



Community Experience Distilled

Monitoring Docker

Monitor your Docker containers and their apps using various native and third-party tools with the help of this exclusive guide!

Russ McKendrick

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Monitoring Docker

Table of Contents

[Monitoring Docker](#)

[Credits](#)

[About the Author](#)

[About the Reviewer](#)

[www.PacktPub.com](#)

[Support files, eBooks, discount offers, and more](#)

[Why subscribe?](#)

[Free access for Packt account holders](#)

[Preface](#)

[What this book covers](#)

[What you need for this book](#)

[Who this book is for](#)

[Conventions](#)

[Reader feedback](#)

[Customer support](#)

[Downloading the example code](#)

[Downloading the color images of this book](#)

[Errata](#)

[Piracy](#)

[Questions](#)

[1. Introduction to Docker Monitoring](#)

[Pets, Cattle, Chickens, and Snowflakes](#)

[Pets](#)

[Cattle](#)

[Chickens](#)

[Snowflakes](#)

[So what does this all mean?](#)

[Docker](#)

[Launching a local environment](#)

[Cloning the environment](#)

[Running a virtual server](#)

[Halting the virtual server](#)

[Summary](#)

[2. Using the Built-in Tools](#)

[Docker stats](#)

[Running Docker stats](#)

[What just happened?](#)

[What about processes?](#)

[Docker top](#)

[Docker exec](#)

[Summary](#)

[3. Advanced Container Resource Analysis](#)

[What is cAdvisor?](#)

[Running cAdvisor using a container](#)

[Compiling cAdvisor from source](#)

[Collecting metrics](#)

[The Web interface](#)

[Overview](#)

[Processes](#)

[CPU](#)

[Memory](#)

[Network](#)

[Filesystem](#)

[Viewing container stats](#)

[Subcontainers](#)

[Driver status](#)

[Images](#)

[This is all great, what's the catch?](#)

[Prometheus](#)

[Launching Prometheus](#)

[Querying Prometheus](#)

[Dashboard](#)

[The next steps](#)

[Alternatives?](#)

[Summary](#)

[4. A Traditional Approach to Monitoring Containers](#)

[Zabbix](#)

[Installing Zabbix](#)

[Using containers](#)

[Using vagrant](#)

[Preparing our host machine](#)

[The Zabbix web interface](#)

[Docker metrics](#)

[Create custom graphs](#)

[Compare containers to your host machine](#)

[Triggers](#)

[Summary](#)

[5. Querying with Sysdig](#)

[What is Sysdig?](#)

[Installing Sysdig](#)

[Using Sysdig](#)

[The basics](#)

[Capturing data](#)

[Containers](#)

[Further reading](#)

[Using Csysdig](#)

[Summary](#)

[6. Exploring Third Party Options](#)

[A word about externally hosted services](#)

[Deploying Docker in the cloud](#)

[Why use a SaaS service?](#)

[Sysdig Cloud](#)

[Installing the agent](#)

[Exploring your containers](#)

[Summary and further reading](#)

[Datadog](#)

[Installing the agent](#)

[Exploring the web interface](#)

[Summary and further reading](#)

[New Relic](#)

[Installing the agent](#)

[Exploring the web interface](#)

[Summary and further reading](#)

[Summary](#)

[7. Collecting Application Logs from within the Container](#)

[Viewing container logs](#)

[ELK Stack](#)

[Starting the stack](#)

[Logspout](#)

[Reviewing the logs](#)

[What about production?](#)

[Looking at third party options](#)

[Summary](#)

[8. What Are the Next Steps?](#)

[Some scenarios](#)

[Pets, Cattle, Chickens, and Snowflakes](#)

[Pets](#)

[Cattle](#)

[Chickens](#)

[Snowflakes](#)

[Scenario one](#)

[Scenario two](#)

[Scenario three](#)

[A little more about alerting](#)

[Chickens](#)

[Cattle and Pets](#)

[Sending alerts](#)

[Keeping up](#)

[Summary](#)

[Index](#)

Monitoring Docker

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Russ McKendrick is an experienced solutions architect who has been working in IT and IT-related industries for the better part of 23 years. During his career, he has had varied responsibilities in a number of industries, ranging from looking after entire IT infrastructures to providing first line, second line, and senior support in client facing, and internal teams for corporate organizations.

He works almost exclusively with Linux, using open source systems and tools on various platforms ranging from dedicated hardware and virtual machines to public clouds.

About the Reviewer

Marcelo Correia Pinheiro is a Brazilian software engineer from Porto Alegre. He started to work as a web designer and programmer in 2000 with ASP and PHP, naturally getting in touch with the Microsoft .NET framework and Java running respective databases of choice for web applications. Since 2003, he has used Linux and UNIX-related operational systems, from Slackware to Gobo Linux, Archlinux, CentOS, Debian, and today OSX, having some contact with BSD distributions too. He has lost some nights compiling and applying patches to the Linux kernel to make its desktop work. Since the beginning, he has been acting as a problem solver, no matter what the programming language, database, or platform is—open source enthusiast.

After a few years, he decided to live in São Paulo to work with newer technologies such as NoSQL, cloud computing, and Ruby, where he started to conduct tech talks with this language in Locaweb. He created some tools to standardize development using tools such as vagrant and Ruby gems—some of these in their GitHub—in Locaweb to ensure fast application packaging and reduced deployment rollbacks. In 2013, he changed his career to be a full-stack developer following the DevOps movement. Since 2012, he has attended, as a speaker, some of the biggest software conferences in Brazil—RS on Rails, QConSP, The Developer’s Conference, and RubyConf Brazil—talking not only about Ruby, but also about some of the well-known DevOps tools such as Terraform, Packer, Ansible, and Docker. Today, he works as a DevOps consultant in their company.

In his free time, he loves playing the guitar, having some fun with cats, traveling, and drinking beer. He can be found on his blog (<http://salizzar.net>), Twitter (<https://twitter.com/salizzar>), GitHub (<https://github.com/salizzar>) and LinkedIn (<https://www.linkedin.com/in/salizzar>).

He has worked as a reviewer for *Vagrant Virtual Development Environment Cookbook*, a Packt Publishing book with useful recipes using vagrant with configuration management tools such as Puppet, Chef, Ansible, and SaltStack.

I want to thank all my friends, who believed in my potential since the beginning and who still follow me despite the distance. I would also like to thank my mentors, Gleicon Moraes, Roberto Gaiser, and Rodrigo Campos, who gave me the incentive and tips to be a better software engineer and person.

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Preface

With the increase in the adoption of Docker containers, the need to monitor which containers are running, what resources they are consuming, and how it affects the overall performance of the system, has become a time-related need. *Monitoring Docker* will teach you how monitoring containers and keeping a keen eye on the working of applications help to improve the overall performance of the applications that run on Docker.

This book will cover monitoring containers using Docker's native monitoring functions, various plugins, and also third-party tools that help in monitoring. The book will first cover how to obtain detailed stats for the active containers, resources consumed, and container behavior. This book will also show the readers how to use these stats to improve the overall performance of the system.

What this book covers

[Chapter 1](#), *Introduction to Docker Monitoring*, discusses how different it is to monitor containers compared to more traditional servers such as virtual machines, bare metal machines, and cloud instances (Pets versus Cattle and Chickens versus Snowflakes). This chapter also details the operating systems covered in the examples later in this book and also gives a little information on how to get a local test environment up and running using vagrant, so that installation instructions and practical examples can be easily followed.

[Chapter 2](#), *Using the Built-in Tools*, helps you learn about the basic metrics you can get out of the vanilla Docker installation and how you can use them. Also, we will understand how to get real-time statistics on our running containers, how to use commands that are familiar to us, and how to get information on the processes that are launched as part of each container.

[Chapter 3](#), *Advanced Container Resource Analysis*, introduces cAdvisor from Google, which adds a lot more precision to the basic tools provided by Docker. You will also learn how to install cAdvisor and start collecting metrics.

[Chapter 4](#), *A Traditional Approach to Monitoring Containers*, looks at a traditional tool for monitoring services. By the end of this chapter, you should know your way around Zabbix and the various ways you can monitor your containers.

[Chapter 5](#), *Querying with Sysdig*, describes Sysdig as “an open source, system-level exploration tool to capture system state and activity from a running Linux instance, then save, filter, and analyze it.” In this chapter, you will learn how to use Sysdig to both view your containers’ performance metrics in real time and also record sessions to query later.

[Chapter 6](#), *Exploring Third Party Options*, walks you through a few of the Software as a Service (SaaS) options that are available, why you would use them, and how to install their clients on the host server.

[Chapter 7](#), *Collecting Application Logs from within the Container*, looks at how we can get the content of the log files for the applications running within our containers to a central location so that they are available even if you have to destroy and replace a container.

[Chapter 8](#), *What Are the Next Steps?*, looks at the next steps you can take in monitoring your containers by talking about the benefits of adding alerting to your monitoring. Also, we will cover some different scenarios and look at which type of monitoring is appropriate for each of them.

What you need for this book

To ensure the experience is as consistent as possible, we will be installing vagrant and VirtualBox to run the virtual machine that will act as a host to run our containers. Vagrant is available for Linux, OS X, and Windows; for details on how to install this, see the vagrant website at <https://www.vagrantup.com/>. The details of how to download and install VirtualBox can be found at <https://www.virtualbox.org/>; again, VirtualBox can be installed on Linux, OS X, and Windows.

Who this book is for

This book is for DevOps engineers and system administrators who want to manage Docker containers, better manage these containers using expert techniques and methods, and better maintain applications built on Docker.

Conventions

In this book, you will find a number of text styles that distinguish between different kinds of information. Here are some examples of these styles and an explanation of their meaning.

Code words in text, database table names, folder names, filenames, file extensions, pathnames, dummy URLs, user input, and Twitter handles are shown as follows: “We can include other contexts through the use of the `include` directive.”

A block of code is set as follows:

```
{  
  "fields": {  
    "@timestamp": [  
      1444567706641  
    ]  
  },  
  "sort": [  
    1444567706641  
  ]  
}
```

When we wish to draw your attention to a particular part of a code block, the relevant lines or items are set in bold:

```
{  
  "fields": {  
    "@timestamp": [  
      1444567706641  
    ]  
  },  
  "sort": [  
    1444567706641  
  ]  
}
```

Any command-line input or output is written as follows:

```
cd ~/Documents/Projects/monitoring-docker/vagrant-ubuntu  
vagrant up
```

New terms and **important words** are shown in bold. Words that you see on the screen, for example, in menus or dialog boxes, appear in the text like this: “Clicking the **Next** button moves you to the next screen.”

Note

Warnings or important notes appear in a box like this.

Tip

Tips and tricks appear like this.

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http://www.packtpub.com/sites/default/files/downloads/Monitoring_Docker_ColorImages.pdf

Errata

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Chapter 1. Introduction to Docker Monitoring

Docker has been a recent but very important addition to a SysAdmins toolbox.

Docker describes itself as an open platform for building, shipping, and running distributed applications. This means that developers can bundle their code and pass it to their operations team. From here, they can deploy safe in the knowledge that it will be done so in a way that introduces consistency with the environment in which the code is running.

When this process is followed, it should make the age-old developers versus operations argument of “it worked on my local development server”—a thing of the past. Since before its “production ready” 1.0 release back in June 2014, there had been over 10,000 Dockerized applications available. By the end of 2014, that number had risen to over 71,000. You can see how Docker grew in 2014 by looking at the infographic that was published by Docker in early 2015, which can be found at

<https://blog.docker.com/2015/01/docker-project-2014-a-whirlwind-year-in-review/>.

While the debate is still raging about how production ready the technology is, Docker has gained an impressive list of technology partners, including RedHat, Canonical, HP, and even Microsoft.

Companies such as Google, Spotify, Soundcloud, and CenturyLink, have all open sourced tools that support Docker in some way, shape, or form and there has also been numerous independent developers who have released apps that provide additional functionality to the core Docker product set. Also, all the companies have sprung up around the Docker ecosystem.

This book assumes that you have had some level of experience building, running, and managing Docker containers, and that you would now like to start to metrics from your running applications to further tune them, or that you would like to know when a problem occurs with a container so that you can debug any ongoing issues.

If you have never used Docker before, you may want to try one of the excellent books that serve and introduce you to all the things that Docker provides, books such as *Learning Docker*, Packt Publishing, or Docker’s own introduction to containers, which can be found at their documentation pages, as follows:

- Learning Docker: <https://www.packtpub.com/virtualization-and-cloud/learning-docker>
- Official Docker docs: <https://docs.docker.com/>

Now, we have brought ourselves up to speed with what Docker is; the rest of this chapter will cover the following topics:

- How different is it to monitor containers versus more traditional servers such as virtual machines, bare metal machine, and cloud instances (Pets, Cattle, Chickens, and Snowflakes).

- What are the minimum versions of Docker you should be running?
- How to follow instructions on bringing up an environment locally using Vagrant in order to follow the practical exercises in this book

Pets, Cattle, Chickens, and Snowflakes

Before we start discussing the various ways in which you can monitor your containers, we should get an understanding of what a SysAdmins world looks like these days and also where containers fit into it.

A typical SysAdmin will probably be looking after an estate of servers that are hosted in either an on-site or third-party data center, some may even manage instances hosted in a public cloud such as Amazon Web Services or Microsoft Azure, and some SysAdmins may juggle all their server estates across multiple hosting environments.

Each of these different environments has its own way of doing things, as well as performing best practices. Back in February 2012, Randy Bias gave a talk at Cloudscaling that discussed architectures for open and scalable clouds. Towards the end of the slide deck, Randy introduced the concept of Pets versus Cattle (which he attributes to Bill Baker, who was then an engineer at Microsoft).

You can view the original slide deck at <http://www.slideshare.net/randybias/architectures-for-open-and-scalable-clouds>.

Pets versus Cattle is now widely accepted as a good analogy to describe modern hosting practices.

Pets

Pets are akin to traditional physical servers or virtual machines, as follows:

- Each pet has a name; for example, `myserver.domain.com`.
- When they're not well, you take them to the vet to help them get better. You employ SysAdmins to look after them.
- You pay close attention to them, sometimes for years. You take backups, patch them, and ensure that they are fully documented.

Cattle

Cattle, on the other hand, represent more modern cloud computing instances, as follows:

- You've got too many to name, so you give them numbers; for example, the URL could look something like `ip123123123123.eu.public-cloud.com`.
- When they get sick, you shoot them and if your herd requires it, you replace anything you've killed: A server crashes or shows signs that it is having problems, you terminate it and your configuration automatically replaces it with an exact replica.
- You put them in a field and watch them from far and you don't expect them to live long. Rather than monitoring the individual instances, you monitor the cluster. When more resources are needed, you add more instances and once the resource is no longer required, you terminate the instances to get you back to your base configuration.

Chickens

Next up is a term that is a good way of describing how containers fit into the Pets versus Cattle world; in a blog post title “Cloud Computing: Pets, Cattle and ... Chickens?” on ActiveState, Bernard Golden describes containers as Chickens:

- They’re more efficient than cattle when it comes to resource use. A container can boot in seconds where a instance or server can take minutes; it also uses less CPU power than a typical virtual machine or cloud instance.
- There are many more chickens than cattle. You can quite densely pack containers onto your instances or servers.
- Chickens tend to have a shorter lifespan than cattle and pets. Containers lend themselves to running microservices; these containers may only be active for a few minutes.

The original blog post can be found at <http://www.activestate.com/blog/2015/02/cloud-computing-pets-cattle-and-chickens>.

Snowflakes

The final term is not animal-related and it describes a type of server that you defiantly don't want to have in your server estate, a Snowflake. This term was penned by Martin Fowler in a blog post titled “SnowflakeServer”. Snowflakes is a term applied to “legacy” or “inherited” servers:

- Snowflakes are delicate and are treated with kid gloves. Typically, the server has been in the data center since you started. No one knows who originally configured it and there is no documentation of it; all you know is that it is important.
- Each one is unique and is impossible to exactly reproduce. Even the most hardened SysAdmin fears to reboot the machine incase it doesn't boot afterwards, as it is running end-of-life software that can not easily be reinstalled.

Martin's post can be found at <http://martinfowler.com/bliki/SnowflakeServer.html>.

So what does this all mean?

Depending on your requirements and the application you want to deploy, your containers can be launched onto either pet or cattle style servers. You can also create a clutch of chickens and have your containers run micro-services.

Also, in theory, you can replace your feared snowflake servers with a container-based application that meets all the end-of-life software requirements while remaining deployable on a modern supportable platform.

Each of the different styles of server has different monitoring requirements, in the final chapter we will look at Pets, Cattle, Chickens, and Snowflakes again and discuss the tools we have covered in the coming chapters. We will also cover best practices you should take into consideration when planning your monitoring.

Docker

While Docker hit its version 1.0 milestone over a year ago, it is still in its infancy; with each new release comes new features, bug fixes, and even support for some early functionality that is being depreciated.

Docker itself is now a collection of several smaller projects; these include the following:

- Docker Engine
- Docker Machine
- Docker Compose
- Docker Swarm
- Docker Hub
- Docker Registry
- Kitmatic

In this book, we will be using Docker Engine, Docker Compose, and the Docker Hub.

Docker Engine is the core component of the Docker project and it provides the main bulk of the Docker functionality. Whenever Docker or the `docker` command is mentioned in this book, I will be referring to Docker Engine.

The book assumes you have Docker Engine version 1.71 or later installed; older versions of Docker Engine may not contain the necessary functionality required to run the commands and software covered in the upcoming chapters.

Docker Compose started its life as a third-party orchestration tool called **Fig** before being purchased by Docker in 2014. It is described as a way of defining a multi-container application using YAML (<http://yaml.org>). Simply put, this means that you quickly deploy complex applications using a single command that calls a human readable configuration file.

We assume that you have Docker Compose 1.3.3 or later installed; the `docker-compose.yml` files mentioned in this book have been written with this version in mind.

Finally, the majority of the images we will be deploying during this book will be sourced from the Docker Hub (<https://hub.docker.com/>), which not only houses a public registry containing over 40,000 public images but also 100 official images. The following screenshot shows the official repositories listing on the Docker Hub website:

The screenshot shows the Docker Hub homepage with the URL "hub.docker.com" in the address bar. The top navigation bar includes links for "Dashboard", "Explore", "Organizations", a search bar, and a user profile for "russmckendrick". Below the header, a section titled "Explore Official Repositories" displays a list of six official Docker images:

Image	Name	Official Status	Stars	Pulls	Action
	centos	official	1272	1910066	DETAILS
	busybox	official	255	32876351	DETAILS
	ubuntu	official	2175	15705382	DETAILS
	scratch	official	88	208918	DETAILS
	fedora	official	196	171907	DETAILS
	registry	official	383	4569195	DETAILS

You can also sign up and use the Docker Hub to host your own public and private images.

Launching a local environment

Wherever possible, I will try to ensure that the practical exercises in this book will be able to be run on a local machine such as your desktop or laptop. For the purposes of this book, I will assume that your local machine is running either a recent version OS X or an up-to-date Linux distribution and has a high enough specification to run the software mentioned in this chapter.

The two tools we will be using to launch our Docker instances will also run on Windows; therefore, it should be possible to follow the instructions within this, although you may have to refer the usage guides for any changes to the syntax.

Due to the way in which Docker is architected, a lot of the content of this book will have you running commands and interacting with the command line on the virtual server that is acting as the host machine, rather than the containers themselves. Because of this, we will not be using either Docker Machine or Kitematic.

Both of these are tools provided by Docker to quickly bootstrap a Docker-enabled virtual server on your local machine, as unfortunately the host machines deployed by these tools contain a stripped down operating system that is optimized for running Docker with the smallest footprint as possible.

As we will be installing additional packages on the host machines, a stripped down “Docker only” operating system may not have the components available to meet the prerequisites of the software that we will be running in the later chapters; therefore, to ensure that there are no problems further on, we be running a full operating system.

Personally, I prefer a RPM-based operating system such as RedHat Enterprise Linux, Fedora, or CentOS, as I have been using them pretty much since the day I first logged into a Linux server.

However, as a lot of readers will be familiar with the Debian-based Ubuntu, I will be providing practical examples for both operating systems.

To ensure the experience is as consistent as possible, we will be installing Vagrant and VirtualBox to run the virtual machine that will act as a host to run our containers.

Vagrant, written by Mitchell Hashimoto, is a command line tool for creating and configuring reproducible and portable virtual machine environments. There have been numerous blog posts and articles that actually pitch Docker against Vagrant; however, in our case, the two technologies work quite well together in providing a repeatable and consistent environment.

Vagrant is available for Linux, OS X, and Windows. For details on how to install, go to the Vagrant website at <https://www.vagrantup.com/>.

VirtualBox is a great all round open source virtualization platform originally developed by Sun and now maintained by Oracle. It allows you to run both 32-bit and 64-bit guest operating systems on your local machine. Details on how to download and install VirtualBox can be found at <https://www.virtualbox.org/>; again, VirtualBox can be installed

on Linux, OS X, and Windows.

Cloning the environment

The source for the environment along with the practical examples can be found on GitHub in the Monitoring Docker repository at <https://github.com/russmckendrick/monitoring-docker>.

To clone the repository on a terminal on your local machine, run the following commands (replacing the file path as needed):

```
mkdir ~/Documents/Projects  
cd ~/Documents/Projects/  
git clone https://github.com/russmckendrick/monitoring-docker.git
```

Once cloned, you should see a directory called monitoring-docker and then enter that directory, as follows:

```
cd ~/Documents/Projects/monitoring-docker
```


Running a virtual server

In the repository, you will find two folders containing the necessary Vagrant file to launch either a CentOS 7 or a Ubuntu 14.04 virtual server.

If you would like to use the CentOS 7 vagrant box, change the directory to `vagrant-centos`:

```
cd vagrant-centos
```

Once you are in the `vagrant-centos` directory, you will see that there is a `vagrant` file; this file is all you need to launch a CentOS 7 virtual server. After the virtual server has been booted, the latest version of `docker` and `docker-compose` will be installed and the `monitoring-docker` directory will also be mounted inside the virtual machine using the mount point `/monitoring-docker`.

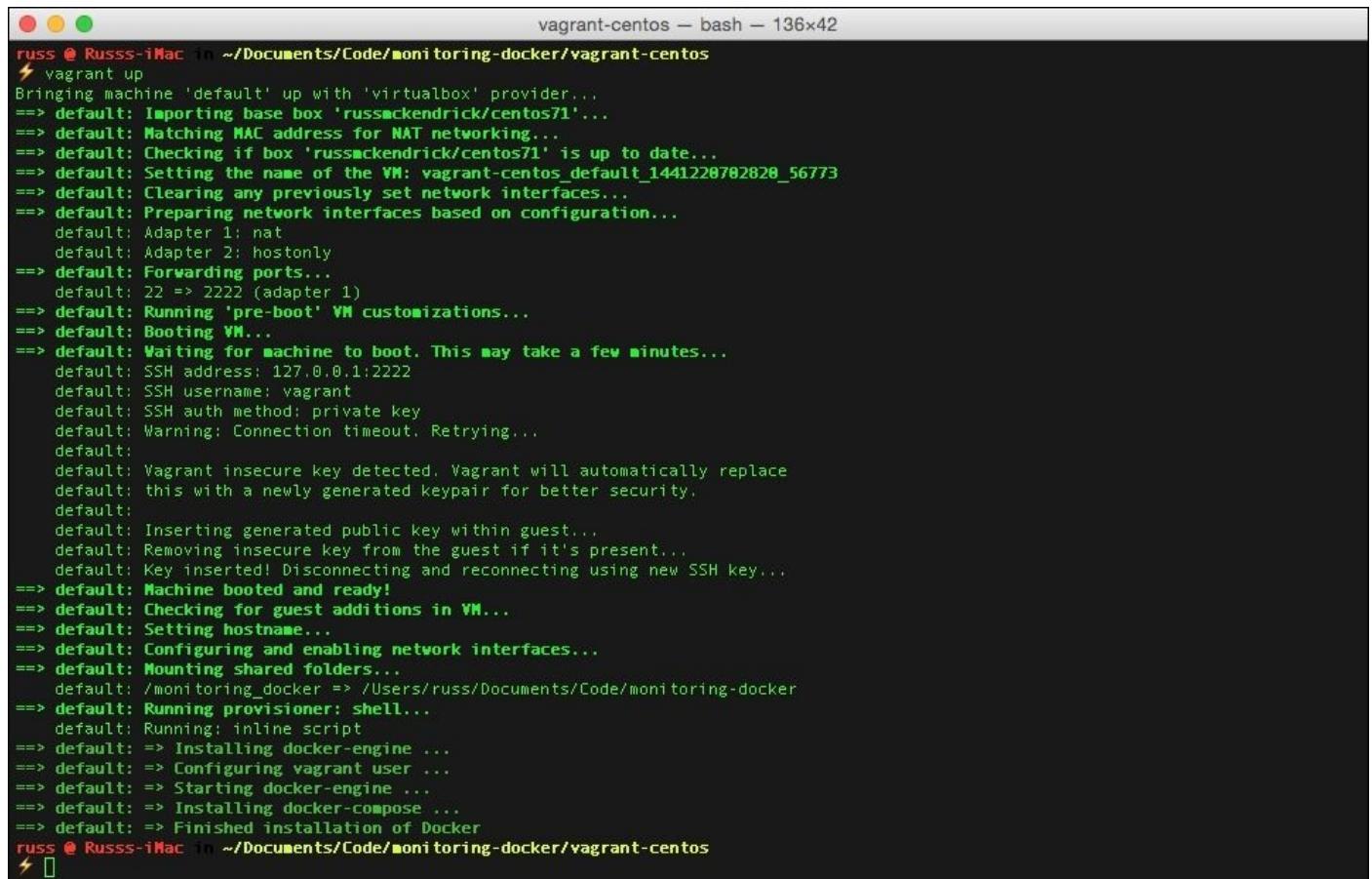
To launch the virtual server, simply type the following command:

```
vagrant up
```

This will download the latest version of the vagrant box from

<https://atlas.hashicorp.com/russmckendrick/boxes/centos71> and then boot the virtual server; it's a 450 MB download so it may take several minutes to download; it only has to do this once.

If all goes well, you should see something similar to the following output:

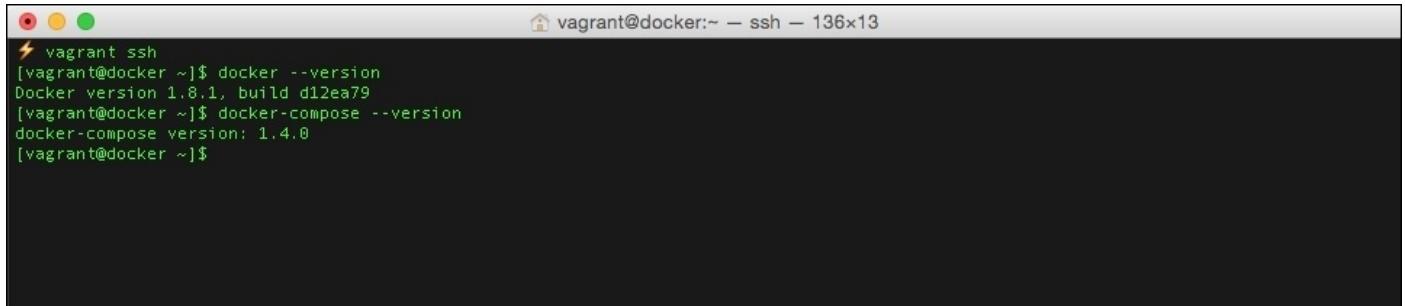


```
russ @ Russs-iMac in ~/Documents/Code/monitoring-docker/vagrant-centos
⚡ vagrant up
Bringing machine 'default' up with 'virtualbox' provider...
==> default: Importing base box 'russmckendrick/centos71'...
==> default: Matching MAC address for NAT networking...
==> default: Checking if box 'russmckendrick/centos71' is up to date...
==> default: Setting the name of the VM: vagrant-centos_default_1441228782828_56773
==> default: Clearing any previously set network interfaces...
==> default: Preparing network interfaces based on configuration...
default: Adapter 1: nat
default: Adapter 2: hostonly
==> default: Forwarding ports...
default: 22 => 2222 (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 timeout. 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: Configuring and enabling network interfaces...
==> default: Mounting shared folders...
default: /monitoring_docker => /Users/russ/Documents/Code/monitoring-docker
==> default: Running provisioner: shell...
default: Running: inline script
==> default: => Installing docker-engine ...
==> default: => Configuring vagrant user ...
==> default: => Starting docker-engine ...
==> default: => Installing docker-compose ...
==> default: => Finished installation of Docker
russ @ Russs-iMac in ~/Documents/Code/monitoring-docker/vagrant-centos
⚡ ⌂
```

Now that you have booted the virtual server, you can connect to it using the following command:

```
vagrant ssh
```

Once logged in, you should verify that docker and docker-compose are both available:

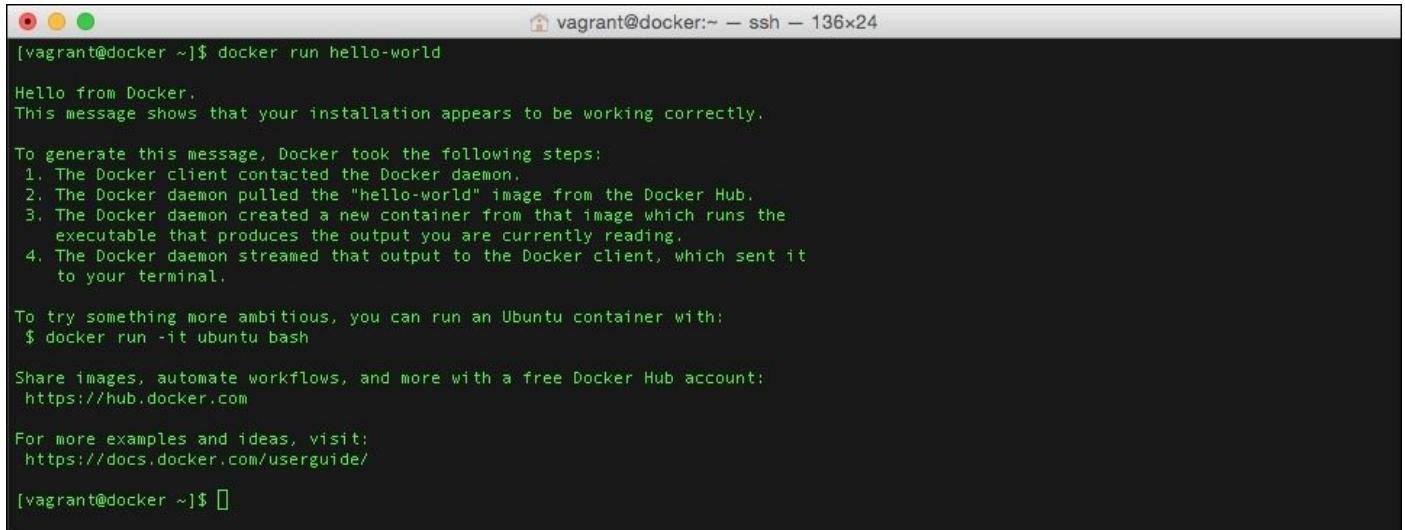


```
vagrant ssh
[vagrant@docker ~]$ docker --version
Docker version 1.8.1, build d12ea79
[vagrant@docker ~]$ docker-compose --version
docker-compose version: 1.4.0
[vagrant@docker ~]$
```

Finally, you can try running the hello-world container using the following command:

```
docker run hello-world
```

If everything goes as expected, you should see the following output:



```
vagrant@docker ~]$ docker run hello-world
Hello from Docker.
This message shows that your installation appears to be working correctly.

To generate this message, Docker took the following steps:
1. The Docker client contacted the Docker daemon.
2. The Docker daemon pulled the "hello-world" image from the Docker Hub.
3. The Docker daemon created a new container from that image which runs the
   executable that produces the output you are currently reading.
4. The Docker daemon streamed that output to the Docker client, which sent it
   to your terminal.

To try something more ambitious, you can run an Ubuntu container with:
$ docker run -it ubuntu bash

Share images, automate workflows, and more with a free Docker Hub account:
https://hub.docker.com

For more examples and ideas, visit:
https://docs.docker.com/userguide/

[vagrant@docker ~]$
```

To try something more ambitious, you can run an Ubuntu container with the following command:

```
docker run -it ubuntu bash
```

Before we launch and enter the Ubuntu container, lets confirm that we are running the CentOS host machine by checking the release file that can be found in /etc:

```
vagrant@docker:~$ cat /etc/*release
CentOS Linux release 7.1.1503 (Core)
NAME="CentOS Linux"
VERSION="7 (Core)"
ID="centos"
ID_LIKE="rhel fedora"
VERSION_ID="7"
PRETTY_NAME="CentOS Linux 7 (Core)"
ANSI_COLOR="0;31"
CPE_NAME="cpe:/o:centos:centos:7"
HOME_URL="https://www.centos.org/"
BUG_REPORT_URL="https://bugs.centos.org/"

CENTOS_MANTISBT_PROJECT="CentOS-7"
CENTOS_MANTISBT_PROJECT_VERSION="7"
REDHAT_SUPPORT_PRODUCT="centos"
REDHAT_SUPPORT_PRODUCT_VERSION="7"

CentOS Linux release 7.1.1503 (Core)
CentOS Linux release 7.1.1503 (Core)
[vagrant@docker ~]$ docker run -it ubuntu bash
root@ca4a8397317e:/# cat /etc/*release
DISTRIB_ID=Ubuntu
DISTRIB_RELEASE=14.04
DISTRIB_CODENAME=trusty
DISTRIB_DESCRIPTION="Ubuntu 14.04.3 LTS"
NAME="Ubuntu"
VERSION="14.04.3 LTS, Trusty Tahr"
ID=ubuntu
ID_LIKE=debian
PRETTY_NAME="Ubuntu 14.04.3 LTS"
VERSION_ID="14.04"
HOME_URL="http://www.ubuntu.com/"
SUPPORT_URL="http://help.ubuntu.com/"
BUG_REPORT_URL="http://bugs.launchpad.net/ubuntu/"
root@ca4a8397317e:/# exit
exit
[vagrant@docker ~]$ docker rm ca4a8397317e
ca4a8397317e
[vagrant@docker ~]$ 
```

Now, we can launch the Ubuntu container. Using the same command, we can confirm that we are inside the Ubuntu container by viewing its release file:

```
vagrant@docker:~$ docker run -it ubuntu bash
unable to find image 'ubuntu:latest' locally
latest: Pulling from library/ubuntu
c63fb41c2213: Pull complete
997caeef76ef: Pull complete
5a4526e952f0: Pull complete
1d073211c498: Pull complete
Digest: sha256:8b1bffa54d8a58395bae61ec32f1a79fc82a939e4a7179e6227eb79e4c3c56f6
Status: Downloaded newer image for ubuntu:latest
root@dc806c481067:~# cat /etc/*release
DISTRIB_ID=Ubuntu
DISTRIB_RELEASE=14.04
DISTRIB_CODENAME=trusty
DISTRIB_DESCRIPTION="Ubuntu 14.04.3 LTS"
NAME="Ubuntu"
VERSION="14.04.3 LTS, Trusty Tahr"
ID=ubuntu
ID_LIKE=debian
PRETTY_NAME="Ubuntu 14.04.3 LTS"
VERSION_ID="14.04"
HOME_URL="http://www.ubuntu.com/"
SUPPORT_URL="http://help.ubuntu.com/"
BUG_REPORT_URL="http://bugs.launchpad.net/ubuntu/"
root@dc806c481067:~# 
```

To exit the container just type in `exit`. This will stop the container from running, as it has terminated the only running process within the container, which was `bash`, and returned you to the host CentOS machine.

As you can see here from our CentOS 7 host, we have launched and removed an Ubuntu container.

Both the CentOS 7 and Ubuntu Vagrant files will configure a static IP address on your virtual machine. It is `192.168.33.10`; also, there is a DNS record for this IP address

available at <http://docker.media-glass.es>. These will allow you to access any containers that expose themselves to a browser at either `http://192.168.33.10/` or <http://docker.media-glass.es/>.

Tip

The URL <http://docker.media-glass.es/> will only work while the vagrant box is up, and you have a container running which serves Web pages.

You can see this in action by running the following command:

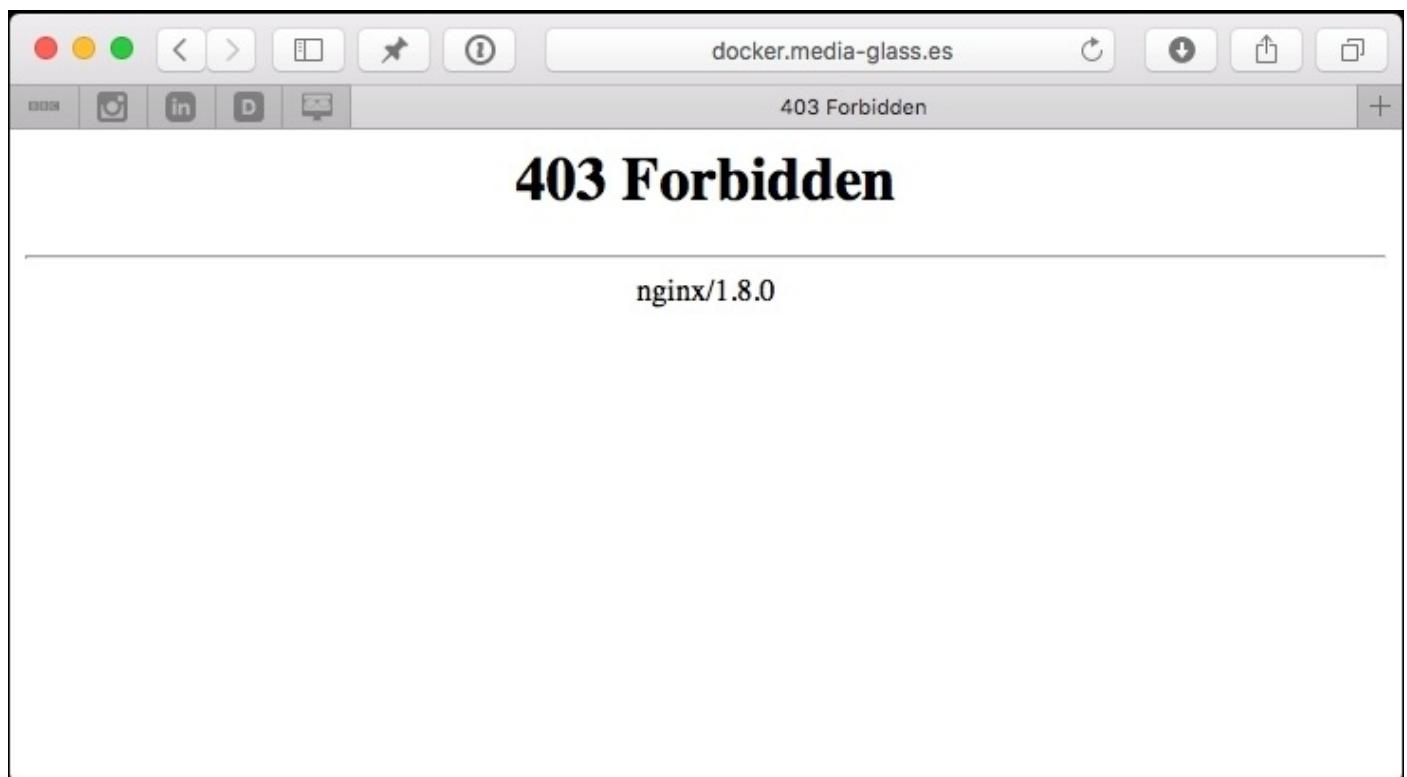
```
docker run -d -p 80:80 russmckendrick/nginx-php
```

Tip

Downloading the example code

You can download the example code files from your account at <http://www.packtpub.com> for all the Packt Publishing books you have purchased. If you purchased this book elsewhere, you can visit <http://www.packtpub.com/support> and register to have the files emailed directly to you.

