

User Manual

ABSTRACT

This document provides a developer/tester with the knowledge to create and run automated tests against a diverse range of ESXi-based test resources.

15 DECEMBER 2013

Table of Contents

DART Automated Test Execution Technology Overview.....	4
What is Tyrant?.....	4
Technical Components Overview.....	4
Palantir.....	4
Undermine + Test Scripts.....	5
Overmind + Test Plans.....	5
Overview.....	6
Reaper.....	7
Remote Commit (Remote Job Submission).....	8
For the Developer.....	9
Repository Structure.....	9
Tools.....	9
Directory Structure.....	10
Assumptions.....	11
Environment Setup.....	12
Leafnodes (Test Scripts).....	12
Leafnode Concepts.....	12
Creating and Running a Simple Leafnode.....	13
Leafnodes in Depth.....	14
Writing Leafnodes.....	14
Storing Leafnodes (Modules and Leafbags).....	24
Running Leafnodes.....	26
Test Plans.....	28
Test Plan Concepts.....	28
Example Test Plan.....	29
Parsing Test Plans.....	30
Running Test Plans.....	30
Working with a Range.....	30
Test Plans in Depth.....	33

UNCLASSIFIED

Plans of Plans.....	36
Remote Commit in Depth.....	36
Appendix A - Event Detection.....	43
Event Detection Theory.....	43
Testing in Adverse Environments.....	43
Environment Setup.....	44
Usage.....	45
With Undermine.....	46
With Overmind.....	46
Contact Information.....	48

DART Automated Test Execution Technology Overview

What is Tyrant?

Tyrant is the name given by Lockheed Martin Advanced Technology Labs to a suite of technology it developed for running automated software tests. It is one of the major components of the complete DART (Dynamic Automated Range Testing) tool suite. (The other major component handles building out cyber test ranges.) The Tyrant suite allows multiple simultaneous developers and testers to run tests in a reproducible manner across a wide array of resources. The Tyrant suite also allows administrators to manage these test resources. Using Tyrant technologies, one can encode the logic of a test to perform against one or more test resources as well as the logic to determine whether the test is a success or failure. One can then run this test against a specific set of resources (i.e. the resources needed to run a single instance of the test), or have multiple instances of the test run against a diverse range of resources to evaluate the functionality of a system-under-test against the whole range of systems it may be run on in the real world. Finally, multiple developers can perform these tests simultaneously against a shared set of resources without conflicting with each other.

Technical Components Overview

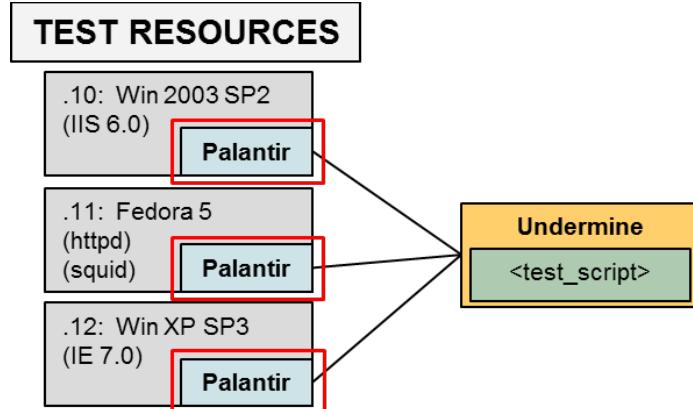
Tyrant is made up of six central technical components:

- Palantir (Testing Interface)
- Undermine (Test Script Harness) + Test Scripts
- Overmind (Test Script Scheduler) + Test Plans
- Overview (Test Resource/Result GUI)
- Reaper (Test Resource Sanitizer)
- Remote Commit (Remote Job Submission)

Each component is standalone from the others, allowing for each user to determine the combination of components most appropriate for their testing scenarios.

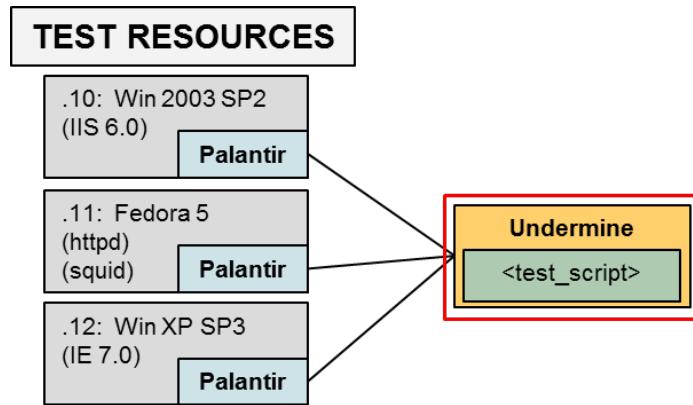
Palantir

Palantir provides a common, cross-platform test interface to each of the computer resources in the test environment that are running commodity operating systems (e.g. Windows, Linux, OSX, FreeBSD, etc.). This allows test script writers to write more cross-platform test scripts, expecting a consistent interface (e.g. “put file”, “execute”, “spawn”, etc.) on each of the computers needed for the user’s test scenario.



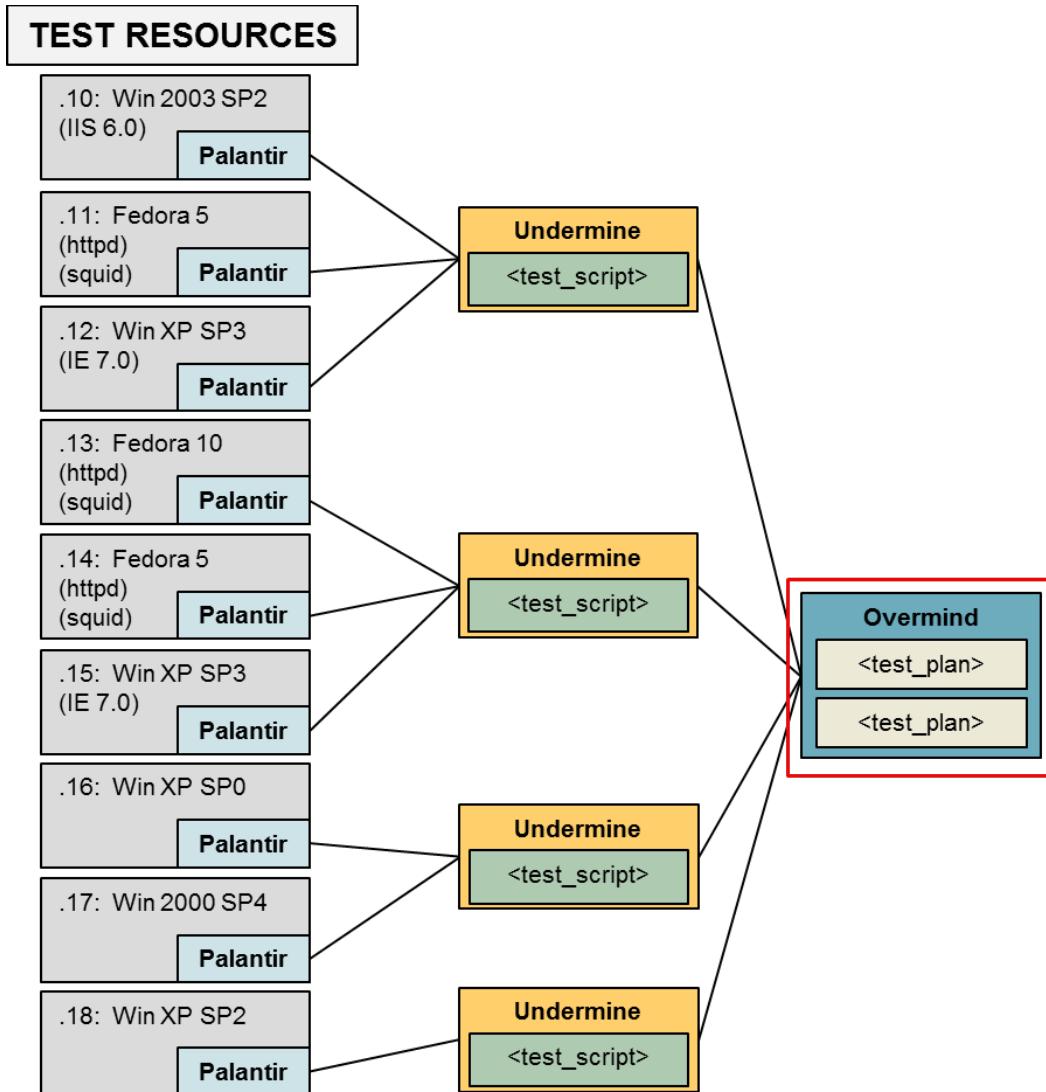
Undermine + Test Scripts

Undermine is a test script harness for executing the user's test scenarios. The user will encode their test procedure in a "test script". Then he/she will run that test script via Undermine, which will effectively automate their procedure. By convention Undermine performs the actions on the test resources via Palantir if it exists on the test resource.



Overmind + Test Plans

Overmind examines the set of test resources in the Test Resource section of the Overmind Database and schedules tests to be run across those resources. The user describes what tests they want to run, the resource constraints, and the desired iteration and/or replication of each test script in a "test plan". Multiple users can submit test plans concurrently, and Overmind will schedule each possible test to run when possible. By convention Overmind runs an instance of Undermine for each test that needs to be performed. When tests are completed Overmind puts the test results into the Test Result section of the Overmind Database and marks the resource as requiring sanitization in the Test Resource section of the Overmind Database.



Overview

Overview is the web-based GUI that allows a user to view currently running and past test results in the Test Result section of the Overmind Database previously inserted by Overmind as well as graphically manage the resources in the Test Resource section of the Overmind Database.

UNCLASSIFIED

[Home](#) | [Namespaces](#) | [Resources](#) | [Recipes](#) | [Management](#)

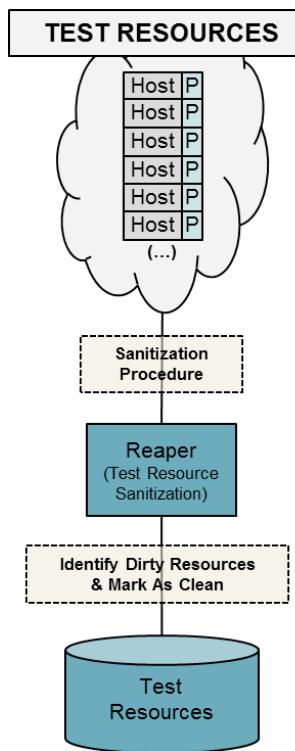
Namespaces ([test plans](#))

Namespace: (*) (*)	NS Notes: (*)	
Limit: 200 <input type="button" value="OK"/> << Prev Next >>		
Filter: n_name~= <input type="text"/> <input type="button" value="OK"/>		
Refresh: <input type="text"/> secs <input type="button" value="START"/>		

	nid	n_name	status	start_time	finished	total	success	failure	attention	skipped	error	purged	running	pending	n_notes
	408	JacallDeltaTest	34 Finished	2013-09-17 12:54:20 EDT	34 / 34	34	32	6	0	5	0	0	0	0	-
	407	preflight-ping-2013_09_17-16_37_50	17 Finished	2013-09-17 12:37:50 EDT	17 / 17	17	16	1							-
	406	DeltaTest	26 Finished	2013-09-16 08:23:49 EDT	26 / 26	26	26								-
	405	OsInfoTest	60 Finished	2013-09-15 16:10:24 EDT	60 / 60	60	52	6		2					-

Reaper

Reaper monitors the Test Resources section of the Overmind Database for resources that require sanitization and performs a custom action to sanitize the resource. The custom action is often something as simple as reverting a VM to a previous snapshot, but it can be as custom as rebuilding the entire operating system on that resource from scratch. Different sanitization modules can be specified for each resource if desired. By convention, the same sanitization module is used for all of the resources in the same hardware class. After the sanitization process completes, Reaper marks the resource as clean in the Test Resource section of the Overmind Database, indicating to Overmind that the resource can be considered for use in a test again.



