Terraform - Introduction

Why Terraform?

- **IaC** (Infrastructure as Code) is one of the most important developments in application deployment in many years.
- Terraform is a **maverick** who appeared on the scene a few years ago and became more popular than all other IaC implementations
- Terraform is **open source** and can be used with any cloud provider, such as Amazon Web Services, IBM Cloud, Google Cloud Platform, Microsoft Azure, etc.
- Terraform is **declarative** and **idempotent** . These are good design principles, and many competitors have also implemented Terraform ideas, making Terraform a de facto standard

Terraform - Bird's Eye View

- What is Terraform?
- How does it compare to other similar tools?
- What is its place in the IaC ecosystem
  - IaC = Infrastructure as Code

What We Will Discuss

- The rise of DevOps
- What is infrastructure as code?
- The benefits of infrastructure as code
- How Terraform works
- How Terraform compares to other infrastructure as code tools

The Rise of DevOps - Before

- To build a software company
- Set up cabinets and racks
- Load them up with servers, etc.
- Set up "Devs" team, set up "Ops" team

The Rise of DevOps - Now

- There are AWS, Azure, GCP, etc.
- There are Chef, Puppet, Terraform, and Docker
  - Sysadmins write code
  - Devs write code
  - Ops write code - so DevOps is born
  - The goal of DevOps is to make software delivery vastly more efficient
- What if I do not have teams of admins, devs, ops?
- Say, my team is a multi-skilled group at a university?
  - DevOps as a movement is popular here as well, if not more
  - Borrowing on the ideas from the enterprise folks

With DevOps

- Nordstrom
  - number of features it delivered per month +100%
  - reduce defects by 50%
  - reduce lead times by 60%
- HP's LaserJet Firmware
  - time its developers spent on developing new features went from 5% to 40%
  - overall development costs were reduced by 40%
- Four core values in the DevOps movement
  - culture, automation, measurement, and sharing (CAMS)
- DevOps is now a **lifestyle**
- In research - ResearchOps in next

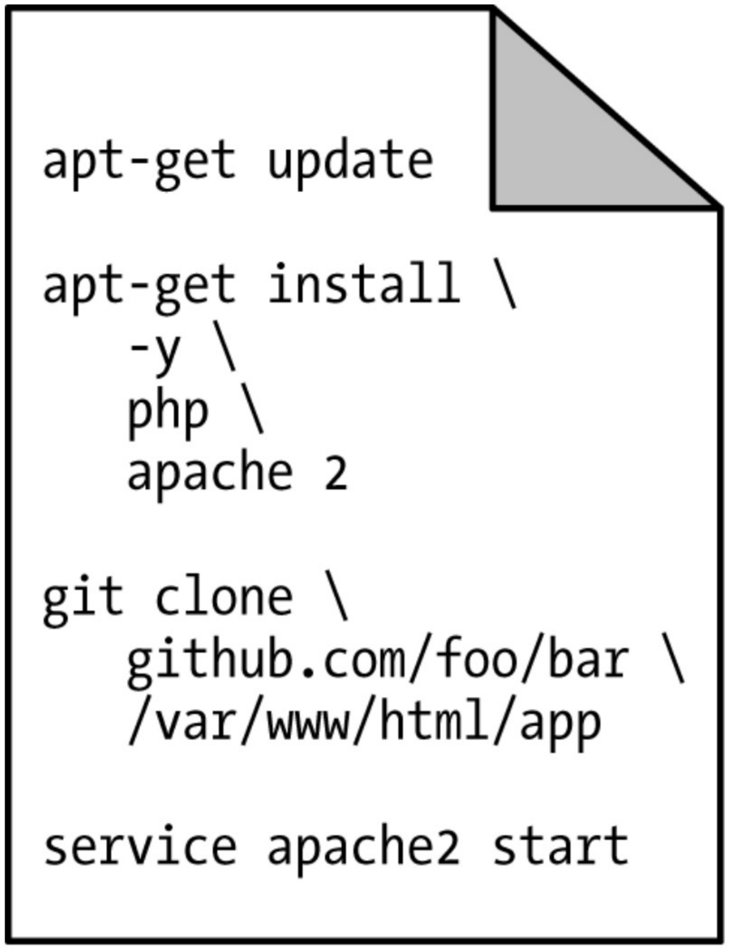
ResearchOps

- IBM paper
  - "ResearchOps: The case for DevOps in scientific applications"
  - Real-life projects at the IBM Research Brazil Lab
  - May just as well apply to other research institutions
  - Paper link

