# Satellite Ads, Inc.

## Auto-Scaling Satellite Control System

D085:CKM2

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## A. INTRODUCTION OF SOLUTION

### A.1. PURPOSE

With the release of their newest generation of space marketing satellites, Satellites Ads Inc. anticipates a spike in advertising demand, which this document aims to address by providing a solution for scaling with increased advertising demand.

### A.2. GOALS AND OBJECTIVES

Satellites Ads Inc. must achieve two goals and objectives. The first is an automated scaling solution for deploying satellite clusters as demand dictates. Four servers that can manage advertisements for up to 300 satellites make up these clusters. Satellite Ads may use up to 60 clusters to meet advertisement capacity during peak demand. The second requirement is monitoring the systems and using elastic services to scale the number of clusters required based on need.

### A.3. SCOPE

The proposed AWS Auto-Scaling Groups will monitor cluster metrics to determine when to scale up or scale down. First, the actual demand for core systems plus 10% and 10% core systems should always be available. Second, when the cluster reaches 300 satellites, a new scaled cluster is created to meet the demand. Furthermore, at least one scaled cluster should always be available. Third, as satellite demand declines, automation will decommission the clusters. Finally, whenever clusters are scaled up or down or errors occur, the system should email helpdesk@satelliteads.com.

### A.4. DESCRIPTION OF FUNCTIONALITY

Scaling up this method will necessitate the usage of a few different tools. Initially, the Automation Station will execute The Chef cookbooks. After the initial cluster is live, the EC2 instances will be enabled as members of the AWS Auto-Scaling Group and CloudWatch rules. For tracking and informational purposes, alerts will be provided to the support desk for any problems and scale events.

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# Satellite Ads Inc.
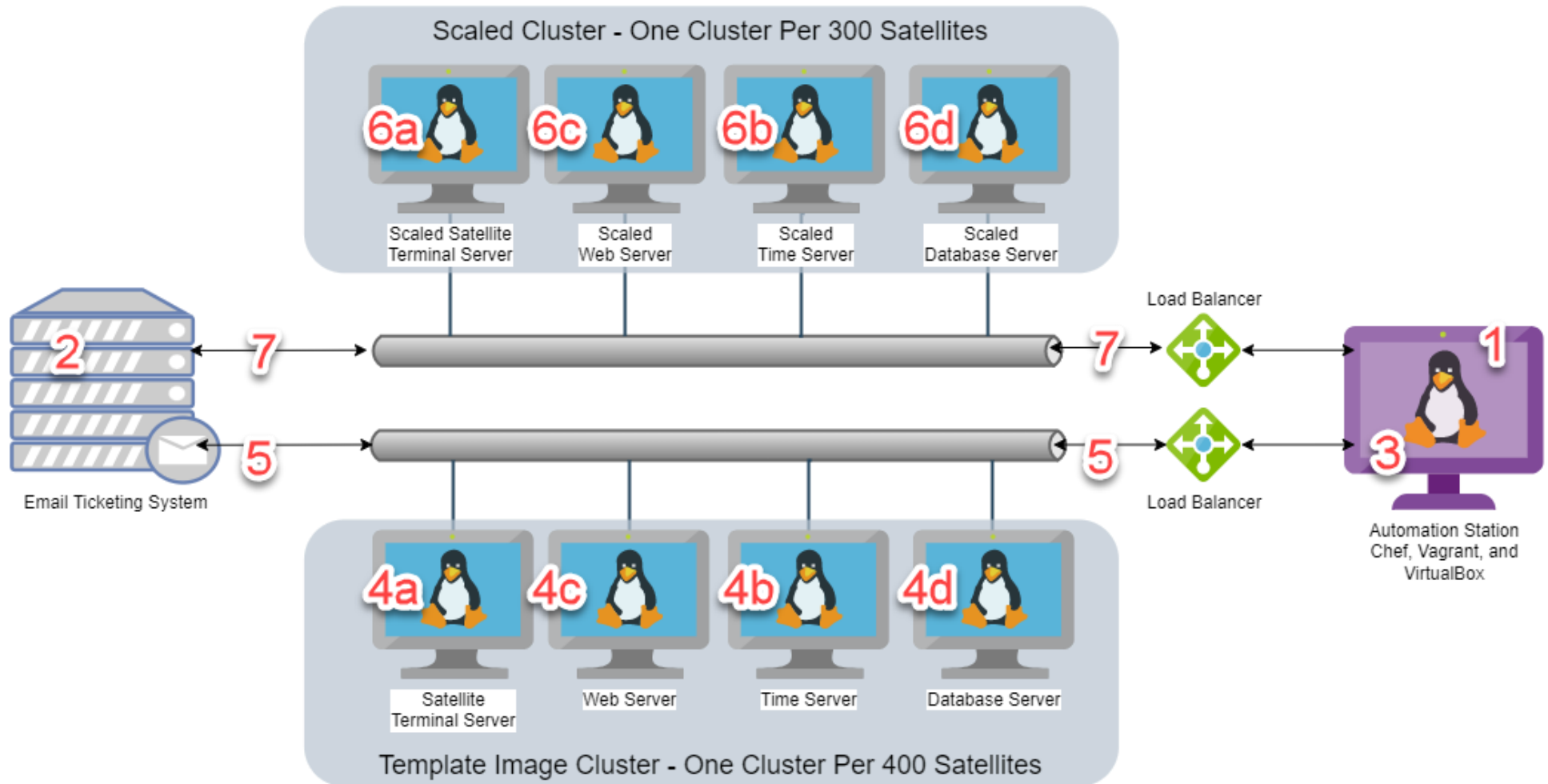
1. The Automation Station is deployed with Chef and Vagrant installed to deploy the initial cluster and scale automatically as demand increases.
2. The Email Ticketing system is created to properly route messages for scaling actions and errors.
3. The kitchen.yml file on the Automation Station has been configured to deploy all servers in the clusters and will be implemented with the kitchen create and kitchen converge commands.
4. For the initial cluster, these servers are created:
    a. Satellite Terminal Server
    b. Master Time Server
    c. Web Server
    d. Database Server
5. A message is passed to the Automation Station and the email ticketing system with a status update.
6. The Automation Station deploys satellite control cluster and these servers are created:
    a. Scaled Satellite Terminal Server
    b. Scaled Master Time Server
    c. Scaled Web Server
    d. Scaled Database Server
7. After 300 Satellites are deployed, a message is sent to the Automation Station to scale up another cluster as in step 6.

## C. AUTOMATION SCRIPT

Copy your automation script from part C here (text only):

```
# Ryan Peterson Student ID: 000980429
---
# Developed locally using Vagrant driver
driver:
  name: vagrant

# Using Chef Zero as an in-memory Chef server for testing purposes
provisioner:
  name: chef_zero
  product_name: chef
  product_version: 14.12.9

# Using Chef InSpec as the automated testing framework
verifier:
  name: inspec

# Operating System that will be used by the virtual machines
platforms:
  - name: centos-7

# For testing purposes, all servers will be built with the learn_chef_httpd
# cookbook sourced from GitHub at: https://github.com/chef/learn_chef_httpd
suites:

# Satellite Terminal Server
  - name: satellite_terminal_server
    driver:
      vm_hostname: terminal.satelliteads.local
    run_list:
      - recipe[learn_chef_httpd::default]
```

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```yaml
      attributes:

# Master Time Server
  - name: master_time_server
    driver:
      vm_hostname: time.satelliteads.local
    run_list:
      - recipe[learn_chef_httpd::default]
    attributes:

# Web Server
  - name: web_server
    driver:
      vm_hostname: web.satelliteads.local
    run_list:
      - recipe[learn_chef_httpd::default]
    attributes:

# Database Server
  - name: database_server
    driver:
      vm_hostname: database.satelliteads.local
    run_list:
      - recipe[learn_chef_httpd::default]
    attributes:

# Scaled Satellite Terminal Server
  - name: scaled_satellite_terminal_server
    driver:
      vm_hostname: scaled-terminal.satelliteads.local
    run_list:
      - recipe[learn_chef_httpd::default]
    attributes:

# Scaled Web Server
  - name: scaled_web_server
    driver:
      vm_hostname: scaled-web.satelliteads.local
    run_list:
      - recipe[learn_chef_httpd::default]
    attributes:

# Scaled Time Server
  - name: scaled_time_server
    driver:
      vm_hostname: scaled-time.satelliteads.local
    run_list:
      - recipe[learn_chef_httpd::default]
    attributes:

# Scaled Database Server
  - name: scaled_database_server
    driver:
      vm_hostname: scaled-database.satelliteads.local
    run_list:
      - recipe[learn_chef_httpd::default]
    Attributes:
```

Screenshot showing that the automation script executes without errors (from part D):

**kitchen list**

kitchen-list.png

```
[astromined@chef learn_chef_httpd]$ kitchen list
Instance                                   Driver   Provisioner  Verifier  Transport  Last Action    Last Error
satellite-terminal-server-centos-7         Vagrant  ChefInfra    Inspec    Ssh        <Not Created>  <None>
master-time-server-centos-7                Vagrant  ChefInfra    Inspec    Ssh        <Not Created>  <None>
web-server-centos-7                        Vagrant  ChefInfra    Inspec    Ssh        <Not Created>  <None>
database-server-centos-7                   Vagrant  ChefInfra    Inspec    Ssh        <Not Created>  <None>
scaled-satellite-terminal-server-centos-7  Vagrant  ChefInfra    Inspec    Ssh        <Not Created>  <None>
scaled-web-server-centos-7                 Vagrant  ChefInfra    Inspec    Ssh        <Not Created>  <None>
scaled-time-server-centos-7                Vagrant  ChefInfra    Inspec    Ssh        <Not Created>  <None>
scaled-database-server-centos-7            Vagrant  ChefInfra    Inspec    Ssh        <Not Created>  <None>
```

**kitchen create**

kitchen-create-full.png