This will download and launch a container running NGINX. You can then go to `http://192.168.33.10/` or <http://docker.media-glass.es/> in your browser; you should see a forbidden page. This is because we have not yet given NGINX any content to serve (more on this will be covered later in the book):



For more examples and ideas, go to the website at <http://docs.docker.com/userguide/>.

Halting the virtual server

To log out of the virtual server and return to your local machine, you type `exit`.

You should now see your local machine's terminal prompt; however, the virtual server you booted will still be running in the background happily, using resources, until you either power it down using the following command:

```
vagrant halt
```

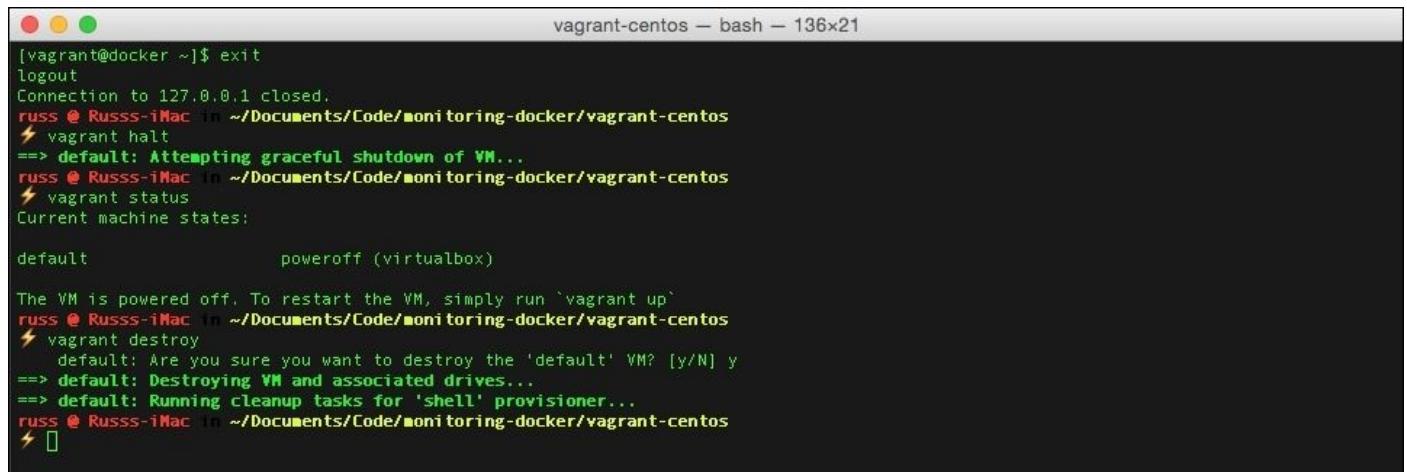
Terminate the virtual server altogether using `vagrant destroy`:

```
vagrant destroy
```

To check the current status of the virtual server, you can run the following command:

```
vagrant status
```

The result of the preceding command is given in the following output:



```
vagrant-centos — bash — 136x21
[vagrant@docker ~]$ exit
logout
Connection to 127.0.0.1 closed.
russ @ Russs-iMac in ~/Documents/Code/monitoring-docker/vagrant-centos
⚡ vagrant halt
==> default: Attempting graceful shutdown of VM...
russ @ Russs-iMac in ~/Documents/Code/monitoring-docker/vagrant-centos
⚡ vagrant status
Current machine states:

default          poweroff (virtualbox)

The VM is powered off. To restart the VM, simply run `vagrant up`
russ @ Russs-iMac in ~/Documents/Code/monitoring-docker/vagrant-centos
⚡ vagrant destroy
  default: Are you sure you want to destroy the 'default' VM? [y/N] y
==> default: Destroying VM and associated drives...
==> default: Running cleanup tasks for 'shell' provisioner...
russ @ Russs-iMac in ~/Documents/Code/monitoring-docker/vagrant-centos
⚡
```

Either powering the virtual server back on or creating it from scratch again, can be achieved by issuing the `vagrant up` command again.

The preceding details show how to use the CentOS 7 vagrant box. If you would prefer to launch an Ubuntu 14.04 virtual server, you can download and install the vagrant box by going into the `vagrant-ubuntu` directory using the following command:

```
cd ~/Documents/Projects/monitoring-docker/vagrant-ubuntu
vagrant up
```

From here, you will be able run `vagrant up` and follow the same instructions used to boot and interact with the CentOS 7 virtual server.

Summary

In this chapter, we talked about different types of server and also discussed how your containerized applications can fit into each of the categories. We have also installed VirtualBox and used Vagrant to launch either a CentOS 7 or Ubuntu 14.04 virtual server, with docker and docker-compose installed.

Our new virtual server environment will be used throughout the upcoming chapters to test the various different types of monitoring. In the next chapter, we will start our journey by using Docker's in-built functionality to explore metrics about our running containers.

Chapter 2. Using the Built-in Tools

In the later chapters of this book, we will explore the monitoring parts of the large ecosystem that has started to flourish around Docker over the last 24 months. However, before we press ahead with that, we should take a look at what is possible with a vanilla installation of Docker. In this chapter, we will cover the following topics:

- Using the tools built into Docker to get real-time metrics on container performance
- Using standard operating system commands to get metrics on what Docker is doing
- Generating a test load so you can view the metrics changing

Docker stats

Since version 1.5, there has been a basic statistic command built into Docker:

```
docker stats --help
```

```
Usage: docker stats [OPTIONS] CONTAINER [CONTAINER...]
```

```
Display a live stream of one or more containers' resource usage statistics
```

```
--help=false          Print usage  
--no-stream=false    Disable streaming stats and only pull the first  
result
```

This command will stream details of the resource utilization of your containers in real time. The best way to find out about the command is to see it in action.

Running Docker stats

Let's launch a container using the vagrant environment, which we covered in the last chapter:

```
[russ@mac ~]$ cd ~/Documents/Projects/monitoring-docker/vagrant-centos/  
[russ@mac ~]$ vagrant up  
Bringing machine 'default' up with 'virtualbox' provider...  
==> default: Importing base box 'russmckendrick/centos71'...  
==> default: Matching MAC address for NAT networking...  
==> default: Checking if box 'russmckendrick/centos71' is up to date...  
.....  
==> default: => Installing docker-engine...  
==> default: => Configuring vagrant user...  
==> default: => Starting docker-engine...  
==> default: => Installing docker-compose...  
==> default: => Finished installation of Docker  
[russ@mac ~]$ vagrant ssh
```

Now that you are connected to the vagrant server, launch the container using the Docker compose file in /monitoring_docker/Chapter01/01-basic/:

```
[vagrant@centos7 ~]$ cd /monitoring_docker/Chapter01/01-basic/  
[vagrant@centos7 01-basic]$ docker-compose up -d  
Creating 01basic_web_1...
```

You have now pulled down and launched a container in the background. The container is called 01basic_web_1 and it runs NGINX and PHP serving a single PHP information page (<http://php.net/manual/en/function.phpinfo.php>).

To check whether everything has been launched as expected, run docker-compose ps. You should see your single container with State of Up:

```
[vagrant@centos7 01-basic]$ docker-compose ps  
      Name        Command       State        Ports  
-----  
01basic_web_1   /usr/local/bin/run   Up      0.0.0.0:80->80/tcp
```

Finally, you should be able to see the page containing the output of the PHP information at <http://192.168.33.10/> (this IP address is hardcoded into the vagrant configuration), if you put it in your local browser:

The screenshot shows a web browser window with the URL 192.168.33.10. The title bar says "PHP Version 5.6.11". The main content area displays a table of PHP configuration details. At the bottom, there is a note about Zend Engine usage and a large "zend engine" logo.

System	Linux 83d302e3ec73 3.10.0-229.7.2.el7.x86_64 #1 SMP Tue Jun 23 22:06:11 UTC 2015 x86_64
Build Date	Jul 10 2015 09:44:50
Server API	FPM/FastCGI
Virtual Directory Support	disabled
Configuration File (php.ini) Path	/etc
Loaded Configuration File	/etc/php.ini
Scan this dir for additional .ini files	/etc/php.d
Additional .ini files parsed	/etc/php.d/10-opcache.ini, /etc/php.d/20-bz2.ini, /etc/php.d/20-calendar.ini, /etc/php.d/20-ctype.ini, /etc/php.d/20-curl.ini, /etc/php.d/20-dom.ini, /etc/php.d/20-exif.ini, /etc/php.d/20-fileinfo.ini, /etc/php.d/20-ftp.ini, /etc/php.d/20-gd.ini, /etc/php.d/20-gettext.ini, /etc/php.d/20-iconv.ini, /etc/php.d/20-mbstring.ini, /etc/php.d/20-mcrypt.ini, /etc/php.d/20-mysqlind.ini, /etc/php.d/20-pdo.ini, /etc/php.d/20-phar.ini, /etc/php.d/20-posix.ini, /etc/php.d/20-pspell.ini, /etc/php.d/20-shmop.ini, /etc/php.d/20-simplexml.ini, /etc/php.d/20-snmp.ini, /etc/php.d/20-sockets.ini, /etc/php.d/20-sqlite3.ini, /etc/php.d/20-sysvmsg.ini, /etc/php.d/20-sysvsem.ini, /etc/php.d/20-sysvshm.ini, /etc/php.d/20-tokenizer.ini, /etc/php.d/20-xml.ini, /etc/php.d/20-xmlwriter.ini, /etc/php.d/20-xsl.ini, /etc/php.d/20-zip.ini, /etc/php.d/30-mysql.ini, /etc/php.d/30-mysqli.ini, /etc/php.d/30-pdo_mysql.ini, /etc/php.d/30-pdo_sqlite.ini, /etc/php.d/30-wddx.ini, /etc/php.d/30-xmireader.ini, /etc/php.d/30-xmlrpc.ini, /etc/php.d/40-json.ini
PHP API	20131106
PHP Extension	20131226
Zend Extension	220131226
Zend Extension Build	API220131226,NTS
PHP Extension Build	API20131226,NTS
Debug Build	no
Thread Safety	disabled
Zend Signal Handling	disabled
Zend Memory Manager	enabled
Zend Multibyte Support	provided by mbstring
IPv6 Support	enabled
DTrace Support	enabled
Registered PHP Streams	https, ftps, compress.zlib, php, file, glob, data, http, ftp, compress.bzip2, phar, zip
Registered Stream Socket Transports	tcp, udp, unix, udg, ssl, sslv3, sslv2, tls, tlsv1.0, tlsv1.1, tlsv1.2
Registered Stream Filters	zlib.* , string.rot13, string.toupper, string.tolower, string.strip_tags, convert.* , consumed, dechunk, bzip2.* , convert.iconv.* , mcrypt.* , mdecrypt.*

This program makes use of the Zend Scripting Language Engine:
 Zend Engine v2.6.0, Copyright (c) 1998-2015 Zend Technologies
 with Zend OPcache v7.0.6-dev, Copyright (c) 1999-2015, by Zend Technologies

zend engine

Now, you have a container up and running; let's look at some of the basic stats. We know from the output of docker -compose that our container is called `01basic_web_1`, so enter the following command to start streaming statistics in your terminal:

```
docker stats 01basic_web_1
```

It will take a second to initiate; after this is done, you should see your container listed along with the statistics for the following:

- **CPU %:** This shows you how much of the available CPU resource the container is currently using.
- **MEM USEAGE/LIMIT:** This tells you how much RAM the container is utilizing; it also displays how much allowance the container has. If you haven't explicitly set a limit, it will show the total amount of RAM on the host machine.
- **MEM %:** This shows you what percentage of the RAM allowance the container is using.

- **NET I/O:** This gives a running total of how much bandwidth has been transferred in and out of the container.

If you go back to your browser window and start to refresh `http://192.168.33.10/`, you will see that the values in each of the columns start to change. To stop streaming the statistics, press `Ctrl + c`.

Rather than keeping on hitting refresh over and over again, let's generate a lot of traffic to `01basic_web_1`, which should put the container under a heavy load.

Here, we will launch a container that will send 10,000 requests to `01basic_web_1` using ApacheBench (<https://httpd.apache.org/docs/2.2/programs/ab.html>). Although it will take a minute or two to execute, we should run `docker stats` as soon as possible:

```
docker run -d --name=01basic_load --link=01basic_web_1 russmckendrick/ab ab -k -n 10000 -c 5 http://01basic_web_1/ && docker stats 01basic_web_1 01basic_load
```

After the ApacheBench image has been downloaded and the container that will be called `01basic_load` starts, you should see the statistics for both `01basic_web_1` and `01basic_load` begin to stream in your terminal:

CONTAINER	CPU %	MEM USAGE/LIMIT	MEM %	NET I/O
<code>01basic_load</code>	<code>18.11%</code>	<code>12.71 MB/1.905 GB</code>	<code>0.67%</code>	<code>335.2 MB/5.27 MB</code>
<code>01basic_web_1</code>	<code>139.62%</code>	<code>96.49 MB/1.905 GB</code>	<code>5.07%</code>	<code>5.27 MB/335.2 MB</code>

After a while, you will notice that most of the statistics for `01basic_load` will drop off to zero; this means that the test has completed and that the container running the test has exited. The `docker stats` command can only stream statistics for the running containers; ones that have exited are no longer running and, therefore, do not produce output when running `docker stats`.

Exit from `docker stats` using `Ctrl + c`; to see the results of the ApacheBench command, you can type `docker logs 01basic_load`; you should see something like the following screenshot:

```
vagrant@centos7:~/monitoring_docker/Chapter01/01-basic — ssh — 136x43
[vagrant@centos7 01-basic]$ docker logs 01basic_load
This is ApacheBench, Version 2.3 <$Revision: 1430300 $>
Copyright 1996 Adam Twiss, Zeus Technology Ltd, http://www.zeustech.net/
Licensed to The Apache Software Foundation, http://www.apache.org/

Benchmarking 01basic_web_1 (be patient)
Completed 1000 requests
Completed 2000 requests
Completed 3000 requests
Completed 4000 requests
Completed 5000 requests
Completed 6000 requests
Completed 7000 requests
Completed 8000 requests
Completed 9000 requests
Completed 10000 requests
Finished 10000 requests

Server Software:      nginx/1.8.0
Server Hostname:     01basic_web_1
Server Port:          80

Document Path:        /
Document Length:     90841 bytes

Concurrency Level:    5
Time taken for tests: 14.994 seconds
Complete requests:   10000
Failed requests:      9964
    (Connect: 0, Receive: 0, Length: 9964, Exceptions: 0)
Write errors:          0
Keep-Alive requests:   0
Total transferred:   910057704 bytes
HTML transferred:    908437704 bytes
Requests per second:  666.95 [#/sec] (mean)
Time per request:    7.497 [ms] (mean)
Time per request:    1.499 [ms] (mean, across all concurrent requests)
Transfer rate:       59274.09 [Kbytes/sec] received

Connection Times (ms)
              min  mean[+/-sd] median   max
Connect:        0    0  0.1     0     2
```

You shouldn't worry if you see any failures like in the preceding output. This exercise was purely to demonstrate how to view the statistics of the running containers and not to tune a web server to handle the amount of traffic we sent to it using ApacheBench.

To remove the containers that we launched, run the following commands:

```
[vagrant@centos7 01-basic]$ docker-compose stop
Stopping 01basic_web_1...
[vagrant@centos7 01-basic]$ docker-compose rm
Going to remove 01basic_web_1
Are you sure? [yN] y
Removing 01basic_web_1...
[vagrant@centos7 01-basic]$ docker rm 01basic_load
01basic_load
```

To check whether everything has been removed successfully, run `docker ps -a` and you should not be able to see any running or exited containers that have `01basic_` in their names.

What just happened?

While running the ApacheBench test, you may have noticed that the CPU utilization on the container running NGINX and PHP was high; in the example in the previous section, it was using 139.62 percent of the available CPU resource.

As we did not attach any resource limits to the containers we launched, it was easy for our test to use all of the available resources on the host **Virtual Machine (VM)**. If this VM was being used by several users, all running their own containers, they may have started to notice that their applications had started to slow down or, even worse, the applications had started showing errors.

If you ever find yourself in this situation, you can use `docker stats` to help track down the culprit.

Running `docker stats $(docker ps -q)` will stream the statistics for all the currently running containers:

CONTAINER	CPU %	MEM USAGE/LIMIT	MEM %	NET I/O
361040b7b33e	0.07%	86.98 MB/1.905 GB	4.57%	2.514 kB/738 B
56b459ae9092	120.06%	87.05 MB/1.905 GB	4.57%	2.772 kB/738 B
a3de616f84ba	0.04%	87.03 MB/1.905 GB	4.57%	2.244 kB/828 B
abdbbee7b5207	0.08%	86.61 MB/1.905 GB	4.55%	3.69 kB/738 B
b85c49cf740c	0.07%	86.15 MB/1.905 GB	4.52%	2.952 kB/738 B

As you may have noticed, this displays the container ID rather than the name; this information should, however, be enough to spot the resource hog so that you can quickly stop it:

```
[vagrant@centos7 01-basic]$ docker stop 56b459ae9092  
56b459ae9092
```

Once stopped, you can then get the name of the rogue container by running the following command:

```
[vagrant@centos7 01-basic]$ docker ps -a | grep 56b459ae9092  
56b459ae9092      russmckendrick/nginx-php    "/usr/local/bin/run" 9  
minutes ago        Exited (0) 26 seconds ago    my_bad_container
```

Alternatively, for more detailed information, you can run `docker inspect 56b459ae9092`, which will give you all the information you need on the container.

What about processes?

One of the great things about Docker is that it isn't really virtualization; as mentioned in the previous chapter, it is a great way of isolating processes rather than running an entire operating system.

This can get confusing when running tools such as top or ps. To get an idea just how confusing this can get, lets launch several containers using docker-compose and see for ourselves:

```
[vagrant@centos7 ~]$ cd /monitoring_docker/Chapter01/02-multiple
[vagrant@centos7 02-multiple]$ docker-compose up -d
Creating 02multiple_web_1...
[vagrant@centos7 02-multiple]$ docker-compose scale web=5
Creating 02multiple_web_2...
Creating 02multiple_web_3...
Creating 02multiple_web_4...
Creating 02multiple_web_5...
Starting 02multiple_web_2...
Starting 02multiple_web_3...
Starting 02multiple_web_4...
Starting 02multiple_web_5...
```

Now, we have five web servers that have all been launched from the same image using the same configuration. One of the first things I do when logging into a server to troubleshoot a problem is run ps -aux; this will show all the running processes. As you can see, when running the command, there are a lot processes listed.

Even just trying to look at the processes for NGINX is confusing, as there is nothing to differentiate the processes from one container to another, as shown in the following output:

```
vagrant@centos7:~/monitoring_docker/Chapter01/02-multiple -- ssh -- 136x40
[vagrant@centos7 02-multiple]$ ps aux | grep nginx
root      4942  0.0  0.0  47512 1212 ?        Ss   19:33  0:00 nginx: master process nginx
vboxadd  4943  0.0  0.0  48048 1860 ?        S    19:33  0:00 nginx: worker process
root      5228  0.0  0.0  47512 1200 ?        Ss   19:37  0:00 nginx: master process nginx
vboxadd  5229  0.0  0.0  48048 1852 ?        S    19:37  0:00 nginx: worker process
root      5370  0.0  0.0  47512 1208 ?        Ss   19:37  0:00 nginx: master process nginx
vboxadd  5371  0.0  0.0  48048 1856 ?        S    19:37  0:00 nginx: worker process
root      5526  0.0  0.0  47512 1208 ?        Ss   19:37  0:00 nginx: master process nginx
vboxadd  5527  0.0  0.0  48048 1856 ?        S    19:37  0:00 nginx: worker process
root      5611  0.0  0.0  47512 1204 ?        Ss   19:37  0:00 nginx: master process nginx
vboxadd  5612  0.0  0.0  48048 1856 ?        S    19:37  0:00 nginx: worker process
root      6466  0.0  0.0  47512 1200 ?        Ss   19:44  0:00 nginx: master process nginx
vboxadd  6467  0.0  0.0  48048 1852 ?        S    19:44  0:00 nginx: worker process
root      6867  0.0  0.0  47512 1204 ?        Ss   19:44  0:00 nginx: master process nginx
vboxadd  6868  0.0  0.0  48048 1852 ?        S    19:44  0:00 nginx: worker process
root      6879  0.0  0.0  47512 1208 ?        Ss   19:44  0:00 nginx: master process nginx
vboxadd  6881  0.0  0.0  48048 1856 ?        S    19:44  0:00 nginx: worker process
root      6962  0.0  0.0  47512 1208 ?        Ss   19:44  0:00 nginx: master process nginx
vboxadd  6963  0.0  0.0  48048 1856 ?        S    19:44  0:00 nginx: worker process
root      6974  0.0  0.0  47512 1212 ?        Ss   19:44  0:00 nginx: master process nginx
vboxadd  6975  0.0  0.0  48048 1860 ?        S    19:44  0:00 nginx: worker process
root      7658  0.0  0.1  47508 3456 ?        S    19:47  0:00 nginx
root      7659  0.0  0.1  47508 3452 ?        S    19:47  0:00 nginx
root      7660  0.0  0.1  47508 3448 ?        S    19:47  0:00 nginx
root      7661  0.0  0.1  47508 3452 ?        S    19:47  0:00 nginx
root      7662  0.0  0.1  47508 3448 ?        S    19:47  0:00 nginx
root      7663  0.0  0.1  47508 3448 ?        S    19:47  0:00 nginx
vagrant   7665  0.0  0.0  112644  960 pts/0   R+   19:47  0:00 grep --color=auto nginx
[vagrant@centos7 02-multiple]$
```

So, how can you know which container owns which processes?

Docker top

This command lists all the processes that are running within a container; think of it as a way of filtering the output of the `ps aux` command we ran on the host machine:

```
vagrant@centos7:~/monitoring_docker/Chapter01/02-multiple - ssh - 136x40
[vagrant@centos7 02-multiple]$ docker-compose ps
      Name        Command   State    Ports
----- 
02multiple_web_1  /usr/local/bin/run  Up      0.0.0.0:32772->80/tcp
02multiple_web_2  /usr/local/bin/run  Up      0.0.0.0:32773->80/tcp
02multiple_web_3  /usr/local/bin/run  Up      0.0.0.0:32774->80/tcp
02multiple_web_4  /usr/local/bin/run  Up      0.0.0.0:32775->80/tcp
02multiple_web_5  /usr/local/bin/run  Up      0.0.0.0:32776->80/tcp
[vagrant@centos7 02-multiple]$ docker top 02multiple_web_3
UID        PID  PPID   C      STIME   TTY      TIME
CMD
root      6749     4412   0      19:44   ?
root      6877     6749   0      19:44   ?
root      6879     6749   0      19:44   ?
root      6881     6879   0      19:44   ?
vboxaddd  6881     6879   0      19:44   ?
root      6900     6877   0      19:44   ?
666       6901     6877   0      19:44   ?
root      6902     6877   0      19:44   ?
666       6903     6877   0      19:44   ?
root      6904     6877   0      19:44   ?
root      6955     6749   0      19:44   ?
postfix   6959     6955   0      19:44   ?
postfix   6960     6955   0      19:44   ?
root      8945     6749   0      19:54   ?
nginx
[vagrant@centos7 02-multiple]$ ]
```

As `docker top` is an implementation of the standard `ps` command, any flags you would normally pass to `ps` should work as follows:

```
[vagrant@centos7 02-multiple]$ docker top 02multiple_web_3 -aux
[vagrant@centos7 02-multiple]$ docker top 02multiple_web_3 -faux
```

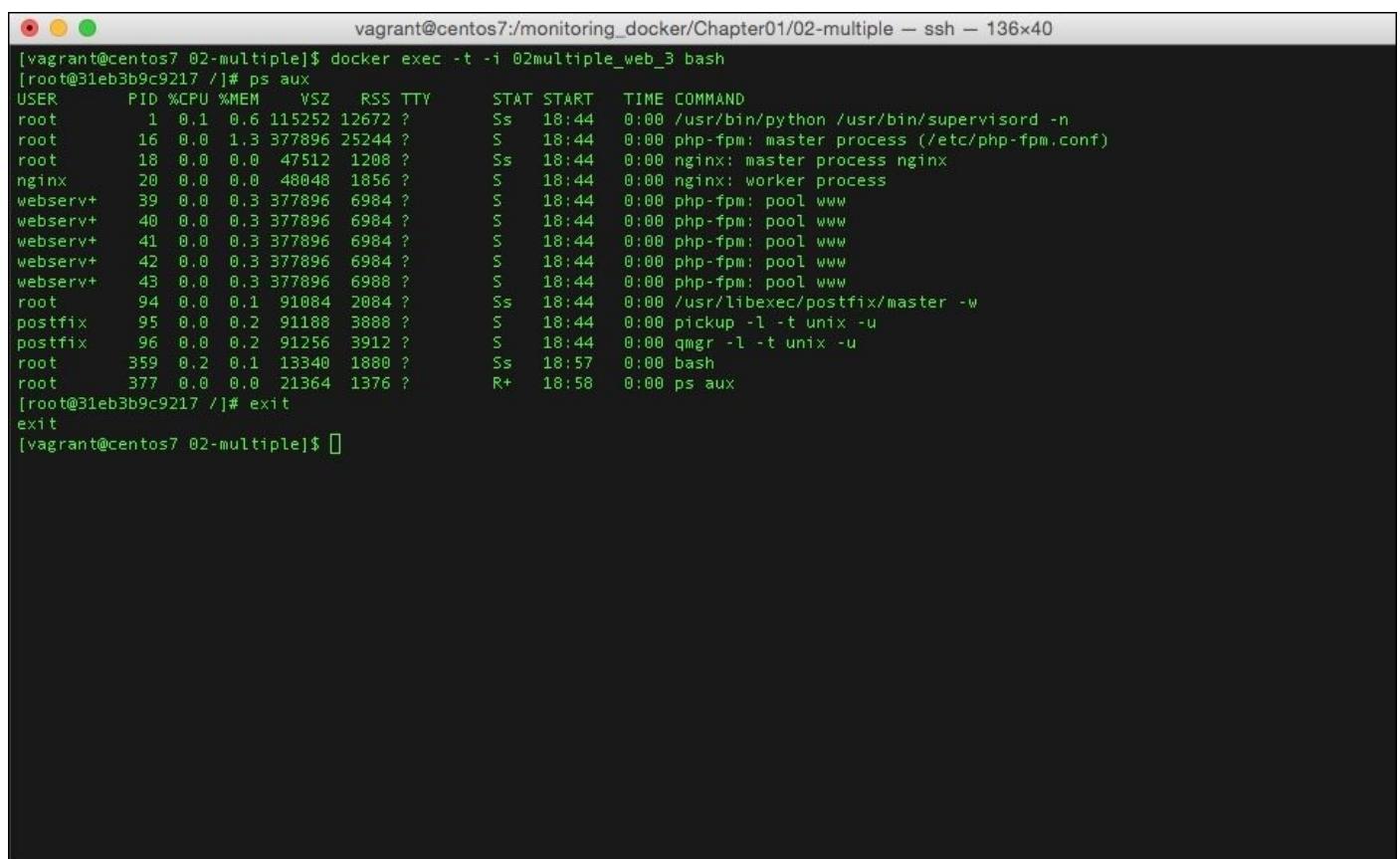
Docker exec

Another way to view what is going on within a container is to enter it. To enable you to do this, Docker introduced the `docker exec` command. This allows you to spawn an additional process within an already running container and then attach to the process; so, if we wanted to look at what is currently running on `02multiple_web_3`, we should use the following command spawn a bash shell within an already running container:

```
docker exec -t -i 02multiple_web_3 bash
```

Once you have an active shell on the container, you will notice that your prompt has changed to the container's ID. Your session is now isolated to the container's environment, meaning that you will only be able to interact with the processes belonging to the container you entered.

From here, you can run the `ps aux` or `top` command as you would do on the host machine, and only see the processes associated with the container you are interested in:



```
vagrant@centos7:~/monitoring_docker/Chapter01/02-multiple — ssh — 136x40
[vagrant@centos7 02-multiple]$ docker exec -t -i 02multiple_web_3 bash
[root@31eb3b9c9217 /]# ps aux
USER      PID %CPU %MEM    VSZ   RSS TTY      STAT START  TIME COMMAND
root         1  0.1  0.6 115252 12672 ?
root        16  0.0  1.3 377896 25244 ?
root        18  0.0  0.0 47512 1208 ?
nginx       20  0.0  0.0 48048 1856 ?
webserv+   39  0.0  0.3 377896 6984 ?
webserv+   40  0.0  0.3 377896 6984 ?
webserv+   41  0.0  0.3 377896 6984 ?
webserv+   42  0.0  0.3 377896 6984 ?
webserv+   43  0.0  0.3 377896 6988 ?
root        94  0.0  0.1 91084 2084 ?
postfix    95  0.0  0.2 91188 3888 ?
postfix    96  0.0  0.2 91256 3912 ?
root       359  0.2  0.1 13340 1880 ?
root       377  0.0  0.0 21364 1376 ?
Ss  18:44  0:00 /usr/bin/python /usr/bin/supervisord -n
S   18:44  0:00 php-fpm: master process (/etc/php-fpm.conf)
Ss  18:44  0:00 nginx: master process nginx
S   18:44  0:00 nginx: worker process
S   18:44  0:00 php-fpm: pool www
Ss  18:44  0:00 /usr/libexec/postfix/master -w
S   18:44  0:00 pickup -l -t unix -u
S   18:44  0:00 qmgr -l -t unix -u
Ss  18:57  0:00 bash
R+  18:58  0:00 ps aux
[root@31eb3b9c9217 /]# exit
exit
[vagrant@centos7 02-multiple]$
```

To leave the container, type in `exit`, you should see your prompt change back in your host machine.

Finally, you can stop and remove the containers by running `docker-compose stop` and `docker-compose kill`.

Summary

In this chapter, we saw how we can get real-time statistics on our running containers and how we can use commands that are familiar to us, to get information on the processes that are launched as part of each container.

On the face of it, `docker stats` seems like a really basic piece of functionality that isn't really anything more than a tool to help you identify which container is using all the resources while a problem is occurring. However, the Docker command is actually pulling the information from a quite powerful API.

This API forms the basis for a lot of the monitoring tools we will be looking at in the next few chapters.

Chapter 3. Advanced Container Resource Analysis

In the last chapter, we looked at how you can use the API built into Docker to gain an insight to what resources your containers are running. Now, we are to see how we can take it to the next level by using cAdvisor from Google. In this chapter, you will cover the following topics:

- How to install cAdvisor and start collecting metrics
- Learn all about the web interface and real-time monitoring
- What your options are for shipping metrics to a remote Prometheus database for long-term storage and trend analysis

What is cAdvisor?

Google describes cAdvisor as follows:

“cAdvisor (Container Advisor) provides container users an understanding of the resource usage and performance characteristics of their running containers. It is a running daemon that collects, aggregates, processes, and exports information about running containers. Specifically, for each container, it keeps resource isolation parameters, historical resource usage, histograms of complete historical resource usage, and network statistics. This data is exported by a container and is machine-wide.”

The project started off life as an internal tool at Google for gaining an insight into containers that had been launched using their own container stack.

Note

Google's own container stack was called “Let Me Contain That For You” or lmctfy for short. The work on lmctfy has been installed as a Google port functionality over to libcontainer that is part of the Open Container Initiative. Further details on lmctfy can be found at <https://github.com/google/lmctfy/>.

cAdvisor is written in Go (<https://golang.org>); you can either compile your own binary or you can use the pre-compiled binary that are supplied via a container, which is available from Google's own Docker Hub account. You can find this at <http://hub.docker.com/u/google/>.

Once installed, cAdvisor will sit in the background and capture metrics that are similar to that of the docker stats command. We will go through these stats and understand what they mean later in this chapter.

cAdvisor takes these metrics along with those for the host machine and exposes them via a simple and easy-to-use built-in web interface.

Running cAdvisor using a container

There are a number of ways to install cAdvisor; the easiest way to get started is to download and run the container image that contains a copy of a precompiled cAdvisor binary.

Before running cAdvisor, let's launch a fresh vagrant host:

```
[russ@mac ~]$ cd ~/Documents/Projects/monitoring-docker/vagrant-centos/  
[russ@mac ~]$ vagrant up  
Bringing machine 'default' up with 'virtualbox' provider...  
==>default: Importing base box 'russmckendrick/centos71'...  
==>default: Matching MAC address for NAT networking...  
==>default: Checking if box 'russmckendrick/centos71' is up to date...  
....  
==>default: => Installing docker-engine...  
==>default: => Configuring vagrant user...  
==>default: => Starting docker-engine...  
==>default: => Installing docker-compose...  
==>default: => Finished installation of Docker  
[russ@mac ~]$ vagrant ssh
```

Tip

Using a backslash

As we have a lot options to pass to the `docker run` command, we are using \ to split the command over multiple lines so it's easier to follow what is going on.

Once you have access to the host machine, run the following command:

```
docker run \  
  --detach=true \  
  --volume=/:/rootfs:ro \  
  --volume=/var/run:/var/run:rw \  
  --volume=/sys:/sys:ro \  
  --volume=/var/lib/docker/:/var/lib/docker:ro \  
  --publish=8080:8080 \  
  --privileged=true \  
  --name=cadvisor \  
 google/cadvisor:latest
```

You should now have a cAdvisor container up and running on your host machine. Before we start, let's look at cAdvisor in more detail by discussing why we have passed all the options to the container.

The cAdvisor binary is designed to run on the host machine alongside the Docker binary, so by launching cAdvisor in a container, we are actually isolating the binary in its own environment. To give cAdvisor access to the resources it requires on the host machine, we have to mount several partitions and also give the container privileged access to let the cAdvisor binary think it is being executed on the host machine.

Note

When a container is launched with `--privileged`, Docker will enable full access to devices on the host machine; also, Docker will configure both AppArmor or SELinux to allow your container the same access to the host machine as a process running outside the container will have. For information on the `--privileged` flag, see this post on the Docker blog at <http://blog.docker.com/2013/09/docker-can-now-run-within-docker/>.

Compiling cAdvisor from source

As mentioned in the previous section, cAdvisor really ought to be executed on the host machine; this means, you may have to use a case to compile your own cAdvisor binary and run it directly on the host.

To compile cAdvisor, you will need to perform the following steps:

1. Install Go and Mercurial on the host machine—version 1.3 or higher of Go is needed to compile cAdvisor.
2. Set the path for Go to work from.
3. Grab the source code for cAdvisor and godep.
4. Set the path for your Go binaries.
5. Build the cAdvisor binary using godep to source the dependencies for us.
6. Copy the binary to /usr/local/bin/.
7. Download either an Upstart or Systemd script and launch the process.

