Aim : To learn Software Configuration Management and provisioning using Puppet Blocks(Manifest, Modules, Classes, Function).

Theory :

What is Configuration Management?

Configuration management is the process of maintaining software and computer systems (for example servers, storage, networks) in a known, desired and consistent state. It also allows access to an accurate historical record of system state for project management and audit purposes.System Administrators mostly perform repetitive tasks like installing servers, configuring those servers, etc. These professionals can automate this task, by writing scripts.However, it is a difficult job when they are working on a massive infrastructure. The Configuration Management tool like a Puppet was introduced to resolve such issues.

What is Puppet?

Puppet is a system management tool for centralizing and automating the configuration management process. Puppet is also used as a software deployment tool. It is an open-source configuration management software widely used for server configuration, management, deployment, and orchestration of various applications and services across the whole infrastructure of an organization.
Puppet is specially designed to manage the configuration of Linux and Windows systems. It is written in Ruby and uses its unique **D**omain **S**pecific **L**anguage (DSL) to describe system configuration.

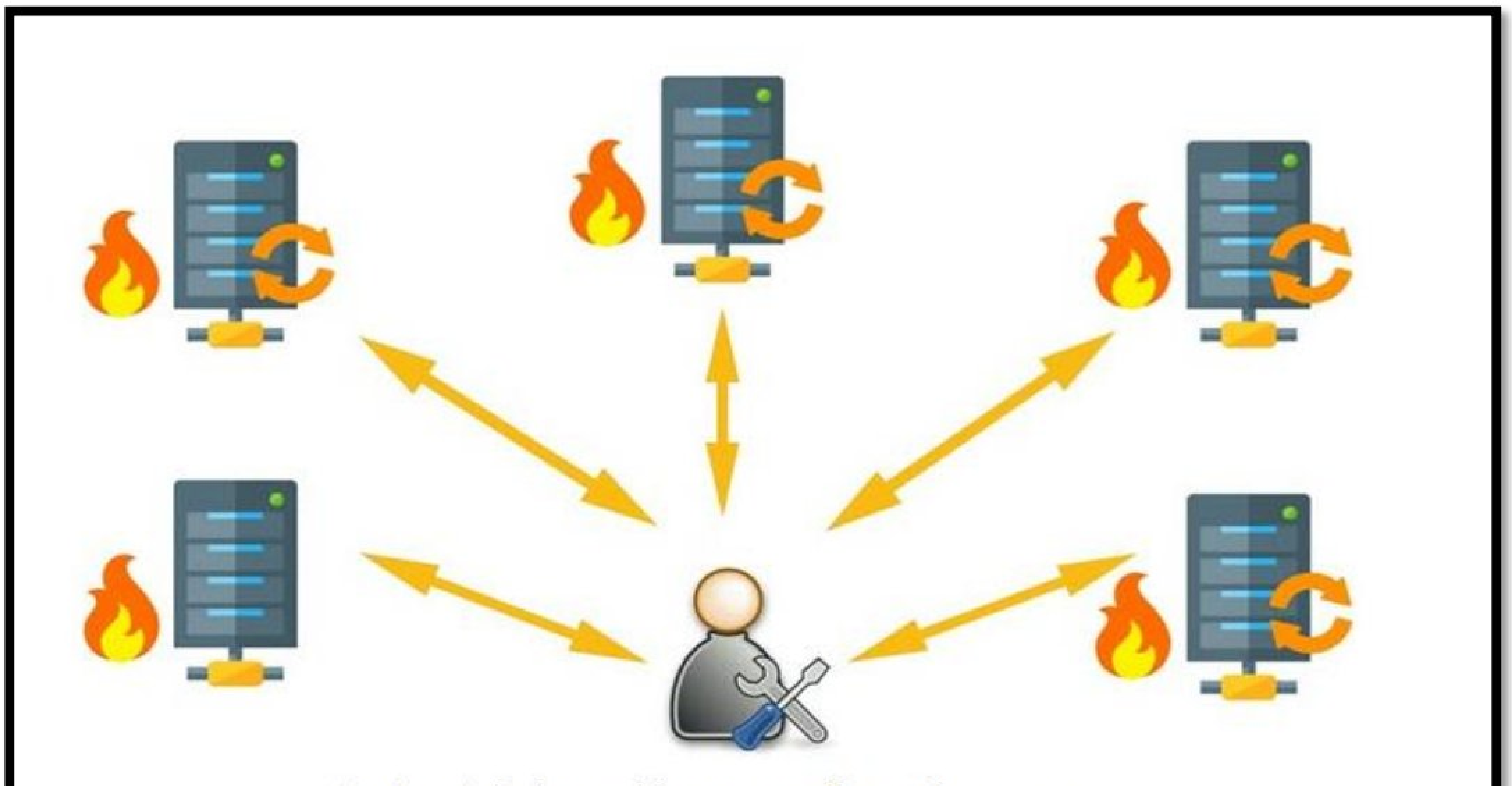
What are the Puppet versions?

Puppet comes in two versions:

- **Open Source Puppet**: It is a basic version of Puppet configuration management tool, which is also known as Open Source Puppet. It is available directly from Puppet's website and is licensed under the Apache 2.0 system.
- **Puppet Enterprise**: Commercial version that offers features like compliance reporting, orchestration, role-based access control, GUI, API, and command-line tools for effective management of nodes.

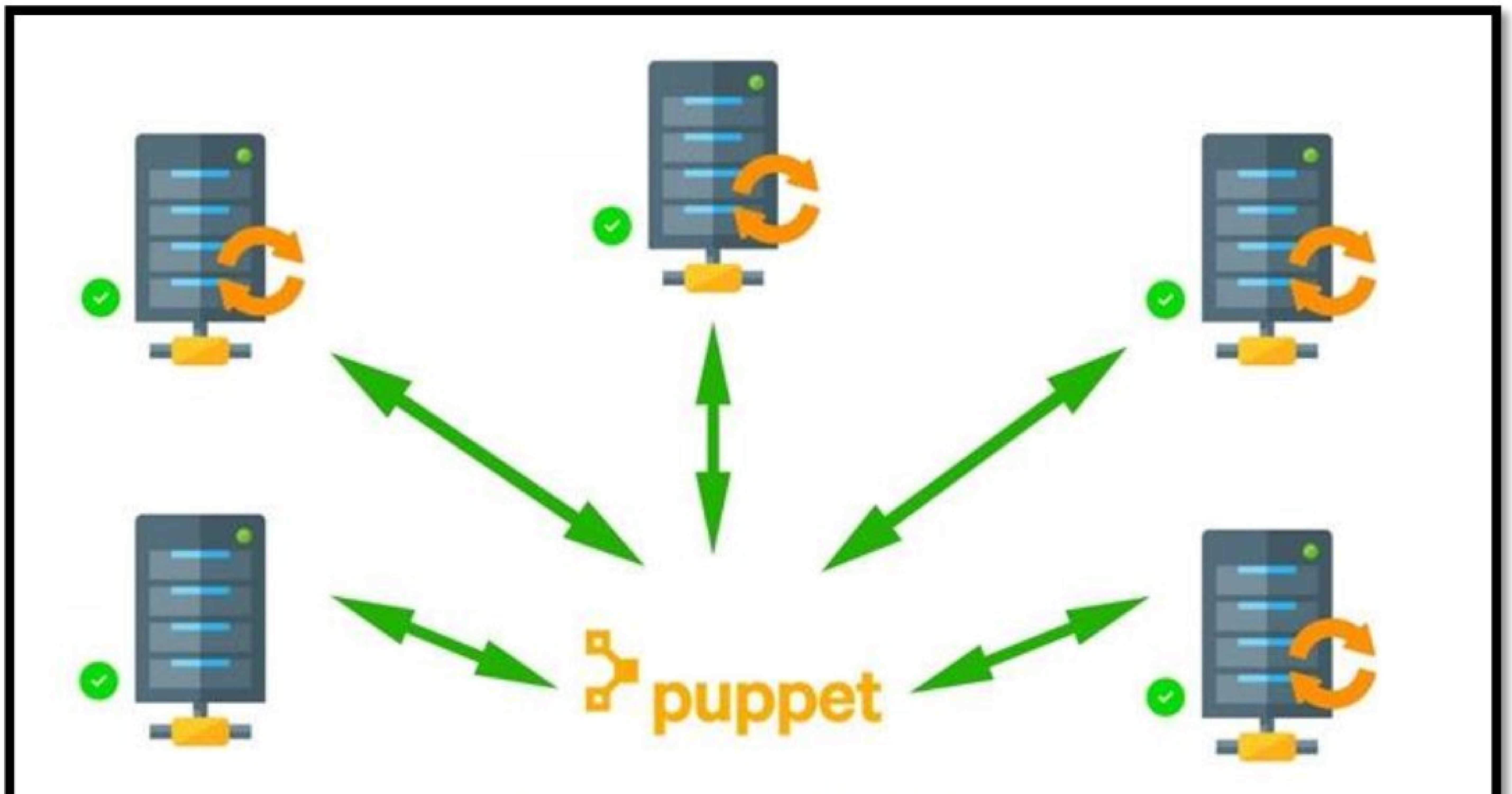
What Puppet can do?

For example, you have an infrastructure with about 100 servers. As a system admin, it's your role to ensure that all these servers are always up to date and running with full functionality.



System Admin working manually on the servers

To do this, you can use Puppet, which allows you to write a simple code which can be deployed automatically on these servers. This reduces the human effort and makes the development process fast and effective.



Puppet automates Server Management

Puppet performs the following functions:

- Puppet allows you to define distinct configurations for every host.
- The tool allows you to continuously monitor servers to confirm whether the required configuration exists or not and it is not altered. If the config is changed, Puppet tool will revert to the pre-defined configuration on the host.
- It also provides control over all the configured system, so a centralized change gets automatically effected.
- It is also used as a deployment tool as it automatically deploys software to the system. It implements the **infrastructure as a code because policies and configurations are written as code.**

Puppet DSL and Programming Paradigms

Before we learn Puppet DSL, let's understand programming paradigms:
A programming paradigm is a style you are using in computer programming.

