Virtual Environments

Containers

Containers

Overview

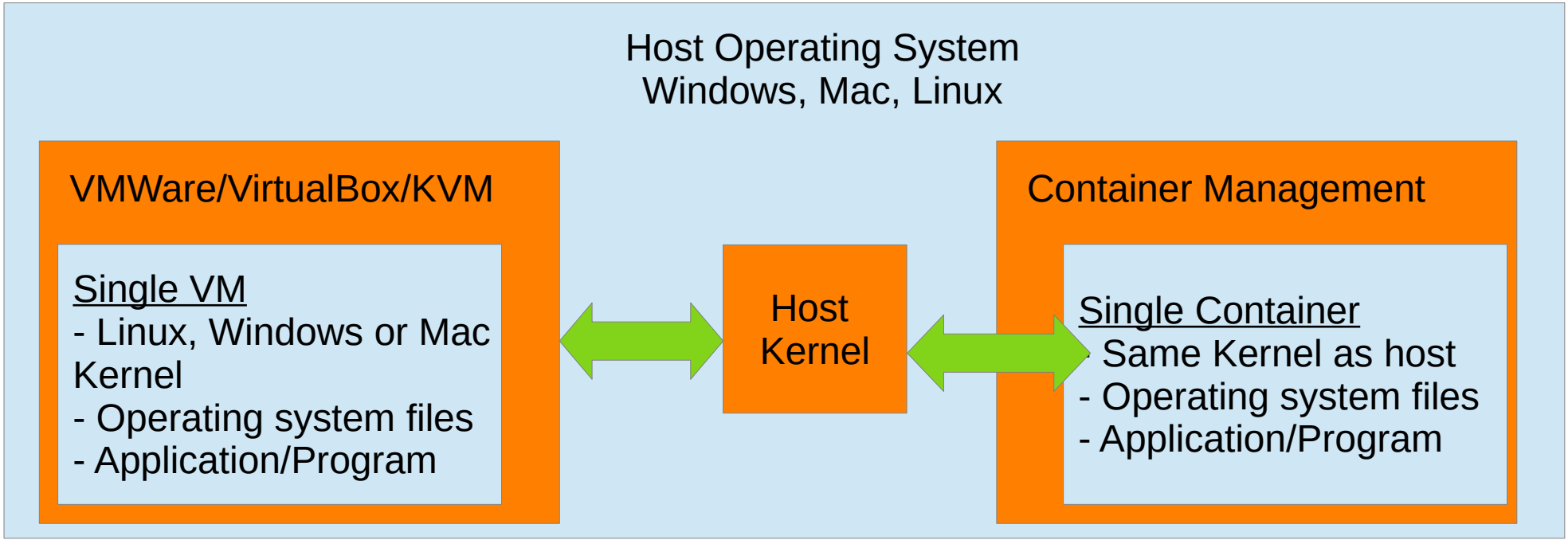
Containers

- A Linux Container is a virtual computer (guest) which uses the same kernel as the host operating system

- **Host**: The operating system which boots up when you turn on your computer
- **Guest**: The operating system which is run within the container

Containers

- Differences between a Virtual Guest and a Container Guest



Containers

- Differences between a Virtual Guest and a Container Guest: The differences can look very subtle
  - Containers share the same kernel as the host operating system
  - This means a container MUST be the same operating system as the host
  - Virtualization (VMWare, Virtual-box, KVM) uses a completely different kernel than the host
  - The virtualized kernel talks to the host kernel using the virtualization engine

Containers

- Benefits of Virtualized Machines
  - The guest is a completely self contained operating system
  - The guest can protect the Host operating system
  - The guest is a complete operating system independent of the host
  - The guests security policy is part of the guest operating system
  - Different operating systems than the host
  - Full guest operating system GUI available

Containers

- Con’s of Virtualized Machines
  - Large install footprint
  - Must be installed and configured
  - The number of virtual machines running at the same time on the host are limited because of their overhead needs (memory, disk space, etc.)