If you followed the instructions in the previous section, you will already have a cAdvisor process running. Before compiling from source, you should start with a clean host; let's log out of the host and launch a fresh copy:

```
[vagrant@centos7 ~]$ exit
logout
Connection to 127.0.0.1 closed.
[russ@mac ~]$ vagrant destroy
default: Are you sure you want to destroy the 'default' VM? [y/N] y
==>default: Forcing shutdown of VM...
==>default: Destroying VM and associated drives...
==>default: Running cleanup tasks for 'shell' provisioner...
[russ@mac ~]$ vagrant up
Bringing machine 'default' up with 'virtualbox' provider...
==>default: Importing base box 'russmckendrick/centos71'...
==>default: Matching MAC address for NAT networking...
==>default: Checking if box 'russmckendrick/centos71' is up to date...

.....
==>default: => Installing docker-engine...
==>default: => Configuring vagrant user...
==>default: => Starting docker-engine...
==>default: => Installing docker-compose...
==>default: => Finished installation of Docker
[russ@mac ~]$ vagrant ssh
```

To build cAdvisor on the CentOS 7 host, run the following command:

```
sudo yum install -y golanggit mercurial
export GOPATH=$HOME/go
go get -d github.com/google/cadvisor
go get github.com/tools/godep
export PATH=$PATH:$GOPATH/bin
cd $GOPATH/src/github.com/google/cadvisor
```

```
godep go build .
sudocpcadvisor /usr/local/bin/
sudowgethttps://gist.githubusercontent.com/russmckendrick/f647b2faad5d92c96
771/raw/86b01a044006f85eebbe395d3857de1185ce4701/cadvisor.service -O
/lib/systemd/system/cadvisor.service
sudosystemctl enable cAdvisor.service
sudosystemctl start cAdvisor
```

On the Ubuntu 14.04 LTS host, run the following command:

```
sudo apt-get -y install software-properties-common
sudo add-apt-repository ppa:evarlast/golang1.4
sudo apt-get update

sudo apt-get -y install golang mercurial

export GOPATH=$HOME/go
go get -d github.com/google/cadvisor
go get github.com/tools/godep
export PATH=$PATH:$GOPATH/bin
cd $GOPATH/src/github.com/google/cadvisor
godep go build .
sudocpcadvisor /usr/local/bin/
sudowgethttps://gist.githubusercontent.com/russmckendrick/f647b2faad5d92c96
771/raw/e12c100d220d30c1637bedd0ce1c18fb84beff77/cadvisor.conf -O
/etc/init/cadvisor.conf
sudo start cAdvisor
```

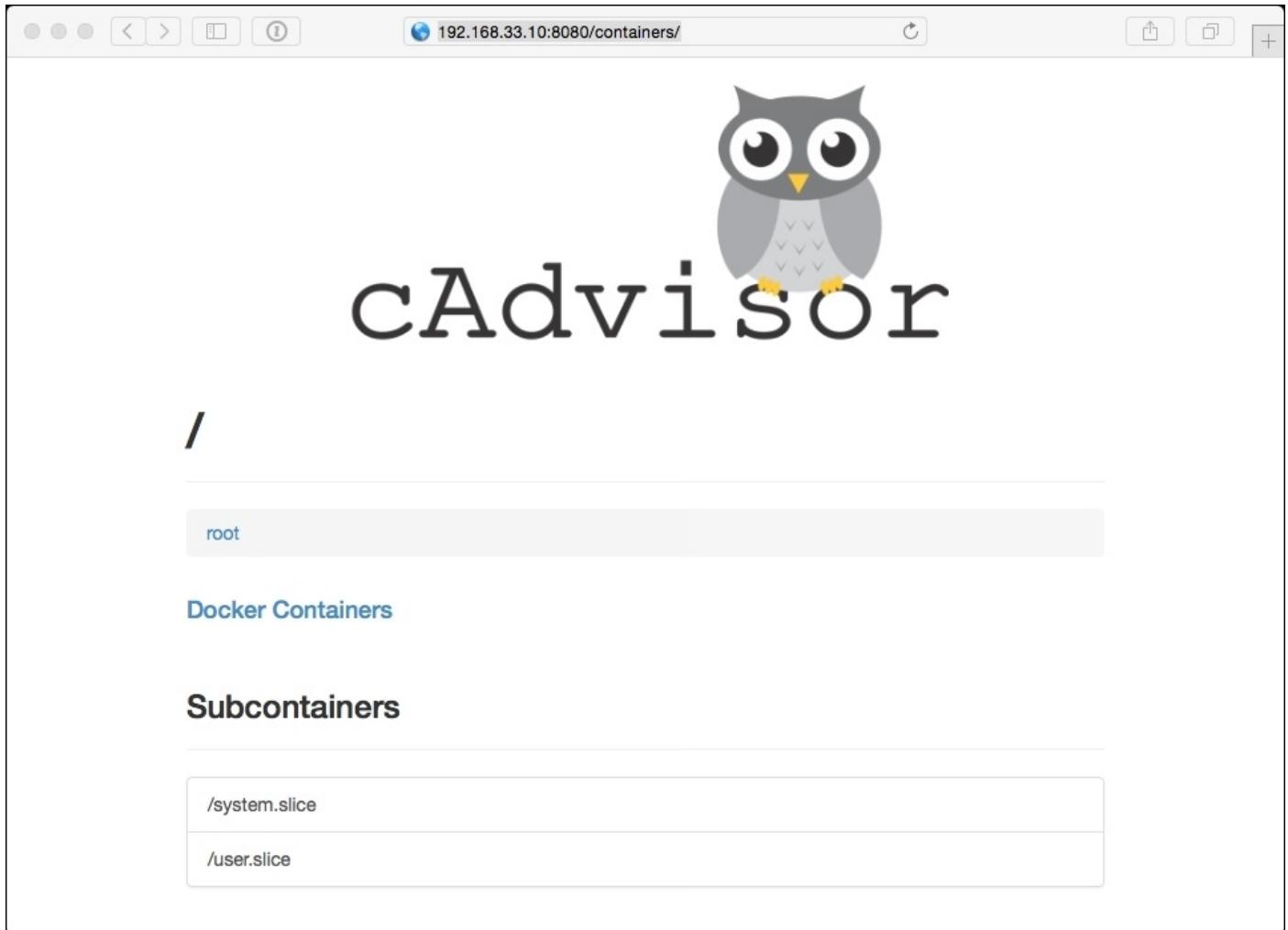
You should now have a running cAdvisor process. You can check this by running ps aux | grep cAdvisor and you should see a process with a path of /usr/local/bin/cAdvisor running.

Collecting metrics

Now, you have cAdvisor running; what do you need to do to configure the service in order to start collecting metrics? The short answer is, nothing at all. When you started the cAdvisor process, it instantly started polling your host machine to find out what containers are running and gathered information on both the running containers and your host machine.

The Web interface

cAdvisor should be running on the 8080 port; if you open `http://192.168.33.10:8080/`, you should be greeted with the cAdvisor logo and an overview of your host machine:



This initial page streams live stats about the host machine, though each section is repeated when you start to drill down and view the containers. To start with, let's look at each section using the host information.

Overview

This overview section gives you a bird's-eye view of your system; it uses gauges so you can quickly get an idea of which resources are reaching their limits. In the following screenshot, there is very little in the way of CPU utilization and the file system usage is relatively low; however, we are using 64% of the available RAM:



Processes

The following screenshot displays a combined view of the output of the `ps aux`, `docker ps` and `top` commands we used in the previous chapter:

Processes										
User	PID	PPID	Start Time	CPU %	MEM %	RSS	Virtual Size	Status	Running T	
root	4807	4411	19:42	1.20	1.30	25.38 KiB	359.63 KiB	Ssl	00:00	
root	4424	2	19:41	0.50	0.00	0.00 B	0.00 B	S<	00:00	
root	6	2	19:40	0.20	0.00	0.00 B	0.00 B	S	00:00	
root	4411	1	19:41	0.20	1.50	27.52 KiB	654.76 KiB	Ssl	00:00	
root	1	0	19:40	0.10	0.20	3.83 KiB	52.89 KiB	Ss	00:00	
root	47	2	19:40	0.10	0.00	0.00 B	0.00 B	S	00:00	
root	2	0	19:40	0.00	0.00	0.00 B	0.00 B	S	00:00	
root	20	2	19:40	0.00	0.00	0.00 B	0.00 B	S<	00:00	
root	21	2	19:40	0.00	0.00	0.00 B	0.00 B	S	00:00	
root	22	2	19:40	0.00	0.00	0.00 B	0.00 B	S<	00:00	
root	23	2	19:40	0.00	0.00	0.00 B	0.00 B	S<	00:00	

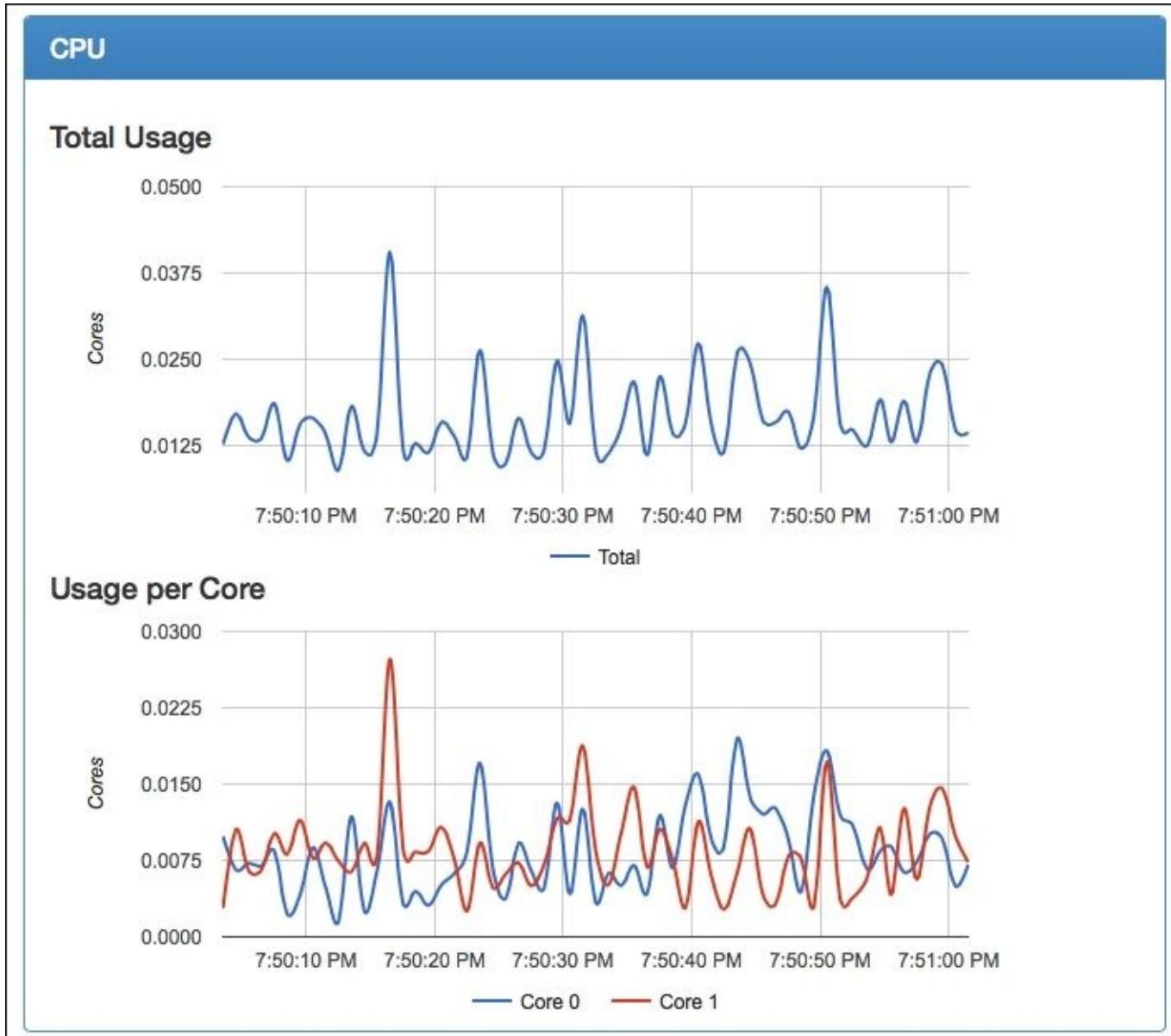
Here is what each column heading means:

- **User:** This shows which user is running the process
- **PID:** This is the unique process ID
- **PPID:** This is the **PID** of the parent process
- **Start Time:** This shows what time the process started
- **CPU %:** This is the percentage of the CPU the process is currently consuming
- **MEM %:** This is the percentage of the RAM the process is currently consuming
- **RSS:** This shows how much of the main memory the process is using
- **Virtual Size:** This shows how much of the virtual memory the process is using
- **Status:** This shows the current status of the process; this are the standard Linux process state codes
- **Running Time:** This shows how long the process has been running
- **Command:** This shows which command the process is running
- **Container:** This shows which container the process is attached to; the container listed as / is the host machine

As there could be several hundred processes active, this section is split into pages; you can navigate to these with the buttons on the bottom-left. Also, you can sort the processes by clicking on any of the headings.

CPU

The following graph shows the CPU utilization over the last minute:



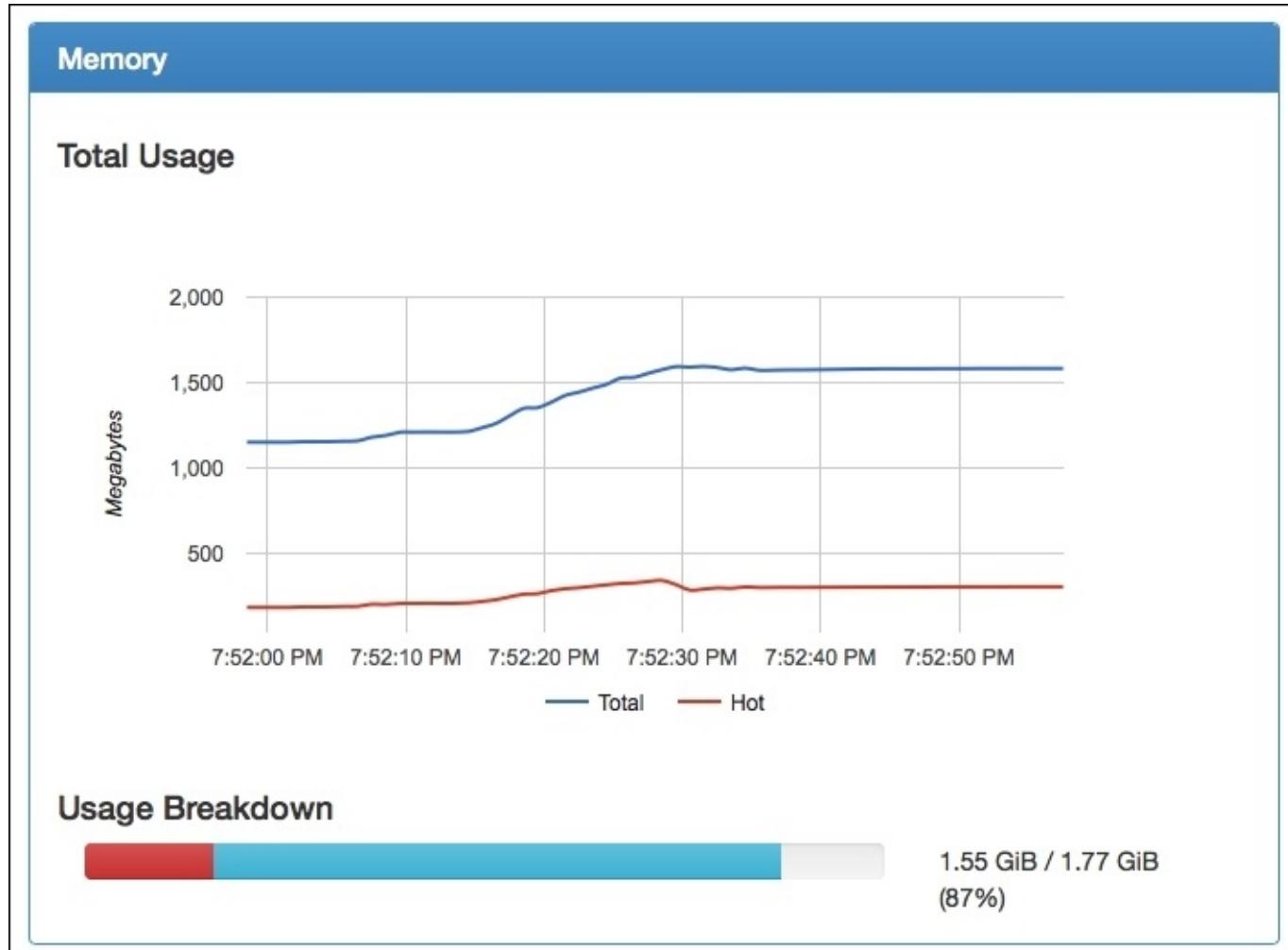
Here is what each term means:

- **Total Usage:** This shows an aggregate usage across all cores
- **Usage per Core:** This graph breaks down the usage per core
- **Usage Breakdown** (not shown in the preceding screenshot): This shows aggregate usage across all cores, but breaks it down to what is being used by the kernel and what is being used by the user-owned processes

Memory

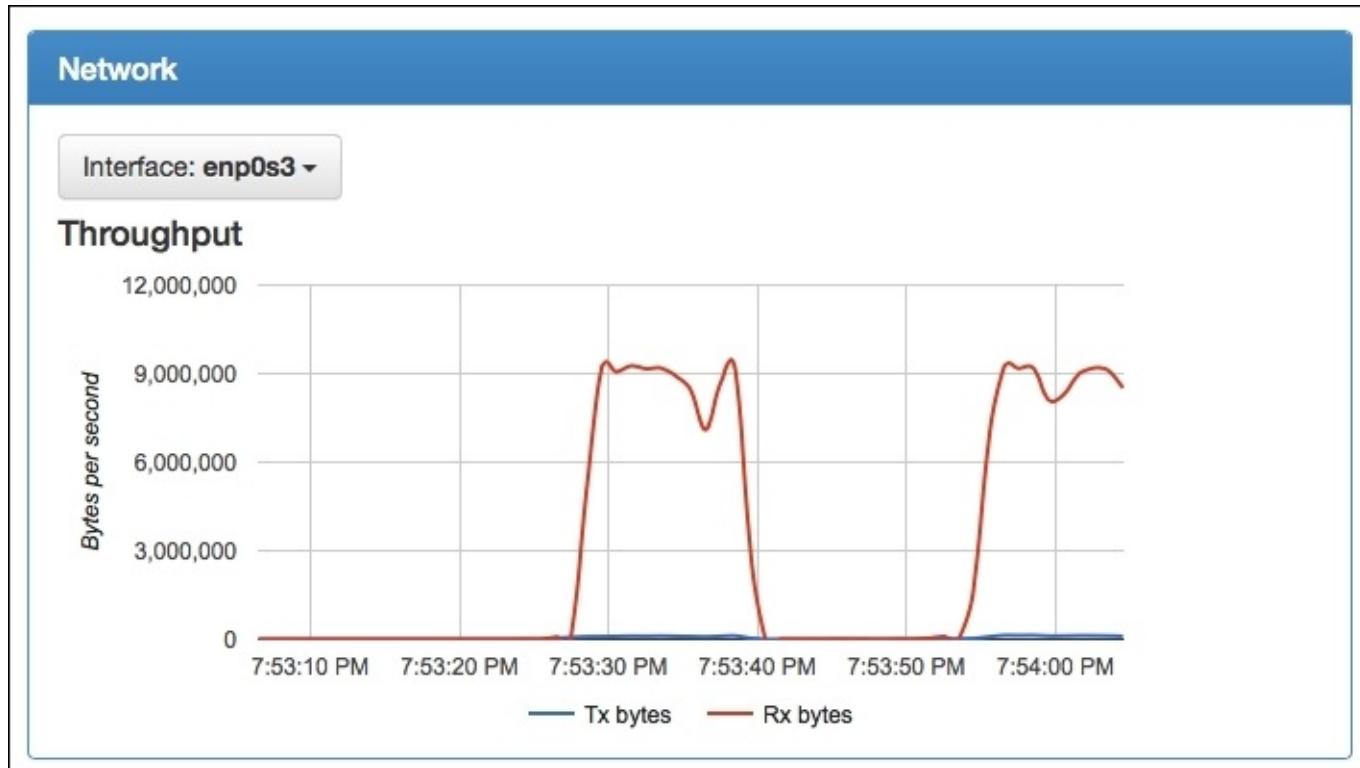
The **Memory** section is split into two parts. The graph tells you the total amount of memory used by all the processes for the host or container; this is the total of the hot and cold memory. The **Hot** memory is the current working set: pages that have been touched by the kernel recently. The **Cold** memory is the page that hasn't been touched for a while and could be reclaimed if needed.

The **Usage Breakdown** gives a visual representation of the total memory in the host machine, or allowance in the container, alongside the total and hot usage:



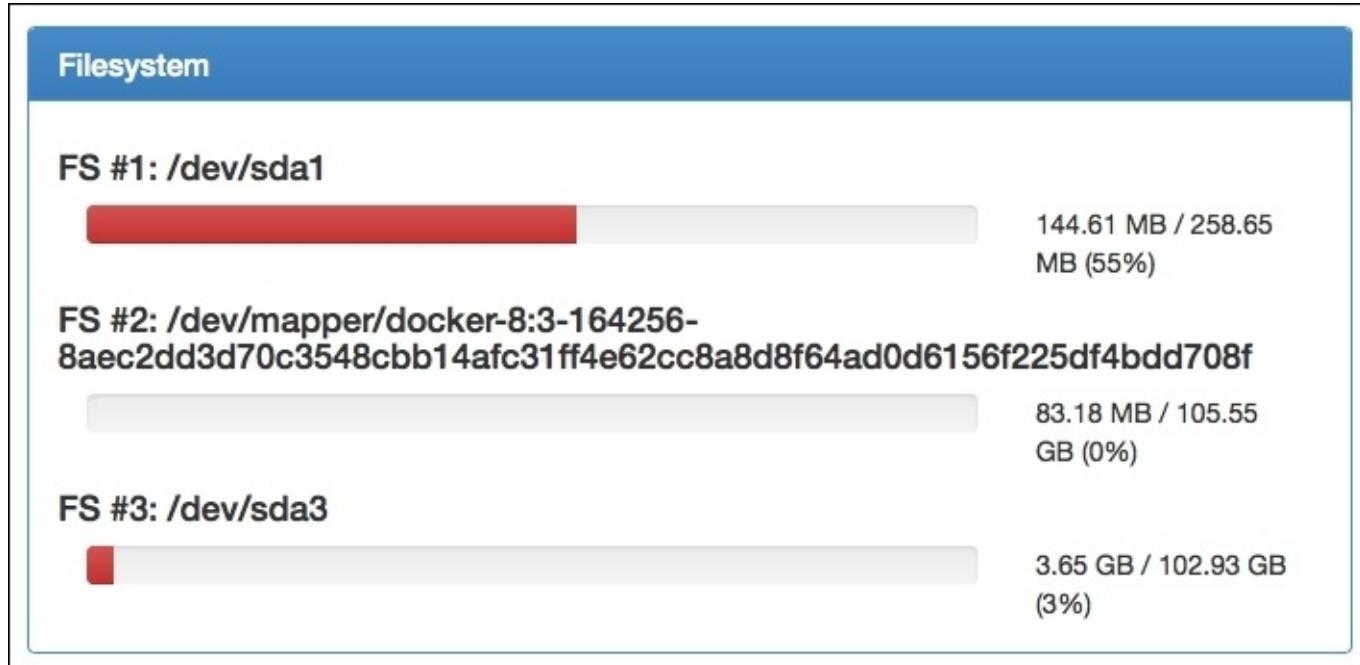
Network

This section shows the incoming and outgoing traffic over the last minute. You can change the interface using the drop-down box on the top-left. There is also a graph that shows any networking errors. Typically, this graph should be flat. If it isn't, then you will be seeing performance issues with your host machine or container:



Filesystem

The final section gives a break down of the filesystem usage. In the following screenshot, /dev/sda1 is the boot partition, /dev/sda3 is the main filesystem, and /dev/mapper/docker-8... is an aggregate of the write file systems of your running containers:



Viewing container stats

At the top of the page, there is a link of your running containers; you can either click on the link or go directly to `http://192.168.33.10:8080/docker/`. Once the page loads, you should see a list of all your running containers, and also a detailed overview of your Docker process, and finally a list of the images you have downloaded.

Subcontainers

Subcontainers shows a list of your containers; each entry is a clickable link that will take you to a page that will give you the following details:

- Isolation:
 - **CPU:** This shows you the CPU allowances of the container; if you have not set any resource limits, you will see the host's CPU information
 - **Memory:** This shows you the memory allowances of the container; if you have not set any resource limits, your container will show an unlimited allowance
- Usage:
 - **Overview:** This shows gauges so you can quickly see how close to any resource limits you are
 - **Processes:** This shows the processes for just your selected container
 - **CPU:** This shows the CPU utilization graphs isolated to just your container
 - **Memory:** This shows the memory utilization of your container

Driver status

The driver gives the basic stats on your main Docker process, along with the information on the host machine's kernel, host name, and also the underlying operating system.

It also gives information on the total number of containers and images. You may notice that the total number of images is a much larger figure than you expected to see; this is because it is counting each file system as an individual image.

Note

For more details on Docker images, see the Docker user guide at <https://docs.docker.com/userguide/dockerimages/>.

It also gives you a detailed breakdown of your storage configuration.

Images

Finally, you get a list of the Docker images which are available on the host machine. It lists the Repository, Tag, Size, and when the image was created, along with the images' unique ID. This lets you know where the image originated from (Repository), which version of the image you have downloaded (Tag) and how big the image is (Size).

This is all great, what's the catch?

So you are maybe thinking to yourself that all of this information available in your browser is really useful; being able to see real-time performance metrics in an easily readable format is a really plus.

The biggest drawback of using the web interface for cAdvisor, as you may have noticed, is that it only shows you one minute's worth of metrics; you can quite literally see the information disappearing in real time.

As a pane of glass gives a real-time view into your containers, cAdvisor is a brilliant tool; if you want to review any metrics that are older than one minute, you are out of luck.

That is, unless you configure somewhere to store all of your data; this is where Prometheus comes in.

Prometheus

So what's Prometheus? Its developers describe it as follows:

Prometheus is an open-source system's monitoring and alerting toolkit built at SoundCloud. Since its inception in 2012, it has become the standard for instrumenting new services at SoundCloud and is seeing growing external usage and contributions.

OK, but what does that have to do with cAdvisor? Well, Prometheus has quite a powerful database backend that stores the data it imports as a time series of events.

Wikipedia describes a time series as follows:

"A time series is a sequence of data points, typically consisting of successive measurements made over a time interval. Examples of time series are ocean tides, counts of sunspots, and the daily closing value of the Dow Jones Industrial Average. Time series are very frequently plotted via line charts."

https://en.wikipedia.org/wiki/Time_series

One of the things cAdvisor does, by default, is expose all the metrics it is capturing on a single page at /metrics; you can see this at `http://192.168.33.10:8080/metrics` on our cAdvisor installation. The metrics are updated each time the page is loaded:

```
# HELP container_cpu_system_seconds_total Cumulative system cpu time consumed in seconds.
# TYPE container_cpu_system_seconds_total counter
container_cpu_system_seconds_total{id="/",name="/" } 13.94
container_cpu_system_seconds_total{id="/system.slice",name="/system.slice"} 0.09
container_cpu_system_seconds_total{id="/system.slice/-.-mount",name="/system.slice/-.-mount"} 0
container_cpu_system_seconds_total{id="/system.slice/NetworkManager-dispatcher.service",name="/system.slice/NetworkManager-dispatcher.service"} 0
container_cpu_system_seconds_total{id="/system.slice/NetworkManager-wait-online.service",name="/system.slice/NetworkManager-wait-online.service"} 0
container_cpu_system_seconds_total{id="/system.slice/NetworkManager.service",name="/system.slice/NetworkManager.service"} 0
container_cpu_system_seconds_total{id="/system.slice/boot.mount",name="/system.slice/boot.mount"} 0
container_cpu_system_seconds_total{id="/system.slice/brandbot.service",name="/system.slice/brandbot.service"} 0
container_cpu_system_seconds_total{id="/system.slice/cpupower.service",name="/system.slice/cpupower.service"} 0
container_cpu_system_seconds_total{id="/system.slice/crond.service",name="/system.slice/crond.service"} 0
container_cpu_system_seconds_total{id="/system.slice/dbus.service",name="/system.slice/dbus.service"} 0
container_cpu_system_seconds_total{id="/system.slice/dbus.socket",name="/system.slice/dbus.socket"} 0
container_cpu_system_seconds_total{id="/system.slice/dev-disk-by\\x2did-ata\\x2dVBOX_HARDDISK_VB25363e5b\\x2db6742bbf\\x2dpart2.swap",name="/system.slice/dev-disk-by\\x2did-ata\\x2dVBOX_HARDDISK_VB25363e5b\\x2db6742bbf\\x2dpart2.swap"} 0
container_cpu_system_seconds_total{id="/system.slice/dev-disk-by\\x2duuid-f9595940\\x2d2813\\x2d45a1\\x2dae5e\\x2dc60e7373c342.swap",name="/system.slice/dev-disk-by\\x2duuid-f9595940\\x2d2813\\x2d45a1\\x2dae5e\\x2dc60e7373c342.swap"} 0
container_cpu_system_seconds_total{id="/system.slice/dev-sda2.swap",name="/system.slice/dev-sda2.swap"} 0
container_cpu_system_seconds_total{id="/system.slice/docker-4e9e860c475e96935e65028bbf324138fd7f98c1167e9c426f7f5911d0f129a0.scope",name="cadvisor"} 0.05
```

As you can see in the preceding screenshot, this is just a single long page of raw text. The way Prometheus works is that you configure it to scrape the /metrics URL at a user-defined interval, let's say every five seconds; the text is in a format that Prometheus understands and it is ingested into the Prometheus's time series database.

What this means is that, using Prometheus's powerful built-in query language, you can start to drill down into your data. Let's look at getting Prometheus up and running.

Launching Prometheus

Like cAdvisor there are several ways you can launch Prometheus. To start with, we will launch a container and inject our own configuration file so that Prometheus knows where our cAdvisor endpoint is:

```
docker run \
--detach=true \
-- 
volume=/monitoring_docker/Chapter03/prometheus.yml:/etc/prometheus/prometheus.yml \
--publish=9090:9090 \
--name=prometheus \
prom/prometheus:latest
```

Once you have launched the container, Prometheus will be accessible on the following URL: <http://192.168.33.10:9090>. When you first load the URL, you will be taken to a status page; this gives some basic information on the Prometheus installation. The important part of this page is the list of targets. This lists the URL that Prometheus will be scrapping to capture metrics; you should see your cAdvisor URL listed with a state of **HEALTHY**, as shown in the following screenshot:

Targets				
cadvisor				
Endpoint	State	Base Labels	Last Scrape	Error
http://192.168.33.10:8080/metrics	HEALTHY	none	4.625239876s ago	

Another information page contains the following:

- **Runtime information:** This displays how long Prometheus has been up and polling data, if you have configured an endpoint
- **Build information:** This contains the details of the version of Prometheus that you have been running
- **Configuration:** This is a copy of the configuration file we injected into the container when it was launched
- **Rules:** This is a copy of any rules we injected; these will be used for alerting
- **Startup flags:** This shows all the runtime variables and their values

Querying Prometheus

As we only have a few containers up and running at the moment, let's launch one that runs Redis so we can start to look at the query language built into Prometheus.

We will use the official Redis image for this and as we are only going to use this as an example we won't need to pass it any user variables:

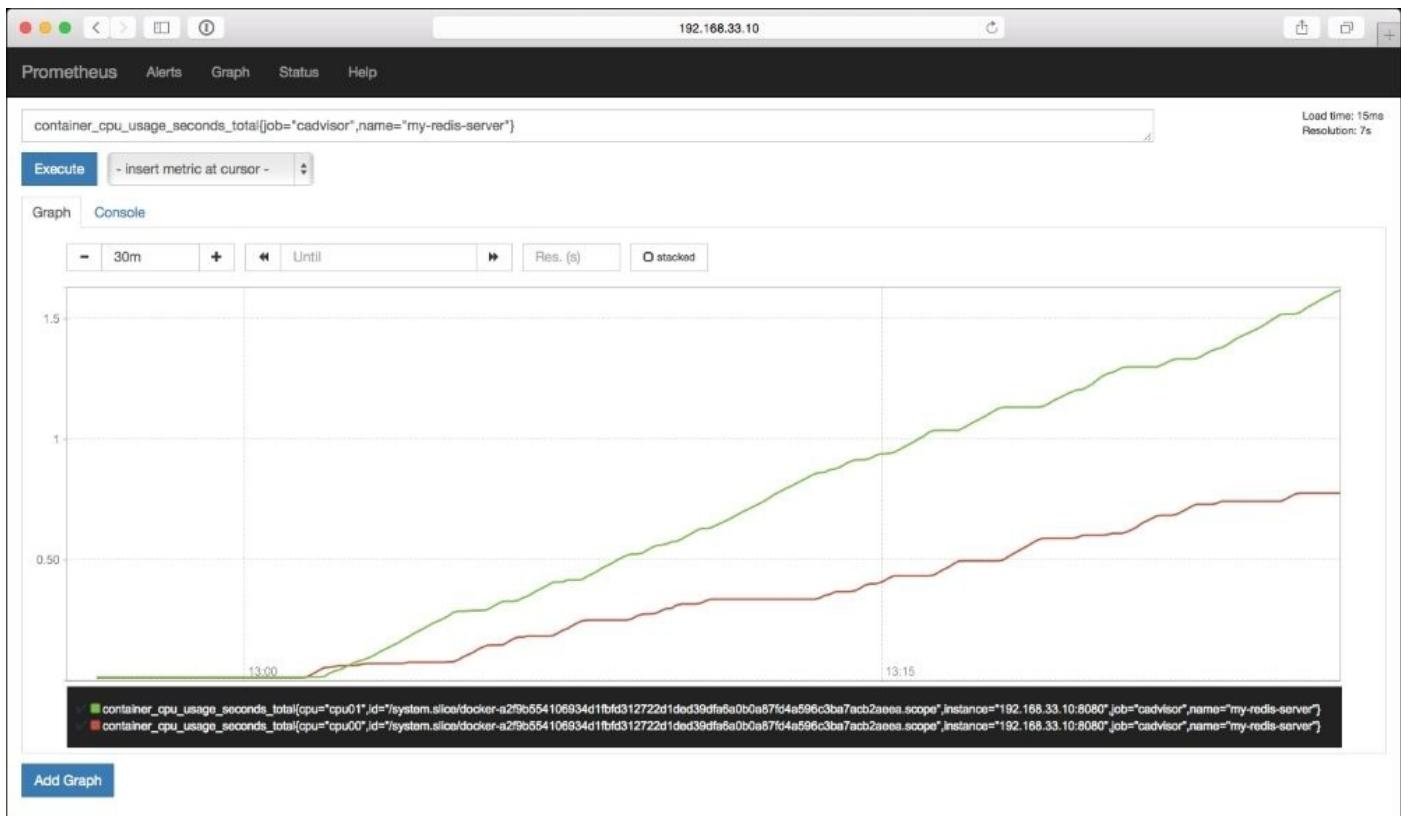
```
docker run --name my-redis-server -d redis
```

We now have a container called `my-redis-server` running. cAdvisor should already be exposing metrics about the container to Prometheus; let's go ahead and see. In the Prometheus web interface, go to the **Graph** link in the menu at the top of the page. Here, you will be presented with a text box into which you can enter your query. To start with, let's look at the CPU usage of the Redis container.

In the box, enter the following:

```
container_cpu_usage_seconds_total{job="cadvisor", name="my-redis-server"}
```

Then, after clicking on **Execute**, you should have two results returned, listed in the **Console** tab of the page. If you remember, cAdvisor records the CPU usage of each of the CPU cores that the container has access to, which is why we have two values returned, one for "cpu00" and one for "cpu01". Clicking on the **Graph** link will show you results over a period of time:



As you can see in the preceding screenshot, we now have access to the usage graphs for the last 25 minutes, which is about how long ago I launched the Redis instance before

generating the graph.

Dashboard

Also, when creating one of the graphs using the query tool in the main application, you can install a separate Dashboard application. This runs in a second container that connects to your main Prometheus container using the API as a data source.

Before we start the Dashboard container, we should initialize a SQLite3 database to store our configuration. To ensure that the database is persistent, we will store this on the host machine in /tmp/prom/file.sqlite3:

```
docker run \
--volume=/tmp/prom:/tmp/prom \
-e DATABASE_URL=sqlite3:/tmp/prom/file.sqlite3 \
prom/promdash ./bin/rake db:migrate
```

Once we have initialized the database, we can launch the Dashboard application properly:

```
docker run \
--detach=true \
--volume=/tmp/prom:/tmp/prom \
-e DATABASE_URL=sqlite3:/tmp/prom/file.sqlite3 \
--publish=3000:3000 \
--name=promdash \
prom/promdash
```

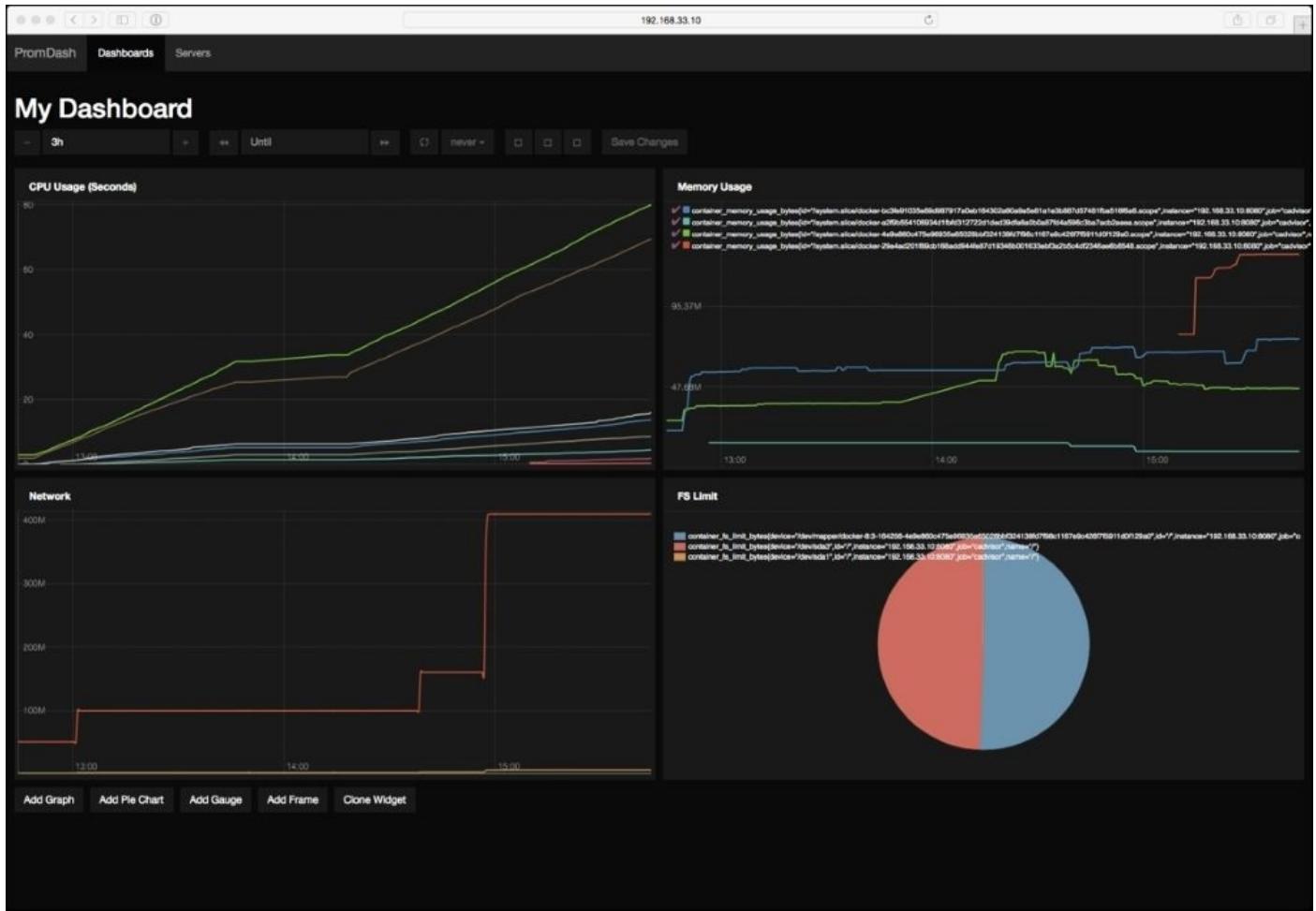
The application should now be accessible at <http://192.168.33.10:3000/>. The first thing we need to do is set up the data source. To do this, click on the **Servers** link at the top of the screen and then click on **New Server**. Here, you will be asked to provide the details of your Prometheus server. Name the server and enter the following URL:

- **Name:** cAdvisor
- **URL:** <http://192.168.33.10:9090>
- **Server Type:** Prometheus

Once you click on **Create Server**, you should receive a message saying **Server was successfully created**. Next up, you need to create a directory; this is where your dashboards will be stored.