Four types of paradigms are:

Imperative.

Declarative.

Functional (which is considered a subset of that declarative paradigm)

Object-oriented.

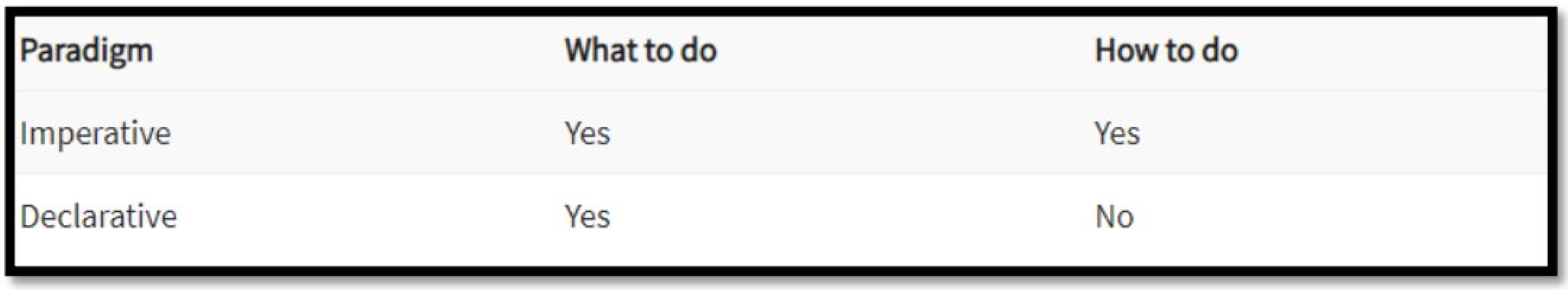
We will focus on Imperative and Declarative.

Imperative Paradigms:

This programming paradigm expresses the logic of a computation(What to do) and describes its control flow(How to do)
Example:
Assume you are going to your office, you book a cab and start giving step by step directions to the driver until you reach the office. Specifying what to do and how to do is an imperative style.

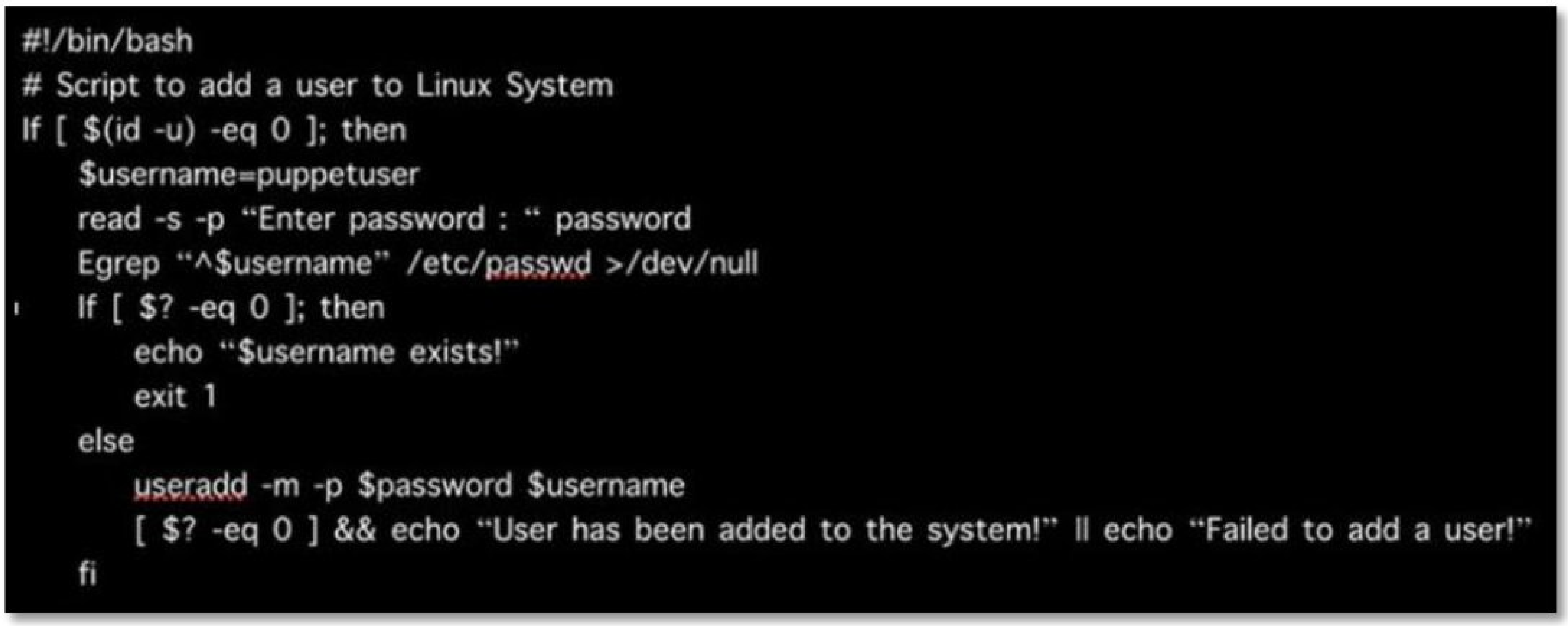
Declarative Paradigms:

This programming paradigm expresses the logic of a computation(What to do) without describing its control flow(How to do)
Example:
Assume you are going to your office, you book Uber cab and specify the final destination (Office). Specifying what to do not how to do is a declarative style.



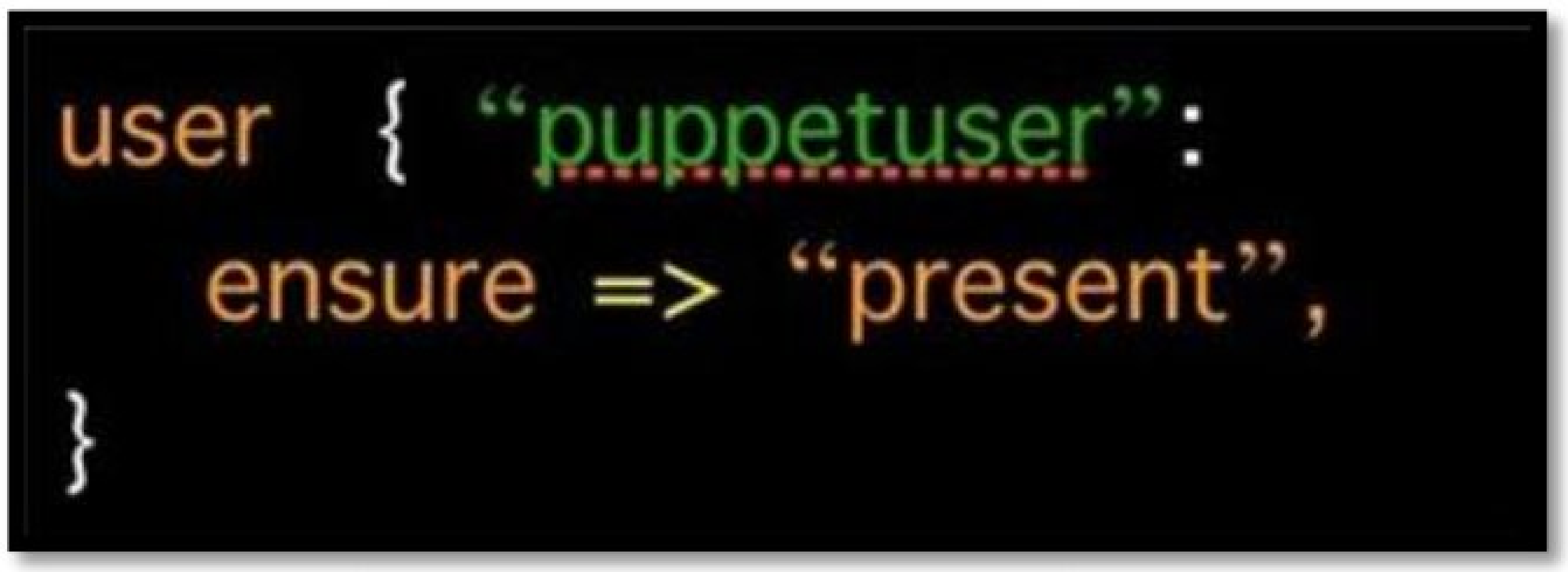
Paradigm	What to do	How to do
Imperative	Yes	Yes
Declarative	Yes	No

uppet uses a declarative programming paradigm
Puppet uses a declarative programming approach.
Example: Create a user on the system:
It can be done using Imperative programming pattern by a shell script: Here we specify how to create the user and what commands to use on the operating system.



```
#!/bin/bash
# Script to add a user to Linux System
If [ $(id -u) -eq 0 ]; then
    $username=puppetuser
    read -s -p "Enter password : " password
    Egrep "^$username" /etc/passwd >/dev/null
    If [ $? -eq 0 ]; then
        echo "$username exists!"
        exit 1
    else
        useradd -m -p $password $username
        [ $? -eq 0 ] && echo "User has been added to the system!" ll echo "Failed to add a user!"
    fi
```

However, it can be done using Declarative programming pattern with only a few lines of puppet code, Puppet domain specific language (DSL), and still achieve the same result.



```
user  { "puppetuser":
    ensure => "present",
}
```

Deployment models of configuration management tools
There are two deployment models for configuration management tools :