Containers

- Benefits of Containers
  - The container can protect the Host operating system
  - The container shares the host kernel allowing the container to be very small
  - The container can be a root-enabled container, or it can be a non-root container to help security
  - The container, since it is small, can be easily shared
  - The container, since it is small, is easy to install
  - The container will see any system wide changes

Containers

- Con’s of Containers
  - A container can only be the same operating system as the host
  - No GUI (yet)
  - Root and Non-Root containers can be clunky to understand and use

Containers

- Uses of Containers
  - A way to package your application to run in its own little virtual environment
  - A way to run an application multiple times within the same host operating system
  - A way to run different versions of the same application at the same time
  - A way to run many containers at the same time on the host as each is smaller than a virtual machine

Containers

- More Information
  - Red Hat Linux Containers
  - Debian/Ubuntu Linux Containers
  - Windows Containers

Containers

Demonstration

Containers

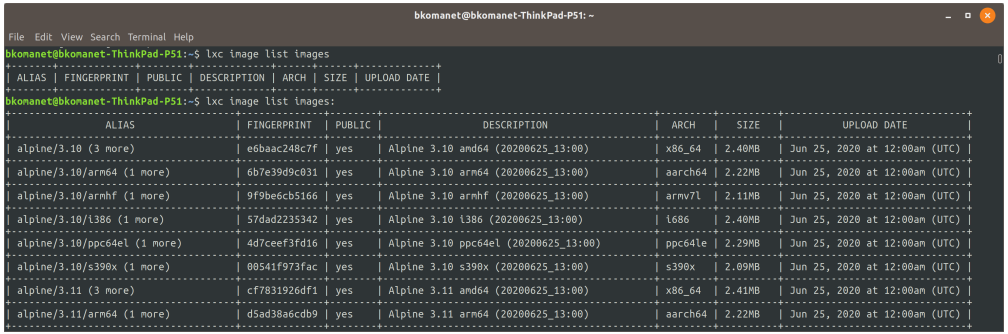
- Let’s try it
  - We’ll use Ubuntu/Debian Linux to do this demonstration
  - Red Hat linux works, but requires a subscription
  - Windows works, but requires Windows Server

Debian Containers

- Install lxc container management
  - Open a terminal
  - Type:
    - ***sudo apt -y install lxc***
    - ***sudo apt -y install lxd***
    - ***sudo apt-y install lxd-client***
    - ***sudo apt-y install lxd-tools***
    - ***sudo usermod -a -G lxd yourID***
      - This last command will let your ID issue lxd commands without having to ‘sudo’

Debian Containers

- List container images available:
  - Open a terminal
  - Type:
    - ***lxc image list images:***
    - The colon at the end is VERY important
    - This command will list container images available on-line (you can create your own images later)



Debian Containers

- List container images available:
  - You can also filter images – let's look for Fedora Linux Images
  - Type:
    - ***lxc image list images: "fedora"***
    - This command will list container images available on-line for the fedora operating system

```
bkomanet@bkomanet-ThinkPad-P51: ~
File  Edit  View  Search  Terminal  Help
bkomanet@bkomanet-ThinkPad-P51:~$ lxc image list images: "fedora"
+-----------------------+-------------+--------+-----------------------------------+------+---------+-----------------------------+
|        ALIAS          | FINGERPRINT | PUBLIC |          DESCRIPTION              | ARCH |  SIZE   |        UPLOAD DATE          |
+-----------------------+-------------+--------+-----------------------------------+------+---------+-----------------------------+
| fedora/30 (3 more)    | 6af4059c9ead | yes    | Fedora 30 amd64 (20200615_20:35)  | x86_64 | 77.82MB | Jun 15, 2020 at 12:00am (UTC) |
+-----------------------+-------------+--------+-----------------------------------+------+---------+-----------------------------+
| fedora/30/arm64 (1 more) | 34fbf2c3a7cc | yes    | Fedora 30 arm64 (20200615_20:33)  | aarch64 | 74.95MB | Jun 15, 2020 at 12:00am (UTC) |
+-----------------------+-------------+--------+-----------------------------------+------+---------+-----------------------------+
| fedora/30/cloud (1 more) | 7212ff1cb3b0 | yes    | Fedora 30 amd64 (20200615_20:33)  | x86_64 | 93.45MB | Jun 15, 2020 at 12:00am (UTC) |
+-----------------------+-------------+--------+-----------------------------------+------+---------+-----------------------------+
| fedora/30/cloud/arm64 | a53c85815419 | yes    | Fedora 30 arm64 (20200615_20:33)  | aarch64 | 89.96MB | Jun 15, 2020 at 12:00am (UTC) |
+-----------------------+-------------+--------+-----------------------------------+------+---------+-----------------------------+
| fedora/30/cloud/ppc64el | 8422395a960c | yes    | Fedora 30 ppc64el (20200615_20:33) | ppc64le | 95.13MB | Jun 15, 2020 at 12:00am (UTC) |
+-----------------------+-------------+--------+-----------------------------------+------+---------+-----------------------------+
| fedora/30/cloud/s390x | b44a67494f55 | yes    | Fedora 30 s390x (20200615_20:33)  | s390x | 88.40MB | Jun 15, 2020 at 12:00am (UTC) |
+-----------------------+-------------+--------+-----------------------------------+------+---------+-----------------------------+
| fedora/30/ppc64el (1 more) | cce80effa2d1 | yes    | Fedora 30 ppc64el (20200615_20:33) | ppc64le | 79.30MB | Jun 15, 2020 at 12:00am (UTC) |
+-----------------------+-------------+--------+-----------------------------------+------+---------+-----------------------------+
| fedora/30/s390x (1 more) | 131849ea1c5a | yes    | Fedora 30 s390x (20200615_20:33)  | s390x | 73.45MB | Jun 15, 2020 at 12:00am (UTC) |
+-----------------------+-------------+--------+-----------------------------------+------+---------+-----------------------------+
| fedora/31 (3 more)    | d97e8949def3 | yes    | Fedora 31 amd64 (20200624_20:33)  | x86_64 | 96.09MB | Jun 24, 2020 at 12:00am (UTC) |
+-----------------------+-------------+--------+-----------------------------------+------+---------+-----------------------------+
| fedora/31/arm64 (1 more) | 300592d286ce | yes    | Fedora 31 arm64 (20200624_20:33)  | aarch64 | 92.86MB | Jun 24, 2020 at 12:00am (UTC) |
```