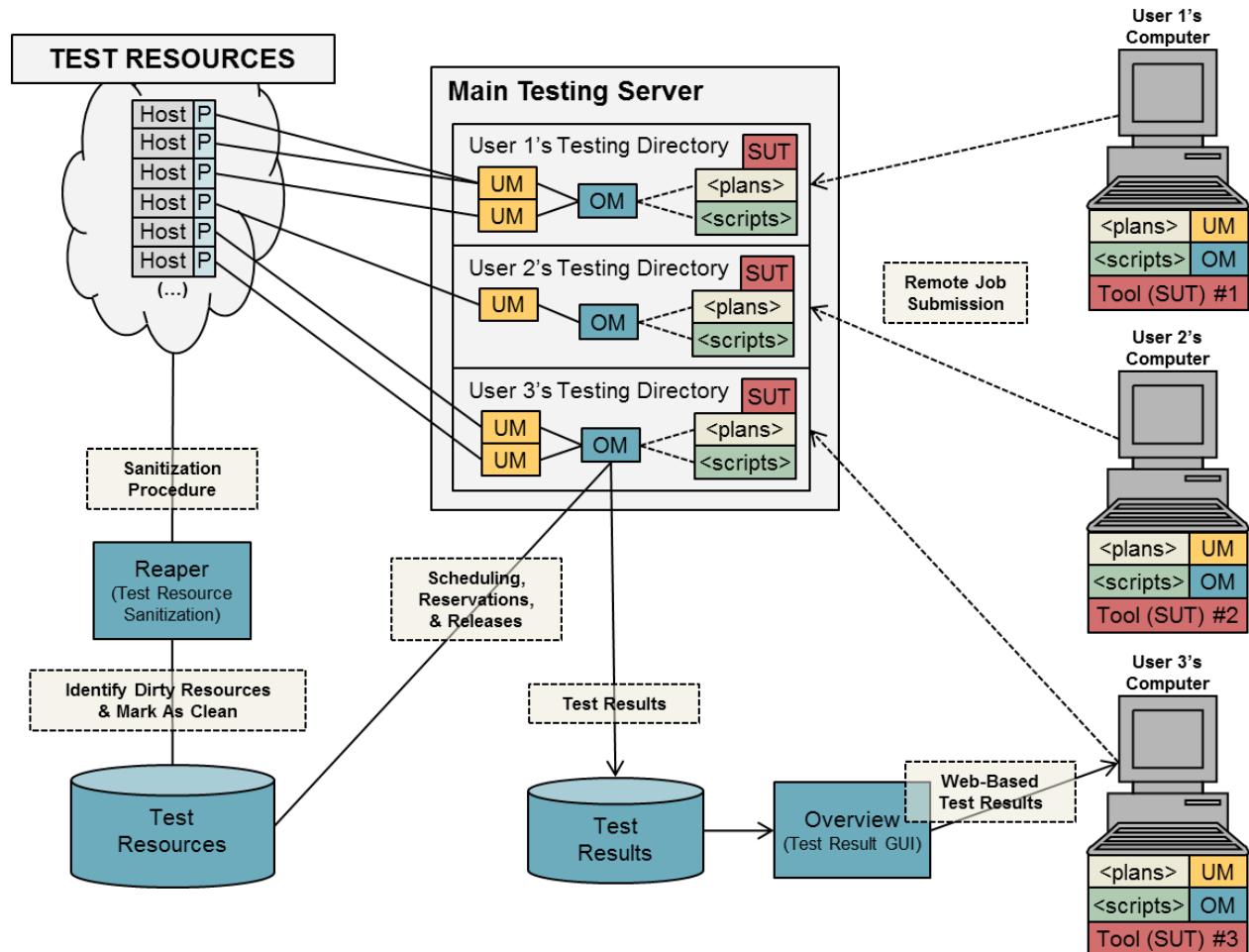
Remote Commit (Remote Job Submission)

While there are many ways to install and configure the Tyrant software, one very common setup is the one that allows for multiple users to submit and run their own tests on a set of common testing resources.

In this scenario each user has their own local copy of Overmind, Undermine, his/her tool or System Under Test (SUT), and test scripts and test plans relative to that SUT. Each user runs the `remote_commit` tool to copy those five components from their local box to the main testing server, start Overmind, and submit the necessary test plans. This ensures that each user can be running completely different tests from every other user. This also allows each user to continue their development of any of those five components without affecting currently running tests.

Each user can then browse to the Overview web GUI to monitor progress of their running tests.

The following picture illustrates all of the Tyrant components working together to execute this CONOP. (“P” == Palantir, “UM” == Undermine, “OM” == Overmind)



For the Developer

For the developer, Tyrant provides the tools to create and run automated test scripts (in undermine) and test plans (in overmind), view test results, and work simultaneously on a range of resources. This manual covers how to use a range of ESXi virtual machine resources previously set up by an administrator and how to create and run tests.

Repository Structure

The core of Tyrant is provided in two Mercurial repositories: tybase and tyworkflow. The tybase repository provides the tools used for running single tests. The tyworkflow repository provides the tools used for running tests across ranges of resources and managing these ranges. The tybase repository is standalone, but the tyworkflow repository has dependencies on tybase.

With the split of functionality between tybase and tyworkflow, it can sometimes be difficult to determine which repository you should be in to perform certain operations. Unless specifically directed otherwise by this manual, the following are a few general rules to help you determine the correct place to perform certain operations:

- If the operation relates to running an individual test against specific test resources without use of any range scheduling (e.g. overmind), you should be in tybase.
- If the operation relates to linking in collections of test scripts (leafbags), you should be in tybase.
- If the operation relates to scheduling tests to run on a range or managing a range of shared resources, you should be in tyworkflow.

The emissary repository adds the ability to perform operations on Windows-based resources as a regular user, rather than the SYSTEM context in which normal palantir operations run.

The magnum repository contains code used for testing with PSPs (Personal Security Products) and for automatic software updating. It also contains support for detecting PSP events by watching a resource's screen for changes. Related to magnum are the PIL repositories (PIL-linux-i686 and PIL-linux-x86_64). These provide the Python Imaging Library, which is used by magnum event detection to find changes between screenshots. Two exist because they contain compiled code which needs to match the architecture of the system it will run on.

In-depth descriptions of the contents of each repository are included in [Appendix B](#).

Tools

This manual covers the following Tyrant tools, which will be used and configured by the range administrator (with the repository containing each tool in parentheses):

palantir (tybase): A component which runs on each test resource, allowing the resource to be controlled by test scripts via a TCP connection. Palantir serves on ports 51134 and 51135 (for Windows) and 51134 (for Linux).

UNCLASSIFIED

undermine (tybase): The component which runs a single instance of a test. Undermine connects via palantir to the resource(s) used by a test and runs the given test script.

overmind (tyworkflow): The component which schedules tests to run simultaneously. Overmind uses a database of test resources and schedules these resources for incoming tests.

reaper (tyworkflow): The component which handles reverting a resource to a clean state prior to running a test. What this means depends upon the reaper module in use for a given resource. For a virtual machine, this usually means reverting to a snapshot, but for a physical computer, this could mean using some imaging or auto-building solution to build out a certain OS configuration on a resource on-demand for a test.

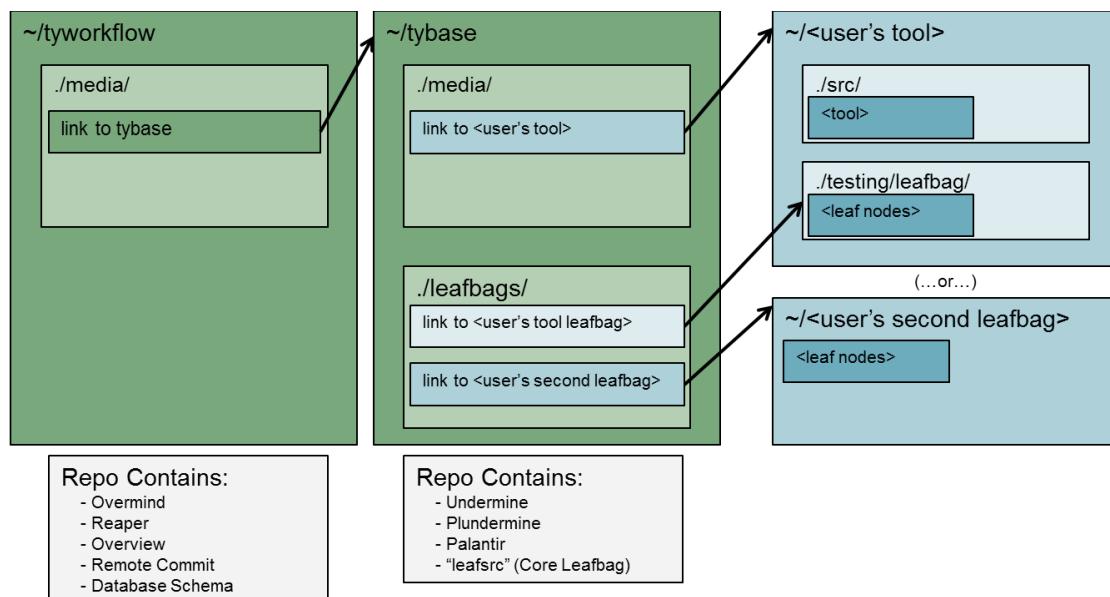
overview (tyworkflow): The component which displays test results and allows some management of test resources via a web-based interface.

process_plan (tyworkflow): A command-line tool used to process test plans (specifications for running multiple instances of tests against a specified variety of resources). This lets you submit plans to be run or see how many combos (specific runs of a test on specific resources and with specific parameters) would be run.

remote_commit (tyworkflow): A tool which allows remote submission of tests to a central Tyrant environment. While overmind on its own allows simultaneous tests to be run against a range of resources, remote commit makes overmind useful for a team of developers running different sets of code.

Directory Structure

Because each setup will involve testing different components, users will need to create a directory structure similar to the following:



UNCLASSIFIED

Symlinks can be made between the various repositories using the standard `ln -s` command.

Additionally, a user should be in the base of either `tyworkflow` or `tybase` to run specific commands. For example, if a user was running `./bin/undermine`, he would be doing so out of the `tybase` directory. If he was running `./bin/remote_commit`, he would be doing so out of the `tyworkflow` directory.

Assumptions

This document makes some assumptions about the type of setup desired. Specifically:

- It is assumed that testing will be performed on VMWare ESXi virtual machines.
- It is assumed that remote commit-style testing will be performed (with a team of developers, each at their own workstation, remotely submitting tests to a central server).
- It is assumed a mysql database will be used for storing resource and test information rather than sqlite3.
- The remote commit environment on the test server will run as root, and developers will submit their tests as root on the test server.
- The reader is familiar with working on the Linux command line and programming in Python.

Environment Setup

Before we can get to the work of writing and running tests, the environment must be set up. We will perform the setup now and verify its correctness in later sections.

On your developer workstation, clone the tybase and tyworkflow repositories as siblings in the same directory. In the tyworkflow directory, run make. This links tyworkflow to tybase and unpacks our built-in python distribution.

A few configuration files need to be modified to enable you to use the range that's been set up for you. In tyworkflow, copy the file `rc/defaults/db.rc` to `rc/`. In the copied file, make the following changes (you may need to talk to the administrator to get this information):

- set `resource_manager/dbname` to the name of the overmind database
- set `resource_manager/engine` to mysql instead of sqlite3
- set `mysql/host` to the hostname or IP address of the test server, which is where the overmind database resides
- set `mysql/user` and `mysql/passwd` to the username and password used to access the database you set in `resource_manager/dbname`

Also, copy `rc/defaults/remote_commit.rc` to `rc/` and make the following changes:

- `remote_commit/remote_user`: the user to connect to the testing server as (via SSH when syncing up files or running commands; defaults to root, which is typical)
- `remote_commit/remote_host`: the hostname or IP address of your testing server
- `remote_commit/remote_commit_dir`: the path on your testing server to the commits directory (`/proj/testing/commits` is the example used in the administrator manual).

For the above settings, make sure you uncomment any options which you set which are currently commented. That is, remove the semicolon from the beginning of any option line that you modify.

Leafnodes (Test Scripts)

Test scripts (known as “leafnodes” in Tyrant lingo) are the main units of work performed by undermine. Leafnodes typically involve one or more assets with palantir installed on them (but not always). Leafnodes can be as simple as a Python function that operates on some input parameters, to as complex as a class that choreographs a set of actions on multiple remote hosts via palantir. Where practical, leafnodes should be made smaller rather than larger to facilitate reuse.

Leafnode Concepts

Leafnodes come in different types (detailed below), but share some or all of the following concepts, which will be helpful to keep in mind for the rest of this manual:

UNCLASSIFIED

- hosts: The test hosts, or resources against which the leafnode works. Some leafnodes do not use any resources, but most do, as running tests on computers is a primary purpose of leafnodes.
- inputs: If you think of the leafnode as a function, these are the arguments.
- progress messages: Asynchronous messages the leafnode can output during the course of its execution.
- result code: An indicator of the status of the leafnode returned when it's finished (e.g. success, failure, error).
- result (or output): A return value from the leafnode (different from its status).

Creating and Running a Simple Leafnode

We'll start by creating a simple leafnode, then having done that, delve into the details that will let you create more powerful test scripts.

To start, inside your tybase directory, create the directory path leafbags/tutorial/tutorial (the duplicate `tutorial` in the path is intentional). In this directory, create an empty `__init__.py` file to make it a valid python package.