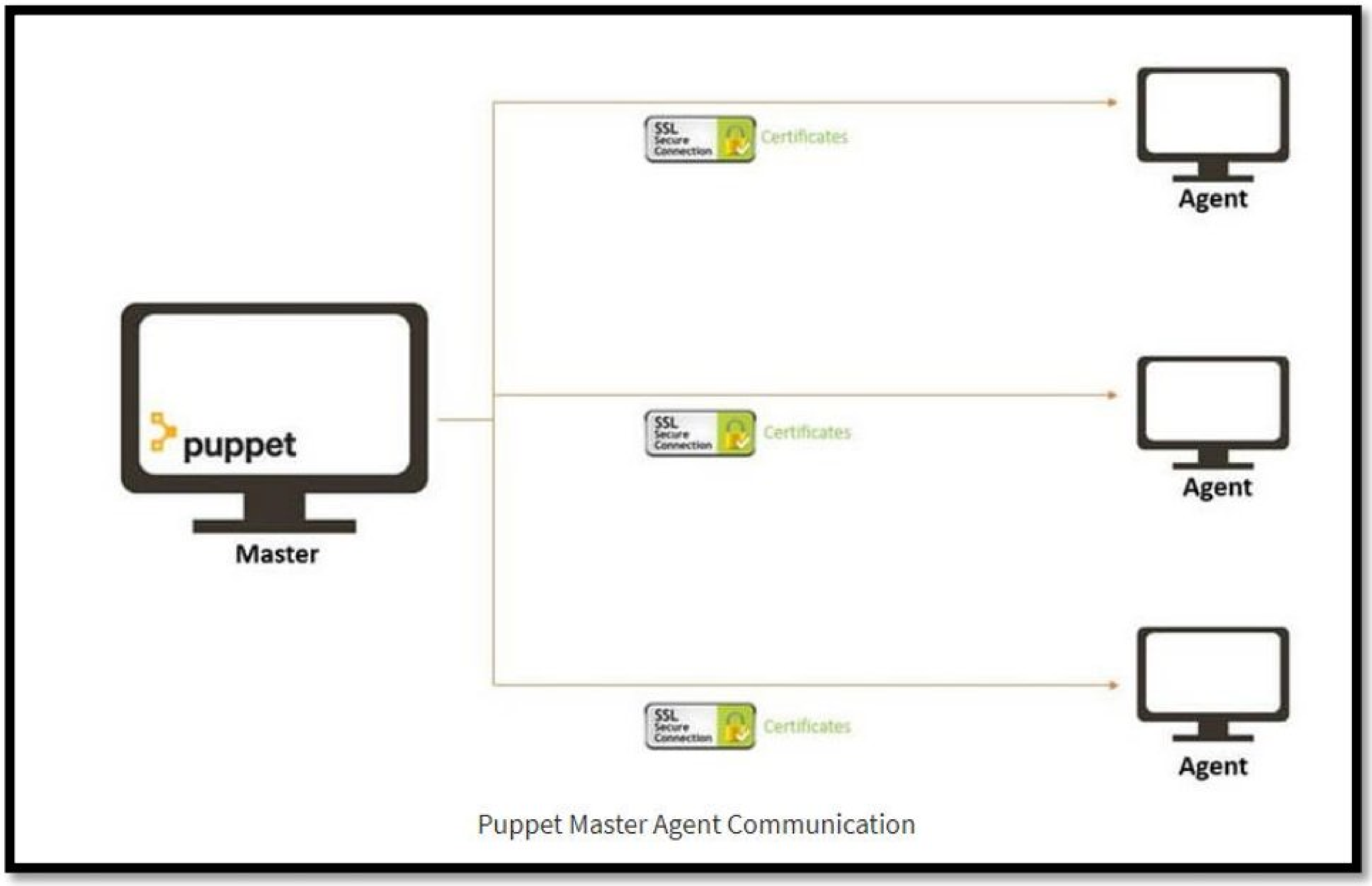
- Push-based deployment model: initiated by a master node.
- Pull-based deployment model: initiated by agents.

Push-based deployment model:
In this deployment model master server pushes the configurations and software to the individual agents. After verifying a secure connection, the master runs commands remotely on the agents. For example, Ansible and Salt Stack.
Pull-based deployment model.
In this deployment model, individual servers contact a master server, verify and establish a secure connection, download their configurations and software and then configure themselves accordingly — for example, Puppet and Chef.

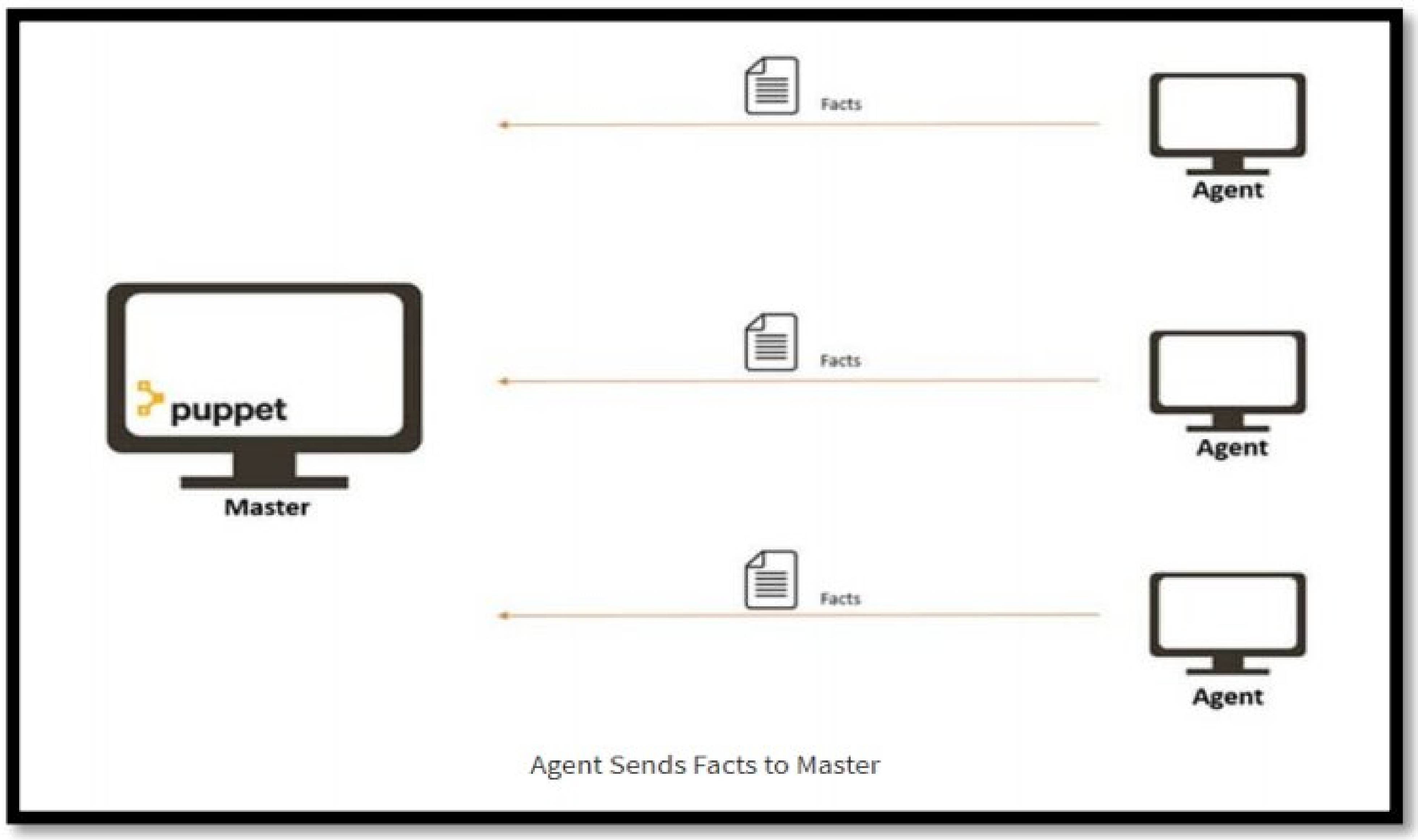
How Puppet works?
Puppet is based on a Pull deployment model, where the agent nodes check in regularly after every **1800** seconds with the master node to see if anything needs to be updated in the agent. If anything needs to be updated the agent pulls the necessary puppet codes from the master and performs required actions.
Let's explain it by an example:
Example: Master – Agent Setup:
The Master:
A Linux based machine with Puppet master software installed on it. It is responsible for maintaining configurations in the form of puppet codes. The master node can only be Linux.

The Agents:
The target machines managed by a puppet with the puppet agent software installed on them.
The agent can be configured on any supported operating system such as Linux or Windows or Solaris or Mac OS.
The communication between master and agent is established through secure certificates.

Communication between the Master and the Agent:
Step 1) Once the connectivity is established between the agent and the master, the Puppet agent sends the data about its state to the Puppet master server. These are called Facts: This information includes the hostname, kernel details, IP address, file name details, etc….