What Is Infrastructure as Code?

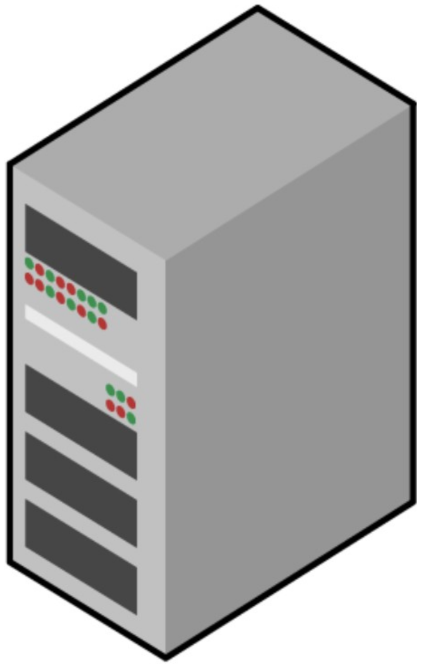
- There are five broad categories of IAC tools:
  - Ad hoc scripts
  - Configuration management tools
  - Server templating tools
  - Orchestration tools
  - Provisioning tools

Ad Hoc Scripts



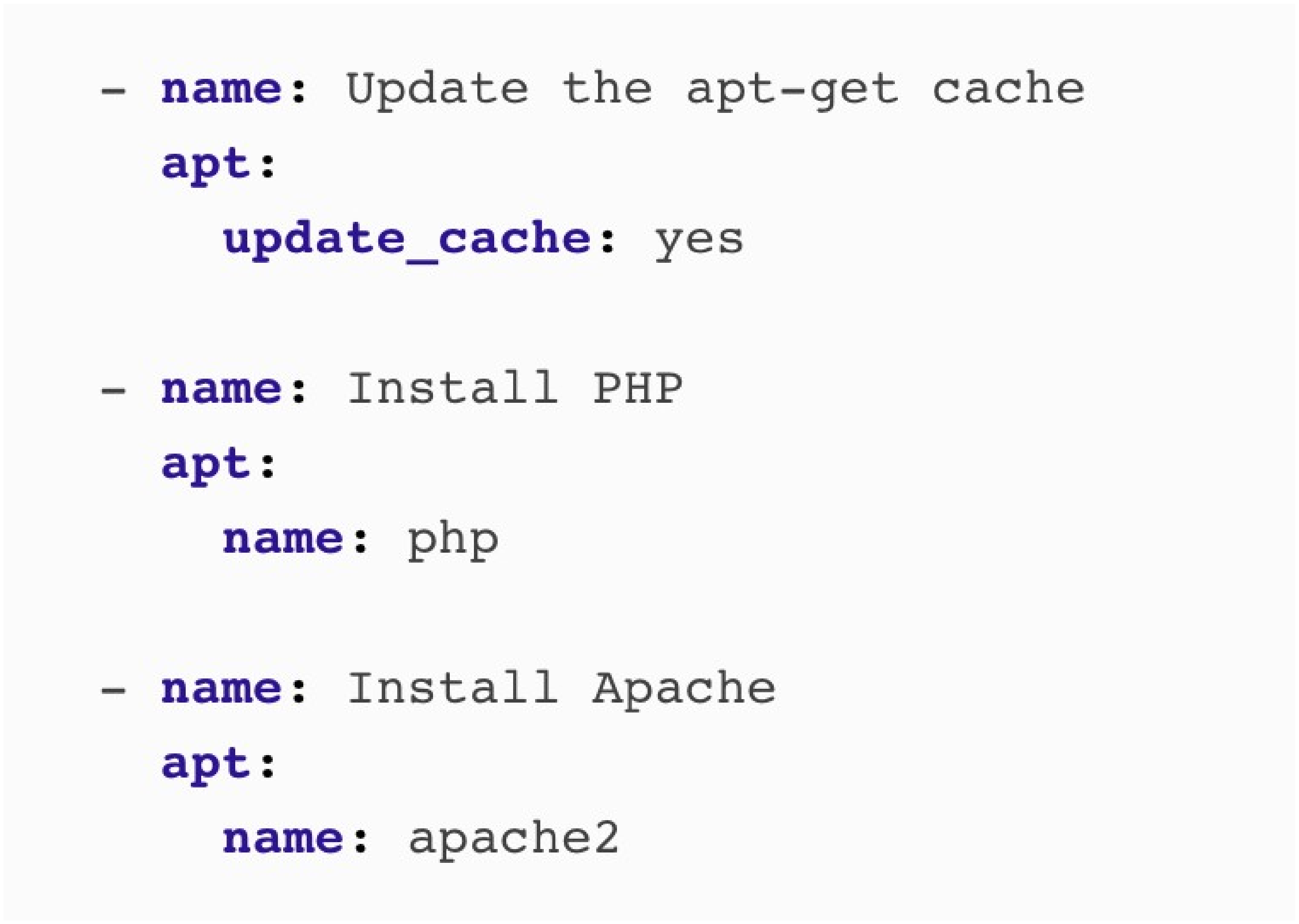
```
apt-get update

apt-get install \
   -y \
   php \
   apache 2

git clone \
   github.com/foo/bar \
   /var/www/html/app

service apache2 start
```