Open up your text editor of choice and enter the following text:

```
from tybase.undermine.leaf import Leaf
from tybase.undermine.meta import leafi

@leafi.DefineActuator()
class Hello(Leaf):
    def run(self):
        host = self.hosts[0]
        ret = host.execcmd('echo', self.args[0])
        host.fwrite('/tmp/test.txt', self.args[0])
        dat = host.fread('/tmp/test.txt')
        if dat.strip() == ret.strip():
            return self.SUCCESS, 'cmd output matched file contents'
        else:
            return self.FAILURE, 'cmd output differs from file contents'
```

Save this as `leafbags/tutorial/tutorial/hello_world.py`.

In your web browser, navigate to the overview web interface running on the test server (e.g. `http://testserver.example.com/overview`). This is the interface by which you will later be able to view your test results, and will be covered in detail later. For now, click the Management link. Select a Linux resource whose "status" column says "avail", check the box next to it, put your name in the "Reserve Name" field on the left-hand side of the page, and click "Reserve". This reserves the machine for your use so that it won't be scheduled for others' automated tests, preventing your work from messing up others' or vice versa. Note the IP address of this resource.

UNCLASSIFIED

In your tybase clone, run the following command, where IP_ADDR is the IP address of the resource you reserved:

```
bin/undermine tutorial.hello_world.Hello IP_ADDR - "hello, world"
```

Here's an example of the output you should see:

```
2013-09-23_16:51:02.44 (00191) [INF] script 22331: output_dir:  
./output/undermine/nlsheppa/2013_09_23-16_51_02_348754  
2013-09-23_16:51:02.44 (00191) [INF] script 22331: COMPLETION:  
success 'hello, world'
```

If you look on the actual Linux VM you reserved, you'll find a file /tmp/hello.txt with contents "hello, world".

You have written and run your first leafnode. Unreserve the resource you reserved previously by going back to the Management page, checking the box on the resource you reserved and clicking the "Use Testing" button.

Leafnodes in Depth

Writing Leafnodes

The general idea of writing a leafnode is that you write some sort of callable (see below) which receives zero or more palantir client objects, arguments and keyword arguments, performs some operations with them, and then returns a result code (see below) and result value, optionally with some progress message along the way. The callable is decorated with various decorators to define "metadata" for the leafnode.

In this section, we first illustrate the different ways of writing leafnodes, then dive in to the details of how to define metadata on them.

Types of Leafnodes

Here we cover the two main styles of leafnodes, class-based and function-based.

Type 1: class-based leafnodes

Class-based leafnodes are the most powerful and consist of a class which inherits from the Leaf class provided in tybase (by importing tybase.undermine.leaf.Leaf) and overrides certain methods (all of which take no arguments other than the self reference to the instance they're bound to). The methods which the leafnode may override are:

- `runSetup`: Run before the body of the leafnode. If this raises an exception, the leafnode will stop and the `SKIPPED` result code will be returned.
- `run`: The body of the leafnode. If this raises an exception, the leafnode will stop and the `ERROR` result code will be returned. Otherwise, this method must return a tuple of the result code and output value of the leafnode.
- `runCleanup`: Run after the body of the leafnode in all cases except when the leafnode times out, regardless of the leafnode's result code. If `runSetup` has an error other than a timeout, `runCleanup` is still run (so `runCleanup` is similar to the `finally` block of `try ... except ... finally`). The

UNCLASSIFIED

success or failure of runCleanup does not affect the final result code of the leafnode. If the leafnode body returns SUCCESS, the final result code will be SUCCESS even if runCleanup throws an exception.

- stopHandler: Run in the case of a timeout, when the leafnode is being stopped. This method has a limited time (currently five minutes) in which to run, which is why it's separate from runCleanup, which doesn't have as small a time limit.

In this style of leafnode, self is your reference to the currently running script. You access your host(s) through self.hosts, which is a list of palantir client objects (even if the leafnode only takes one host). Your arguments are provided initially in self.args (positionally-specified arguments) and self.kwargs (arguments specified with keywords) without regard to what's defined in the input parameters. You'll probably want to normalize your args by calling either self.normalize_args or self.normalize_kwargs in your run method (see below).

Here's an example python script illustrating this type of leafnode (the DefineActuator and other metadata decorators will be covered later):

```
from tybase.undermine.leaf import Leaf
from tybase.undermine.meta import leafi

@leafi.DefineActuator()
class MyLeafnode(Leaf):
    def runSetup(self):
        #here you do setup tasks, like perhaps installing some
        #supporting piece of software on an asset
        pass

    def runCleanup(self):
        #here you do cleanup, like perhaps deleting some temporary
        #files
        pass

    def run(self):
        #the body of your leafnode

        #normalize to a dict of kwargs so we get our default values

        #and everything easily accessible by name, even if the args
        #were given positionally
        self.kwargs = self.normalize_kwargs()

        #a common thing to do if you only have one host
        host = self.hosts[0]

        #do some testing stuff
        #perhaps we want to measure how much data was exchanged over
        #the network in this case, our result value is an integer;
```

```
#data type specification will be explained further on
traffic_size = some_measurement_function()

return (self.SUCCESS, traffic_size)
```

Type 2: function-based leafnodes

When you have a simpler testing task, you might choose this second type, in which you simply write a python function, which you optionally decorate with some metadata. This type of leafnode is simpler, but also less powerful. Differences compared to class-based leafnodes are:

- Your reference to the currently running script is stored at the `context` attribute of a host object. This unfortunately means that if your function-based leafnode takes no hosts, you will not have access to a reference to the currently running script and will not be able to do things which require it, like running a sub leafnode.
- You cannot define setup and cleanup logic like you can with `runSetup` and `runCleanup` for class-based leafnodes.
- You have less flexibility in setting the result code of your leafnode, as follows:
 - If your function raises an exception, `ERROR` will be returned, with the exception as the result value.
 - If your function returns at all (whether `True`, `False`, a number, `None`, anything), then `SUCCESS` will be used.
- Input parameters are typically defined implicitly by the function prototype, rather than explicitly with metadata on the leafnode.
- Arguments are handled differently. The arguments that are passed to your function-based leafnode consist of the host objects, followed by the args, followed by the kwargs. Thus, if your leafnode is called with too many or two few hosts, you can end up with an argument you expected to be a host containing an arg value (too few hosts), or an arg containing a host rather than the arg value you expected (too many hosts).
- Hosts, args and kwargs are accessed by the names you give them in the function prototype, as with any function.

Here's an example python script illustrating a function-based leafnode:

```
import tybase.undermine.meta.leafi as leafi

def my_leafnode(host1, host2, arg1, arg2, kwarg1=0, kwarg2=True):
    #do some testing stuff
    #no matter what you return here, the result will be SUCCESS (as
    #long as you actually return and don't throw an exception)
    return True
```

Leafnode Metadata

Leafnode metadata is how you define things like what kinds of assets your leafnode works against, what kinds of data it takes on input and output, whether it provides asset properties, etc. Metadata is set on a leafnode by decorating the leafnode with decorators provided in the `tybase.undermine.meta.leafi`

UNCLASSIFIED

module. Metadata is not strictly required to run a leafnode, but it is advised, and it is necessary to take advantage of certain advanced leafnode features. This section's subsections explain the provided metadata decorators organized by the purpose they serve, with the name of the decorator in parentheses.

Defining the Leafnode Purpose (DefineActuator, DefineSensor, DefineProcessor)

These three mutually exclusive decorators describe the function the leafnode serves and how it will interact (or not) with any assets it uses. Currently the usage of these decorators is only by convention; they don't do anything special to the leafnode you put them on (except for DefineSensor with asset properties). However, leafnodes need to have some type of metadata, and putting one of these on the leafnode is a good way to satisfy that requirement.

The convention for these decorators is:

- DefineActuator: leafnodes that make changes to an asset (e.g. delete a file, install a piece of software, etc)
- DefineSensor: leafnodes that only query information on an asset, not make changes to it. If you want your leafnode to assert (provide) asset properties, it must have this decorator.
- DefineProcessor: leafnodes that do not care about what assets they receive, and may not even take any hosts at all

Defining Input Parameters (Inputs)

This decorator takes as its arguments tuples defining

- the name of an input parameter
- its data type (see below for valid types and how to specify them)
- optionally a default value for the parameter.

This decorator only makes sense for the first type of leafnode (class-based), since the other two types depend on the arguments defined in the function prototype.

An example usage is:

```
import tybase.undermine.meta.leafi as leafi

@leafi.Inputs(
    ('num_runs', int),
    ('interval', float, 5.0),
    ('path', str, 'C:\\\\test_dir'),
    ('quick_run', bool, False)
)
class MyLeafnode...
```

Input and Output Data Types

Leaf node parameter data types can be any scalar type that can be pickled, as well as lists or structs.

UNCLASSIFIED

For scalar types, the data type definition (the second field of the input parameter tuple, or the argument to the `FinalOutput` decorator) is simply the type. For example:

```
@leafi.Inputs(('num_runs', int, 5)) (defines a single input parameter of type int named num_runs with default value 5)
```

```
@leafi.FinalOutput(bool) (defines a result value of type bool)
```

Typical scalar types are str, int, float and bool.

For complex types, you show the data types of the scalar parts of the complex types in the context of that type (as a list for lists, as a dict for structs). Also, complex types may be nested. For example:

```
@leafi.Inputs(['animals', [str]]) (defines a single input parameter which will be a list of strings named animals and have no default value)
```

```
@leafi.FinalOutput({'MemTotal': int, 'MemFree': int, 'Swapfile': str}) (defines a result value which will be a struct with three fields of type int, int and str, respectively)
```

```
@leafi.FinalOutput([{'name': str, 'lat': float, 'long': float}]) (defines a result value which will be a list of structs, each representing a city)
```

```
@leafi.FinalOutput({'size': int, 'files': [str]}) (defines a result value which will be a struct of a size value and a list of filenames [perhaps this is the size and contents of some archive file the leafnode processed])
```

However, valid leaf node lists and structs are more limited than what can be expressed in Python lists and dicts, as follows:

Lists

Lists are defined by giving the type of the scalar values of the list in list context in the input/output definition, as seen in the above table. Thus, every element contained in a list must be of the same type. If you need to pass a static set of values of different types, consider using a struct instead. If you really need to pass a variable number of items of different types, consider (1) a list of structs, or (2) multiple lists, each of which contains a different type.

Structs

Structs are defined by giving a dict whose keys are the names of the struct fields and whose values are the scalar types for each field. The difference between the leafnode struct type and regular Python dicts is that structs are defined with a static set of fields. If you really need to input (or output) a dict-like data structure, here are a couple of options:

```
('keyVals1', [[str]]), # only if key and value types are the same  
('keyVals2', [{'key':str, 'val':int}]) # different types for key & value
```

UNCLASSIFIED

Even with the above alternatives, leafnodes are still restricted in that they cannot input or output arbitrary types.

Deriving Inputs from Function Introspection (DeriveInputs)

For function- and method-based leafnodes, where input parameters are based on the function/method definition, this decorator will use function introspection to automatically generate input parameter metadata (as you would specify with the Inputs decorator for class-based leafnodes) from the function/method definition. You simply provide this decorator with no arguments, like so:

```
@leafi.DeriveInputs()  
def my_leafnode(...)
```

Defining the Result Data Type (FinalOutput)

The data type of the result value, aka output, is defined using the FinalOutput decorator, which takes the data type specification as its argument. This decorator uses the same specification as the Input decorator, as explained above.

Defining the Progress Message Data Type (ProgressOutput)

The progress message data type is defined just as with the result data type, but using the ProgressOutput decorator instead of the FinalOutput decorator.

Defining Leafnode Alias (Alias inside of a Define*)

The Define* decorators do have another purpose. Inside of a Define* decorator, you can also specify an alias with the Alias class provided in the leafi module. This is used with polymorphic leafnodes. You define an alias like so:

```
@leafi.DefineActuator(leafi.Alias('uber_leafnode'))  
def my_leafnode(...)
```

Defining the Leafnode "Subjects" (assets to run against) (Subject)

Using the Subject decorator, you can define constraints to restrict what your leafnode can run on. These constraints utilize asset properties (a list of which can be found [here](#)). In the Subject decorator, with the constraints keyword, you specify a list of constraint comparisons with the Prop, AndProp and OrProp classes provided in the leafi module. All the elements of the constraints list must match for the leafnode to be allowed to run.

Some examples:

Require 64-bit Windows 7:

```
@leafi.Subject(  
    constraints=  
        leafi.Prop('sw.os.architecture') == 'x86_64',  
        leafi.Prop('sw.os.name') == '6.1',  
        leafi.Prop('sw.os.family') == 'Windows'
```

```

    )
)
)
```

Require 64-bit Windows 7 (illustrating the use of AndProp, which is unnecessary, but valid):

```

@leafi.Subject(
    constraints=(
        leafi.AndProp(
            leafi.Prop('sw.os.architecture') == 'x86_64',
            leafi.Prop('sw.os.name') == '6.1',
            leafi.Prop('sw.os.family') == 'Windows'
        ),
    )
)
```

Require 32-bit Windows 7 or XP (illustrating the use of OrProp):

```

@leafi.Subject(
    constraints=(
        leafi.OrProp(
            leafi.Prop('sw.os.name') == '5.1',
            leafi.Prop('sw.os.name') == '6.1'
        ),
        leafi.Prop('sw.os.architecture') == 'x86_64',
    )
)
```

Defining the Default Leafnode in a Module (MainLeaf)

If you so choose, you can mark a leafnode in a module as the default leafnode for that module. Then, when you specify the leafnode to run (e.g. on the undermine command line), you need only specify as far as the module, and undermine will automatically run the default leafnode you marked. To do this, place the MainLeaf decorator on the desired leafnode.