```
[astromined@chef learn_chef_httpd]$ kitchen create
-----> Starting Test Kitchen (v3.2.2)
-----> Creating <satellite-terminal-server-centos-7>...
       Bringing machine 'default' up with 'virtualbox' provider...
       ==> default: Importing base box 'bento/centos-7'...
==> default: Matching MAC address for NAT networking...
       ==> default: Checking if box 'bento/centos-7' version '202110.25.0' is up to date...
       ==> default: Setting the name of the VM: kitchen-learn_chef_httpd-satellite-terminal-server-centos-7-e3f409d6-6e6c-4593-ab3e-265bfb5f7508
       ==> default: Clearing any previously set network interfaces...
       ==> default: Preparing network interfaces based on configuration...
           default: Adapter 1: nat
       ==> default: Forwarding ports...
           default: 22 (guest) => 2222 (host) (adapter 1)
       ==> default: Running 'pre-boot' VM customizations...
       ==> default: Booting VM...
       ==> default: Waiting for machine to boot. This may take a few minutes...
           default: SSH address: 127.0.0.1:2222
           default: SSH username: vagrant
           default: SSH auth method: private key
           default: Warning: Connection reset. Retrying...
           default:
           default: Vagrant insecure key detected. Vagrant will automatically replace
           default: this with a newly generated keypair for better security.
           default:
           default: Inserting generated public key within guest...
           default: Removing insecure key from the guest if it's present...
           default: Key inserted! Disconnecting and reconnecting using new SSH key...
       ==> default: Machine booted and ready!
       ==> default: Checking for guest additions in VM...
       ==> default: Setting hostname...
       ==> default: Mounting shared folders...
           default: /tmp/omnibus/cache => /home/astromined/.kitchen/cache
       ==> default: Machine not provisioned because `--no-provision` is specified.
       [SSH] Established
       Vagrant instance <satellite-terminal-server-centos-7> created.
       Finished creating <satellite-terminal-server-centos-7> (0m58.44s).
-----> Creating <master-time-server-centos-7>...
       Bringing machine 'default' up with 'virtualbox' provider...
       ==> default: Importing base box 'bento/centos-7'...
==> default: Matching MAC address for NAT networking...
       ==> default: Checking if box 'bento/centos-7' version '202110.25.0' is up to date...
       ==> default: Setting the name of the VM: kitchen-learn_chef_httpd-master-time-server-centos-7-5e8132be-6d9c-47ab-a7ca-513785eb3c87
       ==> default: Fixed port collision for 22 => 2222. Now on port 2200.
       ==> default: Clearing any previously set network interfaces...
       ==> default: Preparing network interfaces based on configuration...
           default: Adapter 1: nat
       ==> default: Forwarding ports...
           default: 22 (guest) => 2200 (host) (adapter 1)
       ==> default: Running 'pre-boot' VM customizations...
       ==> default: Booting VM...
       ==> default: Waiting for machine to boot. This may take a few minutes...
           default: SSH address: 127.0.0.1:2200
           default: SSH username: vagrant
           default: SSH auth method: private key
           default: Warning: Connection reset. Retrying...
           default:
           default: Vagrant insecure key detected. Vagrant will automatically replace
           default: this with a newly generated keypair for better security.
           default:
           default: Inserting generated public key within guest...
           default: Removing insecure key from the guest if it's present...
           default: Key inserted! Disconnecting and reconnecting using new SSH key...
       ==> default: Machine booted and ready!
       ==> default: Checking for guest additions in VM...
       ==> default: Setting hostname...
       ==> default: Mounting shared folders...
           default: /tmp/omnibus/cache => /home/astromined/.kitchen/cache
       ==> default: Machine not provisioned because `--no-provision` is specified.
       [SSH] Established
       Vagrant instance <master-time-server-centos-7> created.
       Finished creating <master-time-server-centos-7> (0m57.76s).
-----> Creating <web-server-centos-7>...
```

```
        Vagrant instance <master-time-server-centos-7> created.
        Finished creating <master-time-server-centos-7> (0m57.76s).
-----> Creating <web-server-centos-7>...
        Bringing machine 'default' up with 'virtualbox' provider...
        ==> default: Importing base box 'bento/centos-7'...
==> default: Matching MAC address for NAT networking...
        ==> default: Checking if box 'bento/centos-7' version '202110.25.0' is up to date...
        ==> default: Setting the name of the VM: kitchen-learn_chef_httpd-web-server-centos-7-5c52f9ae-0dff-4873-b07a-f2b2d72113b0
        ==> default: Fixed port collision for 22 => 2222. Now on port 2201.
        ==> default: Clearing any previously set network interfaces...
        ==> default: Preparing network interfaces based on configuration...
        default: Adapter 1: nat
        ==> default: Forwarding ports...
        default: 22 (guest) => 2201 (host) (adapter 1)
        ==> default: Running 'pre-boot' VM customizations...
        ==> default: Booting VM...
        ==> default: Waiting for machine to boot. This may take a few minutes...
        default: SSH address: 127.0.0.1:2201
        default: SSH username: vagrant
        default: SSH auth method: private key
        default:
        default: Vagrant insecure key detected. Vagrant will automatically replace
        default: this with a newly generated keypair for better security.
        default:
        default: Inserting generated public key within guest...
        default: Removing insecure key from the guest if it's present...
        default: Key inserted! Disconnecting and reconnecting using new SSH key...
        ==> default: Machine booted and ready!
        ==> default: Checking for guest additions in VM...
        ==> default: Setting hostname...
        ==> default: Mounting shared folders...
        default: /tmp/omnibus/cache => /home/astromined/.kitchen/cache
        ==> default: Machine not provisioned because `--no-provision` is specified.
        [SSH] Established
        Vagrant instance <web-server-centos-7> created.
        Finished creating <web-server-centos-7> (1m4.99s).
-----> Creating <database-server-centos-7>...
        Bringing machine 'default' up with 'virtualbox' provider...
        ==> default: Importing base box 'bento/centos-7'...
==> default: Matching MAC address for NAT networking...
        ==> default: Checking if box 'bento/centos-7' version '202110.25.0' is up to date...
        ==> default: Setting the name of the VM: kitchen-learn_chef_httpd-database-server-centos-7-cbb884ea-a45c-46e5-85bb-9ba616b7ba00
        ==> default: Fixed port collision for 22 => 2222. Now on port 2202.
        ==> default: Clearing any previously set network interfaces...
        ==> default: Preparing network interfaces based on configuration...
        default: Adapter 1: nat
        ==> default: Forwarding ports...
        default: 22 (guest) => 2202 (host) (adapter 1)
        ==> default: Running 'pre-boot' VM customizations...
        ==> default: Booting VM...
        ==> default: Waiting for machine to boot. This may take a few minutes...
        default: SSH address: 127.0.0.1:2202
        default: SSH username: vagrant
        default: SSH auth method: private key
        default:
        default: Vagrant insecure key detected. Vagrant will automatically replace
        default: this with a newly generated keypair for better security.
        default:
        default: Inserting generated public key within guest...
        default: Removing insecure key from the guest if it's present...
        default: Key inserted! Disconnecting and reconnecting using new SSH key...
        ==> default: Machine booted and ready!
        ==> default: Checking for guest additions in VM...
        ==> default: Setting hostname...
        ==> default: Mounting shared folders...
        default: /tmp/omnibus/cache => /home/astromined/.kitchen/cache
        ==> default: Machine not provisioned because `--no-provision` is specified.
        [SSH] Established
        Vagrant instance <database-server-centos-7> created.
        Finished creating <database-server-centos-7> (1m4.42s).
-----> Creating <scaled-satellite-terminal-server-centos-7>...
        Bringing machine 'default' up with 'virtualbox' provider...
        ==> default: Importing base box 'bento/centos-7'...
==> default: Matching MAC address for NAT networking...
        ==> default: Checking if box 'bento/centos-7' version '202110.25.0' is up to date...
        ==> default: Setting the name of the VM: kitchen-learn_chef_httpd-scaled-satellite-terminal-server-centos-7-ca9cc638-430b-4ef4-aad3-8bc33ea3c79
        ==> default: Fixed port collision for 22 => 2222. Now on port 2203.
        ==> default: Clearing any previously set network interfaces...
        ==> default: Preparing network interfaces based on configuration...
        default: Adapter 1: nat
        ==> default: Forwarding ports...
        default: 22 (guest) => 2203 (host) (adapter 1)
        ==> default: Running 'pre-boot' VM customizations...
        ==> default: Booting VM...
        ==> default: Waiting for machine to boot. This may take a few minutes...
        default: SSH address: 127.0.0.1:2203
        default: SSH username: vagrant
        default: SSH auth method: private key
        default: Warning: Connection reset. Retrying...
        default:
        default: Vagrant insecure key detected. Vagrant will automatically replace
        default: this with a newly generated keypair for better security.
        default:
        default: Inserting generated public key within guest...
        default: Removing insecure key from the guest if it's present...
        default: Key inserted! Disconnecting and reconnecting using new SSH key...
        ==> default: Machine booted and ready!
        ==> default: Checking for guest additions in VM...
        ==> default: Setting hostname...
        ==> default: Mounting shared folders...
        default: /tmp/omnibus/cache => /home/astromined/.kitchen/cache
        ==> default: Machine not provisioned because `--no-provision` is specified.
        [SSH] Established
        Vagrant instance <scaled-satellite-terminal-server-centos-7> created.
        Finished creating <scaled-satellite-terminal-server-centos-7> (0m57.41s).
-----> Creating <scaled-web-server-centos-7>...
        Bringing machine 'default' up with 'virtualbox' provider...
```

```
        Vagrant instance <scaled-satellite-terminal-server-centos-7> created.
        Finished creating <scaled-satellite-terminal-server-centos-7> (0m57.41s).
-----> Creating <scaled-web-server-centos-7>...
        Bringing machine 'default' up with 'virtualbox' provider...
        ==> default: Importing base box 'bento/centos-7'...
==> default: Matching MAC address for NAT networking...
        ==> default: Checking if box 'bento/centos-7' version '202110.25.0' is up to date...
        ==> default: Setting the name of the VM: kitchen-learn_chef_httpd-scaled-web-server-centos-7-bd94fe84-5342-476d-a00d-d8969eb2135b
        ==> default: Fixed port collision for 22 => 2222. Now on port 2204.
        ==> default: Clearing any previously set network interfaces...
        ==> default: Preparing network interfaces based on configuration...
            default: Adapter 1: nat
        ==> default: Forwarding ports...
            default: 22 (guest) => 2204 (host) (adapter 1)
        ==> default: Running 'pre-boot' VM customizations...
        ==> default: Booting VM...
        ==> default: Waiting for machine to boot. This may take a few minutes...
            default: SSH address: 127.0.0.1:2204
            default: SSH username: vagrant
            default: SSH auth method: private key
            default:
            default: Vagrant insecure key detected. Vagrant will automatically replace
            default: this with a newly generated keypair for better security.
            default:
            default: Inserting generated public key within guest...
            default: Removing insecure key from the guest if it's present...
            default: Key inserted! Disconnecting and reconnecting using new SSH key...
        ==> default: Machine booted and ready!
        ==> default: Checking for guest additions in VM...
        ==> default: Setting hostname...
        ==> default: Mounting shared folders...
            default: /tmp/omnibus/cache => /home/astromined/.kitchen/cache
        ==> default: Machine not provisioned because `--no-provision` is specified.
        [SSH] Established
        Vagrant instance <scaled-web-server-centos-7> created.
        Finished creating <scaled-web-server-centos-7> (1m4.59s).
-----> Creating <scaled-time-server-centos-7>...
        Bringing machine 'default' up with 'virtualbox' provider...
        ==> default: Importing base box 'bento/centos-7'...
==> default: Matching MAC address for NAT networking...
        ==> default: Checking if box 'bento/centos-7' version '202110.25.0' is up to date...
        ==> default: Setting the name of the VM: kitchen-learn_chef_httpd-scaled-time-server-centos-7-51276557-b693-4838-94b7-ceb494559433
        ==> default: Fixed port collision for 22 => 2222. Now on port 2205.
        ==> default: Clearing any previously set network interfaces...
        ==> default: Preparing network interfaces based on configuration...
            default: Adapter 1: nat
        ==> default: Forwarding ports...
            default: 22 (guest) => 2205 (host) (adapter 1)
        ==> default: Running 'pre-boot' VM customizations...
        ==> default: Booting VM...
        ==> default: Waiting for machine to boot. This may take a few minutes...
            default: SSH address: 127.0.0.1:2205
            default: SSH username: vagrant
            default: SSH auth method: private key
            default:
            default: Vagrant insecure key detected. Vagrant will automatically replace
            default: this with a newly generated keypair for better security.
            default:
            default: Inserting generated public key within guest...
            default: Removing insecure key from the guest if it's present...
            default: Key inserted! Disconnecting and reconnecting using new SSH key...
        ==> default: Machine booted and ready!
        ==> default: Checking for guest additions in VM...
        ==> default: Setting hostname...
        ==> default: Mounting shared folders...
            default: /tmp/omnibus/cache => /home/astromined/.kitchen/cache
        ==> default: Machine not provisioned because `--no-provision` is specified.
        [SSH] Established
        Vagrant instance <scaled-time-server-centos-7> created.
        Finished creating <scaled-time-server-centos-7> (1m7.97s).
-----> Creating <scaled-database-server-centos-7>...
        Bringing machine 'default' up with 'virtualbox' provider...
        ==> default: Importing base box 'bento/centos-7'...
==> default: Matching MAC address for NAT networking...
        ==> default: Checking if box 'bento/centos-7' version '202110.25.0' is up to date...
        ==> default: Setting the name of the VM: kitchen-learn_chef_httpd-scaled-database-server-centos-7-68d11e5a-b07d-46f0-83bb-44a18b608d4f
        ==> default: Fixed port collision for 22 => 2222. Now on port 2206.
        ==> default: Clearing any previously set network interfaces...
        ==> default: Preparing network interfaces based on configuration...
            default: Adapter 1: nat
        ==> default: Forwarding ports...
            default: 22 (guest) => 2206 (host) (adapter 1)
        ==> default: Running 'pre-boot' VM customizations...
        ==> default: Booting VM...
        ==> default: Waiting for machine to boot. This may take a few minutes...
            default: SSH address: 127.0.0.1:2206
            default: SSH username: vagrant
            default: SSH auth method: private key
            default:
            default: Vagrant insecure key detected. Vagrant will automatically replace
            default: this with a newly generated keypair for better security.
            default:
            default: Inserting generated public key within guest...
            default: Removing insecure key from the guest if it's present...
            default: Key inserted! Disconnecting and reconnecting using new SSH key...
        ==> default: Machine booted and ready!
        ==> default: Checking for guest additions in VM...
        ==> default: Setting hostname...
        ==> default: Mounting shared folders...
            default: /tmp/omnibus/cache => /home/astromined/.kitchen/cache
        ==> default: Machine not provisioned because `--no-provision` is specified.
        [SSH] Established
        Vagrant instance <scaled-database-server-centos-7> created.
        Finished creating <scaled-database-server-centos-7> (1m9.06s).
-----> Test Kitchen is finished. (8m26.16s)
[astromined@chef learn_chef_httpd]$
```

**kitchen converge**

kitchen-converge-full.png