Click on the **Dashboards** link in the top menu and then click on **New directory** and create one called `Test` directory. Now, you are ready to start creating Dashboards. Click on **New Dashboard**, call it **My Dashboard**, place it in `Test` directory. Once you click on **Create Dashboard**, you will be taken to the preview screen.

From here, you can build up dashboards using the control in the top right-hand side of each section. To add data, you simply enter the query you would like to see in the dashboard section:



Note

For detailed information on how to create Dashboards, see the **PROMDASH** section of the Prometheus documentation at <http://prometheus.io/docs/visualization/promdash/>.

The next steps

At the moment, we are running Prometheus in a single container and its data is being stored within that same container. This means, if for any reason the container is terminated, our data is lost; it also means that we can't upgrade without losing out data. To get around this problem, we can create a data volume container.

Note

A data volume container is a special type of container that only exists as storage for other containers. For more details, see the Docker user guide at

<https://docs.docker.com/userguide/dockervolumes/#creating-and-mounting-a-data-volume-container>.

First of all, let's make sure we have removed all the running Prometheus containers:

```
docker stop prometheus&&docker rm Prometheus
```

Next up, let's create a data container called `promdata`:

```
docker create \
--volume=/promdata \
--name=promdata \
prom/prometheus /bin/true
```

Finally, launch Prometheus again, this time, using the data container:

```
docker run \
--detach=true \
--volumes-from promdata \
-- \
volume=/monitoring_docker/Chapter03/prometheus.yml:/etc/prometheus/prometheus.yml \
--publish=9090:9090 \
--name=prometheus \
prom/prometheus
```

This will ensure that, if you have to upgrade or relaunch your container, the metrics you have been capturing are safe and sound.

We have only touched on the basics of using Prometheus in this section of the book; for further information on the application, I recommend the following links as a good starting point:

- Documentation: <http://prometheus.io/docs/introduction/overview/>
- Twitter: <https://twitter.com/PrometheusIO>
- Project page: <https://github.com/prometheus/prometheus>
- Google groups: <https://groups.google.com/forum/#!forum/prometheus-developers>

Alternatives?

There are some alternatives to Prometheus. One such alternative is InfluxDB that describes itself as follows:

An open-source distributed time series database with no external dependencies.

However, at the time of writing, cAdvisor is not currently compatible with the latest version of InfluxDB. There are patches in the codebase for cAdvisor; however, these are yet to make it through to the Google-maintained Docker Image.

For more details on InfluxDB and its new visualization application Chronograf, see the project website at <https://influxdb.com/> and for more details on how to export cAdvisor statistics to InfluxDB, see the supporting documentation for cAdvisor at <https://github.com/google/cadvisor/tree/master/docs>.

Summary

In this chapter, we learned how to take the viewing real-time statistics of our containers off the command line and into the web browser. We explored some different methods to install Google's cAdvisor application and also how to use its web interface to keep an eye on our running containers. We also learned how to capture metrics from cAdvisor and store them using Prometheus, a modern time series database.

The two main technologies we have covered in this chapter have only been publically available for less than twelve months. In the next chapter, we will look at using a monitoring tool that has been in a SysAdmins toolbox for over 10 years—Zabbix.

Chapter 4. A Traditional Approach to Monitoring Containers

So far, we have looked at only a few technologies to monitor our containers, so in this chapter, we will be looking more at a traditional tool for monitoring services. By the end of this chapter, you should know your way around Zabbix and the various ways you can monitor your containers. We will cover the following topics in this chapter:

- How to run a Zabbix Server using containers
- How to launch a Zabbix Server on a vagrant machine
- How to prepare our host system for monitoring containers using the Zabbix agent
- How to find your way around the Zabbix web interface

Zabbix

First things first, what is Zabbix and why use it?

I have personally been using it since version 1.2; the Zabbix site describes it as follows:

“With Zabbix, it is possible to gather virtually limitless types of data from the network. High-performance real-time monitoring means that tens of thousands of servers, virtual machines, and network devices can be monitored simultaneously. Along with storing the data, visualization features are available (overviews, maps, graphs, screens, and so on), as well as very flexible ways of analyzing the data for the purpose of alerting.

Zabbix offers great performance for data gathering and can be scaled to very large environments. Distributed monitoring options are available with the use of Zabbix proxies. Zabbix comes with a web-based interface, secure user authentication, and a flexible user permission schema. Polling and trapping is supported, with native high-performance agents gathering data from virtually any popular operating system; agent-less monitoring methods are available as well.”

At the time I started using Zabbix, the only real viable options were as follows:

- Nagios: <https://www.nagios.org/>
- Zabbix: <http://www.zabbix.com/>
- Zenoss: <http://www.zenoss.org/>

Out of the these three options, Zabbix seemed to be the most straightforward one at the time. It was doing enough work to manage the several hundred servers I was going to monitor without having to have the extra work of learning the complexities of setting up Nagios or Zenoss; after all, given the task the software had, I needed to be able to trust that I had set it up correctly.

In this chapter, while I am going to go into some detail about the setup and the basics of using Zabbix, we will only be touching on some of the functionalities, which can do a lot more than just monitor your containers. For more information, I would recommend the following as a good starting point:

- Zabbix blog: <http://blog.zabbix.com>
- Zabbix 2.4 manual: <https://www.zabbix.com/documentation/2.4/manual>
- Further reading: <https://www.packtpub.com/all/?search=zabbix>

Installing Zabbix

As you may have noticed from the links in the previous section, there are a lot of moving parts in Zabbix. It leverages several open source technologies, and a production-ready installation needs a little more planning than we can go into in this chapter. Because of this we are going to look at two ways of installing Zabbix quickly rather than go into too much detail.

Using containers

At the time of writing, there are over a hundred Docker images available on the Docker Hub (<https://hub.docker.com>) that mentions Zabbix. These range from full server installations to just the various parts, such as the Zabbix agent or proxy services.

Out of the ones listed, there is one that is recommended by Zabbix itself. So, we will look at this one; it can be found at the following URLs:

- Docker Hub: <https://hub.docker.com/u/zabbix/>
- Project page: <https://github.com/zabbix/zabbix-community-docker>

To get the ZabbixServer container up and running, we must first launch a database container. Let's start afresh with our vagrant instance by running the following command:

```
[russ@mac ~]$ cd ~/Documents/Projects/monitoring-docker/vagrant-centos/
[russ@mac ~]$ vagrant destroy
default: Are you sure you want to destroy the 'default' VM? [y/N] y
==>default: Forcing shutdown of VM...
==>default: Destroying VM and associated drives...
==>default: Running cleanup tasks for 'shell' provisioner...
[russ@mac ~]$ vagrant up
Bringing machine 'default' up with 'virtualbox' provider...
==>default: Importing base box 'russmckendrick/centos71'...
==>default: Matching MAC address for NAT networking...
==>default: Checking if box 'russmckendrick/centos71' is up to date...

.....
==>default: => Installing docker-engine...
==>default: => Configuring vagrant user...
==>default: => Starting docker-engine...
==>default: => Installing docker-compose...
==>default: => Finished installation of Docker
[russ@mac ~]$ vagrant ssh
```

Now, we have a clean environment and it's time to launch our database container, as follows:

```
docker run \
--detach=true \
--publish=3306 \
--env="MARIADB_USER=zabbix" \
--env="MARIADB_PASS=zabbix_password" \
--name=zabbix-db \
million12/mariadb
```

This will download the `million12/mariadb` image from <https://hub.docker.com/r/million12/mariadb/> and launch a container called `zabbix-db`, running MariaDB 10 (<https://mariadb.org>) with a user called `zabbix` who has a password `zabbix_password`. We have also opened the MariaDB port 3306 up on the container, but as we will be connecting to it from a linked container, there is no need to expose that port on the host machine.

Now, we have the database container up and running, we now need to launch our Zabbix Server container:

```
docker run \
--detach=true \
--publish=80:80 \
--publish=10051:10051 \
--link=zabbix-db:db \
--env="DB_ADDRESS=db" \
--env="DB_USER=zabbix" \
--env="DB_PASS=zabbix_password" \
--name=zabbix \
zabbix/zabbix-server-2.4
```

This downloads the image, which at the time of writing is over 1 GB so this process could take several minutes depending on your connection, and launches a container called zabbix. It maps the web server (port 80) and the Zabbix Server process (port 10051) on the host to the container, creates a link to our database container, sets up the alias db, and injects the database credentials as environment variables so that the scripts that launch when the container boots can populate the database.

You can verify that everything worked as expected by checking the logs on the container. To do this, enter `docker logs zabbix`. This will print details of what happened when the container launched on screen:

```

[vagrant@docker ~]$ docker logs zabbix
Nginx status page: allowed address set to 127.0.0.1.
PHP-FPM status page: allowed address set to 127.0.0.1.
[LOG 18:31:37] Preparing server configuration
[LOG 18:31:37] Config updated.
[LOG 18:31:37] Enabling Logging and pid management.
[LOG 18:31:38] Done
[LOG 18:31:38] Checking if Database exists or fresh install
ERROR 1049 (42000) at line 1: Unknown database 'zabbix'
[WARNING 18:31:38] Zabbix DB doesn't exists. Installing and importing default settings

[LOG 18:31:38] Database and user created. Importing Default SQL

[LOG 18:31:45] Import Finished. Starting
2015-08-30 10:31:46,128 CRIT Supervisor running as root (no user in config file)
2015-08-30 10:31:46,128 WARN Included extra file "/etc/supervisor.d/php-fpm.conf" during parsing
2015-08-30 10:31:46,128 WARN Included extra file "/etc/supervisor.d/zabbix.conf" during parsing
2015-08-30 10:31:46,128 WARN Included extra file "/etc/supervisor.d/nginx.conf" during parsing
2015-08-30 10:31:46,141 INFO RPC interface 'supervisor' initialized
2015-08-30 10:31:46,141 INFO supervisord started with pid 96
2015-08-30 10:31:47,152 INFO spawned: 'nginx' with pid 99
2015-08-30 10:31:47,153 INFO spawned: 'nginx-reload' with pid 100
2015-08-30 10:31:47,154 INFO spawned: 'php-fpm' with pid 101
2015-08-30 10:31:47,156 INFO spawned: 'zabbix-agent' with pid 102
2015-08-30 10:31:47,157 INFO spawned: 'zabbix-server' with pid 103
2015-08-30 10:31:47,208 DEBUG 'nginx' stderr output:
2015/08/30 10:31:47 [notice] 99#0: using the "epoll" event method
2015/08/30 10:31:47 [notice] 99#0: nginx/1.8.0
2015/08/30 10:31:47 [notice] 99#0: built by gcc 4.8.2 20140120 (Red Hat 4.8.2-16) (GCC)
2015/08/30 10:31:47 [notice] 99#0: OS: Linux 3.10.0-229.7.2.el7.x86_64
2015/08/30 10:31:47 [notice] 99#0: getrlimit(RLIMIT_NOFILE): 1048576:1048576
2015/08/30 10:31:47 [notice] 99#0: start worker processes
2015/08/30 10:31:47 [notice] 99#0: start worker process 115
2015/08/30 10:31:47 [notice] 99#0: start worker process 116

2015-08-30 10:31:47,208 DEBUG fd 18 closed, stopped monitoring <POutputDispatcher at 139910770631168 for <Subprocess at 139910773013824 with name zabbix-agent in state STARTING> (stdout>
2015-08-30 10:31:47,208 DEBUG 'zabbix-agent' stderr output:
zabbix_agentd [102]: Running in foreground...

2015-08-30 10:31:47,208 DEBUG fd 22 closed, stopped monitoring <POutputDispatcher at 139910770631312 for <Subprocess at 139910773013824 with name zabbix-agent in state STARTING> (stderr>
2015-08-30 10:31:47,361 DEBUG fd 13 closed, stopped monitoring <POutputDispatcher at 139910770605952 for <Subprocess at 139910773013680 with name php-fpm in state STARTING> (stdout>
2015-08-30 10:31:47,362 DEBUG 'php-fpm' stderr output:
[30-Aug-2015 10:31:47] WARNING: Nothing matches the include pattern '/data/conf/php-fpm-www-* .conf' from /etc/php-fpm.d/www.conf at line 18.

2015-08-30 10:31:47,362 DEBUG fd 17 closed, stopped monitoring <POutputDispatcher at 139910770605664 for <Subprocess at 139910773013680 with name php-fpm in state STARTING> (stderr>
2015-08-30 10:31:48,363 INFO success: nginx entered RUNNING state, process has stayed up for > than 1 seconds (startsecs)
2015-08-30 10:31:48,363 INFO success: nginx-reload entered RUNNING state, process has stayed up for > than 1 seconds (startsecs)
2015-08-30 10:31:48,363 INFO success: php-fpm entered RUNNING state, process has stayed up for > than 1 seconds (startsecs)
2015-08-30 10:31:48,363 INFO success: zabbix-agent entered RUNNING state, process has stayed up for > than 1 seconds (startsecs)
2015-08-30 10:31:48,363 INFO success: zabbix-server entered RUNNING state, process has stayed up for > than 1 seconds (startsecs)
[vagrant@docker ~]$ 
```

Now, once we have the container up and running, it is time to move to the browser for our first taste of the web interface. Go to <http://192.168.33.10/> in your browser and you will be greeted by a welcome page; before we can start using Zabbix, we need to complete the installation.

On the welcome page, click on **Next** to be taken to the first step. This will verify that everything we need to run a Zabbix Server is installed. As we have launched it in a container, you should see **OK** next to all of the prerequisites. Click on **Next** to move onto the next step.

Now, we need to configure the database connection for the web interface. Here, you should have the same details as you did when you launched the container, as illustrated in the following screenshot:



Once you have entered the details, click on **Test connection** and you should receive an **OK** message; you will not be able to proceed until this test completes successfully. Once you have entered the details and have an **OK** message, click on **Next**.

Next up, are the details on the Zabbix Server that the web interface needs to connect to; click on **Next** here. Next up, you will receive a summary of the installation. To proceed, click on **Next** and you will be get confirmation that the /usr/local/src/zabbix/frontends/php/conf/zabbix.conf.php file has been created. Click on **Finish** to be taken to the login page.

Using vagrant

While writing this chapter, I thought a lot about providing another set of installation instructions for the Zabbix Server service. While the book is all about Monitoring Docker containers, having a service as resource intensive as Zabbix running inside a container feels a little counter intuitive. Because of this, there is a vagrant machine that uses Puppet to bootstrap a working installation of Zabbix Server:

```
[russ@mac ~]$ cd ~/Documents/Projects/monitoring-docker/vagrant-zabbix/  
[russ@mac ~]$ vagrant up  
Bringing machine 'default' up with 'virtualbox' provider...  
==>default: Importing base box 'russmckendrick/centos71'...  
==>default: Matching MAC address for NAT networking...  
==>default: Checking if box 'russmckendrick/centos71' is up to date...  
.....  
==>default: Debug: Received report to process from zabbix.media-glass.es  
==>default: Debug: Evicting cache entry for environment 'production'  
==>default: Debug: Caching environment 'production' (ttl = 0 sec)  
==>default: Debug: Processing report from zabbix.media-glass.es with  
processor Puppet::Reports::Store
```

As you may have noticed, there is a lot of output streamed to the terminal, so what just happened? First of all, a CentOS 7 vagrant instance was launched and then a Puppet agent was installed. Once installed, the installation was handed off to Puppet. Using the Zabbix Puppet module by Werner Dijkerman, Zabbix Server was installed; for more details on the module, see its Puppet Forge page at <https://forge.puppetlabs.com/wdijkerman/zabbix>.

Unlike the containerized version of Zabbix Server, there is no additional configuration required, so you should be able to access the Zabbix login page at <http://zabbix.media-glass.es/> (an IP address of 192.168.33.11 is hardcoded into the configuration).

Preparing our host machine

For the remainder of this chapter, I will assume that you are using the Zabbix Server that is running on its own vagrant instance. This helps to ensure that your environment is consistent with the configuration of the Zabbix agent we will be looking at.

To pass the statistics from our containers to the Zabbix agent, which will then in turn expose them to the Zabbix Server, we will be installing using the Zabbix-Docker-Monitoring Zabbix agent module that has been developed by Jan Garaj. For more information on the project, see the following URLs:

- The Project page: <https://github.com/monitoringartist/Zabbix-Docker-Monitoring/>
- The Zabbix share page: <https://share.zabbix.com/virtualization/docker-containers-monitoring>

To get the agent and module installed, configured, and running, we need to execute the following steps:

1. Install the Zabbix package repository.
2. Install the Zabbix agent.
3. Install the prerequisites for the module.
4. Add the Zabbix agent user to the Docker group.
5. Download the auto-discovery bash script.
6. Download the precompiled zabbix_module_docker binary.
7. Configure the Zabbix agent with the details of our Zabbix Server and also the Docker module.
8. Set the correct permissions on all the files we have downloaded and created.
9. Start the Zabbix agent.

While the steps remain the same for both CentOS and Ubuntu, the actions taken to do the initial package installation differ slightly. Rather than going through the process of showing the commands to install and configure the agent, there is a script for each of the host operating systems in the /monitoring_docker/chapter04/ folder. To view the scripts, run the following command from your terminal:

```
cat /monitoring_docker/chapter04/install-agent-centos.sh  
cat /monitoring_docker/chapter04/install-agent-ubuntu.sh
```

Now, you have taken a look at the scripts its time to run them, to do this type one of the following commands. If you are running CentOS, run this command:

```
bash /monitoring_docker/chapter04/install-agent-centos.sh
```

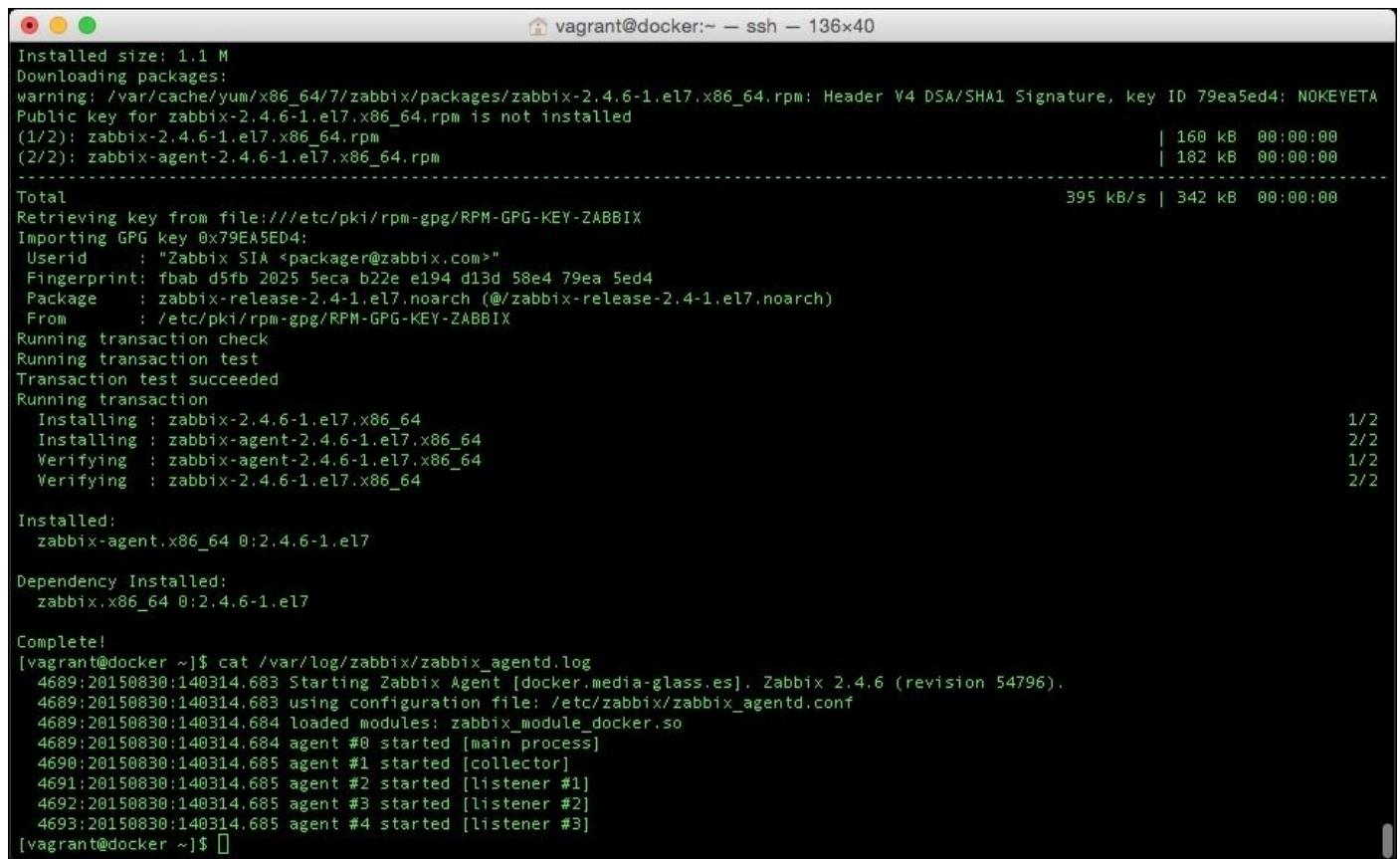
For Ubuntu, run the following command:

```
bash /monitoring_docker/chapter04/install-agent-ubuntu.sh
```

To verify that everything ran as expected, check the Zabbix agent log file by running the following command:

```
cat /var/log/zabbix/zabbix_agentd.log
```

You should see that the end of the file confirms that the agent has started and that the `zabbix_module_docker.so` module has been loaded:



```
vagrant@docker:~ — ssh — 136x40
Installed size: 1.1 M
Downloading packages:
warning: /var/cache/yum/x86_64/7/zabbix/packages/zabbix-2.4.6-1.el7.x86_64.rpm: Header V4 DSA/SHA1 Signature, key ID 79ea5ed4: NOKEYETA
Public key for zabbix-2.4.6-1.el7.x86_64.rpm is not installed
(1/2): zabbix-2.4.6-1.el7.x86_64.rpm | 160 kB 00:00:00
(2/2): zabbix-agent-2.4.6-1.el7.x86_64.rpm | 182 kB 00:00:00
Total                                         395 KB/s | 342 KB 00:00:00
Retrieving key from file:///etc/pki/rpm-gpg/RPM-GPG-KEY-ZABBIX
Importing GPG key 0x79EA5ED4:
Userid      : "Zabbix SIA <packager@zabbix.com>"
Fingerprint: fbab d5fb 2025 Seca b22e e194 d13d 58e4 79ea 5ed4
Package     : zabbix-release-2.4-1.el7.noarch (@zabbix-release-2.4-1.el7.noarch)
From       : /etc/pki/rpm-gpg/RPM-GPG-KEY-ZABBIX
Running transaction check
Running transaction test
Transaction test succeeded
Running transaction
  Installing : zabbix-2.4.6-1.el7.x86_64          1/2
  Installing : zabbix-agent-2.4.6-1.el7.x86_64    2/2
  Verifying   : zabbix-agent-2.4.6-1.el7.x86_64    1/2
  Verifying   : zabbix-2.4.6-1.el7.x86_64         2/2
Installed:
  zabbix-agent.x86_64 0:2.4.6-1.el7

Dependency Installed:
  zabbix.x86_64 0:2.4.6-1.el7

Complete!
[vagrant@docker ~]$ cat /var/log/zabbix/zabbix_agentd.log
4689:20150830:140314.683 Starting Zabbix Agent [docker.media-glass.es]. Zabbix 2.4.6 (revision 54796).
4689:20150830:140314.683 using configuration file: /etc/zabbix/zabbix_agentd.conf
4689:20150830:140314.684 loaded modules: zabbix_module_docker.so
4689:20150830:140314.684 agent #0 started [main process]
4690:20150830:140314.685 agent #1 started [collector]
4691:20150830:140314.685 agent #2 started [listener #1]
4692:20150830:140314.685 agent #3 started [listener #2]
4693:20150830:140314.685 agent #4 started [listener #3]
[vagrant@docker ~]$
```

Before we move onto the Zabbix web interface, let's launch a few containers using the `docker-compose` file from [Chapter 2, Using the Built-in Tools](#):

```
[vagrant@docker ~]$ cd /monitoring_docker/chapter02/02-multiple/
[vagrant@docker 02-multiple]$ docker-compose up -d
[vagrant@docker 02-multiple]$ docker-compose scale web=3
[vagrant@docker 02-multiple]$ docker-compose ps
```

We should now have three web server containers running and a running Zabbix agent on the host.

The Zabbix web interface

Once you have Zabbix installed you can open the Zabbix web interface by going to <http://zabbix.media-glass.es/> in your browser, this link will only work when you have the Zabbix vagrant box up and running, if you don't have it running the page will time out. You should be presented with a login screen. Enter the default username and password here, which is Admin and zabbix (note that the username has a capital A), to login.

Once logged in, you will need to add the host templates. These are preconfigured environment settings and will add some context around the statistics that the Zabbix agent is sending to the server, along with the auto-discovery of containers.

To add the templates, go to the **Configuration** tab in the top menu and select **Template**; this will bring up a list of all the templates that are currently installed. Click on the **Import** button in the header and upload a copy of the two template files you can find in the `~/Documents/Projects/monitoring-docker/chapter04/template` folder on your main machine; there is no need to change the rules when uploading the templates.

Once both templates have been successfully imported, it is time to add our Docker host. Again, go to the **Configuration** tab, but this time select **Hosts**. Here, you need to click on **Create host**. Then, enter the following information in the **Host** tab:

The screenshot shows the Zabbix configuration interface for adding a new host. The host name is set to "docker.media-glass.es" and the visible name is "Docker Host". The host is assigned to the "Virtual machines" group. There are other groups listed on the right: Discovered hosts, Hypervisors, Linux servers, Templates, and Zabbix servers. The Agent interfaces section shows an IP address of 192.168.33.10, connected to port 10050. The "Enabled" checkbox is checked. At the bottom, there are "Add" and "Cancel" buttons.

Here are the details of the preceding information:

- **Host name:** This is the host name of our Docker host
- **Visible name:** Here, the name server will appear as in Zabbix
- **Groups:** Which group within Zabbix the server you would like the Docker host to be part of
- **Agent Interfaces:** This is the IP address or the DNS name of our Docker host
- **Enabled:** This should be ticked

Before clicking on **Add**, you should click on the **Templates** tab and link the following two templates to the host:

- **Template App Docker**
- **Template OS Linux**

Here is the screenshot of the host:

The screenshot shows the Zabbix interface for configuring hosts. The top navigation bar includes links for Monitoring, Inventory, Reports, Configuration (which is selected), Administration, Help, Get support, Print, Profile, and Logout. The URL is zabbix.media-glass.es. The main content area is titled "CONFIGURATION OF HOSTS" and shows a table of "Linked templates". It lists two templates: "Template App Docker" and "Template OS Linux", each with an "Unlink" button. Below this is a section for "Link new templates" with a search input field and an "Add" button.

Once you have added the two templates, click on **Add** to configure and enable the host. To verify that the host has been added correctly, you should go to the **Monitoring** tab and then **Latest data**. From here, click on **Show filter** and enter the host machine in the **Hosts** box. You should then start to see items appearing:

The screenshot shows the Zabbix interface for monitoring latest data. The top navigation bar includes links for Monitoring, Inventory, Reports, Configuration, Administration, Dashboard, Overview, Web, Latest data (which is selected), Triggers, Events, Graphs, Screens, Maps, Discovery, and IT services. The URL is zabbix.media-glass.es. The main content area is titled "LATEST DATA" and shows a table of "Items". The table has columns for Name, Last check, Last value, and Change. The "Host groups" filter is set to "Docker Host". The table lists various items grouped by host, such as CPU, Docker, General, Memory, OS, Performance, Processes, Security, and Zabbix agent. The "CPU" group has 13 items, "Docker" has 18 items, "General" has 5 items, "Memory" has 5 items, "OS" has 8 items, "Performance" has 13 items, "Processes" has 2 items, "Security" has 2 items, and "Zabbix agent" has 3 items. The "Last check" column shows the last update time, "Last value" shows the current value, and "Change" indicates if there has been a change.

Don't worry if you don't see the **Docker** section immediately, by default, Zabbix will attempt to auto-discover new containers every five minutes.

Docker metrics

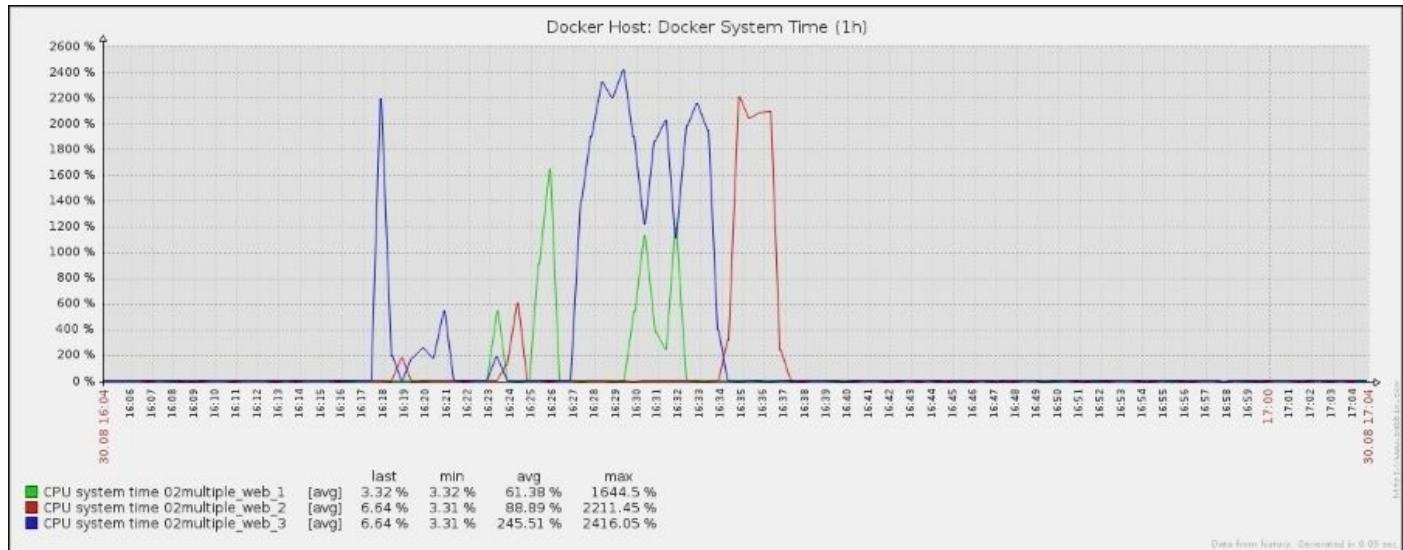
For each container, Zabbix discovers the following metrics that will be recorded:

- Container (your Containers name) is running
- CPU system time
- CPU user time
- Used cache memory
- Used RSS memory
- Used swap

Apart from “Used swap”, these are the same metrics recorded by cAdvisor.

Create custom graphs

You can access a time-based graph for any of the metrics collected by Zabbix; you can also create your own custom graphs. In the following graph, I have created a graph that plots all the CPU System stats from the three web containers we launched earlier in the chapter:



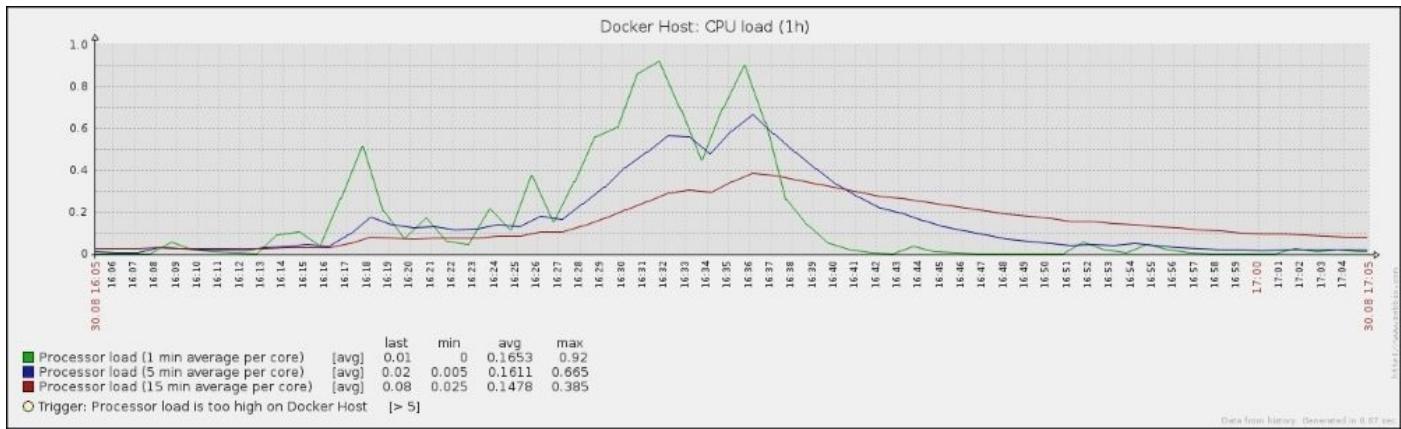
As you can see, I performed a few tests using ApacheBench to make the graph a little more interesting.

For more information on how to create custom graphs, see the graphs section of the documentation site at

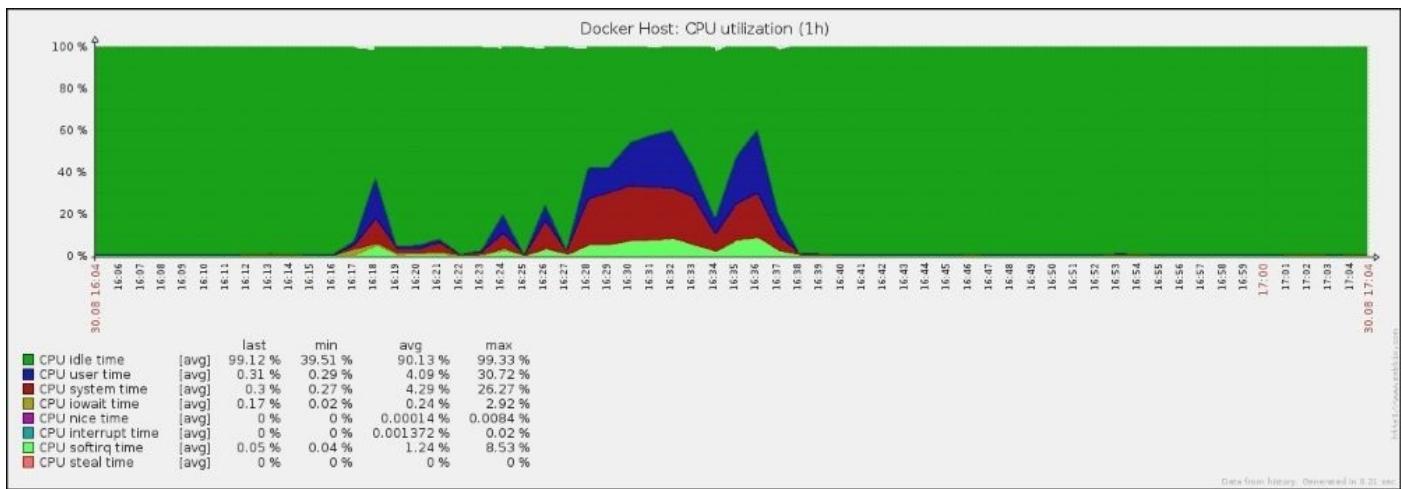
<https://www.zabbix.com/documentation/2.4/manual/config/visualisation/graphs>.

Compare containers to your host machine

As we added the Linux OS template and the Docker template to the host and we are also recording quite a lot of information about the system, here we can tell the effect the testing with ApacheBench had on the overall processor load:



We can drill down further to get information on the overall utilization:



Triggers

Another feature of Zabbix is triggers: you can define actions to happen when a metric meets a certain set of criteria. In the following example, Zabbix has been configured with a trigger called **Container Down**; this changes the status of the monitored item to **Problem** with a severity of **Disaster**:

The screenshot shows the Zabbix web interface with the URL `zabbix.media-glass.es`. The navigation bar includes links for Monitoring, Inventory, Reports, Configuration, Administration, Help, Get support, Print, Profile, and Logout. The current page is 'Dashboard > Status of triggers > Latest events > Configuration of media types > Status of triggers'. The main content area is titled 'STATUS OF TRIGGERS [2015-08-30 17:43:01]'. A table lists six triggers:

	Severity	Status	Info	Last change	Age	Acknowledged	Host	Name	Description
<input type="checkbox"/>	Disaster	PROBLEM		2015-08-30 17:39:54	3m 7s	Acknowledge (1)	Docker Host	Container Down	Add
<input type="checkbox"/>	Information	OK		2015-08-30 17:35:21	7m 40s	Acknowledged	Docker Host	Host name of zabbix_agentd was changed on Docker Host	Add
<input type="checkbox"/>	Information	OK		2015-08-30 17:35:20	7m 41s	Acknowledged	Docker Host	Version of zabbix_agent(d) was changed on Docker Host	Add
<input type="checkbox"/>	Information	OK		2015-08-30 17:35:02	7m 59s	Acknowledged	Docker Host	Host information was changed on Docker Host	Add
<input type="checkbox"/>	Information	OK		2015-08-30 17:35:01	8m	Acknowledged	Docker Host	Hostname was changed on Docker Host	Add
<input type="checkbox"/>	Warning	OK		2015-08-30 17:34:55	8m 6s	Acknowledged	Docker Host	/etc/passwd has been changed on Docker Host	Add

At the bottom, there are buttons for 'Bulk acknowledge' and 'Go (0)'. The footer indicates 'Zabbix 2.4.6 Copyright 2001-2015 by Zabbix SIA' and 'Connected as 'Admin''.