Ad hoc script



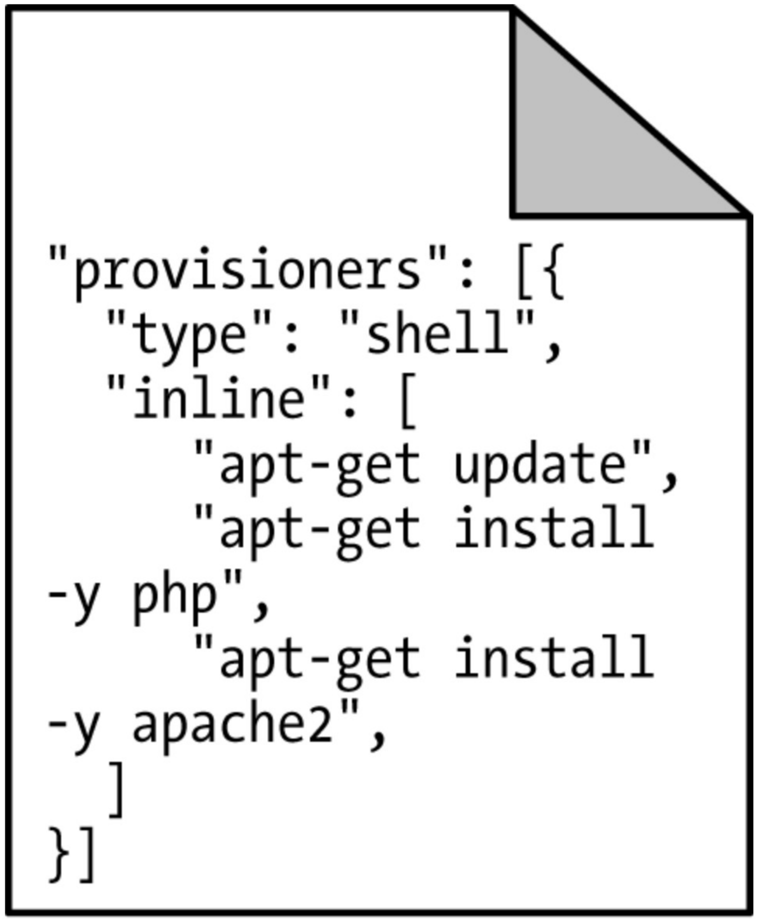
Configuration Management Tools

- Chef, Puppet, Ansible, and SaltStack
- Example of Ansible script



```
- name: Update the apt-get cache
  apt:
    update_cache: yes

- name: Install PHP
  apt:
    name: php