```
[astromined@chef learn_chef_httpd]$ kitchen converge
-----> Starting Test Kitchen (v3.2.2)
-----> Converging <satellite-terminal-server-centos-7>...
       Preparing files for transfer
       Preparing dna.json
       Resolving cookbook dependencies with Berkshelf 7.2.2...
       Removing non-cookbook files before transfer
       Preparing validation.pem
       Preparing client.rb
       el 7 x86_64
       Getting information for chef stable 14.12.9 for el...
       downloading https://omnitruck.chef.io/stable/chef/metadata?v=14.12.9&p=el&pv=7&m=x86_64
         to file /tmp/kitchen/metadata.txt
       trying curl...
       sha1     0c987093a78f7a7c70e635301eb8f82f8f36c4a7
       sha256   749a0550b220a2a50ce7744eb32ab8959840cb3d870cc19e58e10bd86726693a
       url      https://packages.chef.io/files/stable/chef/14.12.9/el/7/chef-14.12.9-1.el7.x86_64.rpm
       version  14.12.9
       downloaded metadata file looks valid...
       /tmp/omnibus/cache/chef-14.12.9-1.el7.x86_64.rpm exists
       Comparing checksum with sha256sum...
       Installing chef 14.12.9
       installing with rpm...
       warning: /tmp/omnibus/cache/chef-14.12.9-1.el7.x86_64.rpm: Header V4 DSA/SHA1 Signature, key ID 83ef826a: NOKEY
       Preparing...                          ############################### [100%]
       Updating / installing...
          1:chef-14.12.9-1.el7               ############################### [100%]
       Thank you for installing Chef!
       Transferring files to <satellite-terminal-server-centos-7>
       Starting Chef Client, version 14.12.9
       Creating a new client identity for satellite-terminal-server-centos-7 using the validator key.
       resolving cookbooks for run list: ["learn_chef_httpd::default"]
       Synchronizing Cookbooks:
         - learn_chef_httpd (0.1.0)
       Installing Cookbook Gems:
       Compiling Cookbooks...
       Converging 5 resources
       Recipe: learn_chef_httpd::default
         * yum_package[httpd] action install
           - install version 0:2.4.6-97.el7.centos.5.x86_64 of package httpd
         * service[httpd] action enable
           - enable service service[httpd]
         * service[httpd] action start
           - start service service[httpd]
         * group[web_admin] action create
           - create group web_admin
         * linux_user[web_admin] action create
           - create user web_admin
         * template[/var/www/html/index.html] action create
           - create new file /var/www/html/index.html
           - update content in file /var/www/html/index.html from none to ef4ffd
           --- /var/www/html/index.html 2022-04-20 05:10:37.178722798 +0000
           +++ /var/www/html/.chef-index20220420-7447-17t08vb.html     2022-04-20 05:10:37.178722798 +0000
           @@ -1 +1,6 @@
           +<html>
           +  <body>
           +    <h1>hello world</h1>
           +  </body>
           +</html>
           - change mode from '' to '0644'
           - change owner from '' to 'web_admin'
           - change group from '' to 'web_admin'
           - restore selinux security context

       Running handlers:
       Running handlers complete
       Chef Client finished, 6/6 resources updated in 33 seconds
       Downloading files from <satellite-terminal-server-centos-7>
       Finished converging <satellite-terminal-server-centos-7> (1m3.82s).
-----> Converging <master-time-server-centos-7>...
       Preparing files for transfer
```

```
Downloading files from <satellite-terminal-server-centos-7>
       Finished converging <satellite-terminal-server-centos-7> (1m3.82s).
-----> Converging <master-time-server-centos-7>...
       Preparing files for transfer
       Preparing dna.json
       Resolving cookbook dependencies with Berkshelf 7.2.2...
       Removing non-cookbook files before transfer
       Preparing validation.pem
       Preparing client.rb
       el 7 x86_64
       Getting information for chef stable 14.12.9 for el...
       downloading https://omnitruck.chef.io/stable/chef/metadata?v=14.12.9&p=el&pv=7&m=x86_64
         to file /tmp/kitchen/metadata.txt
       trying curl...
       sha1      0c987093a78f7a7c70e635301eb8f82f8f36c4a7
       sha256    749a0550b220a2a50ce7744eb32ab8959840cb3d870cc19e58e10bd86726693a
       url       https://packages.chef.io/files/stable/chef/14.12.9/el/7/chef-14.12.9-1.el7.x86_64.rpm
       version   14.12.9
       downloaded metadata file looks valid...
       /tmp/omnibus/cache/chef-14.12.9-1.el7.x86_64.rpm exists
       Comparing checksum with sha256sum...
       Installing chef 14.12.9
       installing with rpm...
       warning: /tmp/omnibus/cache/chef-14.12.9-1.el7.x86_64.rpm: Header V4 DSA/SHA1 Signature, key ID 83ef826a: NOKEY
       Preparing...                          ################################# [100%]
       Updating / installing...
         1:chef-14.12.9-1.el7               ################################# [100%]
       Thank you for installing Chef!
       Transferring files to <master-time-server-centos-7>
       Starting Chef Client, version 14.12.9
       Creating a new client identity for master-time-server-centos-7 using the validator key.
       resolving cookbooks for run list: ["learn_chef_httpd::default"]
       Synchronizing Cookbooks:
         - learn_chef_httpd (0.1.0)
       Installing Cookbook Gems:
       Compiling Cookbooks...
       Converging 5 resources
       Recipe: learn_chef_httpd::default
         * yum_package[httpd] action install
           - install version 0:2.4.6-97.el7.centos.5.x86_64 of package httpd
         * service[httpd] action enable
           - enable service service[httpd]
         * service[httpd] action start
           - start service service[httpd]
         * group[web_admin] action create
           - create group web_admin
         * linux_user[web_admin] action create
           - create user web_admin
         * template[/var/www/html/index.html] action create
           - create new file /var/www/html/index.html
           - update content in file /var/www/html/index.html from none to ef4ffd
           --- /var/www/html/index.html 2022-04-20 05:11:38.001759248 +0000
           +++ /var/www/html/.chef-index20220420-7445-1n38tgg.html      2022-04-20 05:11:38.001759248 +0000
           @@ -1 +1,6 @@
           +<html>
           +  <body>
           +    <h1>hello world</h1>
           +  </body>
           +</html>
           - change mode from '' to '0644'
           - change owner from '' to 'web_admin'
           - change group from '' to 'web_admin'
           - restore selinux security context

       Running handlers:
       Running handlers complete
       Chef Client finished, 6/6 resources updated in 29 seconds
       Downloading files from <master-time-server-centos-7>
       Finished converging <master-time-server-centos-7> (1m0.73s).
-----> Converging <web-server-centos-7>...
       Preparing files for transfer
```

```
      Downloading files from <master-time-server-centos-7>
      Finished converging <master-time-server-centos-7> (1m0.73s).
-----> Converging <web-server-centos-7>...
      Preparing files for transfer
      Preparing dna.json
      Resolving cookbook dependencies with Berkshelf 7.2.2...
      Removing non-cookbook files before transfer
      Preparing validation.pem
      Preparing client.rb
      el 7 x86_64
      Getting information for chef stable 14.12.9 for el...
      downloading https://omnitruck.chef.io/stable/chef/metadata?v=14.12.9&p=el&pv=7&m=x86_64
        to file /tmp/kitchen/metadata.txt
      trying curl...
      sha1     0c987093a78f7a7c70e635301eb8f82f8f36c4a7
      sha256   749a0550b220a2a50ce7744eb32ab8959840cb3d870cc19e58e10bd86726693a
      url      https://packages.chef.io/files/stable/chef/14.12.9/el/7/chef-14.12.9-1.el7.x86_64.rpm
      version  14.12.9
      downloaded metadata file looks valid...
      /tmp/omnibus/cache/chef-14.12.9-1.el7.x86_64.rpm exists
      Comparing checksum with sha256sum...
      Installing chef 14.12.9
      installing with rpm...
      warning: /tmp/omnibus/cache/chef-14.12.9-1.el7.x86_64.rpm: Header V4 DSA/SHA1 Signature, key ID 83ef826a: NOKEY
      Preparing...                          ################################# [100%]
      Updating / installing...
         1:chef-14.12.9-1.el7               ################################# [100%]
      Thank you for installing Chef!
      Transferring files to <web-server-centos-7>
      Starting Chef Client, version 14.12.9
      Creating a new client identity for web-server-centos-7 using the validator key.
      resolving cookbooks for run list: ["learn_chef_httpd::default"]
      Synchronizing Cookbooks:
        - learn_chef_httpd (0.1.0)
      Installing Cookbook Gems:
      Compiling Cookbooks...
      Converging 5 resources
      Recipe: learn_chef_httpd::default
        * yum_package[httpd] action install
          - install version 0:2.4.6-97.el7.centos.5.x86_64 of package httpd
        * service[httpd] action enable
          - enable service service[httpd]
        * service[httpd] action start
          - start service service[httpd]
        * group[web_admin] action create
          - create group web_admin
        * linux_user[web_admin] action create
          - create user web_admin
        * template[/var/www/html/index.html] action create
          - create new file /var/www/html/index.html
          - update content in file /var/www/html/index.html from none to ef4ffd
          --- /var/www/html/index.html 2022-04-20 05:12:46.495479060 +0000
          +++ /var/www/html/.chef-index20220420-7450-1mjs6wc.html    2022-04-20 05:12:46.495479060 +0000
          @@ -1 +1,6 @@
          +<html>
          +  <body>
          +    <h1>hello world</h1>
          +  </body>
          +</html>
          - change mode from '' to '0644'
          - change owner from '' to 'web_admin'
          - change group from '' to 'web_admin'
          - restore selinux security context

