

DART Automated Test Execution

Administration Manual

Lockheed Martin Advanced Technology Labs, May 18, 2015

ABSTRACT

This document provides an administrator with the knowledge to set up and maintain DART automated testing installations for use in ranges of physical and ESXi virtual machines leveraged for cyber testing and verification.

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1 DART Automated Test Execution Technology Overview

1.1 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.

1.2 Technical Components Overview

Tyrant is made up of the following central technical components:

- Palantir (Testing Interface)
- HAL (Hardware Abstraction Layer)
- 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.

The contents of this manual apply to DART Tyrant code released on May 6, 2014.

1.2.1 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.

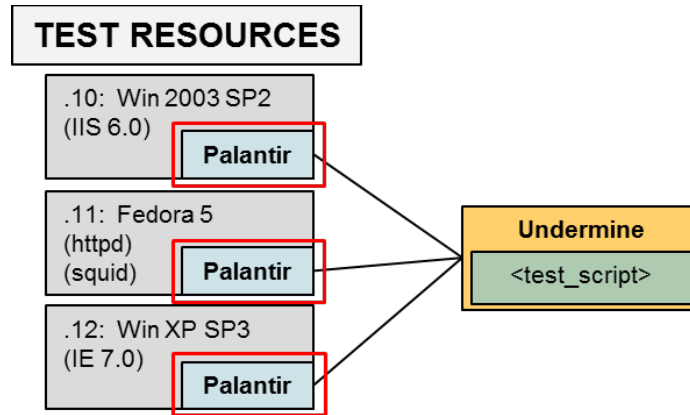


Figure 1 Palantir provides control of each test resource

1.2.2 Hardware Abstraction Layer (HAL)

The HAL provides a framework for implementations of computer-level operations, i.e. operations done to the computer from outside of it, such as powering it on, powering it off or saving its state. These are all operations which can be performed without interacting with the operating system on the computer. Based on attributes of the computer being operated on, the HAL chooses the correct implementation of the logical operation desired (e.g. for a “power_off” operation, the HAL might use an ESXi control library for ESXi VMs, whereas for a physical computer, the HAL would use a configured PDU to power off the outlet the computer is connected to). For controlling saved states, various methods can be implemented as plugins to the HAL framework, such as reverting a VM snapshot for VMs, applying a disk image to physical machines, or using an auto-building system to automatically install an OS on a computer from scratch.

1.2.3 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. Undermine performs the actions on the test resources via Palantir if it exists on the test resource.

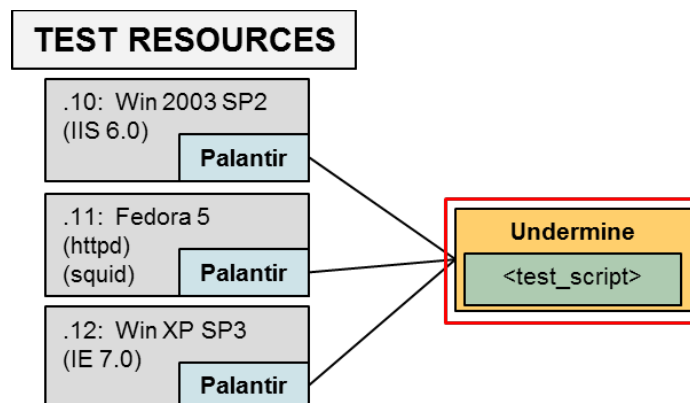


Figure 2 Undermine executes test operations against resources

1.2.4 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. Overmind runs an instance of Undermind 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.

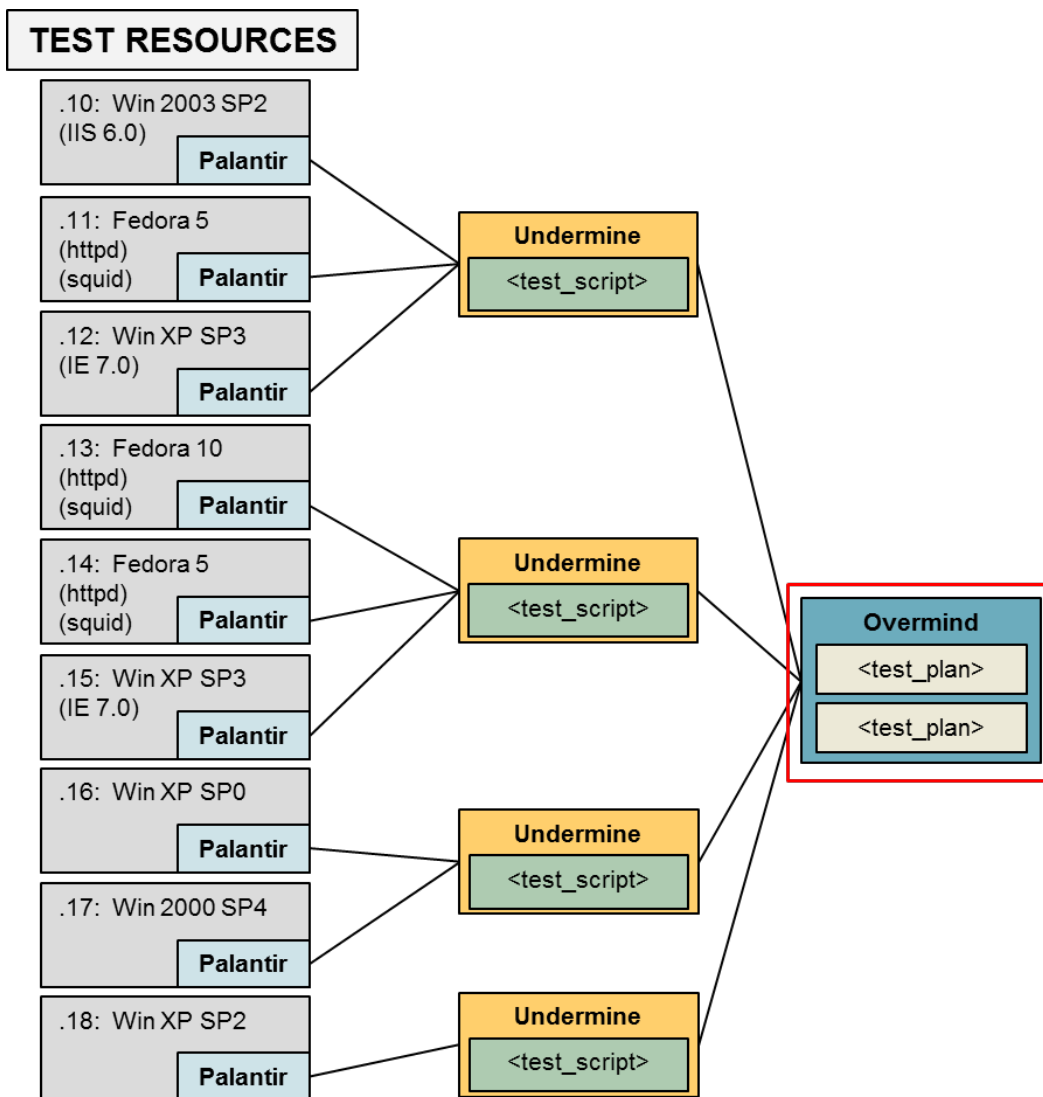


Figure 3 Overmind schedules tests across a range of resources

1.2.5 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.

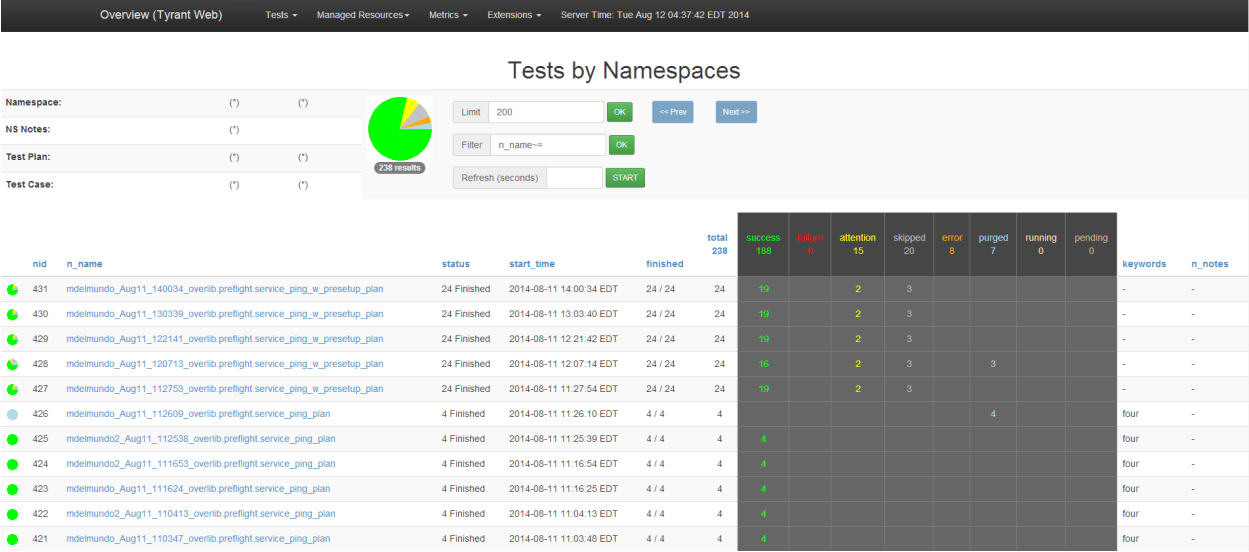


Figure 4 Overview allows viewing of current and prior tests and administering range resources

1.2.6 Reaper

Reaper monitors the Test Resources section of the Overmind Database for resources that require sanitization and uses the HAL to restore a previously-saved, sanitized state to the computer. Different sanitization methods can be specified for each resource. 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.

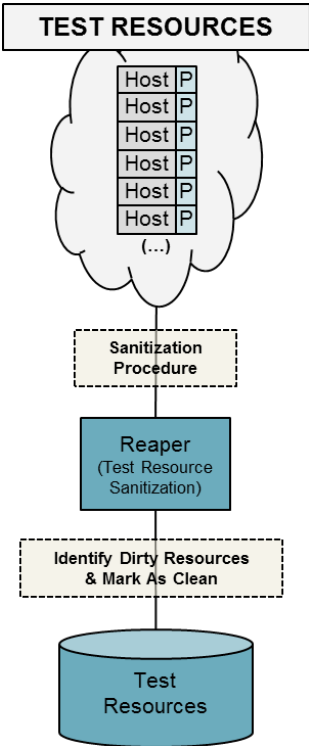


Figure 5 Reaper sanitizes resources for testing

1.2.7 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)

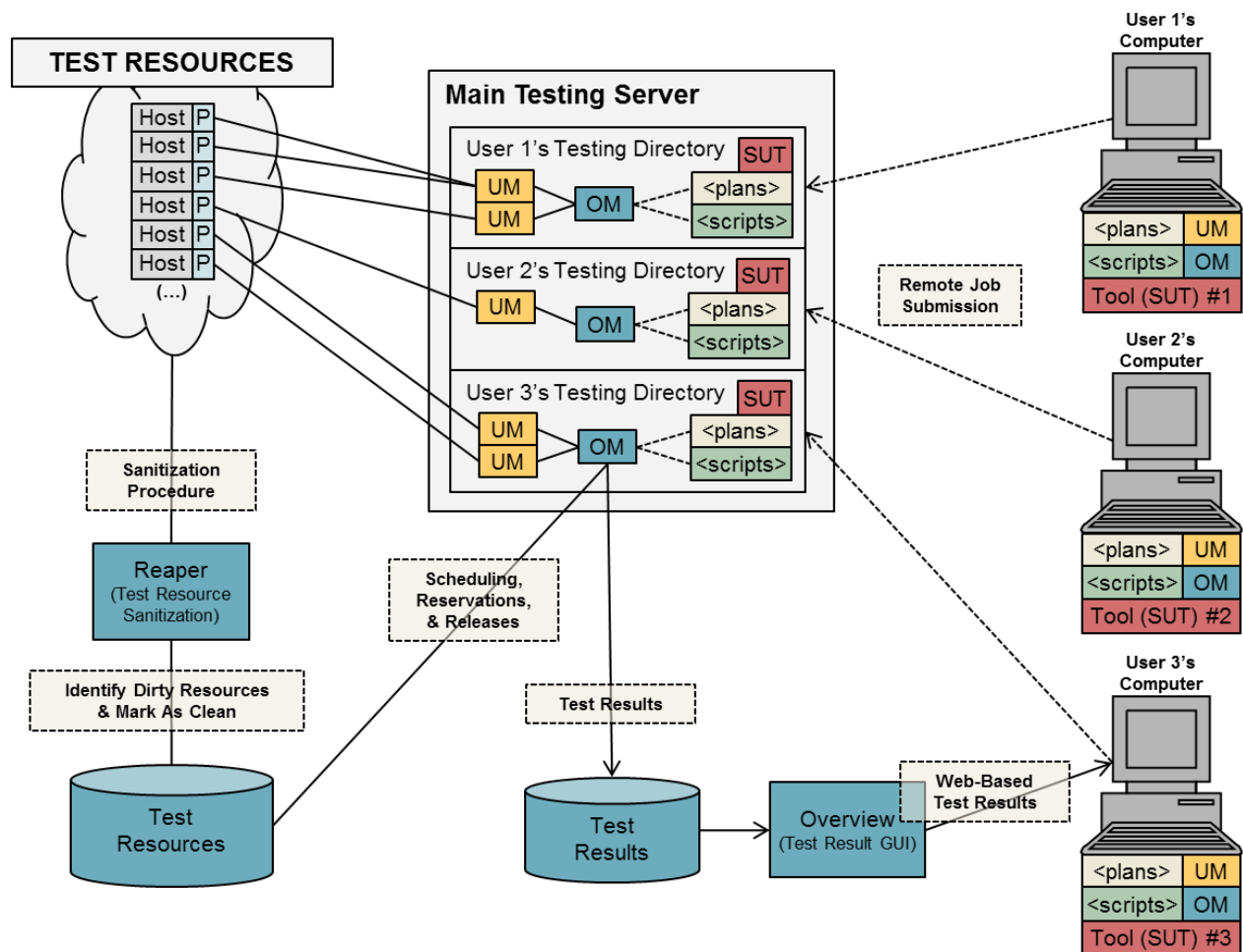


Figure 6 Remote commit allows parallel development and testing

1.2.8 Plunger (Database Cleanup)

There are multiple ways to condense, delete and purge records from the Tyrant database. One approach is to run `bin/db_admin` commands such as `del_reservation_history`, `condense_contentions`, and `del_contentions`. Another is to run the extendable service, Plunger.

The administrator can determine what database condense and cleanup tasks to allow Plunger to run by setting options in the configuration file, *plunger.rc*. He or she can also add plunger modules in the `plunger_extensions` section of the configuration file to perform additional database maintenance functions.

1.3 For the Administrator

For the range administrator, Tyrant provides a set of tools to manage a large range of resources (typically, but not necessarily, virtual machines) for use with automated tests. Tyrant provides the tools to make this range available to developers and testers and coordinate access to its resources to prevent conflicts between tests. This manual covers how to set up ESXi virtual machine and physical resources to be usable for tests and how to set up the Tyrant technologies to make these resources into a range available for automated tests.

While detailed documentation is provided, nearly every tool accepts a command line “-h” option that will have the tool print out its usage.

1.4 Recommended Hardware

This section describes some recommendations for hardware to use based on desired range size. DART would definitely work on less capable hardware than what is listed below; however, the system's throughput would suffer in various ways or features would be lost.

2

2.1

Overview (Tyrant Web)

Tests ▾Managed Resources ▾Metrics ▾Extensions ▾Server Time: Tue Aug 12 07:31:21 EDT 2014

Computer/Recipe Usage Metrics

Start7/29/201400:00

End8/13/201400:00

Computer+Recipe ViewRecipe View

Computer/Recipe Attribute Grouping

FamilyOperating SystemService PackLanguageArchitectureApps

Limit200

Filtername=-

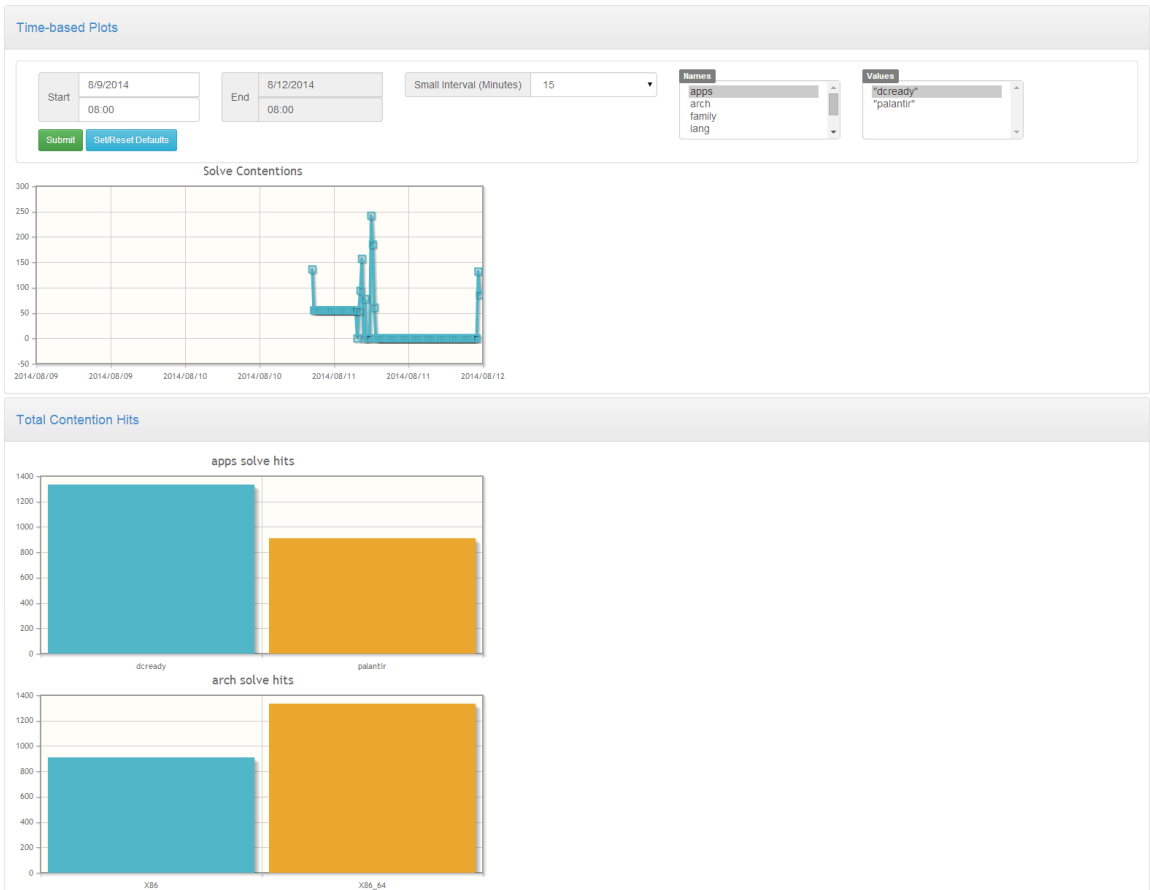
Submit

Displaying Dates: 07/29/2014 00:00 - 08/13/2014 00:00
Usage Over Time Span of 15d, 0h, 0m, 0s

name	family	os	cssp	lang	arch	apps	% Usage	Avg	Min	Max
00-01-vm_ESX5-1_essl_win-xpro-2-en-x86-palantir-20140701112240-1	windows	XP	2	en-US	X86	palantir	0.20	3m, 35s	42s	5m, 19s
00-06-vm_ESX5-1_essl_lin-fe16-0-en-x86-palantir-20140701112240-1	linux	Fedora 16	0	en-US	X86	palantir	0.15	1m, 34s	12s	4m, 45s
00-07-vm_ESX5-1_essl_win-xpro-2-en-x86-palantir-20140808114539	windows	XP	2	en-US	X86	palantir	0.86	2m, 4s	36s	5m, 47s
00-0c-vm-win-7pro-1-en-x64-palantir-20140115003800	windows	7	1	en-US	X86_64	dcready	0.04	3m, 34s	39s	9m, 35s
00-14-vm_win-2008ent-1-en-x64-palantir-20140128111253	windows	2008	1	en-US	X86_64	dcready	0.86	3m, 5s	36s	7m, 47s

2.2

Contention Metrics



Overview (Tyrant Web) Tests Managed Resources Metrics Extensions Server Time: Tue Aug 12 07:28:28 EDT 2014					
Computer Reservation History					
Limit	200	OK	<< Prev	Next >>	
Filter	computer_name==	OK			
Refresh (seconds)		START			
computer_id	computer_name	reserve_name	Reserved	Unreserved	elapsed
402	00-06-vm_ESXi5-1_esxi_lin-fe16-0-en-x86-palantir-20140701112240-1	__clone_in_progress_source__	2014-08-12 05:08:13 EDT	2014-08-12 05:17:39 EDT	9m, 26s
402	00-06-vm_ESXi5-1_esxi_lin-fe16-0-en-x86-palantir-20140701112240-1	UPSYNC_USER	2014-08-11 09:55:17 EDT	2014-08-11 09:57:44 EDT	2m, 27s
401	00-07-vm_ESXi5-1_esxi_win-xppro-2-en-x86-palantir-20140808114539	UPSYNC_USER	2014-08-11 09:53:26 EDT	2014-08-11 09:55:17 EDT	1m, 51s
402	00-06-vm_ESXi5-1_esxi_lin-fe16-0-en-x86-palantir-20140701112240-1	malinda	2014-08-11 09:35:14 EDT	2014-08-11 09:35:46 EDT	32s
402	00-06-vm_ESXi5-1_esxi_lin-fe16-0-en-x86-palantir-20140701112240-1	__clone_in_progress_source__	2014-08-11 09:04:04 EDT	2014-08-11 09:13:26 EDT	9m, 22s
401	00-07-vm_ESXi5-1_esxi_win-xppro-2-en-x86-palantir-20140808114539	__clone_in_progress_source__	2014-08-11 03:54:14 EDT	2014-08-11 03:58:02 EDT	3m, 48s
402	00-06-vm_ESXi5-1_esxi_lin-fe16-0-en-x86-palantir-20140701112240-1	__clone_in_progress_source__	2014-08-11 02:58:54 EDT	2014-08-11 03:08:09 EDT	9m, 15s

Overview (Tyrant Web) Tests Managed Resources Metrics Extensions Server Time: Tue Aug 12 07:32:17 EDT 2014					
Computer Reservation History Metrics					
Start	7/13/2014	End	8/13/2014	Limit	200
	00:00		00:00		< << >> >
Submit		Reset Defaults		Filter	name==
				History Metrics Grouping	
				Computer ID Name	
				Reserve Name	
computer_id	name	Total Reserve Time	Avg	Min	Max
402	00-06-vm_ESXi5-1_esxi_lin-fe16-0-en-x86-palantir-20140701112240-1	5m, 26s	6m, 12s	32s	9m, 26s
401	00-07-vm_ESXi5-1_esxi_win-xppro-2-en-x86-palantir-20140808114539	1m, 51s	2m, 49s	1m, 51s	3m, 48s

Tyrant Metrics shows recommended hardware sets for some common virtual machine range sizes, with Dell PowerEdge model numbers as examples of systems meeting our recommendations.

2.3.1 Test Server

The test server, on which the logic of test scripts is run, needs disk capacity for test output files, and CPU and RAM capacity since each running test instance is a separate process. Disk speed is of little concern because the bottleneck on this server is in processing. As the number of tests you plan on ever running increases, more hard disk capacity is needed (as would be the case for a program which runs for a long time or has heavy active development). As the number of tests you run concurrently increases (e.g. more developers working and testing at once), greater CPU and RAM capacity is needed.

2.3.2 ESXi Infrastructure

The ESXi servers, which actually run the VMs, need disk capacity, disk performance, and CPU performance and RAM capacity. The combination of these factors influence how many VMs each server can successfully run. As the raw number of VMs or number of VM snapshots you wish to have on the server increases, the needed hard drive capacity increases. As the number of VMs you wish to actually have running at once increases (which will usually be at least loosely correlated with the raw number of

VMs), the need for disk performance and CPU and RAM capacity increases. Higher disk performance is also correlated with quicker snapshot reverting capability (which speeds up testing since snapshot reverts are done at the beginning of each test).