For example, consider the example leafnode we created and ran in [Creating and Running a Simple Leafnode](#). If we added the MainLeaf decorator to the Hello class, then rather than referencing the leafnode as `tutorial.hello_world.Hello` like before, you could reference it as simply `tutorial.hello_world`.

The MainLeaf decorator would be added to the example leafnode like so:

```

@leafi.DefineActuator()
@leafi.MainLeaf()
class Hello(Leaf):
```

Inheriting Metadata from Parent Classes (InheritMeta)

With the class-based style, where class inheritance is involved, this decorator can be used to inherit metadata defined on a parent class to the child class. You put this decorator on the class and the class would inherit metadata from parent classes.

Inside the Leafnode

At this point, we know how to structure a leafnode, but what goes in the body?

Technically, pretty much whatever you want within the limits of python. Typically, you interact with palantir client objects to put or get files from assets, run commands on them, do operations influenced by the input parameters, and so forth. To see a list of the operations available with palantir, run `bin/palantir_admin -h` in your tybase clone. Each of the methods documented therein are accessible on the host objects. For example, to put a file, you'd do:

```
self.hosts[0].put(src, dest)
```

During the leafnode, you may choose to emit progress messages and at the end you return a result code and a result value (depending upon leafnode style).

Emitting Progress Messages

To emit a progress message, you call the `emitProgress` method on the Leaf class. If you're in a class-based leafnode, that means calling `self.emitProgress`. If you're in a function- or method-based leafnode, you need a reference to the currently running script, which is available on your palantir client objects as the `context` attribute (e.g. `host.context.emitProgress`). This method is defined as follows:

```
def emitProgress(self, data, seq=-1, tstamp=None, spath=None, dpath=None)
```

where the parameters are:

- `data`: The value of the progress message, which must match the type you defined in the `ProgressOutput` decorator.
- `seq`: Sequence number of the progress message (defaults to one greater than the last one, starting with zero)
- `tstamp`: Time stamp of the progress message, defaults to the current time.
- `spath`: Perhaps this means source path, but it appears to have no meaning and is rarely used, if at all.
- `dpath`: Override the path to the file where the progress message is stored, defaults to a file in the output directory whose name includes the sequence number. This is rarely used.

Usually, you should only provide data. An example call would look like:

```
self.emitProgress({'currentSpeedMPH':88.8})
```

Returning a Result

When in a class-based leafnode, you return a tuple of the result code and the result value. The result codes are constants defined on the Leaf class, as enumerated below. The result value is whatever value you want, of the type you defined in your `FinalOutput` decorator.

UNCLASSIFIED

When in a function-based leafnode, as explained above, you simply return the result value and the result code is determined for you.

Leafnode Result Codes

The valid leafnode result codes are defined as attributes on the Leaf class and are as follows:

- SUCCESS: test completed without error and returned desired results (e.g. your software works)
- FAILURE: test completed without error and returned incorrect results (e.g. your software doesn't work, but your test is written properly)
- ATTENTION: test completed without error and returned generally desired results, but something is fishy and you want a human to follow up
- SKIPPED: test had an error in setup (either in basic undermine stuff like reaping an asset or in your optionally provided setup code)
- ERROR: test had an error while running the body of the test (e.g. your test has a problem and threw an exception)

Based on the convention of these result codes, your code should generally only explicitly return SUCCESS, FAILURE, or ATTENTION. If you want ERROR, you should throw an exception describing the error. Your leafnode body should not return SKIPPED since that is for setup problems.

Normalizing Arguments

Note: This only applies to class-based leafnodes.

By default, the code that calls your leafnode's functions does nothing to set up the arguments for you. That is, when an instance of your leafnode is created, you get some positional arguments and some keyword arguments based on how your leafnode was called. Another effect of this is that default values are not handled at all, which means you end up with `None` for the value of any arguments which are not provided in the call to your leafnode. So that you don't have to write your own argument handling code, two methods (`normalize_args` and `normalize_kwargs`) have been provided. These are methods on the `Leaf` class, so you can access them simply by calling `self.normalize_args` or `self.normalize_kwargs` from your class-based leafnode. Both take no arguments.

`normalize_args` returns the arguments to your leafnode as a list of positional arguments.
`normalize_kwargs` returns the arguments as a dict keyed by input parameter name. Both set default values for arguments which are not provided (if you gave default values in your leafnode's metadata) or otherwise throw exceptions (if you did not give default values). Also, you may only call one of these functions (if you call both, then you may get errors about arguments being provided multiple times). The idea is for you to set `self.args` or `self.kwargs` to the return of the respective `normalize` function (e.g. `self.args = self.normalize_args()`). If your leafnode overrides the `__init__` method, that would be a good place to put it, otherwise you could just put it near the beginning of your `run` method.

Logging Information

Logging information may be output from a leafnode using the `log` attributes present on the script class and each host object. These `log` attributes are instances of the python logging module's `Logger` object (see <http://docs.python.org/2/library/logging.html> for full details on using python logging). Logging entries output using a host object's `log` attribute are tagged with the IP address or hostname of that host. All these log entries will show up in the `script.log` file in the leafnode instance's output directory (explained further in the "Running Leafnodes" section).

Examples:

- Logging an informational message to the script class's logger in a class-based leafnode:
`self.log.info("something happened")`
- Logging an informational message to the script class's logger in a function-based leafnode (assuming the leafnode takes at least one host and the first parameter is named "host"):
`host.context.log.info("something happened")`
- Logging a warning related to a specific host in a class-based leafnode:
`self.hosts[2].log.warning("something might be wrong")`

Performing Palantir Operations as a Normal User (Windows Only)

Normally, when you perform operations on a test resource with palantir (i.e. using methods on one of your host objects), that operation is run on the test resource by a palantir processing running as the SYSTEM user. If you have an operation that you need to run as a regular user (e.g. because you need to interact with the GUI on modern Windows or need the operation to run with limited user privileges), this can be done using functionality in the emissary repository.

To use this, you'll first need to link in the emissary leafbag. Clone the emissary repository into the same directory which contains your tybase and tyworkflow clones, then run the following commands from the root of tybase:

```
ln -s ../../emissary/leafbag leafbags/emissary  
bin/prepare
```

Then, in your test script, import the `createEmissary` function like so:

```
from emissary.emissary import createEmissary
```

Finally, in the body of your leafnode, add a line like the following:

```
emhost = createEmissary(HOST_OBJ,  
                        domain='DOMAIN', username='USERNAME', password='PASSWORD')
```

Replace `HOST_OBJ` with a reference to the existing host object for the test resource on which you want to run operations as a regular logged-in user, and replace `DOMAIN`, `USERNAME`, and `PASSWORD` with the domain name, username, and password of the account you want to run as. If the specified user is not logged in, auto-login registry keys will be set and the test resource will be rebooted to cause the desired user to log in. If domain, username, and password are all omitted, then operations will be run as whatever user is currently logged in. If only domain is omitted, then the domain will be ignored when

determining whether the correct user is logged in and when specifying via the registry what user to automatically log in.

Once this line of code has run, `emhost` will be a reference to an instance of palantir running as the specified user. This works exactly the same as any other palantir client object; it has exactly the same methods and properties, the only difference is what user the remote palantir server is running as.

Storing Leafnodes (Modules and Leafbags)

Leafnodes are stored in python modules in what's known as "leafbags". A leafbag has a very specific definition which must be followed: A leafbag is a directory which contains python packages. These python packages then contain python modules with leafnodes in them.

When undermine runs a leafnode, the roots of all the configured leafbags are on the python path. This is why, when running a leafnode, you can specify it as a "python import path", like you were trying to import it in a python script. Deep down in the guts of undermine, that is what is actually happening.

Structuring Leafnode Modules

Leafnodes are stored in python modules containing one or more leafnodes and having one of several markers within the first 200 bytes of the file. When a module has one of these markers, we call it "leafy". A module must be leafy in order for it to be scanned when tybase's `bin/prepare` is run. This marker allows the leafnode scanner to quickly ignore modules that have a very low potential of containing leafnodes.

Valid leafy markers are as follows:

- the string "`THIS_IS_A_LEAF_MODULE`"
- the string "`#AUTOMATICALLY GENERATED`" at the beginning of a line
- an import involving `tybase.undermine.meta.leafi`, e.g.
`from tybase.undermine.meta.leafi import foo or`
`import tybase.undermine.meta.leafi`
- an import involving `tybase.undermine.leaf`
- an import involving `tybase.undermine.main_script`

Structuring Leafbags

Your leafbag should have one or more levels of subdirectories and you should put leafnodes in these subdirectories (not in the root of the leafbag). In general, you should try to create your leafbags to either be entirely self-contained, or to depend on other leafbags (which you would then link in like normal, with no added complexity). This makes things easier in the long run. However, this is not always practical. If your leafbag depends on other files from elsewhere in your project's repository or just on other files in general, you will need to be aware of this and take it into account when using remote commit. See the section on leafbags with non-leafbag dependencies for how to handle this.

Since the directories in your leafbag are being treated as python packages, they must have `__init__.py` files like any python package. When you run `bin/prepare`, a component of tyrant

UNCLASSIFIED

will scan the leafbag. The leafbag scanner will only recurse into a subdirectory of the leafbag if at least one of the two following conditions is true:

- the subdirectory's `__init__.py` file contains the leafbag marker (the comment `#LEAFBAG`)
- the `__init__.py` file in an ancestor of the subdirectory up to but NOT including the root of the leafbag contains the leafbag marker with the RECURSE flag (the comment `#LEAFBAG RECURSE`). The RECURSE flag tells the scanner to go through all the subdirectories regardless of whether they have a leafbag marker.

So, the simplest thing is to just put an `__init__.py` in each top-level subdirectory of your leafbag with the comment `#LEAFBAG RECURSE`. If for some reason you have directories in your leafbag devoid of leafnodes (such as a large third-party python module), then you might choose to not use recursion globally and only put the leafbag marker in specific subdirectories' `__init__.py` files.

Leafbag structure example

Consider an example software project (call it eproj) whose developers want to perform automated testing with leafnodes. This project may have a code repository (also named eproj) with a subdirectory called tests which is the leafbag for this project. With this in mind, consider the following partial directory and file structure for the example leafbag:

- `eproj/` (root of the repository)
 - o `tests/` (root of the leafbag)
 - `utils/` (supporting python modules, not leafnodes)
 - `__init__.py` (has no leafbag marker)
 - `net_tests/` (leafnodes for testing the software in a network)
 - `__init__.py` (contains leafbag marker)
 - `test_data/` (some kind of data used for the tests and some python modules to work with it, but no leafnodes)
 - o `__init__.py` (exists to make this a valid python package, but has no leafbag marker)
 - `standalone_tests/` (leafnodes for testing the software on a single computer)
 - `__init__.py` (contains leafbag marker with RECURSE flag)
 - `win_xp/` (leafnodes for Windows XP)
 - o `__init__.py` (no leafbag marker)
 - `win_7/` (leafnodes for Windows 7)
 - o `__init__.py` (no leafbag marker)
 - `notes/` (contains no `__init__.py` at all)

With this structure, the scanner will

- skip `utils/` (since it has no leafbag marker, and it's a top-level subdirectory so there is no chance of having an ancestor with a leafbag marker with the RECURSE flag)
- look in `net_tests` (since it has a leafbag marker in its `__init__.py`)

- skip net_tests/test_data (since it doesn't have a leafbag marker and no ancestor has the RECURSE flag)
- look in standalone_tests and any subdirectories (since the `__init__.py` in standalone_tests has a leafbag marker with the RECURSE flag), BUT...
- skip standalone_tests/notes (since it has no `__init__.py` at all and is therefore not a valid python package)

Linking-in leafbags

In order to use leafnodes in a leafbag with tyrant, you must link this leafbag in to your tyrant repo. The typical way to do this is to create a symlink in the leafbags directory of tybase that points to the leafbag you want to use. An alternative is to actually put your leafbag in the leafbags directory of tybase, but this usually doesn't make sense from an organizational standpoint because your typical project using tyrant has its own repository with the leafbag as a subdirectory.

So, following the example leafbag above, assuming your current working directory is the root of tybase and that the eproj repo is checked out in the same directory as tyrant-dev (the two are siblings), you would run the following command to link in the leafbag:

```
ln -s ../../eproj/test leafbags/eproj
```

This results in a symlink called eproj in leafbags that points to the leafbag in the eproj repo.

