on the
                 remote account.
  -v, --verbose
                 Verbose output mode.
  --debug
                 Run suites in non-daemon mode, and show exception tracebacks.
E.2.34 jobs-poll
Usage: cylc [control] jobs-poll JOB-LOG-ROOT [JOB-LOG-DIR ...]
(This command is for internal use. Users should use "cylc poll".) Read job
status files to obtain the statuses of the jobs. If necessary, Invoke the
relevant batch system commands to ask the batch systems for more statuses.
Arguments:
   JOB-LOG-ROOT
                                   The log/job sub-directory for the suite
   [JOB-LOG-DIR ...]
                                   A point/name/submit_num sub-directory
Options:
  -h, --help
                 show this help message and exit
```

Other user account name. This results in command reinvocation

--user=USER

```
on the remote account.
  --host = HOST
                 Other host name. This results in command reinvocation on the
                 remote account.
  -v, --verbose
                 Verbose output mode.
  --debug
                 Run suites in non-daemon mode, and show exception tracebacks.
E.2.35 jobs-submit
Usage: cylc [control] jobs-submit JOB-LOG-ROOT [JOB-LOG-DIR ...]
(This command is for internal use. Users should use "cylc submit".) Submit task
jobs to relevant batch systems. On a remote job host, this command reads the
job files from STDIN.
Arguments:
   JOB-LOG-ROOT
                                    The log/job sub-directory for the suite
   [JOB-LOG-DIR ...]
                                    A point/name/submit_num sub-directory
Options:
  -h, --help
                 show this help message and exit
  --remote-mode
                Is this being run on a remote job host?
  --user=USER
                 Other user account name. This results in command reinvocation
                 on the remote account.
  --host=HOST
                 Other host name. This results in command reinvocation on the
                 remote account.
  -v, --verbose
                 Verbose output mode.
  --debug
                 Run suites in non-daemon mode, and show exception tracebacks.
E.2.36 jobscript
Usage: cylc [prep] jobscript [OPTIONS] REG TASK
Generate a task job script and print it to stdout.
Here's how to capture the script in the vim editor:
 % cylc jobscript REG TASK | vim -
Emacs unfortunately cannot read from stdin:
 % cylc jobscript REG TASK > tmp.sh; emacs tmp.sh
This command wraps 'cylc [control] submit --dry-run'.
Other options (e.g. for suite host and owner) are passed
through to the submit command.
Options:
 -h,--help - print this usage message. (see also 'cylc submit --help')
Arguments:
  REG
              - Registered suite name.
  TASK
              - Task ID (NAME.CYCLE_POINT)
E.2.37 kill
Usage: cylc [control] kill [OPTIONS] REG [TASKID ...]
Kill jobs of active tasks and update their statuses accordingly.
To kill one or more tasks, "cylc kill REG TASKID ..."; to kill all active
tasks: "cylc kill REG".
A TASKID is an identifier for matching individual task proxies and/or families
of them. It can be written in these syntaxes:
* [CYCLE-POINT-GLOB/] TASK-NAME-GLOB[: TASK-STATE]
* [CYCLE-POINT-GLOB/] FAMILY-NAME-GLOB[:TASK-STATE]
* TASK-NAME-GLOB[.CYCLE-POINT-GLOB][:TASK-STATE]
* FAMILY-NAME-GLOB[.CYCLE-POINT-GLOB][:TASK-STATE]
For example, to match:
* all tasks in a cycle: '20200202T0000Z/*' or '*.20200202T0000Z'
```

```
* all tasks in the submitted status: ':submitted'
* retrying 'foo*' tasks in 0000Z cycles: 'foo*.*0000Z:retrying' or
   '*0000Z/foo*:retrying'
* retrying tasks in ',BAR' family: '*/BAR:retrying' or 'BAR.*:retrying'
* retrying tasks in 'BAR' or 'BAZ' families: '*/BA[RZ]:retrying' or 'BA[RZ].*:retrying'
The old 'MATCH POINT' syntax will be automatically detected and supported. To avoid this, use the '--no-multitask-compat' option, or use the new syntax (with a '/' or a '.') when specifying 2 TASKID arguments.
Arguments:
   REG
                                    Suite name
                                    Task identifiers
   [TASKID ...]
Options:
  -h, --help
                            show this help message and exit
  --user=USER
                            Other user account name. This results in command
                             reinvocation on the remote account.
  --host = HOST
                            Other host name. This results in command reinvocation
                             on the remote account.
  -v, --verbose
                             Verbose output mode.
                            Run suites in non-daemon mode, and show exception
  --debug
                             tracebacks.
                             Suite port number on the suite host. NOTE: this is
  --port=INT
                             retrieved automatically if non-interactive ssh is
                             configured to the suite host.
  --use-ssh
                             Use ssh to re-invoke the command on the suite host.
  --no-login
                             Do not use a login shell to run remote ssh commands.
                             The default is to use a login shell.
  --comms-timeout=SEC, --pyro-timeout=SEC
                             Set a timeout for network connections to the running
                             suite. The default is no timeout. For task messaging
                             connections see site/user config file documentation. Print the client UUID to stderr. This can be matched
  --print-uuid
                             to information logged by the receiving suite daemon.
                             Set the client UUID manually (e.g. from prior use of
  --set-uuid=UUID
                             --print-uuid). This can be used to log multiple commands under the same UUID (but note that only the
                             first [info] command from the same client ID will be
                             logged unless the suite is running in debug mode).
                             Do not ask for confirmation before acting. Note that it is not necessary to use this option if interactive
  -f, --force
                             command prompts have been disabled in the site/user
                             config files.
  -m, --family
                             (Obsolete) This option is now ignored and is retained
                             for backward compatibility only. TASKID in the argument list can be used to match task and family
                             names regardless of this option.
  --no-multitask-compat
                             Disallow backward compatible multitask interface.
E.2.38 list
```

Usage: cylc [info|prep] list|ls [OPTIONS] SUITE

Print runtime namespace names (tasks and families), the first-parent inheritance graph, or actual tasks for a given cycle range.

The first-parent inheritance graph determines the primary task family groupings that are collapsible in gcylc suite views and the graph viewer tool. To visualize the full multiple inheritance hierarchy use: 'cylc graph -n'.

Suite name or path

Arguments: SUITE

```
Options:
  -h, --help
                              show this help message and exit
  -a, --all-tasks
  -a, --all-tasks Print all tasks, not just those used in the graph.
-n, --all-namespaces Print all runtime namespaces, not just tasks.
                              Print the linear "method resolution order" for each
  -m, --mro
```

```
namespace (the multiple-inheritance precedence order
                        as determined by the C3 linearization algorithm). Print the first-parent inheritance hierarchy in tree
-t, --tree
                        With -t/--tree, using unicode box characters. Your terminal must be able to display unicode characters.
-b, --box
-w, --with-titles
                        Print namespaces titles too.
-p START[,STOP], --points=START[,STOP]
                        Print actual task IDs from the START [through STOP]
                         cycle points.
--user=USER
                         Other user account name. This results in command
                        reinvocation on the remote account.
--host=HOST
                        Other host name. This results in command reinvocation
                         on the remote account.
-v, --verbose
                        Verbose output mode.
--debug
                        Run suites in non-daemon mode, and show exception
                        tracebacks.
--suite-owner=OWNER
                        Specify suite owner
-s NAME=VALUE, --set=NAME=VALUE
                        Set the value of a Jinja2 template variable in the
                         suite definition. This option can be used multiple
                         times on the command line. NOTE: these settings
                         persist across suite restarts, but can be set again on
                         the "cylc restart" command line if they need to be
                         overridden.
--set-file=FILE
                         Set the value of Jinja2 template variables in the
                         suite definition from a file containing NAME=VALUE
                         pairs (one per line). NOTE: these settings persist
                         across suite restarts, but can be set again on the "cylc restart" command line if they need to be
                         overridden.
```

E.2.39 ls-checkpoints

Usage: cylc [info] ls-checkpoints [OPTIONS] REG [ID ...]

In the absence of arguments and the --all option, list checkpoint IDs, their time and events. Otherwise, display the latest and/or the checkpoints of suite parameters, task pool and broadcast states in the suite runtime database.

```
Arguments:
   R.F.G
                          Suite name
                          Checkpoint ID (default=latest)
   [ID ...]
Options:
 -h, --help
                 show this help message and exit
  -a, --all
                 Display data of all available checkpoints.
  --user=USER
                 Other user account name. This results in command reinvocation
                 on the remote account.
  --host=HOST
                 Other host name. This results in command reinvocation on the
                 remote account.
  -v, --verbose
                Verbose output mode.
  --debug
                 Run suites in non-daemon mode, and show exception tracebacks.
```

E.2.40 message

```
Usage: cylc [task] message [OPTIONS] MESSAGE ...
```

This command is part of the cylc task messaging interface, used by running tasks to communicate progress to their parent suite.

The message command can be used to report "message outputs" completed. Other messages received by the suite daemon will just be logged.

Suite and task identity are determined from the task execution environment supplied by the suite (or by the single task 'submit' command, in which case case the message is just printed to stdout).

Options:

```
-h, --help show this help message and exit
```

```
-p PRIORITY, --priority=PRIORITY
                          message priority: NORMAL, WARNING, or CRITICAL;
                          default NORMAL.
  -v, --verbose
                          Verbose output mode.
E.2.41 monitor
Usage: cylc [info] monitor [OPTIONS] REG
A terminal-based live suite monitor. Exit with 'Ctrl-C'.
Arguments:
   R.F.G
                       Suite name
Options:
  -h, --help
                          show this help message and exit
  -a, --align
                          Align task names. Only useful for small suites.
  -r, --restricted
                          Restrict display to active task states. This may be
                          useful for monitoring very large suites. The state
                          summary line still reflects all task proxies.
  -s ORDER, --sort=ORDER
                           Task sort order: "definition" or "alphanumeric". The
                           default is definition order, as determined by global
                           config. (Definition order is the order that tasks
                           appear under [runtime] in the suite definition).
  -o, --once
-u, --runahead
                          Show a single view then exit.
                          Display task proxies in the runahead pool (off by
                          default).
  -i SECONDS, --interval=SECONDS
                           Interval between suite state retrievals, in seconds
                           (default 1).
  --user=USER
                          Other user account name. This results in command
                          reinvocation on the remote account.
  --host=HOST
                          Other host name. This results in command reinvocation
                          on the remote account.
  -v, --verbose
                          Verbose output mode.
                          Run suites in non-daemon mode, and show exception
  --debug
                           tracebacks.
                          Suite port number on the suite host. NOTE: this is
  --port=INT
                          retrieved automatically if non-interactive ssh is configured to the suite host.
  --use-ssh
                          Use ssh to re-invoke the command on the suite host.
  --no-login
                          Do not use a login shell to run remote ssh commands.
                          The default is to use a login shell.
  --comms-timeout=SEC, --pyro-timeout=SEC
                           Set a timeout for network connections to the running
                          suite. The default is no timeout. For task messaging
                          connections see site/user config file documentation. Print the client UUID to stderr. This can be matched
  --print-uuid
                           to information logged by the receiving suite daemon.
                          Set the client UUID manually (e.g. from prior use of --print-uuid). This can be used to log multiple
  --set-uuid=UUID
                           commands under the same UUID (but note that only the
                          first [info] command from the same client ID will be logged unless the suite is running in debug mode).
```

E.2.42 nudge

Usage: cylc [control] nudge [OPTIONS] REG

Cause the cylc task processing loop to be invoked in a running suite.

This happens automatically when the state of any task changes such that task processing (dependency negotation etc.) is required, or if a clock-trigger task is ready to run.

The main reason to use this command is to update the "estimated time till completion" intervals shown in the tree-view suite control GUI, during periods when nothing else is happening.