The vCenter server needs RAM and hard disk capacity proportional to the desired range size. For larger ranges, an enterprise-class database server (e.g. Oracle 11g) is recommended.

2.3.3 Physical Machine Test Resources

For a range including physical machines, you will need to acquire the physical machines themselves and one or more network-accessible PDUs to enable tyrant to automatically power machines on and off.

In selecting the physical machines themselves, consider the following constraints:

- The machines should have an Ethernet network interface which supports the PXE standard. The vast majority of machines support this; you will find it difficult to find one which doesn't.
- The machines should be capable of being configured to automatically start up whenever the outlet to which they are connected is powered on. This is configured via the BIOS menu on the machine.

Tyrant currently only has support for APC PDUs which are controllable via SNMP. (Specifically, we have used an APC AP7930 PDU in our development.)

2.4 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 upsync_apps 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 tyutils are the PIL repositories (PIL-linux-i686 and PIL-linux-x86_64). These provide the Python Imaging Library, which is used by tyutils 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 - Detailed Repository Layouts.

2.5 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).

comp_admin (tybase): A component which allows you to perform computer-level operations against a computer (e.g. power_on, power_off, save_state, etc.).

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.

create_resource (tyworkflow): A component which uses the HAL to save the current state of the given computer and then automatically creates a resource entry for that combination of computer and state in the database.

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.

autoplan (tyworkflow): A tool which allows the automatic generation and processing of simple test plans based upon command line arguments. This allows users to run tests across a diverse range of resources without having to write a test plan.

2.6 Directory Structure

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

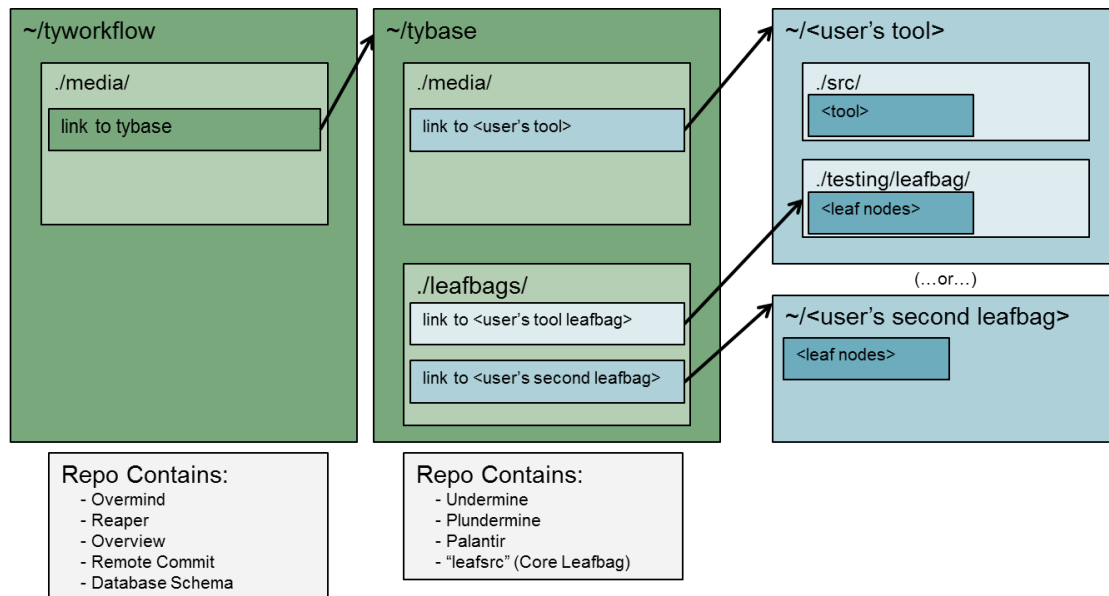


Figure 7 Typical Tyrant testing environment directory structure

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.

2.7 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 or physical machines connected to a network-addressable APC PDU.
- 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.

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- It is assumed you will configure the reaper to connect directly to individual ESXi servers when reverting VMs rather than going through a vCenter server.
- The remote commit environment on the test server will run as root, and developers will submit their tests as root on the test server.
- It is assumed that each VM resource will be set up to revert to the current snapshot, whatever that is (rather than having multiple named snapshots per VM). This doesn't mean that a VM can't have more than snapshot, only that overmind will be set up to simply revert to the current one.
- The administrator is assumed to have a working knowledge of Unix-like operating systems, especially the platform chosen as the testing server.

3 Range Setup

3.1 Pre-Tyrant

Prior to involving Tyrant tools, the environment for the range must be set up. For this you will need as many servers as necessary to host the number of virtual machines you wish to have in your range and as many PDUs as necessary to provide outlets to support the number of physical machines you have. You'll also need a Linux server which may be either a separate physical server or a virtual machine in the ESXi range. This will be known henceforth as the "test server" and is where overmind, the reaper, and overview will be run. A separate physical server is recommended as the test server will be subjected to heavy load if many users are running tests concurrently and will need to store a lot of data (depending upon how much data the tests generate).

The test server should meet the following requirements:

- runs Fedora 10 or later (these are explicitly supported, though other Linux distributions have been known to work without modifications)
- has Apache HTTPD installed (in Fedora, the httpd package) and set to start on boot
 - o For newer versions of Fedora, run `systemctl enable httpd.service`. For older versions, run `chkconfig --levels 2345 httpd on`.
 - o Start it using `service httpd start`.
- "apache" server system user must have sudo permission for all commands without a password, and requiretty must be disabled
 - o Edit `/etc/sudoers`
 - o Add the line `"apache ALL=(ALL) NOPASSWD: ALL"`
 - o Comment out the line `"Defaults requiretty"`
- has MySQL server installed (in Fedora, the mysql-server package) and set to start on boot
 - o Use the same commands as the previous item, but replace httpd with mysqld.
 - o When MySQL is started for the first time, set the password. The command to do this is likely `mysqladmin -u root password "<newpassword>"`.
 - o Configure a user in MySQL which has permissions to create and delete databases. Typically, we use the root account, but you can create a different account for this purpose. In either case, you must be able to log into this account from remote machines. In the case of using the existing root account, you may need to enable remote logins. The following command will do this (replace "password" with the root password for your system):
 - `GRANT ALL PRIVILEGES ON *.* TO 'root'@'%' IDENTIFIED BY '<newpassword>' WITH GRANT OPTION;`
- has PHP installed, with the MYSQL, GD,JSON, and POSIX extensions (in Fedora, the php-mysql, php-gd, php-json, and php-posix packages, which may be included inside of php-common)
 - o Note: The JSON extension is built-in as of PHP 5.2.0. If your PHP predates that version, you'll need to install JSON separately. For 5.2.0+, do not install any separate JSON package.

- has mercurial installed, including the hgweb component (in Fedora, the mercurial package)
- has zip installed (in Fedora, the zip and unzip packages)
- has python, python-devel and MySQL-python packages installed
- has a DHCP server installed and configured to respond to DHCP requests on whichever interface is connected to the same network as the test resources (in Fedora, the dhcp package)
- has an accurate clock which is kept in sync with developer workstations

Configure a mercurial server. This can be done in one of two ways:

- For small environments, you can use the built-in mercurial web server. To do this:
 - o Designate a directory on the test server that will contain the repositories being served. (e.g. /proj/repos)
 - o In this directory, create a text file called hgrc. In this file, place the following contents replacing ALL instances of PATH with the path to the directory contains repositories to serve. Yes, this does mean the above line has the same path twice.


```
[collections]
<PATH> = <PATH>
[web]
push_ssl=False
allow_push=*
```
 - o Run the command `nohup hg serve --webdir-conf <PATH>/hgrc &` where PATH is again the path to the directory of repositories to serve.
 - o Your repositories will be available at e.g. `http://testserver.example.com:8000`.
 - o To make the mercurial server start at boot, add the above command to `/etc/rc.local` in the proper place for user-added commands (generally, just at the end of that file, though comments therein may direct you otherwise). When you put the command in `/etc/rc.local`, ensure that the path to the hgrc file is an absolute path.
- For larger environments, you can run a mercurial server through Apache httpd. Follow the instructions here: <http://mercurial.selenic.com/wiki/PublishingRepositories#hgweb>.

Configure the traffic to get through iptables firewall (which is on by default in most Fedora builds). This can be done by either wholly disabling the firewall or by enabling specific ports that are not on by default.

- Disabling iptables can be done by running the following command as root: `service iptables stop`.
- Changing the iptables rules can be done in a variety of ways – depending on the administrator's preference. One method for doing so would be modifying `/etc/sysconfig/iptables` (or equivalent config file) to open up ports 80 (http), 443 (https), 3306 (mysql), and 8000 (hgweb). After modifying the file, remember to restart iptables using the following command: `service iptables restart`.

Either way, add the tybase and tyworkflow repositories to the set of repositories served here. The code is provided as a repo with a single initial commit, so you can just copy these directories to the repository directory on the test server. When copying from a CD, you *may* have to fix the permissions of the files since files copied from a CD are sometimes set without write permission. To do this, for each repository you copy, run the command

```
chmod -R u+w <DESTDIR>
```

on the copy on your system, where <DESTDIR> is the path to that copy.

Configure the MySQL server to start at boot. Create a user which has permissions to create and drop databases and can log in from remote machines.

Configure Apache HTTPD be accessible from developer workstations. Also, ensure that developer workstations can connect to the test server.

3.2 Remote Commit Environment Setup

Next, we'll set up the environment from which developers submit their tests. The remote job submission scripts are written in bash and have dependencies on modern Fedora Linux distributions to be able to function without modification. What follows is a description of the process that LM ATL went through to set up their most recent Fedora 18 (F18) environments.

1. Acquire the i686 or the x64 Live version of F18.
(We downloaded ours from <http://mirror.anl.gov/pub/fedora/linux/releases/18/Live/>.)
2. Boot the i686 or x64 media and install using default settings.
3. Once up, perform an install (or update) of the following packages:
 - mercurial (hg)
 - make
 - python
 - mysql
 - MySQL-python
 - zip

(NOTE: Most of the packages installed are not strictly required; however, we have found that having them installed in our remote job submission environments has been beneficial over the past years, so we now standardize on having them installed.)

(NOTE: If using Fedora the yum server is not immediately reachable, the user would need to modify the `/etc/yum.conf` file to point it at the appropriate yum server.)

We understand that some in the future might want to do remote job submission natively from a Windows host. This has been something we have historically worked around by mounting directories with Samba (e.g. mounting the build directory of a tool on Linux such that when the tool is built, it is immediately accessible from the remote job submission scripts). However, we anticipate needing to (and want to) write a native Windows process down the road.

It is somewhat likely that the tools being tested themselves may put other requirements on the remote job submission environment (especially if a user wants to integrate tool-specific build and customization logic as part of test submission). Those requirements are not accounted for here.

IMPORTANT: If there are special packages and libraries that need to be installed in order to run tests, these packages must also be installed on the Tyrant server as well as the remote commit machine.

3.3 Remote Commit Directory Setup

On the test server, as root, create a directory which will be the root of the remote commit environment. Our convention is to use `/proj/testing`, and this document will use that path throughout. This is henceforth referred to as the “remote commit root”.

- In the remote commit root, create a directory named `commits` (henceforth referred to as the “commits directory” e.g. `/proj/testing/commits`).
- Inside the commits directory, create subdirectories named for each developer's and each administrator's username. As new developers come on board, you will need to create new directories for them. These directories are where all the files necessary to run a test are synced to when a developer submits a test with remote commit. By default, when a developer submits a test, the files are synced to the directory with the developer's username. By creating multiple directories (e.g. `jdoe`, `jdoe2`, `jdoe3`, etc), developers can submit multiple tests to run simultaneously by specifying the commits directory subdirectory name when they run remote commit.
 - NOTE: If you desire for some users to submit tests with `remote_commit` as a non-root user, then `chown` their commits directories to be owned by the user and primary group they will use. For example, if developer John Doe has a user account named “`jdoe`” whose primary group is “`users`”, then after creating his commits directories, you would run e.g.:


```
chown jdoe:users /proj/testing/jdoe
                /proj/testing/jdoe2 /proj/testing/jdoe3
```

 You will then need to inform John Doe that he should set “`jdoe`” for the value of the `remote_user` option in the `remote_commit` section of `rc/remote_commit.rc` (this is covered in the user manual).
- Back in the remote commit root directory (e.g. `/proj/testing`), clone both `tybase` and `tyworkflow`. `cd` into `tyworkflow` and run `make`.
- For the administrators and each developer or tester who will submit tests to this remote commit environment, add their public SSH identification key to the `.ssh/authorized_keys` file on the test server for the user account that user will use to log in to the test server.. This will allow the developer to log in without a password as root. Without this, the developer would have to type in their password several times when they submit tests. For users who log in as root, this would be `/root/.ssh/authorized_keys`. For John Doe, to continue the example from above, this would be `~jdoe/.ssh/authorized_keys`.

3.4 Overmind Database Setup

Next, the Overmind Database must be set up. We set up the database *before* setting up the test resources because some of the tools we'll use to set up physical machine test resources require data about the physical machines to already be in the database. The purpose of this step is to populate the database with all the data necessary to automatically run test plans. To that end, we will be populating the database with information about the following entities:

- recipes: Specifications of the OS and other software which run on a test resource.
- VM hosts: The bare metal machines on which virtualization infrastructure like ESXi runs and on which VM computers reside.
- PDUs: Network-addressable devices which allow switching power to physical computers on or off, to which physical computers are connected.
- VLANs: Definition of the networks to which the resources may be connected, including a specification of MAC and IP address pools to select from when cloning machines in a VLAN.
- computers: The “shells” on which recipes run (e.g. the physical or virtual machine on which one would install an OS and other software)
- resources: Resources are the combination of a computer, a snapshot name, and a recipe. Effectively, a resource entry declares that “snapshot X on computer Y contains recipe Z”. Resources are the entities which overmind schedules for testing.

First, we configure and initialize the database. In your `tyworkflow` directory in the remote commit root, copy `rc/defaults/db.rc` to `rc/`. In the copied file, make the following changes:

- set `resource_manager/dbname` to the name of the database you want Overmind to use (`db_admin` will create it for you in a later step)
- set `resource_manager/engine` to `mysql` instead of `sqlite3`
- set `mysql/host` to the hostname or IP address of the server the database resides on
- set `mysql/user` and `mysql/passwd` to the username and password used to access the database you set in `resource_manager/dbname`
- 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.

Initialize the database by running the following command *from the root of tyworkflow*. If your database already exists and you wish to wipe it out, add the `+drop` option to the command line:

```
bin/db_admin init_db
```

3.4.1 Importing Recipes

Next, populate the database. First, create a CSV file of the recipes with one recipe per line in the following format:

```
<name>,<family>,<os>,<ossp>,<lang>,<arch>,<apps>
```

None of these fields have specifically defined values (they are just strings in a database that are matched in various places), but the values used must be consistent between the overmind database and test

plans used with the range, because test plans will match on these fields. The values suggested below are the most commonly used values, and their use is strongly recommended.

- name: Whatever you want (that can be put in a SQL text field). A convention is to do family-os-lang-arch, with all the values shortened (e.g. lin-fc14-en-x86 for a 32-bit Fedora 14 English resource). Throw in the service pack before the language if it's a Windows resource (e.g. win-xp-sp3-en-x86).
- family: win, lin
- os:
 - o for Windows, abbreviated OS name plus edition (e.g. xppro, 7ult, 2k8entr2)
 - o for Linux, abbreviated OS name and version (e.g. fc12, fc19)
- ossp:
 - o for Windows: sp0, sp1, sp2, sp3, sp1a (typical Windows service pack numbers)
 - o for Linux: ws
- lang: use the two-letter language codes that Microsoft uses
- arch: x86, x64
- apps: This field is a comma-separated list of app names, which typically indicate either that a certain piece of software (an "app") has been installed in this recipe, or that a certain feature has been enabled. Leave blank if not using any apps.

Import your recipes file with the command:

```
bin/db_admin import_recipes <RECIPE_FILE>
```

where <RECIPE_FILE> is the path to the recipe file you created.

An example `recipe.csv` file with a recommended schema is available for customization in the `docs/` directory.

At this point, you should be able to use `db_admin` to view the recipes you've imported. Run

```
bin/db_admin list_recipes
```

The output should contain records for each recipe you had in `recipes.csv`, with all the correct field values.

3.4.2 Importing VM Hosts and PDUs

In order to support computer-level operations (e.g. power control and saved state control), the database needs to know metadata about the VM hosts on which VMs reside and the PDUs to which physical machines are connected. To this end, you must populate the database with information about VM hosts and PDUs (done in this section). Then when importing computers, inform the database which VM host or PDU the computer resides on (done in section 3.4.3).

First, we'll import VM hosts. Create a VM host csv file with one line per VM host, in the following format:

```
<host>,<type>,<username>,<password>,<max_vms_in_use>
```

The fields have the following meanings:

- `host`: The hostname or IP address of the VM host.
- `type`: The type of VM host. This field is used to pick which HAL implementation to use to perform computer-level operations on resources on this VM host. Use `esxi` here, as all your VMs are ESXi VMs.
- `username`: The username used to log in to the VM host.
- `password`: The password used to log in to the VM host.

Import your VM hosts file with the command:

```
bin/db_admin import_vm_hosts <VM_HOSTS_FILE>
```

where `<VM_HOSTS_FILE>` is the path to the VM hosts file you created.

Verify this by running this command:

```
bin/db_admin list_vm_hosts
```

You should see the VM hosts you just imported.

Next, create a PDU csv file with one PDU per line, in the following format:

```
<host>,<model>,<username>,<password>
```

The fields have the following meanings:

- `host`: The hostname or IP address of the PDU.
- `model`: The model name of the PDU. This is used to pick which PDU control implementation the HAL will use to perform power operations on computers connected to this PDU. Use `apc` here, since all your PDUs should be APC PDUs.
- `username`: The username used to log in to the PDU. Leave this field empty since our APC PDU control implementation does not require authentication (because it uses SNMP).
- `password`: The password used to log in to the PDU. Again, leave this field blank.

Due to the blank username and password fields, you'll end up with csv lines that look like the following:

```
somehost,apc,,
```

This is expected.

Import your PDU file with the command:

```
bin/db_admin import_pdus <PDU_FILE>
```

where `<PDU_FILE>` is the path to the PDU file you created.

3.4.3 Importing VLANs

Next, create a vlan CSV file. This file will inform tyrant about the networks which exist in your range. In the case of VMs, the vlan names **MUST** match the name of the virtual network to which your VM's network interface is attached (i.e. the network name you select in the Properties dialog, in the "Network label" dropdown for an interface on ESXi VMs). Put lines in the vlan CSV file in the following format:

```
<name>,<ip_min>,<ip_max>,<mac_min>,<mac_max>
```

The fields have the following meanings:

- `name`: The name of the vlan.

- `ip_min` and `ip_max`: Lower and upper bounds on a pool of IP addresses from which new unique IP addresses will be chosen when needed (e.g. when cloning a computer in this vlan). It is alright if some IP addresses in this pool are already in use in the tyrant database, as the code which assigns new IP addresses will check for this. These fields MUST be IPv4 addresses specified in dotted-decimal notation.
- `mac_min` and `mac_max`: Lower and upper bounds on a pool of MAC addresses from which new unique MAC addresses will be chosen when needed (e.g. when cloning a computer in this vlan). It is alright if some MAC addresses in this pool are already in use in the tyrant database, as the code which assigns new unique MAC addresses will check for this. These fields must be specified in the traditional hexadecimal format, with octets separated by colons (":"); hyphens ("-") are not acceptable.
 - NOTE: When setting MAC ranges for VMWare, the valid MAC address range is 00:50:56:00:00:00-00:50:56:3F:FF:FF. You will get errors if you try to use addresses outside of this range and operations such as cloning will fail. Also, due to how the clone process autogenerates clone names (if no clone name is specified), you should limit your range to 65,536 addresses (e.g. 00:50:56:00:00:00 to 00:50:56:00:FF:FF).
- `netmask`: The subnet mask in use on the vlan. This must be in IPv4 dotted-decimal notation. For example, if you're used to thinking about your vlan as "192.168.0.0/16", then the value for this field would be "255.255.0.0".
- `gateway`: The default gateway for the vlan, in IPv4 dotted-decimal notation. This field is optional; leave empty in the CSV if you don't want to set it.
- `dns`: IP addresses of DNS server, in IPv4 dotted-decimal notation. Multiple DNS server addresses must be separated with semicolons. This field is optional; leave empty in the CSV if you don't want to set it.

3.4.4 Importing Test Resources

Next, create a resource CSV file which contains the computer and snapshot definitions. The file takes lines in pairs of the following format, where the first line defines a computer and the second line defines a snapshot on that computer.

```
<name>,<ip>,<mac>,<hwtype>,<model>,<pool>,<vlan>,<state_type>,<reaper>,<ext_attrs>
@snapshot,<recipe>,<snapshot>
```

For your VM test resources define one computer line and one snapshot line for each VM. For your physical machine test resources, define ONLY the computer line (the resource entry will be created later on).

The fields have the following meanings:

Computer fields:

- `name`: The name of the computer. This must match the name of the VM in the virtualization environment.
- `ip`: primary IP address of the computer (which the test server can use to connect to the VM)

- **mac**: MAC address of the interface having the IP address given in the `ip` field. This should be formatted with colons (e.g. `01:02:03:f1:f2:f3`).
- **hwtype**: a string designating a broad hardware type. For physical machines, this **must** be “phys”, and for virtual machines of any kind, this must be “vm”. The system will function with degraded functionality if other values are used here, but many HAL operations will not work. For USB thumb drives, use “thumb”.
- **model**: a string designating the model of computer. There is currently no pre-defined value for this; the intention is to give some indication of the hardware present in the computer. To that end, for physical machines, we recommend using a concise representation of the computer’s actual model (e.g. for a Dell 1850, you might use “dell1850”) and for ESXi VMs, you could just use “esxi” for simplicity.
- **pool**: pool name the computer is part of. The pool is just a grouping construct for VMs. We use it to group VMs for certain types of testing. Then, in the plan files for our tests, we restrict certain tests to certain pools.
- **vlan**: name of the vlan the computer is connected to. This is used as a designation of the network the VM is on and must match the name of a vlan imported in the previous section. In our test environment, we have several networks VMs can be connected to, some of which are isolated from others. Some of our tests require VMs on the same network, or on two different networks, so we use the vlan field in test plans in order to select VMs from the desired networks. Using a feature of the overmind test plan language, users can write test plans which require resources that reside on the same (or different) networks.
- **state_type**: name of the type of saved states used by this computer. The value here is used by the HAL to pick the saved state control implementation which will be used to revert the machine to a clean state (when the reaper sanitizes the machine at the beginning of a test), among other places. Use “esxi” for your VMs, and “clonezilla” for your physical machines. For USB thumb drives, use “nop”.
- **reaper**: name of the reaper to use. This needs to match one of the reapers defined in the merging of `rc/reaper.rc` and `rc/defaults/reaper.rc` (which is covered in section 3.8 Reaper Setup). For the parallel reaper setup this document uses for ESXi VMs, this field is the DNS name of the ESXi host on which the resource resides, matching the names of one of the sections you will put in your `reaper.rc` in the following section (e.g. for an ESXi host named “foo”, you will define a `reaper.rc` section called “reaper_foo”, and a VM which resides on this ESXi server would have a reaper value of “foo”). For physical machines, set this to “clonezilla”.
- **ext_attrs**: extra optional fields which provide hardware-type-specific extended attributes about the computer. These are specified as comma-separated key/value pairs in the format `<KEY>=<VALUE>`. **For ESXi VMs, define the `vm_host` attribute to be the hostname or IP address of the ESXi host the VM resides on (which must be identical to one of the host fields you set when you imported VM hosts in section 3.4.2).** For physical machines connected to a network-addressable PDU, define the `pdu_host` attribute to be the hostname or IP address of the PDU the machine is connected to (must match a PDU you imported in section 3.4.2) and define the `pdu_outlet` attribute to be the outlet number to which the machine is connected.