- name: Install Apache
  apt:
    name: apache2
```

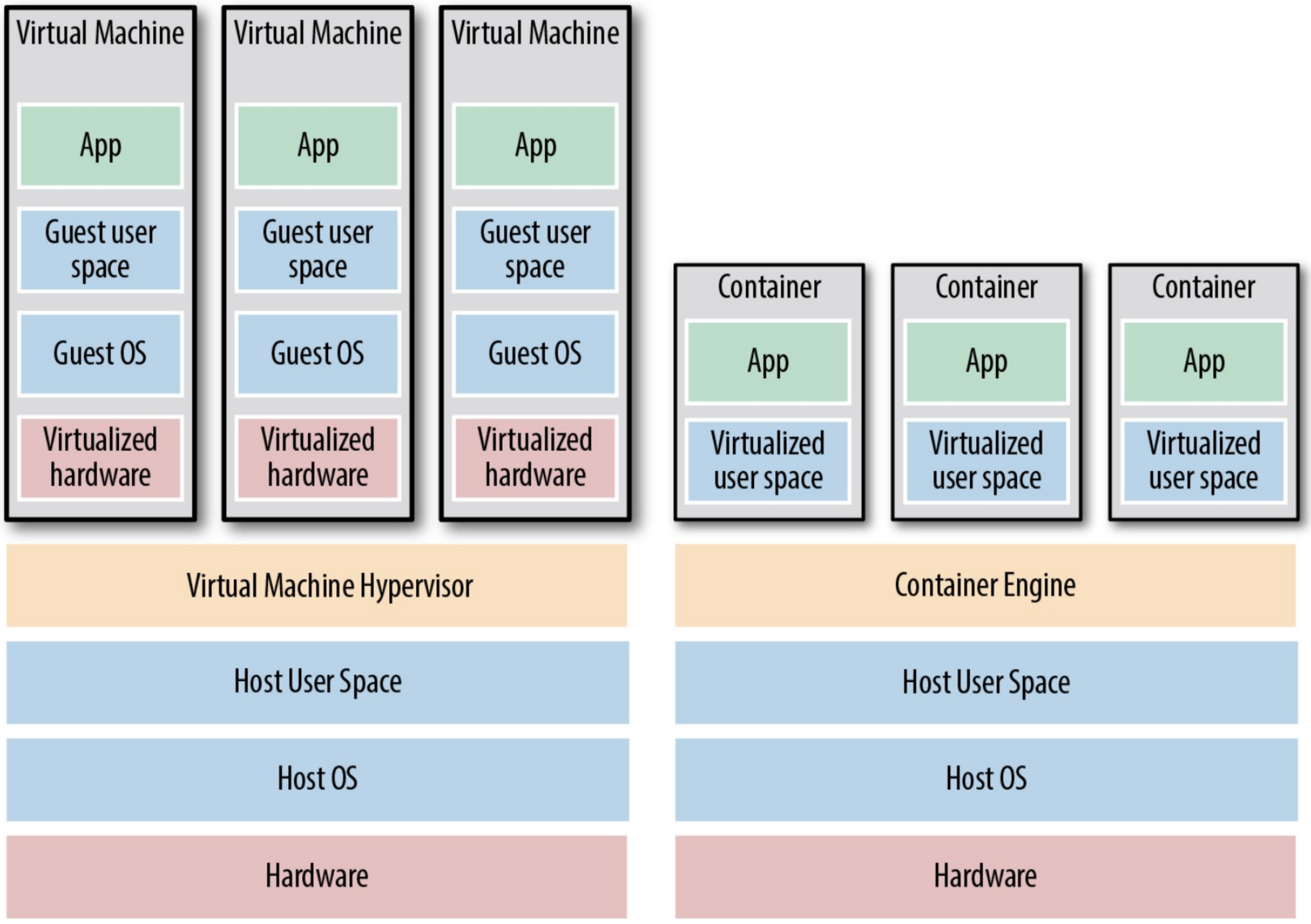
Server Templating Tools



```
"provisioners": [{
  "type": "shell",
  "inline": [
     "apt-get update",
     "apt-get install
-y php",
     "apt-get install
-y apache2",
  ]
}]
```