```
Arguments:
             R.F.G
                                                                                                Suite name
Options:
         -h, --help
                                                                                                              show this help message and exit
           --user=USER
                                                                                                             Other user account name. This results in command
                                                                                                              reinvocation on the remote account.
         --host=HOST
                                                                                                              Other host name. This results in command reinvocation
                                                                                                             on the remote account.
         -v, --verbose
                                                                                                              Verbose output mode.
         --debug
                                                                                                             Run suites in non-daemon mode, and show exception
                                                                                                              tracebacks.
                                                                                                              Suite port number on the suite host. NOTE: this is retrieved automatically if non-interactive ssh is % \left( 1\right) =\left( 1\right) +\left( 1\right
         --port=INT
                                                                                                               configured to the suite host.
         --use-ssh
                                                                                                              Use ssh to re-invoke the command on the suite host.
                                                                                                              Do not use a login shell to run remote ssh commands.
         --no-login
                                                                                                             The default is to use a login shell.
         --comms-timeout=SEC, --pyro-timeout=SEC
                                                                                                              Set a timeout for network connections to the running
                                                                                                              suite. The default is no timeout. For task messaging
                                                                                                              connections see site/user config file documentation. Print the client UUID to stderr. This can be matched
         --print-uuid
                                                                                                              to information logged by the receiving suite daemon. Set the client UUID manually (e.g. from prior use of
         --set-uuid=UUID
                                                                                                               --print-uuid). This can be used to log multiple
                                                                                                                commands under the same UUID (but note that only the
                                                                                                              first [info] command from the same client ID will be
                                                                                                              logged unless the suite is running in debug mode).
                                                                                                              Do not ask for confirmation before acting. Note that it is not necessary to use this option if interactive
        -f, --force
                                                                                                               command prompts have been disabled in the site/user
```

E.2.43 ping

Usage: cylc [discovery] ping [OPTIONS] REG [TASK]

If suite REG is running or TASK in suite REG is currently running, exit with success status, else exit with error status.

config files.

Arguments:

R.F.G Suite name Task NAME.CYCLE_POINT [TASK]

Options:

-h, --help show this help message and exit --print-ports Print the port range from the cylc site config file. --user=USER Other user account name. This results in command reinvocation on the remote account. --host=HOST Other host name. This results in command reinvocation on the remote account. -v, --verbose Verbose output mode. --debug Run suites in non-daemon mode, and show exception tracebacks. --port = INTSuite port number on the suite host. NOTE: this is retrieved automatically if non-interactive ssh is configured to the suite host. Use ssh to re-invoke the command on the suite host. Do not use a login shell to run remote ssh commands. --use-ssh --no-login The default is to use a login shell. --pyro-timeout=SEC --comms-timeout=SEC, Set a timeout for network connections to the running suite. The default is no timeout. For task messaging connections see site/user config file documentation. Print the client UUID to stderr. This can be matched --print-uuid to information logged by the receiving suite daemon. --set-uuid=UUID Set the client UUID manually (e.g. from prior use of --print-uuid). This can be used to log multiple commands under the same UUID (but note that only the

first [info] command from the same client ID will be logged unless the suite is running in debug mode).

E.2 Commands E COMMAND REFERENCE -f, --force Do not ask for confirmation before acting. Note that it is not necessary to use this option $i\tilde{f}$ interactive command prompts have been disabled in the site/user config files. E.2.44 poll Usage: cylc [control] poll [OPTIONS] REG [TASKID ...] Poll jobs of active tasks to verify or update their statuses. To poll one or more tasks, "cylc poll REG TASKID"; to poll all active tasks: "cylc poll REG". Note that automatic job polling can used to track task status on task hosts that do not allow any communication by HTTPS or ssh back to the suite host - see site/user config file documentation. Polling is also done automatically on restarting a suite, for any tasks that were recorded as submitted or running when the suite went down. A TASKID is an identifier for matching individual task proxies and/or families of them. It can be written in these syntaxes:
* [CYCLE-POINT-GLOB/] TASK-NAME-GLOB[:TASK-STATE] * [CYCLE-POINT-GLOB/] FAMILY-NAME-GLOB[: TASK-STATE] * TASK-NAME-GLOB[.CYCLE-POINT-GLOB][:TASK-STATE]

For example, to match:
* all tasks in a cycle: '20200202T0000Z/*' or '*.20200202T0000Z'

* all tasks in the submitted status: ':submitted'

* FAMILY-NAME-GLOB[.CYCLE-POINT-GLOB][:TASK-STATE]

* retrying 'foo*' tasks in 0000Z cycles: 'foo*.*0000Z:retrying' or '*0000Z/foo*:retrying'

* retrying tasks in 'BAR' family: '*/BAR:retrying' or 'BAR.*:retrying' * retrying tasks in 'BAR' or 'BAZ' families: '*/BA[RZ]:retrying' or 'BA[RZ].*:retrying'

The old 'MATCH POINT' syntax will be automatically detected and supported. To avoid this, use the '--no-multitask-compat' option, or use the new syntax (with a '/' or a '.') when specifying 2 TASKID arguments.

Arguments:

Suite name [TASKID ...] Task identifiers

Options:

-h, --help show this help message and exit --user=USER Other user account name. This results in command reinvocation on the remote account. --host=HOST Other host name. This results in command reinvocation on the remote account. Verbose output mode. -v, --verbose --debug Run suites in non-daemon mode, and show exception tracebacks. Suite port number on the suite host. NOTE: this is --port = INTretrieved automatically if non-interactive ssh is configured to the suite host. Use ssh to re-invoke the command on the suite host. --use-ssh --no-login Do not use a login shell to run remote ssh commands. The default is to use a login shell. --comms-timeout=SEC, --pyro-timeout=SEC Set a timeout for network connections to the running suite. The default is no timeout. For task messaging connections see site/user config file documentation. Print the client UUID to stderr. This can be matched --print-uuid to information logged by the receiving suite daemon. Set the client UUID manually (e.g. from prior use of --print-uuid). This can be used to log multiple --set-unid=UUID commands under the same UUID (but note that only the first [info] command from the same client ID will be logged unless the suite is running in debug mode). -f, --force Do not ask for confirmation before acting. Note that

```
it is not necessary to use this option if interactive
                            command prompts have been disabled in the site/user
                            config files.
  -m, --family
                            (Obsolete) This option is now ignored and is retained
                            for backward compatibility only. TASKID in the argument list can be used to match task and family
                            names regardless of this option.
  --no-multitask-compat
                            Disallow backward compatible multitask interface.
E.2.45 print
Usage: cylc [prep] print [OPTIONS] [REGEX]
Print registered (installed) suites.
Note on result filtering:
(a) The filter patterns are Regular Expressions, not shell globs, so the general wildcard is '.*' (match zero or more of anything), NOT '*'.
(b) For printing purposes there is an implicit wildcard at the end of each pattern ('foo' is the same as 'foo/*'); use the string end marker to prevent this ('foo$' matches only literal 'foo').
Arguments:
   [REGEX]
                            Suite name regular expression pattern
Options:
  -h, --help
-t, --tree
                   show this help message and exit
                   Print suites in nested tree form.
  -b, --box
                   Use unicode box drawing characters in tree views.
                   Align columns.
                   \mbox{\tt don't} print suite definition directory paths. Don't print suite titles.
  -x
  -y
  --fail
                   Fail (exit 1) if no matching suites are found.
  --user=USER
                    Other user account name. This results in command reinvocation
                   on the remote account.
  --host = HOST
                   Other host name. This results in command reinvocation on the
                    remote account.
  -v, --verbose
                   Verbose output mode.
  --debug
                   Run suites in non-daemon mode, and show exception tracebacks.
E.2.46 random
Usage: cylc [util] random A B
Generate a random integer in the range [A,B). This is just a command
interface to Python's random.randrange() function.
Arguments:
          start of the range interval (inclusive)
   A
   В
          end of the random range (exclusive, so must be > A)
Options:
  -h, --help show this help message and exit
E.2.47 register
Usage: cylc [prep] register [OPTIONS] REG [PATH]
Register the suite definition located in PATH (or $PWD) as REG.
This creates the suite run directory, and authentication files in a
sub-directory called ".service/".
Suite names are the same as the directory path under the suite run directory.
They may contain alphanumeric characters plus '_' '-' and '/'.
Example: if the cylc run directory is $HOME/cylc-run$ (the default) and
/home/bob/suites/test is a suite source directory, then:
% cylc reg nwp/test1 /home/bob/suites/test
```