For an ESXi VM residing on an ESXi host named `abdon`, you might have the following line in your `computers` CSV file (this would be a single line in the CSV file; it's only wrapped here due to space constraints):

```
comp01,192.168.5.45,00:50:5c:3e:00:04,vm,esxi,pool01,vlan01,esxi,
  abdon,vm_host=abdon
```

For a physical Dell Precision T3500 using `clonezilla` saved states connected to outlet 6 of the PDU at IP address 192.168.4.24, you might have the following computer CSV line (again, a single line in the CSV but wrapped here due to spacing):

```
comp01,192.168.5.46,5c:26:0a:41:e5:61,phys,dellpt3500,pool01,vlan01,
  clonezilla,cz,pdu_host=192.168.4.24,pdu_outlet=6
```

Snapshot fields:

- `recipe`: the name or ID of the recipe this computer has installed on it; must match an existing recipe (as you would have imported just a bit ago)
- `snapshot`: the unique identifier of the snapshot for this computer. The meaning of this field is dependent upon the state control implementation used for the computer this snapshot is bound to (as selected by the `state_type` field earlier). For the "esxi" state type, this field is the name of an ESXi snapshot, or the special value "latest" which means to simply use the VM's current snapshot. For physical machines with the "clonezilla" state type, you should not be putting snapshot lines in the CSV file (this will effectively be done later).

Administrator note: If using named snapshots in overmind, the name of the specified snapshot must be unique across all snapshots for the VM.

Administrator note: Because "latest" in the snapshot field for ESXi VMs has special meaning, do not name any snapshots "latest" in ESXi if using named snapshots in overmind as they cannot be reverted to by name.

Import your resource file with the command:

```
bin/db_admin import_computers <COMPUTER_FILE>
```

where `<COMPUTER_FILE>` is the path to the file you created.

An example `computer.csv` file is available for customization in the `docs/` directory.

At this point, you should be able to see your imported data in the output of a few `db_admin` commands. First, run this command:

```
bin/db_admin list_computers
```

This command shows information about all the computers in the overmind database. This deals roughly with the physical (or virtual) "shell" on which a recipe resides. Thus, `list_computers` shows information like the IP address, MAC address, etc, but not recipe information like OS family or service pack level. You should see all of the VMs you listed in `computer.csv` (the first line of each pair of lines) in the output of this command. Next, run this command:

```
bin/db_admin list_snapshots
```

This command lists all the snapshot names known by overmind. In your case, there should only be one

record, named “latest” (later, after set up the physical machines, this command will show more than just “latest”). Finally, run this command:

```
bin/db_admin list_resources
```

This command shows you the resources available for testing. A resource is a combination of a computer (the shell on which a recipe resides), a snapshot name, and a recipe (this is the reason why there is only one snapshot record from the previous command). You should see all of the snapshots you listed in `computer.csv` (the second in each pair of lines) in the output of this command. Currently, this will only show you the VMs you added because we have not finished setting up the physical machines.

Set the computers you added in the database to be usable for testing. By default, when you insert computers into the database, they have their `testing_use` flag set to 'N' in case you don't want them to immediately get used for tests. Run the following command to set all computers in the database which are currently set not to be used for testing to be used for testing:

```
bin/db_admin set_computer_flag testing_use 'Y' testing_use='N'
```

This command is saying "set the `testing_use` computer flag to 'Y' for all computers which currently have the `testing_use` flag set to 'N'". If you then run

```
bin/db_admin list_computers
```

again, you should see all the same computer records, but the `testing_use` field should now say “N” for all of them.

After setting up a resource, you may also test power options on the resource. To do this, go to `tybase` root and run the following power cycle command for the computer:

```
bin/comp_admin name=test_comp power_cycle
```

Running the power cycle command should cut off power from the PDU to the machine. (You should see the light for the outlet on the PDU turn off.) Then, after the delay time, power from the PDU to the machine should be restored.

3.4.5 Creating Database Users

So far, you have been using the root database user (or a database user with root privileges). Tyrant allows you to also create database users with lower levels of privilege (or create more users with root privileges). Tyrant has three database privilege levels:

- `view`: Users at this level are only able to read data from the database. They cannot make any changes or add anything to the database.
- `test`: Users at this level are able to run tests and create and destroy clones.
- `admin`: Users at this level have full privileges. They can change anything in the database or even drop and re-create it.

If you know now that you have certain people whom you’ll want to have different levels of access, create database user accounts for them. For each user, choose a username and password and decide what level of access they should have. Then, in `tyworkflow`, run the following command:

```
bin/db_admin add_dbuser <USERNAME> <LEVEL> <PASSWORD>
```

Inform each user of their username and password. They will put this username and password in the mysql section of `rc/db.rc` in their workstation copies of tyworkflow, just as you did in this test server copy of tyworkflow at the beginning of section 3.4. Optionally, you may omit the `<PASSWORD>` parameter from the above command and you will be prompted to enter and confirm a password.

3.5 Default Overmind Post-Op Threads Configuration

Users can specify post-test operations as part of their test plans, which will be run in the context of the Overmind server (i.e., *not* as part of the Undermine process; in this way they differ from the “presetup” and “postcleanup” operations that can be encoded in test plans to run as part of Undermine). For example, a user can write a test plan such that if a test returns a certain result code, then clones will be created from all the resources used in that test. These post-test operations can have arbitrary runtime. As such, they cannot simply be run as part of the Overmind scheduling loop, when Overmind sees that a test has finished and cleans up after it (freeing resources, writing information to the database, etc), since doing so would cause the server to hang to indeterminate periods of time.

To handle this, if a test instance has post-test operations, those operations are all run, serially, in a thread for that test instance. Overmind can be configured for the maximum number of post-test threads to run at one time. If this limit is reached, then further tests which have post-test operations are put on a queue to be run later when threads become available. The maximum number of concurrent post-test operation threads can be configured via the `max_popthreads` setting in the `overmind` section of `rc/overmind.rc`. The default setting for this value is listed in `rc/defaults/overmind.rc`. Consider the processing power of your test server and the capacity of your range and, if desired, change this limit by editing `rc/overmind.rc` (*do not* edit the file in `rc/defaults`). For example, if you wish to set the max postop threads setting to 10, you would put the following in `rc/overmind.rc`:

```
[overmind]
max_popthreads = 10
```

Some notes are in order:

- Because this is a per-overmind setting, users can override this when they commit tests to the server, either by modifying `overmind.rc`, or using the `set_popthreads` subcommand to `remote_commit`.
- Other limits also apply which will effectively limit the load on your range. For example, ESXi hosts can have a limit on the number of concurrent VMs in use. Because the resources are still marked as in-use at the time post-op threads are run, if you have many tests running which all want to do post-test cloning, the number of VMs actually being cloned at any given time as part of post-test operations will still respect the ESXi host limit.

3.6 Clonezilla Setup

To support saving and restoring disk images of physical machines with clonezilla, you must set up the test server to enable computers in the range to netboot from it. This section assumes your test server is already set up as a standard DHCP server, so in this section we simply add the necessary files and configuration to support netbooting from it.

1. Install the tftp-server and syslinux packages (command for Fedora servers):


```
yum install tftp-server syslinux
```
2. Copy the PXE “boot stub” file to the tftp server root directory:


```
cp /usr/share/syslinux/pxelinux.0 /var/lib/tftpboot
```
3. Set up the PXE config directory and populate it with a default config file. This default config file causes any machine for which there does not exist a specific MAC-address-named config file to simply boot its local hard drive (effectively the same as if it had not netbooted at all, but with a slight delay for the netboot process to occur).
 - a. Create the directory:


```
mkdir /var/lib/tftpboot/pxelinux.cfg
```
 - b. Write the following text to /var/lib/tftpboot/pxelinux.cfg/default:


```
DEFAULT local

LABEL local
    LOCALBOOT 0
```
4. Enable the tftp server to start on boot. How this is done depends upon what version of Fedora your test server is running, as follows:
 - a. If your version of Fedora predates systemd (in which case the “systemctl” command will not exist), then we’ll use chkconfig to set xinetd to start at boot time, which will automatically start tftp on-demand:
 - i. Ensure the disable setting in /etc/xinetd.d/tftp is set to “no”.
 - ii. Run the command `chkconfig --levels 2345 xinetd on`
 - iii. Run `service xinetd start` to start xinetd (if not already running).
 - b. If your version of Fedora has systemd but the file /usr/lib/systemd/system/tftp.socket does not exist, we will set systemd to start xinetd at boot:
 - i. Ensure the disable setting in /etc/xinetd.d/tftp is set to “no”.
 - ii. Run the command `systemctl enable xinetd.service`
 - iii. Run `systemctl start xinetd` (if not already running).
 - c. If your version of Fedora has systemd and the tftp.socket file exists, then we’ll set systemd to start tftp directly on-demand:
 - i. Run the commands:


```
systemctl enable tftp.socket
systemctl start tftp.socket
```
5. Modify the dhcp server config at /etc/dhcp/dhcpd.conf to configure netbooting support.
 - a. Outside of any subnet section (e.g. at the top of the file) add the following lines, which enable netbooting support generally:

- ```
allow booting;
allow bootp;
```
- b. In the subnet section which serves DHCP for your physical machines, add the following setting which tells dhcpd what file to serve to machines requesting to netboot:
 

```
filename "pxelinux.0";
```
  - c. Restart the dhcpd service to apply the changes. For older, pre-systemd versions of Fedora, do
 

```
service dhcpd restart
```

 For systemd-based versions, do
 

```
systemctl restart dhcpd
```
  6. Obtain the clonezilla live stable release i486 zip file (the stable Debian version, not the "alternative stable" Ubuntu version). This can be downloaded from <http://clonezilla.org/downloads.php>.
  7. Create a directory which will contain the clonezilla netboot root (which will be served via NFS and used as the root filesystem for computers which are netbooting to do clonezilla operations) and unpack the downloaded clonezilla zip to it. We'll use /proj/cz\_netboot\_root for our example. Then, copy a couple files from the clonezilla root to the tftp root. Run:
 

```
mkdir /proj/cz_netboot_root
unzip ~/clonezilla-*.zip -d /proj/cz_netboot_root
cp /proj/cz_netboot_root/live/vmlinuz /var/lib/tftpboot
cp /proj/cz_netboot_root/live/initrd.img /var/lib/tftpboot
```
  8. Create a directory which will be used as the root for clonezilla disk images, and create a couple directories inside of it. We'll use /proj/cz\_img\_root in our example. Run this command:
 

```
mkdir -p /proj/cz_img_root/{images,markers}
chmod -R 755 /proj/cz_img_root
```
  9. Share the clonezilla image and netboot directories via NFS. Add the following lines to /etc/exports:
 

```
/proj/cz_netboot_root *(rw, sync, no_root_squash)
/proj/cz_img_root *(rw, sync, no_root_squash)
```

 Then, run this command:
 

```
exportfs -r -a
```
  10. If you want users to be able to initiate clonezilla operations remotely (which could occur if, for example, a user were to use the hal in their test to save or restore a state on a resource whose state\_type is "clonezilla"), start the clonezilla XMLRPC daemon. In the root of tybase on the test server, run
 

```
bin/czxmlrpcd
```

 If desired, configure the test server to automatically start the clonezilla XMLRPC daemon at boot time. For example, put an entry in /etc/rc.d/rc.local, like the following:
 

```
(cd /proj/testing/tyworkflow && bin/czxmlrpcd)
```

    - a. NOTE: The clonezilla XMLRPC daemon can be managed by bin/czxmlrpc\_admin. Run with the -h option to see available functionality.

Next, verify that the functionality necessary for netbooting is working.



1. First, verify tftp functionality. From another linux machine (either an existing Linux VM or a developer workstation), run the following (if necessary, do yum install tftp first to get the tftp client), replacing <TESTSERVER\_IP> with the IP address or hostname of your test server:
 

```
tftp <TESTSERVER_IP> -c get pxelinux.cfg/default
```

When this command completes, you should find a file named “default” in the current directory, and it should have the same contents as what you put in the default PXE config file earlier.
2. Next, verify that the default of booting to the local hard drive works properly. Simply select one of your existing test resources (a physical machine or virtual machine; it doesn’t matter which), ensure BIOS settings are such that the machine will attempt to netboot before booting its local hard drive, and then reboot it. You should see messages on the screen indicating that the machine is attempting a DHCP request, followed by some quick messages about PXE, and then the machine should start booting whatever OS is currently installed on it.
  - a. If you see no signs whatsoever of a DHCP process, then the machine is likely not properly configured to attempt a netboot before booting the local hard drive.
  - b. If you see signs of DHCP but get a failure (such as “No DHCP offers received”), then something is wrong with the DHCP server. Ensure it is running.
    - i. Note, however, that if you have multiple network interfaces on your machine and the first interface is not connected to the same network as the DHCP server, you can expect to see the first interface fail, but then a later interface, which is connected to the same network as the DHCP server, should succeed.
  - c. If the DHCP process appears to succeed, but then the TFTP process fails (for example, with the error “TFTP open timeout”), there is something wrong with the tftp server. Ensure it is running.
  - d. In the case of other errors, such as files not being found, ensure that you copied the files to /var/lib/tftpboot as prescribed earlier.
    - i. Note that if certain files are missing, the PXE client in the machine’s BIOS will very quickly fall back to booting the local hard drive. You will need to watch the screen very closely to see if there are any error messages. If you miss errors here, it’s not the end of the world; they will become apparent later.
3. Finally, ensure that the clonezilla netboot environment works properly. To do this, first obtain the MAC address of the machine you used for testing in the previous step. Create a file named for the machine’s MAC address in /var/lib/tftpboot/pxelinux.cfg, using dashes and lower-case letters, prepended with “01-“. For example, if your machine’s MAC address is 00:50:56:3E:00:25, you would create the file /var/lib/tftpboot/pxelinux.cfg/01-00-50-56-3e-00-25. In this file, place the following text (replacing <TESTSERVER\_IP> with your test server’s IP address):
 

```
DEFAULT cz

LABEL cz
KERNEL vmlinuz
```

```
APPEND initrd=initrd.img boot=live config noswap netboot=nfs
nfsroot=<TESTSERVER_IP>:/proj/cz_netboot_root
```

(Note that the last line is a single line.)

Reboot the test machine. You should see it perform a netboot except this time, instead of going to the local hard drive, it should start booting a Linux kernel and eventually end up at a clonezilla text menu.

- a. If this fails, ensure you properly unzipped the clonezilla live zip to /proj/cz\_netboot\_root. The immediate contents of that directory should consist of two files (Clonezilla-Live-Version, GPL) and seven directories (boot, EFI, home, isolinux, live, syslinux, utils).
- b. NOTE: After finishing this test, make sure to delete the MAC-address-named config file you created.

Having successfully completed the tests, we'll finish by setting up tybase to use your clonezilla setup. To do this, in your tybase clone in the remote commit root directory, create the file rc/ha1.rc and put the following in it:

```
[state_clonezilla]
netboot_root_nfs_host: <TESTSERVER_IP>
img_root_nfs_host: <TESTSERVER_IP_OR_HOST>
```

Replace <TESTSERVER\_IP> with the IP address of your test server (it MUST be an IP address).

Replace <TESTSERVER\_IP\_OR\_HOST> with either the IP address or hostname of your test server.

Our clonezilla module also includes support for wiping a drive before restoring an image to it, which is turned off by default but can be enabled in rc/ha1.rc. The wipe is a simple single pass of writing zeroes to the drive. If you'd like this wipe to occur, then set the pre\_restore\_wipe option to True. Also, there is a timeout setting for the maximum amount of time to allow for wiping the drive. The default setting is 5400 seconds (1.5 hours), which based on a rough analysis, should be suitable for a 500GB drive on a slow interface. If you want to change this timeout, set the wipe\_timeout option to the desired number of seconds. Both these wipe-related options are set like those in the above rc file snippet, in the state\_clonezilla section.

### **3.7 Palantir Configuration (Optional)**

Tyrant provides palantir installation packages which are created when the make command is run in tybase. Prior to running make and installing palantir, there are certain configuration options you should set which will dictate how palantir is installed on resources in your range. All the settings mentioned in this section will be set in the palantir section of rc/palantir.rc. See rc/defaults/palantir.rc for detailed explanation of all palantir configuration options.

If you wish palantir to use nonstandard ports (the defaults are 51134 for the service instance, which runs as root on Linux and as SYSTEM on Windows and 51135 for the user instance [which runs as the currently-logged in user; only for Windows]), set the svc\_port and usr\_port settings.

The palantir installer build code includes the ability to slightly change the contents of binaries in ELF, PE, or Mach-O format (the executable/shared object formats used on Linux, Windows, and OS X, respectively), thus changing the checksums of those files. If this behavior is desired, set the `bin_salt` option to some 32-bit integer. This integer will be written to an unused location in each executable and shared object file that goes into the palantir installer packages. For PE files, which have an internal checksum, the checksum will be regenerated using a python implementation of the PE checksum algorithm.

By default, the palantir installer only deploys byte-compiled (pyc) files of our 1<sup>st</sup>-party palantir code (3<sup>rd</sup>-party code such as standard python modules are still deployed as normal python source files). Sometimes, for debugging purposes, it is useful to have the source python files of 1<sup>st</sup>-party palantir code deployed also. If this is desired, set the `inst_keep_src` option to True.

Assuming all of the above options were desired, you would end up with something like the following in `rc/palantir.rc`:

```
[palantir]
svc_port: 46000
usr_port: 46001
bin_salt: 4277009102
inst_keep_src: True
```

WARNING: There are a few important things to keep in mind when making palantir configuration changes:

1. The above settings affect how the palantir installer packages are built. If you change them, you must re-run `make` in `tybase` in order to build new palantir installer packages.
2. If you change the palantir ports after having already installed palantir on some resources, you must reinstall palantir because the previously-installed instances of palantir will be communicating on the old ports.
3. If you change the palantir ports, ALL users of your range must have the same ports set in their palantir rc files, or none of their tests will be able to communicate with palantir on the test resources. The best way to avoid this problem is to check `rc/palantir.rc` into a central repository so that others who use the repository will receive your changes. This will be done in a later step.

### **3.8 Reaper Setup**

As root, in your `tyworkflow` directory in the remote commit root directory, create the file `rc/reaper.rc`. In this file, we'll define global reaper server configuration and, optionally, named reaper configurations for each ESXi server.

Each computer in the tyrant database has a reaper field (which you imported previously). Each named reaper can have a separate configuration as far as the maximum number of concurrent reverts happening for that reaper, and the maximum number of attempts to make reverting a given resource

before giving up. In addition, the reaper server can have an overall limit on the maximum number of reverts the server has running at once. Defining a separate reaper for each ESXi server is a convenient way to appropriately manage load on your ESXi servers. Each reaper corresponding to an ESXi server can be set for the proper number of concurrent reverts based on how powerful that ESXi server is.

Creating the named reaper configuration sections in the reaper RC file is not necessary. Named reapers which lack explicit configuration in the reaper RC file will be set with default settings (currently, five concurrent reverts and two tries). Creating an explicit section in the reaper RC file is only necessary if you want to override these defaults.

If you wish to change the reaper-server-level maximum concurrent revert setting, set the `max_children` option in the `reaper` section to the desired number. If not set, the same default setting as used for reapers which lack a `reaper.rc` section will be used at the server level.

To alter settings for specific named reapers, create sections named `reaper_NAME`, where `NAME` is the DNS name of an ESXi server (and the same as what you put in the `reaper` field when creating your computer CSV file in the previous section). In this section, you may define two options:

- `max_children` (maximum number of concurrent reverts on this ESXi server)
- `max_tries` (maximum number of attempts to revert a computer before giving up). You will likely only want to set `max_children`, if even that.

Example:

```
[reaper_NAME]
max_children = 10
```

If you wish to override the settings for physical machines (which you set to use the “clonezilla” reaper earlier), then simply create a “`reaper_clonezilla`” section and set the `max_children` or `max_tries` options as desired, just like with the ESXi reapers above. For example:

```
[reaper_clonezilla]
max_children = 8
max_tries = 1
```

Finally, install the Reaper as a system service. On the testing server, change into the install directory of the tyworkflow clone in your remote commit root directory (e.g. `/proj/testing/tyworkflow/install`). Run

```
./setup_service.sh reaper
```

which will install the reaper init script and enable it so that the Reaper will start at boot. Run

```
/etc/init.d/reaper start
```

to start the Reaper immediately without having to reboot.

### 3.9 Plunger Setup

As root, in your `tyworkflow` directory on the Tyrant server, if you wish to change any settings from default or add extensions, create the file `rc/plunger.rc`. In this file, set plunger configurations. The default configuration file, `rc/defaults/plunger.rc` describes each configurable setting.

To run plunger, execute the following command:

```
bin/plunger -x
```

You may run plunger with verbose debug output with the `-v` argument:

```
bin/plunger -x -v
```

To stop plunger, run the command:

```
bin/plunger_admin service_shutdown
```

If desired, configure the test server to automatically start the plunger daemon at boot time. For example, put an entry in `/etc/rc.d/rc.local`, like the following:

```
(cd /proj/testing/tyworkflow && bin/plunger -x)
```

### 3.9.1 Plunger Admin

When the Plunger service is running, additional commands can be run to change configurations or resynchronize database time. For descriptions of these commands, run

```
bin/plunger_admin -h
```

### 3.9.2 Plunger Extensions

If you wish to add plunger extensions, you must create an importable module with a defined function `plungerAction(*args, **kwargs)`. This function must return `True` on successful completion, or raise an exception upon any error. The exception will be caught by Plunger to print out to the plunger log file.

For example, the `upsync` leafbag has been setup for Tyrant. The following extension exists in the configuration file:

```
[plunger_extensions]
upsync = upsync.plunger.plungerAction
```

The “`upsync`” extension imports the module `upsync.plunger.plungerAction`. The `plungerAction` module defines the function `plungerAction()` and returns `True`:

```
def plungerAction(*args, **kwargs):
 p = configuration.read_config('upsync.rc')
 upsync_history_limit = p.getint('plunger', 'upsync_history_limit') if
p.has_option('plunger', 'upsync_history_limit') else 7
 upsync_db = DB()
 try:
 upsync_db.del_upsync_history(upsync_history_limit)
 finally:
 upsync_db.close()

 return True
```

### 3.10 Overview Setup

In your HTTPD document root, create a symlink which points to the `src/tyworkflow/overview` subdirectory of your tyworkflow copy in the remote commit directory made earlier. If necessary, enable the `FollowSymLinks` option on your HTTPD document root.

At this point, navigating to the test server's `/overview` directory (e.g. `http://testserver.example.com/overview`) should present you with a menu of overview pages (Namespaces, Recipes, Resources, Management). If you click on Management, you should see a table listing all the resources you imported in the previous step.

Verify that resources are set as 'dirty'. This will ensure they are reaped properly at the beginning of the first tests run.

### 3.11 Overview Test Scheduler Setup

These steps assume that the web server user ("apache") has been added to the sudoers file as described in the pre-Tyrant setup. To complete the setup for the Test Scheduler do the following:

- Within the `/etc/cron.d/` create the empty text file "ATL-Tyrant-Cron-Scheduler"
- Ensure "ATL-Tyrant-Cron-Scheduler" has 644 permissions and is owned by "apache"
- Ensure "`<tyworkflow root>/src/tyworkflow/overview/cron/cron_start.sh`" has 755 permissions (it should be owned by root)
- Ensure "`/etc/sysconfig/crond`" includes the line: `CRONDARGS="-p"` and restart crond (systemctl restart crond.service)

If Test Scheduler is failing to render properly ensure the php-posix library has been installed (yum install php-posix) as described in the pre-Tyrant setup.

### 3.12 Intermediate Step: Check In Configuration Changes

Now that you've configured the reaper on the test server, check in the configuration file changes. To do this:

- change directory into your tyworkflow clone
- run `hg add rc/*.rc` (this causes mercurial to start tracking the rc files you created earlier)
- run `hg commit` (and provide a useful commit log message)
- run `hg push`. If you've made other local changes and you don't want to commit those, then make sure to exclude them from your commit. (NOTE: This won't work if you did not set up a mercurial server as prescribed in earlier steps of the manual.)

### 3.13 Clone Setup

Tyworkflow provides support for cloning resources if the HAL has support for cloning for that resource's hardware type. Tyworkflow's cloning support will automatically select new unique MAC and IP

addresses for the clone in order to prevent network conflicts between the clone and source. Some configuration is required to make this work smoothly, and one important setting differs between the tyworkflow instance on the test server and the users' instances.