Debian Containers

- Downloading an Image for use locally
  - Open a terminal
  - Type:
    - ***lxc image copy images:fedora/32/cloud local:***
    - This command will download the container image and install it locally in your image inventory
  - Type:
    - ***lxc image list***
    - This will list your image inventory

```
bkomanet@bkomanet-ThinkPad-P51:~$ lxc image list
+------------+--------------+--------+-----------------------------------------+--------+----------+------------------------------+
|   ALIAS    | FINGERPRINT  | PUBLIC |                DESCRIPTION              |  ARCH  |   SIZE   |         UPLOAD DATE          |
+------------+--------------+--------+-----------------------------------------+--------+----------+------------------------------+
| Fedora23   | f4818132f2ba | no     | Fedora 32 amd64 (20200525_20:33)        | x86_64 | 94.57MB  | May 26, 2020 at 4:21am (UTC) |
+------------+--------------+--------+-----------------------------------------+--------+----------+------------------------------+
| ubuntu2004 | 40775fd923e2 | no     | ubuntu 20.04 LTS amd64 (release) (20200522) | x86_64 | 346.09MB | May 26, 2020 at 3:38am (UTC) |
+------------+--------------+--------+-----------------------------------------+--------+----------+------------------------------+
|            | 38f68c083436 | no     | Centos 8 amd64 (20200625_07:08)         | x86_64 | 125.22MB | Jun 25, 2020 at 4:46pm (UTC) |
+------------+--------------+--------+-----------------------------------------+--------+----------+------------------------------+
|            | a9ac7bdefdde | no     | Fedora 32 amd64 (20200624_20:33)        | x86_64 | 102.90MB | Jun 25, 2020 at 4:54pm (UTC) |
+------------+--------------+--------+-----------------------------------------+--------+----------+------------------------------+
```

Debian Containers

- Giving an Image a name
  - When you download an image, it contains a very strange name or fingerprint. To give it a real name – an alias, do this:
  - Type:
    - ***lxc image alias create yourChosenAliasName fingerprint***
  - Type:
    - ***lxc image list***
    - This will list your image inventory and you should see your new yourChoseAliasName instead of just a cryptic fingerprint

Debian Containers

- Starting an image
  - Open a terminal
  - Type:
    - Format: lxc launch imagename containername
    - ***lxc launch Fedora23 myFedora23***
    - This will create the image and then start it. If a program is setup to automatically run in the image, that program will begin

```
bkomanet@bkomanet-ThinkPad-P51:~$ lxc launch Fedora23 myFedora23
Creating myFedora23
Starting myFedora23
bkomanet@bkomanet-ThinkPad-P51:~$
```