```
will create the following suite run directory:
/home/bob/cylc-run/nwp/test1
  -- .service
    |-- passphrase
    |-- source -> /home/bob/test
    |-- ssl.cert
    '-- ssl.pem
The suite can subsequently be started and targeted by cylc commands using
"nwp/test1" as the name.
Arguments:
   R.E.G
                          Suite name
   [PATH]
                          Suite definition directory (defaults to $PWD)
Options:
  -h, --help
                  show this help message and exit
   --user=USER
                  Other user account name. This results in command reinvocation
                  on the remote account.
  --host = HOST
                  Other host name. This results in command reinvocation on the
                  remote account.
  -v. --verbose
                  Verbose output mode.
                  Run suites in non-daemon mode, and show exception tracebacks.
  --debug
E.2.48 release
Usage: cylc [control] release|unhold [OPTIONS] REG [TASKID ...]
Release one or more held tasks (cylc release REG TASKID)
or the whole suite (cylc release REG). Held tasks do not submit even if they are ready to run.
See also 'cylc [control] hold'.
A TASKID is an identifier for matching individual task proxies and/or families
of them. It can be written in these syntaxes:
* [CYCLE-POINT-GLOB/] TASK-NAME-GLOB[:TASK-STATE]
* [CYCLE-POINT-GLOB/] FAMILY-NAME-GLOB[:TASK-STATE]
* TASK-NAME-GLOB[.CYCLE-POINT-GLOB][:TASK-STATE]
* FAMILY-NAME-GLOB[.CYCLE-POINT-GLOB][:TASK-STATE]
For example, to match:
* all tasks in a cycle: '20200202T0000Z/*' or '*.20200202T0000Z'
* all tasks in the submitted status: ':submitted'
* retrying 'foo*' tasks in 0000Z cycles: 'foo*.*0000Z:retrying' or
  '*0000Z/foo*:retrying'
* retrying tasks in 'BAR' family: '*/BAR:retrying' or 'BAR.*:retrying' 
* retrying tasks in 'BAR' or 'BAZ' families: '*/BA[RZ]:retrying' or
  'BA[RZ].*:retrying'
The old 'MATCH POINT' syntax will be automatically detected and supported. To
avoid this, use the '--no-multitask-compat' option, or use the new syntax (with a '/' or a '.') when specifying 2 TASKID arguments.
Arguments:
   R.F.G
                                 Suite name
   [TASKID ...]
                                 Task identifiers
Options:
  -h, --help
                          show this help message and exit
                          Other user account name. This results in command
  --user=USER
                          reinvocation on the remote account.
  --host=HOST
                          Other host name. This results in command reinvocation
                          on the remote account.
  -v, --verbose
                          Verbose output mode.
  --debug
                          Run suites in non-daemon mode, and show exception
                          tracebacks.
  --port=INT
                          Suite port number on the suite host. NOTE: this is
                          retrieved automatically if non-interactive ssh is
                          configured to the suite host.
```

--use-ssh Use ssh to re-invoke the command on the suite host. --no-login Do not use a login shell to run remote ssh commands. The default is to use a login shell. --comms-timeout=SEC, --pyro-timeout=SEC Set a timeout for network connections to the running suite. The default is no timeout. For task messaging connections see site/user config file documentation. Print the client UUID to stderr. This can be matched --print-uuid to information logged by the receiving suite daemon. Set the client UUID manually (e.g. from prior use of --print-uuid). This can be used to log multiple commands under the same UUID (but note that only the --set-uuid=UUID first [info] command from the same client ID will be logged unless the suite is running in debug mode). Do not ask for confirmation before acting. Note that it is not necessary to use this option if interactive command prompts have been disabled in the site/user -f, --force config files. -m, --family (Obsolete) This option is now ignored and is retained for backward compatibility only. TASKID in the argument list can be used to match task and family names regardless of this option. --no-multitask-compat

Disallow backward compatible multitask interface.

E.2.49 reload

Usage: cylc [control] reload [OPTIONS] REG

Tell a suite to reload its definition at run time. All settings including task definitions, with the exception of suite log configuration, can be changed on reload. Note that defined tasks can be be added to or removed from a running suite with the 'cylc insert' and 'cylc remove' commands, without reloading. This command also allows addition and removal of actual task definitions, and therefore insertion of tasks that were not defined at all when the suite started (you will still need to manually insert a particular instance of a newly defined task). Live task proxies that are orphaned by a reload (i.e. their task definitions have been removed) will be removed from the task pool if they have not started running yet. Changes to task definitions take effect immediately, unless a task is already running at reload time.

If the suite was started with Jinja2 template variables set on the command line (cylc run --set FOO=bar REG) the same template settings apply to the reload (only changes to the suite.rc file itself are reloaded).

If the modified suite definition does not parse, failure to reload will be reported but no harm will be done to the running suite.

Arguments:

REG Suite name

Options:

-h, --help show this help message and exit --user=USER Other user account name. This results in command reinvocation on the remote account. --host=HOST Other host name. This results in command reinvocation on the remote ${\tt account}$. -v, --verbose Verbose output mode. --debug Run suites in non-daemon mode, and show exception tracebacks. --port = INTSuite port number on the suite host. NOTE: this is retrieved automatically if non-interactive ssh is configured to the suite host. --use-ssh Use ssh to re-invoke the command on the suite host. --no-login Do not use a login shell to run remote ssh commands. The default is to use a login shell. --comms-timeout=SEC, --pyro-timeout=SEC Set a timeout for network connections to the running suite. The default is no timeout. For task messaging connections see site/user config file documentation.

```
Print the client UUID to stderr. This can be matched
--print-uuid
                           to information logged by the receiving suite daemon.
--set-uuid=UUID
                           Set the client UUID manually (e.g. from prior use of
                           --print-uuid). This can be used to log multiple
                           commands under the same UUID (but note that only the
                           first [info] command from the same client ID will be
                           logged unless the suite is running in debug mode).
                           Do not ask for confirmation before acting. Note that it is not necessary to use this option if interactive command prompts have been disabled in the site/user
-f, --force
                           config files.
```

```
E.2.50 remove
Usage: cylc [control] remove [OPTIONS] REG TASKID [...]
Remove one or more tasks (cylc remove REG TASKID), or all tasks with a
given cycle point (cylc remove REG *.POINT) from a running suite.
Tasks will spawn successors first if they have not done so already.
A TASKID is an identifier for matching individual task proxies and/or families
of them. It can be written in these syntaxes:
* [CYCLE-POINT-GLOB/] TASK-NAME-GLOB[:TASK-STATE]
* [CYCLE-POINT-GLOB/] FAMILY-NAME-GLOB[: TASK-STATE]
* TASK-NAME-GLOB[.CYCLE-POINT-GLOB][:TASK-STATE]
* FAMILY-NAME-GLOB[.CYCLE-POINT-GLOB][:TASK-STATE]
For example, to match:
* all tasks in a cycle: '20200202T0000Z/*' or '*.20200202T0000Z'
* all tasks in the submitted status: ':submitted'
* retrying 'foo*' tasks in 0000Z cycles: 'foo*.*0000Z:retrying' or
'*0000Z/foo*:retrying'
* retrying tasks in 'BAR' family: '*/BAR:retrying' or 'BAR.*:retrying' 
* retrying tasks in 'BAR' or 'BAZ' families: '*/BA[RZ]:retrying' or
  'BA[RZ].*:retrying'
The old 'MATCH POINT' syntax will be automatically detected and supported. To
avoid this, use the '--no-multitask-compat' option, or use the new syntax (with a '/' or a '.') when specifying 2 TASKID arguments.
Arguments:
                                   Suite name
   TASKID [...]
                                   Task identifiers
Options:
  -h, --help
                           show this help message and exit
  --no-spawn
                            Do not spawn successors before removal.
  --user=USER
                            Other user account name. This results in command
                            reinvocation on the remote account.
  --host=HOST
                            Other host name. This results in command reinvocation
                            on the remote account.
  -v, --verbose
                            Verbose output mode.
  --debug
                            Run suites in non-daemon mode, and show exception
                            tracebacks.
  --port = INT
                            Suite port number on the suite host. NOTE: this is
                            retrieved automatically if non-interactive ssh is
                            configured to the suite host.
                            Use ssh to re-invoke the command on the suite host. Do not use a login shell to run remote ssh commands.
  --use-ssh
  --no-login
                            The default is to use a login shell.
  --comms-timeout=SEC,
                           --pyro-timeout=SEC
                            Set a timeout for network connections to the running
                            suite. The default is no timeout. For task messaging
                            connections see site/user config file documentation. Print the client UUID to stderr. This can be matched
  --print-uuid
                            to information logged by the receiving suite daemon.
  --set-uuid=UUID
                            Set the client UUID manually (e.g. from prior use of
                            --print-uuid). This can be used to log multiple
                            commands under the same UUID (but note that only the
                            first [info] command from the same client ID will be
                            logged unless the suite is running in debug mode).
```

```
-f, --force
                             Do not ask for confirmation before acting. Note that
                             it is not necessary to use this option i\tilde{f} interactive
                             command prompts have been disabled in the site/user
                             config files.
                             (Obsolete) This option is now ignored and is retained for backward compatibility only. TASKID in the argument list can be used to match task and family
-m. --family
                             names regardless of this option.
--no-multitask-compat
                             Disallow backward compatible multitask interface.
```

E.2.51 reset

Usage: cylc [control] reset [OPTIONS] REG [TASKID ...]

Force one or more task proxies in a running suite to change state and modify their prerequisites and outputs accordingly. For example, --state=waiting means "prerequisites not satisfied, outputs not completed"; --state=ready means "prerequisites satisfied, outputs not completed" (this generally has the same effect as using the "cylc trigger" command).

"cylc reset --state=spawn" is deprecated: use "cylc spawn" instead.

See the documentation for the -s/--state option for legal reset states. A TASKID is an identifier for matching individual task proxies and/or families of them. It can be written in these syntaxes:

- * [CYCLE-POINT-GLOB/] TASK-NAME-GLOB[: TASK-STATE]
- * [CYCLE-POINT-GLOB/] FAMILY-NAME-GLOB[:TASK-STATE]
- * TASK-NAME-GLOB[.CYCLE-POINT-GLOB][:TASK-STATE]
- * FAMILY-NAME-GLOB[.CYCLE-POINT-GLOB][:TASK-STATE]

- For example, to match: * all tasks in a cycle: '20200202T0000Z/*' or '*.20200202T0000Z'
- * all tasks in the submitted status: ':submitted'
- * retrying 'foo*' tasks in 0000Z cycles: 'foo*.*0000Z:retrying' or '*0000Z/foo*:retrying'
- * retrying tasks in 'BAR' family: '*/BAR:retrying' or 'BAR.*:retrying' * retrying tasks in 'BAR' or 'BAZ' families: '*/BA[RZ]:retrying' or 'BA[RZ].*:retrying'

The old 'MATCH POINT' syntax will be automatically detected and supported. To avoid this, use the '--no-multitask-compat' option, or use the new syntax (with a '/' or a '.') when specifying 2 TASKID arguments.

Arguments:

R.E.G Suite name Task identifiers [TASKID ...]

Options:

-h, --help sl -s STATE, --state=STATE show this help message and exit

Reset task state to STATE, can be succeeded, failed, held, waiting, ready, expired --user=USER Other user account name. This results in command

reinvocation on the remote account. --host=HOST Other host name. This results in command reinvocation

on the remote account. -v, --verbose Verbose output mode.

--debug Run suites in non-daemon mode, and show exception

tracebacks.

--port=INTSuite port number on the suite host. NOTE: this is retrieved automatically if non-interactive ssh is configured to the suite host.

--use-ssh Use ssh to re-invoke the command on the suite host. --no-login Do not use a login shell to run remote ssh commands.

The default is to use a login shell.

--comms-timeout=SEC, --pyro-timeout=SEC

Set a timeout for network connections to the running suite. The default is no timeout. For task messaging connections see site/user config file documentation. Print the client UUID to stderr. This can be matched --print-uuid to information logged by the receiving suite daemon.