Packer Template

Images and Containers



Virtual Machines vs Containers

- Virtual machines
  - A virtual machine (VM) emulates an entire computer system, including the hardware. You run a hypervisor, such as VMWare, VirtualBox, or Parallels, to virtualize (i.e., simulate) the underlying CPU, memory, hard drive, and networking.
  - Benefit: complete isolation
  - Drawback: waste of resources
  - You can define VM images as code using tools such as Packer and Vagrant.
- Containers
  - A container emulates the user space of an OS. You run a container engine, such as Docker, CoreOS rkt, or cri-o, to create isolated processes, memory, mount points, and networking.
  - Benefit: you run on top of the container engine can see only its own user space
  - Benefit: of the containers running on a single server share, milliseconds boot time

Happiness with IaC

- Happiness
  - Deploying code and managing infrastructure manually is repetitive and tedious
  - No one will take notice—until that one day when you mess it up
  - That creates a stressful and unpleasant environment
  - Here is a painting of a happy man (see notes)

Why Infrastructure as Code?

- Q: With all the different flavors of IaC why bother IaC (i.e. Terraform)?
  - Why learn a bunch of new languages and tools and encumber yourself with yet more code to manage?
- A: Code is powerful
  - you get dramatic improvements in your ability to deliver software
  - organizations that use DevOps practices, such as IaC
    - deploy 200 times more frequently
    - recover from failures 24 times faster
    - have lead times that are 2,555 times lower.
- D: Discuss
  - How much does this apply to your use cases?
  - Say you are a researcher who seldom uses dev and prod environment. Do you still see the benefits of IaC? Where?
  - Again, ResearchOps paper