Create the file `rc/clone.rc` in tyworkflow on the test server, and create a section within it named `clone`. Only commonly-set options are explained here; see `rc/defaults/clone.rc` for more detail. In this section, set the following options as desired:

- `dhcpd_commit_cmd`: The command to use to restart the DHCP daemon on the test server. The defaults file provides some command examples.
- `use_arp`: Set to `True` to have an ARP ping done for extra assurance that an IP address that is available according to the tyrant database is not in use elsewhere on the network.
- `arping`: Optional path to specify the location of arping program, if it's not present at the default location. Only applies if ARP is turned on.
- `arping_dev`: Device from which the ARP ping should originate. Must be set if the test server has multiple network interfaces. In this case, set it to the interface which connects to the network the test resources are on. Only applies if ARP is turned on.
- `xmlrpc_host`: Set this to the IP address or host name of the test server. When set, cloning operations will use the XMLRPC server rather than the local code backend. This **MUST NOT** be set on the tyworkflow instance on the test server (the one powering overview and the reaper), but **MUST** be set for user instances (e.g. a developer's tyworkflow from which `remote_commit` is run).

After the above options have been set properly for your environment (including setting `xmlrpc_host` appropriately for a developer), add and commit the `rc/clone.rc` file just like you did the other rc files in the previous section. Then, after pushing that change, unset the `xmlrpc_host` setting so that the tyworkflow instance on the test server will NOT use the clone XMLRPC daemon.

Next, start the clone XMLRPC daemon on the test server. This daemon is necessary so that clones can be initiated remotely, and so that users who use `remote_commit` with a non-root user account are still able to initiate clones (since cloning involves some steps that require root privileges). In the root of tyworkflow, run:

```
bin/clonexmlrpcd
```

If desired, configure the test server to automatically start the clone XMLRPC daemon at boot time. For example, put an entry in `/etc/rc.d/rc.local`, like the following:

```
(cd /proj/testing/tyworkflow && bin/clonexmlrpcd)
```

The clone XMLRPC daemon can be managed by `bin/clonexmlrpc_admin`. Run with the `-h` option to see available functionality.

### 3.13.1 Destroying Clones with a vCenter Server

The clone feature of tyworkflow allows one to create and then later delete clones. The normal operation of deleting ESXi VM-based clones involves connecting directly to the ESXi host on which the clone resides

and deleting it from there. In a range controlled by a vCenter server, this will result in the deleted clone showing up as orphaned in the vCenter server's view of VMs (i.e. when connected via the vSphere client). To prevent this, you can inform Tyrant of the username and password used to log in to the vCenter server. If this is configured, then when destroying a clone, Tyrant will first log in to the ESXi host the clone resides on, query the host to determine if it is controlled by a vCenter server, and then log into the vCenter server and perform the deletion there (which effectively deletes the clone from the ESXi host and does not leave an orphaned VM in the vCenter server view). To enable this feature, set the `vc_user` and `vc_pass` options in the `esxi` section of `rc/hal.rc` to the username and password, respectively. For example, you would put something like the following in `rc/clone.rc`:

```
[esxi]
vc_user: Administrator
vc_pass: admin_password
```

Commit and push this change.

### **3.14 Test Resource Setup**

Now we move to setting up the actual resources which will be used in automated tests and the infrastructure to support them. For both VMs and physical machines, this means installing the base OS and any other applications, installing palantir, and then snapshotting the VM. For physical machines, after installing the OS and all software, you'll run a provided command which will save a clonezilla image of the state of the computer. If you have multiple physical machines of the same model, you need only build each desired recipe on one of the actual physical machines of that model because the clonezilla image taken from one machine is usable on all other machines of the same model.

#### **3.14.1 ESXi Virtual Machine Infrastructure**

Install and configure the ESXi servers as necessary to support the desired size of your range (instructions for this are beyond the scope of this document). Ensure that the ESXi servers are reachable from the test server and developer workstations over the network at the IP addresses or hostnames you set when you imported VM hosts earlier. Also, set the username and password on the servers according to what you set when importing VM hosts.

If you intend to have other networks than the main network which VMs are normally connected to which will be used for testing, ensure that each ESXi host has a connection to that network, and that the name of that network is identical between each ESXi host and identical to the value in the "name" field of the vlan table. If test traffic (i.e. palantir traffic) is ever intended to flow over this network, then also ensure that any locations on which tests are run (the test server and possibly developer workstations) are able to connect to this network. These points about network setup are particularly important given the network switching functionality detailed in the user manual.

#### **3.14.2 PDU & Physical Machine Hardware Setup**

Physically install the PDUs which will be used to control your physical machines and the physical machines themselves. Set up the PDUs with network access at the IP addresses or hostnames you set earlier and enable SNMP interaction with the PDUs.



Connect each physical machine to the correct outlet (according to the `pdu_outlet` setting you provided for each machine when you imported it). For each machine, configure the outlet's power cycle delay on the PDU. This is the amount of time the PDU will wait between powering an outlet off and powering it back on when a power cycle command is issued to the PDU. If the delay is too short, then the computer will not automatically power itself back on when power is restored, even if the BIOS settings are configured properly. The necessary delay is machine-specific and must be determined empirically. For APC PDUs, perform the following steps to set the delay on an outlet:

1. On the Tyrant Server, telnet into the APC PDU with the command:  
`telnet [apc ip address]`
2. Enter the username and password when prompted. (Unless the username and password was reset, it will be the default credentials for APC PDUs)
3. After successfully logging into the APC PDU, the **Control Console** menu will be displayed. Enter "1" to select Device Manager.
4. In **Device Manager**, enter "2" to select *Outlet Management*.
5. In **Outlet Management**, enter "1" to select *Outlet Control/Configuration*.
6. Press the Enter key again for input prompt.
7. Enter the outlet number you wish to reconfigure.
8. Enter "2" to select *Configure Outlet*.
9. In **Configure Outlet**, enter 4 to set *Reboot Duration*.
10. Enter the delay in seconds.
11. In **Configure Outlet**, the "Pending" status should appear next to *Accept Changes*.
12. Enter "5" to Accept Changes. If changes were successful, the "Success" status appears next to *Accept Changes*.
13. To configure other outlets, press the Esc key twice to the **Outlet Control/Configuration** outlet list and repeat steps 6-12 for every other outlet.
14. Finally, logoff the APC PDU by pressing the Esc key until the main **Control Console** screen appears. Then enter "4" to Logout.

For each physical machine, configure its BIOS so that the machine will automatically turn on whenever power is restored to the outlet the machine is connected to. Also, configure each machine's BIOS so that the machine attempts to netboot (PXE boot) before attempting to boot the local hard drive. Depending upon the machine, this may be as simple as including a "network boot" item in the machine's boot order settings, but it may also require enabling PXE boot for the network interface in a different section of the BIOS menu. Without these two crucial BIOS settings, the machine will not be usable for automated tests.

### 3.14.3 ESXi Virtual Machine Resource Setup

Build out your range of virtual machines with whatever method you see fit (e.g. hand-installation, some sort of autobuilding system, cloning).

Configure networking so that the test server can connect to the virtual machines. For the virtual machines, it is important that they keep the same IP addresses. Therefore, either configure the VMs with static IP addresses, or give them DHCP reservations based on MAC address so each VM always gets the same IP address. When running test scripts, connect to your VMs by IP address, not by DNS hostname, even if you have DNS set up (there are currently some parts of Tyrant which may break if DNS

names are used). Whichever method you choose, remember to set the IP addresses for each VM properly according to what you previously imported to the database.

Install palantir on the VM (see section 3.15).

Take a snapshot of the VM. It is this snapshot to which the reaper will revert the resource to cleanse it prior to running a test on it.

**Administrator note:** Each VM must have a name which is unique across the entire range, as DART references VMs by this field. Our naming convention is to include the base OS recipe name and the last two octets of the MAC address. For example, a Windows XP Professional SP3 32-bit English VM whose MAC address ends with 01:fe would be 01-fe-win-xppro-sp3-en-x86. The inclusion of the MAC address guarantees global name uniqueness as long as there are no more than 65,536 VMs in the range.

**Administrator note:** ESXi has some optimizations that come into play when multiple similar VMs reside on the same ESXi host. Therefore, we recommend collocating VMs of the same or similar base OS on the same ESXi host.

**Administrator note:** To increase user effectiveness, there are some optimizations administrators can make on their VMs and snapshots. You can use the Microsoft tool `bginfo` to include useful system information on the computer background. You can also ensure that the screen size is small enough that the whole screen is visible without scrolling. These two simple changes can greatly increase usability of the system.

#### 3.14.4 Physical Machine Resource Setup

For each desired combination of model and recipe, build out the recipe on one instance of the computer model. As with VMs, configure networking so the test server can contact the machine. You will almost certainly want to use DHCP with physical machines so that a specific IP address is not baked into the image which will be created shortly (since the same image may be restored to different physical machines, which should have different IP addresses).

**Note:** To decrease the time necessary to run tests on physical machines, we recommend building each recipe to use the minimum reasonable amount of hard drive space. For example, when installing Windows, rather than allow it to fill the entire hard drive, limit it to 10GB (or whatever is reasonable for the OS you're installing). Although the clonezilla tool used to image the drive is intelligent enough not to store empty space, imaging a large, mostly-empty partition still takes longer than a smaller one since clonezilla's tools must scan the entire partition).

Install palantir on the machine (see section 3.15).

Once a model/recipe combination is built, run the following command *from the root of tyworkflow*. This command uses the HAL to save the state of the computer (in this case, as a clonezilla image since you set the `state_type` field to clonezilla when you imported your physical machines previously) and automatically adds a resource entry to the database linking this computer to the image it automatically

creates.

```
bin/create_resource <COMPUTER> <RECIPE> <STATE>
```

where the arguments are as follows:

- <COMPUTER>: the name of the computer (identical to what you put as the name when you imported the computer)
- <RECIPE>: the name of the recipe currently on the computer (identical to one of the recipe names you used when you imported recipes)
- <STATE>: the name to save the state as (similar to snapshot name for ESXi VMs). For clonezilla images, the state name must be unique for all states which apply to a given hardware type/model combination, but is not required to be globally unique (i.e. all clonezilla saved states for physical machines with model set to "dellpt3500" must have unique names, but a clonezilla saved state for a "dellpt3500" and a "dellp390" may have the same name without conflict).

For all other physical machines of the same model, run the same `create_resource` command as above, but substituting the other computers' names instead of the first computer's name. This links the clonezilla image created by the first `create_resource` run to the other physical machines of the same model, so that the recipe you just set up is usable on all instances of the same kind of computer. Only the first run of `create_resource` will actually save the image; the subsequent runs will see that the given image already exists and automatically link it in the database with the subsequent computers.

Once you've finished setting up all the desired model/recipe combinations, you'll need to run a similar command as you ran when importing to set newly-imported resources as usable for testing:

```
bin/db_admin set_computer_flag testing_use 'Y' hwtype='phys'
```

### 3.15 Palantir Installation

To install palantir on an asset, do the following:

1. From the root of tybase, run `make`.
  - a. NOTE: If you intend to make palantir configuration changes (as in section 3.7), make those changes *before* you run `make`.
2. For each resource Palantir is being installed on, copy the appropriate platform-specific installation directory from `src/tybase/palantir/installer/distro` to the resource. The subdirectories of `distro` are named for the operating system and architecture they work on.
3. On each resource, with the Palantir installation directory you copied over as the current working directory, run the installation script. For Windows, this is `setup.bat`. For Linux, it's `setup_service.sh`.
  - a. NOTE: Linux test resources must have `zip` installed (the `zip` and `unzip` packages on Fedora).
4. If some of your resources have firewalls running on them, they may block palantir. You may notice this immediately upon installing palantir, if the firewall is triggered by listening sockets, or you may not notice it until a connection attempt is made. In either case, make whatever changes are necessary to the firewall configuration to allow palantir to accept connections.

Typically, this means opening ports 51134 (and for Windows, also opening port 51135 and/or allowing a “pythonw.exe” process to accept incoming connections).

5. Verify successful Palantir installation by running the following command from the root of tybase (this assumes your tybase copy is on a machine which can access the resources over the network), where IP\_ADDR is the IP address or hostname of the resource:

```
bin/palantir_admin -s <IP_ADDR> service_ping
```

The last line should end something like

```
[INF] root 2647: service_ping([], {}) = True
```

It should say True at the end; if it says False, then Palantir is not properly installed. If the resource is a Windows resource, also run the following similar command (replacing 51135 with your user port setting if you changed that in rc/palantir.rc):

```
bin/palantir_admin -s <IP_ADDR> -p 51135 service_ping
```

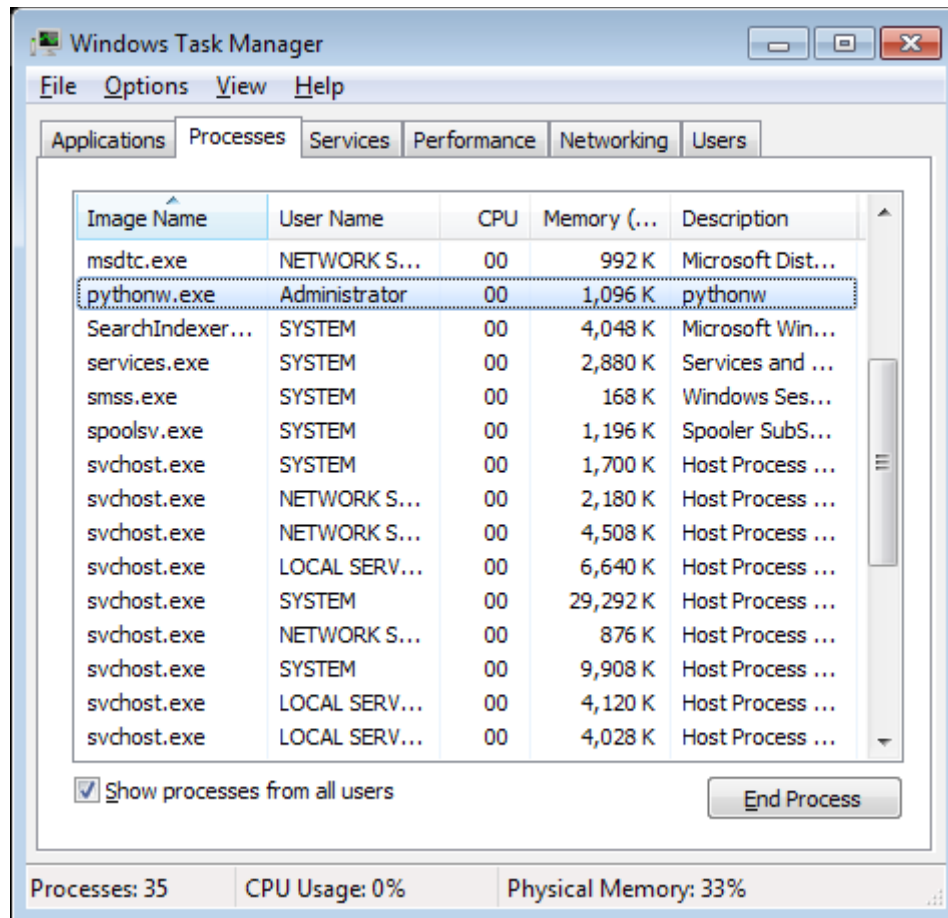
It should also say True at the end. The purpose of this second command is to test the user instance of Palantir, which is provided on Windows.

- o If these tests fail and you see a firewall popup on your test resource, you may need to change the firewall configuration to allow palantir to communicate.

### 3.16 Palantir Update

If a version older than 8.0 is already installed on a resource, you must uninstall the older version and install the newer one. To update Palantir, do the following:

1. Run steps 1-2 in section 3.15 above. The latest version of Palantir should be copied over to each resource.
2. Stop all Palantir services on the resource on which you want to update palantir.
  - On Linux, in a terminal, run  
service palantir stop
  - On Windows, in the command line console, run  
c:\palantir\_service\service.bat stop  
Open Windows Task Manager. If additional “pythonw” processes exist, select them and click **End Process**.  
An example of this is shown below.



3. Delete Palantir directories of the older version.

- In Linux, these directories include:  
/palantir\_service
- In Windows, these directories include:  
c:/palantir\_service  
c:/palantir\_user

Run the remaining steps 4-6 in the [Palantir Installation](#) section above to install the new version of Palantir.

### 3.17 Range Setup Verification

Before moving on, we'll verify the proper setup of the range. To do so, we'll use the `process_plan` and `remote_commit` tools to evaluate and submit a simple test plan which verifies Palantir connectivity to each resource and verifies that the resource actually has the recipe which the database says it has. The plan is set up such that it will run once on every single combination of recipe and computer (which, for our purposes, means every single resource in the range).

#### 3.17.1 Local Verification

First, we'll perform a local (to the test server) `solve` operation on the plan. This will tell us how many combos the plan will generate. In your `tyworkflow` clone in the remote commit root directory, run the

following command:

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

This command will potentially generate a lot of output, but at the end will say how many combos were generated with a line like the following:

```
Plan overlib.preflight.verify_os_plan generated 50 combos.
```

The number of combos generated should be equal to the number of resources shown on the overview Management page or in the output of `bin/db_admin list_resources`. If not, this indicates that some of the resources may not have been properly imported, or that some of the resources were left marked as reserved. On the overview Management page, check that none of the test resources are marked as reserved (yellow background) or fubar (gray background). If any are marked reserved, check the box next to each one and then click the “Use Testing” button on the left side.

### 3.17.2 Remote Verification

Next, we'll actually run this plan. We'll do this from the position of a developer using `remote_commit`, which will allow us to verify proper Overmind functioning, proper Reaper functioning, and proper Remote Commit functioning.

- Log in to a developer's workstation. On this computer, clone `tybase` and `tyworkflow` into the same base directory.
- In `tyworkflow`, run `make` as before. Also, like before, configure the `db.rc` file to use the Overmind Database located on the testing server. Run the same `solve` test as above from here to verify remote database connectivity.
- In `tyworkflow`, configure remote commit to use the environment you set up on the test server. Copy `rc/defaults/remote_commit.rc` to `rc/` and modify it as follows:

- o `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)
- o `remote_commit/remote_host`: the hostname or IP address of your testing server
- o `remote_commit/remote_commit_dir`: the path on your testing server to the commits directory (`/proj/testing/commits` in our example).
- o For the above settings, make sure you uncomment them. That is, remove the semicolon from the beginning of each option line that you modify.

- Now, remotely submit the ping plan. Run the following command from your `tyworkflow` copy:

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

Several things should happen when this command is run:

- o The current state of your `tybase` and `tyworkflow` copies will be written to text files in the `tyworkflow` directory. If you set up the mercurial server to use authentication, then this step may prompt developers for a password. If that happens, the developers should add their password to their personal `hgrc` files (at `~/.hgrc`). If they don't do so, they'll have to type their password multiple times whenever they submit tests. Set up the password in the `hgrc` file with the following content:

```
[auth]
testserver.prefix = http://testserver.example.com/hg/
```

```
testserver.username = <USERNAME>
```

```
testserver.password = <PASSWORD>
```

- o Your tybase and tyworkflow copies will be synced up to a subdirectory of the commits directory named for the user you're running as. If this prompts you for a password, that indicates that the public SSH key of the user you're running as was not properly added to root's `.ssh/authorized_keys` file. Most SSH servers are rather strict on the permissions of this file, so make sure the file has mode 600 if you created it new. If you receive an error that your commits directory doesn't exist, that likely means there is no subdirectory of the commits directory on the test server named for the user specified.
- o An instance of Overmind for scheduling your tests will be started on the test server, running from the tyworkflow directory just synced up.
- o The `service_ping_plan` test plan will be submitted to this remote Overmind instance. When this occurs, you should see a line of output telling you how many combos were generated, similar to when you ran `process_plan solve`. This number of combos should agree with the previous number of combos from your `process_plan solve` tests.
- Finally, remotely submit the OS verification plan. Run the following command from your tyworkflow copy:
 

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

  - o This plan checks all of the host operating systems against what is in the database, and it checks to ensure that Palantir is running properly on each hosts in a more thorough manner than the previous ping test.

Once any run of `remote_commit` is successfully completed, you should see a namespace for your test on the overview Namespaces page (e.g.

[http://testserver.example.com/overview/test\\_namespaces.php](http://testserver.example.com/overview/test_namespaces.php)). The number of test cases in the total column should equal the number of combos returned previously. As you refresh this page, test cases should complete and move to the success column. The ping test and OS verification tests are quick, so users ought to see some test cases complete after only a couple minutes (though physical machines will take significantly longer because restoring clonezilla images is slow relative to reverting ESXi snapshots). When the plan is complete, the count in the success column should equal the number of combos and all other columns should be zero (i.e. all test cases have completed successfully). Assuming this happens, your range is ready to go.

If any test cases complete with other statuses, then something is wrong with the resources used in those test cases. Refer to the section 4.12 for common problems you may encounter, and refer to section 4.11 for how to fix a saved state, since the process differs for physical and virtual machines.

### 3.18 Final Steps

Now that you've made more configuration changes (the remote commit settings made in your tyworkflow clone on the developer workstation), you should again check them in. This will make it easier for future users to utilize the overmind range you've set up, as they won't need to mess with

configuring overmind and remote commit themselves. Like before, change directory into your tyworkflow clone (that you used to remote commit from) and run `hg commit`, then `hg push`.



## 4 Range Maintenance

After setting up a range, it is sometimes necessary to perform maintenance tasks on it. This section explains how to perform some common maintenance tasks with either the overview web interface or the `db_admin` command-line tool. This, and other command line tools in Tyrant, have usage documentation available by running the tool with the “-h” option.

Note also that the `db_admin` tool supports the command line switch “-j”, which causes the tool to print JSON-encoded output instead of output formatted nicely for a human to read. If you ever have a need to programmatically parse and consume `db_admin` output, the “-j” switch is the way to go.

### 4.1 Viewing Resources

A simple task to start with is to view the list of resources. As has already been covered, a user can see the list of resources in overview on either the Resources or Management page. Both show similar information, but Management adds some ability to perform tasks on the resources.

On the command-line, `db_admin`'s `list_computers` and `list_resources` subcommands allow viewing the computers and resources. The difference is that `list_computers` shows one entry for each computer in the range (in our case, each VM). `list_resources` shows each resource, so if a given VM has multiple named snapshots defined in the Overmind Database, then there will be multiple entries for that VM in the resources listing. For our purposes, there is one and only one snapshot for each VM, so the number of computers and resources will be identical.

The `list_resources` and `list_computers` commands accept filters to specify what subset of resources/computers to show. The filter can specify values for the fields defined on a resource as follows: `pool`, `ip`, `mac`, `recipe`, `vlan`, `snapshot`, `reaper`, `reserve_name` and `reserve_time` fields, (all seen as column titles on the overview Management page). Also, the `testing_use`, `testing_in_use`, `testing_dirty` and `testing_fubar` (only for resources) flags may be specified (these fields match the corresponding columns in the overview Management page, sans the `testing_` prefix).

So, to show all computers in the “pool001” resource pool, you would run:

```
bin/db_admin list_computers filter_by="pool=pool001"
```

To see the resource with the IP address “192.168.56.101”, use the command:

```
bin/db_admin list_resources filter_by="ip=192.168.56.101"
```

### 4.2 Reserving Resources

When performing maintenance, one of the first things to do is reserve the computer you'll be working on. Reserving a computer prevents it from being scheduled for tests, so that it doesn't suddenly get used while you're working on it, and so that any changes you make to it while servicing it don't cause problems for developers' tests.

To reserve a computer in overview, navigate to the Management page (e.g. <http://testserver.example.com/overview/add-computer.php>). This page lists all the resources in the range and allows various tasks to be performed on them. Check the box on the row for the computer you want to reserve, enter your name or some other sensible identifier in the “Reserver’s Name” field on the left side of the page, and click the “Reserve” button. When the page refreshes, the resource you selected will have a yellow background for its row and the “use” field will say “N”. To un-reserve a resource, making it available for testing again, check the resource’s box and click the “Use Testing” button. The row will lose its yellow background and “use” will say “Y”.

With the `db_admin` command-line tool, you can reserve a computer with the `reserve_asset` subcommand and un-reserve it with `unreserve_asset`. `reserve_asset` takes as its first positional argument the reservation name to store on the computer (same as the “Reserver’s Name” field in overview). Following that, keyword arguments may be specified which give computer attribute values to match; only computers with matching values for those attributes will be reserved. Run

```
bin/db_admin -h list_computers
```

to see a full list of the fields which may be matched on. The `unreserve_asset` command takes these same matching keyword arguments to specify computers to unreserve.