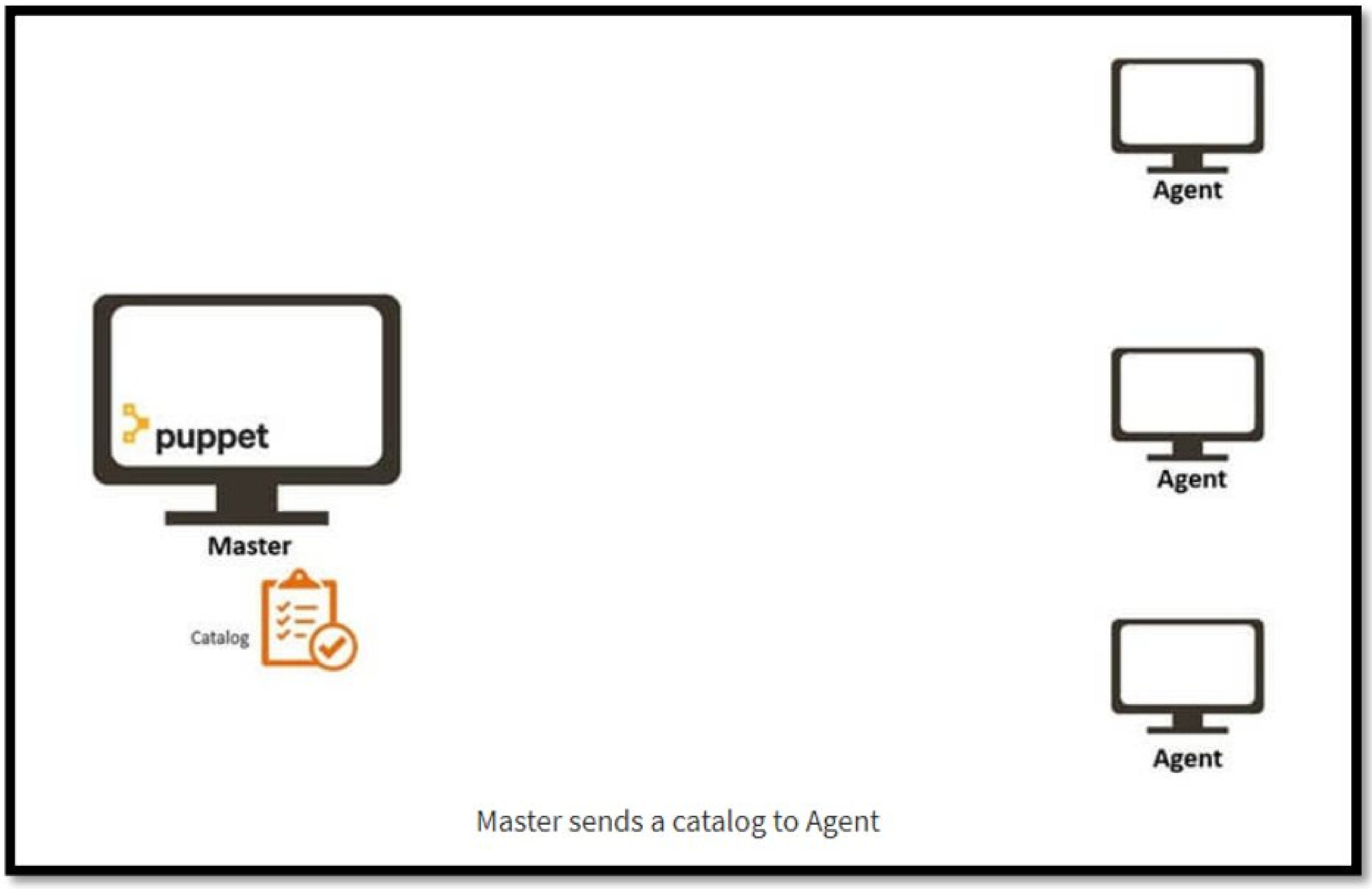


Puppet Master Agent Communication

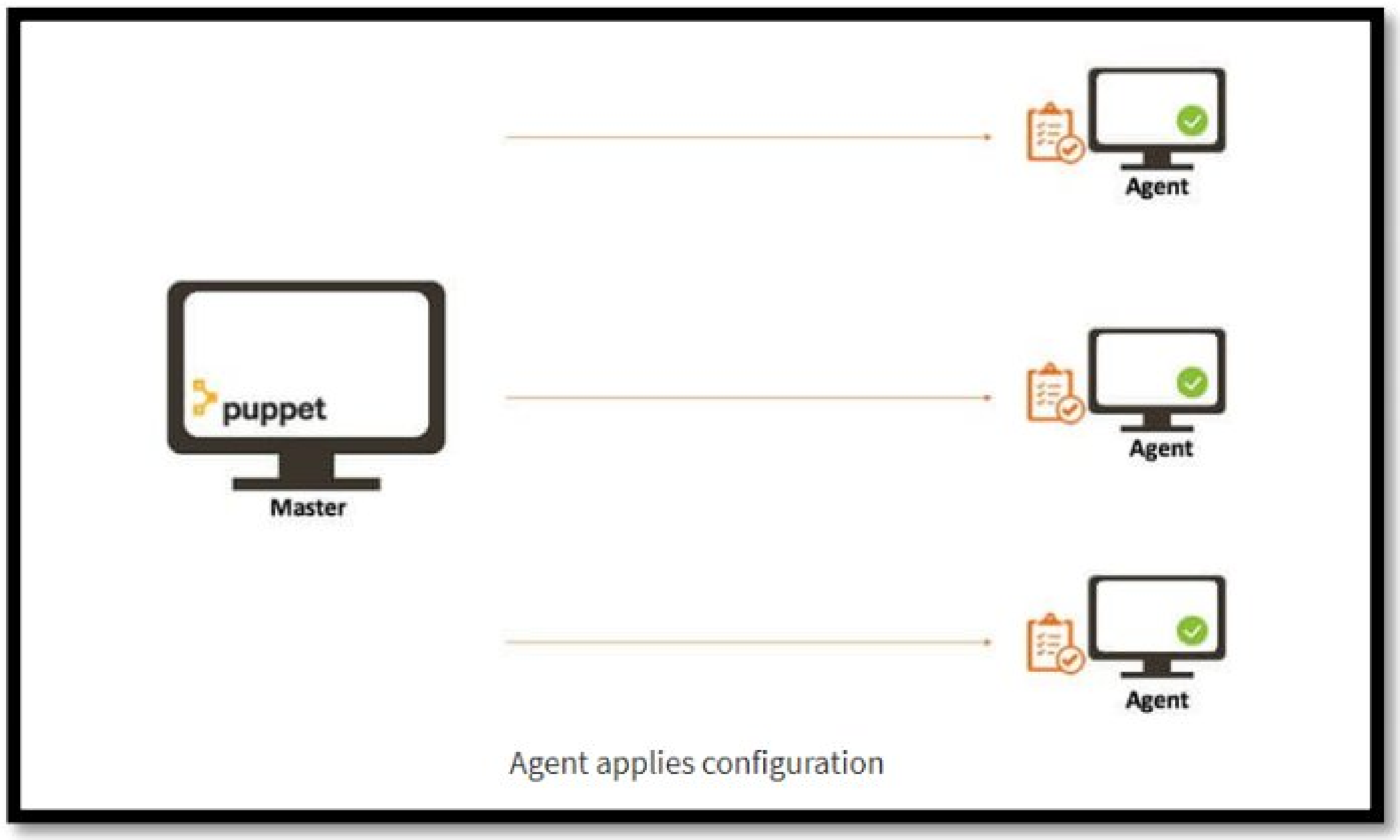


Agent Sends Facts to Master

Step 2) Puppet Master uses this data and compiles a list with the configuration to be applied to the agent. This list of configuration to be performed on an agent is known as a **catalog.** This could be changed such as package installation, upgrades or removals, File System creation, user creation or deletion, server reboot, IP configuration changes, etc.



Step 3) The agent uses this list of configuration to apply any required configuration changes on the node.
In case there are no drifts in the configuration, Agent does not perform any configuration changes and leaves the node to run with the same configuration.



Step 4) Once it is done the node reports back to puppet master indicating that the configuration has been applied and completed.

Puppet Blocks

Puppet provides the flexibility to integrate Reports with third-party tools using Puppet APIs.

Four types of Puppet building blocks are

1. Resources
2. Classes
3. Manifest
4. Modules

Puppet Resources:

Puppet Resources are the building blocks of Puppet.

Resources are the **inbuilt functions** that run at the back end to perform the required operations in puppet.

Puppet Classes:

A combination of different resources can be grouped together into a single unit called class.

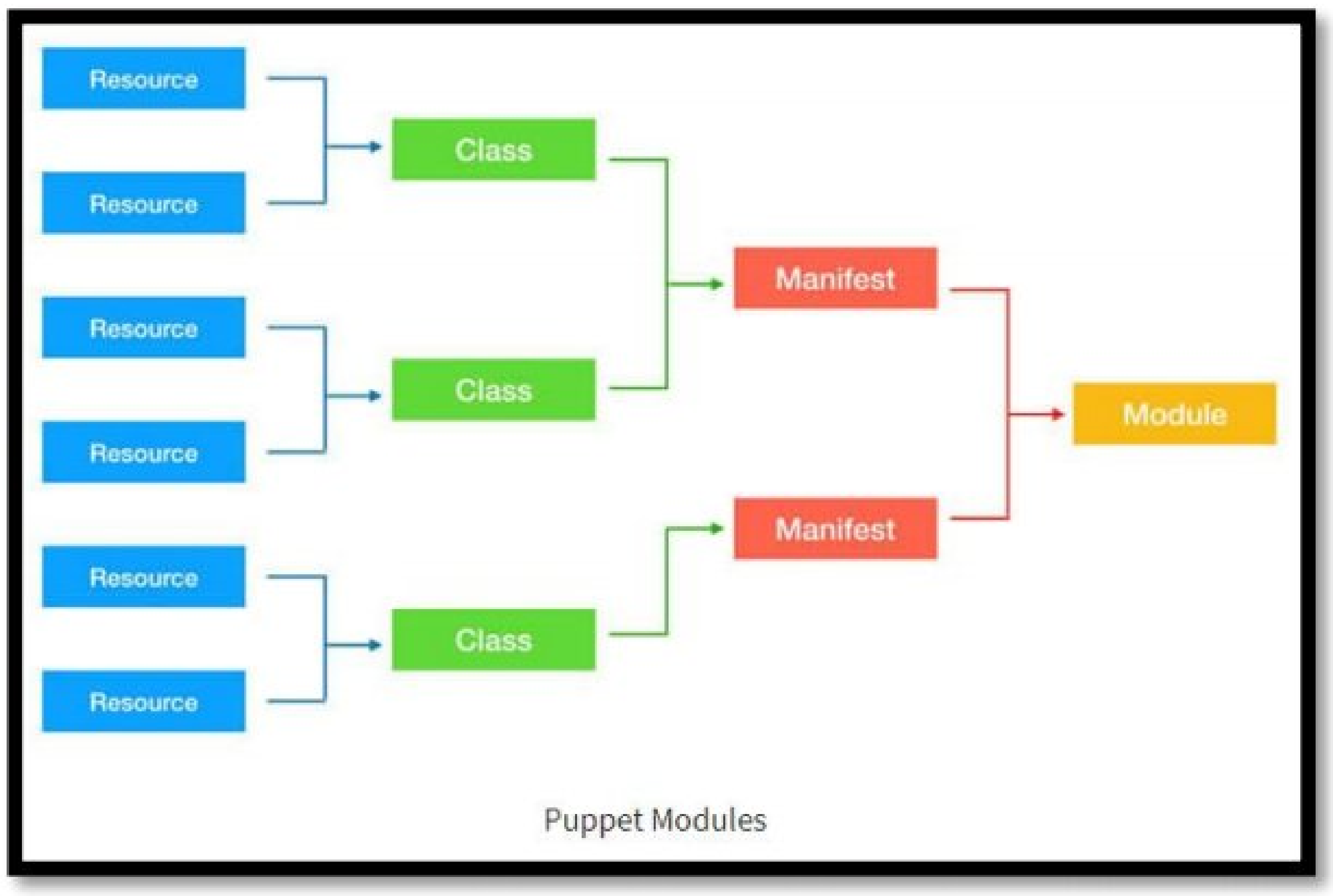
Puppet Manifest:

Manifest is a directory containing puppet DSL files. Those files have a .pp extension. The .pp extension stands for puppet program. The puppet code consists of definitions or declarations of Puppet Classes.

Puppet Modules:

Modules are a collection of files and directories such as Manifests, Class definitions. They are the re-usable and sharable units in Puppet.

For example, the MySQL module to install and configure MySQL or the Jenkins module to manage Jenkins, etc..



Types of Puppet resources

In general, a system consists of files, users, services, processes, packages, etc. In Puppet, these are called resources. Resources are the fundamental building blocks in

Puppet. All the operations on puppet agents are performed with the help of puppet resources.

Puppet resources are the readymade tools that are used to perform various tasks and operations on any supported platform. We can use a single puppet resource to perform a specific task, or we can use multiple puppet resources together to perform some complex application configurations deployments.

Resources can have different types. Puppet uses **resources** and **resource types** in order to describe a system's configuration.

There are three kinds of resource types:

1. Puppet core or built-in resource types.
2. Puppet defined resource types.
3. Puppet custom resource types.

Puppet core or built-in resource types:

Core or built-in resource types are the pre-built puppet resource types shipped with puppet software. All of the core or built-in Puppet resource types are written and maintained by Puppet team.

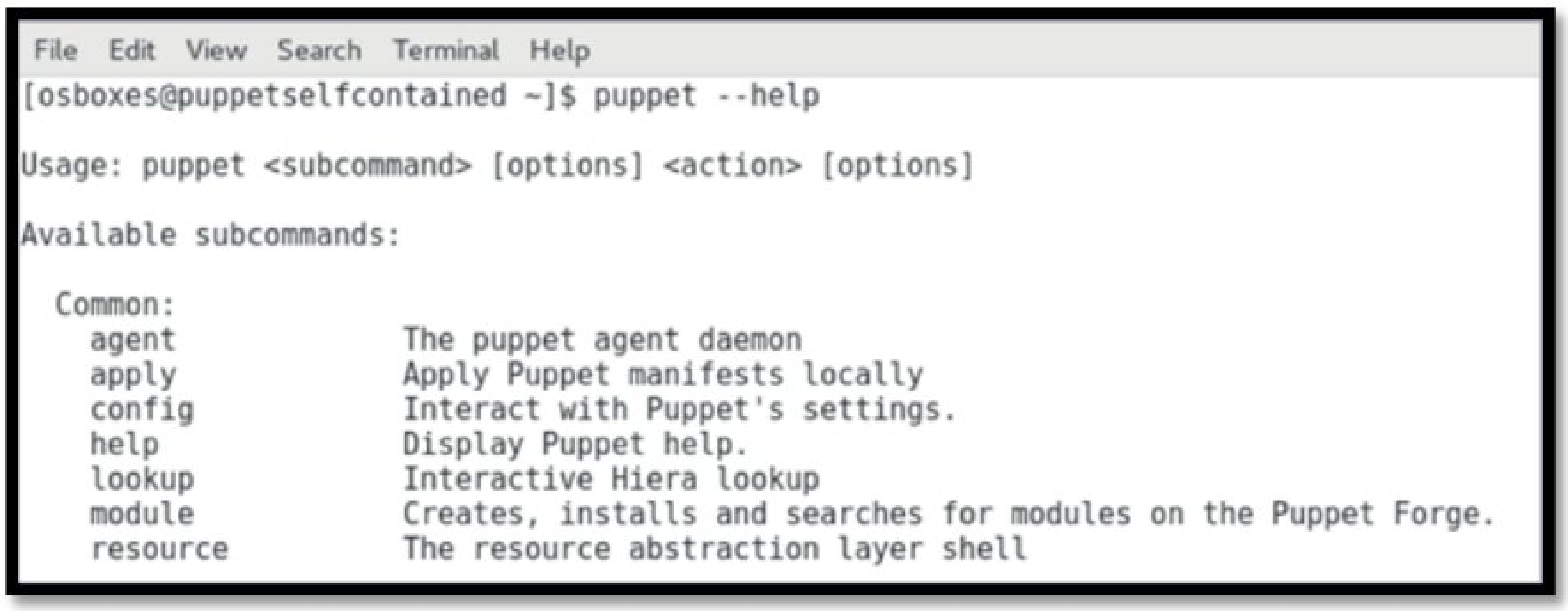
Puppet defined resource types:

Defined resource types are lightweight resource types written in Puppet declarative language using a combination of existing resource types.

Puppet custom resource types:

Custom resource types are completely customized resource types written in Ruby. command to display a list of Puppet relevant subcommands:

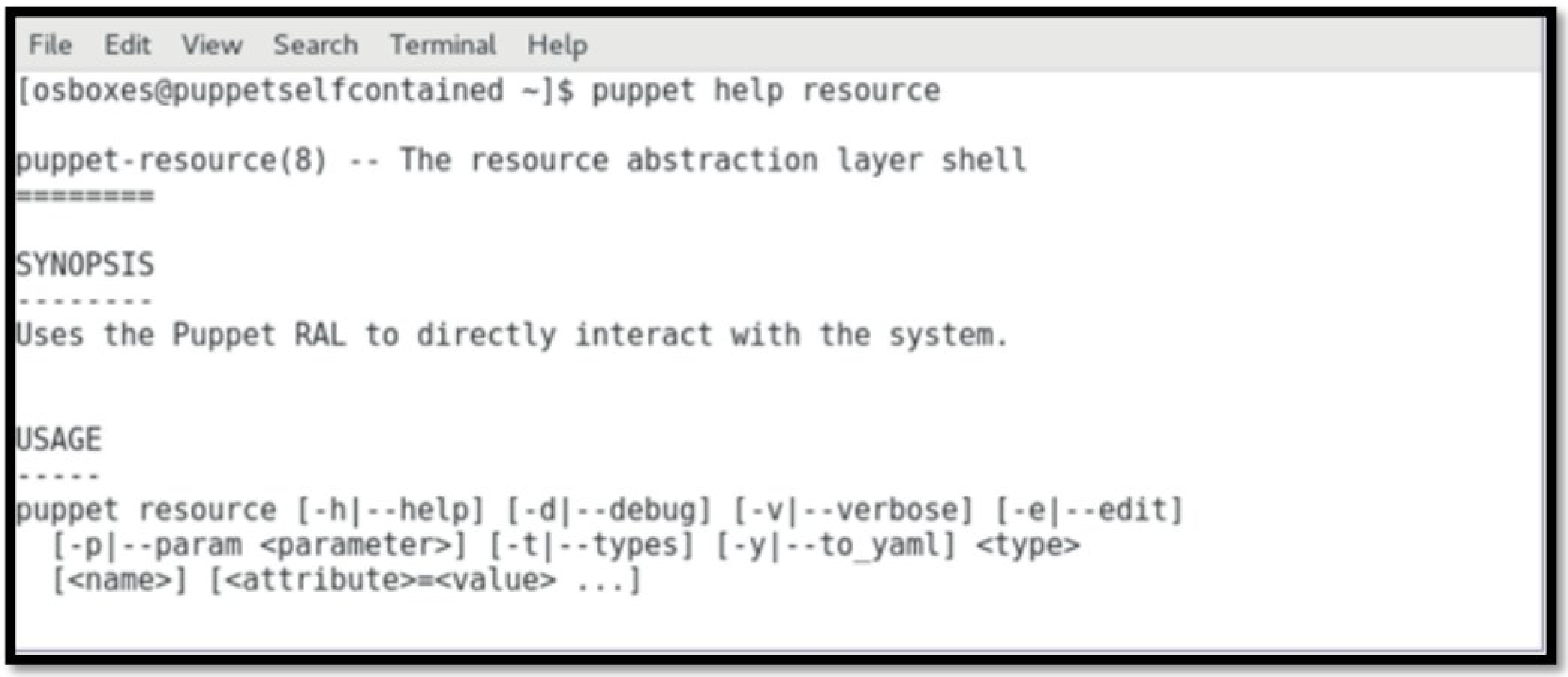
```
Puppet --help
```



```
[osboxes@puppetselfcontained ~]$ puppet --help

Usage: puppet <subcommand> [options] <action> [options]

Available subcommands:

  Common:
    agent            The puppet agent daemon
    apply            Apply Puppet manifests locally
    config           Interact with Puppet's settings.
    help             Display Puppet help.
    lookup           Interactive Hiera lookup
    module           Creates, installs and searches for modules on the Puppet Forge.
    resource         The resource abstraction layer shell
```