      Running handlers:
      Running handlers complete
      Chef Client finished, 6/6 resources updated in 34 seconds
      Downloading files from <web-server-centos-7>
      Finished converging <web-server-centos-7> (1m8.58s).
-----> Converging <database-server-centos-7>...
      Preparing files for transfer
```

```
Downloading files from <web-server-centos-7>
Finished converging <web-server-centos-7> (1m8.58s).
-----> Converging <database-server-centos-7>...
       Preparing files for transfer
       Preparing dna.json
       Resolving cookbook dependencies with Berkshelf 7.2.2...
       Removing non-cookbook files before transfer
       Preparing validation.pem
       Preparing client.rb
       el 7 x86_64
       Getting information for chef stable 14.12.9 for el...
       downloading https://omnitruck.chef.io/stable/chef/metadata?v=14.12.9&p=el&pv=7&m=x86_64
         to file /tmp/kitchen/metadata.txt
       trying curl...
       sha1      0c987093a78f7a7c70e635301eb8f82f8f36c4a7
       sha256    749a0550b220a2a50ce7744eb32ab8959840cb3d870cc19e58e10bd86726693a
       url       https://packages.chef.io/files/stable/chef/14.12.9/el/7/chef-14.12.9-1.el7.x86_64.rpm
       version   14.12.9
       downloaded metadata file looks valid...
       /tmp/omnibus/cache/chef-14.12.9-1.el7.x86_64.rpm exists
       Comparing checksum with sha256sum...
       Installing chef 14.12.9
       installing with rpm...
       warning: /tmp/omnibus/cache/chef-14.12.9-1.el7.x86_64.rpm: Header V4 DSA/SHA1 Signature, key ID 83ef826a: NOKEY
       Preparing...                          ################################# [100%]
       Updating / installing...
          1:chef-14.12.9-1.el7               ################################# [100%]
       Thank you for installing Chef!
       Transferring files to <database-server-centos-7>
       Starting Chef Client, version 14.12.9
       Creating a new client identity for database-server-centos-7 using the validator key.
       resolving cookbooks for run list: ["learn_chef_httpd::default"]
       Synchronizing Cookbooks:
         - learn_chef_httpd (0.1.0)
       Installing Cookbook Gems:
       Compiling Cookbooks...
       Converging 5 resources
       Recipe: learn_chef_httpd::default
         * yum_package[httpd] action install
           - install version 0:2.4.6-97.el7.centos.5.x86_64 of package httpd
         * service[httpd] action enable
           - enable service service[httpd]
         * service[httpd] action start
           - start service service[httpd]
         * group[web_admin] action create
           - create group web_admin
         * linux_user[web_admin] action create
           - create user web_admin
         * template[/var/www/html/index.html] action create
           - create new file /var/www/html/index.html
           - update content in file /var/www/html/index.html from none to ef4ffd
           --- /var/www/html/index.html 2022-04-20 05:13:53.047885432 +0000
           +++ /var/www/html/.chef-index20220420-7449-1csoszq.html      2022-04-20 05:13:53.047885432 +0000
           @@ -1 +1,6 @@
           +<html>
           +  <body>
           +    <h1>hello world</h1>
           +  </body>
           +</html>
           - change mode from '' to '0644'
           - change owner from '' to 'web_admin'
           - change group from '' to 'web_admin'
           - restore selinux security context

       Running handlers:
       Running handlers complete
       Chef Client finished, 6/6 resources updated in 36 seconds
       Downloading files from <database-server-centos-7>
       Finished converging <database-server-centos-7> (1m6.39s).
-----> Converging <scaled-satellite-terminal-server-centos-7>...
       Preparing files for transfer
```

```
      Downloading files from <database-server-centos-7>
      Finished converging <database-server-centos-7> (1m6.39s).
-----> Converging <scaled-satellite-terminal-server-centos-7>...
      Preparing files for transfer
      Preparing dna.json
      Resolving cookbook dependencies with Berkshelf 7.2.2...
      Removing non-cookbook files before transfer
      Preparing validation.pem
      Preparing client.rb
      el 7 x86_64
      Getting information for chef stable 14.12.9 for el...
      downloading https://omnitruck.chef.io/stable/chef/metadata?v=14.12.9&p=el&pv=7&m=x86_64
        to file /tmp/kitchen/metadata.txt
      trying curl...
      sha1      0c987093a78f7a7c70e635301eb8f82f8f36c4a7
      sha256    749a0550b220a2a50ce7744eb32ab8959840cb3d870cc19e58e10bd86726693a
      url       https://packages.chef.io/files/stable/chef/14.12.9/el/7/chef-14.12.9-1.el7.x86_64.rpm
      version   14.12.9
      downloaded metadata file looks valid...
      /tmp/omnibus/cache/chef-14.12.9-1.el7.x86_64.rpm exists
      Comparing checksum with sha256sum...
      Installing chef 14.12.9
      installing with rpm...
      warning: /tmp/omnibus/cache/chef-14.12.9-1.el7.x86_64.rpm: Header V4 DSA/SHA1 Signature, key ID 83ef826a: NOKEY
      Preparing...                          ################################# [100%]
      Updating / installing...
         1:chef-14.12.9-1.el7              ################################# [100%]
      Thank you for installing Chef!
      Transferring files to <scaled-satellite-terminal-server-centos-7>
      Starting Chef Client, version 14.12.9
      Creating a new client identity for scaled-satellite-terminal-server-centos-7 using the validator key.
      resolving cookbooks for run list: ["learn_chef_httpd::default"]
      Synchronizing Cookbooks:
        - learn_chef_httpd (0.1.0)
      Installing Cookbook Gems:
      Compiling Cookbooks...
      Converging 5 resources
      Recipe: learn_chef_httpd::default
        * yum_package[httpd] action install
          - install version 0:2.4.6-97.el7.centos.5.x86_64 of package httpd
        * service[httpd] action enable
          - enable service service[httpd]
        * service[httpd] action start
          - start service service[httpd]
        * group[web_admin] action create
          - create group web_admin
        * linux_user[web_admin] action create
          - create user web_admin
        * template[/var/www/html/index.html] action create
          - create new file /var/www/html/index.html
          - update content in file /var/www/html/index.html from none to ef4ffd
          --- /var/www/html/index.html 2022-04-20 05:15:00.024820535 +0000
          +++ /var/www/html/.chef-index20220420-7442-1i4ioon.html      2022-04-20 05:15:00.024820535 +0000
          @@ -1 +1,6 @@
          +<html>
          +   <body>
          +      <h1>hello world</h1>
          +   </body>
          +</html>
          - change mode from '' to '0644'
          - change owner from '' to 'web_admin'
          - change group from '' to 'web_admin'
          - restore selinux security context

      Running handlers:
      Running handlers complete
      Chef Client finished, 6/6 resources updated in 34 seconds
      Downloading files from <scaled-satellite-terminal-server-centos-7>
      Finished converging <scaled-satellite-terminal-server-centos-7> (1m7.11s).
-----> Converging <scaled-web-server-centos-7>...
      Preparing files for transfer
```

```
Downloading files from <scaled-satellite-terminal-server-centos-7>
Finished converging <scaled-satellite-terminal-server-centos-7> (1m7.11s).
-----> Converging <scaled-web-server-centos-7>...
       Preparing files for transfer
       Preparing dna.json
       Resolving cookbook dependencies with Berkshelf 7.2.2...
       Removing non-cookbook files before transfer
       Preparing validation.pem
       Preparing client.rb
       el 7 x86_64
       Getting information for chef stable 14.12.9 for el...
       downloading https://omnitruck.chef.io/stable/chef/metadata?v=14.12.9&p=el&pv=7&m=x86_64
         to file /tmp/kitchen/metadata.txt
       trying curl...
       sha1     0c987093a78f7a7c70e635301eb8f82f8f36c4a7
       sha256   749a0550b220a2a50ce7744eb32ab8959840cb3d870cc19e58e10bd86726693a
       url      https://packages.chef.io/files/stable/chef/14.12.9/el/7/chef-14.12.9-1.el7.x86_64.rpm
       version  14.12.9
       downloaded metadata file looks valid...
       /tmp/omnibus/cache/chef-14.12.9-1.el7.x86_64.rpm exists
       Comparing checksum with sha256sum...
       Installing chef 14.12.9
       installing with rpm...
       warning: /tmp/omnibus/cache/chef-14.12.9-1.el7.x86_64.rpm: Header V4 DSA/SHA1 Signature, key ID 83ef826a: NOKEY
       Preparing...                          ################################# [100%]
       Updating / installing...
          1:chef-14.12.9-1.el7               ################################# [100%]
       Thank you for installing Chef!
       Transferring files to <scaled-web-server-centos-7>
       Starting Chef Client, version 14.12.9
       Creating a new client identity for scaled-web-server-centos-7 using the validator key.
       resolving cookbooks for run list: ["learn_chef_httpd::default"]
       Synchronizing Cookbooks:
         - learn_chef_httpd (0.1.0)
       Installing Cookbook Gems:
       Compiling Cookbooks...
       Converging 5 resources
       Recipe: learn_chef_httpd::default
         * yum_package[httpd] action install
           - install version 0:2.4.6-97.el7.centos.5.x86_64 of package httpd
         * service[httpd] action enable
           - enable service service[httpd]
         * service[httpd] action start
           - start service service[httpd]
         * group[web_admin] action create
           - create group web_admin
         * linux_user[web_admin] action create
           - create user web_admin
         * template[/var/www/html/index.html] action create
           - create new file /var/www/html/index.html
           - update content in file /var/www/html/index.html from none to ef4ffd
           --- /var/www/html/index.html 2022-04-20 05:16:05.269945239 +0000
           +++ /var/www/html/.chef-index20220420-7448-1f7vi74.html      2022-04-20 05:16:05.269945239 +0000
           @@ -1 +1,6 @@
           +<html>
           +  <body>
           +    <h1>hello world</h1>
           +  </body>
           +</html>
           - change mode from '' to '0644'
           - change owner from '' to 'web_admin'
           - change group from '' to 'web_admin'
           - restore selinux security context