To reserve a computer by name, you would run (from `tyworkflow`):

```
bin/db_admin reserve_asset my_name name=comp001
```

To reserve all computers which are currently not reserved:

```
bin/db_admin reserve_asset my_name testing_use=y
```

To reserve all computers in a given pool:

```
bin/db_admin reserve_asset my_name pool=pool001
```

To unreserve all resources previously reserved with a given reservation name:

```
bin/db_admin unreserve_asset reserve_name=my_name
```

To unreserve all resources, simply specify no filter:

```
bin/db_admin unreserve_asset
```

### ***4.3 Deleting Computers and Resources***

To delete computers from overview, navigate to the Management page, check the box for the resource(s) to be deleted, and click the “Remove Computer(s)” button. Overview does not have the capability to delete individual resources.

With `db_admin`, the `del_computer` subcommand will delete a computer (and all snapshots defined for it). `del_computer` takes the name of the computer to delete as its first argument, e.g.:

```
bin/db_admin del_computer comp001
```

The `del_snapshot` subcommand deletes snapshots. Either all snapshots for a specific computer may be deleted or only those snapshots with a given recipe. To delete all snapshots for a named computer,

you'd run:

```
bin/db_admin del_snapshot comp001
```

To delete only the Windows XP SP3 x86 English snapshot for that computer, you'd run:

```
bin/db_admin del_snapshot comp001 win-xp-3-en_US-x86
```

(assuming that is the precise name given to the Windows XP SP3 x86 English recipe).

To delete a resource (not a computer and all of its associated snapshots), you must delete both the snapshot state and record. Deleting a resource is more common for physical machine resource management.

To delete the snapshot state, first list the existing snapshots for the computer in **tybase** root. This will return a list of current states for the computer on the command line:

```
bin/comp_admin name=test_comp list_states
```

Then, delete the state for the resource you wish to delete:

```
bin/comp_admin name=test_comp delete_state state_name
```

Finally, in tyworkflow root, delete the snapshot for the computer resource:

```
bin/db_admin del_snapshot test_comp snapshot=state_name
```

## 4.4 Modifying Computers and Resources

Overview provides limited capability to make changes to computers. Using the box on the left-hand side of the Management page, one can change the resource pool or vlan a computer is in, change the reaper used for it, or reset its `testing_in_use` (whether or not the resource is currently being used for a test) or `testing_fubar` (whether the resource is currently broken) flags.

On the command-line, several `db_admin` subcommands provide full computer/resource modification functionality.

The `set_computer_attr` subcommand allows modifying the name, pool, ip, mac, vlan and reaper attributes (all the attributes which relate to a computer) as well as the extended attributes `vm_host`, `pdu_host` and `pdu_outlet` (meaning you can use `set_computer_attr` to change the database's understanding of which VM host a VM resides on, or which PDU a physical computer is connected to). This command takes filters as previously explained. To change the pool of a named computer

```
bin/db_admin set_computer_attr pool new_pool name=pool001
```

The `set_computer_flag` subcommand allows modifying the `testing_use`, `testing_in_use` and `testing_dirty` flags, e.g.:

```
bin/db_admin set_computer_flag testing_dirty R name=comp001
```

The `set_resource_flag` subcommand allows setting the resource flag `testing_fubar`.

Note that for most of the attributes being set with `set_computer_attr`, you must first add the value to the database. This is due to how attribute values are stored in the database. We hope to simplify this situation as a future enhancement. For now, this complexity applies to all the computer attributes except `reserve_name`, `reserve_time`, and `snapshot_id`. For the attributes `ip`, `mac`, `hwtype`, `model`, `pool`, `vlan`, `state_type` and `reaper`, you can use the `add_attr` subcommand, as these attributes are simple values. For example, if you wanted to change the IP address of a computer named "testcomp" to the value "192.168.6.101", you would do:

```
bin/db_admin add_attr ip 192.168.6.101
```

```
bin/db_admin set_computer_attr ip 192.168.1.101 name=testcomp
```

For the `vm_host` and `pdu_host` extended attributes, you cannot use `add_attr` as these attributes actually provide linkages to the tables holding information about VM hosts, and PDUs. Therefore, you must first use either the `add_vm_host` or `add_pdu` subcommands to add a record for the desired VM host or PDU, and then use the "host" field value as the value argument to `set_computer_attr`. For example:

```
bin/db_admin add_vm_host ehost01 esxi root root_pass
```

```
bin/db_admin set_computer_attr vm_host ehost01 name=testcomp
```

See `bin/db_admin -h` for much more detail about modifying entities in the database.

## 4.5 Deleting Old Test Results

As a range is used over time, more and more test results build up in the database and on the test server's disk. The `db_admin` tool provides the ability to delete individual test cases, test plans, or entire test namespaces. Test records are removed from the database, and the test output directories are also optionally deleted.

To delete a testcase, identify the testcase ID (this can be seen in Overview on the detail page for a single test case, or the test case list page for a plan or namespace). Then, run the following command:

```
bin/db_admin del_testcase <tid>
```

where `<tid>` is the testcase ID. You will be asked to confirm that you wish to delete the testcase from the database, and then also asked to confirm deletion of the testcase's output directory. If you want the testcase to be deleted immediately, without asking for confirmation, you can add the string "+really-do-it" to the end of the previous command (this string also works to prevent confirmation prompting for the other test result deletion commands outlined in this section). Note, however, that you will always be prompted to confirm deletion of test output directories, regardless of what you put on the command line.

To delete a test plan, identify the test plan ID (which is visible in Overview on the test plan list page for a namespace, as well as on the test case list page for the plan or the test case detail page for any test case in the plan). Then, run the following command:

```
bin/db_admin del_testplan <pid>
```

where `<pid>` is the test plan ID. You will be prompted to confirm deletion of the plan from the database,

and for deleting the directory containing all the test case output directories on the test server. Again, adding "+really-do-it" will suppress prompting for confirmation for deleting the plan from the database.

To delete an entire namespace, you can use either the name of the namespace or the namespace ID. These pieces of information are visible in Overview on the namespace list page, or any of the list or detail pages for any element (e.g. test case, test plan) in the namespace. Then, run the following command:

```
bin/db_admin del_namespace <name_or_nid>
```

where <name\_or\_nid> is the name or the namespace ID. As above, you will be prompted to delete the namespace from the database, and to delete the directory containing all its test case output directories from the server, and the "+really-do-it" string will suppress prompting for confirmation of deletion from the database.

**WARNING:** Take care when using these commands, as they are destructive! A small typo on the command line could cause you to delete a namespace you didn't intend to delete. Also, pay close attention to the filesystem path(s) you are asked to confirm to delete. Though this has never happened in practice, in theory, if an incorrect filesystem path got into the database somehow, it could be possible for much more than was intended to be deleted. So, look closely at the path(s) the command tells you it is going to delete and make sure they make sense.

## 4.6 Managing VM Hosts and PDUs

Overview has support for viewing VM hosts and PDUs present in the database but does not provide the ability to modify their attributes.

On the command-line, the db\_admin subcommands list\_vm\_hosts and list\_p dus allow you to see the VM hosts and PDUs in the database. These work the same as the other list\_\* subcommands as far as arguments used to modify their results.

The del\_vm\_host and del\_pdu subcommands let you delete VM hosts and PDUs. Both take as their only argument the host field of the respective entity. For example, to delete a VM host name "abdon", you would run:

```
bin/db_admin del_vm_host abdon
```

The subcommands set\_vm\_host\_attr and set\_pdu\_attr provide the ability to modify VM hosts and PDUs. For both entities, all fields except the ID may be modified. The complexity mentioned previously with set\_computer\_attr does not apply to modifying VM host and PDU information.

For example, to change the username of a VM host whose host field is set to "abdon", you would run

```
bin/db_admin set_vm_host_attr user new_username host=abdon
```

To change the host field of a PDU whose host field is currently "apc01", you would run

```
bin/db_admin set_pdu_attr host new_hostname host=apc01
```

## 4.7 Managing Database Users

In section 3.4.5 you learned how to create database users with the `add_dbuser` subcommand to `bin/db_admin`. Several other subcommands are defined for working with database users. Note that these subcommands should only be used on database user accounts created with `add_dbuser`.

The `list_dbusers` subcommand lists all the database users that appear to have been created by the `add_dbuser` subcommand, and shows you the username and privilege level for each such user.

`list_dbusers` accepts the same arguments as other `list_*` subcommands. For example, to list all users:

```
bin/db_admin list_dbusers
```

To list only users with test privilege level:

```
bin/db_admin list_dbusers filter_by=level=test
```

The `del_dbuser` subcommand allows you to delete a single database user by name. For example:

```
bin/db_admin del_dbuser user01
```

The `set_dbuser_password` allows you to change the password for a named user. Like `add_dbuser`, you may either provide the new password on the command line, or omit it and then be prompted to enter and confirm it. For example:

```
bin/db_admin set_dbuser_password user01 my_new_pass
```

The `set_dbuser_privlev` subcommand allows you to change the privilege level of an existing user by specifying the existing user's name and the desired new level. For example:

```
bin/db_admin set_dbuser_privlev user01 admin
```

would elevate the user "user01" to the administrative privilege level (unless he/she were already at that level, in which case this would effectively be a no-op).

### 4.7.1 Warning about Database Updates

In the future, new tables or fields may be added to the Tyrant database and delivered in an update. In the case of the "test" privilege level, it is likely that in conjunction with changes to the database, there will be changes to the set of privileges granted to a "test"-level user. Thus, in the case of a database update, you will need to reset privileges for any "test"-level users. To do this, simply run the `set_dbuser_privlev` subcommand for each "test"-level user, setting their privilege level to "test". This will cause the existing deprecated set of privileges to be removed, and the correct set to be applied.

## 4.8 Controlling Computers

As previously mentioned, the HAL provides support for abstract computer-level operations. For an administrator, these operations are exposed on the command line via the `comp_admin` tool in `tybase`.

### 4.8.1 General Usage

General usage of the `comp_admin` tool is as follows (run from the root of `tybase`):

```
bin/comp_admin <COMPUTER_ATTRS> <CMD> [<ARGS> ...]
```

where:

- `<COMPUTER_ATTRS>` is a comma-separated list of key/value pairs of attributes identifying the computer you wish to operate over (explained below).
- `<CMD>` is the name of the computer-level operation to perform.
- `<ARGS>` are arguments for the computer-level operation (not all operations take arguments). Keyword arguments may be specified in the format `KEY=VALUE`.

Unlike `undermine` and `palantir_admin`, which simply use the IP address to connect to a test resource via `palantir`, `comp_admin` requires more metadata about the computer it is to operate on, and the specific pieces of metadata required differ based on the operation being performed and the type of computer the operation is being performed on. For example, in order to power off an ESXi VM, `comp_admin` needs to know the name of the VM, the hostname or IP address of the ESXi host the VM resides on, and the username and password for that host. To power off a physical computer, `comp_admin` needs to know the hostname or IP address, username, and password of the PDU the computer is connected to, and the identifier of the specific outlet the computer is plugged into on that PDU.

These aforementioned pieces of computer metadata are readily available in the Overmind database, since you provided them when you imported your resources, but `comp_admin` is a `tybase` tool. How is `comp_admin` to obtain all this information? This is where the `<COMPUTER_ATTRS>` argument comes in. `<COMPUTER_ATTRS>` is a comma-separated list of key/value pairs of the computer metadata. The valid keys are the names of computer fields (e.g. the column headers returned by `bin/db_admin list_computers`).

Using `<COMPUTER_ATTRS>`, there are two ways to provide `comp_admin` with the information it needs to perform the desired operation:

- If (and only if) `tyworkflow` is linked to `tybase` (which would be the case if you cloned `tybase` and `tyworkflow` as siblings in the same directory and then ran `make` in `tyworkflow`), then `comp_admin` will use the provided attributes as a filter to find a specific computer entry in the database from which it can get the necessary information. So, for example, you can simply provide the computer name, which is unique, and `comp_admin` can automatically obtain the rest of the information it needs. If zero or more than one computer entry in the database match the provided computer attributes, then `comp_admin` will fail.
- If `tyworkflow` is not linked to `tybase`, then all necessary pieces of information must be specified on the command line.

Our expectation (and strong recommendation) is that you simply ensure the Overmind database is available as `comp_admin` will be much easier to use that way.

As with some other Tyrant command line utilities, values which begin with numbers or contain dashes must be quoted and the quotes must be escaped.

To bring this all together, here are some examples. Suppose you have a computer named “098lfws11x64” which you wish to power off, and suppose that tyworkflow is linked to tybase, so that the Overmind database is available. You would then run:

```
bin/comp_admin name=\'098lfws11x64\' power_off
```

Note the escaped quotes, since the value begins with a number. If the Overmind database were not available, you would have to specify all the necessary computer attributes on the command line, like so (note this command is all on one line, but is wrapped in this document):

```
bin/comp_admin
name=\'098lfws11x64\', vm_host=esxi01.example.com, vm_host_user=root, vm_
host_password=rootpass power_off
```

If you wanted to save the state of a computer named “test\_comp\_001”, naming the saved state “my\_first\_state”, and the Overmind database were available, you would use the following command:

```
bin/comp_admin name=test_comp_001 save_state my_first_state
```

If the Overmind database were not available and test\_comp\_001 were a VM configured to use ESXi snapshots, then in addition to the computer name, you would need to provide the ESXi host name, username and password. If instead it were a physical computer configured to use clonezilla snapshots, you would need to provide the hostname, username and password of the PDU it’s connected to, the identifier of the specific outlet it’s connected to, and its MAC address (needed by clonezilla to facilitate the netboot process).

### 4.8.2 Controlling Power

For controlling power to a computer, the following commands are available:

- `power_on`: Turns a computer on.
- `power_off`: Turns a computer off.
- `power_cycle`: Cycles a computer’s power, finishing with the computer on. For VMs, if the computer is already on, this means a “reset” operation. In general, if the computer is off, then `power_cycle` is the same as `power_on`.
- `power_state`: Tells you what power state the computer is in. Possible values are “on”, “off”, “suspended” (VMs only) and “unknown” (used for physical computers connected to a PDU, since the PDU only tells us whether the outlet the computer is connected to is powered, but not conclusively whether the computer *itself* is on).
- `suspend`: Suspends a computer (only for VMs).
- `resume`: Starts a suspended computer back up (only for VMs).

### 4.8.3 Controlling Saved States

`comp_admin` also provides the ability to manage saved states for computer (e.g., for VMs, snapshots or for physical computers, disk images of some sort). The type of saved states used for a computer are determined by the computer’s `state_type` field value. The reason for a separate field determining this (as opposed to just inferring the state type from the computer’s `hwtype` and `model` fields) is that some state types can apply to different types of computers. For example, one can use clonezilla disk images with physical machines or VMs (though the reverse is not true: one cannot use ESXi VM snapshots with physical machines).



Of the following commands, only the `restore_state` operation is guaranteed to be available. All other operations may or may not be supported, depending upon state control implementation.

To restore a state, use the `restore_state` command and provide the name of the state to restore as an argument, e.g.:

```
bin/comp_admin name=test_comp restore_state old_state
```

For ESXi VMs only, if no state name is given as an argument, or the special state name “latest” is given, then the VM will be reverted to whatever its current snapshot is.

To save a computer’s state, use the `save_state` command, with the name of the state as an argument. For example:

```
bin/comp_admin name=test_comp save_state new_state
```

For ESXi VMs only, the following keyword arguments are also supported:

- `memory`: Boolean which determines whether or not the VM’s memory should be stored in the snapshot (in other words, is it a “powered on” or “powered off” snapshot?); default is `True`.
- `quiesce`: Boolean which sets ESXi’s “quiesce” option; default is `False`.

To delete a state, use the `delete_state` command with the name of the state to delete as an argument, e.g.:

```
bin/comp_admin name=test_comp delete_state old_state
```

For ESXi VMs only, the keyword argument `delete_children` is supported. This Boolean argument determines whether only the given snapshot, or the given snapshot plus all its children in the snapshot tree should be deleted. Default is `False` (only delete the given snapshot).

Note that the `delete_state` operation has different effect for different state control implementations. For ESXi VM snapshots, this deletes a snapshot from a specific VM. For clonezilla states, this deletes a clonezilla disk image from the image storage directory. If other computers also depend upon that disk image, it will not be available for them either. This difference is due to the fact that VM snapshots are inherently tied to one and only one VM, whereas clonezilla disk images may be applicable to multiple computers.

To see what states are available for a computer, use `list_states`, e.g.:

```
bin/comp_admin name=test_comp list_states
```

To see whether a computer has a specific saved state available to it, use `has_state` with the name of the desired state, e.g.:

```
bin/comp_admin name=test_comp has_state some_state
```

To see the current state of a computer (currently only applicable to ESXi VMs), use `current_state`, e.g.:

```
bin/comp_admin name=test_comp current_state
```

To rename a saved state, use `rename_state`, providing it with the old and new names, e.g.:

```
bin/comp_admin name=test_comp old_state new_state
```

#### 4.8.4 Advisory Notes

There is nothing in `comp_admin` which will prevent you from doing something that would mess up somebody else's test. For example, if a computer were in the middle of running an automated test and you were to run the `power_off` operation against it, the computer would power off in the middle of a test, thus invalidating that test. To avoid this, check the Overview Management page to see what computers are in use and reserve a specific computer before you work with it.

Operations run in `comp_admin` do not make any changes to the Overmind database. Thus, certain `comp_admin` operations can delete things which an Overmind test range depends upon. For example, you could, using `comp_admin`, delete a clonezilla disk image that multiple physical machine resources depend upon, meaning that future tests run through Overmind that need to use that disk image would fail.

Operations involving clonezilla saved states currently only work when run on the test server as root (we have plans to improve this situation in a future release). That is, you cannot manage clonezilla saved states by running `comp_admin` on, for example, a developer workstation, nor by running as regular user even when on the test server.

### 4.9 Purging Tests

At times you may find it necessary to kill or "purge" some running tests. One reason this could occur is if you have to reserve some VMs to do maintenance on them, but some tests have already been committed which depend upon those VMs. In that case, the tests will never be able to run because a resource the test scheduler thought would be available to the tests is no longer available.

To kill the tests, you first need to determine what user name the tests were submitted under. The username is the string before the first underscore of a test namespace name (as seen on the overview Namespaces page) and should match one of the subdirectories in the commits directory on the test server. For example, given a namespace name "jdoe\_Sep26\_131054\_someplan", the commits directory the test is running out of would be `/proj/testing/commits/jdoe`, following our previous examples. You can use this username `jdoe` in conjunction with `remote_commit`'s `purge` subcommand to purge tests running out of that commits directory. This command can be invoked from any tyworkflow clone on a system which has network access to the test server; you do not need to be in the user's commits subdirectory on the test server to run this command since `remote_commit` runs the commands remotely.

To purge all tests running out of a user's directory, run:

```
bin/remote_commit -u jdoe purge
```

If you only wish to purge tests running in a specific namespace, obtain the namespace ID ("nid") from the overview Namespaces page and specify it with the `nid` keyword like so:

```
bin/remote_commit -u jdoe purge nid=1234
```

(Usually, there will only be one namespace running from a given commits subdirectory, though it is possible to have multiple). To purge only a specific test plan, get the plan ID ("pid") from overview (from

the Namespace page, click on the namespace the test is running in, then look in the “pid” column), and use the `pid` keyword:

```
bin/remote_commit -u jdoe purge pid=1234
```

Finally, one can purge only a single test case with the testcase ID (“tid”), obtained from overview by clicking on a plan name and noting the “tid” column value, then using the `tid` keyword:

```
bin/remote_commit -u jdoe purge tid=1234
```

## 4.10 Restarting & Shutting Down Remote Overmind Instances

Occasionally you may find it necessary to restart or shut down a user’s remote Overmind instance. When remote commit is used, an instance of Overmind runs out of a user’s commits subdirectory. When you know the name of the user’s commits subdirectory (for example, continuing from the previous section, “jdoe”), you can use the `-u` option as before with the `stop` subcommand, like so:

```
bin/remote_commit -u jdoe stop
```

You can also restart the remote overmind instance with the `restart` subcommand.

```
bin/remote_commit -u jdoe restart
```

In the rare case in which you need to manually kill a user’s Overmind instance, you can determine the PID of the Overmind instance by looking for running processes containing the words “overmind” and the username. For example, to get the Overmind running out of jdoe2’s commits directory, run:

```
ps aux | grep jdoe2 | grep overmind | grep python
```

In the resulting list, you should see a process containing

```
python -m tyworkflow.overmind.main
```

and whose path also contains that user’s commits subdirectory (e.g.

/proj/testing/commits/jdoe2). That is the process you want to kill.

## 4.11 Fixing Broken Saved States

Sometimes you may find that a test resource has a problem which is baked in to the saved state being used with the resource (e.g. an ESXi VM snapshot has a bad palantir install, or a clonezilla image has a problematic OS setting). This section details how to apply fixes to saved states, since the process differs between ESXi VMs and physical machines using clonezilla images.

### 4.11.1 ESXi VM Snapshots

The process for fixing broken ESXi snapshots is relatively uninvolved and can be performed entirely within the vSphere client:

- Revert the VM to the broken state.
- Make whatever changes are needed to fix the problem (e.g. reinstall palantir).
- Take a new snapshot of the VM.
- Delete the broken snapshot (not strictly necessary, but advised to avoid running out of disk space on your ESXi server).

Because your ESXi test resources are all set to use the special “latest” snapshot, no changes to the database are necessary. If you did have ESXi test resources with named snapshots, you could get around

modifying the database by renaming the broken snapshot to some other name, and creating the new, fixed snapshot with the same name the broken snapshot originally had.

#### 4.11.2 Clonezilla Images

The process for fixing broken clonezilla images is more complicated due to the fact that a given clonezilla image can apply to multiple physical computers.

- Restore the broken state to one of the physical machines of the correct model. This can be done using the `comp_admin` tool run *from the root of tybase*:  
`bin/comp_admin name=<COMPUTER> restore_state <STATE>`  
 where `<COMPUTER>` is the name of the computer (same as when you imported) and `<STATE>` is the name of the broken state.
- On the computer you restored to, make whatever changes are needed to fix the problem.
- Rename the broken state using `comp_admin`. Doing this will allow you to save the new, fixed state with the same name as the original broken state, so you will not have to make any changes to the database.  
`bin/comp_admin name=<COMPUTER> rename_state <OLD_STATE> <NEW_STATE>`  
 where `<OLD_STATE>` is the original name of the broken state and `<NEW_STATE>` is some new name (perhaps just the old with “-BROKEN” appended).
- Use the `create_resource` tool *from the root of tyworkflow* to take a new image of this computer.  
`bin/create_resource <COMPUTER> <RECIPE> <STATE>`  
 where `<COMPUTER>` is the same as above, `<RECIPE>` is the name of the recipe in the saved state which you fixed, and `<STATE>` is the original name of the broken state.
- Use `comp_admin` to delete the broken state from the clonezilla image storage directory (not strictly necessary, but advised to save disk space):  
`bin/comp_admin delete_state name=<COMPUTER> delete_state <STATE>`  
 where `<STATE>` is now the new name of the broken state (the `<NEW_STATE>` argument you gave to the `rename_state` subcommand earlier).

### 4.12 Cleaning Up After Terminated Clone Operations

Although Tyrant clone support is able to gracefully clean up if an error is encountered during cloning, it lacks the capability to gracefully clean up if terminated (e.g. with a SIGKILL or SIGTERM or a Ctrl+C on the command line). This means that if a running `clone_admin create` process is killed, or an Overmind server is killed in the middle of running one or more test-result-based clone post-test operations, the range can be left in an inconsistent state. The range will still function properly (e.g. users will be able to submit tests), but there will be artifacts left over that should have been cleaned up.

Thus, we provide a set of steps to perform to clean up after a clone process that was terminated. How many of these steps you will need to perform depends upon how far along the clone process was at the time it was terminated. We readily acknowledge that manually cleaning up after a terminated clone process is complicated. For this reason, we strongly recommend that you *not* terminate a clone process, or terminate a running Overmind server in the middle of running post-test clone operations.