```
--set-uuid=UUID

Set the client UUID manually (e.g. from prior use of --print-uuid). This can be used to log multiple commands under the same UUID (but note that only the first [info] command from the same client ID will be logged unless the suite is running in debug mode).

-f, --force

Do not ask for confirmation before acting. Note that it is not necessary to use this option if interactive command prompts have been disabled in the site/user config files.

-m, --family

(Obsolete) This option is now ignored and is retained for backward compatibility only. TASKID in the argument list can be used to match task and family names regardless of this option.

--no-multitask-compat

Disallow backward compatible multitask interface.
```

E.2.52 restart

Usage: cylc [control] restart [OPTIONS] REG

Start a suite run from the previous state. To start from scratch (cold or warm start) see the 'cylc run' command.

The scheduler runs in daemon mode unless you specify n/--no-detach or --debug.

Tasks recorded as submitted or running are polled at start-up to determine what happened to them while the suite was down.

Arguments:

REG Suite name

```
Options:
```

```
-h, --help
                        show this help message and exit
--non-daemon
                        (deprecated: use --no-detach)
                        Do not daemonize the suite
-n, --no-detach
-a, --no-auto-shutdown
                        Do not shut down the suite automatically when all tasks have finished. This flag overrides the \,
                        corresponding suite config item.
                        Output profiling (performance) information
--profile
--checkpoint=CHECKPOINT
                        Use specified checkpoint to restart
--ignore-final-cycle-point
                        Ignore the final cycle point in the suite run
                        database. If one is specified in the suite definition
                        it will be used, however.
--ignore-initial-cycle-point
                        Ignore the initial cycle point in the suite run
                        database. If one is specified in the suite definition
                        it will be used, however.
Shut down after all tasks have PASSED this cycle
--until=CYCLE POINT
                        point.
--hold
                        Hold (don't run tasks) immediately on starting.
--hold-after=CYCLE_POINT
                        Hold (don't run tasks) AFTER this cycle point.
-m STRING, --mode=STRING
                        Run mode: live, simulation, or dummy; default is live.
                        Generate a reference log for use in reference tests.
--reference-log
--reference-test
                        Do a test run against a previously generated reference
                        log.
-S SOURCE, --source=SOURCE
                        Specify the suite source.
Other user account name. This results in command
--user=USER
                        reinvocation on the remote account.
--host=HOST
                        Other host name. This results in command reinvocation
                        on the remote account.
-v, --verbose
                        {\tt Verbose} \ \ {\tt output} \ \ {\tt mode} \ .
--debug
                        Run suites in non-daemon mode, and show exception
                        tracebacks.
-s NAME=VALUE, --set=NAME=VALUE
                        Set the value of a Jinja2 template variable in the
```

suite definition. This option can be used multiple

times on the command line. NOTE: these settings persist across suite restarts, but can be set again on the "cylc restart" command line if they need to be overridden. Set the value of Jinja2 template variables in the suite definition from a file containing ${\tt NAME=VALUE}$ --set-file=FILE pairs (one per line). NOTE: these settings persist across suite restarts, but can be set again on the "cylc restart" command line if they need to be overridden.

E.2.53 run

Usage: cylc [control] run|start [OPTIONS] REG [START POINT]

Start a suite run from scratch, wiping out any previous suite state. To restart from a previous state see 'cylc restart --help'.

The scheduler runs in daemon mode unless you specify --no-detach or --debug.

Any dependence on cycle points earlier than the start cycle point is ignored.

A "cold start" (the default) starts from the suite initial cycle point (specified in the suite.rc or on the command line). Any dependence on tasks prior to the suite initial cycle point is ignored.

A "warm start" (-w/--warm) starts from a given cycle point later than the suite initial cycle point (specified in the suite.rc). Any dependence on tasks prior to the given warm start cycle point is ignored. The suite initial cycle point is preserved.

Arguments:

REG Suite name [START_POINT] Initial cycle point or 'now'; overrides the suite definition.

Options:

-h, --help show this help message and exit (deprecated: use --no-detach) --non-daemon -n, --no-detach Do not daemonize the suite -a, --no-auto-shutdown Do not shut down the suite automatically when all tasks have finished. This flag overrides the corresponding suite config item. --profile Output profiling (performance) information Warm start the suite. The default is to cold start. Does nothing, option for backward compatibility only -w, --warm --until=CYCLE_POINT Shut down after all tasks have PASSED this cycle point. Hold (don't run tasks) immediately on starting. --hold-after=CYCLE POINT Hold (don't run tasks) AFTER this cycle point. -m STRING, --mode=STRING Run mode: live, simulation, or dummy; default is live. Generate a reference log for use in reference tests. --reference-log --reference-test Do a test run against a previously generated reference log -S SOURCE, --source=SOURCE Specify the suite source. Other user account name. This results in command $% \left(1\right) =\left(1\right) +\left(1\right)$ --user=USER reinvocation on the remote account. --host=HOST Other host name. This results in command reinvocation on the remote account. -v, --verbose Verbose output mode. --debug Run suites in non-daemon mode, and show exception tracebacks. -s NAME=VALUE, --set=NAME=VALUE Set the value of a Jinja2 template variable in the suite definition. This option can be used multiple times on the command line. NOTE: these settings persist across suite restarts, but can be set again on

the "cylc restart" command line if they need to be

overridden. --set-file=FILE Set the value of Jinja2 template variables in the suite definition from a file containing NAME=VALUE pairs (one per line). NOTE: these settings persist across suite restarts, but can be set again on the "cylc restart" command line if they need to be overridden.

E.2.54 scan

Usage: cylc [discovery] scan [OPTIONS] [HOSTS ...]

Print information about cylc suites currently running on scanned hosts. The list of hosts to scan is determined by the global configuration "[suite host scanning] " setting, or hosts can be specified explicitly on the command line.

By default, just your own suites are listed (this assumes your username is the same on all scanned hosts). Use -a/--all-suites to see all suites on all hosts, or restrict suites displayed with the -o/--owner and -n/--name options (with --name the default owner restriction (i.e. just your own suites) is disabled.

Suite passphrases are not needed to get identity information (name and owner) from suites running cylc >= 6.6.0. Titles, descriptions, state totals, and cycle point state totals may also be revealed publicly, depending on global and sutie authentication settings. Suite passphrases still grant full access regardless of what is revealed publicly.

Passphrases are still required to get identity information from older suites (cylc \leq 6.5.0), otherwise you'll see "connection denied (security reasons)".

WARNING: a suite suspended with Ctrl-Z will cause port scans to hang until the connection times out (see --comms-timeout).

Arguments:

[HOSTS ...] Hosts to scan instead of the configured hosts.

Options:

```
-h, --help
                     show this help message and exit
```

-a, --all, --all-suites

List all suites found on all scanned hosts (the default is just your own suites).

-n PATTERN, --name=PATTERN

List suites with name matching PATTERN (regular expression). Defaults to any name. Can be used multiple times.

-o PATTERN, --suite-owner=PATTERN

List suites with owner matching PATTERN (regular expression). Defaults to just your own suites. Can be used multiple times.

-d, --describe Print suite titles and descriptions if available. Print number of tasks in each state if available -s, --state-totals

(total, and by cycle point).

Print all available information about each suite. -f, --full

-c, --color, --colour

Print task state summaries using terminal color

control codes. -b, --no-bold Don't use any bold text in the command output. --print-ports

Print the port range from the site config file (\$CYLC_DIR/conf/global.rc).
--comms-timeout=SEC, --pyro-timeout=SEC

Set a timeout for network connections to each running suite. The default is 5 seconds.
Legacy output format ("suite owner host port").

--old, --old-format

-r, --raw, --raw-format

Parsable format ("suite|owner|host|property|value") --user=USER Other user account name. This results in command

reinvocation on the remote account.

--host=HOST Other host name. This results in command reinvocation

on the remote account.

-v. --verbose Verbose output mode.

Run suites in non-daemon mode, and show exception --debug tracebacks.

```
--port = INT
                        Suite port number on the suite host. NOTE: this is
                        retrieved automatically if non-interactive ssh is
                        configured to the suite host.
--use-ssh
                        Use ssh to re-invoke the command on the suite host.
--no-login
                        Do not use a login shell to run remote ssh commands.
                        The default is to use a login shell.
                        Print the client UUID to stderr. This can be matched
--print-uuid
                        to information logged by the receiving suite daemon.
--set-uuid=UUID
                        Set the client UUID manually (e.g. from prior use of
                        --print-uuid). This can be used to log multiple commands under the same UUID (but note that only the
                        first [info] command from the same client ID will be
                        logged unless the suite is running in debug mode).
```

E.2.55 scp-transfer

Usage: cylc [util] scp-transfer [OPTIONS]

An scp wrapper for transferring a list of files and/or directories at once. The source and target scp URLs can be local or remote (scp can transfer files between two remote hosts). Passwordless ssh must be configured appropriately.

```
ENVIRONMENT VARIABLE INPUTS:

$SRCE - list of sources (files or directories) as scp URLs.

$DEST - parallel list of targets as scp URLs.