Mitigation of naming conflicts

Note that leafbags can cause naming conflicts. For example, consider two projects, eproj and fproj. Suppose that both projects have leafbags with subdirectories named net_tests. In this case, if both leafbags are linked in to tyrant at the same time, a naming conflict will occur. The preferred way to mitigate this is to add an extra directory level in the leafbags named for the project. For example, in the current situation, the net_tests subdirectories that are conflicting are located at eproj/tests/net_tests and fproj/tests/net_tests. To mitigate this, one could add an extra directory level to end up with eproj/tests/eproj/net_tests and fproj/tests/fproj/net_tests, respectively. Then, leafnodes in eproj/tests/eproj/net_tests would be referenced with a python import path starting with eproj.net_tests, and those in fproj/tests/fproj/net_tests would be referenced starting with fproj.net_tests.

Running Leafnodes

This section deals with running leafnodes apart from the automated workflow and range management features provided by overmind. For range testing, see the sections on Test Plans and Remote Commit.

Single Tests

Undermine, provided in the tybase repository, is the primary tool used to run leafnodes. Undermine lets a user run a single instance of a test script against one or more specific resources. The basic usage of undermine is as follows:

```
bin/undermine <leaf_spec> <host_spec> [<host_spec> ...] --<args_and_kwargs>
```

The command line components are as follows:

- **leaf_spec**: This is the specification of the leafnode to run, and may be given as one of the following:
 - **python import path** to the leafnode: Since all leafbags are on the python path, you can give the "python import path" to your leafnode as if you were in python code trying to import it. For example, suppose you have a leafnode called ping in the file leafbags/my_leafbag/utils/network_funcs.py (relative to the root of tybase). Then, since leafbags/my_leafbag is on the python path, if you were in python code and wanted to import your ping leafnode, you would say `import utils.network_funcs.ping`. Therefore, to run this leafnode, you would use `utils.network_funcs.ping` as the `leaf_spec`. If you put the `MainLeaf` decorator on your ping leafnode, then you could get away with just `utils.network_funcs`.
 - **filesystem path**: An alternative way is to specify the filesystem path to the leafnode. This *may* allow you to run leafnodes even when they're not in leafbags (caveat emptor). To do this, you just give the filesystem path to the python file containing the leafnode, followed by the name of the leafnode in the file, with an '@' in between. For example: `leafbags/my_leafbag/utils/network_funcs.py@ping`. As with the python import path, if you put the `MainLeaf` decorator on the ping leafnode, you can leave off the @ping component.
- **host_spec**: This is a specification of the host to connect to with palantir. Since palantir currently only runs over TCP/IP, this must be either the IP address or hostname of the host.
- **args_and_kwargs**: Here you specify, space-delimited, the arguments and keyword arguments to the leafnode. See the output of `bin/undermine -h` for an extensive description of exactly how arguments and keyword arguments are specified.

When `undermine` runs it logs into two files: `script.log` and `undermine.log`. `script.log` contains logging and output specifically from the test script. `undermine.log` contains lower-level logging from `undermine` and `palantir`, logging which the test script developer may not care about. These files are located in the script's output directory.

When running test scripts standalone with `undermine`, by default, output directories are stored under `output/undermine/<USERNAME>` relative to the `tybase` root, where `<USERNAME>` is the user name of the user running `undermine`. Under this directory, a subdirectory named with the current date and time is created, and this timestamp directory is the output directory of the leafnode. Also, in the `<USERNAME>` directory will be a symlink called "latest" which always points to the most-recently-run leafnode. This is especially helpful when there are lots of output directories sitting around in a `<USERNAME>` directory.

Batch Testing

The `plundermine` tool provided in `tybase` allows running simple combinations of tests against specific test resources. To use it, you give `plundermine` a leafnode to run, and lists of hosts and parameters for

UNCLASSIFIED

each host and parameter slot the leafnode takes. Plundermine will generate all the possible combinations and run them with a level of parallelism (up to a configurable maximum number of concurrent undermine runs). In the fairly common degenerate case of a leafnode which accepts only one host and no arguments, plundermine is an effective tool for running a given leafnode against a whole set of resources. This is useful for some range management tasks.

See the output of `bin/plundermine -h` for full details. Some examples are:

- Run a leafnode which only accepts one host against the three listed hosts:
`bin/plundermine underlib.test_leafnode
192.168.56.1,192.168.56.2,192.168.56.3`
- Run a leafnode which accepts two hosts and no arguments against all possible combinations of hosts listed in the two specified files:
`bin/plundermine underlib.client_server_test file:clients
file:servers`
- Run a leafnode which accepts two hosts and two arguments against all possible combinations of the hosts from the first file, the hosts from the comma-separated list for the second host slot, and the specified values for the two argument slots:
`bin/plundermine underlib.complex_test file:first_hosts
192.168.56.1,192.168.56.2 - one,two,three x,y,z`

For plundermine, output directories are stored in `output/plundermine/<USERNAME-TIMESTAMP>`, where `<USERNAME>` is the name of the user who ran plundermine, and `<TIMESTAMP>` is the date and time at which plundermine was run. Inside each of these directories are numbered subdirectories representing each of the test instances run. These numbered subdirectories are each undermine output directories containing the undermine log and data files.

Test Plans

Test plans are the units of work performed by Overmind. They specify what test to run (the leafnode the user already has) and what to run it on ("all versions of Windows", "all languages of Windows XP SP2", etc). Overmind utilizes the reaper to revert assets to previously stored state (typically, reverting to a snapshot on a VM). Overmind stores the results of undermine runs in a database which can then be viewed through the overview web gui. Like leafnodes, test plans are written in python and stored in leafbags and are referenced on the command line in the same manner (either as python import paths or filesystem paths).

Test Plan Concepts

The following terms will be useful to know when writing and running test plans:

- test plan: A python script which defines test cases. This is the thing you run with overmind.
- test case: A description of what leafnode to run, on what assets, with what parameters.
- combo or test instance: A specific combination of leafnode, assets and parameters. A test case expands into multiple test instances at run time. These test instances represent individual runs

of undermine. NOTE: In overview, the overmind web gui, test instances are referred to as test cases.

- namespace: An overall identifier in overmind under which multiple plans can run.
- purge: To immediately cancel a running namespace, plan, or test instance.
- reap: To revert an asset to a previously stored state.
- recipe: A definition of an OS which can be placed on a computer (e.g. the family, service pack, architecture, language, installed apps)
- computer: A computer on which a recipe can be installed (e.g. a VM or physical machine)
- resource: A specific computer with a specific recipe on it.

Example Test Plan

In your tyworkflow repository, look at

`src/leafbag/overlib/preflight/service_ping_plan.py`. This is a test plan which runs the `service_ping_test` on all unique combinations of computer and recipe in the range, which for our purposes is equivalent to all the resources on the range. We'll walk through this line-by-line:

```
from tyworkflow.support.planlang import *
```

This line imports the plan language objects used in writing the test plan

```
test = TESTCASE (
```

We begin the definition of a test case which will be used to generate all the actual tests run.

```
    script = 'overlib.preflight.service_ping_test',
```

This defines what leafnode to run. You must use the “python import path” method of specifying the leafnode to run; do not use a filesystem path.

```
    hostslots = [HOST() % FACTORS(computer_id=1, recipe_id=1)],
```

This defines how to generate the actual tests run, or “combos”. This hostslots setting indicates the test only takes one host (since a list of only one element is provided), puts no constraints on the chosen host (because of the empty argument list to HOST), and indicates that the combination of computer_id and recipe_id for each chosen host must be unique. This is covered in-depth later.

```
    samples = -1,
```

This line specifies how many of the generated combos to actually choose. The special value -1 indicates that all combos should be used.

```
    namespace = 'preflight-ping-$t',
```

This specifies the name of the namespace to use if no namespace is .

The values defined in the TESTCASE declaration may be overridden on the command line.

```
EXECUTE (
    testcase = test,
)
```

This block sets the testcase defined above to be execute.

Parsing Test Plans

Prior to actually running a test plan, there are a couple operations which may be performed on it to verify that it will do what you expect. Because you configured your database by editing `rc/db.rc` in `tyworkflow` earlier, you can run these steps locally even though your test plans will be run remotely.

The `process_plan` command provided in `tyworkflow` provides the parse and solve subcommands. Parse will parse your test plan and give back to you overmind's understanding of what you're written. You can use it as a quick verification that you wrote what you intended. To parse the example plan from above, you would run

```
bin/process_plan parse overlib.preflight.service_ping_plan
```

If you wanted to parse the plan but then override the samples setting, you could run

```
bin/process_plan parse overlib.preflight.service_ping_plan samples=10
```

and you would see that change reflected in the output.

The solve subcommand will parse your plan and then show you what combos your plan would generate.

To solve the example plan, you'd run:

```
bin/process_plan solve overlib.preflight.service_ping_plan
```

You could override samples like above, and depending upon how diverse your range is, you may see the number of combos decrease.

Running Test Plans

The remote commit command (`bin/remote_commit`) in `tyworkflow` allows you to submit your tests to a remote test server. Once your test is submitted, you can continue your development in your local environment without affecting the test you just submitted. You can even submit tests in parallel, allowing you to try one approach to solving a problem, submit a test of it, then try a different approach and submit a test for that approach in a different namespace. Here we explain how to run test plans, but remote commit has more functionality which is covered in detail later on.

Test plans are run through remote commit with either the `run` or `runlite` subcommands. These commands sync your local environment up to the test server and submit your test to your remote overmind instance. These commands take the same arguments as `process_plan`'s `solve` and `parse`. To submit the `service_ping_plan` with `remote_commit`, you'd run:

```
bin/remote_commit run overlib.preflight.service_ping
```

If you wanted to limit the number of samples, you would run

```
bin/remote_commit run overlib.preflight.service_ping samples=10
```

Another useful option is to specify some notes on the namespace with the `n_notes` argument:

```
bin/remote_commit run overlib.preflight.service_ping samples=10
n_notes="please work"
```

Working with a Range

As a developer, overview will be your primary interface to range testing. Overview lets you browse test results and reserve machines for use outside of normal automated testing.

UNCLASSIFIED

Seeing Test Results

To see test results, navigate to overview's Namespaces page (e.g.

http://testserver.example.com/test_namespaces.php). Here you'll see a listing of all the namespaces that have been run. When remote commit is in use, there will usually be only one plan in a namespace.

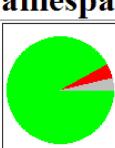
At each of the list levels, on the right side of the table, you'll see a summary of how many testcases in that entity are in the various states a test can be in (either pending, running, or one of the completion statuses).

The list pages also have forms at the top allowing you to filter by matching on various attributes of namespaces, plans, or test cases (specified by naming the field of the table to filter on and the pattern to match, e.g. `status=error` to see all error testcases or `n_name=~preflight` to see all namespaces whose name matches the pattern "preflight").

The **Refresh** field specifies the interval in which any particular page will refresh. This is particularly useful for monitoring test results as they finish.

Finally, the **Limit** field allows you to specify how many rows you want to be displayed (whether namespaces, test plans, or test cases). This prevents loading an entire page with 1000's of rows if the loading time would take too long.

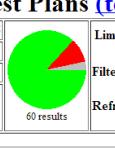
Namespaces (test plans)

Namespace:	(*)	(*)	NS Notes:	(*)		Limit:	200	OK	<< Prev	Next >>
Test Plan:	(*)	(*)	Filter:	n_name~=	<input type="button" value="OK"/>					
Test Case:	(*)	(*)	Refresh:	<input type="text"/> secs	<input type="button" value="START"/>					

nid	n_name	status	start_time	finished	total	success	failure	attention	skipped	error	purged	running	pending	n_notes
408	JacalDeltaTest	34 Finished	2013-09-17 12:54:20 EDT	34 / 34	34	32								-
407	preflight-ping-2013_09_17-16_37_50	17 Finished	2013-09-17 12:37:50 EDT	17 / 17	17	16								-
406	DeltaTest	26 Finished	2013-09-16 08:23:49 EDT	26 / 26	26	26								-
405	OsInfoTest	60 Finished	2013-09-15 16:10:24 EDT	60 / 60	60	52	6							-

Clicking on a namespace brings you a list of all of the test plans in that namespace.