- First, determine the name of the source and clone computers. You can do this by checking `clone.log` (for clones initiated with `bin/clone_admin` run from the test server's `tyworkflow` clone or clones initiated from Overview), or `clone_xmlrpcd.log` (for clones initiated by overmind as part of the post-test clone feature). In both cases, the log file will be located in the root of the test server's `tyworkflow` clone (e.g. `/proj/testing/tyworkflow`). Make note of the time at which you terminated the clone operation(s) to help you look in the right place in the log file.
- Determine the MAC and IP address which were chosen for the clone. If there is an entry in the database for the clone, you can simply look on Overview. Otherwise, you will need to look in the same log file as the previous point.
- If the clone has a resource entry in the database, delete it. This can be done via the Management page of Overview, or via the `del_snapshot` and `del_computer` subcommands to `bin/db_admin`. If using `bin/db_admin`, you must run `del_snapshot` first, followed by `del_computer`. For both, provide only the computer name as argument. For example:
 

```
bin/db_admin del_snapshot clone01
bin/db_admin del_computer clone01
```
- Delete the clone's IP and MAC addresses from the database. This must be done using two calls of the `del_attr` subcommand to `bin/db_admin`, like so:
 

```
bin/db_admin del_attr ip <CLONE_IP>
bin/db_admin del_attr mac <CLONE_MAC>
```

 where `<CLONE_IP>` and `<CLONE_MAC>` are the IP and MAC addresses selected for the clone.
- If the source computer is reserved, unreserve it. If it is suspended, resume it (e.g. via the vSphere Client).
- Check the vSphere client to see if the clone exists as a VM. If so, right-click it and choose "Delete from Disk".
- Browse the ESXi datastore on which the source resides to see if there is a directory named for the clone. If so, delete the clone directory and its contents.

## 4.13 Debugging and Troubleshooting

### 4.13.1 Palantir Connection Errors

- Check that palantir is actually running on the resource you're trying to connect to. In Linux, run `ps aux | grep palantir`. You should see a process running `"python -m tybase.palantir"`. In Windows, check the Task Manager process list for two `"pythonw.exe"` processes, one running as SYSTEM, and one running as the currently-logged-in user (if no user is currently logged in, then there will only be the SYSTEM instance). If it's not running, then
  - o for Windows
    - start the system instance by running `net start palantir`
    - start the user instance by logging out and back in
  - o for Linux: run `/etc/init.d/palantir start`

- Check that any firewall on the system is not blocking palantir connections (ports 51134 and 51135 [the latter only on Windows]), or blocking the palantir process from using the network (process running pythonw.exe).
- Check that you can connect to the network on the test resource at all. Can you ping the test resource from your workstation? Can the test resource ping your workstation?

### 4.13.2 Overmind/Overview/Reaper Issues

#### 4.13.2.1 Problems Connecting to the Database

- From the machine on which overmind/overview/reaper are running, can you log in to the MySQL server specified in the tyworkflow's db.rc file using the username and password specified there? If not, check your MySQL server permissions to make sure the user you've specified in db.rc is able to log in remotely and create and delete databases.
- Is a firewall enabled on the server running MySQL that's preventing remote connections to the MySQL server?
- Is the database server running? If not, start it and ensure it's set to start on boot.
- Is iptables configured to allow connections to the mysql server (default port 3306)?

#### 4.13.2.2 Errors When Viewing Overview

- Check the apache httpd error log (by default, /etc/httpd/error\_log) and address any issues presented therein.
- Ensure httpd is running and is set to run at boot.
- Ensure httpd is configured to follow symlinks (otherwise, httpd will refuse to follow the symlink and will give you an access denied error instead).
- Ensure iptables, if running, is configured to allow incoming connections on port 80.

#### 4.13.2.3 General Issues

- First, check the logs. The logs for the reaper instance in charge of reverting resources is located in the tyworkflow clone in the test server's remote commit environment (e.g. /proj/testing/tyworkflow), named reaper.log. If there are errors connecting to an ESXi server, they will show up here (and as a symptom, you'll see tests complete with the "skipped" result due to being unable to set a resource to a clean state before running).
- Each developer's remote Overmind instance has a log named overmind.log in tyworkflow in the developer's commit directory (e.g. /proj/testing/commits/jdoe/tyworkflow/overmind.log). This file will show problems with Overmind scheduling.
- If test cases take a long time to complete and result in the skipped status and the message "host(s) not reaped", that indicates a problem with the Reaper. Check to make sure the Reaper is running. From the tyworkflow clone in the remote commit root directory on the test server, the command  

```
bin/reaper_admin service_ping
```

should return True. If it doesn't, the Reaper isn't running. Also, check the reaper.log in that same directory for any errors. Ensure that the login information placed in rc/reaper.rc for each ESXi server is correct.

- If resources show up on the Resources or Management overview pages as having “fubar” status, this usually means an error occurred reverting the machine to a clean state. This can happen if the reaper is not working properly. Check to make sure the reaper is running (e.g. by running `/etc/init.d/reaper status` or `systemctl status reaper`). Also, check the reaper log (`reaper.log` in the `tyworkflow` directory on the test server which reaper is running out of, e.g. `/proj/testing/tyworkflow`) for errors. If there are errors in the reaper configuration, you’ll see something about it here.
  - If it is simply due to a reaper problem, then after fixing the reaper, you can make the machines available again by checking the box next to each one on the overview Management page and then clicking the “Reset FUBAR” button on the left side.
- Another reason reverting could fail, and machines could be marked fubar, is if you forgot to snapshot your VMs before using them (i.e. if the VM has no snapshot to revert to, then reverting will fail). Make snapshots of the failed machines, then reset them as above, by checking them and then clicking “Reset FUBAR”.
- When using the ‘remote commit’ functionality, time differences between the workstation submitting the tests and the test server will cause tests to fail. The supported configuration is to have all machines times synchronized via an NTP server.

#### 4.13.3 Test Script Issues

- Check the script and undermine logs for an individual test. These can reveal some range setup problems, as well as problems unrelated to range setup. To see the logs for a specific test case, start at the Namespace overview page, click on the name of the namespace the test is in, then the name of the plan in that namespace (there will usually be only one per namespace), then the specific test case, and then the `script.log` or `undermine.log` links in the “Undermine Logs” section.
  - If Palantir installation to a resource doesn't complete properly, this will show up in the undermine log as an inability to connect to the resource. The log will contain repeated attempts to connect, and the test will eventually end with a timeout).
- If you receive an error status with the message “.is\_clean failed”, this indicates that the resource the test attempted to run on is marked as dirty. When Overmind runs undermine to perform a test, it instructs undermine to verify that the machine is not dirty (i.e. not having previously run a test without being reaped) by checking for a marker on the resource. If you receive this error, then either the Reaper is not working properly and falsely returning success, or an operation was performed on an asset which incorrectly left a dirty marker. If you know the asset is clean, you can manually remove the dirty marker by deleting the `dirty_marker.xxx` directory from the installed Palantir directory on the resource (`C:\palantir_service` for Windows, `/palantir_service` for Linux). In this case, you’ll likely want to take a new snapshot since the existing snapshot was probably taken with the dirty marker on the box.

#### 4.13.4 General Issues

- If on a Linux system, ensure selinux is turned off.
- Have you run `make` in `tybase` and `tyworkflow`?

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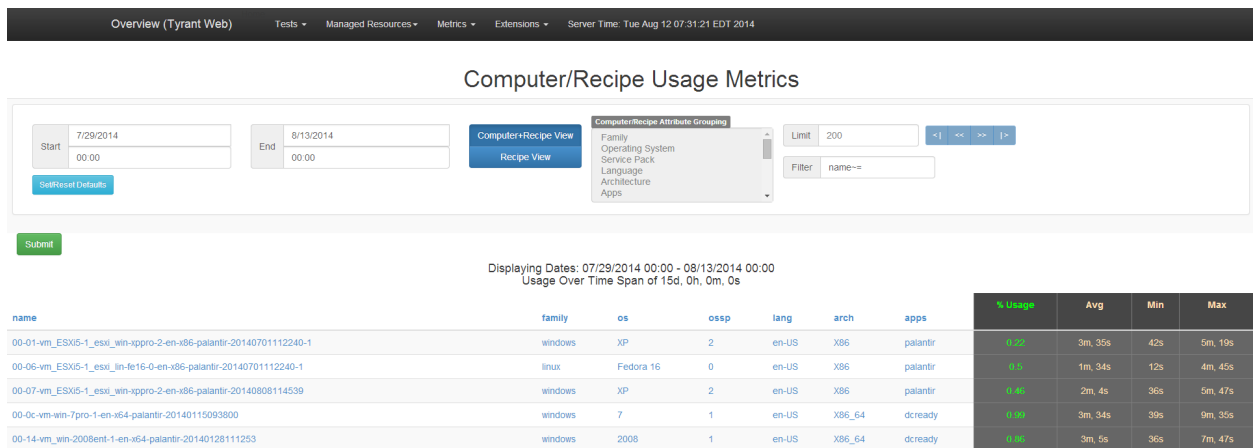
## 5 Tyrant Metrics

### 5.1 Historical Resource and Recipe Usage

These metrics show the percentage of time a resource or recipe was used in test cases for a specified period of time. Additionally, the metric results display the average, minimum, and maximum run times for a resource.

This metric can allow administrators to determine resources which have been most in demand. For example: “resource 00-04-win-xp-1-x86-en has been used in 50% of scheduled tests within the past 30 days” or “resources with recipe windows-xp-1-x86-en have been used in 62% of scheduled tests within the past eight hours”.

To view historical resource and recipe usage, navigate to `metrics_resource_usage.php` (Metrics  Computer/Recipe Usage Metrics)



| name                                                             | family  | os        | ossp | lang  | arch   | apps     | % Usage | Avg     | Min | Max     |
|------------------------------------------------------------------|---------|-----------|------|-------|--------|----------|---------|---------|-----|---------|
| 00-01-vm_ESX5-1_esxi_win-ppro-2-en-x86-palantir-20140701112240-1 | windows | XP        | 2    | en-US | X86    | palantir | 0.20    | 3m, 35s | 42s | 5m, 19s |
| 00-06-vm_ESX5-1_esxi_in-8e16-0-en-x86-palantir-20140701112240-1  | linux   | Fedora 16 | 0    | en-US | X86    | palantir | 0.15    | 1m, 34s | 12s | 4m, 45s |
| 00-07-vm_ESX5-1_esxi_win-ppro-2-en-x86-palantir-20140808114539   | windows | XP        | 2    | en-US | X86    | palantir | 0.46    | 2m, 4s  | 36s | 5m, 47s |
| 00-0c-vm-win-7pro-1-en-x64-palantir-20140115003800               | windows | 7         | 1    | en-US | X86_64 | dcready  | 0.04    | 3m, 34s | 39s | 9m, 35s |
| 00-14-vm_win-2008ent-1-en-x64-palantir-20140128111253            | windows | 2008      | 1    | en-US | X86_64 | dcready  | 0.36    | 3m, 5s  | 36s | 7m, 47s |

Select a start date and time and an end date and time. The metric results include the tests run within the start and end dates. The usage span is calculated by the difference between the start and end dates. The default end date is the current date and time. The default start date is one week before the current date and time.

Select the metric mode to view results. The Resource mode calculates usage according to the resource (computer and recipe combination). The Recipe mode calculates usage grouped by recipe attributes. For example, in Recipe Mode, when “os” is selected, the usage results is the total non-overlapping time all resources with the same “os” attribute in test over the total selected period of time. Furthermore, when “os” AND “arch” is selected, the usage results is the total non-overlapping time all resources with the same “os” and “arch” over the total selected period of time.

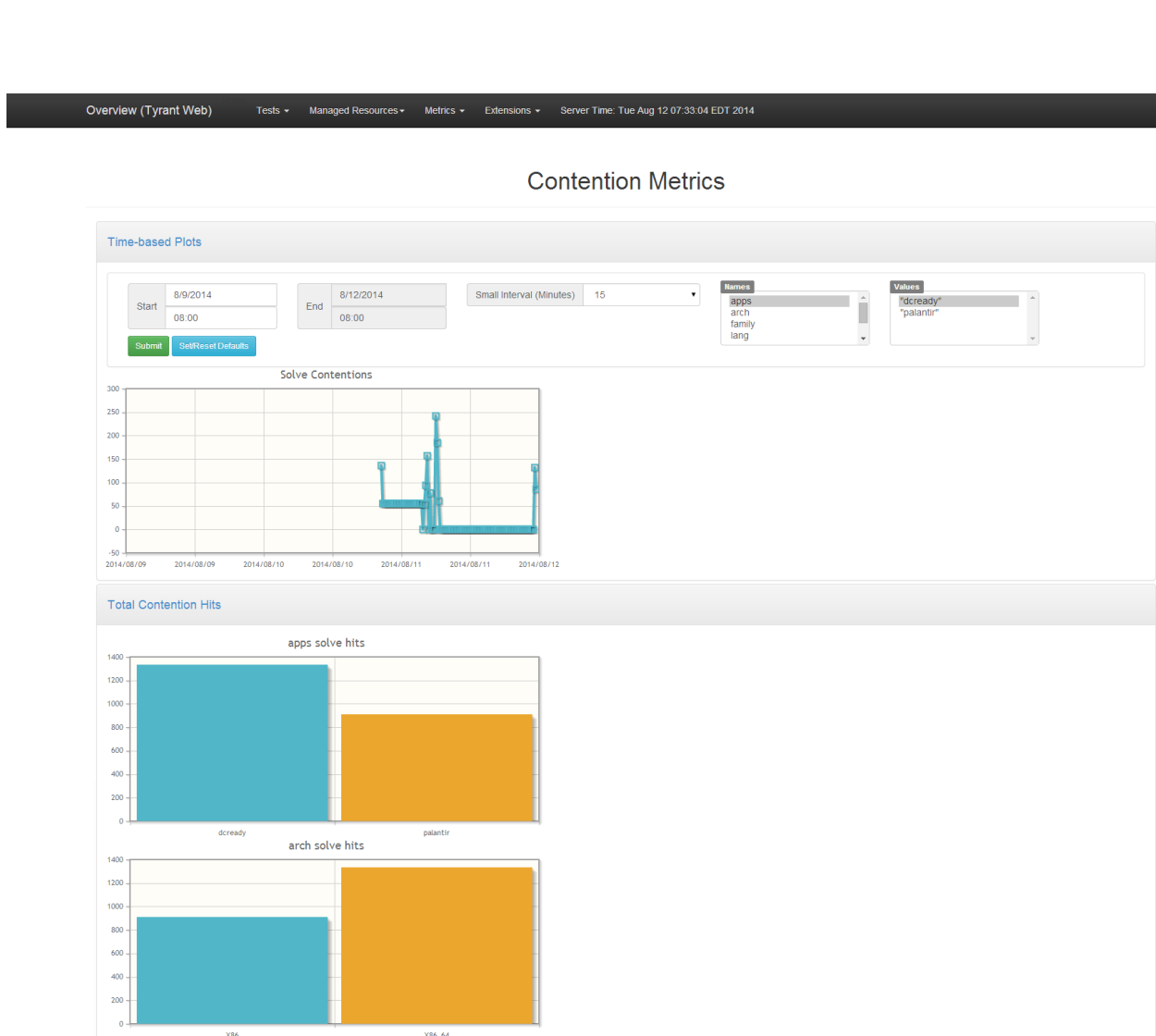
When the Recipe Mode is selected, the Recipe Attribute list appears. You must select one or more attributes. To select multiple attributes, hold the CTRL key and click the desired item.

Enter the limit and the filter string to view usage metrics for only specific resources or recipe attributes.

## ***5.2 Test Solving Contentions***

The Overmind server consists of a main processing loop which, among other things, schedules tests. At each iteration of this loop, the server attempts to schedule all the combos for a single plan, up to the specified samples limit. For each combo, the server attempts to “solve” the combo, which is our term for the process of finding a set of resources which match the host constraints in the combo. At any given time, some combos may fail to solve. If this occurs, we record a “contention hit” against the resource attributes the combo requires. For example, if a combo requires a 32-bit Windows host, and no 32-bit Windows hosts are available, we would record a contention hit for the 32-bit architecture and a contention hit for the Windows family. Over time, the host attributes which are most frequently needed but not available will rise to the top (due to having a greater contention hit count), giving range administrators an idea of what kinds of resources they should add to their range in order to increase test throughput.

To view contention metrics, navigate to metrics\_contentions.php (Metrics  $\square$  Contentions Metrics)



The Time-Based Plots section shows contention hits for a specific attribute name and value.

Select the start date to vary the range in the contentions plot graph. The default start date is a few days before the current date and time.

Select the small interval to display the interval in minutes between contention hit counts. **NOTE:** If the administrator chooses to record contention hit counts larger than the small interval, there may be gaps in hit counts.

Select the attribute name and then attribute value. Selecting the attribute name populates the values selection list. If contention hits never occurred for an attribute, it will not appear in the list.

The Total Contention Hits section shows the total contention hits for attribute values grouped by attribute name.

### 5.3 Computer Reservation History and Metrics

Resources are reserved at the computer level. A computer (and therefore any resources which involve that computer) may be reserved by a user at any time.

To view all records of computer reservation history, navigate to reservation\_history.php (Managed Resources [Computer Reservation History](#))

| Computer Reservation History                                                                                                                                                                                                                                                                                                                                          |                                                                  |                              |                         |                         |         |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------|------------------------------|-------------------------|-------------------------|---------|
| <div> Limit: <input type="text" value="200"/> <input type="button" value="OK"/> <input type="button" value="Prev"/> <input type="button" value="Next"/> </div> <div> Filter: <input type="text" value="computer_name=~"/> <input type="button" value="OK"/> </div> <div> Refresh (seconds): <input type="text" value=""/> <input type="button" value="START"/> </div> |                                                                  |                              |                         |                         |         |
| computer_id                                                                                                                                                                                                                                                                                                                                                           | computer_name                                                    | reserve_name                 | Reserved                | Unreserved              | elapsed |
| 402                                                                                                                                                                                                                                                                                                                                                                   | 00-06-vm_ESX05-1_esxi_in-fe16-0-en-x86-palantir-2014070112240-1  | __clone_in_progress_source__ | 2014-08-12 05:08:13 EDT | 2014-08-12 05:17:39 EDT | 9m, 26s |
| 402                                                                                                                                                                                                                                                                                                                                                                   | 00-06-vm_ESX05-1_esxi_in-fe16-0-en-x86-palantir-2014070112240-1  | UPSYNC_USER                  | 2014-08-11 09:55:17 EDT | 2014-08-11 09:57:44 EDT | 2m, 27s |
| 401                                                                                                                                                                                                                                                                                                                                                                   | 00-07-vm_ESX05-1_esxi_win-xppro-2-en-x86-palantir-20140808114539 | UPSYNC_USER                  | 2014-08-11 09:53:26 EDT | 2014-08-11 09:55:17 EDT | 1m, 51s |
| 402                                                                                                                                                                                                                                                                                                                                                                   | 00-06-vm_ESX05-1_esxi_in-fe16-0-en-x86-palantir-2014070112240-1  | malinda                      | 2014-08-11 09:35:14 EDT | 2014-08-11 09:35:46 EDT | 32s     |
| 402                                                                                                                                                                                                                                                                                                                                                                   | 00-06-vm_ESX05-1_esxi_in-fe16-0-en-x86-palantir-2014070112240-1  | __clone_in_progress_source__ | 2014-08-11 09:04:04 EDT | 2014-08-11 09:13:26 EDT | 9m, 22s |
| 401                                                                                                                                                                                                                                                                                                                                                                   | 00-07-vm_ESX05-1_esxi_win-xppro-2-en-x86-palantir-20140808114539 | __clone_in_progress_source__ | 2014-08-11 03:54:14 EDT | 2014-08-11 03:58:02 EDT | 3m, 48s |
| 402                                                                                                                                                                                                                                                                                                                                                                   | 00-06-vm_ESX05-1_esxi_in-fe16-0-en-x86-palantir-2014070112240-1  | __clone_in_progress_source__ | 2014-08-11 02:58:54 EDT | 2014-08-11 03:08:09 EDT | 9m, 15s |

To view metrics from computer reservation history, navigate to reservation\_history\_metrics.php (Metrics [Reservation History Metrics](#))

The reservation time span metric allows the administrator to know how often and how long a resource has been manually reserved within a given period of time. This metric indicates to the administrator the demand for a resource outside the scope of Overmind as well as its unavailability to other users and tests. Because Overmind reservations are made at a computer level (not resource level) there will be only a Computer view for this metric.

| Computer Reservation History Metrics                                                                                                                                                                                                                                                                                                                                                                                        |                                                                  |                    |         |         |         |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------|--------------------|---------|---------|---------|
| <div> Start: <input type="text" value="7/13/2014 00:00"/> End: <input type="text" value="8/13/2014 00:00"/> Limit: <input type="text" value="200"/> <input type="button" value="Prev"/> <input type="button" value="Next"/> </div> <div> Filter: <input type="text" value="name=~"/> <input type="button" value="Get Default"/> </div> <div> History Metrics Grouping: <input type="text" value="Computer ID/name"/> </div> |                                                                  |                    |         |         |         |
| computer_id                                                                                                                                                                                                                                                                                                                                                                                                                 | name                                                             | Total Reserve Time | Avg     | Min     | Max     |
| 402                                                                                                                                                                                                                                                                                                                                                                                                                         | 00-06-vm_ESX05-1_esxi_in-fe16-0-en-x86-palantir-2014070112240-1  | 3m, 26s            | 6m, 12s | 32s     | 9m, 26s |
| 401                                                                                                                                                                                                                                                                                                                                                                                                                         | 00-07-vm_ESX05-1_esxi_win-xppro-2-en-x86-palantir-20140808114539 | 1m, 51s            | 2m, 49s | 1m, 51s | 3m, 48s |

Select a start and end date and time to change the time span to calculate reservation history metrics.

Enter a limit number and filter string to show only specific computers.

The reservation history metrics can be grouped by Computer ID, Reserve Name, or both.

## 6 Appendix A - ESXi Physical Hardware to Range Size Charts

### 6.1 Test Range Size: 50-100 Nodes

|                                                                                                                                                                                              |                                                                                                                                                                                                                                                   |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Test Server (e.g. R310) <ul style="list-style-type: none"> <li>• 1 TB Disk Space</li> <li>• 24 GB RAM</li> <li>• 3 GigE NIC</li> <li>• 2 Intel Xeon Quad-core (e.g. X3400 series)</li> </ul> | 1 ESXi Server (e.g. R510) <ul style="list-style-type: none"> <li>• 2 TB Disk Space</li> <li>• 64 GB RAM</li> <li>• 3 GigE NIC</li> <li>• ESX Standard License (2 CPU per server)</li> <li>• 2 Intel Xeon Quad-core (e.g. E5500 series)</li> </ul> |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

### 6.2 Test Range Size: 100-500 Nodes

|                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                         |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Test Server (e.g. R610) <ul style="list-style-type: none"> <li>• 3 TB Disk Space</li> <li>• 32 GB RAM</li> <li>• 3 GigE NIC</li> <li>• 2 Intel Xeon Quad-core (e.g. E5600 series)</li> </ul>                                                        | VCenter Server for VM Management (e.g. R310) <ul style="list-style-type: none"> <li>• 500 GB Disk Space</li> <li>• 24 GB RAM</li> <li>• 1 GigE NIC</li> <li>• vCenter Standard License</li> <li>• 2 Intel Xeon Quad-core (e.g. X3400 series)</li> </ul> |
| 2-6 ESXi Server (e.g. R510) <ul style="list-style-type: none"> <li>• 2 TB Disk Space</li> <li>• 64 GB RAM</li> <li>• 3 GigE NIC</li> <li>• ESX Standard License (2 CPU per server)</li> <li>• 2 Intel Xeon Quad-core (e.g. E5500 series)</li> </ul> |                                                                                                                                                                                                                                                         |

### 6.3 Test Range Size: 500-1000 Nodes

|                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                   |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Test Server (e.g. R610) <ul style="list-style-type: none"> <li>• 4 TB Disk Space</li> <li>• 64 GB RAM</li> <li>• 4 GigE NIC</li> <li>• 2 Intel Xeon Quad-core (e.g. E5600 series)</li> </ul>                                                      | VCenter Server for VM Management (e.g. R310) <ul style="list-style-type: none"> <li>• Enterprise-Class Database Server (e.g. Oracle)</li> <li>• 500 GB Disk Space</li> <li>• 32 GB RAM</li> <li>• 1 GigE NIC</li> <li>• vCenter Standard License</li> <li>• 2 Intel Xeon Quad-core (e.g. X3400 series)</li> </ul> |
| ESXi Servers: (high-end boxes host more VMs; low-end boxes host less; use a mix)                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                   |
| 10-20 Low End (e.g. R510) <ul style="list-style-type: none"> <li>• 2 TB Disk Space</li> <li>• 64 GB RAM</li> <li>• 3 GigE NIC</li> <li>• ESX Standard License (2 CPU per server)</li> <li>• 2 Intel Xeon Quad-core (e.g. E5500 series)</li> </ul> | 6-12 High End (e.g. R710) <ul style="list-style-type: none"> <li>• 3 TB Disk Space</li> <li>• 128 GB RAM</li> <li>• 3 GigE NIC</li> <li>• ESX Standard License (2 CPU per server)</li> <li>• 2 Intel Xeon Quad-core (e.g. X5600 series)</li> </ul>                                                                |

### 6.4 Test Range Size: 1000-5000 Nodes

|                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                   |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Test Server (e.g. R610) <ul style="list-style-type: none"> <li>• 10 TB Disk Space</li> <li>• 64 GB RAM</li> <li>• 4 GigE NIC</li> <li>• 2 Intel Xeon Quad-core (e.g. E5600 series)</li> </ul> | VCenter Server for VM Management (e.g. R310) <ul style="list-style-type: none"> <li>• Enterprise-Class Database Server (e.g. Oracle)</li> <li>• 1.5 TB Disk Space</li> <li>• 48 GB RAM</li> <li>• 1 GigE NIC</li> <li>• vCenter Standard License</li> <li>• 2 Intel Xeon Quad-core (e.g. X3400 series)</li> </ul> |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

|                                                                                                                                                                                                                                                    |  |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| 12-24 ESXi Servers (e.g. R720) <ul style="list-style-type: none"><li>• 3 TB Disk Space</li><li>• 128 GB RAM</li><li>• 3 GigE NIC</li><li>• ESX Standard License (2 CPU per server)</li><li>• 2 Intel Xeon Six-core (e.g. E5-2600 series)</li></ul> |  |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|

## 7 Appendix B - Detailed Repository Layouts

### 7.1 *tybase*

- bin: Shell scripts used to run Tyrant components present in tybase
- docs: Some documentation which is superseded by this manual
- leafbags: Directory in which collections of test scripts and plans are linked in, making them available to be run by undermine or overmind
- media: Directory in which third-party supporting media is included or linked in
  - lib\_esxi-0.1: library which allows controlling ESXi servers via the vSphere API
- PythonLocal: Built-in python distribution used by Tyrant. This directory is only present after running make.
- rc: Configuration files for components in tybase.
  - defaults: Default settings which are checked into the repository; these are overridden by settings in the files directly in rc.
- src: Source code for Tyrant components in tybase. This directory is present on the python path when running any Tyrant components.
  - leafbag: A collection of built-in leafnodes.
  - tybase
    - hal: Source code for the HAL component, used to perform computer-level operations on test resources
    - palantir: Source code for the palantir component, used to run operations on test resources
      - installer: The code used to install palantir on test resources, as well as a pre-built python for the OS/architecture combinations supported by tybase.
    - support: Supporting modules used by various parts of Tyrant.
    - undermine: Source code for parsing and running leafnodes.
- test: A collection of regression tests for tybase components.