The source and destination lists should be space-separated.
```

We let scp determine the validity of source and target URLs. Target directories are created pre-copy if they don't exist.

Options:

```
-v - verbose: print scp stdout.
--help - print this usage message.
```

E.2.56 search

Usage: cylc [prep] search|grep [OPTIONS] SUITE PATTERN [PATTERN2...]

Search for pattern matches in suite definitions and any files in the suite bin directory. Matches are reported by line number and suite section. An unquoted list of PATTERNs will be converted to an OR'd pattern. Note that the order of command line arguments conforms to normal cylc command usage (suite name first) not that of the grep command.

Note that this command performs a text search on the suite definition, it does not search the data structure that results from parsing the suite definition – so it will not report implicit default settings.

For case insenstive matching use '(?i)PATTERN'.

Arguments:

```
SUITE Suite name or path
PATTERN Python-style regular expression
[PATTERN2...] Additional search patterns
```

${\tt Options}:$

```
-h, --help
                     show this help message and exit
                     Do not search in the suite bin directory
- X
--user=USER
                     Other user account name. This results in command
                     reinvocation on the remote account.
--host=HOST
                     Other host name. This results in command reinvocation
                     on the remote account.
-v, --verbose
                     Verbose output mode.
                     Run suites in non-daemon mode, and show exception
--debug
                     tracebacks.
--suite-owner=OWNER Specify suite owner
```

E.2.57 set-runahead

Usage: cylc [control] set-runahead [OPTIONS] REG [HOURS]

Change the suite runahead limit in a running suite. This is the number of hours that the fastest task is allowed to get ahead of the slowest. If a task spawns beyond that limit it will be held back from running until the slowest tasks catch up enough. WARNING: if you omit HOURS no runahead limit will be set - DO NOT DO THIS for for any cycling suite that has no near stop cycle set and is not constrained by clock-trigger tasks.

Arguments: R.F.G Suite name [HOURS] Runahead limit (default: no limit) Options: -h, --help show this help message and exit --user=USER Other user account name. This results in command reinvocation on the remote account. --host = HOSTOther host name. This results in command reinvocation on the remote account. -v, --verbose Verbose output mode. --debug Run suites in non-daemon mode, and show exception tracebacks. Suite port number on the suite host. NOTE: this is --port = INTretrieved automatically if non-interactive ssh is configured to the suite host. --use-ssh Use ssh to re-invoke the command on the suite host. Do not use a login shell to run remote ssh commands. --no-login The default is to use a login shell. --comms-timeout=SEC, --pyro-timeout=SEC Set a timeout for network connections to the running suite. The default is no timeout. For task messaging connections see site/user config file documentation. Print the client UUID to stderr. This can be matched --print-uuid to information logged by the receiving suite daemon. Set the client UUID manually (e.g. from prior use of --print-uuid). This can be used to log multiple --set-uuid=UUID commands under the same UUID (but note that only the first [info] command from the same client ID will be logged unless the suite is running in debug mode). Do not ask for confirmation before acting. Note that it is not necessary to use this option if interactive -f. --force

E.2.58 set-verbosity

Usage: cylc [control] set-verbosity [OPTIONS] REG LEVEL

config files.

Change the logging priority level of a running suite. Only messages at or above the chosen priority level will be logged; for example, if you choose WARNING, only warnings and critical messages will be logged.

command prompts have been disabled in the site/user

Arguments:

```
REG
                        Suite name
   LEVEL
                        INFO, WARNING, NORMAL, CRITICAL, ERROR, DEBUG
Options:
  -h, --help
                         show this help message and exit
  --user=USER
                         Other user account name. This results in command
                         reinvocation on the remote account.
  --host=HOST
                         Other host name. This results in command reinvocation
                         on the remote account.
 -v, --verbose
                         Verbose output mode.
  --debug
                         Run suites in non-daemon mode, and show exception
                         tracebacks.
  --port=INT
                         Suite port number on the suite host. NOTE: this is
                         \hbox{\tt retrieved automatically if non-interactive } \hbox{\tt ssh is}
                         configured to the suite host.
                         Use ssh to re-invoke the command on the suite host.
  --use-ssh
                         Do not use a login shell to run remote ssh commands.
  --no-login
                         The default is to use a login shell.
  --comms-timeout=SEC, --pyro-timeout=SEC
```

Set a timeout for network connections to the running suite. The default is no timeout. For task messaging connections see site/user config file documentation. Print the client UUID to stderr. This can be matched --print-uuid to information logged by the receiving suite daemon. Set the client UUID manually (e.g. from prior use of --set-uuid=UUID --print-uuid). This can be used to log multiple commands under the same UUID (but note that only the first [info] command from the same client ID will be logged unless the suite is running in debug mode). Do not ask for confirmation before acting. Note that it is not necessary to use this option if interactive -f, --force command prompts have been disabled in the site/user config files.

E.2.59show

Usage: cylc [info] show [OPTIONS] REG [TASKID ...]

Interrogate a suite daemon for the suite title and description; or for the title and description of one of its tasks; or for the current state of the prerequisites, outputs, and clock-triggering of a specific task instance. A TASKID is an identifier for matching individual task proxies and/or families of them. It can be written in these syntaxes:
* [CYCLE-POINT-GLOB/]TASK-NAME-GLOB[:TASK-STATE] * [CYCLE-POINT-GLOB/] FAMILY-NAME-GLOB[:TASK-STATE] * TASK-NAME-GLOB[.CYCLE-POINT-GLOB][:TASK-STATE] * FAMILY-NAME-GLOB[.CYCLE-POINT-GLOB][:TASK-STATE]

For example, to match: * all tasks in a cycle: '20200202T0000Z/*' or '*.20200202T0000Z'

* all tasks in the submitted status: ':submitted'
* retrying 'foo*' tasks in 0000Z cycles: 'foo*.*0000Z:retrying' or

'*0000Z/foo*:retrying' * retrying tasks in 'BAR' family: '*/BAR:retrying' or 'BAR.*:retrying' * retrying tasks in 'BAR' or 'BAZ' families: '*/BA[RZ]:retrying' or 'BA[RZ].*:retrying'

The old 'MATCH POINT' syntax will be automatically detected and supported. To avoid this, use the '--no-multitask-compat' option, or use the new syntax (with a '/' or a '.') when specifying 2 TASKID arguments.

Arguments:

R.F.G Suite name [TASKID ...] Task names or identifiers

Options:

-h, --help

--user=USER --host=HOST -v, --verbose --debug --port = INT--use-ssh

--no-login --comms-timeout=SEC,

--print-uuid --set-uuid=UUID

show this help message and exit

Other user account name. This results in command reinvocation on the remote account. Other host name. This results in command reinvocation on the remote account. Verbose output mode. Run suites in non-daemon mode, and show exception tracebacks. Suite port number on the suite host. ${\tt NOTE:}$ this is retrieved automatically if non-interactive ssh is configured to the suite host. Use ssh to re-invoke the command on the suite host. Do not use a login shell to run remote ssh commands. The default is to use a login shell. --pyro-timeout=SEC

Set a timeout for network connections to the running suite. The default is no timeout. For task messaging connections see site/user config file documentation. Print the client UUID to stderr. This can be matched to information logged by the receiving suite daemon. Set the client UUID manually (e.g. from prior use of --print-uuid). This can be used to log multiple commands under the same UUID (but note that only the first [info] command from the same client ID will be logged unless the suite is running in debug mode).

```
-m, --family
                              (Obsolete) This option is now ignored and is retained
                              for backward compatibility only. TASKID in the argument list can be used to match task and family
                              names regardless of this option.
   --no-multitask-compat
                              Disallow backward compatible multitask interface.
E.2.60 spawn
Usage: cylc [control] spawn [OPTIONS] REG [TASKID ...]
Force one or more task proxies to spawn successors at the next cycle point
in their sequences. This is useful if you need to run successive instances
of a task out of order.
A TASKID is an identifier for matching individual task proxies and/or families
of them. It can be written in these syntaxes:
* [CYCLE-POINT-GLOB/] TASK-NAME-GLOB[:TASK-STATE]
* [CYCLE-POINT-GLOB/] FAMILY-NAME-GLOB[:TASK-STATE]
* TASK-NAME-GLOB[.CYCLE-POINT-GLOB][:TASK-STATE]
* FAMILY-NAME-GLOB[.CYCLE-POINT-GLOB][:TASK-STATE]
For example, to match:
* all tasks in a cycle: '20200202T0000Z/*' or '*.20200202T0000Z'
* all tasks in the submitted status: ':submitted'
* retrying 'foo*' tasks in 0000Z cycles: 'foo*.*0000Z:retrying' or
   '*0000Z/foo*:retrying'
* retrying tasks in 'BAR' family: '*/BAR:retrying' or 'BAR.*:retrying' * retrying tasks in 'BAR' or 'BAZ' families: '*/BA[RZ]:retrying' or
  'BA[RZ].*:retrying'
The old 'MATCH POINT' syntax will be automatically detected and supported. To avoid this, use the '--no-multitask-compat' option, or use the new syntax (with a '/' or a '.') when specifying 2 TASKID arguments.
Arguments:
    REG
                                     Suite name
                                     Task identifiers
    [TASKID ...]
Options:
  -h, --help
                              show this help message and exit
   --user=USER
                              Other user account name. This results in command
                              reinvocation on the remote account.
   --host=HOST
                              Other host name. This results in command reinvocation
                              on the remote account.
  -v, --verbose
                              Verbose output mode.
   --debug
                              Run suites in non-daemon mode, and show exception
                              tracebacks.
                              Suite port number on the suite host. NOTE: this is
   --port=INT
                              retrieved automatically if non-interactive ssh is configured to the suite host.
                              Use ssh to re-invoke the command on the suite host.
  --use-ssh
  --no-login
                              Do not use a login shell to run remote ssh commands.
                              The default is to use a login shell.
   --comms-timeout=SEC,
                             --pyro-timeout=SEC
                              Set a timeout for network connections to the running
                              suite. The default is no timeout. For task messaging
                              connections see site/user config file documentation. Print the client UUID to stderr. This can be matched
  --print-uuid
                              to information logged by the receiving suite daemon.
                              Set the client UUID manually (e.g. from prior use of --print-uuid). This can be used to log multiple commands under the same UUID (but note that only the
  --set-uuid=UUID
                              first [info] command from the same client ID will be
                              logged unless the suite is running in debug mode).
                              Do not ask for confirmation before acting. Note that it is not necessary to use this option if interactive
  -f, --force
                              command prompts have been disabled in the site/user
                              config files.
                              (Obsolete) This option is now ignored and is retained for backward compatibility only. TASKID in the
  -m, --family
```

argument list can be used to match task and family

```
names regardless of this option.
--no-multitask-compat
                      Disallow backward compatible multitask interface.
```

E.2.61 stop

Usage: cylc [control] stop|shutdown [OPTIONS] REG [STOP]

Tell a running suite daemon to shut down. In order to prevent failures going unnoticed, suites only shut down automatically at a final cycle point if no failed tasks are present. There are several shutdown methods:

- 1. (default) stop after current active tasks finish
- 2. (--now) stop immediately, orphaning current active tasks
- 3. (--kill) stop after killing current active tasks
 4. (with STOP as a cycle point) stop after cycle point STOP
- 5. (with STOP as a task ID) stop after task ID STOP has succeeded 6. (--wall-clock=T) stop after time T (an ISO 8601 date-time format e.g. CCYYMMDDThh:mm, CCYY-MM-DDThh, etc).

Tasks that become ready after the shutdown is ordered will be submitted immediately if the suite is restarted. Remaining task event handlers and job poll and kill commands, however, will be executed prior to shutdown, unless -now is used.

This command exits immediately unless --max-polls is greater than zero, in which case it polls to wait for suite shutdown.