       Running handlers:
       Running handlers complete
       Chef Client finished, 6/6 resources updated in 33 seconds
       Downloading files from <scaled-web-server-centos-7>
       Finished converging <scaled-web-server-centos-7> (1m5.21s).
-----> Converging <scaled-time-server-centos-7>...
       Preparing files for transfer
```

```
             Downloading files from <scaled-web-server-centos-7>
             Finished converging <scaled-web-server-centos-7> (1m5.21s).
-----> Converging <scaled-time-server-centos-7>...
             Preparing files for transfer
             Preparing dna.json
             Resolving cookbook dependencies with Berkshelf 7.2.2...
             Removing non-cookbook files before transfer
             Preparing validation.pem
             Preparing client.rb
             el 7 x86_64
             Getting information for chef stable 14.12.9 for el...
             downloading https://omnitruck.chef.io/stable/chef/metadata?v=14.12.9&p=el&pv=7&m=x86_64
               to file /tmp/kitchen/metadata.txt
             trying curl...
             sha1      0c987093a78f7a7c70e635301eb8f82f8f36c4a7
             sha256    749a0550b220a2a50ce7744eb32ab8959840cb3d870cc19e58e10bd86726693a
             url       https://packages.chef.io/files/stable/chef/14.12.9/el/7/chef-14.12.9-1.el7.x86_64.rpm
             version   14.12.9
             downloaded metadata file looks valid...
             /tmp/omnibus/cache/chef-14.12.9-1.el7.x86_64.rpm exists
             Comparing checksum with sha256sum...
             Installing chef 14.12.9
             installing with rpm...
             warning: /tmp/omnibus/cache/chef-14.12.9-1.el7.x86_64.rpm: Header V4 DSA/SHA1 Signature, key ID 83ef826a: NOKEY
             Preparing...                          ################################# [100%]
             Updating / installing...
                1:chef-14.12.9-1.el7               ################################# [100%]
             Thank you for installing Chef!
             Transferring files to <scaled-time-server-centos-7>
             Starting Chef Client, version 14.12.9
             Creating a new client identity for scaled-time-server-centos-7 using the validator key.
             resolving cookbooks for run list: ["learn_chef_httpd::default"]
             Synchronizing Cookbooks:
               - learn_chef_httpd (0.1.0)
             Installing Cookbook Gems:
             Compiling Cookbooks...
             Converging 5 resources
             Recipe: learn_chef_httpd::default
               * yum_package[httpd] action install
                 - install version 0:2.4.6-97.el7.centos.5.x86_64 of package httpd
               * service[httpd] action enable
                 - enable service service[httpd]
               * service[httpd] action start
                 - start service service[httpd]
               * group[web_admin] action create
                 - create group web_admin
               * linux_user[web_admin] action create
                 - create user web_admin
               * template[/var/www/html/index.html] action create
                 - create new file /var/www/html/index.html
                 - update content in file /var/www/html/index.html from none to ef4ffd
                 --- /var/www/html/index.html 2022-04-20 05:17:22.769934407 +0000
                 +++ /var/www/html/.chef-index20220420-7463-9w53i7.html      2022-04-20 05:17:22.769934407 +0000
                 @@ -1 +1,6 @@
                 +<html>
                 +  <body>
                 +    <h1>hello world</h1>
                 +  </body>
                 +</html>
                 - change mode from '' to '0644'
                 - change owner from '' to 'web_admin'
                 - change group from '' to 'web_admin'
                 - restore selinux security context

             Running handlers:
             Running handlers complete
             Chef Client finished, 6/6 resources updated in 37 seconds
             Downloading files from <scaled-time-server-centos-7>
             Finished converging <scaled-time-server-centos-7> (1m17.32s).
-----> Converging <scaled-database-server-centos-7>...
             Preparing files for transfer
```

```
         Downloading files from <scaled-time-server-centos-7>
         Finished converging <scaled-time-server-centos-7> (1m17.32s).
-----> Converging <scaled-database-server-centos-7>...
         Preparing files for transfer
         Preparing dna.json
         Resolving cookbook dependencies with Berkshelf 7.2.2...
         Removing non-cookbook files before transfer
         Preparing validation.pem
         Preparing client.rb
         el 7 x86_64
         Getting information for chef stable 14.12.9 for el...
         downloading https://omnitruck.chef.io/stable/chef/metadata?v=14.12.9&p=el&pv=7&m=x86_64
           to file /tmp/kitchen/metadata.txt
         trying curl...
         sha1     0c987093a78f7a7c70e635301eb8f82f8f36c4a7
         sha256   749a0550b220a2a50ce7744eb32ab8959840cb3d870cc19e58e10bd86726693a
         url      https://packages.chef.io/files/stable/chef/14.12.9/el/7/chef-14.12.9-1.el7.x86_64.rpm
         version  14.12.9
         downloaded metadata file looks valid...
         /tmp/omnibus/cache/chef-14.12.9-1.el7.x86_64.rpm exists
         Comparing checksum with sha256sum...
         Installing chef 14.12.9
         installing with rpm...
         warning: /tmp/omnibus/cache/chef-14.12.9-1.el7.x86_64.rpm: Header V4 DSA/SHA1 Signature, key ID 83ef826a: NOKEY
         Preparing...                       ################################# [100%]
         Updating / installing...
            1:chef-14.12.9-1.el7            ################################# [100%]
         Thank you for installing Chef!
         Transferring files to <scaled-database-server-centos-7>
         Starting Chef Client, version 14.12.9
         Creating a new client identity for scaled-database-server-centos-7 using the validator key.
         resolving cookbooks for run list: ["learn_chef_httpd::default"]
         Synchronizing Cookbooks:
           - learn_chef_httpd (0.1.0)
         Installing Cookbook Gems:
         Compiling Cookbooks...
         Converging 5 resources
         Recipe: learn_chef_httpd::default
           * yum_package[httpd] action install
             - install version 0:2.4.6-97.el7.centos.5.x86_64 of package httpd
           * service[httpd] action enable
             - enable service service[httpd]
           * service[httpd] action start
             - start service service[httpd]
           * group[web_admin] action create
             - create group web_admin
           * linux_user[web_admin] action create
             - create user web_admin
           * template[/var/www/html/index.html] action create
             - create new file /var/www/html/index.html
             - update content in file /var/www/html/index.html from none to ef4ffd
             --- /var/www/html/index.html 2022-04-20 05:18:36.794574963 +0000
             +++ /var/www/html/.chef-index20220420-7438-vwsrab.html       2022-04-20 05:18:36.794574963 +0000
             @@ -1 +1,6 @@
             +<html>
             +  <body>
             +    <h1>hello world</h1>
             +  </body>
             +</html>
             - change mode from '' to '0644'
             - change owner from '' to 'web_admin'
             - change group from '' to 'web_admin'
             - restore selinux security context

         Running handlers:
         Running handlers complete
         Chef Client finished, 6/6 resources updated in 36 seconds
         Downloading files from <scaled-database-server-centos-7>
         Finished converging <scaled-database-server-centos-7> (1m13.94s).
-----> Test Kitchen is finished. (9m7.35s)
[astromined@chef learn_chef_httpd]$
```
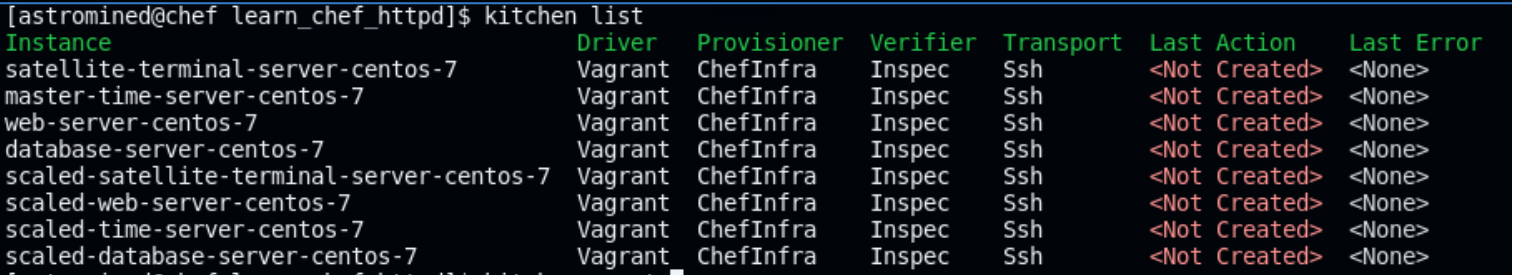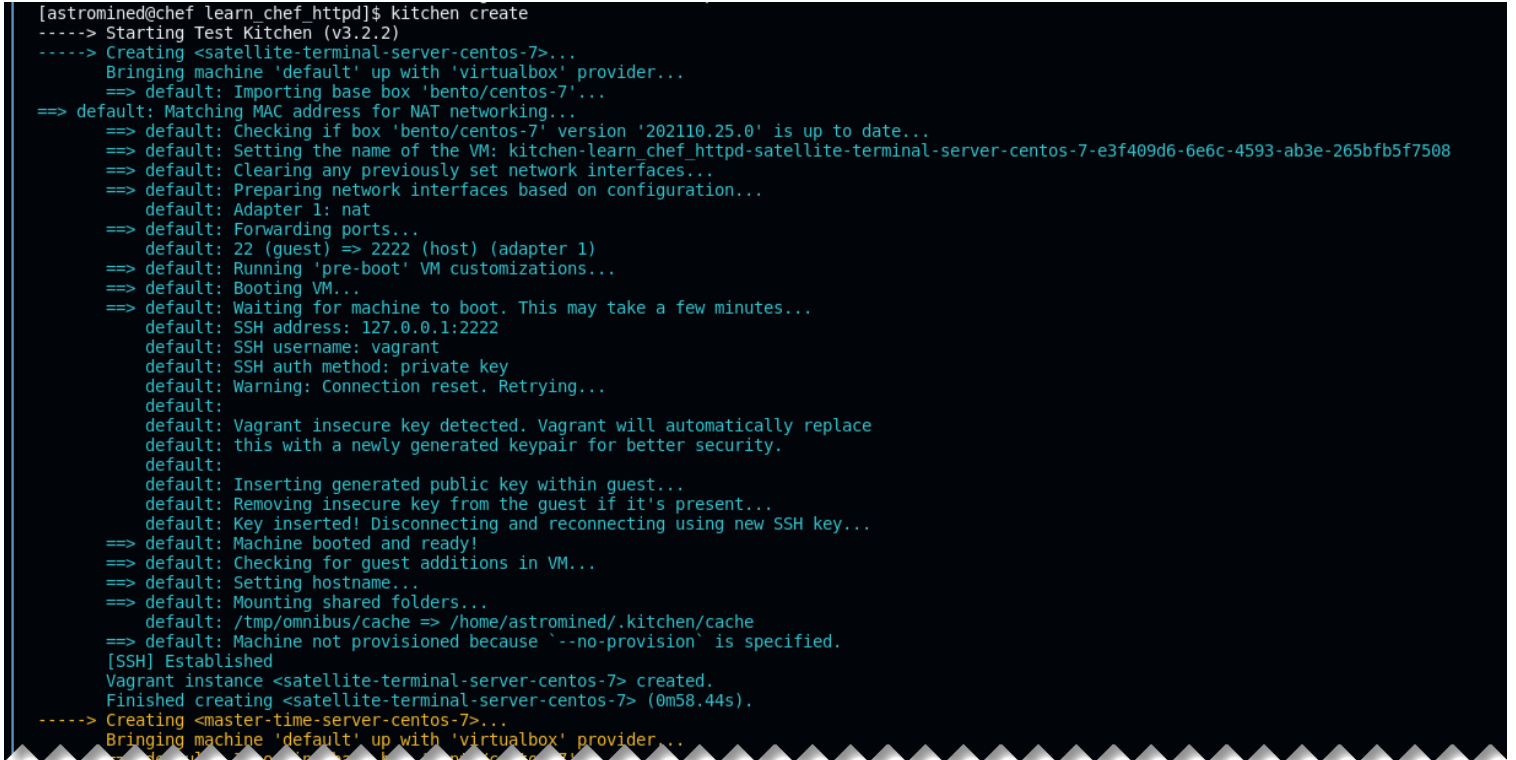
| Data Description | Optimal Range | Data and Results | Automation Script Used to Extract Data (text only) | Screenshot of Result of Script |
|---|---|---|---|---|
| Time to scale from 1 cluster to 200 clusters<br><br>(60,000 advertisements expected at peak global usage) based on 300 satellites per cluster (subject to change based on load testing) | 15–30 minutes for each cluster | One cluster = 8:26<br><br>200 clusters = 28:13:20 | kitchen list<br><br>kitchen create<br><br>kitchen converge | kitchen-list.png  kitchen-create-full.png kitchen-create-reduced.png  kitchen-converge-full.png kitchen-converge-reduced.png |