### 7.2 *tyworkflow*

The tyworkflow repository is structured similarly to tybase. The list below highlights the differences.

- install: Code used to install overmind and reaper as a system service.
- src
  - leafbag: Built-in leafbag containing test scripts and plans for verifying a range is properly set up.
  - tyworkflow
    - overmind: Source code for overmind, the component which schedules tests across shared resources.
    - overview: Source code for the web gui used to see test results and manage a range.

- overview\_httpd: Built-in web server for running overview in small environments (e.g. on a laptop while traveling).
- reaper: Source code for the reaper component, which handles sanitizing resources prior to a test.
- resource\_manager: Source code for the component which tracks the state of test resources using a database.
- support: Supporting code for various components of tyworkflow.

### **7.3 *tyutils/event\_detection***

- config: TYUTILS configuration files.
  - defaults: Default settings for tyutils event detection; overridden by the files directly in config.
- event\_detectors: Modules implementing the two types of event detection.
- harness: A leafnode which can be used to wrap your own leafnode with event detection logic, as well as some code for testing event detection.
- util: Common utility functions used by event detectors and harness scripts.

### **7.4 *PIL-\****

These repositories each contain a PIL subdirectory in which reside the Python Imaging Library code and compiled components.

### **7.5 *upsync***

- bin: scripts used to run the tools included in upsync
- leafbag
  - upsync
    - db\_admin: code for interacting with upsync-specific information in the overmind resource database
    - exporter: code for the low-side resource export tool
    - importer: code for the high-side resource import tool
    - updater: code for the low-side automatic update tool

### **7.6 *upsync\_apps***

- leafbag
  - upsync\_apps: container for application support packages; each subdirectory provides automatic internet-connected update support for a specific app
    - avira\_IS\_2012: support for Avira Internet Security 2012
    - COMMON: place for common code shared among app support packages
    - kaspersky\_IS\_2012: support for Kaspersky Internet Security 2012
    - mcafee\_VSent\_8\_8: support for McAfee VirusScan Enterprise 8.8
    - windows: support for updating the Windows OS



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## 8 Appendix C – Event Detection Setup

Via an add-on repository called “tyutils”, Tyrant provides the ability to run arbitrary test scripts in a wrapper which monitors the video output of a test resource for screen changes. This works by periodically taking screenshots according to a configurable interval and then comparing the screenshots over time to see what changes occur. Event Detection libraries were extracted from the “magnum” add-on repository. One can run event detection without “magnum”.

Tyutils includes *the event\_detection* library which 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.

### 8.1 Assumptions

This appendix makes the following assumptions:

- All of the ESXi servers in your range have an account with the same username and password which has privileges to take screenshots of VMs.
- Your test server uses NFSv3 (if it uses NFSv4, you will need to look up instructions on how to configure it).

### 8.2 Range Setup

First, on the test server, export (e.g. “share”) a directory via NFS. Following convention in this document, we’ll use `/proj/testing/tyrantshare`.

- Create the directory `/proj/testing/tyrantshare`.
- Add the following line to `/etc/exports` (create that file if it doesn’t exist):  
`/proj/testing/tyrantshare *(rw, sync, no_root_squash)`
- Run `exportfs -a`.
- Check if `nfs` is running with one of the following commands (depending upon Linux distro in use):  
`/etc/init.d/nfs status`  
`systemctl status nfs`  
 If it’s not running, then start it with one of the following:  
`/etc/init.d/nfs start`  
`systemctl start nfs`
- If `nfs` isn’t set to start at boot, set it to do so with one of the following:  
`chkconfig --levels 2345 nfs on`  
`systemctl enable nfs`
- If `iptables` is running, ensure `nfs` traffic is allowed through.

Next, on each ESXi server in the range, add this NFS share as a datastore. In brief, this is done by connecting to each ESXi server (or a central vCenter server) with the vSphere client, going to the Configuration tab for each ESXi server, choosing the Storage section, choosing to Add Storage, selecting the NFS datastore type, entering the hostname or IP address of the test server and entering `/proj/testing/tyrantshare` as the directory path. Name the datastore “tyrantshare”.

### 8.3 Verification

On a developer workstation (perhaps at the same location you used when verifying the initial range setup in the main part of this manual), we’ll run a test of event detection to verify it’s working.

- In the same directory where your tyworkflow and tybase clones are, clone the tyutils repository (`hg clone http://testserver.example.com:8000/tyutils`).
- 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.
- create the file `leafbag/tyutils/event_detection/config/main.conf` and set the following settings in it. Reference `leafbag/tyutils/event_detection/config/defaults/main.conf` for more details and example syntax:
  - In the tester section:
    - Set `esxi_evdet_ds_name` to the name of the NFS datastore you created in the previous section (e.g. `tyrantshare`).
    - Set `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`).
- In your tyutils clone, edit the file `leafbags/tyutils/event_detection/harness/test/evdet_test_plan.py`. In the `paramslots` variable, change `USERNAME` and `PASSWORD` to the username and password used to log in to each ESXi to take screenshots. Also in this file, remove the line under `paramslots` which sets `esxi_host`.
- Change directory to your tybase clone and run the following commands to link in tyutils:
 

```
ln -s ../../tyutils media/tyutils
ln -s ../../PIL_REPO leafbags/PIL (where PIL_REPO is whichever PIL repository you cloned)
```
- In your tyworkflow clone, run `media/tybase/media/tyutils/leafbag/make_links.sh`.
- Change directory to your tyworkflow clone and use remote commit to run the `evdet_test_plan`:
 

```
bin/remote_commit run
tyutils.event_detection.harness.test.evdet_test_plan
```

By default, this test plan will only run one combo. To have it run more, add the `samples` keyword argument on the end with the desired number of samples (e.g. `samples=5`).

- Browse to the overview Namespaces page (e.g. [http://testserver.example.com/overview/test\\_namespaces.php](http://testserver.example.com/overview/test_namespaces.php)) in a web browser and watch for your test(s) to complete. When a test completes, navigate to its testcase detail page (i.e. click on the namespace name, then on the plan name, then on the testcase name). You should see a few screenshots, one of which should show Internet Explorer. If this is the case, event detection is working properly.

## ***8.4 Finishing Up***

Now that you've developed a working tyutils configuration for the range, commit this change to the tyutils repository so others can get it automatically. From the root of your tyutils clone, run:

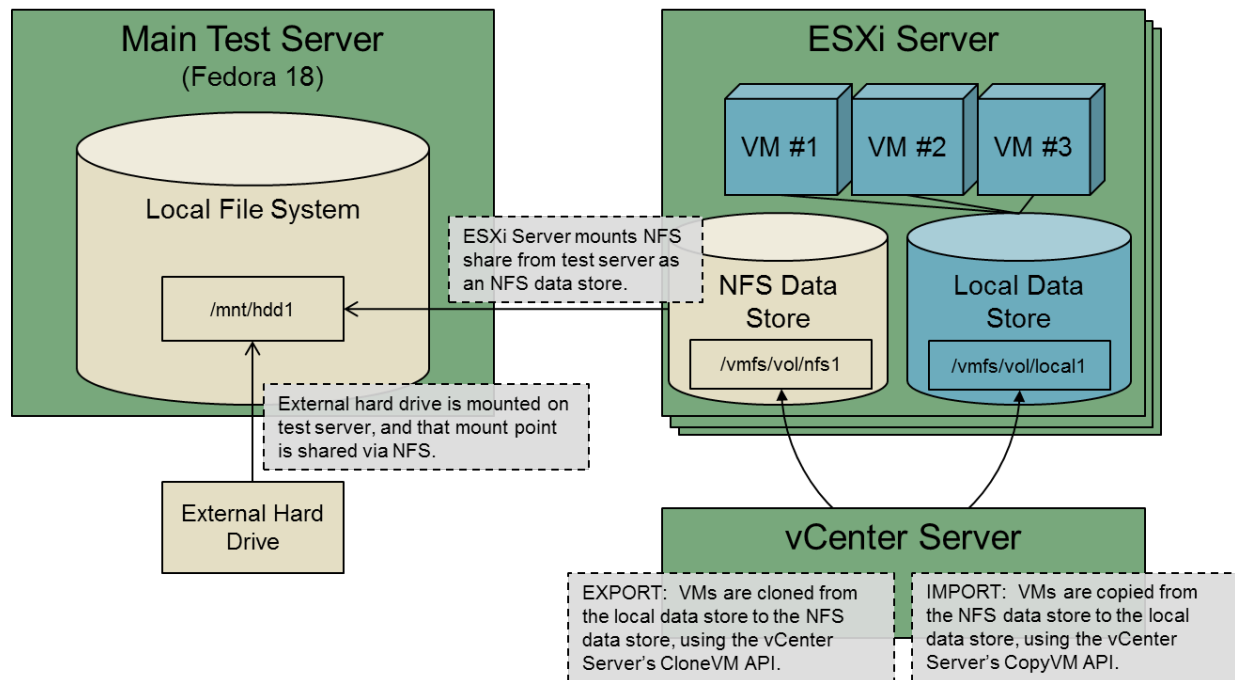
```
hg commit -m 'validated tyutils configuration'
hg push
```

## 9 Appendix D – Automatic Update and Resource Export/Import (Upsync)

The upsync system provides the ability to automatically update software on low-side, internet-connected resources (currently only virtual machines) and then move those resources over to a high-side range where they can be used for testing. Upsync functionality is broken into two areas: automatic update and resource export/import.

### 9.1 Upsync Setup and Administration

A typical upsync setup consists of two separate Overmind-controlled ranges: a low-side, internet-connected range on which automatic updates are performed and from which resources are exported; and a high-side testing range into which the low-side-exported resources are imported and on which testing is performed.



**IMPORTANT:** See the separate Upsync documentation for complete details on how to set up and administer an upsync system.

### 9.2 Upsync Usage

(NOTE: This section serves as a quick reference guide for routine upsync usage features. Additional options, detail, and explanation is included in the separate Upsync documentation.)

#### 9.2.1 Low Side Updating

Automatic updates against the low-side range will be run via Overmind with the `autoplan` tool.

To run the `update_for_export` leafnode against all resources in the range via `remote_commit`, run the following command from the root of `tyworkflow` on the developer workstation:

```
bin/remote_commit autorun upsync.updater.update_for_export -H '' samples=-1
```

The quoted empty string argument to `-H` means no filter for that host slot (i.e. match all resources). Note that certain field values require special quoting. See the separate user manual for more information.

### 9.2.2 Low-Side Exporting

After the low side has been set up and resources have been updated, you can perform an export of resources on an Overmind range by mounting the transfer drive, running the `export` command line tool, and then unmounting the transfer drive in preparation for moving it to the high side.

After mounting the transfer drive, use the `upsync export` tool to identify and stage resources that are destined for the high side. From the base `upsync` directory:

```
bin/export
```

You will be prompted to review the export machine list and enter Y or N to continue. The export process will not continue until it receives a user input response. Enter “y” to continue, or “n” to cancel. If you wish to bypass all prompts and always continue with the export process without user input, run the export process with the `force` option.

```
bin/export -f
```

When the export completes, the high-side import can begin. Unmount the transfer drive from the low-side, and carry it to the high side location.

### 9.2.3 High-Side Importing

Once you have exported resources on a transfer drive, you can import them to a high-side Overmind range by running the `import` command line tool. Before running the import tool, mount the transfer drive on the high side.

Run the tool with only the staging ground option.

```
bin/import -i /mnt/transfer-drive/20140117174347
```

In the beginning of the import process, before any actions are taken, you will be prompted to review the operations list and enter Y or N to continue. Operations will be performed in the order listed on output.

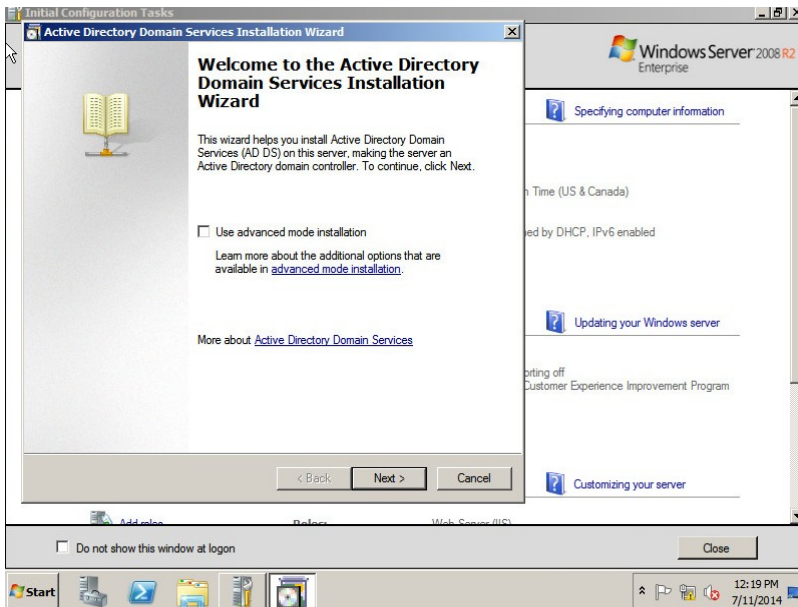
If you wish to bypass all prompts and always continue with the export process without user input, run the export process with the `force` option.

```
bin/import -i /mnt/transfer-drive/20140117174347 -f
```

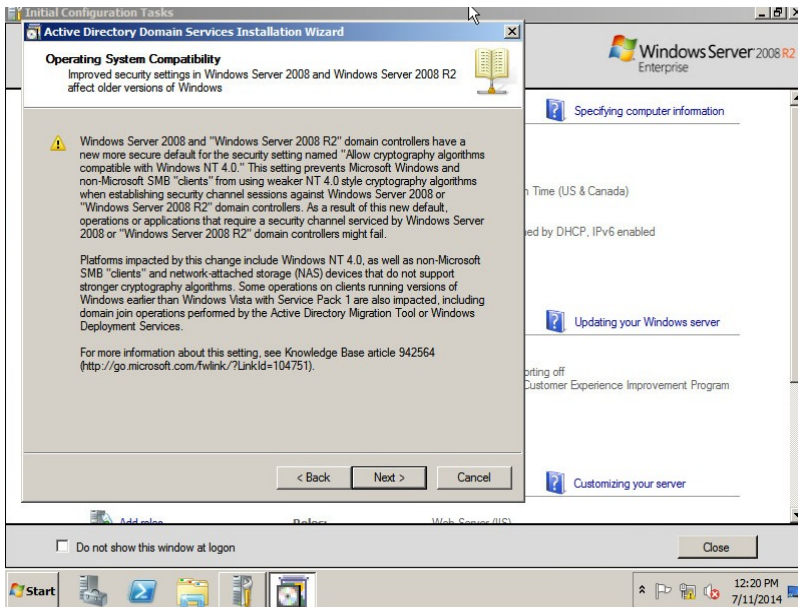
After all the import operations are finished, the result for each operation will appear on the terminal and in the log file.

## 10 Appendix F – Windows Active Directory Setup

1. Install 2k3/2k8 Server
2. Run “dcpromo”.
3. Click “next”.

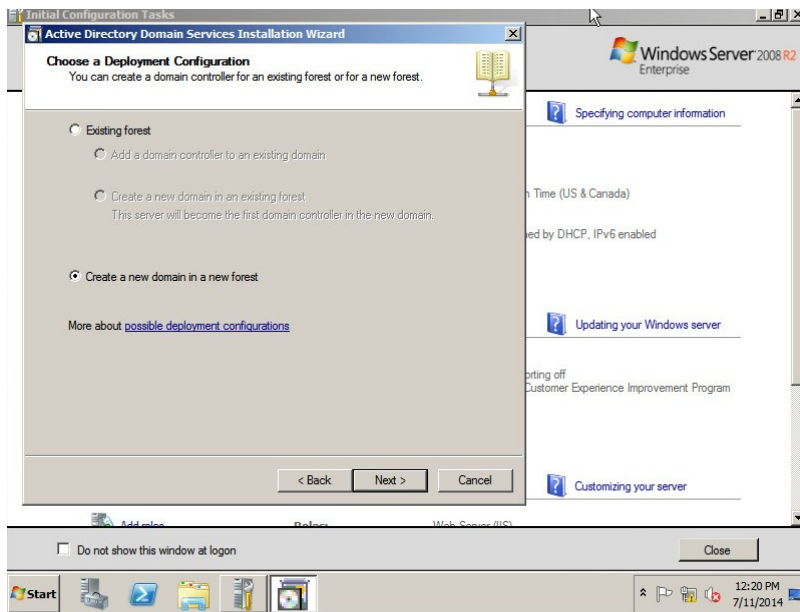


4. Click “next”.

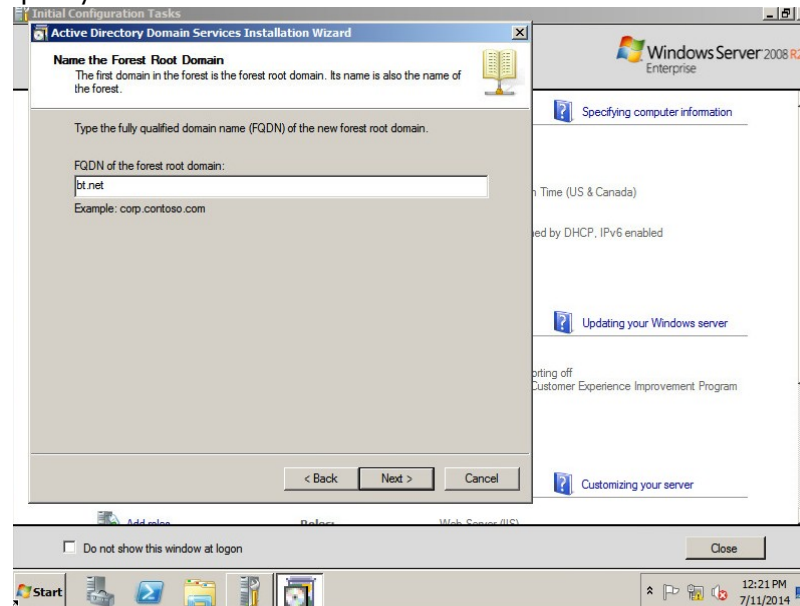


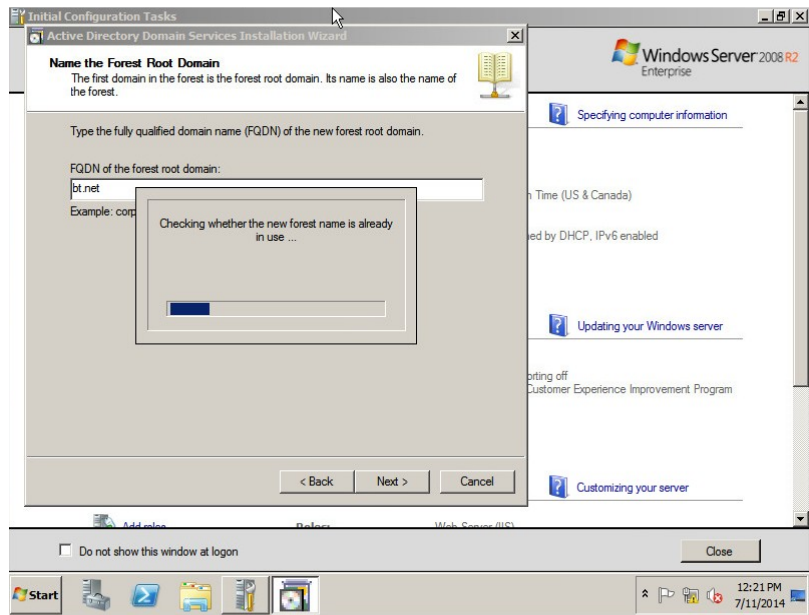


5. Select new domain if no trust relationships needed.

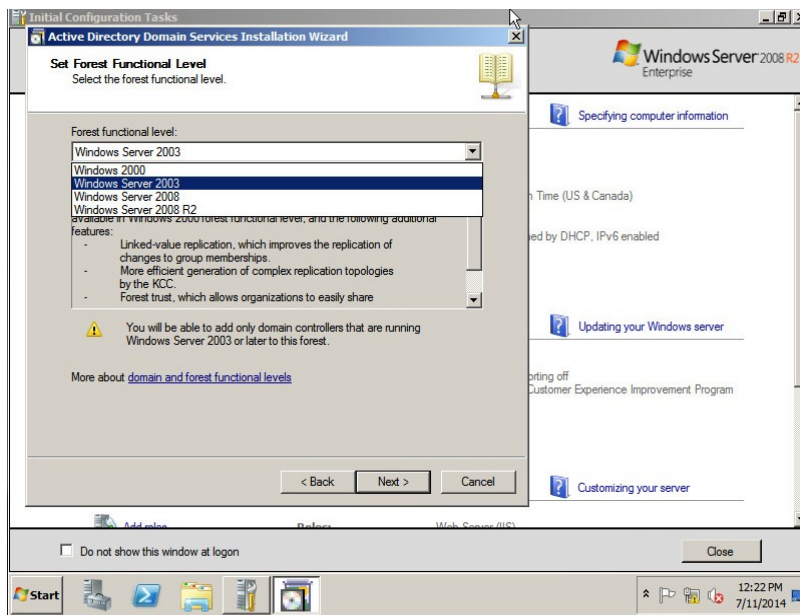


6. Specify full domain name.

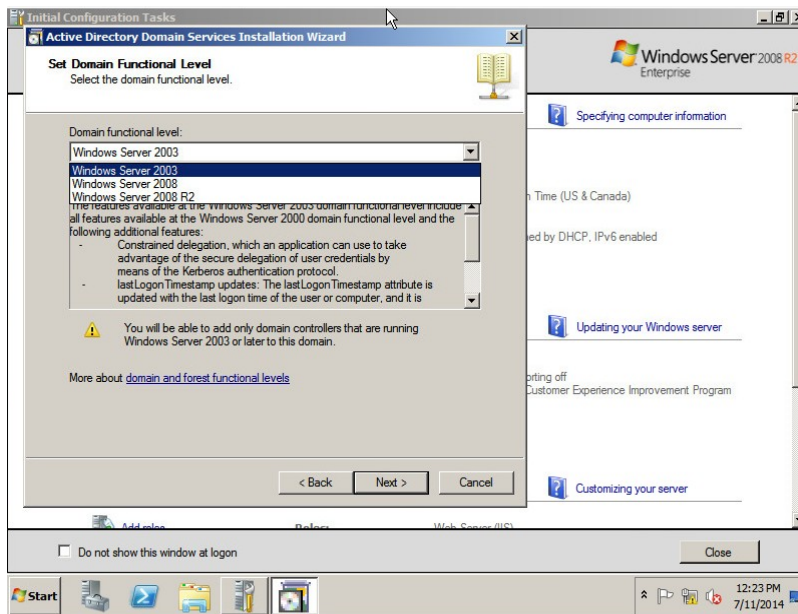




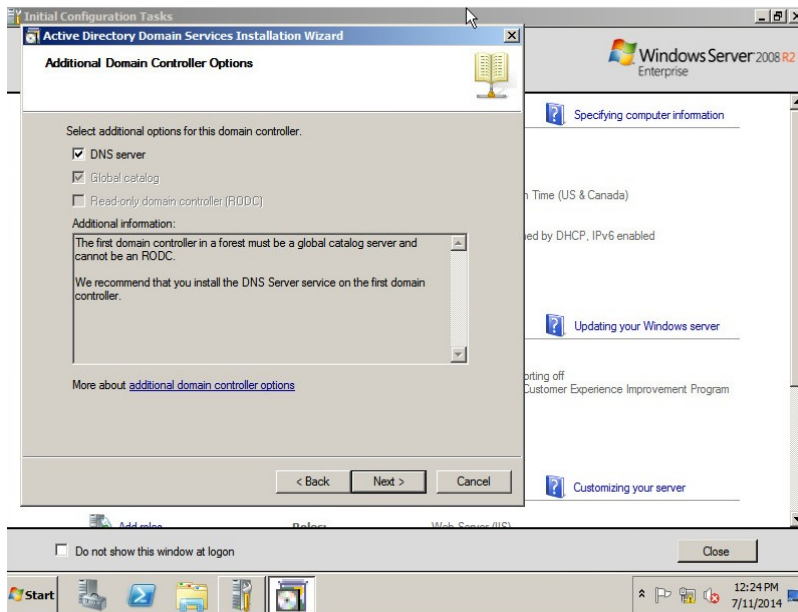
7. Select forest functional level.