This change in status then triggers an e-mail to inform that, for some reason the container is no longer up and running:

The screenshot shows an email client window with the subject 'PROBLEM: Container Down – Inbox'. The email is from 'zabbix@localhost.docker.dev' to 'russ@mckendrick.io'. The body of the email contains the following text:

PROBLEM: Container Down
Trigger: Container Down
Trigger status: PROBLEM
Trigger severity: Disaster
Trigger URL:

Item values:

1. Container 02multiple_web_1 is running (Docker Host:docker.up[/02multiple_web_1]): Down (0)
2. *UNKNOWN* (*UNKNOWN*:*UNKNOWN*): *UNKNOWN*
3. *UNKNOWN* (*UNKNOWN*:*UNKNOWN*): *UNKNOWN*

Original event ID: 149

This could have also triggered other tasks, such as running a custom script, sending an instant message via Jabber, or even triggering a third-party service such as PagerDuty (<https://www.pagerduty.com>) or Slack (<https://slack.com>).

For more information on Triggers, Events, and Notifications, see the following sections of the documentation:

- <https://www.zabbix.com/documentation/2.4/manual/config/triggers>
- <https://www.zabbix.com/documentation/2.4/manual/config/events>
- <https://www.zabbix.com/documentation/2.4/manual/config/notifications>

Summary

So, how does this traditional approach to monitoring fit into a container's lifecycle?

Going back to the Pets versus Cattle analogy, at first glance, Zabbix seems to be geared more towards Pets: its feature set is best suited to monitoring services that are static over a long period of time. This means that the same approach to monitoring a pet can also be applied to long-running processes running within your containers.

Zabbix is also the perfect option for monitoring mixed environments. Maybe you have several database servers that are not running as containers, but you have several hosts running Docker, and have equipment such as switches and SANs that you need to monitor. Zabbix can provide you with a single pane of glass showing you metrics for all your environments, along with being able to alert you to problems.

So far, we have looked at using APIs and metrics provided by Docker and LXC, but what about other metrics can we use? In the next chapter, we will look at a tool that hooks straight into the host machine's kernel to gather information on your containers.

Chapter 5. Querying with Sysdig

The previous tools we have looked at have all relied on making API calls to Docker or reading metrics from LXC. Sysdig works differently by hooking itself into the hosts machine's kernel while this approach does go against Docker's philosophy of each service being run in its own isolated container, the information you can get by running Sysdig only for a few minutes far outweighs any arguments about not using it.

In this chapter, we will look at the following topics:

- How to install Sysdig and Csysdig on the host machine
- Basic usage and how to query your containers in real time
- How to capture logs so they can be queried later

What is Sysdig?

Before we start to get into Sysdig, let's first understand what it is. When I first heard about the tool, I thought to myself that it sounded too good to be true; the website describes the tool as follows:

“Sysdig is open source, system-level exploration: capture system state and activity from a running Linux instance, then save, filter and analyze. Sysdig is scriptable in Lua and includes a command line interface and a powerful interactive UI, csysdig, that runs in your terminal. Think of sysdig as strace + tcpdump + htop + iftop + lsof + awesome sauce. With state of the art container visibility on top.”

This is quite a claim as all the tools that it is claiming to be as powerful were all in a set of goto commands to run when looking into problems, so I was a little skeptical at first.

As any one who has had to try and track down a haywire process or try and track down an issue that isn't being very verbose in its error logs on a Linux server will know that using tools such as strace, lsof, and tcpdump can get complicated very quickly and it normally involves capturing a whole lot of data and then using a combination of several tools to slowly, and manually, trace the problem by reducing the amount of data you captured.

Imagine my delight when Sysdig's claims turned out to be true. It made me wish I had the tool back when I was a front line engineer; it would have made my life a lot easier.

Sysdig comes in two different flavors, first is the Open Source version available at <http://www.sysdig.org/>; this comes with an ncurses interface so that you can easily access and query data from a terminal-based GUI.

Note

Wikipedia describes **ncurses** (new curses) as a programming library that provides an API that allows the programmer to write text-based user interfaces in a terminal-independent manner. It is a toolkit for developing “GUI-like” application software that runs under a terminal emulator. It also optimizes screen changes in order to reduce the latency experienced when using remote shells.

There is also a commercial service that allows you to stream your Sysdig to their externally hosted service; this version has a web-based interface for viewing and querying your data.

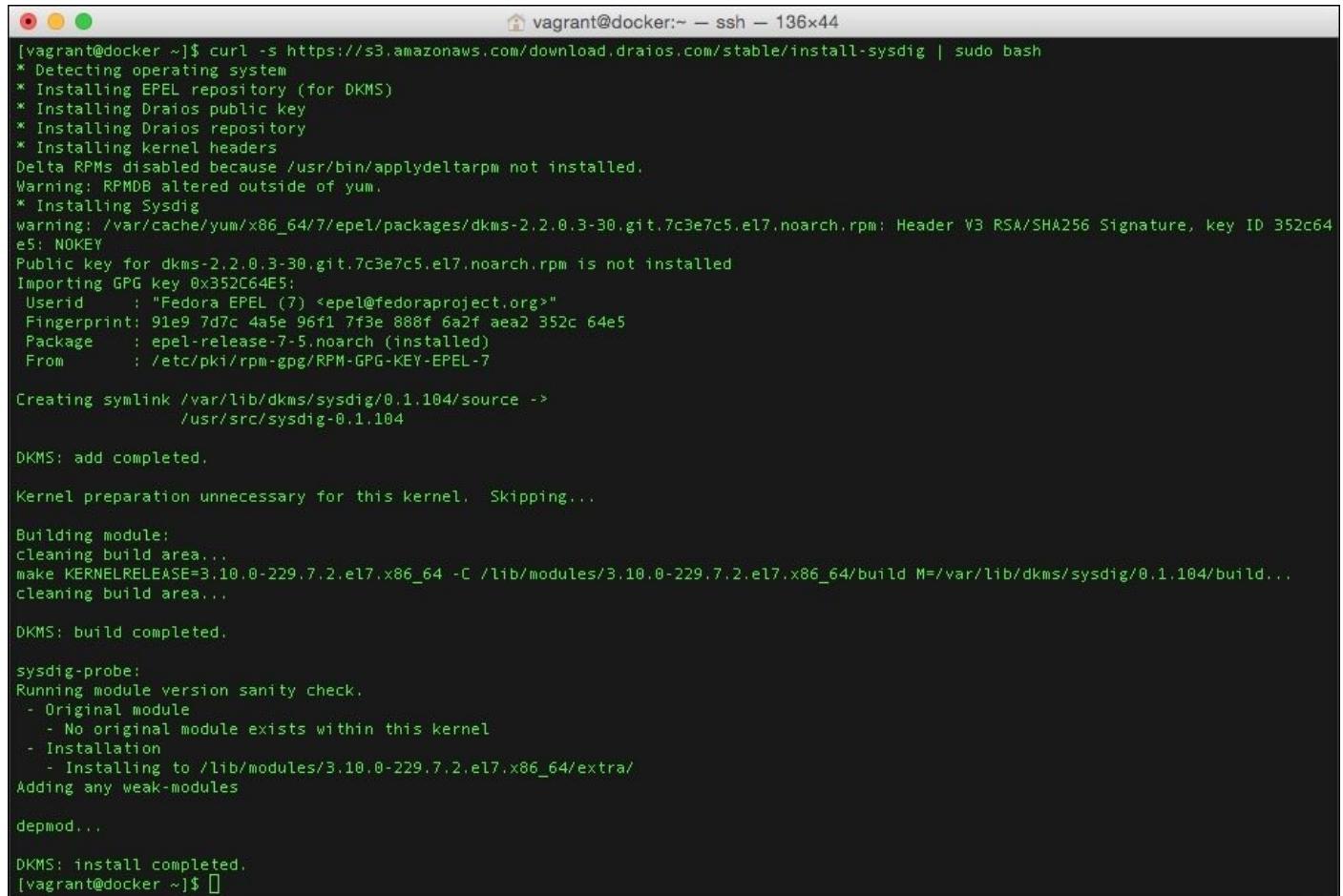
In this chapter, we will be concentrating on the open source version.

Installing Sysdig

Considering how powerful Sysdig is, it has one of the most straightforward installation and configuration processes I have come across. To install Sysdig on either a CentOS or Ubuntu server, type the following command:

```
curl -s https://s3.amazonaws.com/download.draios.com/stable/install-sysdig  
| sudo bash
```

After running the preceding command, you will get the following output:



```
vagrant@docker:~$ curl -s https://s3.amazonaws.com/download.draios.com/stable/install-sysdig | sudo bash  
* Detecting operating system  
* Installing EPEL repository (for DKMS)  
* Installing Draios public key  
* Installing Draios repository  
* Installing kernel headers  
Delta RPMs disabled because /usr/bin/applydeltarpm not installed.  
Warning: RPMDDB altered outside of yum.  
* Installing Sysdig  
warning: /var/cache/yum/x86_64/7/epel/packages/dkms-2.2.0.3-30.git.7c3e7c5.el7.noarch.rpm: Header V3 RSA/SHA256 Signature, key ID 352c64  
e5: NOKEY  
Public key for dkms-2.2.0.3-30.git.7c3e7c5.el7.noarch.rpm is not installed  
Importing GPG key 0x352c64E5:  
Userid : "Fedora EPEL (7) <epel@fedoraproject.org>"  
Fingerprint: 91e9 7d7c 4a5e 96f1 7f3e 888f 6a2f aea2 352c 64e5  
Package : epel-release-7-5.noarch (installed)  
From : /etc/pki/rpm-gpg/RPM-GPG-KEY-EPEL-7  
  
Creating symlink /var/lib/dkms/sysdig/0.1.104/source ->  
/usr/src/sysdig-0.1.104  
  
DKMS: add completed.  
  
Kernel preparation unnecessary for this kernel. Skipping...  
  
Building module:  
cleaning build area...  
make KERNELRELEASE=3.10.0-229.7.2.el7.x86_64 -C /lib/modules/3.10.0-229.7.2.el7.x86_64/build M=/var/lib/dkms/sysdig/0.1.104/build...  
cleaning build area...  
  
DKMS: build completed.  
  
sysdig-probe:  
Running module version sanity check.  
- Original module  
- No original module exists within this kernel  
- Installation  
- Installing to /lib/modules/3.10.0-229.7.2.el7.x86_64/extr/  
Adding any weak-modules  
  
depmod...  
  
DKMS: install completed.  
[vagrant@docker ~]$
```

That's it, you are ready to go. There is nothing more to configure or do. There is a manual installation process and also a way of installing the tool using containers to build the necessary kernel modules; for more details, see the installation guide as follows:

<http://www.sysdig.org/wiki/how-to-install-sysdig-for-linux/>

Using Sysdig

Before we look at how to use Sysdig, let's launch a few containers using docker-compose by running the following command:

```
cd /monitoring_docker/chapter05/wordpress/  
docker-compose up -d
```

This will launch a WordPress installation running a database and two web server containers that are load balanced using an HAProxy container. You will be able to view the WordPress installation at <http://docker.media-glass.es/> once the containers have launched. You will need to enter some details to create the admin user before the site is visible; follow the on-screen prompts to complete these steps.

The basics

At its core, Sysdig is a tool for producing a stream of data; you can view the stream by typing `sudo sysdig` (to quit, press *Ctrl+c*).

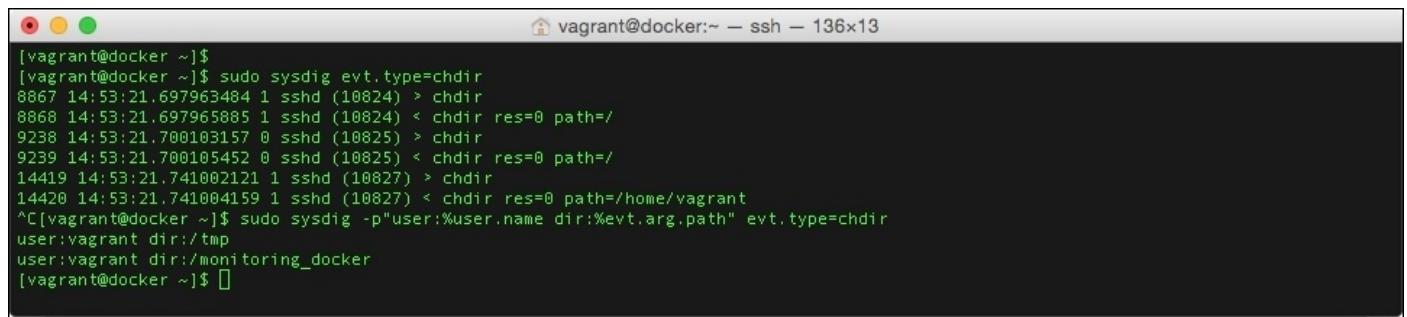
There is a lot information there so let's start to filter the stream down and run the following command:

```
sudosysdig evt.type=chdir
```

This will display only events in which a user changes directory; to see it in action, open a second terminal and you will see that when you log in, you see some activity in the first terminal. As you can see, it looks a lot like a traditional log file; we can format output to give information such as the username, by running the following command:

```
sudosysdig -p"user:%user.name dir:%evt.arg.path" evt.type=chdir
```

Then, in your second terminal, change the directory a few times:



A screenshot of a terminal window titled "vagrant@docker:~ — ssh — 136x13". The window shows the command `sudo sysdig -p"user:%user.name dir:%evt.arg.path" evt.type=chdir` being run. The output displays a series of events from the sshd process, showing directory changes for user "vagrant". The output is as follows:

```
[vagrant@docker ~]$ sudo sysdig evt.type=chdir
8867 14:53:21.697963484 1 sshd (10824) > chdir
8868 14:53:21.697965885 1 sshd (10824) < chdir res=0 path=/
9238 14:53:21.700103157 0 sshd (10825) > chdir
9239 14:53:21.700105452 0 sshd (10825) < chdir res=0 path=/
14419 14:53:21.741002121 1 sshd (10827) > chdir
14420 14:53:21.741004159 1 sshd (10827) < chdir res=0 path=/home/vagrant
^C[vagrant@docker ~]$ sudo sysdig -p"user:%user.name dir:%evt.arg.path" evt.type=chdir
user:vagrant dir:/tmp
user:vagrant dir:/monitoring_docker
[vagrant@docker ~]$
```

As you can see, this is a lot easier to read than the original unformatted output. Press *Ctrl + c* to stop filtering.

Capturing data

In the previous section, we looked at filtering data in real time; it is also possible to stream Sysdig data to a file so that you can query the data at a later time. Exit from your second terminal and run the following command on your first one:

```
sudosysdig -w ~/monitoring-docker.scap
```

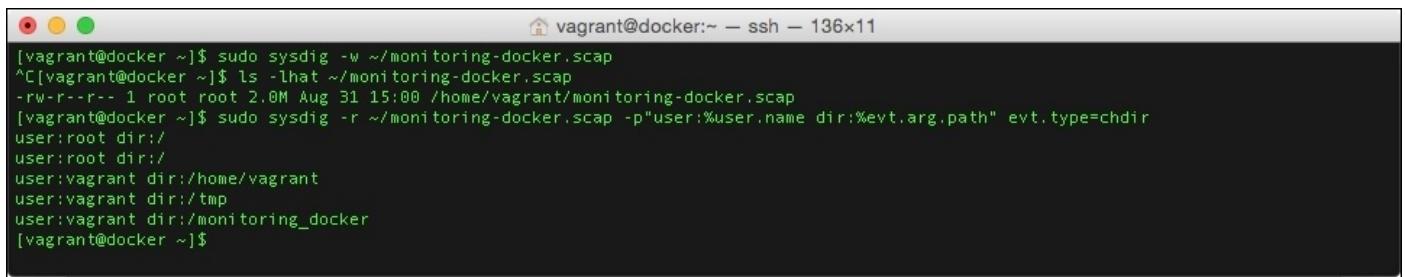
While the command is running on the first terminal, log in to the host on the second one and change the directory a few times. Also, while we are recording, click around the WordPress site we started at the beginning of this section, the URL is <http://docker.media-glass.es/>. Once you have done that, stop the recording by pressing *Crtl + c*; you should have now dropped back to a prompt. You can check the size of the file created by Sysdig by running the following:

```
ls -lha ~/monitoring-docker.scap
```

Now, we can use the data that we have captured to apply the same filter as we did when looking at the real-time stream:

```
sudosysdig -r ~/monitoring-docker.scap -p"user:%user.name  
dir:%evt.arg.path" evt.type=chdir
```

By running the preceding command, you will get the following output:



The screenshot shows a terminal window titled "vagrant@docker:~ — ssh — 136x11". The terminal displays the following sequence of commands and their results:

```
vagrant@docker ~]$ sudo sysdig -w ~/monitoring-docker.scap
^C[vagrant@docker ~]$ ls -lthat ~/monitoring-docker.scap
-rw-r--r-- 1 root root 2.0M Aug 31 15:00 /home/vagrant/monitoring-docker.scap
[vagrant@docker ~]$ sudo sysdig -r ~/monitoring-docker.scap -p"user:%user.name dir:%evt.arg.path" evt.type=chdir
user:root dir:/
user:root dir:/
user:vagrant dir:/home/vagrant
user:vagrant dir:/tmp
user:vagrant dir:/monitoring_docker
[vagrant@docker ~]$
```

Notice how we get similar results to when we were viewing the data in real time.

Containers

One of the things that was recorded in `~/monitoring-docker.scap` was details on the system state; this includes information on the containers we launched at the start of the chapter. Let's use this file to get some stats on the containers. To list the containers that were active during the time, we captured the data file run:

```
sudo sysdig -r ~/monitoring-docker.scap -c lscontainers
```

To see which of the containers utilized the CPU most of the time, we were clicking around the WordPress site run:

```
sudo sysdig -r ~/monitoring-docker.scap -c topcontainers_cpu
```

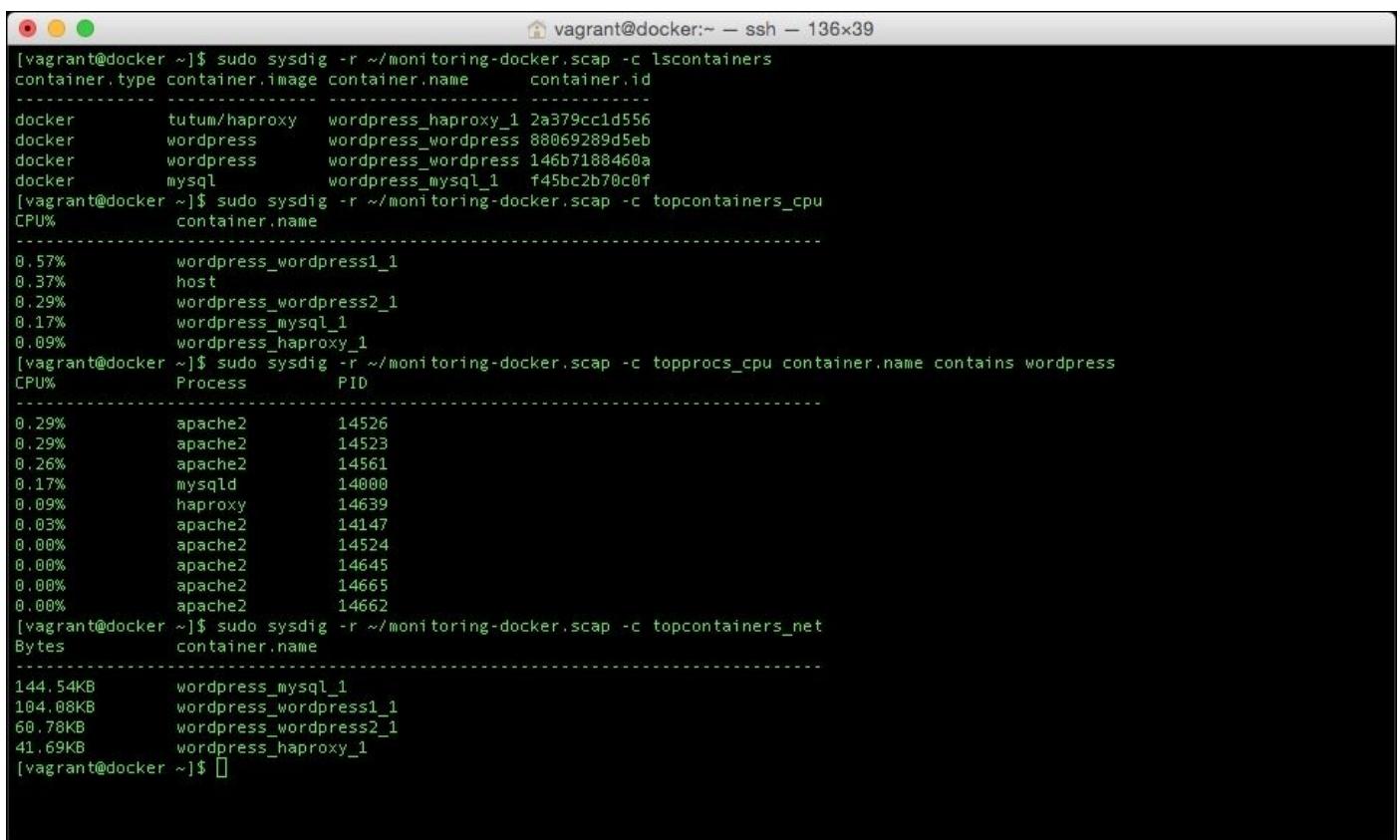
To have a look at the top processes in each of the containers that have “wordpress” in their names (which is all of them in our case), run the following command:

```
sudo sysdig -r ~/monitoring-docker.scap -c topprocs_cpu container.name contains wordpress
```

Finally, which of our containers transferred the most amount of data?:

```
sudosysdig -r ~/monitoring-docker.scap -c topcontainers_net
```

By running the preceding command, you will get the following output:



The screenshot shows a terminal window titled "vagrant@docker:~ — ssh — 136x39". It displays three separate sysdig command outputs:

- `sudo sysdig -r ~/monitoring-docker.scap -c lscontainers` output:

container.type	container.image	container.name	container.id
docker	tutum/haproxy	wordpress_haproxy_1	2a379cc1d556
docker	wordpress	wordpress_wordpress	88069289d5eb
docker	wordpress	wordpress_wordpress	146b7188460a
docker	mysql	wordpress_mysql_1	f45bc2b70c0f
- `sudo sysdig -r ~/monitoring-docker.scap -c topcontainers_cpu` output:

CPU%	container.name
0.57%	wordpress_wordpress1_1
0.37%	host
0.29%	wordpress_wordpress2_1
0.17%	wordpress_mysql_1
0.09%	wordpress_haproxy_1
- `sudo sysdig -r ~/monitoring-docker.scap -c topprocs_cpu container.name contains wordpress` output:

CPU%	Process	PID
0.29%	apache2	14526
0.29%	apache2	14523
0.26%	apache2	14561
0.17%	mysqld	14000
0.09%	haproxy	14639
0.03%	apache2	14147
0.00%	apache2	14524
0.00%	apache2	14645
0.00%	apache2	14665
0.00%	apache2	14662
- `sudo sysdig -r ~/monitoring-docker.scap -c topcontainers_net` output:

Bytes	container.name
144.54KB	wordpress_mysql_1
104.08KB	wordpress_wordpress1_1
60.78KB	wordpress_wordpress2_1
41.69KB	wordpress_haproxy_1

As you can see, we have extracted quite a bit of information on our containers from the data we captured. Also, using the file, you can remove the `-r ~/monitoring-docker.scap` part of the command to view the container metrics in real time.

It's also worth pointing out that there are binaries for Sysdig that work on both OS X and Windows; while these do not capture any data, they can be used to read data that you have recorded on your Linux host.

Further reading

From the few basic exercises covered in this section, you should start to get an idea of just how powerful Sysdig can be. There are more examples on the Sysdig website at <http://www.sysdig.org/wiki/sysdig-examples/>. Also, I recommend you to read the blog post at <https://sysdig.com/fishing-for-hackers/>; it was my first exposure to Sysdig and it really demonstrates its usefulness.

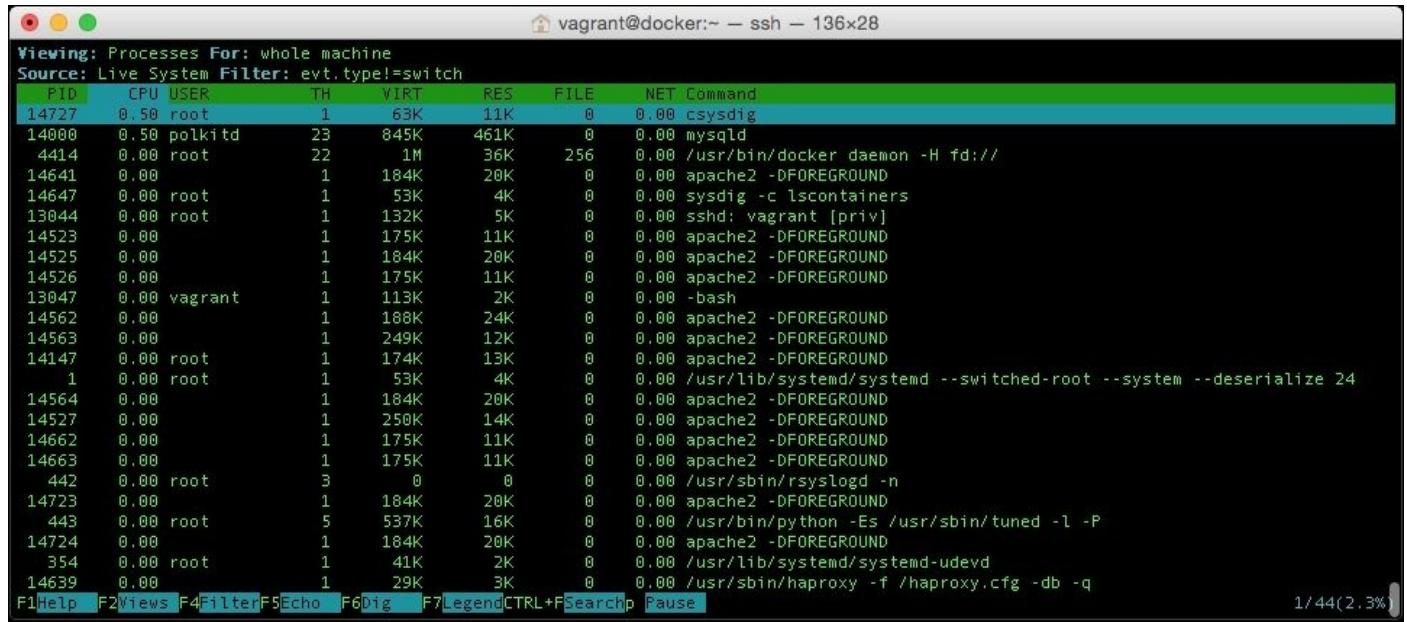
Using Csysdig

As easy as it is to view data captured by Sysdig using the command line and manually filtering the results, it can get more complicated as you start to string more and more commands together. To help make the data captured by Sysdig as accessible as possible, Sysdig ships with a GUI called **Csysdig**.

Launching the Csysdig is done with a single command:

```
sudo csysdig
```

Once the process has launched, it should instantly look familiar to anyone who has used top or cAdvisor (minus the graphs); its default view will show you real-time information on the processes that are running:



The screenshot shows a terminal window titled "vagrant@docker:~ — ssh — 136x28". The title bar also displays "Viewing: Processes For: whole machine" and "Source: Live System Filter: evt.type!=switch". The main area is a table with the following columns: PID, CPU, USER, TH, VIRT, RES, FILE, NET, and Command. The table lists numerous processes, including csysdig, mysqld, apache2, sshd, and various system daemons. The bottom of the window shows a menu bar with F1 through F8 keys and a status bar indicating "1/44(2.3%)".

PID	CPU	USER	TH	VIRT	RES	FILE	NET	Command
14727	0.50	root	1	63K	11K	0	0.00	csysdig
14000	0.50	polkitd	23	845K	461K	0	0.00	mysqld
4414	0.00	root	22	1M	36K	256	0.00	/usr/bin/docker daemon -H fd://
14641	0.00		1	184K	20K	0	0.00	apache2 -DFOREGROUND
14647	0.00	root	1	53K	4K	0	0.00	sysdig -c lscontainers
13044	0.00	root	1	132K	5K	0	0.00	sshd: vagrant [priv]
14523	0.00		1	175K	11K	0	0.00	apache2 -DFOREGROUND
14525	0.00		1	184K	20K	0	0.00	apache2 -DFOREGROUND
14526	0.00		1	175K	11K	0	0.00	apache2 -DFOREGROUND
13047	0.00	vagrant	1	113K	2K	0	0.00	-bash
14562	0.00		1	188K	24K	0	0.00	apache2 -DFOREGROUND
14563	0.00		1	249K	12K	0	0.00	apache2 -DFOREGROUND
14147	0.00	root	1	174K	13K	0	0.00	apache2 -DFOREGROUND
1	0.00	root	1	53K	4K	0	0.00	/usr/lib/systemd/system --switched-root --system --deserialize 24
14564	0.00		1	184K	20K	0	0.00	apache2 -DFOREGROUND
14527	0.00		1	250K	14K	0	0.00	apache2 -DFOREGROUND
14662	0.00		1	175K	11K	0	0.00	apache2 -DFOREGROUND
14663	0.00		1	175K	11K	0	0.00	apache2 -DFOREGROUND
442	0.00	root	3	0	0	0	0.00	/usr/sbin/rsyslogd -n
14723	0.00		1	184K	20K	0	0.00	apache2 -DFOREGROUND
443	0.00	root	5	537K	16K	0	0.00	/usr/bin/python -Es /usr/sbin/tuned -l -P
14724	0.00		1	184K	20K	0	0.00	apache2 -DFOREGROUND
354	0.00	root	1	41K	2K	0	0.00	/usr/lib/systemd/systemd-udevd
14639	0.00		1	29K	3K	0	0.00	/usr/sbin/haproxy -f /haproxy.cfg -db -q

To change this view, known as the **Processes** view, press *F2* to open the **Views** menu; from here, you can use the up and down arrows on your keyboard to select a view. As you may have already guessed, we would like to see the **Containers** view:

Viewing: Processes For: whole machine
 Source: Live System Filter: evt.type!=switch
 Select View Containers
 Connections List all the containers running on this machine, and the resources that each of them uses.
 Containers
 Containers Errors
 Directories
 Errors
 File Opens List
 Files
 I/O by Type
 New Connections
 Page Faults
 Processes
 Processes CPU
 Processes Errors
 Processes FD Usage
 Server Ports
 Spy Syslog
 Spy Users
 System Calls
 Threads

Tips
 Select a container and click enter to drill down into it. At that point, you will be able to access several views that will show you the details of the selected container.

Columns

- CPU: Amount of CPU used by the container.
- PROCS: Number of processes currently running inside the container.
- THREADS: Number of threads currently running inside the container.
- VIRT: total virtual memory for the process (as kb).
- RES: resident non-swapped memory for the process (as kb).
- FILE: Total (input+output) file I/O bandwidth generated by the container, in bytes per second.
- NET: Total (input+output) network bandwidth generated by the container, in bytes per second.
- IMAGE: Container image name.
- ID: Container ID. The format of this column depends on the containerization technology. For example, Docker ID are 12 characters hexadecimal digit strings.
- NAME: Name of the container.

ID
 containers

Filter
 container.name != host

F1Help F2Views F4FilterF5Echo F6Dig F7LegendCTRL+FSearchp Pause 1/46(2.2%)

However, before we drill down into our containers, let's quit Csysdig by pressing *q* and load up the file we created in the previous section. To do this, type the following command:

```
sudo csysdig -r ~/monitoring-docker.scap
```

Once Csysdig loads, you will notice that **Source** has changed from **Live System** to the file path of our data file. From here, press *F2* and use the up arrow to select containers and then hit *Enter*. From here, you can use the up and down arrows to select one of the two web servers, these would be either `wordpress_wordpress1_1` or `wordpress_wordpress2_1` as shown in the following screen:

CPU	PROCS	THREADS	VIRT	RES	FILE	NET	IMAGE	ID	NAME
0.57	8	8	2M	148K	146K	2.97K	wordpress	146b7188460a	wordpress_wordpress1_1
0.29	7	7	2M	136K	99K	1.74K	wordpress	88069289d5eb	wordpress_wordpress2_1
0.17	1	20	845K	461K	226K	4.13K	mysql	f45bc2b70c0f	wordpress_mysql_1
0.09	2	2	87K	18K	0	1.19K	tutum/haproxy	2a379cc1d556	wordpress_haproxy_1

F1Help F2Views F4FilterF5Echo F6Dig F7LegendCTRL+FSearchp Pause 2/4(50.0%)

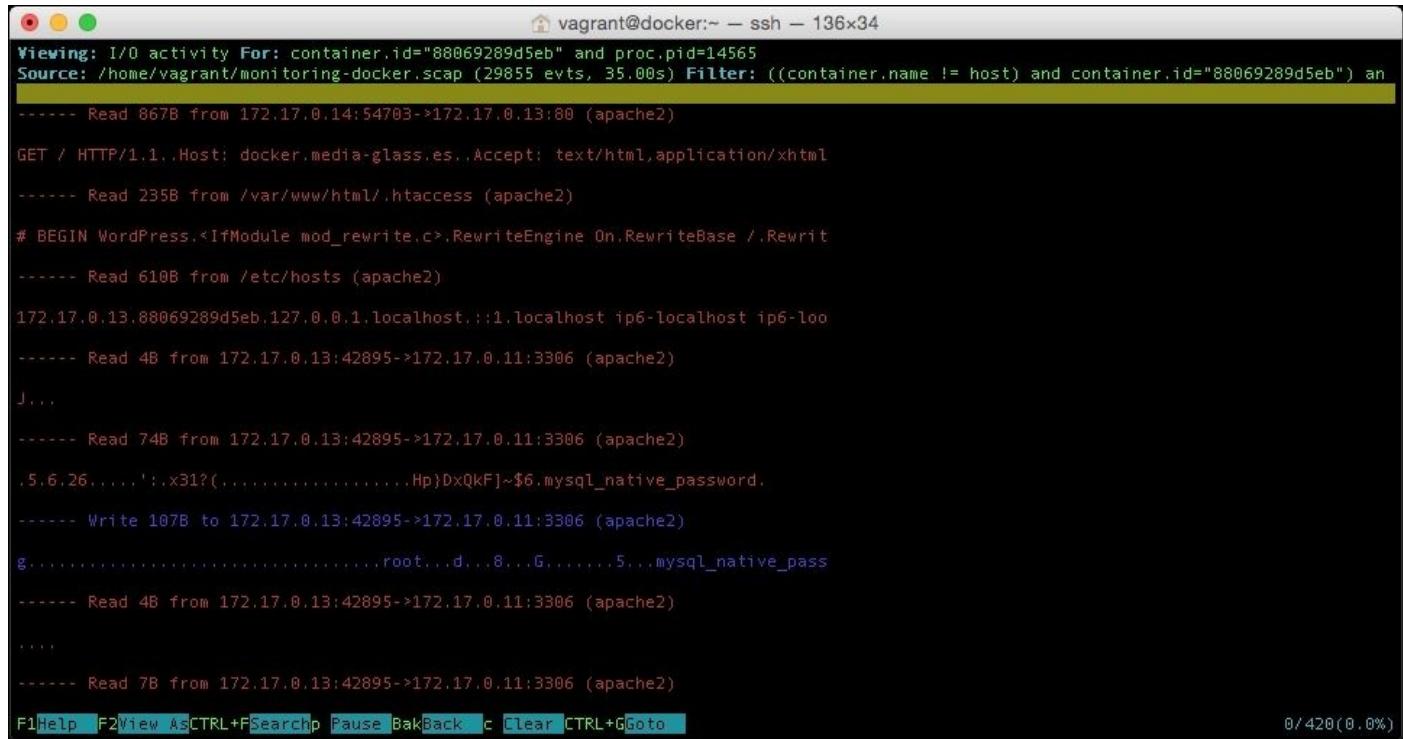
Note

The remaining part of this chapter assumes that you have Csysdig open in-front of you, it will talk you through how to navigate around the tool. Please feel free to explore yourself as well.

Once you have selected a server, hit *Enter* and you will be presented with a list of processes that the container was running. Again, you can use the arrow keys to select a process to drill down further into.

I suggested looking at one of the Apache processes that has a value listed in the **File** column. This time, rather than pressing *Enter* to select the process, let's "Echo" what the process was up to at the time we captured the data; with the process selected, press *F5*.

You can use the up and down arrows to scroll through the output:



The screenshot shows a terminal window titled "vagrant@docker:~ — ssh — 136x34". The title bar also displays "Viewing: I/O activity For: container.id="88069289d5eb" and proc.pid=14565" and "Source: /home/vagrant/monitoring-docker.scap (29855 evts, 35.00s) Filter: ((container.name != host) and container.id="88069289d5eb") and proc.pid=14565". The main pane displays network traffic logs. A yellow highlight covers the top line of the log, which reads: "----- Read 867B from 172.17.0.14:54703->172.17.0.13:80 (apache2)". Below this, the log continues with various requests and responses, including "GET / HTTP/1.1..Host: docker.media-glass.es..Accept: text/html,application/xhtml", "----- Read 235B from /var/www/html/.htaccess (apache2)", and configuration lines like "# BEGIN WordPress.<IfModule mod_rewrite.c>.RewriteEngine On.RewriteBase /.Rewrit". The bottom of the window shows a menu bar with F1, Help, F2, View, AsCTRL+F, Search, p, Pause, Bak, Back, c, Clear, CTRL+G, Goto, and a status bar indicating 0/420(0.0%).

To better format the data, press *F2* and select **Printable ASCII**. As you can see from the preceding screenshot, this Apache process performed the following tasks:

- Accepted an incoming connection
- Accessed the `.htaccess` file
- Read the `mod_rewrite` rules
- Got information from the hosts file
- Made a connection to the MySQL container
- Sent the MySQL password

By scrolling through the remainder of the data in the "Echo" results for the process, you should be able to easily follow the interactions with the database all the way through to the page being sent to the browser.

To leave the "Echo" screen, press *Backspace*; this will always take you a level back.

If you want a more detailed breakdown on what the process was doing, then press *F6* to enter the **Dig** view; this will list the files that the process was accessing at the time, along with the network interaction and how it is accessing the RAM.