```
[astromined@chef learn_chef_httpd]$ kitchen converge
-----> Starting Test Kitchen (v3.2.2)
-----> Converging <satellite-terminal-server-centos-7>...
       Preparing files for transfer
       Preparing dna.json
       Resolving cookbook dependencies with Berkshelf 7.2.2...
       Removing non-cookbook files before transfer
       Preparing validation.pem
       Preparing client.rb
       el 7 x86_64
       Getting information for chef stable 14.12.9 for el...
       downloading https://omnitruck.chef.io/stable/chef/metadata?v=14.12.9&p=el&pv=7&m=x86_64
         to file /tmp/kitchen/metadata.txt
       trying curl...
       sha1     0c987093a78f7a7c70e635301eb8f82f8f36c4a7
       sha256   749a0550b220a2a50ce7744eb32ab8959840cb3d870cc19e58e10bd86726693a
       url      https://packages.chef.io/files/stable/chef/14.12.9/el/7/chef-14.12.9-1.el7.x86_64.rpm
       version  14.12.9
       downloaded metadata file looks valid...
       /tmp/omnibus/cache/chef-14.12.9-1.el7.x86_64.rpm exists
       Comparing checksum with sha256sum...
       Installing chef 14.12.9
       installing with rpm...
       warning: /tmp/omnibus/cache/chef-14.12.9-1.el7.x86_64.rpm: Header V4 DSA/SHA1 Signature, key ID 83ef826a: NOKEY
       Preparing...                          ################################# [100%]
       Updating / installing...
          1:chef-14.12.9-1.el7               ################################# [100%]
       Thank you for installing Chef!
       Transferring files to <satellite-terminal-server-centos-7>
       Starting Chef Client, version 14.12.9
       Creating a new client identity for satellite-terminal-server-centos-7 using the validator key.
       resolving cookbooks for run list: ["learn_chef_httpd::default"]
       Synchronizing Cookbooks:
         - learn_chef_httpd (0.1.0)
       Installing Cookbook Gems:
       Compiling Cookbooks...
       Converging 5 resources
       Recipe: learn_chef_httpd::default
         * yum_package[httpd] action install
           - install version 0:2.4.6-97.el7.centos.5.x86_64 of package httpd
         * service[httpd] action enable
           - enable service service[httpd]
         * service[httpd] action start
           - start service service[httpd]
         * group[web_admin] action create
           - create group web_admin
         * linux_user[web_admin] action create
           - create user web_admin
         * template[/var/www/html/index.html] action create
           - create new file /var/www/html/index.html
           - update content in file /var/www/html/index.html from none to ef4ffd
           --- /var/www/html/index.html 2022-04-20 05:10:37.178722798 +0000
           +++ /var/www/html/.chef-index20220420-7447-17t08vb.html     2022-04-20 05:10:37.178722798 +0000
           @@ -1 +1,6 @@
           +<html>
           +  <body>
           +    <h1>hello world</h1>
           +  </body>
           +</html>
           - change mode from '' to '0644'
           - change owner from '' to 'web_admin'
           - change group from '' to 'web_admin'
           - restore selinux security context

       Running handlers:
       Running handlers complete
       Chef Client finished, 6/6 resources updated in 33 seconds
       Downloading files from <satellite-terminal-server-centos-7>
       Finished converging <satellite-terminal-server-centos-7> (1m3.82s).
-----> Converging <master-time-server-centos-7>...
       Preparing files for transfer
       Preparing dna.json
```

```
       Running handlers complete
       Chef Client finished, 6/6 resources updated in 36 seconds
       Downloading files from <scaled-database-server-centos-7>
       Finished converging <scaled-database-server-centos-7> (1m13.94s).
-----> Test Kitchen is finished. (9m7.35s)
[astromined@chef learn_chef_httpd]$
```
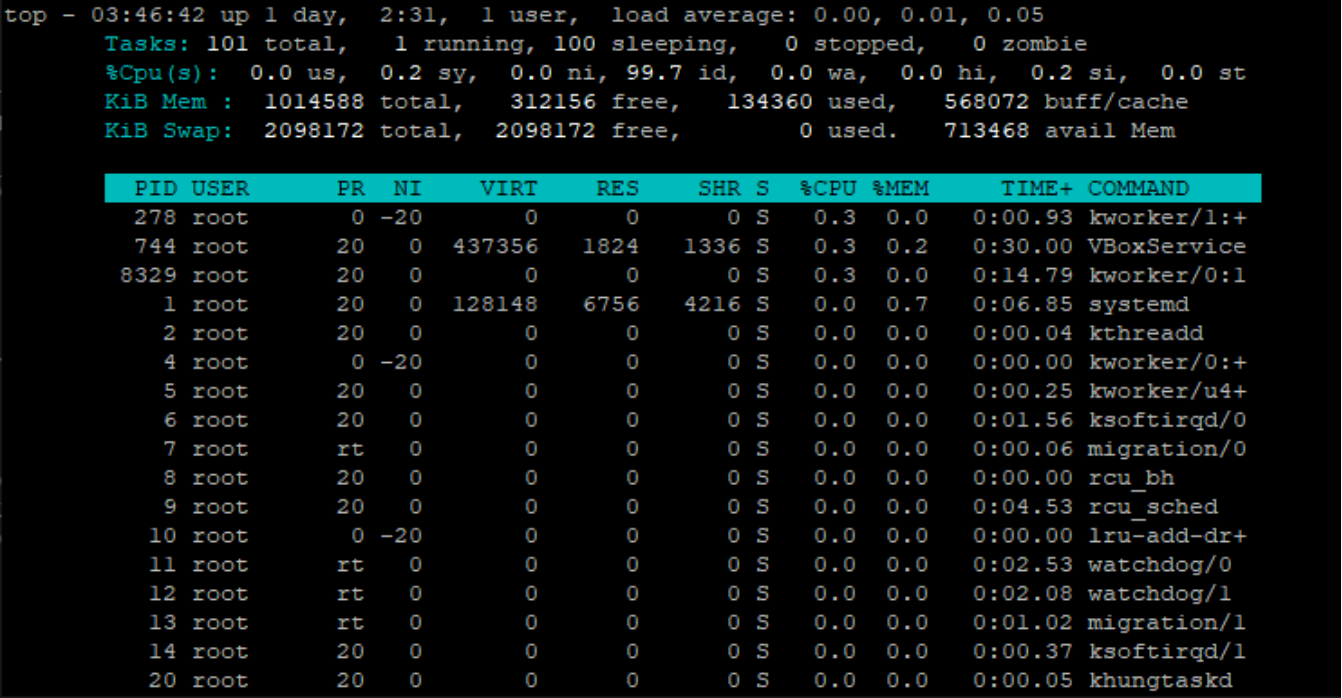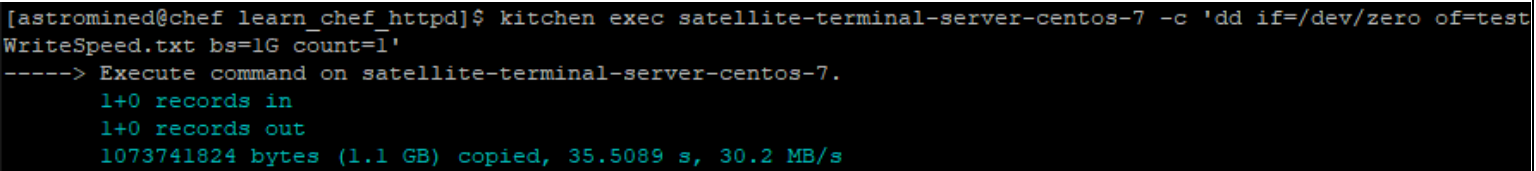
| | | | | |
|---|---|---|---|---|
| Time to register a cluster and then quench connections to the load balancer, taking the cluster off-line (start-up, operation, shutdown) | 1 minute per connection quench, start of cluster launch, and part of time to scale cluster, can be tracked separately as a quench | One cluster = 00:00:44 | kitchen destroy |  |

| | | | | |
|---|---|---|---|---|
| Peak load averages per system at 200, and 300, satellites per cluster | 60% of CPU triggers new cluster launch; if reaching core load at 200 satellites, launch new cluster on 60% CPU loads | load average: 0.00, 0.01, 0.05 | kitchen exec satellite-terminal-server-centos-7 -c 'top' | [kitchen-exec-top.png](kitchen-exec-top.png)<br><br>![top output screenshot]<br>`top - 03:46:42 up 1 day,  2:31,  1 user,  load average: 0.00, 0.01, 0.05`<br>`Tasks: 101 total,   1 running, 100 sleeping,   0 stopped,   0 zombie`<br>`%Cpu(s):  0.0 us,  0.2 sy,  0.0 ni, 99.7 id,  0.0 wa,  0.0 hi,  0.2 si,  0.0 st`<br>`KiB Mem :  1014588 total,   312156 free,   134360 used,   568072 buff/cache`<br>`KiB Swap:  2098172 total,  2098172 free,        0 used.   713468 avail Mem` |
| Write times to the diagnostic data drive | <30 milliseconds | 1073741824 bytes (1.1 GB) copied, 35.5089 s, 30.2 MB/s | kitchen exec satellite-terminal-server-centos-7 -c 'dd if=/dev/zero of=testWriteSpeed.txt bs=1G count=1' | [kitchen-exec-dd.png](kitchen-exec-dd.png)<br><br>`[astromined@chef learn_chef_httpd]$ kitchen exec satellite-terminal-server-centos-7 -c 'dd if=/dev/zero of=testWriteSpeed.txt bs=1G count=1'`<br>`-----> Execute command on satellite-terminal-server-centos-7.`<br>`1+0 records in`<br>`1+0 records out`<br>`1073741824 bytes (1.1 GB) copied, 35.5089 s, 30.2 MB/s` |

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| | | | | |
|---|---|---|---|---|
| Pull time from the game instances (1 Satellite Terminal Server, 1 Web Server, 1 Database, and 1 time server) and initialization time | Part of cluster launch 15–30 minutes | One cluster = 8:26 | kitchen list<br><br>kitchen create<br><br>kitchen converge | kitchen-list.png<br><br><br><br>kitchen-create-full.png<br><br>kitchen-create-reduced.png<br><br><br><br>kitchen-converge-full.png<br><br>kitchen-converge-reduced.png |