In our case, we are interested in the subcommand "**resource**" which we will use to find the information about inbuilt puppet resource types.
In the terminal, type any of the following commands to display a list of **actions** associated with the puppet subcommand "**resource**":

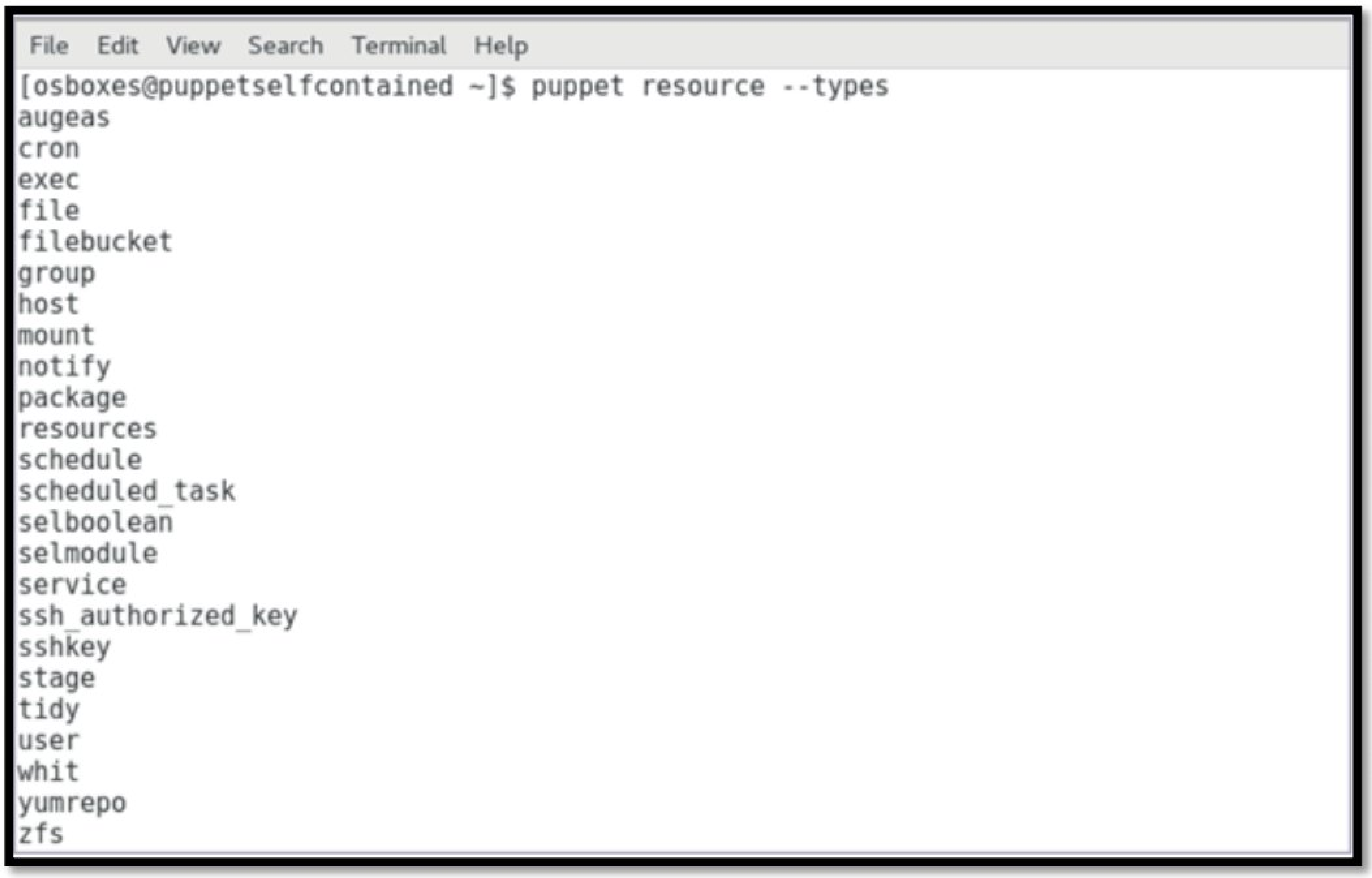
```
Puppet help resource
Puppet resource --help
```



```
[osboxes@puppetselfcontained ~]$ puppet help resource

puppet-resource(8) -- The resource abstraction layer shell
========

SYNOPSIS
--------
Uses the Puppet RAL to directly interact with the system.


USAGE
-----
puppet resource [-h|--help] [-d|--debug] [-v|--verbose] [-e|--edit]
  [-p|--param <parameter>] [-t|--types] [-y|--to_yaml] <type>
  [<name>] [<attribute>=<value> ...]
```

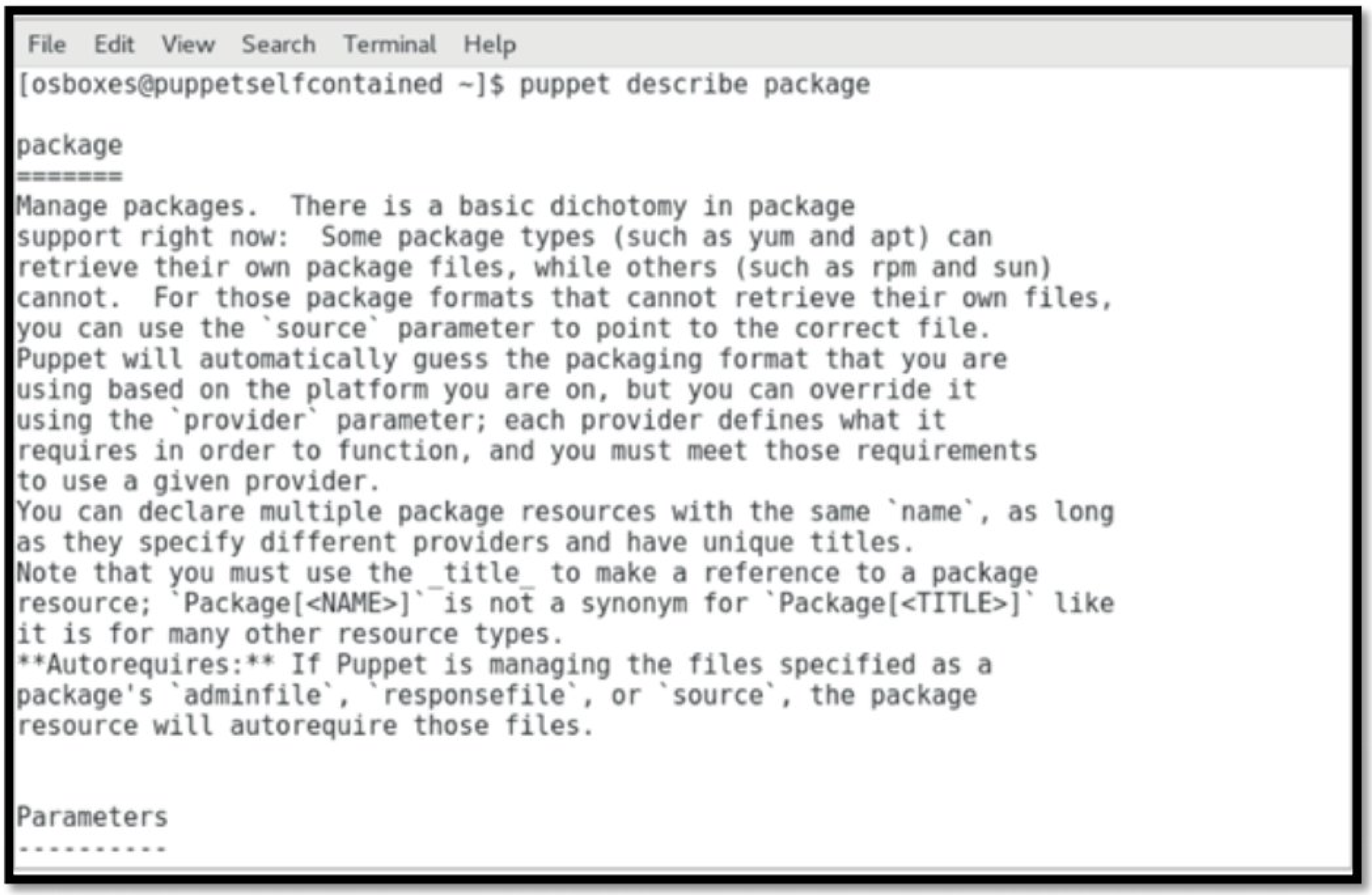
In this case, we have the **resource** as subcommand and **–types** as action.
Puppet has 49 inbuilt core resource types.
In the terminal, type the following command to display a list of available inbuilt puppet resource types:

```
puppet resource –types
```