To view a full list of commands and for more help, you can press *F1* at anytime. Also, to get a breakdown on any columns that are on screen, press *F7*.

Summary

As I mentioned at the start of this chapter, Sysdig is probably one of the most powerful tools I have come across in recent years.

Part of its power is the way that it exposes a lot of information and metrics in a way that never feels overwhelming. It's clear that the developers have spent a lot of time ensuring that both the UI and the way that commands are structured feel natural and instantly understandable, even by the newest member of an operations team.

The only downside is that, unless you want to view the information in real time or look into a problem in development storing the amount of data that is being generated by Sysdig, it can be quite costly in terms of disc space being used.

This is something that Sysdig has recognized, and to help with this, the company offers a cloud-based commercial service called Sysdig Cloud for you to stream your Sysdig data into. In the next chapter, we will look at this service and also some of its competitors.

Chapter 6. Exploring Third Party Options

So far, we have been looking at the tools and services you host yourself. Along with these self-hosted tools, a large amount of cloud-based software has developed around Docker as a service ecosystem. In this chapter, we will look at the following topics:

- Why use a SaaS service over self-hosted or real-time metrics?
- What services are available and what do they offer?
- Installation of agents for Sysdig Cloud, Datadog, and New Relic on the host machines
- Configuration of the agents to ship metrics

A word about externally hosted services

So far, to work through the examples in this book, we have used locally hosted virtual servers that are launched using vagrant. During this chapter, we are going to use services that need to be able to communicate with your host machine, so rather than trying to do this using your local machine, its about time you took your host machine into the cloud.

As we are going to start and stop the remote hosts while we look at the services, it pays to use a public cloud, as we only get charged for what we use.

There are several public cloud services that you can use to evaluate the tools covered in this chapter, which one you choose to use is up to you, you could use:

- Digital Ocean: <https://www.digitalocean.com/>
- Amazon Web Services: <https://aws.amazon.com/>
- Microsoft Azure: <https://azure.microsoft.com/>
- VMware vCloud Air: <http://vcloud.vmware.com/>

Or use your own preferred provider, the only pre-requisite is that your server is publically accessible.

This chapter assumes that you are capable of launching either a CentOS 7 or Ubuntu 14.04 cloud instance and you understand that you will likely incur charges while the cloud instance is up and running.

Deploying Docker in the cloud

Once you have launched your cloud instance, you can bootstrap Docker in the same way that you installed using vagrant. In the chapter 6 folder of the Git repository, there are two separate scripts to download and install the Docker engine and compose it on your cloud instance.

To install Docker, ensure that your cloud instance is updated by running:

```
sudo yum update
```

For the CentOS instance of your Ubuntu, run the following command:

```
sudo apt-get update
```

Once updated, run the following command to install the software. Due to the differences in the way different cloud environments are configured, it is best to switch over to the root user to run the remainder of the commands, to do this, run:

```
sudo su -
```

Now you will be able to run the install script using the following command:

```
curl -fsS https://raw.githubusercontent.com/russmckendrick/monitoring-docker/master/chapter06/install_docker/install_docker.sh | bash
```

To check that everything works as expected, run the following command:

```
docker run hello-world
```

You should see something similar to the terminal output, as shown in the following screenshot:

```
root@testing ~# curl -fsS https://raw.githubusercontent.com/russmckendrick/monitoring-docker/master/chapter06/install_docker/install_docker.sh | bash
>> Installing docker-engine ...
>> Starting docker-engine ...
>> Installing docker-compose ...
>> Finished installation of Docker
[root@testing ~]# docker run hello-world
Unable to find image 'hello-world:latest' locally
latest: Pulling from library/hello-world
535820c3e8ad: Full complete
aef340544cd62: Full complete
library/hello-world:latest: The image you are pulling has been verified. Important: image verification is a tech preview feature and should not be relied on to provide security.
Digest: sha256:82fee8c3220ba086531f606525eceb83f4feb654f62b207191b1c9289108dedd
Status: Downloaded newer image for hello-world:latest

Hello from Docker.
This message shows that your installation appears to be working correctly.

To generate this message, Docker took the following steps:
1. The Docker client contacted the Docker daemon.
2. The Docker daemon pulled the "hello-world" image from the Docker Hub.
3. The Docker daemon created a new container from that image which runs the executable that produces the output you are currently reading.
4. The Docker daemon streamed that output to the Docker client, which sent it to your terminal.

To try something more ambitious, you can run an Ubuntu container with:
$ docker run -it ubuntu bash

Share images, automate workflows, and more with a free Docker Hub account:
https://hub.docker.com

For more examples and ideas, visit:
https://docs.docker.com/userguide/
```

We can start to look at the SaaS services once you have Docker up and running.

Why use a SaaS service?

You may have noticed while working with the examples in the previous chapters that the tools we have used can potentially use many resources if we needed to start collecting more metrics, especially if the applications we want to monitor are in production.

To help shift this load from both storage and CPU, a number of cloud-based SaaS options have started offering support to record metrics for your containers. Many of these services were already offering services to monitor servers, so adding support for containers seemed a natural progression for them.

These typically require you to install an agent on your host machine, once installed, the agent will sit in the background and report to the services, normally cloud-based and API services.

A few of the services allow you to deploy the agents as Docker containers. They offer containerized agents so that the service can run on stripped down operating systems, such as:

- CoreOS: <https://coreos.com/>
- RancherOS: <http://rancher.com/rancher-os/>
- Atomic: <http://www.projectatomic.io/>
- Ubuntu Snappy Core: <https://developer.ubuntu.com/en/snappy/>

These operating systems differ from traditional ones, as you cannot install services on them directly; their only purpose is to run a service, such as Docker, so that you can launch the services or applications you need to be run as containers.

As we are running full operating systems as our host systems, we do not need this option and will be deploying the agents directly to the hosts.

The SaaS options that we are going to look at in this chapter are as follows:

- Sysdig Cloud: <https://sysdig.com/product/>
- Datadog: <https://www.datadoghq.com/>
- New Relic: <http://newrelic.com>

They all offer free trials and two of them offer free cut-down versions of the main service. On the face of it, they might all appear to offer similar services; however, when you start to use them, you will immediately notice that they are in fact all very different from each other.

Sysdig Cloud

In the previous chapter, we had a look at the open source version of Sysdig. We saw that there is a great ncurses interface called cSysdig and it allows us to navigate through all the data that Sysdig is collecting about our host.

The sheer amount of metrics and data collected by Sysdig means that you have to try to stay on top of it either by shipping your files off the server, maybe to Amazon Simple Storage Service (S3), or to some local shared storage. In addition, you can query the data in the command line on the host itself or on your local machine using an installation of the command-line tools.

This is where Sysdig Cloud comes into play; it offers a web-based interface to the metrics that Sysdig captures along with the options to ship the Sysdig captures off your host machine either to Sysdig's own storage or to your S3 bucket.

Sysdig cloud offers the following functionality:

- ContainerVision™
- Real-Time Dashboard
- Historical Replay
- Dynamic Topology
- Alerting

As well as, the option to trigger a capture on any of your hosts and at any time.

Sysdig describes ContainerVision as:

“Sysdig Cloud’s patent-pending core technology, ContainerVision, is the only monitoring technology on the market designed specifically to respect the unique characteristics of containers. ContainerVision offers you deep and comprehensive visibility into all aspects of your containerized environment - applications, infrastructures, servers, and networks - all without the need to pollute your containers with any extra instrumentation. In other words, ContainerVision gives you 100% visibility into the activity inside your containers, from the outside.”

Before we delve into Sysdig Cloud any further, I should point out that this is a commercial server and at the time of writing, it costs \$25 per host per month. There is also a 14-day fully featured trial available. If you wish to work through the agent installation and follow the example in this chapter, you will need an active account that runs either on the 14-day trial or a paid subscription.

- Sign up for a 14-day free trial: <https://sysdig.com/>
- Details on pricing: <https://sysdig.com/pricing/>
- Introduction to the company: <https://sysdig.com/company/>

Installing the agent

The agent installation is similar to installing the open source version; you need to ensure that your cloud host is running an up-to-date kernel and that you are also booted into the kernel.

Some cloud providers keep a tight control on the kernels you can boot into (for example, Digital Ocean), and they do not allow you to manage your kernel on the host itself. Instead, you need to choose the correct version through their control panel.

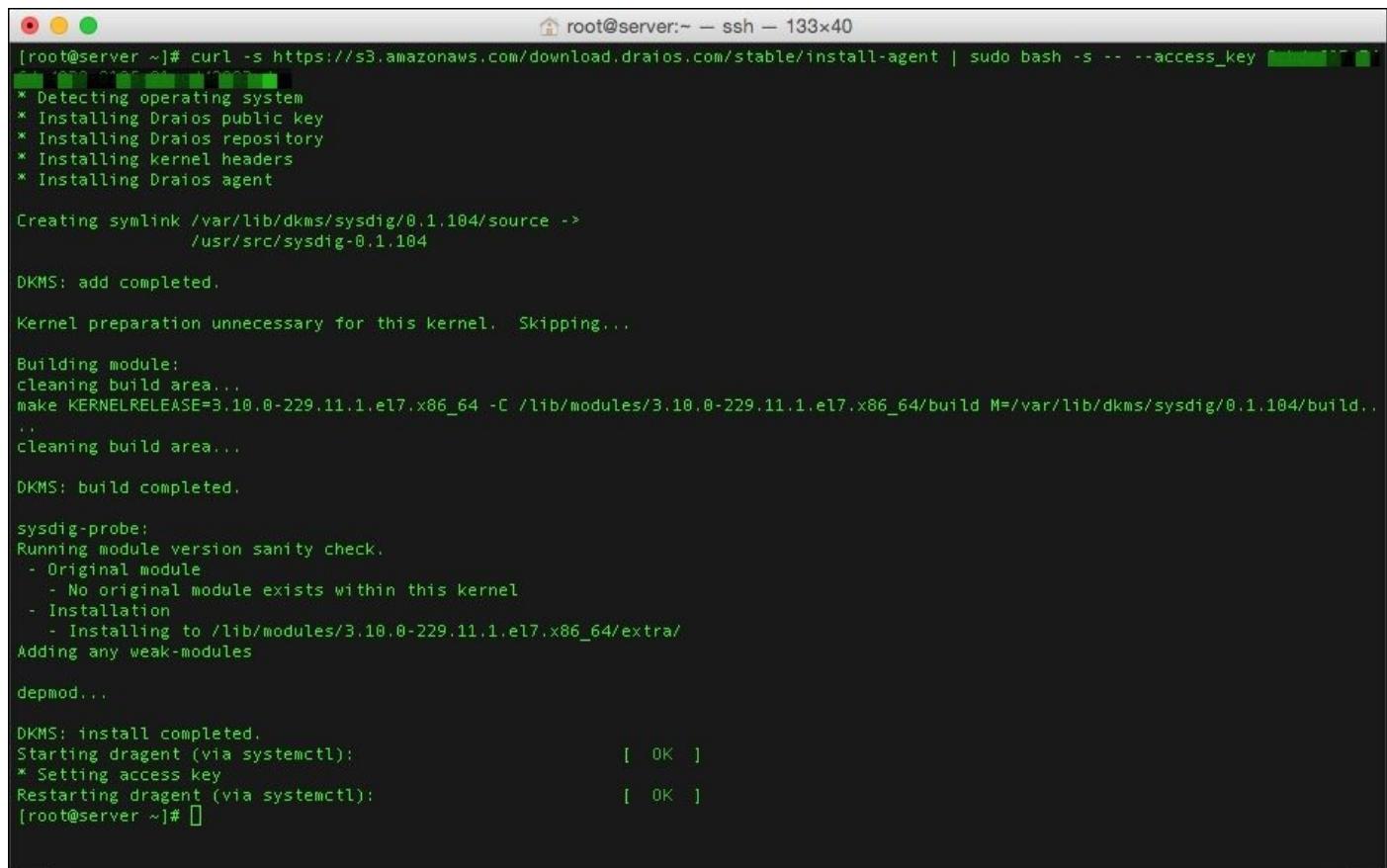
Once you have the correct kernel installed, you should be able to run the following command to install the agent. Ensure that you replace the access key at the end of the command with your own access key, which can be found on your **User Profile** page or on the agent installation pages; you can find these at:

- User Profile: <https://app.sysdigcloud.com/#/settings/user>
- Agent Installation: <https://app.sysdigcloud.com/#/settings/agentInstallation>

The command to run is:

```
curl -s https://s3.amazonaws.com/download.draios.com/stable/install-agent | sudo bash -s -- --access_key wn5AY1hjRhgn3shcjW14y3y0T09WsF7d
```

The shell output should look like the following screen:



```
[root@server ~]# curl -s https://s3.amazonaws.com/download.draios.com/stable/install-agent | sudo bash -s -- --access_key wn5AY1hjRhgn3shcjW14y3y0T09WsF7d
root@server:~ - ssh - 133x40
[  OK  ] * Detecting operating system
[  OK  ] * Installing Draios public key
[  OK  ] * Installing Draios repository
[  OK  ] * Installing kernel headers
[  OK  ] * Installing Draios agent

Creating symlink /var/lib/dkms/sysdig/0.1.104/source ->
/usr/src/sysdig-0.1.104

DKMS: add completed.

Kernel preparation unnecessary for this kernel. Skipping...

Building module:
cleaning build area...
make KERNELRELEASE=3.10.0-229.11.1.el7.x86_64 -C /lib/modules/3.10.0-229.11.1.el7.x86_64/build M=/var/lib/dkms/sysdig/0.1.104/build...
.
cleaning build area...

DKMS: build completed.

sysdig-probe:
Running module version sanity check.
- Original module
- No original module exists within this kernel
- Installation
- Installing to /lib/modules/3.10.0-229.11.1.el7.x86_64/extr...
Adding any weak-modules

depmod...

DKMS: install completed.
Starting dragen (via systemctl):                                [  OK  ]
* Setting access key
Restarting dragen (via systemctl):                               [  OK  ]
[root@server ~]#
```

Once the agent has been installed, it will immediately start to report the data back to Sysdig Cloud. If you click on **Explore**, you will see your host machine and the running

containers:

The screenshot shows the Sysdig Cloud interface with the 'Explore' tab selected. On the left, there's a sidebar with 'Overview' and other monitoring categories like CPU/Memory, Requests Time Breakdown, Network, File I/O, Requests, and Forecast. The main area displays a table of metrics for multiple hosts and containers. The table has columns for Hostname, Instance Type, CPU %, Memory %, Network KIB/s, Req/s, FS Disk %, and File B. KIB/s. One row is highlighted for a container named 'server.mckendrick.io' which is an 'wordpress_hap...' instance. This row shows CPU usage at 14.9%, Memory at 72.3%, Network at 5.0 KIB/s, Requests at 0 req/s, and File I/O at 31.4 KIB/s.

Hostname	Instance Type	CPU %	Memory %	Network KIB/s	Req/s	FS Disk %	File B. KIB/s
server.mckendrick.io	wordpress_hap...	14.9	72.3	5.0	0	31.4	54.4
	wordpress_mys...	0	1.6	2.2	1.0	0	0
	wordpress_wor...	0	45.8	0	0	0	0
	wordpress_wor...	0	22.3	0	0	0	1.3
	wordpress_wor...	0	23.3	0	0	0	0

As you can see here, I have my host machine and four containers running a WordPress installation similar to the one we used in the previous chapter. From here, we can start to drill down into our metrics.

To launch the WordPress installation on your cloud-based machine, run the following commands as the root user:

```
sudo su -  
mkdir ~/wordpress  
curl -L https://raw.githubusercontent.com/russmckendrick/monitoring-docker/master/chapter05/wordpress/docker-compose.yml > ~/wordpress/docker-compose.yml  
cd ~/wordpress  
docker-compose up -d
```

Exploring your containers

The Sysdig Cloud web interface will feel instantly familiar, as it shares a similar design and overall feeling with cSysdig:

The screenshot shows the Sysdig Cloud web interface. At the top, there's a navigation bar with links for Overview, Explore (which is selected), Dashboards, Alerting, and Sysdig. A message about a free trial expiring in six days is displayed. Below the navigation is a secondary menu with options like LAST 1 SECOND, 5 M, 2 H, 1 D, 2 W, GO LIVE, and a search bar.

The main area has two tabs: Servers and AWS Services. The Servers tab is active, showing an Overview section with a table of metrics for a specific host. The table includes columns for Hostname, Instance Type, CPU %, Memory %, Network KIB/s, Req/s, FS Disk %, and File By KIB/s. One row shows a high CPU usage of 100.0% for a WordPress MySQL container.

Below the table, there's a detailed view for the host 'server.mckendrick.io'. It shows four horizontal bar charts under the 'System: Overview by Container' heading. The charts are for CPU %, Memory Usage %, Network Bytes Total, and File Bytes Total. The CPU chart shows high utilization for multiple containers, while the memory chart shows lower usage. The network and file charts show traffic patterns between the containers.

Once you start to drill down, you can see that a bottom pane opens up and this is where you can view the statistics. One of the things I liked about Sysdig Cloud is that it opens up a wealth of metrics and there should be very little that you need to configure from here.

For example, if you want to know what processes have been consuming the most CPU time in the last 2 hours, click on **2H** in the secondary menu and then from the **Views** tab in the bottom-left click on **System: Top Processes**; this will give you a table of the processes, ordered by the ones that have used the most time.

To apply this view to a container, click on a container in the top-section and the bottom-section will be instantly updated to reflect the top CPU utilization for just that container; as most containers will only run one or two processes, this may not be that interesting. So, let's have a deep look at the processes themselves. Let's say, we clicked on our database

container and we wanted information on what is happening within MySQL.

Sysdig Cloud comes with application overlays, these when selected give you more granular information on the processes within the container. Selecting the **App: MySQL/PostgreSQL** view gives you an insight into what your MySQL processes are currently doing:

The screenshot shows the Sysdig Cloud interface with the "Explore" tab selected. In the left sidebar, under the "Overview" section, the "App: MySQL/PostgreSQL" view is highlighted. The main area displays various metrics and performance charts for the MySQL instance "wordpress_mysql_1".

Metrics Overview:

Hostname	Instance Type	CPU %	Memory %	Network Kib/s	Req/s	FS Disk %	File By Kib/s
server.mckendrick.io (4)	-	18.1	74.4	5.2	0	31.7	73.6
wordpress_hapr...	-	0.1	1.6	2.2	1.0	0	0
wordpress_mysql...	-	0.3	45.8	5.0	7.4	0	1.1
wordpress_word...	-	0.6	24.1	0	0	0	1.3
wordpress_word...	-	6.2	23.0	5.0	0	0	14.5

Performance Metrics:

- Number of Requests:** A line chart showing spikes in requests over time, with a peak around 11:18 am.
- Average and Max Request Time:** A line chart comparing average request time (avg) in green and maximum request time (worst) in orange over the last 5 minutes.
- Top Queries by Number of Requests:** A list of SQL queries executed, such as SELECT option_value FROM wp_options WHERE option_name = 'current_theme' LIMIT 1.
- Slowest Tables:** A chart showing the execution time for various MySQL tables, with wp_options being the slowest.
- Slowest Queries:** A list of MySQL queries with their execution times, including SELECT option_value FROM wp_options WHERE option_name = 'current_theme' LIMIT 1.
- Top Tables by Number of Requests:** A chart showing the number of requests per MySQL table, with wp_options at the top.

Here, you can see that view in the bottom section has instantly updated to give a wealth of information on what has been happening in the last 5 minutes within MySQL.

Sysdig Cloud supports a number of application views, including:

- Apache
- HAProxy

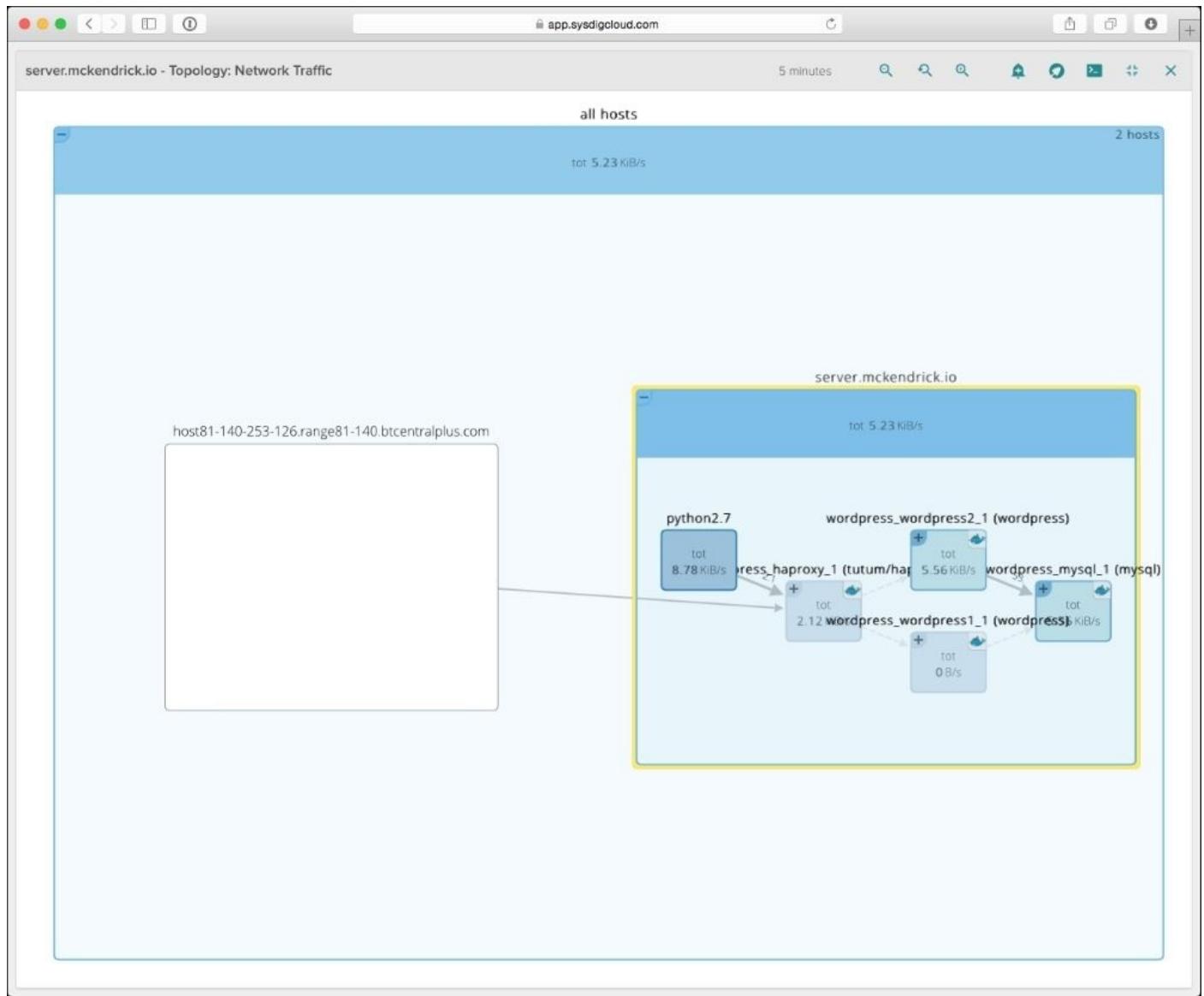
- NGINX
- RabbitMQ
- Redis
- Tomcat

Each one gives you immediate access to metrics, which even the most experienced SysAdmins will find valuable.

You may have noticed that at the top of the second panel there are also a few icons, these allow you to:

- **Add Alert:** Creates an alert based on the view you have open; it lets you tweak the threshold and also choose how you are notified.
- **Sysdig Capture:** Pressing this brings up a dialog, which lets you record a Sysdig session. Once recorded, the session is transferred to Sysdig Cloud or your own S3 bucket. Once the session is available, you download it or explore it within the web interface.
- **SSH Connect:** Gets a remote shell on the server from the Sysdig Cloud web interface; it is useful if you do not have immediate access to your laptop or desktop machine and you want to do some troubleshooting.
- **Pin to dashboard:** Adds the current view to a custom dashboard.

Out these options icons, the “Add Alert” and “Sysdig Capture” options are probably the ones that you will end up using the most. One final view that I found interesting, is the topology one. It gives you a bird’s eye view of your host and containers, this is useful too see the interaction between containers and hosts:



Here, you can see me request a page from the WordPress site (it's in the box on the left), this request hits my host machine (the box on the right). Once it's on the host machine, it is routed to the HAProxy container, which then passes the page request to the Wordpress2 container. From here, the Wordpress2 container interacts with the database that is running on the MySQL container.

Summary and further reading

Although Sysdig Cloud is quite a new service, it feels instantly familiar and fully featured as it is built on top of an already established and respected open source technology. If you like, the level of detail you get from the open source version of Sysdig, then Sysdig Cloud is a natural progression for you to start storing your metrics offsite and also to configure alerts. Some good starting points for learning more about Sysdig Cloud are:

- Video Introduction: <https://www.youtube.com/watch?v=p8UVbpw8n24>
- Sysdig Cloud Best Practices: <http://support.sysdigcloud.com/hc/en-us/articles/204872795-Best-Practices>
- Dashboards: <http://support.sysdigcloud.com/hc/en-us/articles/204863385-Dashboards>
- Sysdig blog: <https://sysdig.com/blog/>

Tip

If you have launched a cloud instance and are no longer using it, now would be a good time to power the instance down or terminate it altogether. This will ensure that you do not get billed for services that you are not using.

Datadog

Datadog is a full monitoring platform; it supports various servers, platforms, and applications. Wikipedia describes the service as:

“Datadog is a SaaS-based monitoring and analytics platform for IT infrastructure, operations and development teams. It brings together data from servers, databases, applications, tools and services to present a unified view of the applications that run at scale in the cloud.”

It uses an agent that is installed on your host machine; this agent sends metrics back to the Datadog service periodically. It also support multiple cloud platforms, such as Amazon Web Services, Microsoft Azure, and OpenStack to name a few.

The aim is to bring all of your servers, applications, and host provider metrics into a single pane of glass; from here, you can create custom dashboards and alerts so that you can be notified of any problem at any level within your infrastructure.

You can sign up for a free trial of the full service at <https://app.datadoghq.com/signup>. You will need at least a trial account to configure the altering, and if your trial has already expired the lite account will do. For more detail on Datadog’s pricing structure, please see <https://www.datadoghq.com/pricing/>.

Installing the agent

The agent can be installed either directly on the host machine or as a container. To install directly on the host machine, run the following command and make sure that you use your own unique DD_API_KEY:

```
DD_API_KEY=wn5AYlhjRhgn3shcjW14y3y0T09WsF7d bash -c "$(curl -L https://raw.githubusercontent.com/DataDog/dd-agent/master/packaging/datadog-agent/source/install_agent.sh)"
```

To run the agent as a container, use the following command and again make sure that you use your own DD_API_KEY:

```
sudo docker run -d --name dd-agent -h `hostname` -v /var/run/docker.sock:/var/run/docker.sock -v /proc/mounts:/host/proc/mounts:ro -v /sys/fs/cgroup:/host/sys/fs/cgroup:ro -e API_KEY=wn5AYlhjRhgn3shcjW14y3y0T09WsF7d datadog/docker-dd-agent
```

Once the agent has been installed, it will call back to Datadog and the host will appear in your account.

If the agent has been installed directly on the host machine then we will need to enable the Docker integration, if you installed the agent using the container then this will have been done for you automatically.

To do this, you first need to allow the Datadog agent access to your Docker installation by adding the dd-agent user to the Docker group by running the following command:

```
usermod -a -G docker dd-agent
```

The next step is to create the docker.yaml configuration file, luckily the Datadog agent ships with an example configuration file that we can use; copy this in place and then restart the agent:

```
cp -pr /etc/dd-agent/conf.d/docker.yaml.example /etc/dd-agent/conf.d/docker.yaml  
sudo /etc/init.d/datadog-agent restart
```

Now the agent on our host machine has been configured and the final step is to enable the integration through the website. To do this, go to <https://app.datadoghq.com/> and click on **Integrations**, scroll down and then click on install on **Docker**:

The screenshot shows the Datadog integration catalog interface. On the left is a sidebar with the Datadog logo and links for Events, Dashboards, Infrastructure, Monitors, Metrics, Integrations, Help, Team, and russ. The main area displays a grid of integration cards. Each card includes the integration logo, name, a brief description, and a 'Install' button.

CHEF	Consul	Couchbase	CouchDB
Chef + Available	Consul + Available	Couchbase + Available	CouchDB + Available
salesforce desk™	Docker	Dyn	elasticsearch.
Desk + Available	Docker is an open-source project that automates the deployment of applications inside software containers. + Install	Dyn + Available	Elasticsearch + Available
etcd	Microsoft Event Viewer	expressjs	Fabric
etcd + Available	Event Viewer + Available	Express + Available	Fabric + Available
fastly	flowdock	fluentd	Gearman
Fastly + Available	FlowDock + Available	fluentd + Available	Gearman + Available

Once you click install, you will be presented with an overview of the integration, click on the **Configuration** tab, this gives instructions on how to configure the agent; as we have already done this step, you can click on **Install Integration**.

You can find more information on installing the agent and the integrations at the following URLs:

- <https://app.datadoghq.com/account/settings#agent>
- <https://app.datadoghq.com/account/settings#integrations>

Exploring the web interface

Now, you have installed the agent and enabled the Docker integration, you can start to have a look around the web interface. To find your host, click on “Infrastructure” in the left-hand side menu.

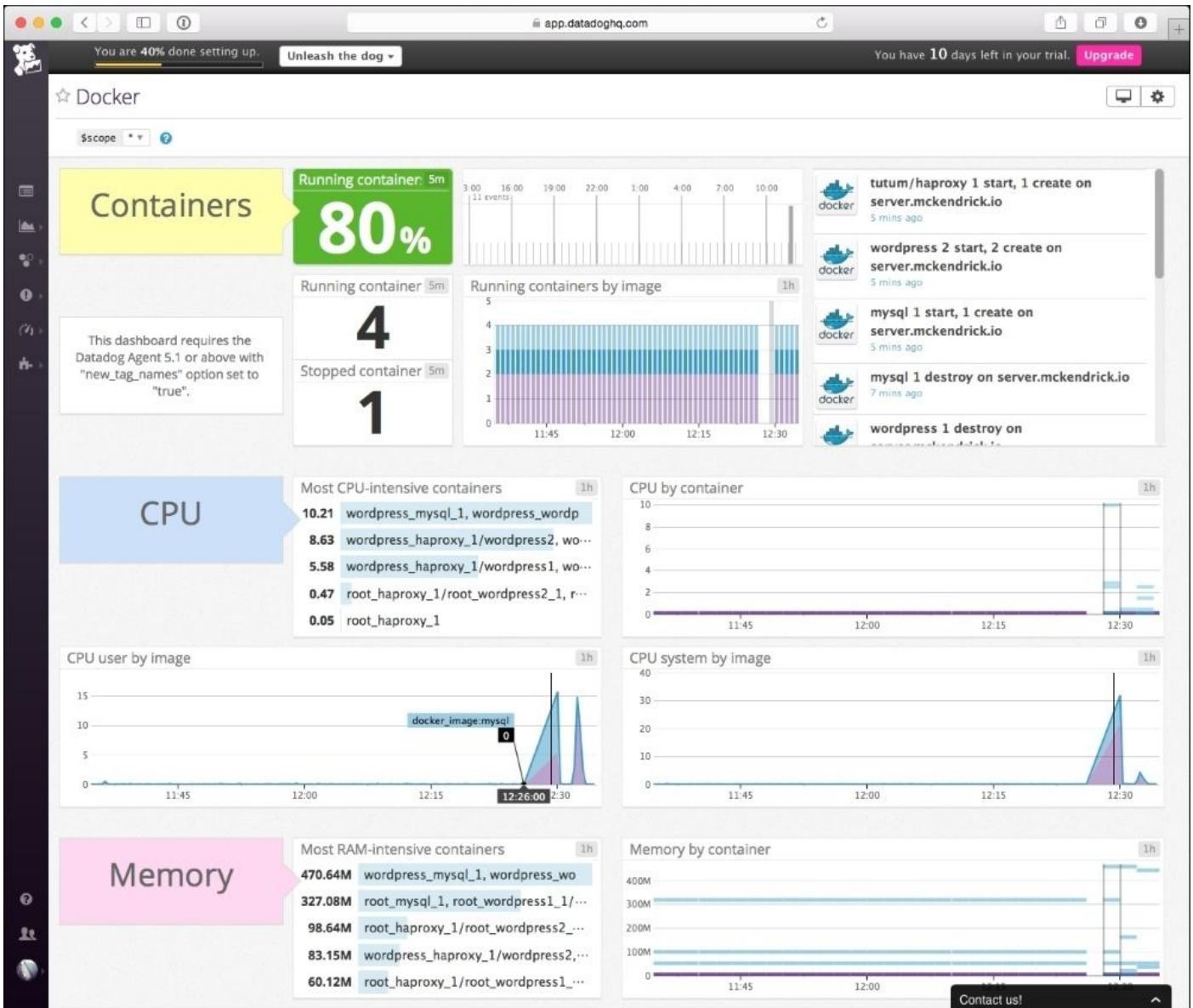
You should be taken to a screen that contains a map of your infrastructure. Like me, you probably only have a single host machine listed, click on it and some basic stats should appear at the bottom of the screen:

The screenshot shows the Datadog web interface. At the top, there's a progress bar indicating "You are 40% done setting up." and a button to "Unleash the dog". On the right, it says "You have 10 days left in your trial." and a "Upgrade" button. Below the header, there are filters for "Filter by", "Group hosts by tags", and "Fill by: % CPU... avg". A large green hexagonal icon represents the host "server.mckendrick.io", containing three blue rectangular boxes labeled "docker", "ntp", and "system". The main dashboard area for "server.mckendrick.io" (dashboard) includes sections for "Apps" (with "docker", "ntp", and "system" buttons), "Agent" (Datadog Agent v5.5.0), "System" (GNU/Linux - 1 CPU - 46.101.5.164 - 0.97GB - 31.34GB), and "Metrics" (as of 7 mins ago, % CPU utilized 1%). There are also "Tags" (User) and "Edit Tags" buttons. At the bottom, it says "Updated 3 mins ago | Copyright Datadog, Inc. 2015 - Terms - Privacy" and "Contact us!".

If you don't already have the containers launched, now would be a good time to do so, lets launch the WordPress installation again using:

```
sudo su -
mkdir ~/wordpress
curl -L https://raw.githubusercontent.com/russmckendrick/monitoring-
docker/master/chapter05/wordpress/docker-compose.yml > ~/wordpress/docker-
compose.yml
cd ~/wordpress
docker-compose up -d
```

Now, go back to the web interface, from there you can click on any of the services listed on the hexagon. This will bring up some basic metrics for the service you have selected. If you click on **docker**, you will see a link for a Docker Dashboard among the various graphs and so on; clicking this will take you to a more detailed view of your containers:



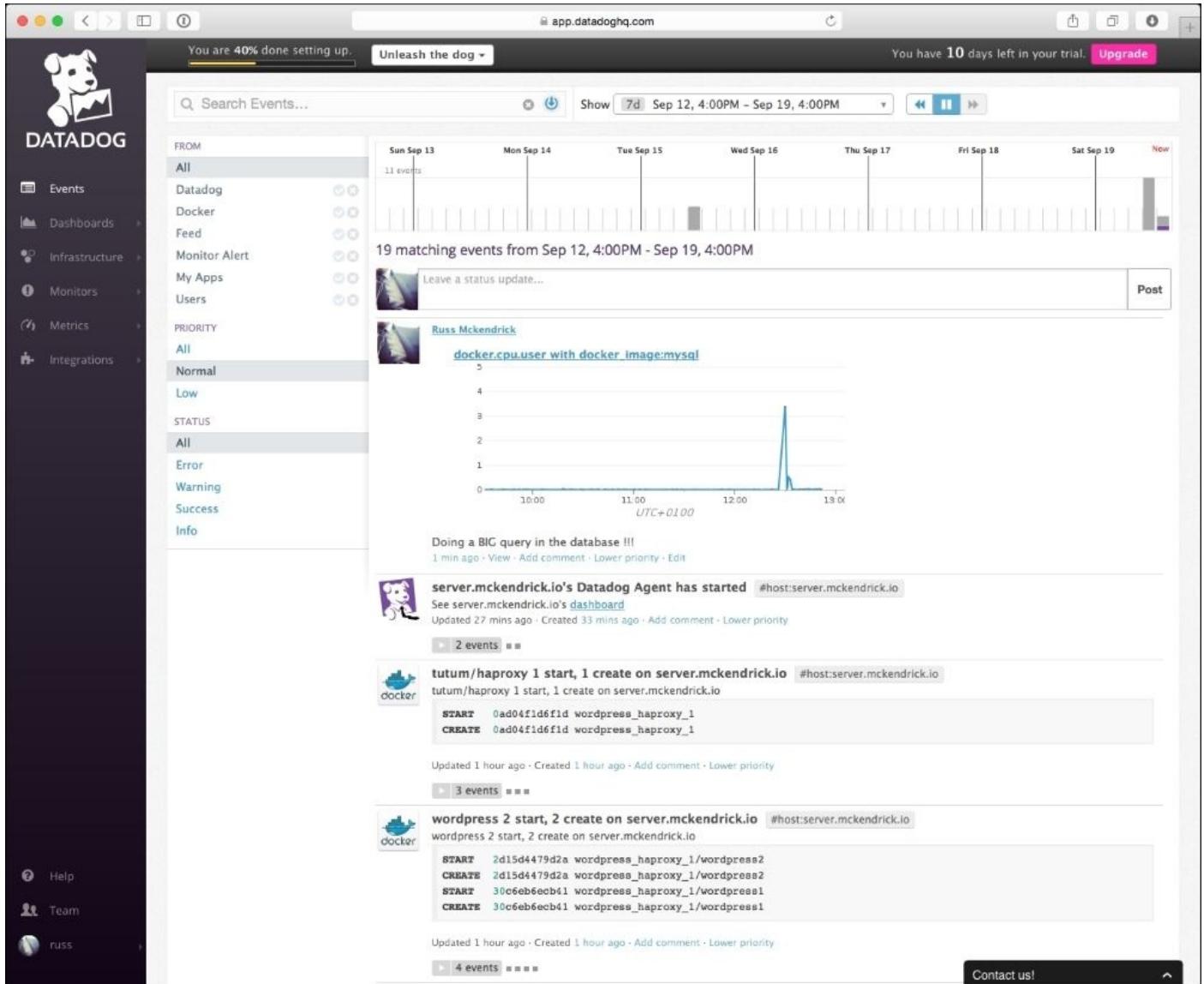
As you can see, this gives us our now familiar break down of the CPU and memory metrics, along with in the top right of the dashboard a breakdown of the container activity on the host machine; this logs events, such as stopping and starting containers.