```
[astromined@chef learn_chef_httpd]$ kitchen converge
-----> Starting Test Kitchen (v3.2.2)
-----> Converging <satellite-terminal-server-centos-7>...
       Preparing files for transfer
       Preparing dna.json
       Resolving cookbook dependencies with Berkshelf 7.2.2...
       Removing non-cookbook files before transfer
       Preparing validation.pem
       Preparing client.rb
       el 7 x86_64
       Getting information for chef stable 14.12.9 for el...
       downloading https://omnitruck.chef.io/stable/chef/metadata?v=14.12.9&p=el&pv=7&m=x86_64
         to file /tmp/kitchen/metadata.txt
       trying curl...
       sha1     0c987093a78f7a7c70e635301eb8f82f8f36c4a7
       sha256   749a0550b220a2a50ce7744eb32ab8959840cb3d870cc19e58e10bd86726693a
       url      https://packages.chef.io/files/stable/chef/14.12.9/el/7/chef-14.12.9-1.el7.x86_64.rpm
       version  14.12.9
       downloaded metadata file looks valid...
       /tmp/omnibus/cache/chef-14.12.9-1.el7.x86_64.rpm exists
       Comparing checksum with sha256sum...
       Installing chef 14.12.9
       installing with rpm...
       warning: /tmp/omnibus/cache/chef-14.12.9-1.el7.x86_64.rpm: Header V4 DSA/SHA1 Signature, key ID 83ef826a: NOKEY
       Preparing...                          ################################# [100%]
       Updating / installing...
          1:chef-14.12.9-1.el7               ################################# [100%]
       Thank you for installing Chef!
       Transferring files to <satellite-terminal-server-centos-7>
       Starting Chef Client, version 14.12.9
       Creating a new client identity for satellite-terminal-server-centos-7 using the validator key.
       resolving cookbooks for run list: ["learn_chef_httpd::default"]
       Synchronizing Cookbooks:
         - learn_chef_httpd (0.1.0)
       Installing Cookbook Gems:
       Compiling Cookbooks...
       Converging 5 resources
       Recipe: learn_chef_httpd::default
         * yum_package[httpd] action install
           - install version 0:2.4.6-97.el7.centos.5.x86_64 of package httpd
         * service[httpd] action enable
           - enable service service[httpd]
         * service[httpd] action start
           - start service service[httpd]
         * group[web_admin] action create
           - create group web_admin
         * linux_user[web_admin] action create
           - create user web_admin
         * template[/var/www/html/index.html] action create
           - create new file /var/www/html/index.html
           - update content in file /var/www/html/index.html from none to ef4ffd
           --- /var/www/html/index.html 2022-04-20 05:10:37.178722798 +0000
           +++ /var/www/html/.chef-index20220420-7447-17t08vb.html     2022-04-20 05:10:37.178722798 +0000
           @@ -1 +1,6 @@
           +<html>
           +  <body>
           +    <h1>hello world</h1>
           +  </body>
           +</html>
           - change mode from '' to '0644'
           - change owner from '' to 'web_admin'
           - change group from '' to 'web_admin'
           - restore selinux security context

       Running handlers:
       Running handlers complete
       Chef Client finished, 6/6 resources updated in 33 seconds
       Downloading files from <satellite-terminal-server-centos-7>
       Finished converging <satellite-terminal-server-centos-7> (1m3.82s).
-----> Converging <master-time-server-centos-7>...
       Preparing files for transfer
       Preparing dna.json
```
```
       Running handlers complete
       Chef Client finished, 6/6 resources updated in 36 seconds
       Downloading files from <scaled-database-server-centos-7>
       Finished converging <scaled-database-server-centos-7> (1m13.94s).
-----> Test Kitchen is finished. (9m7.35s)
[astromined@chef learn_chef_httpd]$
```
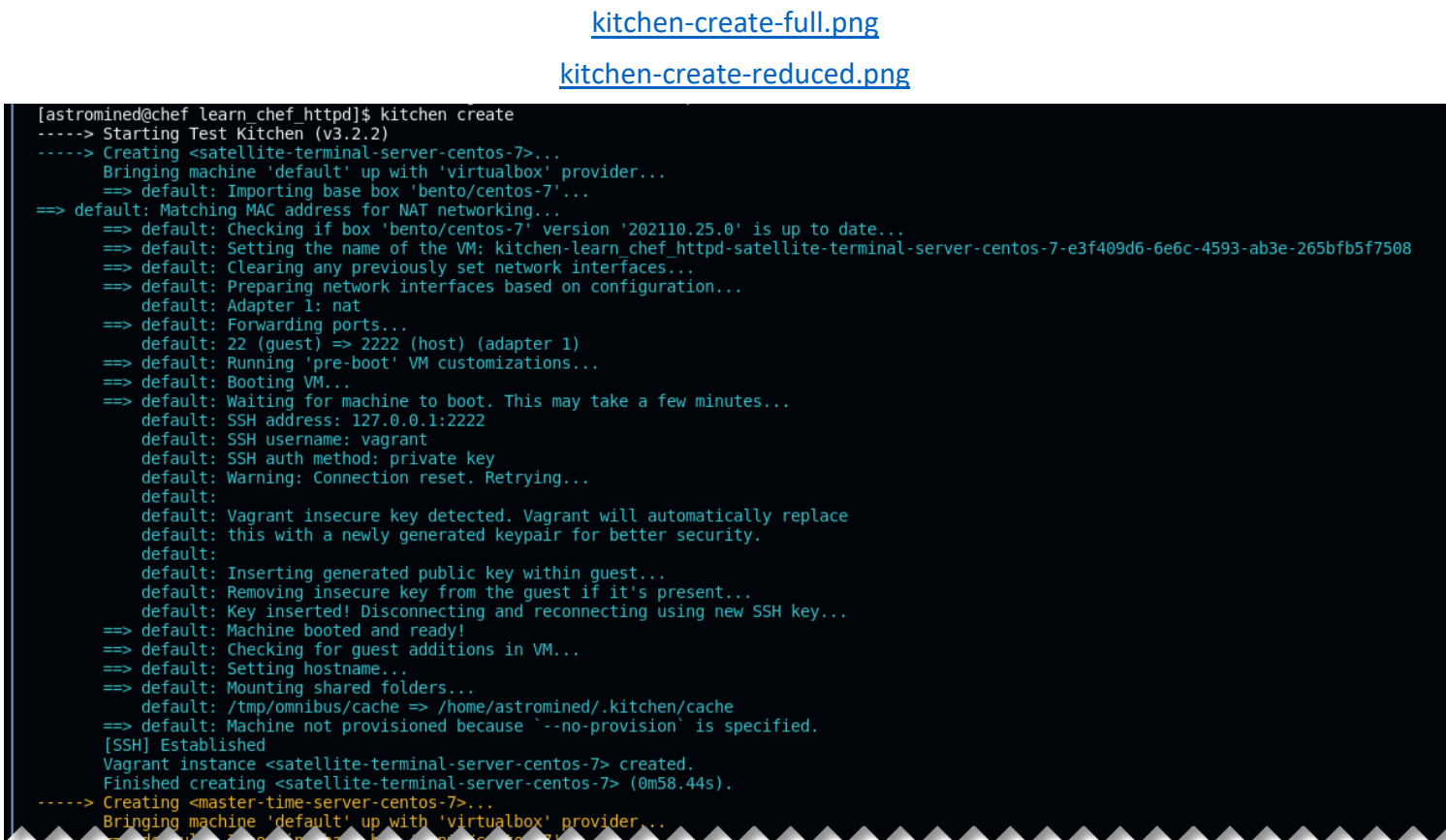
WESTERN GOVERNORS UNIVERSITY.

| | | | | |
|---|---|---|---|---|
| *Average messaging service (queue) time | <1 minute in queue | N/A | N/A | N/A |
| Average latency for the Time server | <30 milliseconds | rtt min/avg/max/mdev = 16.673/17.933/19.118/0.8 95 ms | kitchen exec master-time-server-centos-7  -c 'ping -c 5 google.com' | kitchen-exec-time.png  |
| Average latency of each cluster | <30 milliseconds | rtt min/avg/max/mdev = 0.032/0.049/0.094/0.025 ms | kitchen exec master-time-server-centos-7  -c 'ping -c 5 localhost' | kitchen-exec-ping.png  |
| Network data in and out for each cluster | <1 second | rtt min/avg/max/mdev = 16.673/17.933/19.118/0.8 95 ms | kitchen exec master-time-server-centos-7  -c 'ping -c 5 google.com' | kitchen-exec-time.png  |

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| Overall CPU utilization of the environment for each cluster | Not >60% | load average: 0.00, 0.01, 0.05 | kitchen exec satellite-terminal-server-centos-7 -c 'top' | kitchen-exec-top.png<br> |
|---|---|---|---|---|
| *Diagnostic data able to be written by the automation to the correct cloud bucket storage space | Show read/write times <1 second | N/A | N/A | N/A |
| Scaled Satellite Cluster latency | <30 milliseconds | rtt min/avg/max/mdev = 14.553/16.411/18.780/1.478 ms | kitchen exec scaled-time-server-centos-7 -c 'ping -c 5 google.com' | kitchen-exec-scaled.png<br> |

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| | | | | |
|---|---|---|---|---|
| | | | | [kitchen-exec-scaled.png](kitchen-exec-scaled.png) |
| Scaled Satellite Cluster latency between gateway/scaled clusters and core | <30 milliseconds | rtt min/avg/max/mdev = 14.553/16.411/18.780/1.478 ms | kitchen exec scaled-time-server-centos-7 -c 'ping -c 5 google.com' | ```
[astromined@chef learn_chef_httpd]$ kitchen exec scaled-time-server-centos-7  -c 'ping -c 5 google.com'
-----> Execute command on scaled-time-server-centos-7.
       PING google.com (142.251.45.110) 56(84) bytes of data.
       64 bytes from iad23s04-in-f14.1e100.net (142.251.45.110): icmp_seq=1 ttl=63 time=14.5 ms
       64 bytes from iad23s04-in-f14.1e100.net (142.251.45.110): icmp_seq=2 ttl=63 time=15.8 ms
       64 bytes from iad23s04-in-f14.1e100.net (142.251.45.110): icmp_seq=3 ttl=63 time=18.7 ms
       64 bytes from iad23s04-in-f14.1e100.net (142.251.45.110): icmp_seq=4 ttl=63 time=15.5 ms
       64 bytes from iad23s04-in-f14.1e100.net (142.251.45.110): icmp_seq=5 ttl=63 time=17.2 ms

       --- google.com ping statistics ---
       5 packets transmitted, 5 received, 0% packet loss, time 4007ms
       rtt min/avg/max/mdev = 14.553/16.411/18.780/1.478 ms
``` |
| | | | | [kitchen-exec-scaled.png](kitchen-exec-scaled.png) |
| Scaled Satellite Cluster latency between scaled clusters and environment | <30 milliseconds | rtt min/avg/max/mdev = 14.553/16.411/18.780/1.478 ms | kitchen exec scaled-time-server-centos-7 -c 'ping -c 5 google.com' | ```
[astromined@chef learn_chef_httpd]$ kitchen exec scaled-time-server-centos-7  -c 'ping -c 5 google.com'
-----> Execute command on scaled-time-server-centos-7.
       PING google.com (142.251.45.110) 56(84) bytes of data.
       64 bytes from iad23s04-in-f14.1e100.net (142.251.45.110): icmp_seq=1 ttl=63 time=14.5 ms
       64 bytes from iad23s04-in-f14.1e100.net (142.251.45.110): icmp_seq=2 ttl=63 time=15.8 ms
       64 bytes from iad23s04-in-f14.1e100.net (142.251.45.110): icmp_seq=3 ttl=63 time=18.7 ms
       64 bytes from iad23s04-in-f14.1e100.net (142.251.45.110): icmp_seq=4 ttl=63 time=15.5 ms
       64 bytes from iad23s04-in-f14.1e100.net (142.251.45.110): icmp_seq=5 ttl=63 time=17.2 ms