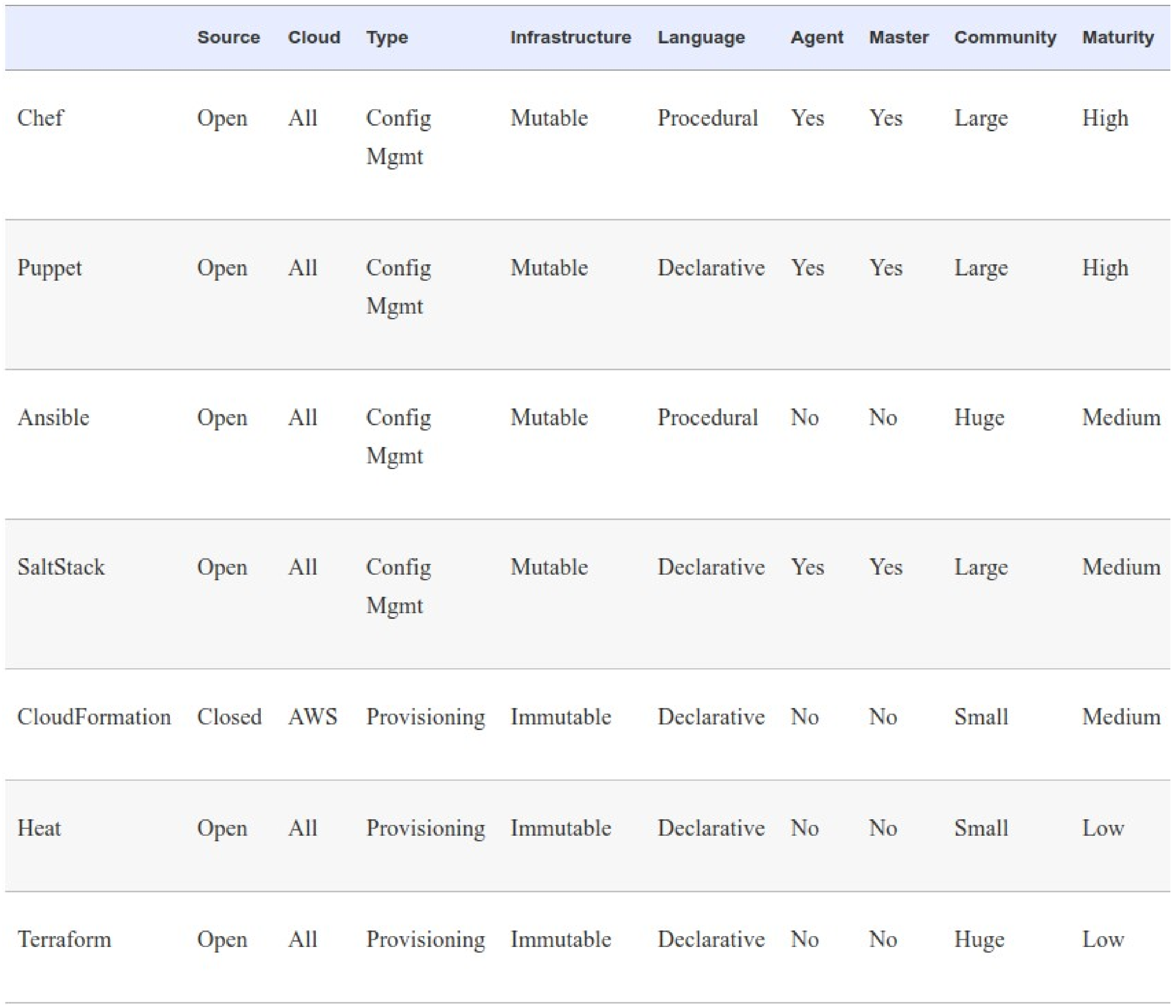
The Benefits of Infrastructure as Code

- Self-service
  - Infrastructure deployment with the scripts, not your admin
- Speed and safety
  - The computer will do a deployment faster and with less errors
- Documentation
  - You can represent the state of your infrastructure in source files
- Version control
  - You can store your IaC source files in version control
- Validation
  - For every single change, you can perform a code review
- Reuse
  - You can build on top of known, documented pieces

How Terraform Works

- Terraform is an open source tool created by HashiCorp and written in the Go programming language
- The Go code compiles down into a single binary called `terraform`
- You can use this binary to deploy infrastructure from your laptop or a build server
  - You don’t need to run any extra infrastructure to make that happen
- The `terraform` binary makes API calls on your behalf to one or more providers
  - AWS
  - Azure
  - Google Cloud
  - DigitalOcean
  - OpenStack, and more

Terraform and Other Tools



	Source	Cloud	Type	Infrastructure	Language	Agent	Master	Community	Maturity
Chef	Open	All	Config Mgmt	Mutable	Procedural	Yes	Yes	Large	High
Puppet	Open	All	Config Mgmt	Mutable	Declarative	Yes	Yes	Large	High
Ansible	Open	All	Config Mgmt	Mutable	Procedural	No	No	Huge	Medium
SaltStack	Open	All	Config Mgmt	Mutable	Declarative	Yes	Yes	Large	Medium
CloudFormation	Closed	AWS	Provisioning	Immutable	Declarative	No	No	Small	Medium
Heat	Open	All	Provisioning	Immutable	Declarative	No	No	Small	Low
Terraform	Open	All	Provisioning	Immutable	Declarative	No	No	Huge	Low