Datadog currently records the following metrics:

- docker.containers.running
- docker.containers.stopped
- docker.cpu.system
- docker.cpu.user
- docker.images.available
- docker.images.intermediate
- docker.mem.cache

- docker.mem/rss
- docker.mem/swap

From the **Metrics** explorer option in the left-hand side menu, you can start to graph these metrics and once you have the graphs, you can then start to add them to your own custom dashboards or even annotate them. When you annotate a graph, a snapshot is created and the graph shows up in the events queue along with the other events, that have been recorded, such as container stopping and starting:



Also, within the web interface you can configure monitors; these allow you to define triggers, which alert you if your conditions are not met. Alerts can be sent as e-mails or via third party services, such as Slack, Campfire, or PagerDuty.

Summary and further reading

While Datadog's Docker integration only gives you the basic metrics on your containers, it does have a wealth of features and integration with other applications and third parties. If you need to monitor a number of different services alongside your Docker containers, then this service could be for you:

- Home page: <https://www.datadoghq.com>
- Overview: <https://www.datadoghq.com/product/>
- Monitoring Docker with Datadog: <https://www.datadoghq.com/blog/monitor-docker-datadog/>
- Twitter: <https://twitter.com/datadoghq>

Tip

Please Remember

If you have launched a cloud instance and are no longer using it then now would be a good time to power the instance down or terminate it altogether. This will ensure that you do not get billed for any services you are not using.

New Relic

New Relic could be considered the granddaddy of SaaS monitoring tools, chances are that if you are a developer you will have heard of New Relic. It has been around for a while and it is the standard to which other SaaS tools compare themselves.

New Relic has grown into several products over the year, currently, they offer:

- **New Relic APM:** The main application performance-monitoring tool. This is what most people will know New Relic for; this toll gives you the code level visibility of your application.
- **New Relic Mobile:** A set of libraries to embed into your native mobile apps, giving APM levels of detail for your iOS and android application.
- **New Relic Insights:** A high-level view of all of the metrics collected by other New Relic services.
- **New Relic Servers:** Monitors your host servers, recording metrics around CPU, RAM, and storage utilization.
- **New Relic Browser:** Gives you an insight into what happens with your web-based applications once they leave your servers and enter your end user's browser
- **New Relic Synthetics:** Monitors your applications responsiveness from various locations around the world.

Rather than looking at all of these offerings that give us an insight into what is happening with our Docker-based code, as that's probably a whole book on its own, we are going to take a look at the server product.

The server monitoring service offered by New Relic is available free of charge, you just need an active New Relic account, you can sign up for an account at <https://newrelic.com/signup/> details on New Relics pricing can be found at their homepage at <http://newrelic.com/>.

Installing the agent

Like the other SaaS offerings we have looked at in this chapter, New Relic Servers has a host-based client, which needs to be able to access the Docker binary. To install this on a CentOS machine, run the following:

```
yum install http://download.newrelic.com/pub/newrelic/el5/i386/newrelic-repo-5-3.noarch.rpm  
yum install newrelic-sysmond
```

For Ubuntu, run the following command:

```
echo 'deb http://apt.newrelic.com/debian/ newrelic non-free' | sudo tee /etc/apt/sources.list.d/newrelic.list  
wget -O- https://download.newrelic.com/548C16BF.gpg | sudo apt-key add -  
apt-get update  
apt-get install newrelic-sysmond
```

Now that you have the agent installed, you need to configure the agent with your license key. You can do this with the following command and make sure that you add your license, which can be found in your settings page:

```
nrsysmond-config --set license_key= wn5AY1hjRhgn3shcjW14y3y0T09WsF7d
```

Now that the agent is configured, we need to add the `newrelic` user to the `docker` group so that the agent has access to our container information:

```
usermod -a -G docker newrelic
```

Finally, we need to start the New Relic Server agent and restart Docker:

```
/etc/init.d/newrelic-sysmond restart  
/etc/init.d/docker restart
```

Tip

Restarting Docker will stop the running containers that you have; make sure that you make a note of these using `docker ps` and then start them manually and back up once the Docker service restarts.

You should see your server appear on your New Relic control panel after a few minutes.

Exploring the web interface

Once you have the New Relic server agent installed, configured, and running on your host machine, you will see something similar to the following screenshot when clicking on **Servers** in the top menu:

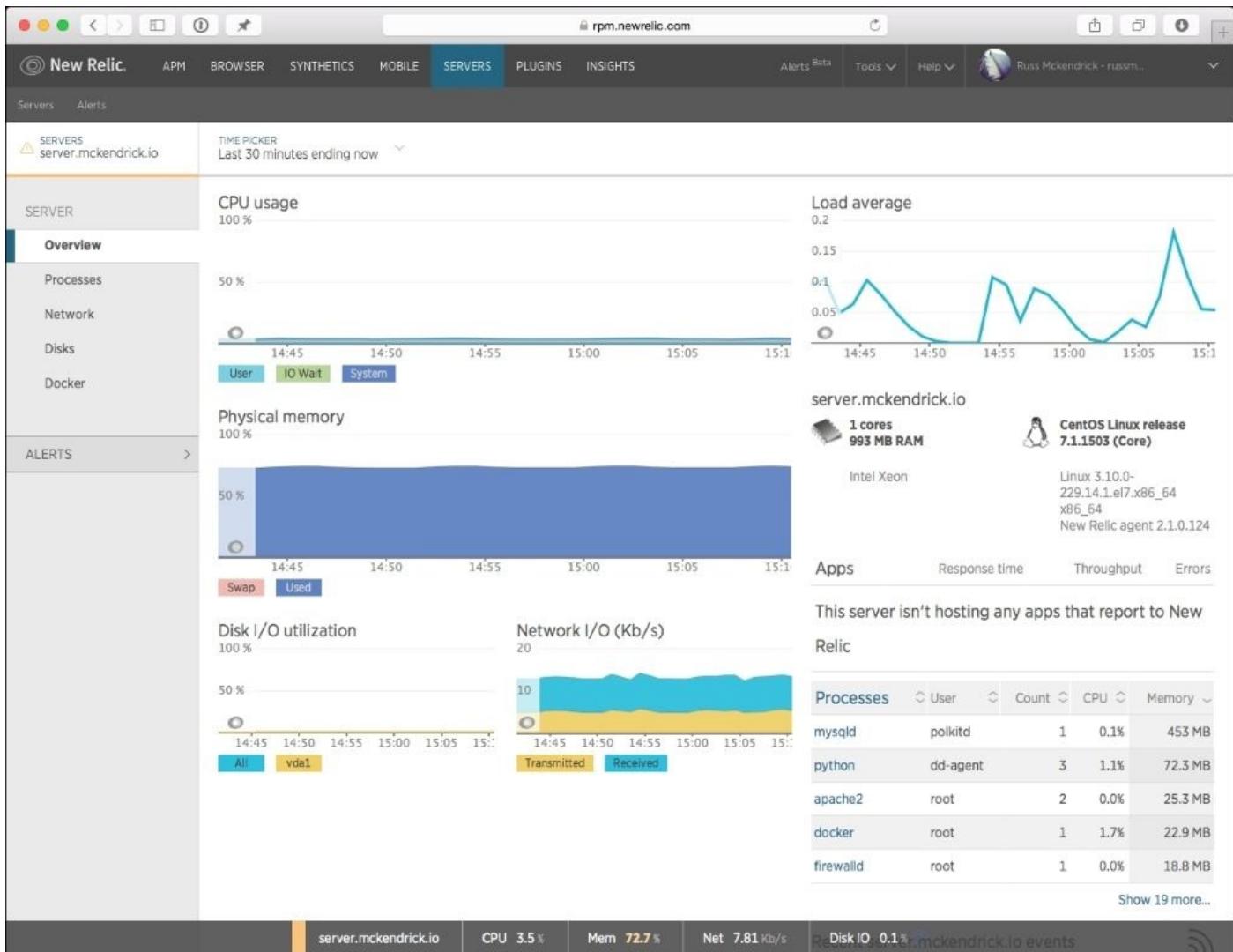
The screenshot shows the New Relic web interface with the URL `rpm.newrelic.com`. The top navigation bar includes links for APM, BROWSER, SYNTHETICS, MOBILE, SERVERS (which is highlighted in blue), PLUGINS, and INSIGHTS. On the right side of the header, there are links for Alerts Beta, Tools, Help, and a user profile for Russ Mckendrick.

The main content area is titled "Servers" and displays a table with one server entry. The columns are Name, CPU, Disk IO, Memory, and Fullest disk. The server listed is `server.mckendrick.io`, with metrics: 3.67% CPU, 0.11% Disk IO, 73.3% Memory (728 MB / 993 MB), and 0% Fullest disk. Below the table, it says "1 Servers" and "1 - 1 of 1".

To the right of the table, there is a sidebar titled "Recent events" which lists an "In-Progress" alert for "SERVER.MCKENDRICK.IO" with the message "Memory > 70% Non-critical problem" at 12:03. There are also "All" and "Kiosk mode" buttons at the bottom of the sidebar.

At the bottom of the page, there are links for newrelic.com, Get support, Privacy, Terms, and social media icons for RSS, Twitter, and Facebook. It also includes links for the App Store and Google Play, and a copyright notice: © 2008-15 New Relic, Inc. All rights reserved.

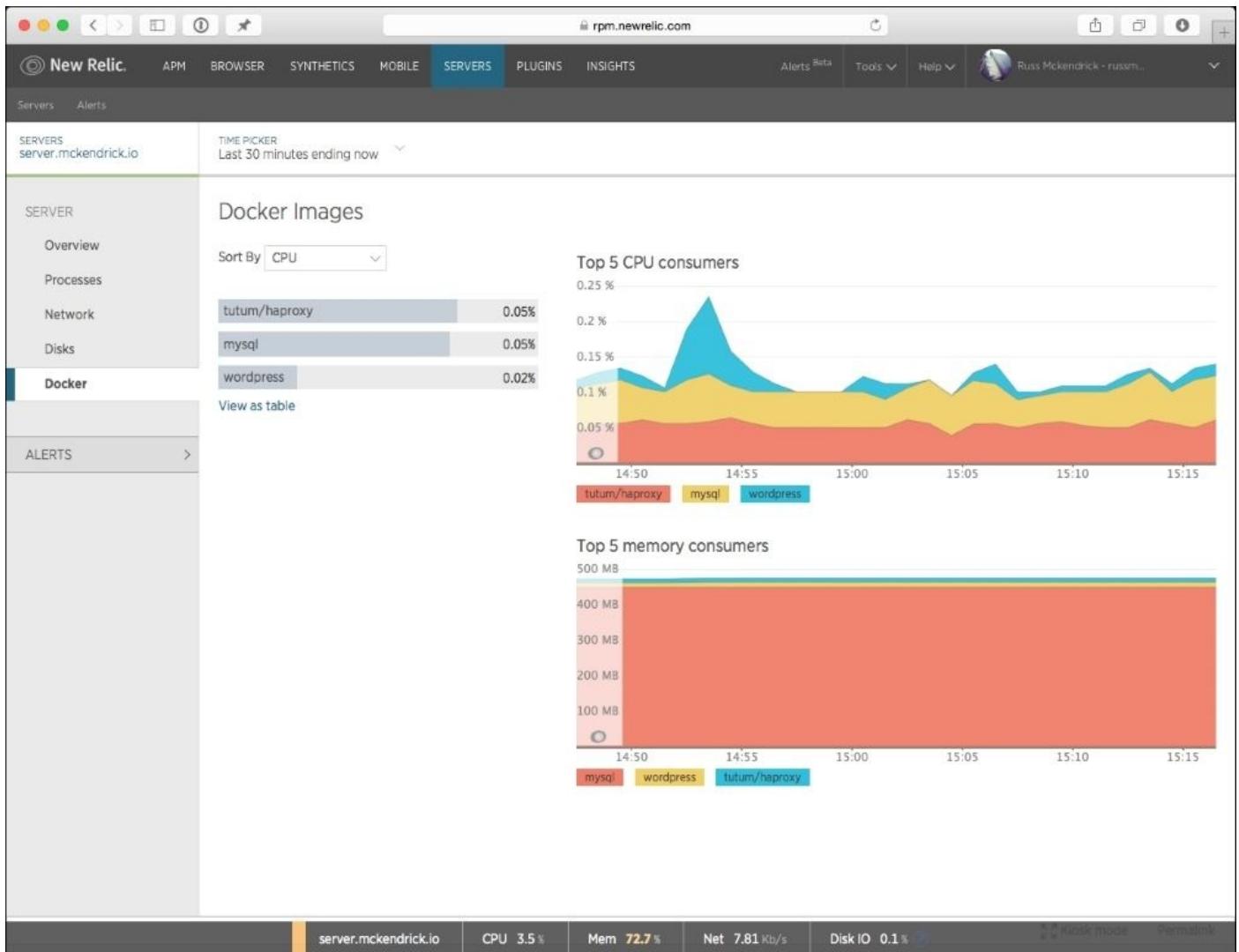
Selecting the server will allow you to start exploring the various metrics that the agent is recording:



From here, you have the option to drill down further:

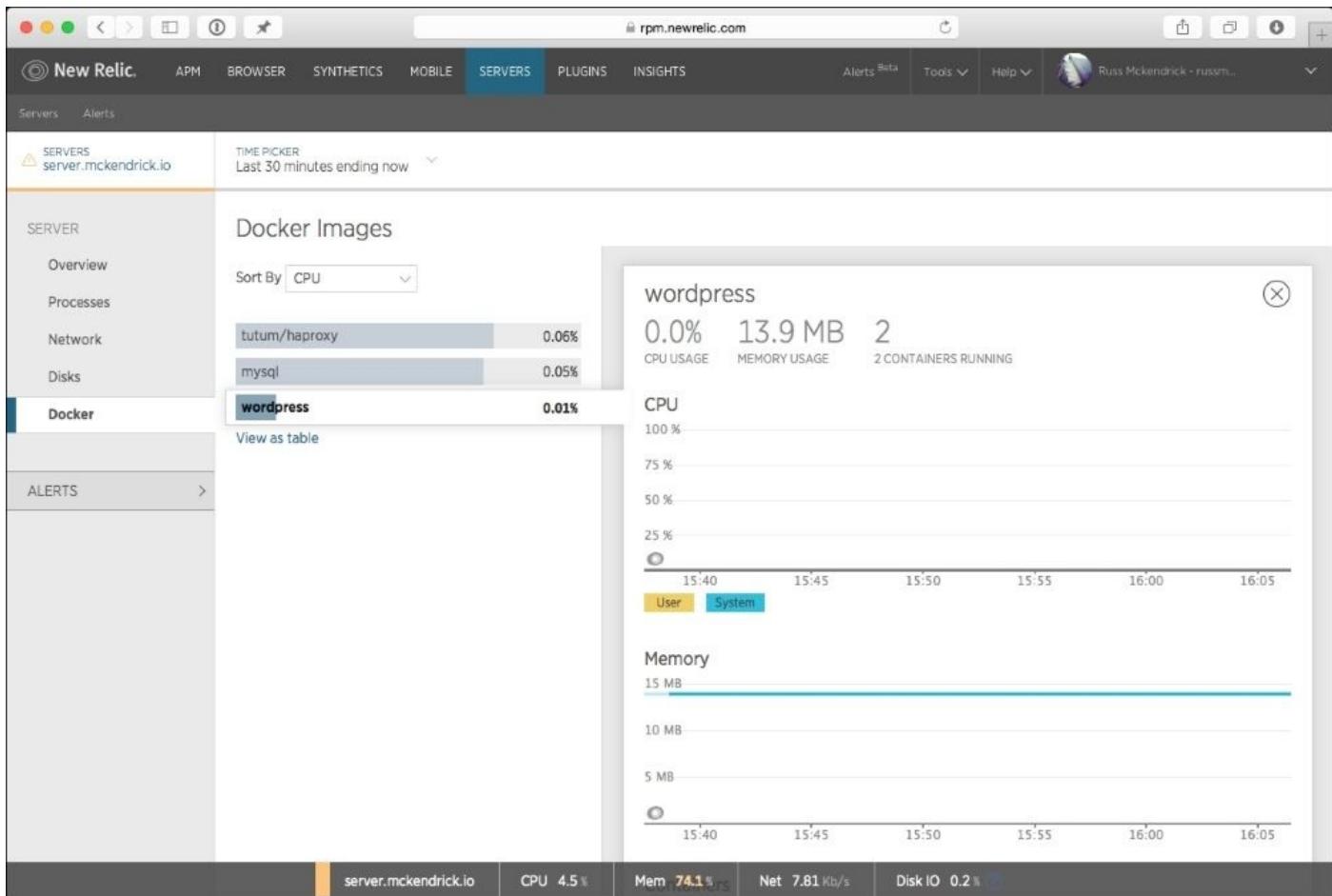
- **Overview:** Gives a quick overview of your host machine
- **Processes:** Lists all of the processes that are running both on the host machine and within your containers
- **Network:** Lets you see the network activity for your host machine
- **Disks:** Gives you details on how much space you are using
- **Docker:** Shows you the CPU and memory utilization for your containers

As you may have guessed, we are going to be looking at the **Docker** item next, click on it and you will see a list of your active images:



You may have noticed a difference between New Relic and the other services, as you can see New Relic does not show you the running containers, instead it shows you the utilization by Docker image.

In the preceding screenshot, I have four containers active and running the WordPress installation we have used elsewhere in the book. If I wanted a breakdown per container, then I would be out of luck, as demonstrated by the following screen:



It's a pretty dull screen, but it gives you an idea about what you will see if you are running multiple containers that have been launched using the same image. So how is this useful? Well, coupled with the other services offered by New Relic, it can give you an indication of what your containers were up to when a problem occurred within your application. If you remember the Pets versus Cattle versus Chickens analogy from [Chapter 1](#), *Introduction to Docker Monitoring*, we don't necessarily care which container did what; we just want to see the impact it had during the issue we are looking into.

Summary and further reading

Due to the amount of products it offers, New Relic can be a little daunting at first, but if you work with a development team that actively uses New Relic within their day-to-day workflow, then having all of the information about your infrastructure alongside this data can be both valuable and necessary, especially during an issue:

- New Relic Server monitoring: <http://newrelic.com/server-monitoring>
- New Relic and Docker: <http://newrelic.com/docker/>
- Twitter: <https://twitter.com/NewRelic>

Tip

If you have launched a cloud instance and are no longer using it then, now is a good time to power the instance down or terminate it altogether, this will ensure you do not get billed for any services you are not using.

Summary

Which SaaS service you choose depends on your circumstances, there are a number of questions you should ask yourself before you start evaluating the SaaS offerings:

- How many containers would you like to monitor?
- How many host machines do you have?
- Is there a non-containerized infrastructure you need to monitor?
- What metrics do you need from the monitoring service?
- How long should the data be retained for?
- Could other departments, such as development and utilize the service?

We covered just three of the available SaaS options in this chapter, there are other options available, such as:

- Ruxit: <https://ruxit.com/docker-monitoring/>
- Scout: https://scoutapp.com/plugin_urls/19761-docker-monitor
- Logentries: <https://logentries.com/insights/server-monitoring/>
- Sematext: <http://sematext.com/spm/integrations/docker-monitoring.html>

Monitoring servers and services are only as good as the metrics you collect, if possible and if your budget allows, you should take full advantage of the services offered by your chosen providers, as more data being recorded by a single provider will only benefit you when it comes to analyzing problems with not only your containerized applications, but also with your infrastructure, code and even your cloud provider.

For example, if you are monitoring your host machine using the same service as you use to monitor your containers, then by using the custom graphing functions, you should be able to create overlay graphs of CPU load spikes of both your host machine and your container. This is a lot more useful than trying to compare two different graphs from different systems side by side.

In the next chapter, we will look at an often-overlooked part of monitoring: shipping your log files away from your containers/hosts to a single location so that they can be monitored and reviewed.

Chapter 7. Collecting Application Logs from within the Container

One of the most overlooked parts of monitoring are log files generated by the application or services such as NGINX, MySQL, Apache, and so on. So far we have looked at various ways of recording the CPU and RAM utilization of the processes within your containers are at a point in time, now its time to do the same for the log files.

If you are running your containers as Cattle or Chickens, then the way you deal with the issues to destroy and relaunch your container either manually or automatically is important. While this should fix the immediate problem, it does not help with tracking down the root cause of the issue and if you don't know that then how can you attempt to resolve it so that it does not reoccur.

In this chapter, we will look at how we can get the content of the log files for the applications running within our containers to the central location so that they are available, even if you have to destroy and replace a container. We are going to cover the following topics in this chapter:

- How to view container logs?
- Deploying an “ELK” stack using a Docker containers stack to ship the logs to
- Reviewing your logs
- What third party options are available?

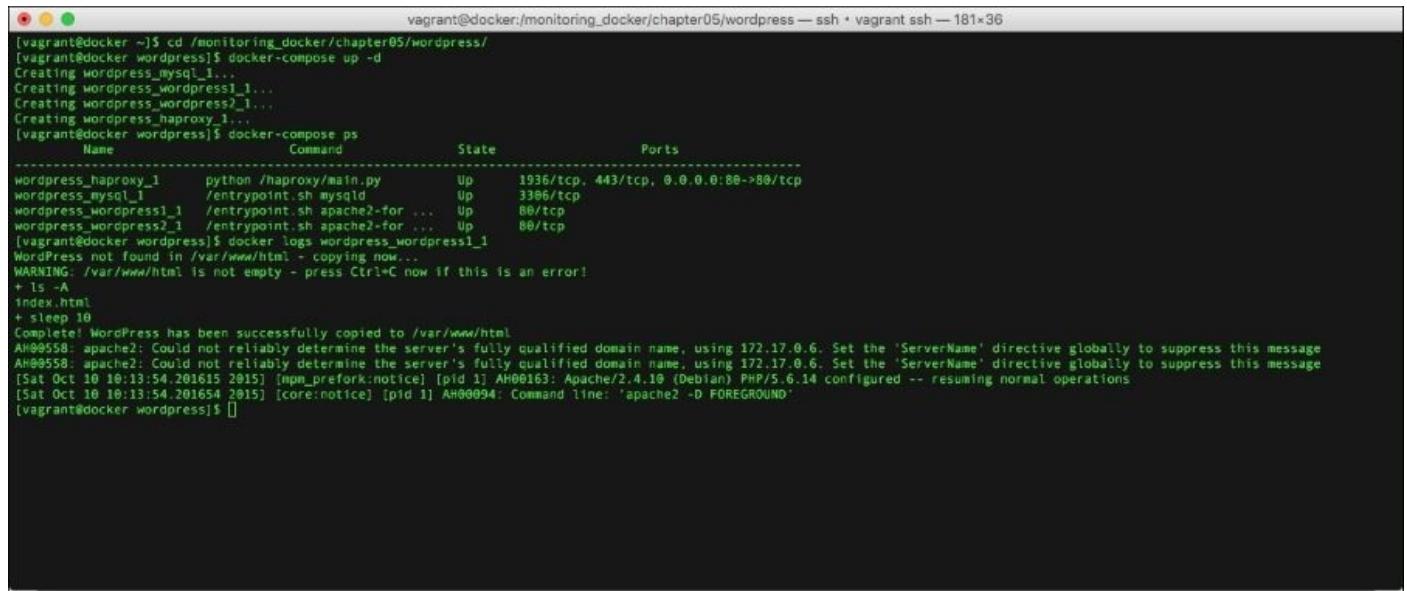
Viewing container logs

Like the docker top command, there is a very basic way of viewing logs. When you use the docker logs command, you are actually viewing the STDOUT and STDERR of the processes that are running within the container.

Note

For more information on Standard Streams, please see https://en.wikipedia.org/wiki/Standard_streams.

As you can see from the following screenshot, the simplest thing you have to do is run docker logs followed by your container name:



The screenshot shows a terminal window with the following content:

```
vagrant@docker:~/monitoring_docker/chapter05/wordpress$ ssh vagrant ssh -t 181x36
[vagrant@docker ~]$ cd /monitoring_docker/chapter05/wordpress/
[vagrant@docker wordpress]$ docker-compose up -d
Creating wordpress_mysql_1...
Creating wordpress_wordpress1_1...
Creating wordpress_wordpress2_1...
Creating wordpress_haproxy_1...
[vagrant@docker wordpress]$ docker-compose ps
      Name          Command       State        Ports
-----+-----+-----+-----+
wordpress_haproxy_1    python /haproxy/main.py     Up      1936/tcp, 443/tcp, 0.0.0.0:80->80/tcp
wordpress_mysql_1      /entrypoint.sh mysqld      Up      3306/tcp
wordpress_wordpress1_1  /entrypoint.sh apache2-for ... Up      80/tcp
wordpress_wordpress2_1  /entrypoint.sh apache2-for ... Up      80/tcp
[vagrant@docker wordpress]$ docker logs wordpress_wordpress1_1
WordPress not found in /var/www/html - copying now...
WARNING: /var/www/html is not empty - press Ctrl+C now if this is an error!
+ ls -A
index.html
+ sleep 10
Complete! WordPress has been successfully copied to /var/www/html
AH00558: apache2: Could not reliably determine the server's fully qualified domain name, using 172.17.0.6. Set the 'ServerName' directive globally to suppress this message
AH00558: apache2: Could not reliably determine the server's fully qualified domain name, using 172.17.0.6. Set the 'ServerName' directive globally to suppress this message
[Sat Oct 10 16:13:54.201654 2015] [mpm_prefork:notice] [pid 1] AH00163: Apache/2.4.10 (Debian) PHP/5.6.14 configured -- resuming normal operations
[Sat Oct 10 16:13:54.201654 2015] [core:notice] [pid 1] AH00094: Command line: 'apache2 -D FOREGROUND'
[vagrant@docker wordpress]$ ]
```

To see this on your own host, let's launch the WordPress installation from chapter05 using the following commands:

```
cd /monitoring_docker/chapter05/wordpress/
docker-compose up -d
docker logs wordpress_wordpress1_1
```

You can extend the dockerlogs command by adding the following flags before your container name:

- -f or --follow will stream the logs in real time
- -t or --timestamps will show a timestamp at the start of each line
- --tail="5" will show the last x number of lines
- --since="5m00s" will show only the entries for the last 5 minutes

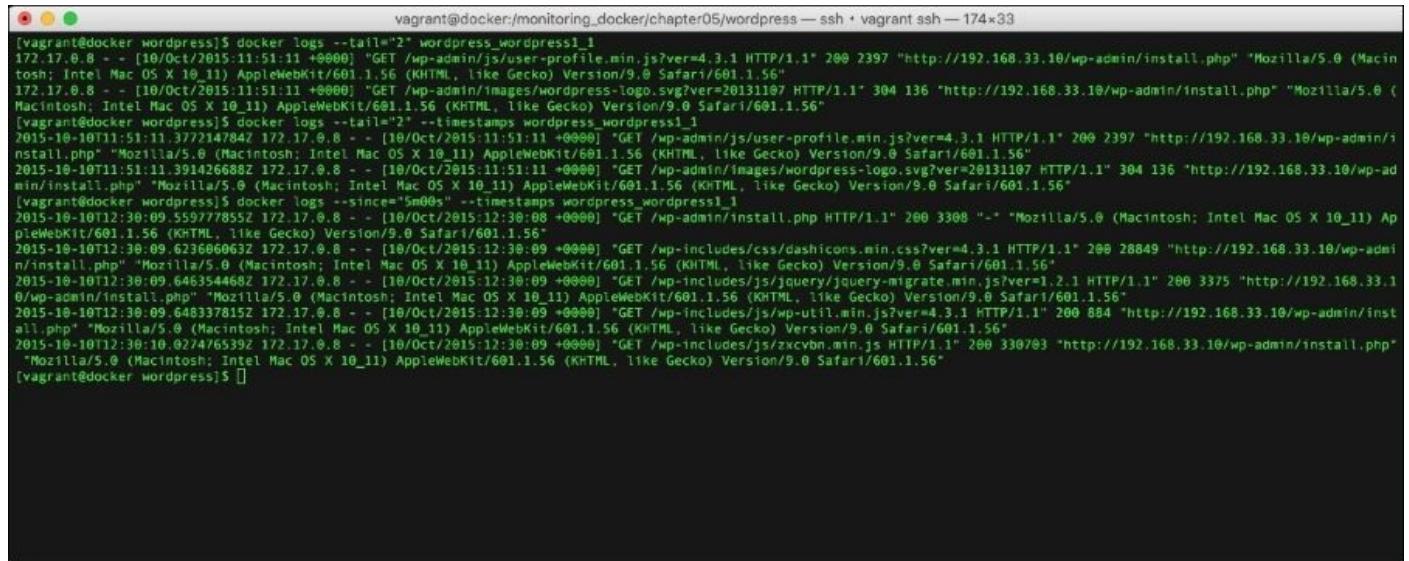
Using the WordPress installation that we have just launched, try running the following commands:

```
docker logs --tail="2" wordpress_wordpress1_1
```

This will show the last two lines of the logs, you can add timestamps using:

```
docker logs --tail="2" -timestamps wordpress_wordpress1_1
```

As you can see in the following terminal output, you can also string commands together to form a very basic query language:



The screenshot shows a terminal window with the following text output:

```
vagrant@docker:/monitoring_docker/chapter05/wordpress — ssh + vagrant ssh — 174x33
[vagrant@docker wordpress]$ docker logs --tail="2" wordpress_wordpress1_1
172.17.0.8 - - [10/Oct/2015:11:51:11 +0000] "GET /wp-admin/js/user-profile.min.js?ver=4.3.1 HTTP/1.1" 200 2397 "http://192.168.33.10/wp-admin/install.php" "Mozilla/5.0 (Macintosh; Intel Mac OS X 10_11) AppleWebKit/601.1.56 (KHTML, like Gecko) Version/9.0 Safari/601.1.56"
172.17.0.8 - - [10/Oct/2015:11:51:11 +0000] "GET /wp-admin/images/wordpress-logo.svg?ver=20131107 HTTP/1.1" 304 136 "http://192.168.33.10/wp-admin/install.php" "Mozilla/5.0 (Macintosh; Intel Mac OS X 10_11) AppleWebKit/601.1.56 (KHTML, like Gecko) Version/9.0 Safari/601.1.56"
[vagrant@docker Wordpress]$ docker logs --tail="2" -timestamps wordpress_wordpress1_1
2015-10-10T11:51:11.377214784Z 172.17.0.8 - - [10/Oct/2015:11:51:11 +0000] "GET /wp-admin/js/user-profile.min.js?ver=4.3.1 HTTP/1.1" 200 2397 "http://192.168.33.10/wp-admin/install.php" "Mozilla/5.0 (Macintosh; Intel Mac OS X 10_11) AppleWebKit/601.1.56 (KHTML, like Gecko) Version/9.0 Safari/601.1.56"
2015-10-10T11:51:11.391426688Z 172.17.0.8 - - [10/Oct/2015:11:51:11 +0000] "GET /wp-admin/images/wordpress-logo.svg?ver=20131107 HTTP/1.1" 304 136 "http://192.168.33.10/wp-admin/install.php" "Mozilla/5.0 (Macintosh; Intel Mac OS X 10_11) AppleWebKit/601.1.56 (KHTML, like Gecko) Version/9.0 Safari/601.1.56"
[vagrant@docker wordpress]$ docker logs --since="5m0s" -timestamps wordpress_wordpress1_1
2015-10-10T12:30:09.559777855Z 172.17.0.8 - - [10/Oct/2015:12:30:08 +0000] "GET /wp-admin/install.php HTTP/1.1" 200 3308 "-" "Mozilla/5.0 (Macintosh; Intel Mac OS X 10_11) AppleWebKit/601.1.56 (KHTML, like Gecko) Version/9.0 Safari/601.1.56"
2015-10-10T12:30:09.623606063Z 172.17.0.8 - - [10/Oct/2015:12:30:09 +0000] "GET /wp-includes/css/dashicons.min.css?ver=4.3.1 HTTP/1.1" 200 28849 "http://192.168.33.10/wp-admin/install.php" "Mozilla/5.0 (Macintosh; Intel Mac OS X 10_11) AppleWebKit/601.1.56 (KHTML, like Gecko) Version/9.0 Safari/601.1.56"
2015-10-10T12:30:09.646354468Z 172.17.0.8 - - [10/Oct/2015:12:30:09 +0000] "GET /wp-includes/js/jquery/jquery-migrate.min.js?ver=1.2.1 HTTP/1.1" 200 3375 "http://192.168.33.10/wp-admin/install.php" "Mozilla/5.0 (Macintosh; Intel Mac OS X 10_11) AppleWebKit/601.1.56 (KHTML, like Gecko) Version/9.0 Safari/601.1.56"
2015-10-10T12:30:09.648337815Z 172.17.0.8 - - [10/Oct/2015:12:30:09 +0000] "GET /wp-includes/js/wp-util.min.js?ver=4.3.1 HTTP/1.1" 200 884 "http://192.168.33.10/wp-admin/install.php" "Mozilla/5.0 (Macintosh; Intel Mac OS X 10_11) AppleWebKit/601.1.56 (KHTML, like Gecko) Version/9.0 Safari/601.1.56"
2015-10-10T12:30:10.027476539Z 172.17.0.8 - - [10/Oct/2015:12:30:09 +0000] "GET /wp-includes/js/zxcvbn.min.js HTTP/1.1" 200 330703 "http://192.168.33.10/wp-admin/install.php" "Mozilla/5.0 (Macintosh; Intel Mac OS X 10_11) AppleWebKit/601.1.56 (KHTML, like Gecko) Version/9.0 Safari/601.1.56"
[vagrant@docker wordpress]$
```

The downside of using `docker logs` is exactly the same as using `docker top`, in that it is only available locally and the logs are only present for the time the container is around, you can view the logs of a stopped container, but once the container is removed, so are the logs.

ELK Stack

Similar to some of the technologies that we have covered in this book, an ELK stack really deserves a book by itself; in fact, there are books for each of the elements that make an ELK stack, these elements are:

- Elasticsearch is a powerful search server, which has been developed with modern workloads in mind
- Logstash sits between your data source and Elasticsearch services; it transforms your data in real time to a format, which Elasticsearch can understand.
- Kibana is in front of your Elasticsearch services and allows you to query your data in a feature-rich web-based dashboard.

There are a lot of moving parts with an ELK stack, so to simplify things, we will use a prebuilt stack for the purpose of testing; however, you probably don't want to use this stack in production.

Starting the stack

Let's launch a fresh vagrant host on which to run the ELK stack:

```
[russ@mac ~]$ cd ~/Documents/Projects/monitoring-docker/vagrant-centos/  
[russ@mac ~]$ vagrant up  
Bringing machine 'default' up with 'virtualbox' provider...  
==> default: Importing base box 'russmckendrick/centos71'...  
==> default: Matching MAC address for NAT networking...  
==> default: Checking if box 'russmckendrick/centos71' is up to date...  
.....  
==> default: => Installing docker-engine...  
==> default: => Configuring vagrant user...  
==> default: => Starting docker-engine...  
==> default: => Installing docker-compose...  
==> default: => Finished installation of Docker  
[russ@mac ~]$ vagrant ssh
```

Now, we have a clean host that is up and running, we can start the stack by running the following commands:

```
[vagrant@docker ~]$ cd /monitoring_docker/chapter07/elk/  
[vagrant@docker elk]$ docker-compose up -d
```

As you may have noticed, it did more than just pull down some images; what happened was:

- An Elasticsearch container was launched using the official image from https://hub.docker.com/_/elasticsearch/.
- A Logstash container was launched using the official image from https://hub.docker.com/_/logstash/, it was also launched with our own configuration, which means that our installation listens for logs sent from Logspout (more about that in a minute).
- A custom Kibana image was built using the official image from https://hub.docker.com/_/kibana/. All it did was add a small script to ensure that Kibana doesn't start until our Elasticsearch container is fully up and running. It was then launched with a custom configuration file.
- A custom Logspout container was built using the official image from <https://hub.docker.com/r/gliderlabs/logspout/> and then we added a custom module so that Logspout could talk to Logstash.

Once docker-compose has finished building and launching the stack you should be able to see the following when running docker-compose ps:

```
vagrant@docker:~/monitoring_docker/chapter07/elk — ssh ✘ vagrant ssh — 122x24
[vagrant@docker elk]$ docker-compose ps
      Name           Command     State            Ports
-----  
elk_elasticsearch_1   /docker-entrypoint.sh elas ...   Up    0.0.0.0:9200->9200/tcp, 9300/tcp
elk_kibana_1          /docker-entrypoint.sh /tmp ...   Up    0.0.0.0:8080->5601/tcp
elk_logspout_1        /bin/logspout           Up    8000/tcp
elk_logstash_1        /docker-entrypoint.sh logs ...   Up    0.0.0.0:5000->5000/tcp
[vagrant@docker elk]$
```

We now have our ELK stack up and running, as you may have noticed, there is an additional container running and giving us an ELK-L stack, so what is Logspout?

Logspout

If we were to launch Elasticsearch, Logstash, and Kibana containers, we should have a functioning ELK stack but we will have a lot of configuration to do to get our container logs into Elasticsearch.

Since Docker 1.6, you have been able to configure logging drivers, this meant that it is possible to launch a container and have it send its `STDOUT` and `STDERR` to a Syslog Server, which will be Logstash in our case; however, this means that you will have to add something similar to the following options each time we launch a container:

```
--log-driver=syslog --log-opt syslog-address=tcp://elk_logstash_1:5000
```

This is where Logspout comes in, it has been designed to collect all of the `STDOUT` and `STDERR` messages on a host machine by intercepting the messages that are being collected by the Docker process and then it routes them to our Logstash instance in a format that is understood by Elasticsearch.

Just as the log-driver, it supports Syslog out of the box; however, there is a third party module that transforms the output to JSON, which Logstash understands. As a part of our build we downloaded, compiled and configured the module.