       --- google.com ping statistics ---
       5 packets transmitted, 5 received, 0% packet loss, time 4007ms
       rtt min/avg/max/mdev = 14.553/16.411/18.780/1.478 ms
``` |

**WESTERN GOVERNORS UNIVERSITY**

| | | | | |
|---|---|---|---|---|
| Pull time from the scaled clusters and initialization time | 15–30 minutes for each cluster | One cluster = 8:26 | kitchen list<br><br>kitchen create<br><br>kitchen converge | [kitchen-list.png](#)<br><br>```<br>[astromined@chef learn_chef_httpd]$ kitchen list<br>Instance                                     Driver   Provisioner  Verifier  Transport  Last Action    Last Error<br>satellite-terminal-server-centos-7           Vagrant  ChefInfra    Inspec    Ssh        <Not Created>  <None><br>master-time-server-centos-7                  Vagrant  ChefInfra    Inspec    Ssh        <Not Created>  <None><br>web-server-centos-7                          Vagrant  ChefInfra    Inspec    Ssh        <Not Created>  <None><br>database-server-centos-7                     Vagrant  ChefInfra    Inspec    Ssh        <Not Created>  <None><br>scaled-satellite-terminal-server-centos-7    Vagrant  ChefInfra    Inspec    Ssh        <Not Created>  <None><br>scaled-web-server-centos-7                   Vagrant  ChefInfra    Inspec    Ssh        <Not Created>  <None><br>scaled-time-server-centos-7                  Vagrant  ChefInfra    Inspec    Ssh        <Not Created>  <None><br>scaled-database-server-centos-7              Vagrant  ChefInfra    Inspec    Ssh        <Not Created>  <None><br>```<br><br>[kitchen-create-full.png](#)<br><br>[kitchen-create-reduced.png](#)<br><br>```<br>[astromined@chef learn_chef_httpd]$ kitchen create<br>-----> Starting Test Kitchen (v3.2.2)<br>-----> Creating <satellite-terminal-server-centos-7>...<br>       Bringing machine 'default' up with 'virtualbox' provider...<br>       ==> default: Importing base box 'bento/centos-7'...<br>==> default: Matching MAC address for NAT networking...<br>       ==> default: Checking if box 'bento/centos-7' version '202110.25.0' is up to date...<br>       ==> default: Setting the name of the VM: kitchen-learn_chef_httpd-satellite-terminal-server-centos-7-e3f409d6-6e6c-4593-ab3e-265bfb5f7508<br>       ==> default: Clearing any previously set network interfaces...<br>       ==> default: Preparing network interfaces based on configuration...<br>           default: Adapter 1: nat<br>       ==> default: Forwarding ports...<br>           default: 22 (guest) => 2222 (host) (adapter 1)<br>       ==> default: Running 'pre-boot' VM customizations...<br>       ==> default: Booting VM...<br>       ==> default: Waiting for machine to boot. This may take a few minutes...<br>           default: SSH address: 127.0.0.1:2222<br>           default: SSH username: vagrant<br>           default: SSH auth method: private key<br>           default:<br>           default: Warning: Connection reset. Retrying...<br>           default:<br>           default: Vagrant insecure key detected. Vagrant will automatically replace<br>           default: this with a newly generated keypair for better security.<br>           default:<br>           default: Inserting generated public key within guest...<br>           default: Removing insecure key from the guest if it's present...<br>           default: Key inserted! Disconnecting and reconnecting using new SSH key...<br>       ==> default: Machine booted and ready!<br>       ==> default: Checking for guest additions in VM...<br>       ==> default: Setting hostname...<br>       ==> default: Mounting shared folders...<br>           default: /tmp/omnibus/cache => /home/astromined/.kitchen/cache<br>       ==> default: Machine not provisioned because `--no-provision` is specified.<br>       [SSH] Established<br>       Vagrant instance <satellite-terminal-server-centos-7> created.<br>       Finished creating <satellite-terminal-server-centos-7> (0m58.44s).<br>-----> Creating <master-time-server-centos-7>...<br>       Bringing machine 'default' up with 'virtualbox' provider...<br>...<br>       [SSH] Established<br>       Vagrant instance <scaled-database-server-centos-7> created.<br>       Finished creating <scaled-database-server-centos-7> (1m9.06s).<br>-----> Test Kitchen is finished. (8m26.16s)<br>```<br><br>[kitchen-converge-full.png](#)<br><br>[kitchen-converge-reduced.png](#) |

```
[astromined@chef learn_chef_httpd]$ kitchen converge
-----> Starting Test Kitchen (v3.2.2)
-----> Converging <satellite-terminal-server-centos-7>...
       Preparing files for transfer
       Preparing dna.json
       Resolving cookbook dependencies with Berkshelf 7.2.2...
       Removing non-cookbook files before transfer
       Preparing validation.pem
       Preparing client.rb
       el 7 x86_64
       Getting information for chef stable 14.12.9 for el...
       downloading https://omnitruck.chef.io/stable/chef/metadata?v=14.12.9&p=el&pv=7&m=x86_64
         to file /tmp/kitchen/metadata.txt
       trying curl...
       sha1     0c987093a78f7a7c70e635301eb8f82f8f36c4a7
       sha256   749a0550b220a2a50ce7744eb32ab8959840cb3d870cc19e58e10bd86726693a
       url      https://packages.chef.io/files/stable/chef/14.12.9/el/7/chef-14.12.9-1.el7.x86_64.rpm
       version  14.12.9
       downloaded metadata file looks valid...
       /tmp/omnibus/cache/chef-14.12.9-1.el7.x86_64.rpm exists
       Comparing checksum with sha256sum...
       Installing chef 14.12.9
       installing with rpm...
       warning: /tmp/omnibus/cache/chef-14.12.9-1.el7.x86_64.rpm: Header V4 DSA/SHA1 Signature, key ID 83ef826a: NOKEY
       Preparing...                          ################################# [100%]
       Updating / installing...
          1:chef-14.12.9-1.el7               ################################# [100%]
       Thank you for installing Chef!
       Transferring files to <satellite-terminal-server-centos-7>
       Starting Chef Client, version 14.12.9
       Creating a new client identity for satellite-terminal-server-centos-7 using the validator key.
       resolving cookbooks for run list: ["learn_chef_httpd::default"]
       Synchronizing Cookbooks:
         - learn_chef_httpd (0.1.0)
       Installing Cookbook Gems:
       Compiling Cookbooks...
       Converging 5 resources
       Recipe: learn_chef_httpd::default
         * yum_package[httpd] action install
           - install version 0:2.4.6-97.el7.centos.5.x86_64 of package httpd
         * service[httpd] action enable
           - enable service service[httpd]
         * service[httpd] action start
           - start service service[httpd]
         * group[web_admin] action create
           - create group web_admin
         * linux_user[web_admin] action create
           - create user web_admin
         * template[/var/www/html/index.html] action create
           - create new file /var/www/html/index.html
           - update content in file /var/www/html/index.html from none to ef4ffd
           --- /var/www/html/index.html 2022-04-20 05:10:37.178722798 +0000
           +++ /var/www/html/.chef-index20220420-7447-17t08vb.html     2022-04-20 05:10:37.178722798 +0000
           @@ -1 +1,6 @@
           +<html>
           +  <body>
           +    <h1>hello world</h1>
           +  </body>
           +</html>
           - change mode from '' to '0644'
           - change owner from '' to 'web_admin'
           - change group from '' to 'web_admin'
           - restore selinux security context

       Running handlers:
       Running handlers complete
       Chef Client finished, 6/6 resources updated in 33 seconds
       Downloading files from <satellite-terminal-server-centos-7>
       Finished converging <satellite-terminal-server-centos-7> (1m3.82s).
-----> Converging <master-time-server-centos-7>...
       Preparing files for transfer
       Preparing dna.json
```

```
       Running handlers complete
       Chef Client finished, 6/6 resources updated in 36 seconds
       Downloading files from <scaled-database-server-centos-7>
       Finished converging <scaled-database-server-centos-7> (1m13.94s).
-----> Test Kitchen is finished. (9m7.35s)
[astromined@chef learn_chef_httpd]$
```

## E.  WEB SOURCES

chef. (n.d.). *GitHub - chef/learn_chef_httpd: Cookbook for the Learn Chef tutorials*. GitHub; github.com. Retrieved April 22, 2022, from https://github.com/chef/learn_chef_httpd

*top(2) - Linux manual page*. (n.d.). Top(1) - Linux Manual Page; man7.org. Retrieved April 22, 2022, from https://man7.org/linux/man-pages/man1/top.1.html

*dd(3) - Linux manual page*. (n.d.). Dd(1) - Linux Manual Page; man7.org. Retrieved April 22, 2022, from https://man7.org/linux/man-pages/man1/dd.1.html

*ping(8) - Linux manual page*. (n.d.). Ping(8) - Linux Manual Page; man7.org. Retrieved April 22, 2022, from https://man7.org/linux/man-pages/man8/ping.8.html

*kitchen (executable)*. (2022, February 24). Kitchen (Executable); docs.chef.io. https://docs.chef.io/workstation/ctl_kitchen/#kitchen-exec

## F.  SOURCES

No other sources were used other than web sources above

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