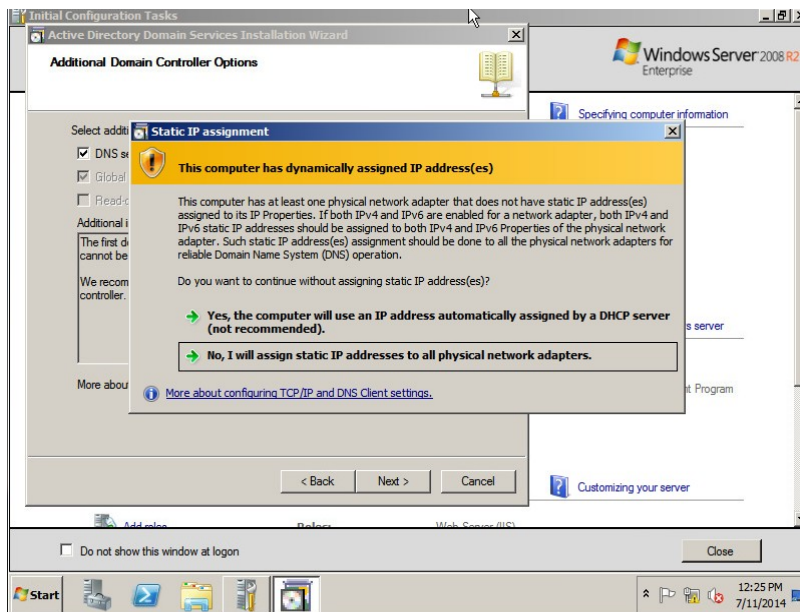
## 8. Select Domain Functional Level.



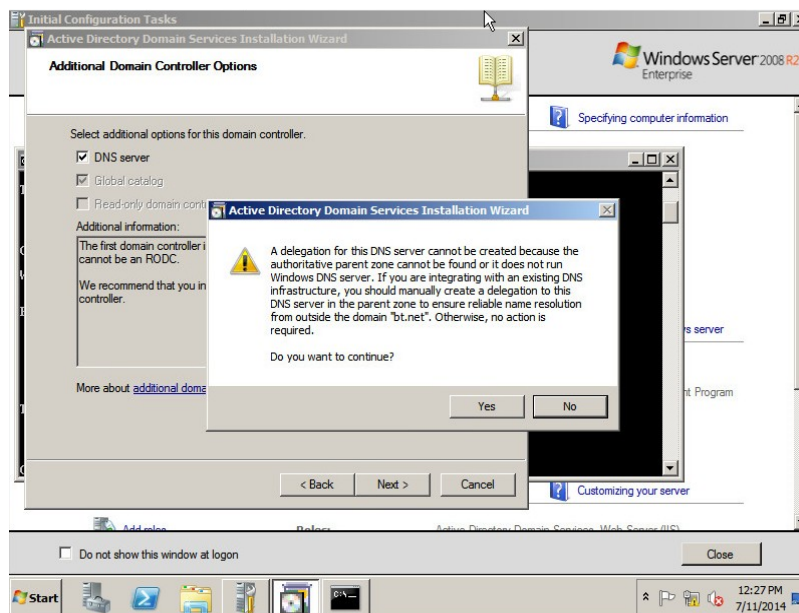
## 9. If this is the first/only Domain Controller, you must select DNS server.



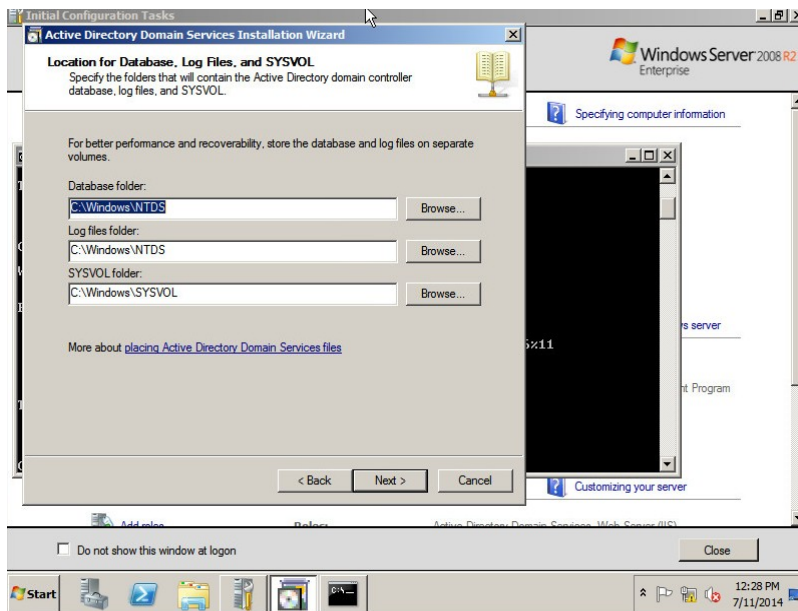
10. Configure the server with a static IP address. This is the best practice for Domain Controllers.



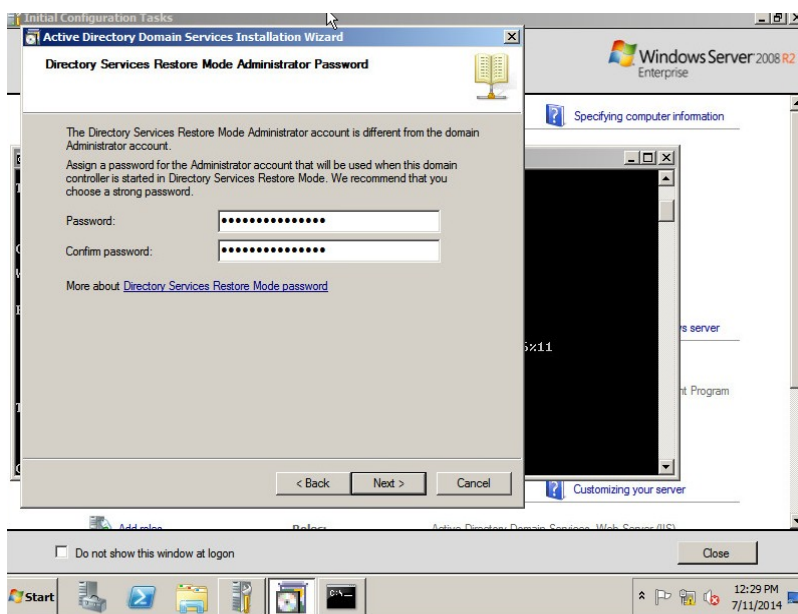
11. If this is a standalone network with no upstream DNS, select "yes" otherwise resolve upstream DNS issues.



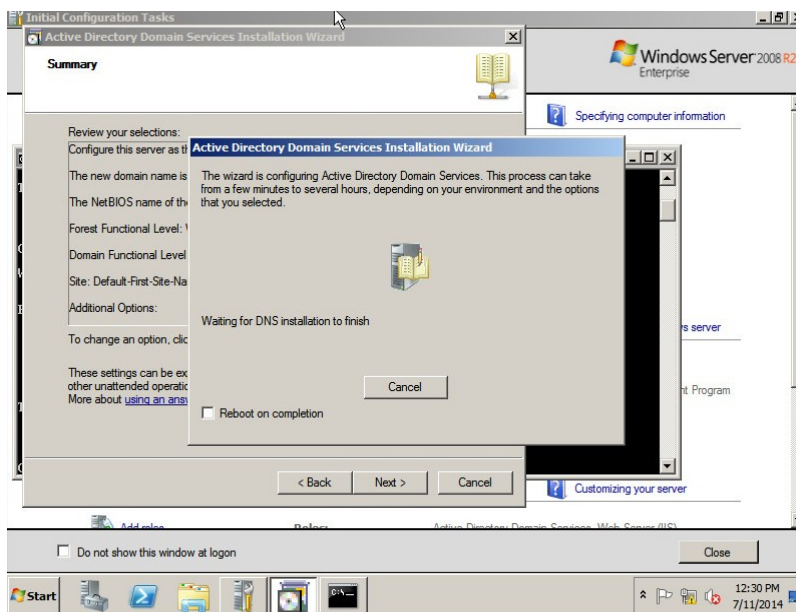
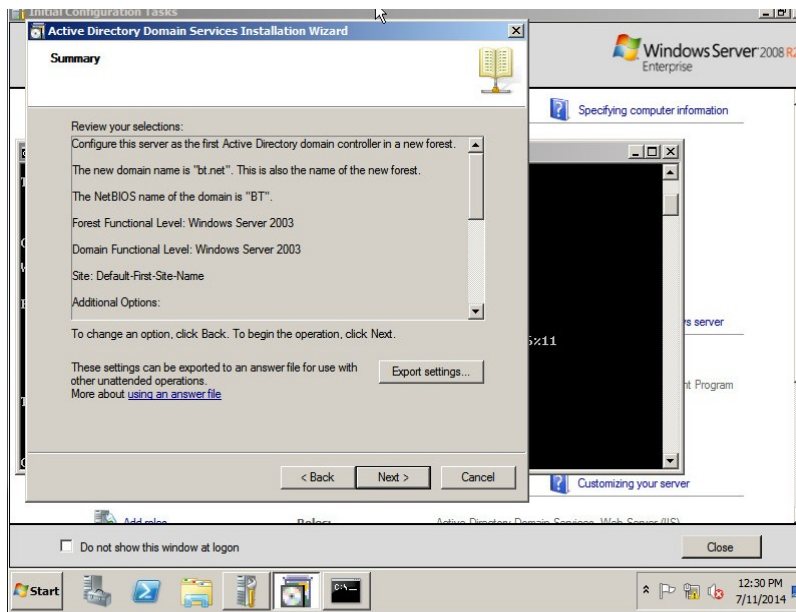
12. Select Defaults.



13. Enter password. Password must meet complexity requirements.

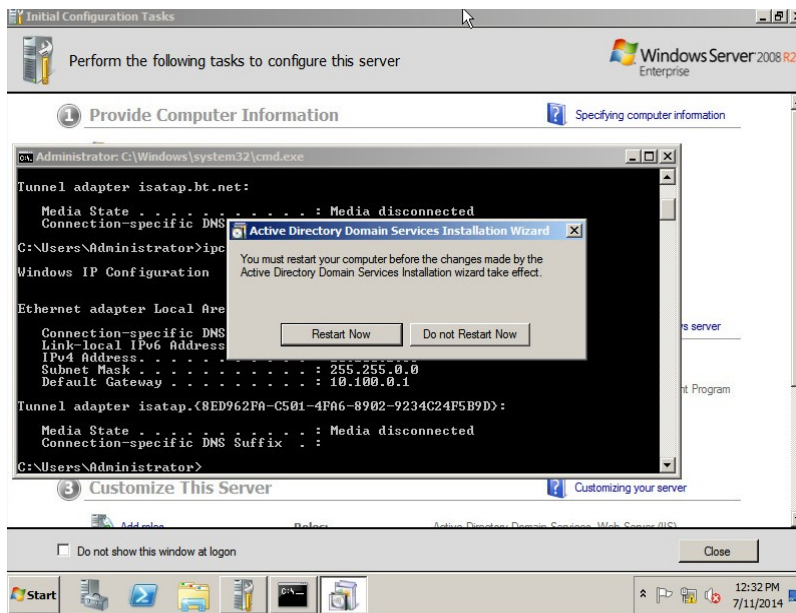
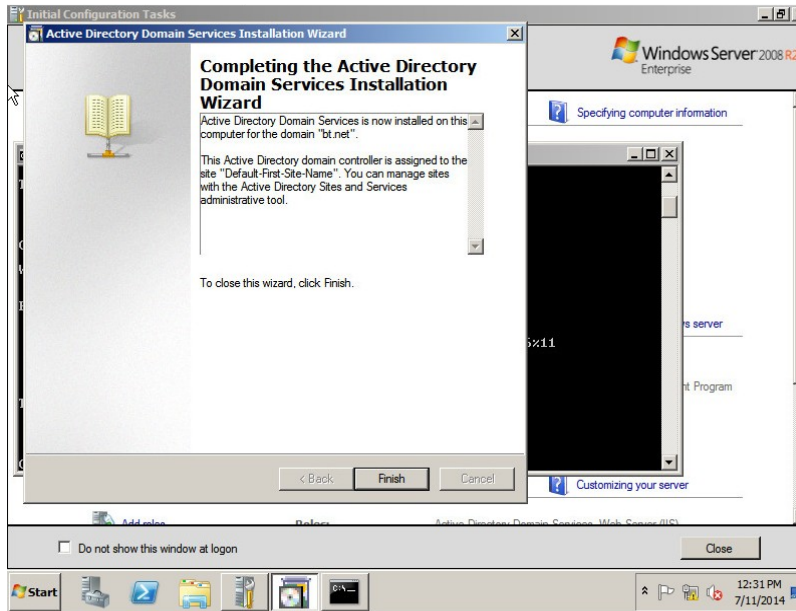


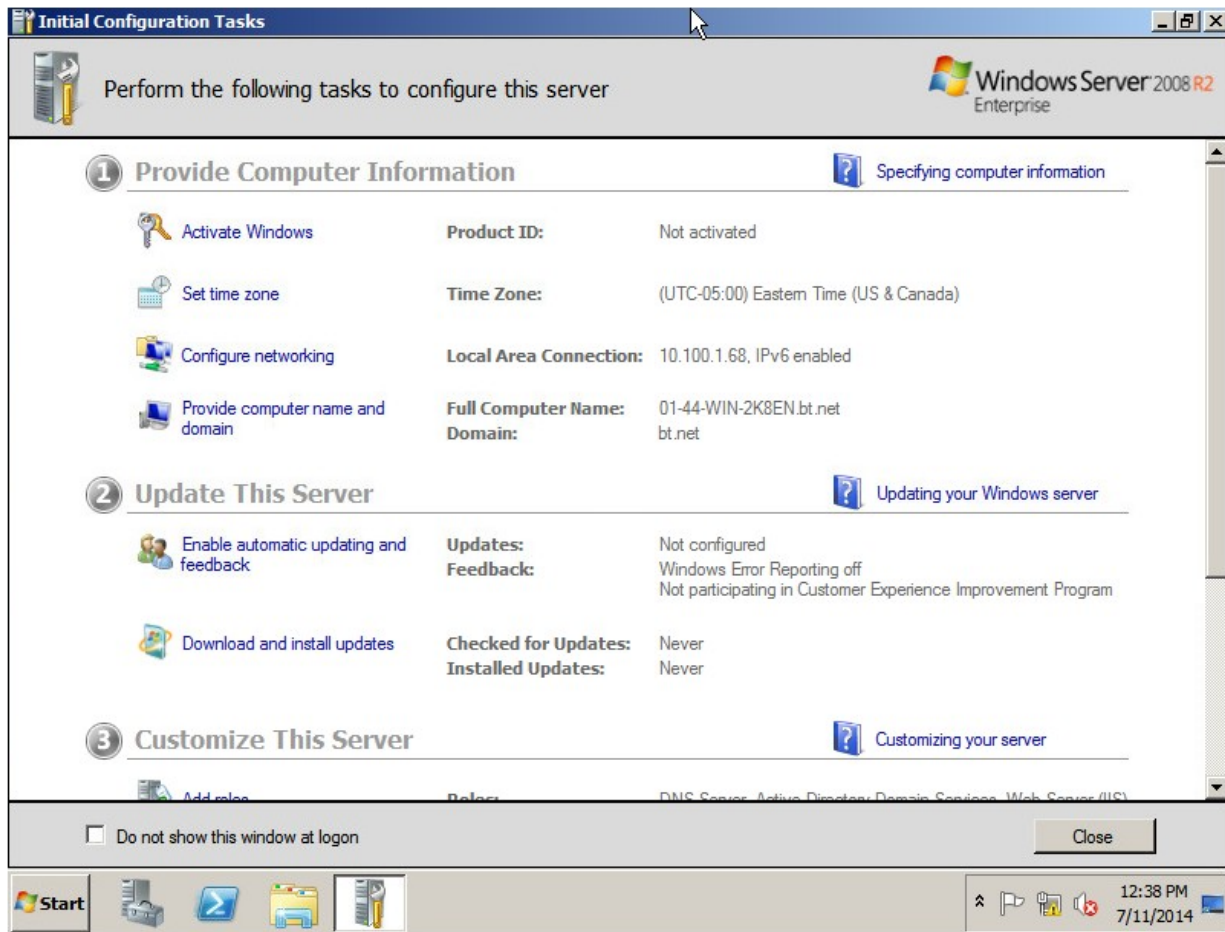
14. Review summary and click “next”.





15. Click Finish and restart when completed.







## 11 Appendix G – Joining Test Server to Active Directory Domain

This section outlines instructions for setting up a Linux machine to join Active Directory. The steps apply to Fedora 18 and newer.

1. Make sure the following ports are opened in the firewall settings:
  - TCP: 80, 88, 389
  - UDP: 88 (at least one of TCP/UDP ports 88 has to be open)

Also note that following ports are necessary for ipa-client working properly after enrollment:

- TCP: 464
- UDP: 464, 123 (if NTP enabled)

To do this, set Firewall by running the following commands:

```
firewall-cmd --add-port=80/tcp --permanent
```

```
firewall-cmd --add-port=88/tcp --permanent
```

```
firewall-cmd --add-port=389/tcp --permanent
```

```
firewall-cmd --add-port=464/udp --permanent
```

```
firewall-cmd --add-port=123/udp --permanent
```

2. Run the following commands to install packages and set ntpdate.

```
yum install realmd sssd gvfs ntpdate PackageKit sssd-tools
```

```
yum install samba-common ntpdate
```

3. Run the following commands to sync date to domain or ntp server.

```
ntpdate <domain_name or ntp server used by domain>
```

4. Ensure your computer name is set and is less than 15 characters. To do this run the following command:

```
hostnamectl set-hostname <new host name> --static
```

```
hostnamectl set-hostname <new host name> --pretty
```

```
hostnamectl set-hostname <new host name> --transient
```

5. Run the following command to join to domain: NOTE: you must use “administrator” credentials to join to Windows Active Directory.

```
realm join -v -U <domain_admin_username> <domain_name>
```

6. To view a full list of domain information run the following command:

```
realm list
```

Sample output is as follows:

```
bt.net
```

```
type: kerberos
realm-name: BT.NET
domain-name: bt.net
configured: kerberos-member
server-software: active-directory
client-software: sssd
required-package: sssd-tools
required-package: sssd
required-package: adcli
required-package: samba-common
login-formats: BT\%U
login-policy: allow-any-login
```

In this example, domain for this system is BT.NET of type Active-Directory. Login is “BT\<username>” and any valid user can login (allow-any-login).

Realm allows you to manage enrollment in Active Directory and manage permissions and configurations. The following is the output of running the “realm” command.

```
realm discover -v [realm-name]
```

```
Discover available realm
```

```
realm join -v [-U user] realm-name
```

```
Enroll this machine in a realm
```

```
realm leave -v [-U user] [realm-name]
```

```
Unenroll this machine from a realm
```

```
realm list
```

```
List known realms
```

```
realm permit [-a] [-R realm] user ...
```

```
 Permit user logins
```

```
realm deny [-a] [-R realm]
```

## 12 Appendix H – Securing Overview with Basic HTTP Authentication

This section outlines how to setup authorization in Apache in an LDAP/Active Directory environment. These instructions apply to Fedora servers.

1. Install httpd .

```
yum -y install httpd openldap mod_ldap mod_authnz_external
create a link for Perl
ln -s /usr/bin/perl /usr/local/bin/perl
```

2. Configure httpd. Open the httpd.conf file in a text editor.

```
vi /etc/httpd/conf/httpd.conf
```

3. Edit the following lines in httpd.conf.

line 55: Add modules to load

```
LoadModule ldap_module modules/mod_ldap.so
LoadModule authnz_ldap_module modules/mod_authnz_ldap.so
```

line 86: Admin's address

```
ServerAdmin admin@bt.net
```

line 95: uncomment and change to your server's name

```
ServerName spartacus.bt.net:80
```

line 144: change (enable CGI and disable Indexes)

```
Options FollowSymLinks ExecCGI
```

line 151: change

```
AllowOverride All
```

line 294: uncomment and add file-type that apache looks them CGI

```
AddHandler cgi-script .cgi .pl
```

add at the last

```
#server's header
```

```
ServerTokens Prod
```

```
define on
```

```
KeepAlive On
```

```
file name it can access only with directory's name
DirectoryIndex index.html index.cgi index.php
```

4. Configure httpd authentication for domain/ldap user groups for the Overview pages:

```
vi /etc/httpd/conf/httpd.conf
```

In the example httpd.conf file below,

- The user group "dart" is the general user of the system.
- The user group "dartadmin" is the DART Administrator group.
- Both groups need to be created on either the Active Directory Domain Controller or in the LDAP config:

```
...
```

```
<Directory "/var/www/html/overview">
 AuthName "private login message here."
 AuthType Basic
 AuthBasicProvider ldap
 AuthUserFile /dev/null
 AuthLDAPURL ldap://bt.net:389/DC=bt,DC=net?sAMAccountName?sub?
(objectClass=*)
 AuthLDAPBindDN admin@bt.net
 AuthLDAPBindPassword xxxxx
 AuthLDAPGroupAttributeIsDN on
 Require ldap-group cn="dart",cn="users",dc="bt",dc="net"
</Directory>
<Directory "/var/www/html/overview/admin">
 AuthName "private login message here."
 AuthType Basic
 AuthBasicProvider ldap
 AuthUserFile /dev/null
 AuthLDAPURL ldap://bt.net:389/DC=bt,DC=net?sAMAccountName?sub?
(objectClass=*)
 AuthLDAPBindDN admin@bt.net
 AuthLDAPBindPassword xxxxx
 AuthLDAPGroupAttributeIsDN on
 Require ldap-group cn="dartadmin",cn="users",dc="bt",dc="net"
</Directory>
...
```

5. Save the *httpd.conf* file and start/restart service.

```
systemctl restart httpd.service
```

6. Set service to start with server

```
systemctl enable httpd.service
```