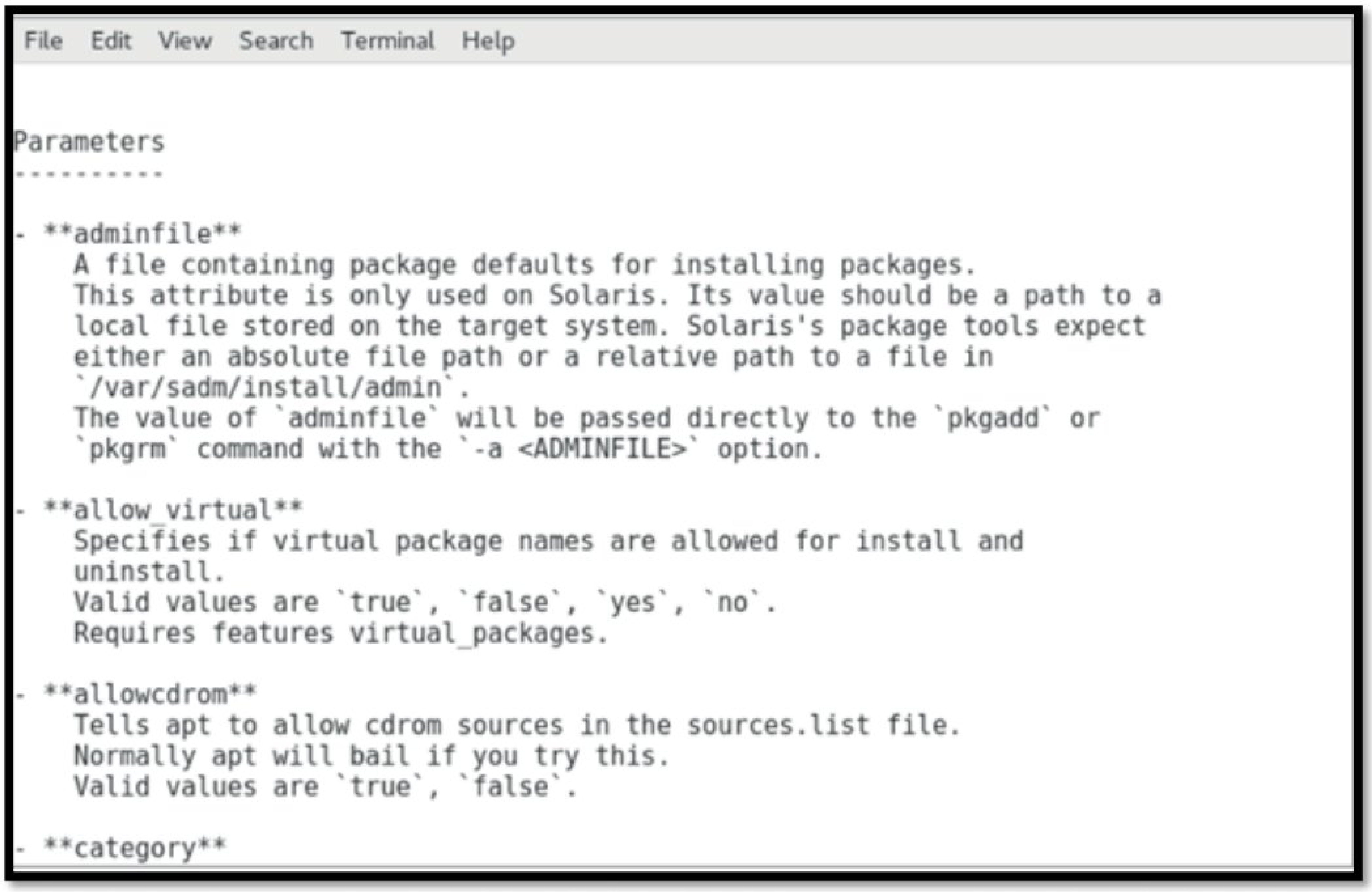


```
[osboxes@puppetselfcontained ~]$ puppet resource --types
augeas
cron
exec
file
filebucket
group
host
mount
notify
package
resources
schedule
scheduled_task
selboolean
selmodule
service
ssh_authorized_key
sshkey
stage
tidy
user
whit
yumrepo
zfs
```

Each type supports a list of **attributes**. These attributes provide a detailed description that Puppet uses to manage the resource.
To find out all the attributes associated with the puppet resource type, use the following command:
puppet describe <resource type name>
Parameters will list all the available attributes for that resource type.
puppet describe package



```
[osboxes@puppetselfcontained ~]$ puppet describe package

package
=======
Manage packages.  There is a basic dichotomy in package
support right now:  Some package types (such as yum and apt) can
retrieve their own package files, while others (such as rpm and sun)
cannot.  For those package formats that cannot retrieve their own files,
you can use the `source` parameter to point to the correct file.
Puppet will automatically guess the packaging format that you are
using based on the platform you are on, but you can override it
using the `provider` parameter; each provider defines what it
requires in order to function, and you must meet those requirements
to use a given provider.
You can declare multiple package resources with the same `name`, as long
as they specify different providers and have unique titles.
Note that you must use the _title_ to make a reference to a package
resource; `Package[<NAME>]` is not a synonym for `Package[<TITLE>]` like
it is for many other resource types.
**Autorequires:** If Puppet is managing the files specified as a
package's `adminfile`, `responsefile`, or `source`, the package
resource will autorequire those files.


Parameters
----------
```



```


Parameters
----------

- **adminfile**
    A file containing package defaults for installing packages.
    This attribute is only used on Solaris. Its value should be a path to a
    local file stored on the target system. Solaris's package tools expect
    either an absolute file path or a relative path to a file in
    `/var/sadm/install/admin`.
    The value of `adminfile` will be passed directly to the `pkgadd` or
    `pkgrm` command with the `-a <ADMINFILE>` option.

- **allow_virtual**
    Specifies if virtual package names are allowed for install and
    uninstall.
    Valid values are `true`, `false`, `yes`, `no`.
    Requires features virtual_packages.

- **allowcdrom**
    Tells apt to allow cdrom sources in the sources.list file.
    Normally apt will bail if you try this.
    Valid values are `true`, `false`.

- **category**
```

It’s hard for a new person to understand and relate many unmanaged puppet code files. This is where we need some grouping to tie together operations. The aim is to solve a single problem, such as all operations required to configure ssh on a server or ntp service or a complete web server or database server from scratch.

What are Puppet Classes?

Puppet classes are the collection of puppet resources bundled together as a single unit.

Puppet introduced classes to make the structure re-usable and organized.

First, we need to define a class using class definition syntax; classes must be unique and can be declared only once with the same name:

```
class <class-name> {
<Resource declarations>
}
```

Example:

```
class ntpconfig {
file {
"/etc/ntp.conf":
ensure=> "present", content=> "server 0.centos.pool.ntp.org iburst\n",
}
}
```

So far we have only defined the class, but we have not used it anywhere. Meaning this code that we have written will never get executed unless we declare this class elsewhere.

Class Declaration

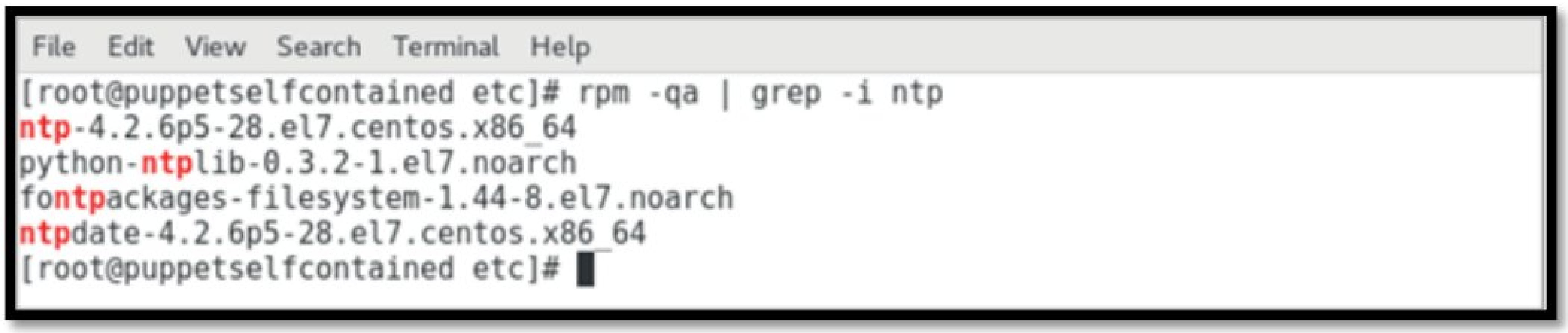
To use a defined class in code, use the **include** keyword.

```
class ntpconfig {
file {
"/etc/ntp.conf":
ensure=> "present",
content=> "server 0.centos.pool.ntp.org iburst\n",
}
}
include ntpconfig
```

Demo install NTP

First, make sure the NTP package is not already present on the server, the following command will return nothing if the telnet is not present on the server:

```
rpm -qa | grep -i ntp
```



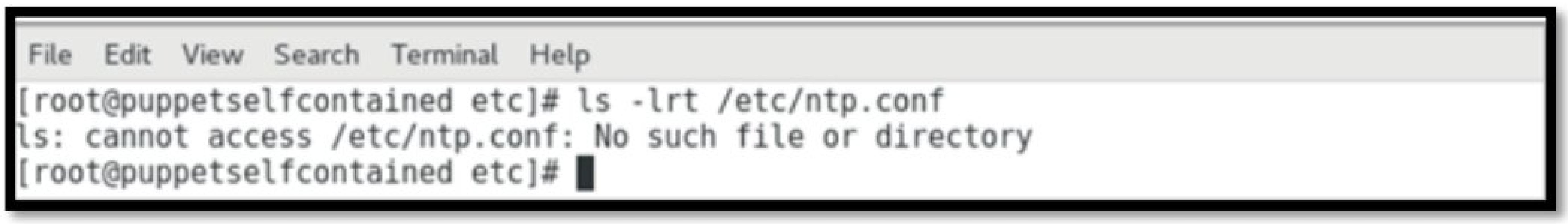
```
File  Edit  View  Search  Terminal  Help
[root@puppetselfcontained etc]# rpm -qa | grep -i ntp
ntp-4.2.6p5-28.el7.centos.x86_64
python-ntplib-0.3.2-1.el7.noarch
fontpackages-filesystem-1.44-8.el7.noarch
ntpdate-4.2.6p5-28.el7.centos.x86_64
[root@puppetselfcontained etc]# 
```