```
Arguments:
   REG
                          Suite name
   [STOP]
                          a/ task POINT (cycle point), or
                              b/ ISO 8601 date-time (clock time), or c/ TASK (task ID).
Options:
  -h, --help
                          show this help message and exit
  -k, --kill
-n, --now
                          Shut down after killing currently active tasks.
                          Shut down without waiting for active tasks to
                          complete. If this option is specified once, wait for
                          task event handler, job poll/kill to complete. If this option is specified more than once, tell the suite to
                          terminate immediately.
  -w STOP, --wall-clock=STOP
                          Shut down after time STOP (ISO 8601 formatted)
                          Maximum number of polls (default 0).
  --max-polls=INT
  --interval=SECS
                          Polling interval in seconds (default 60).
  --user=USER
                          Other user account name. This results in command
                          reinvocation on the remote account.
  --host = HOST
                          Other host name. This results in command reinvocation
                          on the remote account.
  -v, --verbose
                          Verbose output mode.
                          Run suites in non-daemon mode, and show exception
  --debug
                          tracebacks.
  --port=INT
                          Suite port number on the suite host. NOTE: this is
                          retrieved automatically if non-interactive ssh is
                          configured to the suite host.
  --use-ssh
                          Use ssh to re-invoke the command on the suite host.
  --no-login
                          Do not use a login shell to run remote ssh commands.
                          The default is to use a login shell.
  --comms-timeout=SEC,
                         --pyro-timeout=SEC
                          Set a timeout for network connections to the running
                          suite. The default is no timeout. For task messaging
                          connections see site/user config file documentation. Print the client UUID to stderr. This can be matched
  --print-uuid
                          to information logged by the receiving suite daemon.
  --set-uuid=UUID
                          Set the client UUID manually (e.g. from prior use of
```

--print-uuid). This can be used to log multiple commands under the same UUID (but note that only the first [info] command from the same client ID will be logged unless the suite is running in debug mode).
Do not ask for confirmation before acting. Note that
it is not necessary to use this option if interactive

-f, --force

command prompts have been disabled in the site/user config files.

E.2.62 submit

Usage: cylc [task] submit|single [OPTIONS] REG TASK

Submit a single task to run just as it would be submitted by its suite. Task messaging commands will print to stdout but will not attempt to communicate with the suite (which does not need to be running).

For tasks present in the suite graph the given cycle point is adjusted up to the next valid cycle point for the task. For tasks defined under runtime but not present in the graph, the given cycle point is assumed to be valid.

WARNING: do not 'cylc submit' a task that is running in its suite at the same time - both instances will attempt to write to the same job logs.

Arguments:

REG Suite name
TASK Target task (NAME.CYCLE POINT)

Options:

-h, --help -d, --dry-run show this help message and exit Generate the job script for the task, but don't submit it. Other user account name. This results in command --user=USER reinvocation on the remote account. --host=HOST Other host name. This results in command reinvocation on the remote account. -v, --verbose Verbose output mode. --debug Run suites in non-daemon mode, and show exception tracebacks -s NAME=VALUE, --set=NAME=VALUE Set the value of a Jinja2 template variable in the suite definition. This option can be used multiple times on the command line. NOTE: these settings persist across suite restarts, but can be set again on the "cylc restart" command line if they need to be overridden. --set-file=FILE Set the value of Jinja2 template variables in the suite definition from a file containing NAME=VALUE pairs (one per line). NOTE: these settings persist across suite restarts, but can be set again on the "cylc restart" command line if they need to be overridden.

E.2.63 suite-state

Usage: cylc suite-state REG [OPTIONS]

Print task states retrieved from a suite database; or (with --task, --point, and --status) poll until a given task reaches a given state. Polling is configurable with --interval and --max-polls; for a one-off check use --max-polls=1. The suite database does not need to exist at the time polling commences but allocated polls are consumed waiting for it (consider max-polls*interval as an overall timeout).

Note for non-cycling tasks --point=1 must be provided.

Important: cylc suite-state only works with task states and does not work with task messages.

For your own suites the database location is determined by your site/user config. For other suites, e.g. those owned by others, or mirrored suite databases, use --run-dir=DIR to specify the location.

Example usages:

cylc suite-state REG --task=TASK --point=POINT --status=STATUS returns 0 if TASK.POINT reaches STATUS before the maximum number of polls, otherwise returns 1.

```
cylc suite-state REG --task=TASK --point=POINT --status=STATUS --offset=PT6H adds 6 hours to the value of CYCLE for carrying out the polling operation.
  cylc suite-state REG --task=TASK --status=STATUS --task-point
uses CYLC TASK CYCLE POINT environment variable as the value for the CYCLE
to poll. This is useful when you want to use cylc suite-state in a cylc task.
Arguments:
   R.F.G
                          Suite name
Options:
                              show this help message and exit
  -h, --help
  -t TASK, --task=TASK Specify a task to check the state of. -p CYCLE, --point=CYCLE
                              Specify the cycle point to check task states for.
                              Use the CYLC_TASK_CYCLE_POINT environment variable as
  -T, --task-point
                              the cycle point to check task states for. Shorthand
                              for --point=$CYLC_TASK_CYCLE_POINT
  --template=TEMPLATE
                              Cyclepoint template string, used to reformat
                              cyclepoints for querying suites
  -d DIR. --run-dir=DIR
                              The top level cylc run directory if non-standard. The database should be {\rm DIR/REG/log/db}. Use to interrogate
                              suites owned by others, etc.; see note above.
  -s OFFSET, --offset=OFFSET
                              Specify an offset to add to the targeted cycle point
  -S STATUS, --status=STATUS
                              Specify a particular status or triggering condition to
                              check for. Valid triggering conditions to check for include: 'fail', 'finish', 'start', 'submit' and 'succeed'. Valid states to check for include:
                              'runahead', 'waiting', 'held', 'queued', 'ready'
'expired', 'submitted', 'submit-failed', 'submit-
retrying', 'running', 'succeeded', 'failed' and
                              'retrying'.
  --max-polls=INT
                              Maximum number of polls (default 10).
  --interval=SECS
                              Polling interval in seconds (default 60).
  --user=USER
                              Other user account name. This results in command
                              reinvocation on the remote account.
                              Other host name. This results in command reinvocation
  --host = HOST
                              on the remote account.
```

E.2.64 test-battery

-v, --verbose

```
Usage: cylc test-battery [...]
```

Run automated cylc and parsec tests under [FILES or DIRECTORIES]. Test locations default to the following directory tree: /home/vagrant/cylc/tests/

Verbose output mode.

Some tests (e.g. those specific to particular batch schedulers) can be configured in your site/user config file. A few others still submit jobs to a user@host account taken from the environment:

\$CYLC_TEST_TASK_HOST # default localhost
\$CYLC_TEST_TASK_OWNER # defaut \$USER

${\tt Requirements}:$

- * Passwordless ssh must be configured to task host accounts.
- * Some test suites submit jobs to 'at' so atd must be running.

Options and arguments are appended to the "prove -j \$NPROC -s -r \${@:-tests}" command, where NPROC is the number of child processes that can be used to run the test files.

Some tests use a clean global config file. If some items from your site config file are needed in this, e.g. to get remote test hosts working, add them to /home/vagrant/cylc/conf/global-tests.rc.

The command normally uses the "process pool size" setting (default=4) in the

```
site/user global configuration file to determine the number of tests to run in
parallel. You can also change the amount of concurrency with the "-j N" option.
Suite run directories are cleaned up on the suite host for passing tests -
otherwise they are left alone.
To output stderr from failed tests to the terminal, "export CYLC_TEST_DEBUG=true" before running this command.
The command normally uses "diff -u" to compare files. However, if an alternate command such as "xxdiff -D" is desirable (e.g. for debugging), "export
CYLC_TEST_DIFF_CMD=xxdiff -D".
Commits or Pull Requests to cylc/cylc on GitHub will trigger Travis CI to run
generic (non platform-specific) tests - see /home/vagrant/cylc/.travis.yml.
After enabling Travis CI for your own cylc fork, you can skip generic tests locally by setting CYLC_TEST_RUN_GENERIC=false.
By default all tests are executed. To run just a subset of them:
   * list individual tests or test directories to run on the comand line
  * list individual tests or test directories to skip in $CYLC_TEST_SKIP
  * skip all generic tests with CYLC_TEST_RUN_GENERIC=false
  * skip all platform-specific tests with CYLC_TEST_RUN_PLATFORM=false
List specific tests relative to /home/vagrant/cylc (i.e. starting with "test/"). Some platform-specific tests are automatically skipped, depending on platform. DEVELOPERS: new platform-specific tests must set "CYLC_TEST_IS_GENERIC=false"
before sourcing the test_header.
For more information see "Reference Tests" in the User Guide.
  -h, --help
                Print this help message and exit.
Examples:
Run the full test suite with the default options.
  cylc test-battery
Run the full test suite with 12 processes.
cylc test-battery -j 12
Run only tests under "tests/cyclers/" with 12 processes.
  cylc test-battery -j 12 tests/cyclers
Run only "tests/cyclers/16-weekly.t" in verbose mode
cylc test-battery -v tests/cyclers/16-weekly.t
Run only tests under "tests/cyclers/" with 12 processes, and skip 00-daily.t
  export CYLC_TEST_SKIP=tests/cyclers/00-daily.t
  cylc test-battery -j 12 tests/cyclers
E.2.65 trigger
Usage: cylc [control] trigger [OPTIONS] REG [TASKID ...]
Manually trigger one or more tasks. Waiting tasks will be queued (cylc internal
queues) and will submit as normal when released by the queue; queued tasks will submit immediately even if that violates the queue limit (so you may need to trigger a queue-limited task twice to get it to submit).
For single tasks you can use "--edit" to edit the generated job script before it submits, to apply one-off changes. A diff between the original and edited
job script will be saved to the task job log directory.
A TASKID is an identifier for matching individual task proxies and/or families
of them. It can be written in these syntaxes:
* [CYCLE-POINT-GLOB/] TASK-NAME-GLOB[: TASK-STATE]
* [CYCLE-POINT-GLOB/] FAMILY-NAME-GLOB[:TASK-STATE]
* TASK-NAME-GLOB[.CYCLE-POINT-GLOB][:TASK-STATE]
* FAMILY-NAME-GLOB[.CYCLE-POINT-GLOB][:TASK-STATE]
For example, to match:
* all tasks in a cycle: '20200202T0000Z/*' or '*.20200202T0000Z'
* all tasks in the submitted status: ':submitted'
* retrying 'foo*' tasks in 0000Z cycles: 'foo*.*0000Z:retrying' or
  '*0000Z/foo*:retrying'
```