You can find out more about Logspout and logging drivers at the following:

- Official Logspout image: <https://hub.docker.com/r/gliderlabs/logspout/>
- Logspout Project page: <https://github.com/gliderlabs/logspout>
- Logspout Logstash module: <https://github.com/looplabs/logspout-logstash>
- Docker 1.6 release notes: <https://blog.docker.com/2015/04/docker-release-1-6/>
- Docker Logging Drivers: <https://docs.docker.com/reference/logging/overview/>

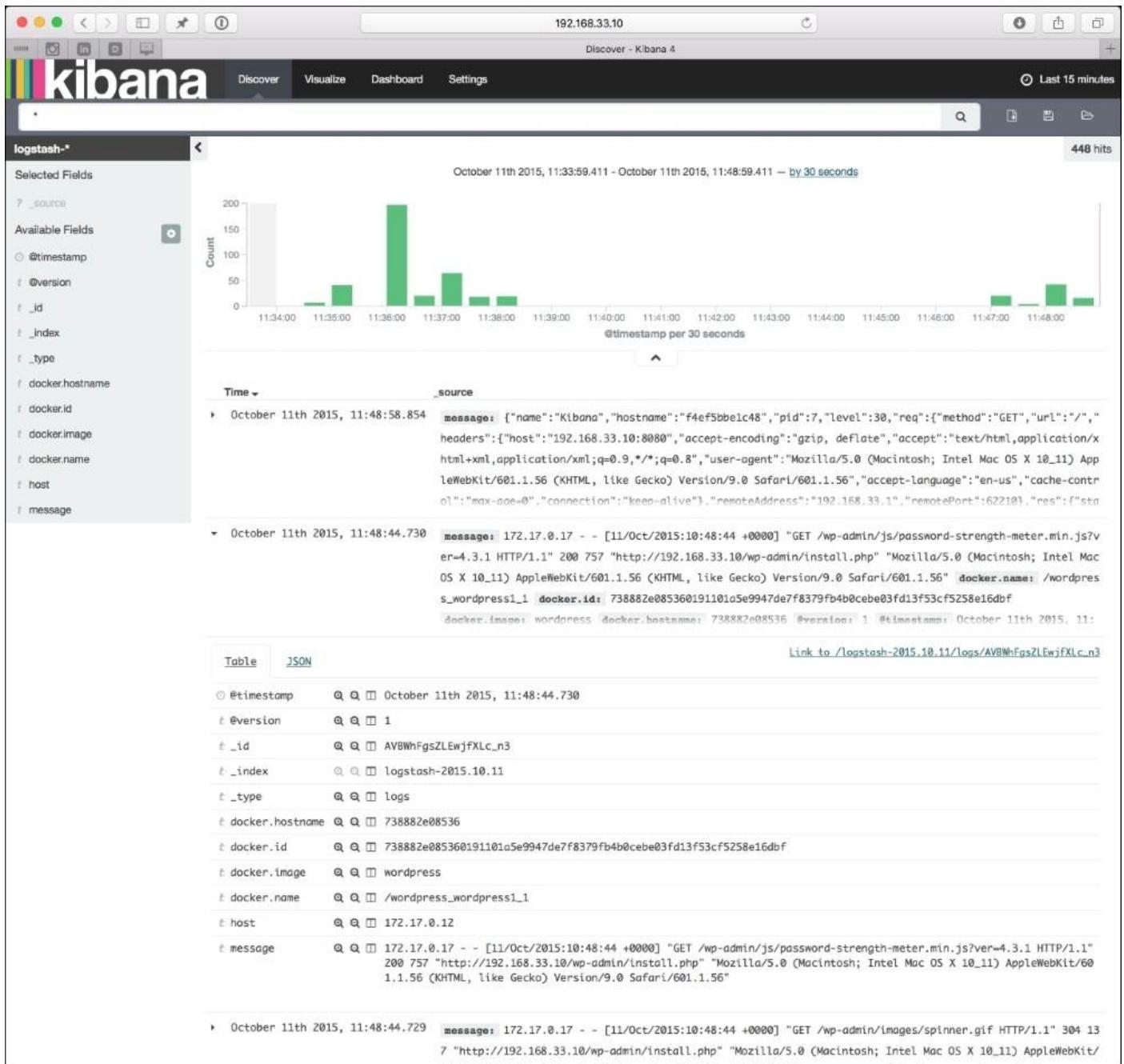
Reviewing the logs

So now, we have our ELK running and a mechanism in place to stream all of the `STDOUT` and `STDERR` messages generated by our containers into Logstash, which in turn routes the data into Elasticsearch. Now its time to view the logs in Kibana. To access Kibana go to `http://192.168.33.10:8080/` in your browser; when you access the page, you will be asked to **Configure an index pattern**, the default index pattern will be fine for our needs so just click the **Create** button.

Once you do, you will see a list of the index patterns, these are taken directly from the Logspout output, and you should notice the following items in the index:

- `docker.name`: The name of container
- `docker.id`: The full container ID
- `docker.image`: The name of the image used to launch the image

From here, if you were to click on **Discover** in the top menu you would see something similar to the following page:



In the screenshot, you will see that I have recently launched the WordPress stack and we have been using it throughout the book, using the following commands:

```
[vagrant@docker elk]$ cd /monitoring_docker/chapter05/wordpress/  
[vagrant@docker wordpress]$ docker-compose up -d
```

To give you an idea of what is being logged, here is the raw JSON taken from Elasticsearch for running the WordPress installation script:

```
{  
  "_index": "logstash-2015.10.11",  
  "_type": "logs",  
  "_id": "AVBW8ewRnBVdqUV1XV0j",  
  "_score": null,  
  "_source": {  
    "message": "172.17.0.11 - - [11/Oct/2015:12:48:26 +0000] \"POST /wp-
```

```
admin/install.php?step=1 HTTP/1.1\" 200 2472 \"http://192.168.33.10/wp-
admin/install.php\" \"Mozilla/5.0 (Macintosh; Intel Mac OS X 10_11)
AppleWebKit/601.1.56 (KHTML, like Gecko) Version/9.0 Safari/601.1.56\",
  "docker.name": "/wordpress_wordpress1_1",
  "docker.id":
"0ba42876867f738b9da0b9e3adbb1f0f8044b7385ce9b3a8a3b9ec60d9f5436c",
  "docker.image": "wordpress",
  "docker.hostname": "0ba42876867f",
  "@version": "1",
  "@timestamp": "2015-10-11T12:48:26.641Z",
  "host": "172.17.0.4"
},
"fields": {
  "@timestamp": [
    1444567706641
  ]
},
"sort": [
  1444567706641
]
}
```

From here, you can start to use the free text search box and build up some quite complex queries to drill down into your container's STDOUT and STDERR logs.

What about production?

As mentioned at the top of this section, you probably don't want to run your production ELK stack using the docker-compose file, which accompanies this chapter. First of all, you will want your Elasticsearch data to be stored on a persistent volume and you more than likely want your Logstash service to be highly available.

There are numerous guides on how to configure a highly available ELK stack, as well as, the hosted services from Elastic, which is the creator of Elasticsearch, and also Amazon Web Services, which offers an Elasticsearch service:

- ELK tutorial: <https://www.youtube.com/watch?v=ge8uHdmtb1M>
- Found from Elastic: <https://www.elastic.co/found>
- Amazon Elasticsearch Service: <https://aws.amazon.com/elasticsearch-service/>

Looking at third party options

There are a few options when it comes to hosting central logging for your containers external to your own server instances. Some of these are:

- Log Entries: <https://logentries.com/>
- Loggly: <https://www.loggly.com/>

Both of these services offer a free tier. Log Entries also offers a “Logentries DockerFree” account that you can find out more about at <https://logentries.com/docker/>

Note

As recommended in the *Exploring Third Party Options* chapter, it is best to use a cloud service when evaluating third party services. The remainder of this chapter assumes that you are running a cloud host.

Let's look at configuring the Log Entries on an external server, first of all you need to have signed up for an account at <https://logentries.com/>. Once you have signed up, you should be taken to a page in which your logs will eventually be displayed.

To start, click on the **Add new log** button in the top-right corner of the page and then click the Docker logo in the **Platforms** section.

You have to name your set of logs in the **Select set** section, so give a name to your log set. You now have the choice of building your own container locally using the Docker file from <https://github.com/logentries/docker-logentries>:

```
git clone https://github.com/logentries/docker-logentries.git
cd docker-logentries
docker build -t docker-logentries .
```

After running the preceding command, you will get the following output:

```
[root@server ~]# git clone https://github.com/logentries/docker-logentries.git
Cloning into 'docker-logentries'...
remote: Counting objects: 182, done.
remote: Total 182 (delta 0), reused 0 (delta 0), pack-reused 182
Receiving objects: 100% (182/182), 219.53 KiB | 381.00 KiB/s, done.
Resolving deltas: 100% (105/105), done.
[root@server ~]# cd docker-logentries
[root@server docker-logentries]# docker build -t docker-logentries .
Sending build context to Docker daemon 498.2 kB
Step 0 : FROM node:0.12-onbuild
0.12-onbuild: Pulling from library/node
843e2bded498: Pull complete
8c9@cfb0175: Pull complete
8b49fe88b40b: Pull complete
20b34874d568: Extracting [=====] 36.21 MB/42.34 MB
16b189cc8ce6: Download complete
09b553853302: Download complete
7ad4d0983ded: Download complete
bf213c115713: Download complete
037e12c3f1a9: Download complete
a4045afffe4a: Download complete
e1f8775d8328: Download complete
c0176947c2d: Download complete
454a566508e9: Download complete
9455a1b0478d: Download complete
97872b5ea4b9: Download complete
3f@b01a1a88e: Download complete
[]
```

Before you start your container, you will need to generate an access token for your log set by clicking on **Generate Log Token**. Once you have this, you can launch your locally built containers using the following command (replace the token with the one you have just generated):

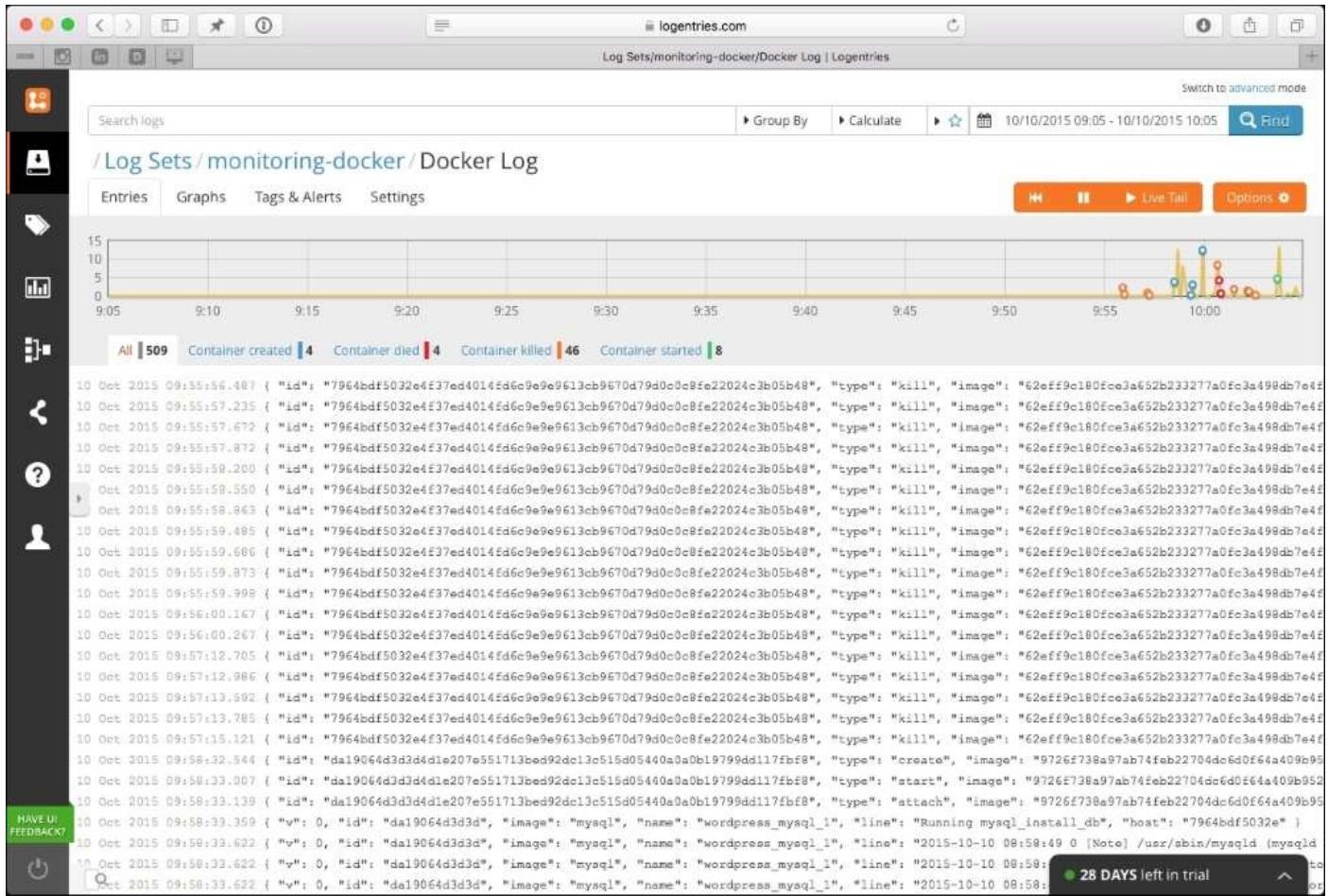
```
docker run -d -v /var/run/docker.sock:/var/run/docker.sock docker-logentries -t wn5AYlh-jRhgn3shc-jW14y3y0-T09WsF7d -j
```

You can download the image straight from the Docker hub by running:

```
docker run -d -v /var/run/docker.sock:/var/run/docker.sock docker-logentries/docker-logentries -t wn5AYlh-jRhgn3shc-jW14y3y0-T09WsF7d -j
```

It's worth pointing out that the automatically generated instructions given by Log Entries launches the container in the foreground, rather than detaching from the container once it has been launched like the preceding instructions.

Once you have the docker-logentries container up and running, you should start to see logs from your container streamed in real-time to your dashboard:



From here, you will be able to query your logs, create dashboards, and create alerts depending on the account option you go for.

Summary

In this chapter, we have covered how to query the `STDOUT` and `STDERR` output from your containers using the tool built into Docker, how to ship the messages to an external source, our ELK stack, and how to store the messages even after the container has been terminated. Finally, we have looked at a few of the third-party services who offer services to which you can stream your logs.

So why go to all of this effort? Monitoring isn't just about keeping and querying CPU, RAM, HDD, and Network utilization metrics; there is no point in knowing if there was a CPU spike an hour ago if you don't have access to the log files to see if any errors were being generated at that time.

The services we have covered in this chapter offer the quickest and most efficient insights into what can quickly become a complex dataset.

In the next chapter, we will look at all of the services and concepts we have covered in the book and apply them to some real world scenarios.

Chapter 8. What Are the Next Steps?

In this final chapter, we will look at the next steps you can take to monitor your containers, by talking about the benefits of adding alerts to your monitoring. Also, we will cover some different scenarios and also which type of monitoring is appropriate for each of them:

- Common problems (performance, availability, and so on) and which type of monitoring is best for your situation.
- What are the benefits of alerting on the metrics you are collecting and what are the options?

Some scenarios

To look at which type of monitoring you might want to implement for your container-based applications, we should work through a few different example configurations that your container-based applications could be deploying into. First, let's remind ourselves about Pets, Cattle, Chickens, and Snowflakes.

Pets, Cattle, Chickens, and Snowflakes

Back in the [Chapter 1, Introduction to Docker Monitoring](#), we spoke about Pets, Cattle, Chickens, and Snowflakes; in that chapter, we described what each term meant when it was applied to modern cloud deployments. Here, we will go into a little more detail about how the terms can be applied to your containers.

Pets

For your containers to be considered a Pet, you will be more than likely to be running either a single or a small number of fixed containers on a designated host.

Each one of these containers could be considered a single point of failure; if any one of them goes down, it will more than likely result in errors for your application. Worst still, if the host machine goes down for any reason, your entire application will be offline.

This is a typical deployment method for most of our first steps with Docker, and in no way should it be considered bad, frowned upon, or not recommended; as long as you are aware of the limitations, you will be fine.

This pattern can also be used to describe most development environments, as you are constantly reviewing its health and tuning as needed.

You will more than likely be hosting the machine on your local computer or on a hosting service such as DigitalOcean (<https://www.digitalocean.com/>).

Cattle

For the bulk of production or business critical deployments, you should aim to launch your containers in a configuration that allows them to automatically recover themselves after a failure, or, when more capacity is needed, additional containers are launched and then terminated when the scaling event is over.

You will more than likely be using a public cloud-based service as follows:

- Amazon EC2 Container Service: <https://aws.amazon.com/ecs/>
- Google Container Engine: <https://cloud.google.com/container-engine/>
- Joyent Triton: <https://www.joyent.com/blog/understanding-triton-containers/>

Alternatively, you will be hosting on your own servers using a Docker-friendly and cluster-aware operating system as follows:

- CoreOS: <https://coreos.com/>
- RancherOS: <http://rancher.com/rancher-os/>

You won't care so much as to where a container is launched within your cluster of hosts, as long as you can route traffic to it. To add more capacity to the cluster, you will be bringing up additional hosts when needed and removing them from the cluster when not needed in order to save on costs.

Chickens

It's more than likely you will be using containers to launch, process data, and then terminate. This can happen anytime from once a day to several times a minute. You will be using a distributed scheduler as follows:

- Kubernetes by Google: <http://kubernetes.io/>
- Apache Mesos: <http://mesos.apache.org/>

Because of this, you will have a large number of containers launching and terminating within your cluster; you definitely won't care about where a container is launched or even how traffic is routed to it, as long as your data is processed correctly and passed back to your application.

Like the cluster described in the *Cattle* section's description, hosts will be added and removed automatically, probably in response to scheduled peaks such as end of month reporting or seasonal sales and so on.

Snowflakes

I hope one of the things you took away from the first chapter is that if you have any servers or services that you consider being Snowflakes, then you should do something to retire them as soon as possible.

Luckily, due to the way the containerizing of your applications works, you should never be able to create a snowflake using Docker, as your containerized environment should always be reproducible, either because you have the Docker file (everyone makes backups right?) or you have a working copy of the container image because you have exported the container as a whole using the built-in tools.

Note

Sometimes it may not be possible to create a container using a Docker file. Instead, you can backup or migrate your containers by using the export command. For more information on exporting your containers, see the following URL:

<https://docs.docker.com/reference/commandline/export/>

If you find yourself in this position, let me be the first to congratulate you on mitigating a future disaster by promoting your Snowflake into a Pet or even Cattle ahead of any problems.

Tip

Still running a Snowflake?

If you find yourself still running a Snowflake server or service, I cannot stress enough that you look at documenting, migrating, or updating the Snowflake as soon as possible. There is no point in monitoring a service that may be impossible for you to recover. Remember that there are containers for old technologies, such as PHP4, if you really need to run them.

Scenario one

You are running a personal WordPress website using the official containers from the Docker Hub; the containers have been launched using a Docker Compose file like the one we have used several times throughout this book.

You have the Docker Compose file stored in a GitHub repository and you can take snapshots of the host machine as a backup. As it's your own blog, you are fine running it on a single cloud-based host.

A suitable monitoring will be as follows:

- Docker stats
- Docker top
- Docker logs
- cAdvisor
- Sysdig

As you are running a single host machine that you are treating as a backup, there is no real need for you to ship your log files to a central location as odds are your host machines; like the containers, its hosting will be online for months or possibly even years.

It is unlikely that you will need to dig too deeply into your containers' historical performance stats, as most of the tuning and troubleshooting will be done in real time as problems occur.

With the monitoring tools suggested, you will be able to get a good insight into what is happening within your containers in real time, and to get more than enough information on processes that are consuming too much RAM and CPU, along with any error messages from within the containers.

You may want to enable a service such as Pingdom (<https://www.pingdom.com/>) or Uptime Robot (<http://uptimerobot.com/>). These services poll your website every few minutes to ensure that the URL you configure them to, check whether its loading within a certain time or at all. If they detect any slowdown or failures with the page loading, they can be configured to send an initial alert to notify you that there is a potential issue, such as both the services mentioned have a free tier.

Scenario two

You are running a custom e-commerce application that needs to be highly available and also scale during your peak times. You are using a public cloud service and the toolset that comes with it to launch containers and route traffic to them.

A suitable monitoring will be as follows:

- cAdvisor + Prometheus
- Zabbix
- Sysdig Cloud
- New Relic Server Monitoring
- Datadog
- ELK + Logspout
- Log Entries
- Loggly

With this scenario, there is a business need to not only be notified about container and host failures, but also to hold your monitoring data and logs away from your host servers so that you can properly review historical information. You may also need to keep logs for PCI compliance or internal auditing for a fixed period of time.

Depending on your budget, you can achieve this by hosting your own monitoring (Zabbix and Prometheus) and central logging (ELK) stacks somewhere within your infrastructure.

You can also choose to run a few different third-party tools such as combining tools that monitor performance, for example, Sysdig Cloud or Datadog, with a central logging service, such as Log Entries or Loggly.

If appropriate, you can also run a combination of self-hosted and third-party tools.

While the self-hosted option may appear to be the most budget-friendly option, there are some considerations to take into account, as follows:

- Your monitoring needs to be hosted away from your application. There is no point in having your monitoring installed on the same host as your application; what will alert you if the host fails?
- Your monitoring needs to be highly available; do you have the infrastructure to do this? If your application needs to be highly available, then so does your monitoring.
- You need to have enough capacity. Do you have the capacity to be able to store log files and metrics going back a month, 6 months, or a year?

If you are going to have to invest in any of the preceding options, then it will be worth weighing up the costs of investing in both the infrastructure and the management of your own monitoring solution against using a third-party that will offer the preceding options as a service.

If you are using a container-only operating system such as CoreOS or RancherOS, then you will need to choose a service whose agent or collector can be executed from within a container, as you will not be able to install the agent binaries directly on the OS.

You will also need to ensure that your host machine is configured to start the agents/collectors on boot. This will ensure that as soon as the host machine joins a cluster (which is typically when containers will start to popup on the host), it is already sending metrics to your chosen monitoring services.

Scenario three

Your application launches a container each time your API is called from your frontend application; the container takes the user input from a database, processes it, and then passes the results back to your front end application. Once the data has been successfully processed, the container is terminated. You are using a distributed scheduling system to launch the containers.

A suitable monitoring will be as follows:

- Zabbix
- Sysdig Cloud
- Datadog
- ELK + Logspout
- Log Entries
- Loggly

In this scenario, you more than likely do not want to monitor things such as CPU and RAM utilization. These containers after all should only be around for a few minutes, and also your scheduler will launch the container on the host machine where there is enough capacity for the task to execute.

Instead, you will probably want to keep a record to verify that the container launched and terminated as expected. You will also want to make sure that you log the STDOUT and STDERR from the container while it is active, as once the container has been terminated, it will be impossible for you to get these messages back.

With the tools listed in the preceding points, you should be able to build some quite useful queries to get a detailed insight into how your short run processes are performing.

For example, you will be able to get the average lifetime of a container, as you know the time the container was launched and when it was terminated; knowing this will then allow you to set a trigger to alert you if any containers are around for any longer than you would expect them to be.

A little more about alerting

A lot of the tools we have looked at in this book offer at least some sort of basic alerting functionality; the million-dollar question is should you enable it?

A lot of this is dependent on the type of application you are running and how the containers have been deployed. As we have already mentioned a few times in this chapter, you should never really have a Snowflake container; this leaves us with Pets, Cattle, and Chickens.

Chickens

As already discussed in the previous section, you probably don't need to worry about getting alerts for RAM, CPU, and hard drive performance on a cluster that is configured to run Chickens.

Your containers should not be up long enough to experience any real problems; however, should there be any unexpected spikes, your scheduler will probably have enough intelligence to distribute your containers to hosts that have the most available resources at that time.

You will need to know if any of your containers have been running longer than you expect them to be up; for example, a process in a container that normally takes no more than 60 seconds is still running after 5 minutes.

This not only means that there is a potential problem, it also means that you find yourself running hosts that only contain stale containers.

Cattle and Pets

When it comes to setting up alerts on Cattle or Pets, you have a few options.

You will more than likely want to receive alerts based on CPU and RAM utilization for both the host machine and the containers, as this could indicate a potential problem that could cause slow down within the application and also loss of business.

As mentioned previously, you will probably also want to be alerted if your application starts to serve the content that is unexpected. For example, a host and a container will quite happily sit there serving an application error.

You can use a service such as Pingdom, Zabbix, or New Relic to load a page and check for the content in the footer; if this content is missing, then an alert can be sent.

Depending on how fluid your infrastructure is, in a Cattle configuration, you will probably want to be alerted when containers spin up and down, as this will indicate periods of high traffic/transactions.

Sending alerts

Sending alerts differs for each tool, for example, an alert could be as simple as sending an email to inform you that there is an issue to the sounding of an audible alert in a **Network Operations Center (NOC)** when the CPU load of a container goes above five, or the load on the host goes above 10.

For those of you who require an on-call team to be alerted, most of the software we have covered has some level of integration alert aggregation services such as PagerDuty (<https://www.pagerduty.com>).

These aggregation services either intercept your alert emails or allow services to make API calls to them. When triggered, they can be configured to place phone calls, send SMS messages, and even escalate to secondary on-call technician if an alert has not been flagged down within a definable time.

I can't think of any cases where you shouldn't look at enabling alerting, after all, it's always best to know about anything that could effect your application before your end users do.

How much alerting you enable is really down to what you are using your containers for; however, I would recommend that you review all your alerts regularly and also actively tune your configuration.

The last thing you want is a configuration that produces too many false positives or one that is too twitchy, as you do not want the team who receives your alerts to become desensitized to the alerts that you are generating.

For example, if a critical CPU alert is triggered every 30 minutes because of a scheduled job, then you will probably need to review the sensitivity of the alert, otherwise it is easy for the engineer to simply dismiss a critical alert without thinking about it, as "this alert comes every half an hour and will be ok in a few minutes", when your entire application could be unresponsive.

Keeping up

While Docker has been built on top of well-established technologies such as **Linux Containers (LXC)**, these have traditionally been difficult to configure and manage, especially for non-system administrators.

Docker removes almost all the barriers to entry, allowing everyone with a small amount of command-line experience to launch and manage their own container-based applications.

This has forced a lot of the supporting tools to also lower their barrier to entry. Software that once required careful planning to deploy, such as some of the monitoring tools we covered in this book, can now be deployed and configured in minutes rather than hours.

Docker is also a very fast-moving technology; while it has been considered production-ready for a while, new features are being added and existing features are improved with regular updates.

So far, in 2015, there have been 11 releases of Docker Engine; of these, only six have been minor updates that fix bugs, and the rest have all been major updates. Details of each release can be found in the project's Changelog, which can be found at <https://github.com/docker/docker/blob/master/CHANGELOG.md>.

Because of the pace of development of Docker, it is important that you also update any monitoring tools you deploy. This is not only to keep up with new features, but also to ensure that you don't lose any functionality due to changes in the way in which Docker works.

This attitude of updating monitoring clients/tools can be a bit of a change for some administrators who maybe in the past would have configured a monitoring agent on a server and then not thought about it again.

Summary

As discussed in this chapter, Docker is a fast moving technology. While this book has been in production, there have been three major versions released from 1.7 to 1.9; with each release Docker has become more stable and more powerful.

In this chapter, we have looked at different ways to implement the technologies that have been discussed in the previous chapters of this book. By now, you should have an idea of which approach is appropriate to monitor your containers and host machines, for both your application and for the way the application has been deployed using Docker.

No matter which approach you chose to take, it is important that you stay up-to-date with Docker's development and also the new monitoring technologies as they emerge, the following links are good starting points to keep yourself informed:

- Docker Engineering Blog: <http://blog.docker.com/category/engineering/>
- Docker on Twitter: <https://twitter.com/docker>
- Docker on Reddit: <https://www.reddit.com/r/docker>
- Docker on Stack Overflow: <http://stackoverflow.com/questions/tagged/docker>

One of the reasons why the Docker project has been embraced by developers, system administrators and even enterprise companies is because it is able to move at a quick pace, while adding more features and very impressively maintaining its ease of use and flexibility.

Over the next 12 months, the technology is set to be even more widespread; the importance of ensuring that you are capturing useful performance metrics and logs from your containers will become more critical and I hope that this book has helped you start your journey into monitoring Docker.

Index

A

- alerts
 - enabling / [A little more about alerting](#)
 - setting up, on Chickens / [Chickens](#)
 - setting up, on Cattle / [Cattle and Pets](#)
 - setting up, on Pets / [Cattle and Pets](#)
 - sending / [Sending alerts](#)
- Amazon EC2 Container Service
 - URL / [Cattle](#)
- Amazon Web Services
 - URL / [A word about externally hosted services](#)
- ApacheBench
 - URL / [Running Docker stats](#)
- Apache Mesos
 - URL / [Chickens](#)
- Atomic
 - URL / [Why use a SaaS service?](#)

B

- backslash
 - using / [Running cAdvisor using a container](#)

C

- cAdvisor
 - about / [What is cAdvisor?](#)
 - executing, container used / [Running cAdvisor using a container](#)
 - compiling, from source / [Compiling cAdvisor from source](#)
 - reference link / [Alternatives?](#)
- Cattle
 - about / [Cattle](#)
 - containers, deploying onto / [Cattle](#)
 - alerts, setting up / [Cattle and Pets](#)
- Changelog, Docker
 - URL / [Keeping up](#)
- Chickens
 - about / [Chickens](#)
 - containers, deploying onto / [Chickens](#)
 - alerts, setting up / [Chickens](#)
- cloud
 - Docker, deploying in / [Deploying Docker in the cloud](#)
- Cloud Computing
 - reference link / [Chickens](#)
- Cloudscaling
 - reference link / [Pets, Cattle, Chickens, and Snowflakes](#)
- container
 - used, for executing cAdvisor / [Running cAdvisor using a container](#)
- Container Down
 - about / [Triggers](#)
- container logs
 - viewing / [Viewing container logs](#)
- containers
 - resource utilization, tracking / [What just happened?](#)
 - comparing, to host machine / [Compare containers to your host machine](#)
 - deploying, onto Pets / [Pets](#)
 - deploying, onto Cattle / [Cattle](#)
 - deploying, onto Chickens / [Chickens](#)
 - deploying, onto Snowflakes / [Snowflakes](#)
- containers, monitoring
 - scenarios / [Scenario one](#), [Scenario two](#), [Scenario three](#)
- container stats
 - viewing / [Viewing container stats](#)
 - subcontainers / [Subcontainers](#)
 - driver status / [Driver status](#)
 - images / [Images](#)
- CoreOS

- URL / [Why use a SaaS service?](#), [Cattle](#)
- Csysdig
 - about / [Using Csysdig](#)
 - using / [Using Csysdig](#)
- custom graphs
 - creating / [Create custom graphs](#)
 - reference link / [Create custom graphs](#)

D

- Dashboard
 - launching / [Dashboard](#)
- Datadog
 - URL / [Why use a SaaS service?](#), [Datadog](#)
 - about / [Datadog](#)
 - agent, installing / [Installing the agent](#)
 - agent installation, URL / [Installing the agent](#)
 - web interface, exploring / [Exploring the web interface](#)
 - references / [Summary and further reading](#)
- data volume container
 - creating / [The next steps](#)
- DigitalOcean
 - URL / [Pets](#)
- Digital Ocean
 - URL / [A word about externally hosted services](#)
- Docker
 - about / [Docker](#)
 - URL, for user guide / [Running a virtual server](#), [The next steps](#)
 - deploying, in cloud / [Deploying Docker in the cloud](#)
 - advancements / [Keeping up](#)
- docker-compose file
 - used, for executing ELK stack / [What about production?](#)
- Docker Compose
 - about / [Docker](#)
- Docker Engine
 - about / [Docker](#)
- Docker exec
 - about / [Docker exec](#)
- docker export command
 - URL / [Snowflakes](#)
- Docker Hub
 - about / [Docker](#)
 - URL / [Docker](#), [What is cAdvisor?](#), [Using containers](#)
- Docker images
 - URL / [Driver status](#)
- Docker stats
 - about / [Docker stats](#)
 - executing / [Running Docker stats](#)
- Docker top
 - about / [Docker top](#)
- driver status
 - obtaining / [Driver status](#)

E

- Elasticsearch
 - URL, for launching / [Starting the stack](#)
- ELK stack
 - about / [ELK Stack](#)
 - starting / [Starting the stack](#)
 - Logspout / [Logspout](#)
 - logs, reviewing / [Reviewing the logs](#)
 - executing, docker-compose file used / [What about production?](#)
 - references / [What about production?](#)
- environment
 - cloning / [Cloning the environment](#)
- externally hosted services
 - about / [A word about externally hosted services](#)
 - Docker, deploying in cloud / [Deploying Docker in the cloud](#)

F

- Fig
 - about / [Docker](#)

G

- Go
 - URL / [What is cAdvisor?](#)
- Google Container Engine
 - URL / [Cattle](#)

H

- host machine
 - containers, comparing to / [Compare containers to your host machine](#)

I

- images
 - listing / [Images](#)
- InfluxDB
 - about / [Alternatives?](#)
 - URL / [Alternatives?](#)

J

- Joyent Triton
 - URL / [Cattle](#)

K

- Kibana
 - URL, for launching / [Starting the stack](#)
- Kubernetes
 - URL / [Chickens](#)

L

- Liquid Wax Ester (LXE)
 - about / [Keeping up](#)
- lmctfy
 - URL / [What is cAdvisor?](#)
- local environment
 - launching / [Launching a local environment](#)
- Log Entries
 - URL / [Looking at third party options](#)
 - configuring / [Looking at third party options](#)
- Loggly
 - URL / [Looking at third party options](#)
- logs
 - reviewing / [Reviewing the logs](#)
- Logspout
 - URL, for launching / [Starting the stack](#)
 - about / [Logspout](#)
 - references / [Logspout](#)
- Logstash
 - URL, for launching / [Starting the stack](#)

M

- MariaDB 10
 - URL / [Using containers](#)
- metrics
 - collecting / [Collecting metrics](#)
 - recording / [Docker metrics](#)
 - custom graphs, creating / [Create custom graphs](#)
 - containers, comparing to host machine / [Compare containers to your host machine](#)
 - triggers, defining / [Triggers](#)
- Microsoft Azure
 - URL / [A word about externally hosted services](#)
- Monitoring Docker repository
 - URL / [Cloning the environment](#)

N

- Nagios
 - URL / [Zabbix](#)
- ncurses
 - about / [What is Sysdig?](#)
- Network Operations Center (NOC)
 - about / [Sending alerts](#)
- New Relic
 - URL / [Why use a SaaS service?, New Relic](#)
 - about / [New Relic](#)
 - agent, installing / [Installing the agent](#)
 - web interface, exploring / [Exploring the web interface](#)
 - references / [Summary and further reading](#)

P

- —privileged flag
 - about / [Running cAdvisor using a container](#)
 - URL / [Running cAdvisor using a container](#)
- PagerDuty
 - URL / [Triggers, Sending alerts](#)
- Pets
 - about / [Pets](#)
 - containers, deploying onto / [Pets](#)
 - alerts, setting up / [Cattle and Pets](#)
- phpinfo
 - URL / [Running Docker stats](#)
- Pingdom
 - URL / [Scenario one](#)
- processes
 - isolating / [What about processes?](#)
 - Docker top / [Docker top](#)
 - Docker exec / [Docker exec](#)
- Prometheus
 - about / [Prometheus](#)
 - launching / [Launching Prometheus](#)
 - querying / [Querying Prometheus](#)
 - Dashboard, launching / [Dashboard](#)
 - URL, for documentation / [Dashboard](#)
 - data volume container, creating / [The next steps](#)
 - references / [The next steps](#)
- Puppet Forge
 - URL / [Using vagrant](#)

R

- RancherOS
 - URL / [Why use a SaaS service?](#), [Cattle](#)

S

- SaaS service
 - using / [Why use a SaaS service?](#)
- server styles
 - selecting / [So what does this all mean?](#)
- Slack
 - URL / [Triggers](#)
- Snowflakes
 - about / [Snowflakes](#)
 - reference link / [Snowflakes](#)
 - containers, deploying onto / [Snowflakes](#)
- Standard Streams
 - reference link / [Viewing container logs](#)
- subcontainers
 - about / [Subcontainers](#)
- SysAdmin
 - about / [Pets, Cattle, Chickens, and Snowflakes](#)
- Sysdig
 - about / [What is Sysdig?](#)
 - installing / [Installing Sysdig](#)
 - URL / [Installing Sysdig](#)
 - using / [Using Sysdig](#)
 - basics / [The basics](#)
 - data, capturing / [Capturing data](#)
 - containers, listing / [Containers](#)
 - references / [Further reading](#)
- SysDig Cloud
 - URL / [Why use a SaaS service?](#)
- Sysdig Cloud
 - about / [Sysdig Cloud](#)
 - functionality / [Sysdig Cloud](#)
 - references / [Sysdig Cloud, Summary and further reading](#)
 - agent, installing / [Installing the agent](#)
 - agent installation, URL / [Installing the agent](#)
 - containers, exploring / [Exploring your containers](#)

T

- time series
 - about / [Prometheus](#)
 - reference link / [Prometheus](#)
- triggers
 - defining / [Triggers](#)

U

- Ubuntu Snappy Core
 - URL / [Why use a SaaS service?](#)
- Uptime Robot
 - URL / [Scenario one](#)

V

- Vagrant
 - URL / [Launching a local environment](#)
- vagrant box
 - URL / [Running a virtual server](#)
- VirtualBox
 - URL / [Launching a local environment](#)
- virtual server
 - executing / [Running a virtual server](#)
 - halting / [Halting the virtual server](#)
- VMware vCloud Air
 - URL / [A word about externally hosted services](#)

W

- Web interface
 - about / [The Web interface](#)
 - overview / [Overview](#)
 - Processes / [Processes](#)
 - CPU / [CPU](#)
 - Memory / [Memory](#)
 - Network / [Network](#)
 - Filesystem / [Filesystem](#)
 - drawbacks / [This is all great, what's the catch?](#)
- WordPress
 - URL, for installation / [Using Sysdig](#)

Y

- YAML
 - URL / [Docker](#)

Z

- Zabbix
 - about / [Zabbix](#)
 - URL / [Zabbix](#), [Using vagrant](#), [The Zabbix web interface](#)
 - references / [Zabbix](#)
 - installing / [Installing Zabbix](#)
 - containers, using / [Using containers](#)
 - vagrant, using / [Using vagrant](#)
 - host machine, preparing / [Preparing our host machine](#)
 - host templates, adding / [The Zabbix web interface](#)
- Zenoss
 - URL / [Zabbix](#)