Test Plans (test cases)

Namespace:	OsInfoTest	405	NS Notes:	-		Limit:	200	OK	<< Prev	Next >>			
Test Plan:	(*)	(*)	Filter:	p_name~=	<input type="button" value="OK"/>								
Test Case:	(*)	(*)	Refresh:	<input type="text"/> secs	<input type="button" value="START"/>								

nid	pid	p_name	s_name	start_time	end_time	elapsed	total	success	failure	attention	skipped	error	purged	running	pending	p_notes
405	421	verify_osinfo_plan-2013_09_17-20_53_40	underlib.preflight.verify_osinfo.test	2013-09-17 16:53:40 EDT	2013-09-17 17:17:27 EDT	23m, 47s	17	14	2							-
405	419	verify_osinfo_plan-2013_09_17-16_43_17	underlib.preflight.verify_osinfo.test	2013-09-17 12:43:28 EDT	2013-09-17 13:16:22 EDT	32m, 54s	17	14	2							-
405	415	delta_manifest_test_plan-2013_09_15-21_33_02	afl tests.unittests.get_os_info	2013-09-15 17:53:03 EDT	2013-09-15 17:41:24 EDT	8m, 21s	13	12	1							-
405	414	os_info_plan-2013_09_15-20_10_24	afl tests.unittests.get_os_info	2013-09-15 16:10:24 EDT	2013-09-15 16:21:29 EDT	11m, 5s	13	12	1							-

Clicking on a plan name brings you to a list of all the test cases in the plan.

UNCLASSIFIED

Test Cases (test plans)

Namespace: OsInfoTest		405											
NS Notes: -			Limit: 200	OK									
Test Plan: verify_osinfo_plan-2013_09_17-20_53_40		421	Filter: t_name~=	OK									
Test Case: (*)		(*)	Refresh:	secs START									
total	success	failure	attention	skipped	error	purged	running	pending					
17	14	2	0	1	0	0	0	0					
nid	pid	tid	t_name	s_name	start_time	end_time	elapsed	result_code	result	host_0/os	lang	arch	hwtype
405	421	614	verify_osinfo_plan-2013_09_17-20_53_49_952576-421	underlib_preflight.verify_osinfo_test	2013-09-17 16:53:50 EDT	2013-09-17 17:17:27 EDT	23m, 37s	success	Pass	windows 7.0	en-US	X86_64	vm
405	421	615	verify_osinfo_plan-2013_09_17-20_53_49_953788-421	underlib_preflight.verify_osinfo_test	2013-09-17 16:53:50 EDT	2013-09-17 17:00:25 EDT	6m, 35s	success	Pass	windows 7.1	fr-FR	X86	vm
405	421	617	verify_osinfo_plan-2013_09_17-20_53_49_956088-421	underlib_preflight.verify_osinfo_test	2013-09-17 16:53:50 EDT	2013-09-17 17:07:26 EDT	13m, 36s	success	Pass	windows Vista 2	zh-CN	X86_64	vm
405	421	618	verify_osinfo_plan-2013_09_17-20_53_49_957633-421	underlib_preflight.verify_osinfo_test	2013-09-17 16:53:51 EDT	2013-09-17 17:02:55 EDT	9m, 4s	success	Pass	windows 2003 2	zh-CN	X86	vm
405	421	619	verify_osinfo_plan-2013_09_17-20_53_49_958962-421	underlib_preflight.verify_osinfo_test	2013-09-17 16:53:51 EDT	2013-09-17 17:07:31 EDT	13m, 40s	success	Pass	windows Vista 2	fr-FR	X86_64	vm
405	421	620	verify_osinfo_plan-2013_09_17-20_53_49_960348-421	underlib_preflight.verify_osinfo_test	2013-09-17 16:53:52 EDT	2013-09-17 17:07:10 EDT	13m, 18s	success	Pass	windows XP 2	ar-SA	X86	vm
405	421	621	verify_osinfo_plan-2013_09_17-20_53_49_961615-421	underlib_preflight.verify_osinfo_test	2013-09-17 16:53:52 EDT	2013-09-17 17:07:11 EDT	13m, 19s	success	Pass	windows 2003 R2 2	en-US	X86_64	vm
405	421	622	verify_osinfo_plan-2013_09_17-20_53_49_961232-421	underlib_preflight.verify_osinfo_test	2013-09-17 16:53:52 EDT	2013-09-17 16:57:37 EDT	3m, 45s	success	Pass	linux Fedora 12 0	en-US	X86	vm
405	421	623	verify_osinfo_plan-2013_09_17-20_53_49_964686-421	underlib_preflight.verify_osinfo_test	2013-09-17 16:53:52 EDT	2013-09-17 17:02:56 EDT	9m, 4s	success	Pass	windows 2008 2	en-US	X86_64	vm
405	421	625	verify_osinfo_plan-2013_09_17-20_53_49_967304-421	underlib_preflight.verify_osinfo_test	2013-09-17 16:53:52 EDT	2013-09-17 17:06:43 EDT	12m, 51s	success	Pass	windows XP 2	ko-KR	X86	vm
405	421	626	verify_osinfo_plan-2013_09_17-20_53_49_968925-421	underlib_preflight.verify_osinfo_test	2013-09-17 16:53:53 EDT	2013-09-17 17:06:47 EDT	12m, 54s	success	Pass	windows Vista 1	ja-JP	X86	vm
405	421	627	verify_osinfo_plan-2013_09_17-20_53_49_970659-421	underlib_preflight.verify_osinfo_test	2013-09-17 16:53:53 EDT	2013-09-17 16:57:38 EDT	3m, 42s	success	Pass	windows 2000 4	en-US	X86	vm
405	421	628	verify_osinfo_plan-2013_09_17-20_53_49_972265-421	underlib_preflight.verify_osinfo_test	2013-09-17 16:53:53 EDT	2013-09-17 17:08:06 EDT	14m, 13s	success	Pass	windows XP 3	es-ES	X86	vm
405	421	629	verify_osinfo_plan-2013_09_17-20_53_49_974028-421	underlib_preflight.verify_osinfo_test	2013-09-17 16:53:53 EDT	2013-09-17 17:06:54 EDT	13m, 1s	success	Pass	windows Vista 0	en-US	X86_64	vm
405	421	616	verify_osinfo_plan-2013_09_17-20_53_49_955046-421	underlib_preflight.verify_osinfo_test	2013-09-17 16:53:50 EDT	2013-09-17 17:07:03 EDT	13m, 13s	failure	patch_level:sp1!=sp0	windows 2003 R2 0	zh-TW	X86	vm
405	421	624	verify_osinfo_plan-2013_09_17-20_53_49_965951-421	underlib_preflight.verify_osinfo_test	2013-09-17 16:53:52 EDT	2013-09-17 17:02:57 EDT	9m, 5s	failure	patch_level:sp1!=sp0	windows 2003 R2 0	ja-JP	X86_64	vm
405	421	613	verify_osinfo_plan-2013_09_17-20_53_49_950800-421	underlib_preflight.verify_osinfo_test	2013-09-17 16:53:50 EDT	2013-09-17 17:10:03 EDT	16m, 13s	skipped	[Errno 113] No route to host	windows 7.0	en-US	X86_64	vm

Clicking on the test case name gives you detailed results from that test.

Test Case Details

Namespace: OsInfoTest		405							
NS Notes: -									
Test Plan: verify_osinfo_plan-2013_09_17-20_53_40		421							
Test Case: verify_osinfo_plan-2013_09_17-20_53_49_955046-421		616							
Result Code: failure									
Start: 2013-09-17 16:53:50 EDT									
End: 2013-09-17 17:07:03 EDT									
Script: underlib.preflight.verify_osinfo_test									
Host_0: 172.2.2.122/windows;2003 R2;0;zh-TW;X86;palantir;vm									
Result: patch_level:sp1!=sp0									
Output Dir: /proj/tyrant-dev/output/OsInfoTest/verify_osinfo_plan-2013_09_17-20_53_40/verify_osinfo_plan-2013_09_17-20_53_49_955046-421									
Undermine Logs									
run_task.log									
script.log									
udata-call-00000001.dat									
udata-result-00000001.dat									
udata-result_code-00000001.dat									
udata-times-00000001.dat									
undermine.log									
Host 0									
win2k3r2std-sp0-x86-tw									
172.2.2.122									
00:50:56:21:00:31									

The file `script.log` contains logging output specifically written by the test script developer (by calling `self.log` or `host.log` in a test script) which `undermine.log` gives lower-level undermine framework logging information. See these files in the case of errors or unexpected results with your tests scripts.

Clicking on any of the log files leads to the raw data from the file system.

UNCLASSIFIED

UNCLASSIFIED

/proj/tyrant-dev/output/OsInfoTest/verify_osinfo_plan-2013_09_17-20_53_40/verify_osinfo_plan-2013_09_17-20_53_49_952576-421/script.log

RegExp Filter:

[Follow]

```
2013-09-17_21:17:23.6. (00450) [INF] script.underlib.preflight.verify_osinfo_test.UnitTest 14936: host: 172.2.2.108
0
2013-09-17_21:17:24.43 (01882) [INF] script.underlib.preflight.verify_osinfo_test.UnitTest 14936: Truth Props {'family': 'windows', 'language': 'en-us', 'ed': '', 'patch_level': 'sp0', 'version'
2013-09-17_21:17:25.72 (03166) [INF] script.underlib.preflight.verify_osinfo_test.UnitTest 14936: Target Props {'family': 'windows', 'language': 'en-us', 'ed': 'ultimate', 'patch_level': 'sp0',
2013-09-17_21:17:25.72 (03171) [INF] script 14936: output_dir: /proj/tyrant-dev/output/OsInfoTest/verify_osinfo_plan-2013_09_17-20_53_40/verify_osinfo_plan-2013_09_17-20_53_49_952576-421
2013-09-17_21:17:25.72 (03172) [INF] script 14936: [1:24;37:42m COMPLETION: success 'Pass' [0m
```

Test Plans in Depth

Within the previously outlined basic structure of plan files, there are many constructs in the “planlang” (provided in your plans by the line

```
from tyworkflow.support.planlang import *
```

present at the top of each plan file). Together, these constructs are used to build the specification of what tests to run, with what arguments and what types of test resources.

FILTER

This is a base class which supports abstract filtering based on values of named attributes. It is extended by some other classes in the planlang and is generally not used directly. The typical usage is the HOST subclass.

HOST

A FILTER subclass that filters resources based on attribute value constraints. The value can be a singleton or a list of values. The constraints are specified in the constructor with the general form:

```
HOST(<attr>=<value>| [<value>, <value>, ...], <attr>=...)
```

For example,

```
HOST(family='windows', os=['2k', 'xp'], ossp='sp0')
```

HOST objects are the primary means to define the desired set of resources to use for a given test script. HOST objects are used in the hosts_slots argument to the TESTCASE constructor, explained later.

IMPORTANT: The values for “family” and “os” and all of the other fields on which a user can write a filter are set by the Overmind database. These values can be viewed using Overview’s “Recipes” and “Resources” pages to determine what valid values are. For example, if the administrator sets the “os” of a box to be the string “xp_pro” instead of “xppro” and the user wants to run on XP boxes, the filter for “os” needs to be “xp_pro” – the exact string match. This loosely-defined schema is nice for rapidly adapting to new recipes; however, it does require coordination between the users and the administrators.

We recommend the schema style specified in the `recipes.csv` file in the `docs/` directory of tyworkflow; however, it is more important that an organization is simply be consistent with whatever schema they choose.

FACTORS

The class used to control the sampling of test instances. For example, consider a plan with 3 host slots and a resource pool of 100 machines. In the worst case, this could generate 100^3 potential test instances. If each test takes 10 minutes, even with max parallelism of 33 simultaneous test instances, it would take a minimum of $10,000,000/33$ minutes or ~21 days. In this case, you may want to sample the set. FACTORS objects specify the attributes of interest to vary across test instances. Other attributes will be randomly selected based on resource availability. The constructor defines the attributes of interest with the general form:

```
FACTOR(<attr>=True|False, ...)
```

For example,

```
FACTOR(family=True, os=True, ossp=True, lang=True)
```

TESTCASE

The class used to compose HOST, FACTOR, and parameter values to form a specification for a set of test instances. Specifically, a TESTCASE constructor takes:

- **script**: Name of test script (leafnode).
- **hostslots**: List of FILTER objects, defining the number of host resources and their constraints. For example:

```
[HOST(), HOST()]
```

The number of elements in the `hostslots` list defines the number of resources each testcase will use and should match the number of resources the test script defined in the `script` argument requires.

- **paramslots**: List of parameter values (defined as a list). For example:

```
[['a', 'b'], ['c']]
```

Combos are generated for each potential value of a parameter slot. In the given example, the first parameter slot can be either 'a' or 'b', but the second parameter slot will always be 'c'. So, for a very simple example range with only one test resource, a plan with this `paramslots` setting would generate two combos, one with arguments 'a' and 'c', the other with arguments 'b' and 'c'.

- **filter**: Singleton FILTER object that defines a global constraint over resources. For example:

```
HOST(pool='pname')
```

- **xatrrs**: Singleton XATTRS object, defining attribute constraints across host objects. For example:

```
XATTRS(vlan='same')
```

This line would ensure that the hosts are on the same subnet.

- **factors**: Singleton FACTORS object, defining sampling attributes. For example:

```
FACTORS(os=1)
```

- **samples**: Maximum number of sample test instances to run.
- **replications**: Number of times to run each sample.
- **priority**: Numeric priority of test instances (used to sort scheduling queue).
- **namespace**: Namespace name to use when storing test results in database.
- **post_ops**: List of functions to run as post operations.