```
* retrying tasks in 'BAR' family: '*/BAR:retrying' or 'BAR.*:retrying'
* retrying tasks in 'BAR' or 'BAZ' families: '*/BA[RZ]:retrying' or
  'BA[RZ].*:retrying'
The old 'MATCH POINT' syntax will be automatically detected and supported. To avoid this, use the '--no-multitask-compat' option, or use the new syntax (with a '/' or a '.') when specifying 2 TASKID arguments.
Arguments:
   REG
                                   Suite name
   [TASKID ...]
                                   Task identifiers
Options:
                           show this help message and exit
  -h, --help
  -e, --edit
                           Manually edit the job script before running it.
                           (with --edit) force use of the configured GUI editor. Other user account name. This results in command
  -g, --geditor
   --user=USER
                           reinvocation on the remote account.
  --host=HOST
                            Other host name. This results in command reinvocation
                           on the remote account.
  -v, --verbose
                            Verbose output mode.
                           Run suites in non-daemon mode, and show exception
  --debug
                           tracebacks.
  --port = TNT
                           Suite port number on the suite host. NOTE: this is
                            retrieved automatically if non-interactive ssh is
                            configured to the suite host.
                            Use ssh to re-invoke the command on the suite host.
  --use-ssh
                            Do not use a login shell to run remote ssh commands.
  --no-login
                           The default is to use a login shell.
  --comms-timeout=SEC, --pyro-timeout=SEC
                            Set a timeout for network connections to the running
                            suite. The default is no timeout. For task messaging
                            connections see site/user config file documentation. Print the client UUID to stderr. This can be matched
  --print-uuid
                            to information logged by the receiving suite daemon.
                            Set the client UUID manually (e.g. from prior use of
  --set-uuid=UUID
                            --print-uuid). This can be used to log multiple commands under the same UUID (but note that only the
                            first [info] command from the same client ID will be
                            logged unless the suite is running in debug mode).
  -f, --force
                            Do not ask for confirmation before acting. Note that
                            it is not necessary to use this option if interactive
                            command prompts have been disabled in the site/user
                            config files
  -m, --family
                            (Obsolete) This option is now ignored and is retained
                            for backward compatibility only. TASKID in the
                            argument list can be used to match task and family
                            names regardless of this option.
  --no-multitask-compat
                            Disallow backward compatible multitask interface.
```

E.2.66 upgrade-run-dir

```
Usage: cylc [admin] upgrade-run-dir SUITE

For one-off conversion of a suite run directory to cylc-6 format.

Arguments:
SUITE suite name or run directory path

Options:
-h, --help show this help message and exit
```

E.2.67 validate

```
Usage: cylc [prep] validate [OPTIONS] SUITE

Validate a suite definition against the official specification files held in $CYLC_DIR/conf/suiterc/.

If the suite definition uses include-files reported line numbers
```

```
will correspond to the inlined version seen by the parser; use
'cylc view -i, --inline SUITE' for comparison.
   SUITE
                        Suite name or path
Options:
  -h, --help
                         show this help message and exit
  --icp=ICP
                         Set an initial cycle point to validate against. This
                         may be required if the suite does not supply one.
                         Fail any use of unsafe or experimental features.
  --strict
                         Currently this just means naked dummy tasks (tasks
                         with no corresponding runtime section) as these may
                         result from unintentional typographic errors in task
                         names.
  -o FILENAME, --output=FILENAME
                         Specify a file name to dump the processed suite.rc.
                         Output profiling (performance) information
  --profile
  --user=USER
                         Other user account name. This results in command
                         reinvocation on the remote account.
  --host=HOST
                         Other host name. This results in command reinvocation
                         on the remote account.
 -v, --verbose
                         Verbose output mode.
  --debug
                         Run suites in non-daemon mode, and show exception
                         tracebacks.
  --suite-owner=OWNER
                        Specify suite owner
  -s NAME=VALUE, --set=NAME=VALUE
                         Set the value of a Jinja2 template variable in the
                         suite definition. This option can be used multiple
                         times on the command line. NOTE: these settings
                         persist across suite restarts, but can be set again on
                         the "cylc restart" command line if they need to be
                         overridden.
  --set-file=FILE
                         Set the value of Jinja2 template variables in the
                         suite definition from a file containing NAME=VALUE
                         pairs (one per line). NOTE: these settings persist
                         across suite restarts, but can be set again on the "cylc restart" command line if they need to be
                         overridden.
```

E.2.68 version

Usage: cylc [info] version

Print the cylc version invoked at the command line.

Note that "cylc -v,--version" just prints the version string from the main command interface, whereas this is a proper cylc command that can take the standard --host and --user options, etc.

For the cylc version of running a suite daemon see "cylc get-suite-version".

Arguments:

```
Options:
```

```
-h, --help show this help message and exit
--long Print the path to the current cylc version
--user=USER Other user account name. This results in command reinvocation on the remote account.
--host=HOST Other host name. This results in command reinvocation on the remote account.
-v, --verbose Verbose output mode.
--debug Run suites in non-daemon mode, and show exception tracebacks.
```

E.2.69 view

Usage: cylc [prep] view [OPTIONS] SUITE

View a read-only temporary copy of suite NAME's suite.rc file, in your editor, after optional include-file inlining and Jinja2 preprocessing.

```
The edit process is spawned in the foreground as follows:
 % <editor> suite.rc
Where <editor> is defined in the cylc site and user config files
($CYLC_DIR/conf/global.rc and $HOME/.cylc/global.rc).
For remote host or owner, the suite will be printed to stdout unless
the '-g,--gui' flag is used to spawn a remote GUI edit session.
See also 'cylc [prep] edit'.
Arguments:
   SUITE
                        Suite name or path
Options:
  -h, --help
-i, --inline
                         show this help message and exit
                         Inline include-files.
  -j, --jinja2
                         View after Jinja2 template processing (implies
                         '-i/--inline' as well).
                         View after all processing (Jinja2, inlining, line-
  -p, --process
                         continuation joining).
  -m, --mark
                         (With '-i') Mark inclusions in the left margin.
                         (With '-i') Label file inclusions with the file name.
  -1, --label
                         Line numbers will not correspond to those reported by
                         the parser
  --single
                         (With '-i') Inline only the first instances of any
                         multiply-included files. Line numbers will not
                         correspond to those reported by the parser.
                         Concatenate continuation lines (line numbers will not
  -c, --cat
                         correspond to those reported by the parser).
  -g, --gui
                         Force use of the configured GUI editor.
                         Print the suite definition to stdout.
  --stdout
  --mark-for-edit
                         (With '-i') View file inclusion markers as for 'cylc
                         edit --inline'.
  --user=USER
                         Other user account name. This results in command
                         reinvocation on the remote account.
  --host=HOST
                         Other host name. This results in command reinvocation
                         on the remote account.
  -v, --verbose
                         Verbose output mode.
  --debug
                         Run suites in non-daemon mode, and show exception
                         tracebacks.
  --suite-owner=OWNER
                         Specify suite owner
  -s NAME=VALUE, --set=NAME=VALUE
                         Set the value of a Jinja2 template variable in the
                         suite definition. This option can be used multiple
                         times on the command line. NOTE: these settings
                         persist across suite restarts, but can be set again on
                         the "cylc restart" command line if they need to be
                         overridden.
  --set-file=FILE
                         Set the value of Jinja2 template variables in the
                         suite definition from a file containing {\tt NAME=VALUE}
                         pairs (one per line). NOTE: these settings persist
                         across suite restarts, but can be set again on the "cylc restart" command line if they need to be
                         overridden.
E.2.70 warranty
Usage: cylc [license] warranty [--help]
  Cylc is released under the GNU General Public License v3.0
```

F The gcylc Graph View

--help

This command prints the GPL v3.0 disclaimer of warranty.

Print this usage message.

The graph view in the gcylc GUI shows the structure of the suite as it evolves. It can work well even for large suites, but be aware that the graphviz layout engine has to do a new global layout every time a task proxy appears in or disappears from the task pool. The following may help mitigate any jumping layout problems:

- The disconnect button can be used to temporarily prevent the graph from changing as the suite evolves.
- The greyed-out base nodes, which are only present to fill out the graph structure, can be toggled off (but this will split the graph into disconnected sub-trees).
- Right-click on a task and choose the "Focus" option to restrict the graph display to that task's cycle point. Anything interesting happening in other cycle points will show up as disconnected rectangular nodes to the right of the graph (and you can click on those to instantly refocus to their cycle points).
- Task filtering is the ultimate quick route to focusing on just the tasks you're interested in, but this will destroy the graph structure.

G Cylc README File

```
# The Cylc Suite Engine
[![Build Status](https://travis-ci.org/cylc/cylc.svg?branch=master)](https://travis-ci.org/cylc/cylc.svg?branch=master)]
## A Workflow Engine and Meta-Scheduler
Cylc specialises in continuous workflows of cycling (repeating) tasks such as
those used in weather and climate forecasting and research, but it can also be
used for non-cycling systems.
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cylc. If not, see [GNU licenses](http://www.gnu.org/licenses/).
## Cylc Documentation
 * See [The Cylc Home Page](https://cylc.github.io/cylc)
## Code Contributors
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    Domingo Manubens Gil
   Jonny Williams
Alex Reinecke
    Chan Wilson
   Kevin Pulo
## Acknowledgement For Non-Cylc Work:
Licences for non-cylc work included in this distribution can be found in the
'licences/' directory.
   'lib/cherrypy/':
```

```
External software library released under a BSD license.
Minor modification to ignore an import warning.
See [cherrypy](http://www.cherrypy.org/).
* 'lib/isodatetime/':
   Unmodified external software library released under the LGPL license.
   See [metomi/isodatetime](https://github.com/metomi/isodatetime/).
* 'lib/jinja2/':
   External software library released under a BSD license.
   See [Jinja2](http://jinja.pocoo.org/).
* 'lib/markupsafe/':
   External software library released under a BSD license, used by Jinja2.
   See [MarkupSafe](http://www.pocoo.org/projects/markupsafe/).
* 'lib/xdot.py':
   External software released under the LGPL license.
   Modifications based on version 0.6. See
   [xdot](https://github.com/jrfonseca/xdot.py)
```

H Cylc INSTALL File