Debian Containers

- Listing our containers
  - Open a terminal
  - Type:
    - ***lxc list***
    - You will see our running container

```
bkomanet@bkomanet-ThinkPad-P51:~$ lxc list
+------------+---------+------+-----------------------------------------------+------------+-----------+
|    NAME    |  STATE  | IPV4 |                     IPV6                      |    TYPE    | SNAPSHOTS |
+------------+---------+------+-----------------------------------------------+------------+-----------+
| Debian9    | STOPPED |      |                                               | PERSISTENT | 0         |
+------------+---------+------+-----------------------------------------------+------------+-----------+
| Fedora23   | STOPPED |      |                                               | PERSISTENT | 0         |
+------------+---------+------+-----------------------------------------------+------------+-----------+
| centos7    | STOPPED |      |                                               | PERSISTENT | 0         |
+------------+---------+------+-----------------------------------------------+------------+-----------+
| centos8    | STOPPED |      |                                               | PERSISTENT | 0         |
+------------+---------+------+-----------------------------------------------+------------+-----------+
| myFedora23 | RUNNING |      | fd42:7d93:45fa:2ccb:216:3eff:fe43:ea51 (eth0) | PERSISTENT | 0         |
+------------+---------+------+-----------------------------------------------+------------+-----------+
| ubuntu1804 | STOPPED |      |                                               | PERSISTENT | 0         |
+------------+---------+------+-----------------------------------------------+------------+-----------+
| ubuntu2004 | STOPPED |      |                                               | PERSISTENT | 0         |
+------------+---------+------+-----------------------------------------------+------------+-----------+
```

Debian Containers

- Interact with a container
  - Open a terminal
  - Type:
    - ***lxc exec myFedora23 bash***
    - This will put you into the container and present a bash command prompt to you so you may interact with the container
    - To leave the BASH terminal, just type ***exit***

Notice we are logged in as root in our myFedora23 operating system

```
bkomanet@bkomanet-ThinkPad-P51:~$ lxc exec myFedora23 bash
[root@myFedora23 ~]#
```

Debian Containers

- Stop a Containter
  - Open a terminal
  - Type:
    - ***lxc stop myFedora23***
    - This will shut down the container. ***lxc list*** will show the result

```
bkomanet@bkomanet-ThinkPad-P51:~$ lxc list
+------------+---------+------+------+------------+-----------+
|    NAME    |  STATE  | IPV4 | IPV6 |    TYPE    | SNAPSHOTS |
+------------+---------+------+------+------------+-----------+
| Debian9    | STOPPED |      |      | PERSISTENT | 0         |
+------------+---------+------+------+------------+-----------+
| Fedora23   | STOPPED |      |      | PERSISTENT | 0         |
+------------+---------+------+------+------------+-----------+
| centos7    | STOPPED |      |      | PERSISTENT | 0         |
+------------+---------+------+------+------------+-----------+
| centos8    | STOPPED |      |      | PERSISTENT | 0         |
+------------+---------+------+------+------------+-----------+
| myFedora23 | STOPPED |      |      | PERSISTENT | 0         |
+------------+---------+------+------+------------+-----------+
| ubuntu1804 | STOPPED |      |      | PERSISTENT | 0         |
+------------+---------+------+------+------------+-----------+
| ubuntu2004 | STOPPED |      |      | PERSISTENT | 0         |
+------------+---------+------+------+------------+-----------+
```

Debian Containers

- Delete a Containter
  - Open a terminal
  - Type:
    - ***lxc delete myFedora23***
    - This will delete the container. ***lxc list*** will show the result

```
bkomanet@bkomanet-ThinkPad-P51:~$ lxc delete myFedora23
bkomanet@bkomanet-ThinkPad-P51:~$ lxc list
+------------+---------+------+------+------------+-----------+
|    NAME    |  STATE  | IPV4 | IPV6 |    TYPE    | SNAPSHOTS |
+------------+---------+------+------+------------+-----------+
| Debian9    | STOPPED |      |      | PERSISTENT | 0         |
+------------+---------+------+------+------------+-----------+
| Fedora23   | STOPPED |      |      | PERSISTENT | 0         |
+------------+---------+------+------+------------+-----------+
| centos7    | STOPPED |      |      | PERSISTENT | 0         |
+------------+---------+------+------+------------+-----------+
| centos8    | STOPPED |      |      | PERSISTENT | 0         |
+------------+---------+------+------+------------+-----------+
| ubuntu1804 | STOPPED |      |      | PERSISTENT | 0         |
+------------+---------+------+------+------------+-----------+
| ubuntu2004 | STOPPED |      |      | PERSISTENT | 0         |
+------------+---------+------+------+------------+-----------+
```

Notice myFedora23 is now gone

Debian Containers

- Saving a Container as an Image
  - Open a terminal
  - Type:
    - ***lxc publish containerName --alias newImageName***
    - This will create a new image and place it into your image inventory
- To export it so someone can use it on another computer
  - Type:
    - ***lxc image export newImageName***
    - This creates a really ugly compressed tar file which you can rename
      - d0d2ca7f82a5bb598858fe5f1e72492168f2fb33574ab7f345e7f9ab285526a9.tar.gz

Containers

- In Summary
  - This is just a quick overview of some of the commands to manage containers in Ubuntu/Mint/Debian Linux
  - Red Hat and Windows use different commands and different container architectures
  - Lots of self studying
  - Enjoy!