UNCLASSIFIED

- n_notes: Informational notes to store with the namespace this testcase will run in. Remember, this MUST be quoted if it contains spaces.
- p_notes: Informational notes to store with the test plan this testcase will run in. Remember, this MUST be quoted if it contains spaces.

EXECUTE

The class used to define which TESTCASEs to run for the plan file. The separation of TESTCASE and EXECUTE allows you to compose TESTCASE separately from specifying which ones to run. The EXECUTE constructor takes the TESTCASE object and an optional set of keyword arguments. If the optional TESTCASE keyword arguments are provided, they are used to override the value for the given TESTCASE. Note this is purely for convenience and EXECUTE(testcase, **plan_ops) is equivalent to:

```
EXECUTE(testcase / TESTCASE(**plan_ops))
```

PARSE

Returns the list of EXECUTE'd TESTCASEs for a given plan file. Any list operator can be applied to this list for composing plans from plans. As with the EXECUTE statement optional arguments can be provided to override the value for the resulting TESTCASEs. Note this is purely for convenience and PARSE(plan_file, **plan_ops) is equivalent to:

```
map(lambda x: x/TESTCASE(**plan_ops), PARSE(plan_file))
```

Planlang Operators

The language provides a set of operators over objects for plan reuse and simplification. For FILTER operators it is best to think of a FILTER object as representing a set, specifically, the set of resources that satisfy the constraints. The valid operators are:

- FILTER & FILTER: A new FILTER object representing the set intersection of the two.
- FILTER | FILTER: A new FILTER object representing the set union of the two.
- FILTER - FILTER: A new FILTER object representing the set subtraction of the two.
- FILTER % FACTORS: Binds the FACTORS to the FILTER object
- FILTER % XATTRS: Binds the XATTRS to the FILTER object
- TESTCASE / TESTCASE: Copy of left TESTCASE with attributes overridden with the defined attributes of the right TESTCASE (undefined attributes use the value from the left TESTCASE).
- TESTCASE & FILTER: Copy of TESTCASE with global filter constraint intersected with FILTER.
- TESTCASE | FILTER: Copy of TESTCASE with global filter constraint unioned with FILTER.
- TESTCASE - FILTER: Copy of TESTCASE with global filter subtracted with FILTER.

Plans of Plans

One incredibly useful feature is to generate plans of plans. A typical use case is to have a high level plan that kicks off a lot more lower level plans. For example, a regression_test plan could include kicking off all of the relevant plans for a single situation.

UNCLASSIFIED

To do this, one needs to generate a plan file that calls `run_plan` on other plans. The arguments to `run_plan` are the following:

- `namespace`: typically `globals()`
- `search_path`: typically the leaf bag containing the plans
- `plan_name`: specific plan name to be called by this plan (without ".py" extension)
- `maxCount`: how many times to run this plan (equivalent to setting "samples=" from the `remote_commit` command line)

For example,

```
from tyworkflow.support.planlakng import run_plan

run_plan(globals(), "my.leafbag", "MyPlan", 5)
run_plan(globals(), "my.leafbag", "MyPlan2", 2)
```

NOTE: Any command line arguments (e.g. "samples=") passed to `remote_commit` will override any arguments passed to the test plans themselves via `run_plan`.

Remote Commit in Depth

Remote commit is provided as an alternative method of setting up an overmind test range and submitting plans to it which is useful for environments of multiple developers working against a single overmind-controlled test range.

For background, the standard (non-remote-commit) way of doing things is to, on a single machine, run the overmind, reaper, and overview servers. The user may choose to set up a MySQL database for overmind to store information about assets and test results in, or they may use the default SQLite database. The user then links in their testing code as a leafbag in their tybase repository and submits plans from their tyworkflow repository (which has tybase linked in at media/tybase). This lends itself well to a single developer working on the range, but doesn't work so well for multiple developers on different workstations. Under this model, they would have to SSH in to the machine running overmind, cd to the appropriate tyrant directory, put their testing code in place, and then submit a plan. Parallel work by multiple developers is not favored in this model.

In contrast, remote commit gets around these problems. With remote commit, a single MySQL database serves as the point of concurrency. Global instances of reaper and overview are run on a server and a directory is created on this server to serve as the root for remote committing to. Users set up their own local working directories of tybase, tyworkflow, and their SUT(s). When the user submits a test plan with remote commit, remote commit rsyncs all their testing code up to the server (in a subdirectory for the developer) and runs the overmind in the tyworkflow the user synced up to schedule the user's tests (referring to the database to see what's available). The results of the user's tests are recorded to the global MySQL database, which all the users can view on the global overview instance. Any files that resulted from the test are also stored on disk and accessible from the overview interface. Once the user

UNCLASSIFIED

has run remote commit, which only takes as long as is needed to sync their code up to the server, they user may continue development in their working directory without affecting the tests that are running on the server. By specifying alternate usernames when submitting test plans, the user may even submit one test plan while another is already running.

SUT Preparation

In order to use a given SUT with remote commit, you must prepare a shell script that provides some functions and constants which remote commit will use. These should be placed in a file named rcoverrides.sh in the root of your SUT's leafbag. It is important that the functions respect posix conventions for return code, i.e. return 0 on success, nonzero on error. All override functions run relative to the tyworkflow root. Likely, you'll want some of your functions to run relative to the tybase root. In that case, you'll need to do something like pushd media/tybase at the top of your function and then popd at the end.

Functions:

- `_roverride_build`: Performs any steps necessary to build the SUT or prepare it for testing that are not encompassed in the actual testing code. For example, if your SUT is a single C file that requires compilation before testing, your `_roverride_build` function might just run `gcc`. If your project is more complicated and has a makefile, your `_roverride_build` could run `make`.
- `_roverride_clobber`: Called immediately after running a `make clobber` in tyworkflow's root, as part of the `clobber` command. Performs a thorough cleanup of the SUT directory. Continuing on the example from the previous function, the `_roverride_clobber` for a simple one-file C SUT might just delete the binary resulting from the compilation encoded in `_roverride_build`, while the implementation for a project with a makefile might run `make clean`.
- `_roverride_stop`: Called when running the `stop` command, immediately after shutting down the overmind service.
- `_roverride_summary`: Called when running the `summary` command, just after running `bin/scan_output` (which summarizes the undermine runs recorded in the output directory). This function allows you to add any custom output to the summary output.
- `_roverride_submit`: Called during running of the `submit` command on the testing server, immediately prior to actually submitting the desired plan to the running overmind. This allows you to do things like make settings changes to the running overmind conditionally based on which test is being run (a specific example would be to increase the maximum number of children for certain larger test plans).

Constants:

- `UNDERMINES`: Overrides the default maximum number of children your remote overmind process will allow.

UNCLASSIFIED

- `CLIENT_TIMEOUT`: Overrides the default client timeout (maximum running time for various interactions with overmind).

Leafbags with non-leafbag dependencies

In order for tests to work with remote commit, the tests and all their dependencies must be linked in to your environment so that they will all end up on the testing server during remote commit's rsync. For the case of a self-contained leafbag, this works trivially: your SUT's leafbag is linked in to your tybase repository (in `leafbags/`), so when remote commit syncs, the leafbag is synced up. When your leafbag has non-leafbag dependencies, those dependencies must also be linked in to your copy of tyrant so that they will also be synced up during remote commit, and your testing code must be written so that it can reference the dependency relative to the tybase root (so that there are no hardcoded paths that will break when the entire directory is synced to some other system). While there is no way this technically must be done, convention is to link in your extra dependency with a symlink in tybase's `media` directory, then write your testing code to refer to the supporting components in that location. Then, using the `search_media_path` function provided by in `tybase.support.util`, you can retrieve the path to the directory you linked in and then do whatever you need to with it (e.g. open a file relative to it, add it to the python path so you can import from it, etc). Call `search_media_path` with the name of the symlink you created inside of `media`, and it will return a usable path to your linked-in media.

Example

Suppose you have a project with a repository called `eproj` which contains the following two subdirectories (among others): `leafbag` (the leafbag with leafnodes for your project) and `data` (a directory with some sort of supporting files that are used both for your tests scripts in `leafbag` and by other parts of the software). You would link the `leafbag` in to `tyrant`'s `leafbags/` as always. Then, you would also put a symlink in `tyrant`'s `media/` pointing to `eproj`'s `data` subdirectory. For example, assuming your current working directory is the root of your `tyrant` copy and `eproj` is a sibling of your `tyrant` copy, you could run

```
ln -s ../../eproj/data media/eproj-data
```

Then, a hypothetical `eproj` test script might contain code like the following to make use of files in that directory:

```
from tybase.support.util import search_media_path
epdata = search_media_path('eproj-data')
with open(os.path.join(epdata, 'seed-001.txt'), 'rb') as seedfh:
    seed_dat = seedfh.read()
```

Shared directories

It may be that your testing involves some large set of files which don't change very much and can be shared among developers. While each developer does need their own copy of these files on their local workstation for any local tests they might be doing, you would rather not have multiple copies of this large set of files on the testing server (since each developer has their own subdirectory of the commits directory to which they would have to sync their own separate copy of the shared files) and would rather not have to go through syncing those files every time a developer runs a test.

UNCLASSIFIED

Remote commit provides a way to handle this. In the `remote_commit.rc` file, create a section called `shared_dirs`. Each option in this section defines a single shared directory. The name of the option is the path to the shared directory relative to the root of tybase (i.e. where the shared directory currently resides in the tybase clone in your local testing environment). The value of the option is the path to the actual shared directory on the testing server. When you do a remote commit operation that involves a sync (`run`, `runlite`, `sync`, or `synclite`), the paths given as the option names in the `shared_dirs` section are excluded from the sync. After the rsync part of the sync process is complete, remote commit will create symlinks inside the remote tybase root (at the paths given as the option names) pointing to the paths given as the values to those option names. This saves having multiple copies of the large shared files on the testing server, however it is your responsibility to make sure the copy of the shared directory on the testing server is kept up to date, since that will not happen automatically when a developer does a “sync”.

Example

Suppose your eproj test scripts require a set of installers and data files that exist in a directory called `eproj_data`. Currently, you make this set of files accessible by putting a symlink named `eproj_data` in tybase's media directory which points to the actual `eproj_data` directory (so the location of that symlink relative to the root of tybase is `media/eproj_data`) and then writing your test scripts to access the files out of media. To set this up as a shared directory for remote commit, you would do the following:

- Place a copy of the shared directory somewhere on the testing server. For our example, we'll put it at `/proj/eproj_data`.
- Add an option to the `shared_dirs` section of tyworkflow's `rc/remote_commit.rc` whose name is the location of the shared directory inside tybase and whose value is the location of the shared directory on the testing server. For our example, this is:
`media/eproj_data = /proj/eproj_data`
- Now, when you do a sync, `media/eproj_data` will be excluded from the initial rsync operation. Then, after that operation completes, a symlink will be created inside the remote tybase at `media/eproj_data` pointing to `/proj/eproj_data`.

Usage

Remote commit provides several commands via the `bin/remote_commit` script (in tyworkflow) which are used to sync your SUT up to the testing server, run tests, and administer your remote instance of overmind. These commands are explained below grouped by use case

(Dry)Running Tests (`run`, `runlite`, `submit`, `num_combos`)

The `run` and `runlite` commands are the backbone of running remote commit; you can ignore all the others and still work effectively with these two commands. They are basically wrappers which run several commands under the hood. They both sync your testing environment up to the testing server, start your remote instance of overmind, and then submit the given plan. The difference between the lite and full versions is that the full version does a clobber and build on the local side before syncing up to the testing server, whereas the lite version does not do this.

UNCLASSIFIED

Usage:

```
bin/remote_commit [-u <USER>] run <PLAN> [<process_plan_opts>]  
bin/remote_commit [-u <USER>] runlite <PLAN>  
[<process_plan_opts>]
```

where <PLAN> is the designator for a plan file (either a python import path or filesystem path). The -u option specifies the subdirectory of the commits directory to work out of, and defaults to the current username (of the person running bin/remote_commit). In the case of run, the developer's testing environment will be synced up to the named subdirectory of the commits directory, the overmind in that directory will be used, etc.

Also, since run and runlite end up calling bin/process_plan on the remote side, you may override certain testcase attributes just as you would if you were calling bin/process_plan directly. This ability to override testcase attributes is available for any of the remote_commit commands that call bin/process_plan on the remote side. The one we find most useful is to override the samples value to run a subset of a potentially large set of combos. For example, your testplan may generate 100 combos, but you only want to run a random ten of them. Then, you would do:

```
bin/remote_commit run PLAN samples=10
```

The submit command simply syncs up your testing environment and submits the given plan without running the build step. This is useful if you make local changes ONLY to your SUT's testing code (or other minor local changes which don't require rebuilding your SUT), because in that case the changes you're syncing up won't have any effect on your remote overmind instance, so a restart is not necessary. If, however, you've made SUT changes that require a rebuild, then submit may not be safe to run; you should use run and runlite instead. If you've made changes to actual tyrant code, then you need to do the sync command (explained later) first to force your remote overmind instance to restart.