```
# Cylc Installation.
**See [The Cylc User Guide](https://cylc.github.io/cylc/documentation.html) for
detailed instructions.**
Note: *to run distributed suites cylc must be installed on task hosts as well as suite
hosts.*
### External Software Packages.
Several external packages required on suite hosts are not needed on task hosts:
*graphviz*, and *pygraphviz*. These should only need to be installed
once, and then updated infrequently.
### Installing Cylc Releases
Download the latest release tarball from https://github.com/cylc/cylc/releases.
Cylc releases should be installed in parallel under a top level 'cylc'
directory such as '/opt/cylc/' or '/home/admin/cylc/'.
'''bash
cd /home/admin/cylc/
tar xzf ~/Downloads/cylc-6.10.0.tar.gz
cd cylc-6.10.0
export PATH=$PWD/bin:$PATH
make # (see below)
Cylc is accessed via a central wrapper script can select between installed
versions. This allows long-running suites to stick with older cylc versions if necessary. The wrapper should be modified slightly to point to your
local installation (see comments in-script) and then installed (once) in
'$PATH' for users, e.g.:
'''bash
cp admin/cylc-wrapper /usr/local/bin/cylc
When you type 'make':
  * A file called VERSION will be created to hold the cylc version string,
  e.g. "6.10.0". This is taken from the name of the parent directory: *do not
  change the name of the unpacked cylc source directory*.
  * The Cylc User Guide will be generated from LaTeX source files (in PDF if 'pdflatex' is installed, and HTML if 'tex4ht' and *ImageMagick* are
  installed).
  * A Python *fast ordered dictionary* module called *orrdereddict* will be
  built from C source in 'ext/ordereddict-0.4.5'. This may give enhanced
  performance over the Python standard library, but it is optional. To use it,
  install it manually into your '$PYTHONPATH'
```

Cloning The Cylc Repository

To get the latest bleeding-edge cylc version and participate in cylc development, fork [cylc on GitHub](https://github.com/cylc/cylc), clone your fork locally, develop changes locally in a new branch, then push the branch to your fork and issue a Pull Request to the cylc development team. Please discuss proposed changes before you begin work, however.

I Cylc Development History - Major Changes

- pre-cylc-3 early versions focused on the new scheduling algorithm. A suite was a collection of "task definition files" that encoded the prerequisites and outputs of each task, exposing cylc's self-organising nature. Tasks could be transferred from one suite to another by simply copying their taskdef files over and checking prerequisite and output consistency. Global suite structure was not easy to discern until run time (although cylc-2 could generate resolved run time dependency graphs).
- cylc-3 a new suite design interface: dependency graph and task runtime properties defined in a single structured, validated, configuration file the suite.rc file; graphical user interface; suite graphing.
- cylc-4 refined and organized the suite.rc file structure; task runtime properties defined by an efficient inheritance hierarchy; support for the Jinja2 template processor in suite definitions.
- cylc-5 multi-threading for continuous network request handling and job submission; more task states to distinguish job submission from execution; dependence between suites via new suite run databases; polling and killing of real task jobs; polling as task communications option.
- cylc-6 specification of all date-times and cycling workflows via the ISO8601 date-times, durations, and recurrence expressions; integer cycling; a multi-process pool to execute job submissions, event handlers, and poll and kill commands.

J Communication Method

Cylc suite daemons and clients (commands, cylc gui, task messaging) communicate via particular ports using the HTTPS protocol, secured by HTTP Digest Authentication using the suite's 20-random-character private passphrase and private SSL certificate.

This is enabled via the included-in-cylc cherrypy library (for the server) and either the Python requests library (if available) or the built-in Python libraries for the clients.

All suites are entirely isolated from one another.

K Cylc 6 Migration Reference

Cylc 6 introduced new date-time-related syntax for the suite.rc file. In some places, this is quite radically different from the earlier syntax.

K.1 Timeouts and Delays

Timeouts and delays such as [cylc][[events]]timeout or [runtime][[my_task]]retry delays were written in a purely numeric form before cylc 6, in seconds, minutes (most common), or hours, depending on the setting.

They are now written in an ISO 8601 duration form, which has the benefit that the units are user-selectable (use 1 day instead of 1440 minutes) and explicit.

Nearly all timeouts and delays in cylc were in minutes, except for:

[runtime][[my_task]][[[suite state polling]]]interval

[runtime][[my_task]][[[simulation mode]]]run time range

which were in seconds, and

[scheduling]runahead limit

which was in hours (this is a special case discussed below in K.2).

See Table 1.

Table 1: Timeout/Delay Syntax Change Examples

Setting	Pre-Cylc-6	Cylc-6+
[cylc][[events]]timeout	180	PT3H
[runtime][[my_task]]retry delays	2*30, 360,	2*PT30M, PT6H,
	1440	P1D
[runtime][[my_task]][[[suite state polling]]]interval	2	PT2S

K.2 Runahead Limit

See A.3.7.

The [scheduling]runahead limit setting was written as a number of hours in pre-cylc-6 suites. This is now in ISO 8601 format for date-time cycling suites, so [scheduling]runahead limit=36 would be written [scheduling]runahead limit=PT36H.

There is a new preferred alternative to runahead limit, [scheduling]max active cycle points. This allows the user to configure how many cycle points can run at once (default 3). See A.3.8.

K.3 Cycle Time/Cycle Point

See A.3.2.

The following suite.rc settings have changed name (Table 2):

Table 2: Cycle Point Renaming

Pre-Cylc-6	Cylc-6+
[scheduling]initial cycle time	[scheduling]initial cycle point
[scheduling]final cycle time	[scheduling]final cycle point
[visualization]initial cycle time	[visualization]initial cycle point
[visualization]final cycle time	[visualization]final cycle point

This change is to reflect the fact that cycling in cylc 6+ can now be over e.g. integers instead of being purely based on date-time.

Date-times written in initial cycle time and final cycle time were in a cylc-specific 10-digit (or less) CCYYMMDDhh format, such as 2014021400 for 00:00 on the 14th of February 2014.

Date-times are now required to be ISO 8601 compatible. This can be achieved easily enough by inserting a T between the day and the hour digits.

Table 3: Cycle Point Syntax Example

Setting	Pre-Cylc-6 Cylc-6	+
[scheduling]initial cycle time	2014021400 20140214	4T00

K.4 Cycling

Special *start-up* and *cold-start* tasks have been removed from cylc 6. Instead, use the initial/run-once notation as detailed in 8.23.2 and 10.3.4.6.

Repeating asynchronous tasks have also been removed because non date-time workflows can now be handled more easily with integer cycling. See for instance the satellite data processing example documented in 10.3.4.7.

For repeating tasks with hour-based cycling the syntax has only minor changes: Pre-cylc-6:

Hour-based cycling section names are easy enough to convert, as seen in Table 4.

Table 4: Hourly Cycling Sections

Pre-Cylc-6	Cylc-6+
[scheduling][[dependencies]][[[0]]]	[scheduling][[dependencies]][[[T00]]]
[scheduling][[dependencies]][[[6]]]	[scheduling][[dependencies]][[[T06]]]
[scheduling][[dependencies]][[[12]]]	[scheduling][[dependencies]][[[T12]]]
[scheduling][[dependencies]][[[18]]]	[scheduling][[dependencies]][[[T18]]]

The graph text in hour-based cycling is also easy to convert, as seen in Table 5.

Table 5: Hourly Cycling Offsets

Pre-Cylc-6	Cylc-6+
my_task[T-6]	my_task[-PT6H]
$my_task[T-12]$	my_task[-PT12H]
$my_task[T-24]$	my_task[-PT24H] or even my_task[-P1D]

K.5 No Implicit Creation of Tasks by Offset Triggers

Prior to cylc-6 inter-cycle triggers implicitly created task instances at the offset cycle points. For example, this pre cylc-6 suite automatically creates instances of task foo at the offset hours 3,9,15,21 each day, for task bar to trigger off at 0,6,12,18:

```
# Pre cylc-6 implicit cycling.
[scheduling]
  initial cycle time = 2014080800
  [[dependencies]]
      [[[00,06,12,18]]]
      # This creates foo instances at 03,09,15,21:
      graph = foo[T-3] => bar
```

You can run this suite to see how it works (cylc-6+ is backward-compatible: it generates the old-style behaviour when it detects an old-style suite definition). Here's the direct translation of this suite to cylc-6+ format:

```
# In cylc-6+ this suite will stall.
[scheduling]
  initial cycle point = 20140808T00
  [[dependencies]]
      [[[T00,T06,T12,T18]]]
      # This does NOT create foo instances at 03,09,15,21:
      graph = foo[-PT3H] => bar
```

If you run this suite, bar.20140808T00 will execute at start-up because dependence on tasks prior to the initial cycle point is ignored, but the suite will then stall with bar.20140808T06 waiting on foo.20140808T03 (right-click on the task in the GUI to see its prerequisites), which does not exist because the offset foo instances have not been created. Note that if you graph the suite the offset foo instances do appear. That's because the graph expresses dependence, and bar really does depend on these instances of foo. The problem is just that the tasks don't get created at run time, which is why the suite stalls. Here's the correct way to get the desired behaviour in cylc-6+:

```
# Cylc-6+ requires explicit task instance creation.
[scheduling]
  initial cycle point = 20140808T00
  [[dependencies]]
      [[[T03,T09,T15,T21]]]
      graph = foo
      [[[T00,T06,T12,T18]]]
      graph = foo[-PT3H] => bar
```

Implicit creation of task instances by offset triggers has been disabled because it is error prone: if a trigger offset is wrong it should cause a triggering failure rather than create task instances at incorrect cycle points.

L Known Issues

L.1 Current Known Issues

The best place to find current known issues is on Github: https://github.com/cylc/cylc/issues.

L.2 Notable Known Issues

L.2.1 Use of pipes in job scripts

In bash, the return status of a pipeline is normally the exit status of the last command. This is unsafe, because if any command in the pipeline fails, the script will continue nevertheless.

For safety, a cylc task job script running in bash will have the set -o pipefail option turned on automatically. If a pipeline exists in a task's script, etc section, the failure of any part of a pipeline will cause the command to return a non-zero code at the end, which will be reported as a task job failure. Due to the unique nature of a pipeline, the job file will trap the failure of the individual commands, as well as the whole pipeline, and will attempt to report a failure back to the suite twice. The second message is ignored by the suite, and so the behaviour can be safely ignored. (You should probably still investigate the failure, however!)

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