As we can see, the NTP package is already present on the server. Let's remove the existing NTP package:

```
yum remove ntp
```

After removing the package, ensure that ntp.conf file is not existing:

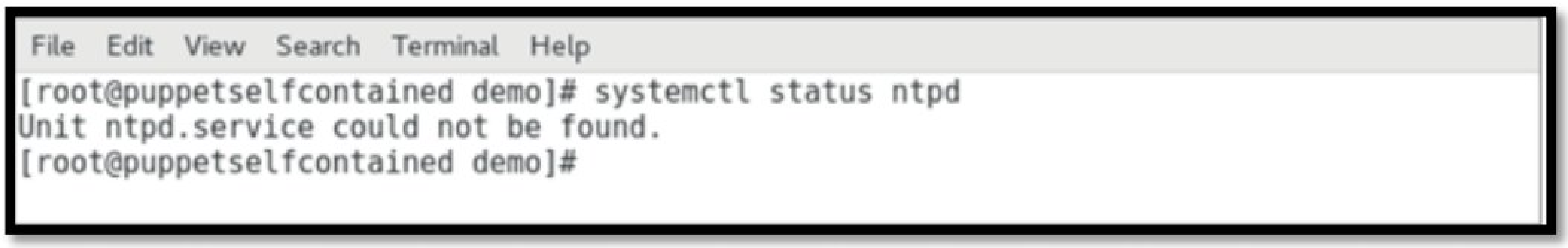
```
ls -lrt /etc/ntp.conf
```



```
File  Edit  View  Search  Terminal  Help
[root@puppetselfcontained etc]# ls -lrt /etc/ntp.conf
ls: cannot access /etc/ntp.conf: No such file or directory
[root@puppetselfcontained etc]# 
```

Verify the ntp service does not exist by running the following command:

```
systemctl status ntp
```



```
File  Edit  View  Search  Terminal  Help
[root@puppetselfcontained demo]# systemctl status ntpd
Unit ntpd.service could not be found.
[root@puppetselfcontained demo]#
```

Create a new .pp file to save the code. From the command line:

```
vi demontp.pp
```

Change to insert mode by pressing i from the keyboard.
code to create a new file:

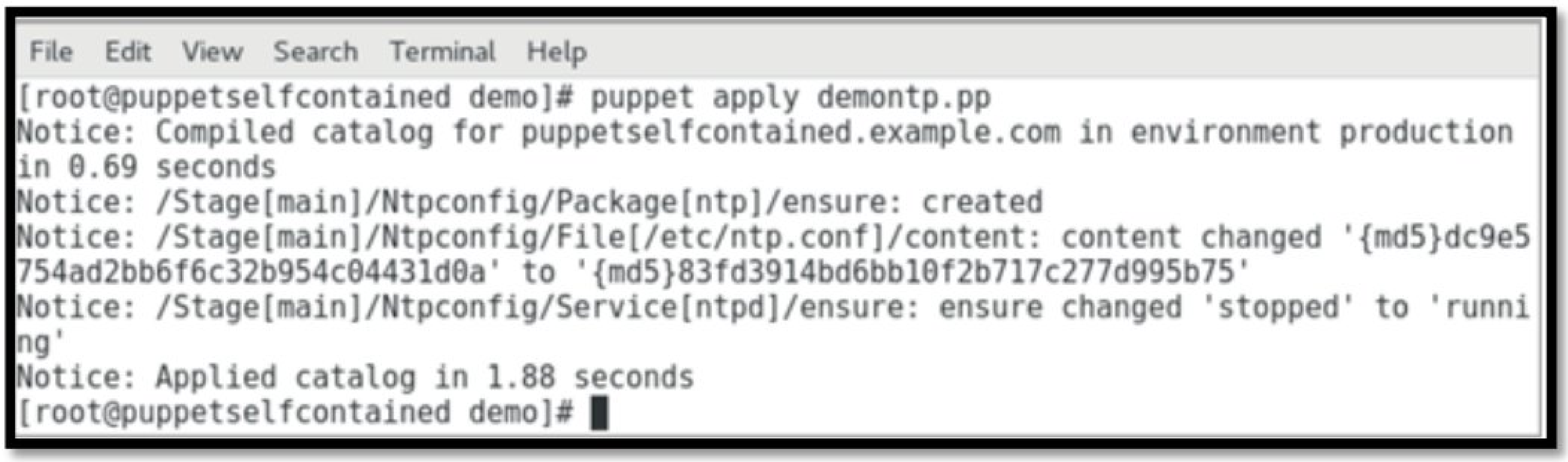
```
# Class Definition
class ntpconfig {
    # Installing NTP Package
  package {"ntp":
    ensure=> "present",
    }
    # Configuring NTP configuration file
  file {"/etc/ntp.conf":
    ensure=> "present",
    content=> "server 0.centos.pool.ntp.org iburst\n",
    }
    # Starting NTP services
  service {"ntpd":
    ensure=> "running",
    }
}
```

After done with editing : press esc
To save the file, press :wq!
Next step is to **check** whether the code has any syntax errors. Execute the following command:
puppet parser validate demontp.pp
Make sure that you switched to the **root** to be able to complete the test without any error, by executing the command :
su root
Test is the next step in the code creation process. Execute the following command to perform a smoke test:
Puppet applies demontp.pp --noop
Last step is to **run** the puppet in real mode and verify the output.
puppet apply demontp.pp

Puppet didn't perform anything because the demo class was just **defined** but not **declared**.
So, until you declare the puppet class, the code will not get applied.
Let's **declare** the demo class inside the same code using **include class name** at the end of the code:

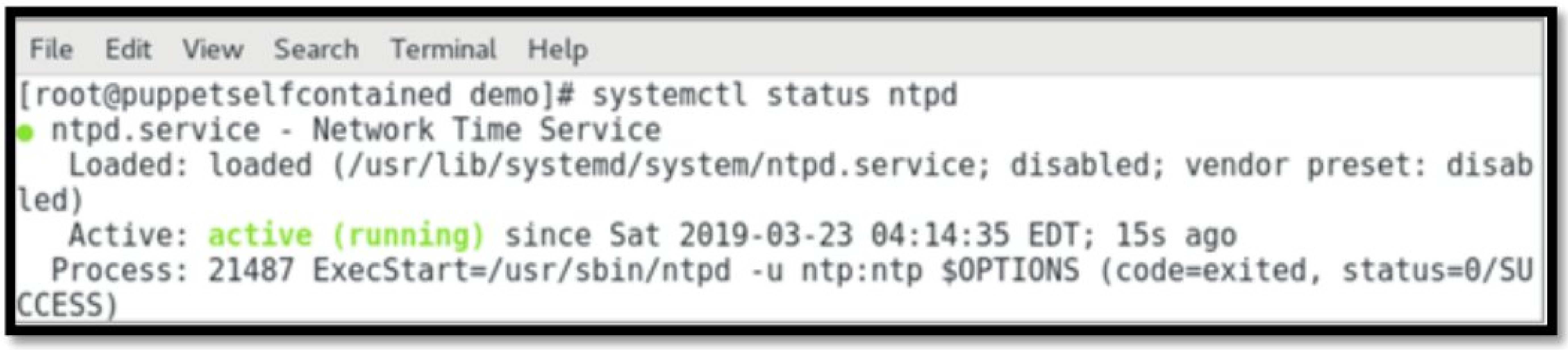
```
# Class Definition
class ntpconfig {
    # Installing NTP Package
  package {"ntp":
    ensure=> "present",
    }
    # Configuring NTP configuration file
  file {"/etc/ntp.conf":
    ensure=> "present",
    content=> "server 0.centos.pool.ntp.org iburst\n",
    }
    # Starting NTP services
  service {"ntpd":
    ensure=> "running",
    }
}

# Class Declaration
include ntpconfig
```

Again **check** whether the code has any syntax errors. Execute the following command:
puppet parser validate demontp.pp
Make sure that you switched to the **root** to be able to complete the test without any error, by executing the command :
su root
Testing is the next step in the code creation process. Execute the following command to perform a smoke test:
Puppet apply demontp.pp --noop
Last step is to **run** the puppet in real mode and verify the output.
puppet apply demontp.pp
This time the code gets applied because the class was defined and then declared.



```
[root@puppetselfcontained demo]# puppet apply demontp.pp
Notice: Compiled catalog for puppetselfcontained.example.com in environment production
in 0.69 seconds
Notice: /Stage[main]/Ntpconfig/Package[ntp]/ensure: created
Notice: /Stage[main]/Ntpconfig/File[/etc/ntp.conf]/content: content changed '{md5}dc9e5
754ad2bb6f6c32b954c04431d0a' to '{md5}83fd3914bd6bb10f2b717c277d995b75'
Notice: /Stage[main]/Ntpconfig/Service[ntpd]/ensure: ensure changed 'stopped' to 'runni
ng'
Notice: Applied catalog in 1.88 seconds
[root@puppetselfcontained demo]# 
```

Ensure that ntp.conf is now existing:
ls -lrt /etc/ntp.conf
Verify the ntp service has been started by running the following command:
systemctl status ntpd



```
[root@puppetselfcontained demo]# systemctl status ntpd
● ntpd.service - Network Time Service
   Loaded: loaded (/usr/lib/systemd/system/ntpd.service; disabled; vendor preset: disab
led)
   Active: active (running) since Sat 2019-03-23 04:14:35 EDT; 15s ago
  Process: 21487 ExecStart=/usr/sbin/ntpd -u ntp:ntp $OPTIONS (code=exited, status=0/SU
CCESS)
```

Conclusion:
Hence, We Successfully Studied Software Configuration Management and provisioning using Puppet Blocks(Manifest, Modules, Classes, Function).