Usage:

```
bin/remote_commit [-u <USER>] submit <PLAN> [<process_plan_opts>]
```

The num_combos command allows you to see how many combos your test plan will run when submitted. This is analogous to the bin/process_plan solve command used with the classical overmind setup.

Usage:

```
bin/remote_commit [-u <USER>] num_combos <PLAN>  
[<process_plan_opts>]
```

Syncing your testing environment (sync, synclite, diff)

These two commands sync your testing environment up to the testing server. As with run and runlite, the full version does a local clobber and build, the lite version does not. An added difference between sync and synclite is that sync forces your remote overmind instance to restart, whereas synclite does not. If you make changes to core tyrant code and want that to take effect on the remote side, you need to use sync, since if the remote overmind doesn't restart, your changes may not

UNCLASSIFIED

take effect, depending upon what you changed. Generally, developers and testers won't be making changes to overmind, but if you receive an updated delivery of tyrant code or the administrator makes some changes, you may need to run a full sync.

Usage:

```
bin/remote_commit [-u <USER>] sync  
bin/remote_commit [-u <USER>] synclite
```

The `diff` command is provided as a dry run of syncing. It just uses rsync's dry run capability to show you what files will be uploaded/changed/deleted when syncing to the testing server.

Usage:

```
bin/remote_commit [-u <USER>] diff
```

Administering your remote overmind instance (start, stop, restart, set_children, get_children)

To start, stop, or restart your remote overmind instance, the respective commands are provided. Users do not typically use these since they are handled automatically when running `r`un or `s`ync commands. During the stop command, the custom `_roverride_stop` function is run, if provided.

Usage:

```
bin/remote_commit [-u <USER>] start  
bin/remote_commit [-u <USER>] stop  
bin/remote_commit [-u <USER>] restart
```

The `set_children` command allows you to set the maximum number of undermine processes your remote overmind process will run in parallel.

Usage:

```
bin/remote_commit [-u <USER>] set_children NUM_CHILDREN
```

where `NUM_CHILDREN` is an integer telling how many children to run in parallel.

The `get_children` command tells you the current max number of undermine processes.

Usage:

```
bin/remote_commit [-u <USER>] get_children
```

Building and clobbering your SUT (build, clobber, rclobber)

The `build` and `clobber` commands run the `_roverride_build` and `_roverride_clobber` functions you provide in your `roverrides.sh` file; in other words, they locally build and clobber your SUT. The `rclobber` command runs the `_roverride_clobber` function, but on the remote testing environment.

Usage:

```
bin/remote_commit [-u <USER>] build  
bin/remote_commit [-u <USER>] clobber  
bin/remote_commit [-u <USER>] rclobber
```

UNCLASSIFIED

Seeing results (summary)

In addition to viewing results of tests via the overview GUI, you can also use remote commit's summary command, which prints out a summary of your remote testing environment's output directory. If provided, the `_roverride_summary` function is also run after printing the default summary information.

Usage:

```
bin/remote_commit [-u <USER>] summary
```

Other commands (client)

`-u <USER>`The client command runs an arbitrary command with the overmind client (bin/overmind_admin) on the remote overmind instance.

Usage:

```
bin/remote_commit [-u <USER>] client <CMD>
```

where `<CMD>` is the command you want to run. See `bin/overmind_admin -h` for a list of potential commands to run.

Appendix A - Event Detection

Via the magnum add-on repository, Tyrant provides the ability to run arbitrary test scripts in a wrapper which monitors a test resource's screen for changes.

Magnum provides two methods of acquiring screenshots: using native Windows functionality to take screenshots (which only works for Windows resources and can be affected by conditions on the resource being tested, but can work on VMs and physical machines alike) and using ESXi screenshot functionality (which only works for VMs, but works for all OS families and is unaffected by conditions on the resource being tested). Here, we cover how to setup and verify ESXi-based event detection.

This appending assumes that the test range you're using has already been set up for event detection.

Event Detection Theory

Event detection works by taking screenshots according to a configurable interval and comparing them to find differences. When differences are found, they are analyzed to determine whether they are considered significant or not. A difference is significant if the number of changed pixels in a set of predefined areas of interest exceeds a defined threshold. The areas of interest and the threshold were determined empirically and are defined in `src/magnum/event_detectors/__init__.py` as percentage boxes bounding the areas of interest. The current threshold is 10000 pixels, and the current areas of interest are:

- A box in the bottom right corner of the screen, extending 25% toward the left and 50% toward the top.
- A box in the center of the screen, whose edges are all 30% away from their respective screen edge (i.e. the left edge of the box is 30% from the left edge of the screen, the bottom edge of the box is 30% from the bottom edge of the screen, etc).
- A box in the upper right corner extending 20% toward the left and 20% toward the bottom.

When no problems occur with event detection, the event detection harness simply returns the result returned by the underlying test script. If, however, the test script returns SUCCESS, but any problems are encountered with event detection (e.g. not being able to take screenshots frequently enough to satisfy the configured interval), then the harness will return ATTENTION along with a message describing what happened.

Testing in Adverse Environments

The goal of testing is always to determine truthful outcomes to potential scenarios as early as possible, so that risks can be understood and evaluated. It is critical for users and testers to be aware of the fact that testing of any kind produces traces and artifacts. These traces and artifacts are created because it is impossible to actuate components that set up test preconditions without changing the state of the machine under test. There are many ways to achieve these actuations. Different methods can (and sometimes do) provide different results. This is especially true in adverse environments. For example: a

tool that passes when a user runs the program from the desktop with the mouse could fail or cause a pop-up if started by another process.

Automated testing frameworks like DART allow testers to cover a greater number of potential scenarios than they could manually. This creates more confidence in the tools being tested. However, it is critical to understand that the automated framework runs in a formulaic way, so it is possible that the methods chosen could routinely produce different results in the real world. It is even possible that by allowing the automated framework to run in an adverse environment, that environment will be changed enough that a different result could show up.

Tester note: You should run a statistically relevant subset of the tests by hand to verify the results given by the automated framework. Follow the spirit of the test plan and ensure that doing things manually produces the same results. This will nearly always be the case, but we have observed instances where there are slight deviations in the past.

Environment Setup

In order to use event detection, you need to do some setup in your local testing environment (the environment in which you run `remote_commit` to submit tests to the range).

- In the same directory where your tyworkflow and tybase clones are, clone the magnum repository (`hg clone http://testserver.example.com:8000/magnum`).
- In that same directory, also clone the provided PIL (Python Imaging Library) repository matching the architecture of the test server. For example, if your test server is running 32-bit Linux, choose the “PIL-linux-i686” repository, but if it’s running 64-bit Linux, use “PIL-linux-x86_64”. This library is used to compare screenshots to find changes.
- In your magnum clone, copy `config/main.conf.example` to `config/main.conf` and set the following settings. Magnum has many features besides event detection, so some of these settings are unrelated but need to have some value set for them to prevent warning messages.
 - Set `tester/evdet_type` to `esxi`.
 - Set `tester/esxi_evdet_ds_name` to the name of the NFS datastore you created in the previous section (e.g. `tyrantshare`).
 - Set `tester/esxi_evdet_local_ds` to the path on the test server of the directory what was exported via NFS in the previous section (e.g. `/proj/testing/tyrantshare`).
 - Set `server/upd_root` and `server/inst_root` both to `/tmp`.
 - Set `server/ip_addr` to `127.0.0.1`.
 - Set `repository/repo_path`, `repository/repo_url`, `repository/repo_user`, and `repository/repo_pass` to `UNUSED`.

Usage

To use event detection, you use an event detection harness leafnode provided by magnum. You tell it what test script you want it to run and what arguments and keyword arguments to run it with and give it various other pieces of information to configure the event detection. The harness takes the following arguments:

- **host_index**: Zero-counting integer index of which host event detection should be performed on. This is necessary when your test case uses more than one host, but you want event detection run on some host other than the first. Default is to use the first host.
- **interval**: Float number of seconds for the screen polling interval. Default is 5 seconds.
- **use_emissary**: Boolean indicating whether or not to use emissary when using the onhost event detection method. Not applicable for `esxi` event detection. Default is `False`.
- **type**: Selects which type of event detection to perform (`esxi` or `onhost`). Default is `onhost`. For what this appendix is covering, you will always choose `esxi` here.
- **esxi_host**: For `esxi` event detection, specifies the ESXi server to connect to to take screenshots. This may be either the specific ESXi host the VM resides on, or (we assume, but have not tested) a vCenter server for the range in which the VM resides (we assume this because other operations like reverting work both when directly connected to an ESXi host or when connected to a vCenter server). If not specified, the harness will attempt to query the overmind database (if present) and will assume the reaper field for the test resource indicates the DNS name or IP address of the ESXi host the VM resides on.
- **esxi_user**: Username to use for connecting to the ESXi host.
- **esxi_pass**: Password to use for connecting to the ESXi host.
- **vm_name**: ESXi name of the VM. If not specified, the harness will attempt to query the overmind database (if present) and will use the computer name field as the VM name in ESXi.
- **debug**: Boolean indicating whether or not to perform event detection debugging. This causes the generation of extra log messages and several intermediate images during the screen differencing process. Do not use this unless you actually need to debug the screen differencing process. This does not affect debugging for the test script being wrapped. Default is `False`.
- **debug_dir**: If `debug` is `True`, specifies a directory path to which to output the extra files generated by debugging. Default is to use a subdirectory of the output directory for the run of the harness.
- **keep**: Boolean indicating whether or not to keep screenshots which indicate differences determined to be insignificant. Default is `False`.
- **test**: Specification of the leafnode to run. Specify this as a “python import path”, not a filesystem path.
- **test_args**: List of positional arguments to the specified leafnode.
- **test_kwargs**: Dict of keyword arguments to the specified leafnode.

Note that these arguments are subject to the argument quoting rules of undermine. See the output of `bin/undermine -h` (run in tybase) for details.

With Undermine

To use event detection to run single test instances with undermine, simply call the event detection harness with the proper arguments. For example:

```
bin/undermine magnum.harness.evdet_harness 192.168.56.101
192.168.56.103 192.168.56.104 -- host_index=@1 interval=@3.0
type=esxi esxi_host=192.168.56.10 esxi_user=someuser
esxi_pass=somepass vm_name=test_vm_001
test=mysut.tests.sometest test_args=@"[yes, yes, no]"
test_kwargs=@"{one=1, two=2}"
```

If running out of an environment linked to an overmind range (i.e. tybase and tyworkflow are linked and tyworkflow's db.rc is configured to use an overmind database) and using IP addresses that are part of the range, you can leave out the esxi_host and vm_name arguments and they will be determined automatically by looking in the overmind database.

With Overmind

To use event detection in an overmind range, for each test script you wish to run with event detection, you'll need to write your own test plan that calls the event detection harness with the arguments as explained previously.

To make this easier, start with the following template plan:

```
from tyworkflow.support.planlang import *

test = TESTCASE(
    script = 'magnum.harness.evdet_harness',
    hostslots = [PUT_HOSTS_HERE],
    samples = -1,
    namespace='TEST_NAME-$t',
    paramslots = [
        ['test=LEAFNODE_SPEC'],
        ['esxi_user=USERNAME'],
        ['esxi_pass=PASSWORD'],
        ['keep=@True']
    ]
)

EXECUTE(
    testcase = test,
)
```

Save this code to a new file with your other plans and scripts (DO NOT simply modify this file in place), and modify the copy as follows:

- In the hostslots parameter, replace PUT_HOSTS_HERE with HOST objects according to the number and type of hosts your test script requires. (If your test script takes multiple hosts and

UNCLASSIFIED

the host on which you want event detection is not the first host, remember to set the `host_index` keyword argument in `paramslots`).

- If you want to have a default limit on the number of samples the plan will generate, then change the `samples` parameter. You probably just want to leave it at `-1`, though.
- In the `namespace` parameter, replace `TEST_NAME` with a very concise name of your test; this will be used as part of the default namespace name when submitting this plan.
- In `paramslots`,
 - Replace `LEAFNODE_SPEC` with the specification of your leafnode (using “python import path”, as before).
 - Replace `USERNAME` and `PASSWORD` with the username and password used to log in to the ESXi hosts on your range.
 - If you have a central vCenter server managing all the ESXi hosts in the range, you can define add the `esxi_host` parameter in `paramslots` with the vCenter server’s DNS-resolvable hostname or IP address as the value. Otherwise, leave `esxi_host` out and it will be determined by looking in the overmind database.
 - Add definitions for `test_args` (a list) and `test_kwargs` (a dict) to `paramslots` to define the positional and keyword arguments to be passed to your test script being run under event detection.

At this point, you should now have a working test plan that will run your test script under event detection. You can run this test plan with remote commit like any other, and see its results in overview, except now, you will get screenshots as well.