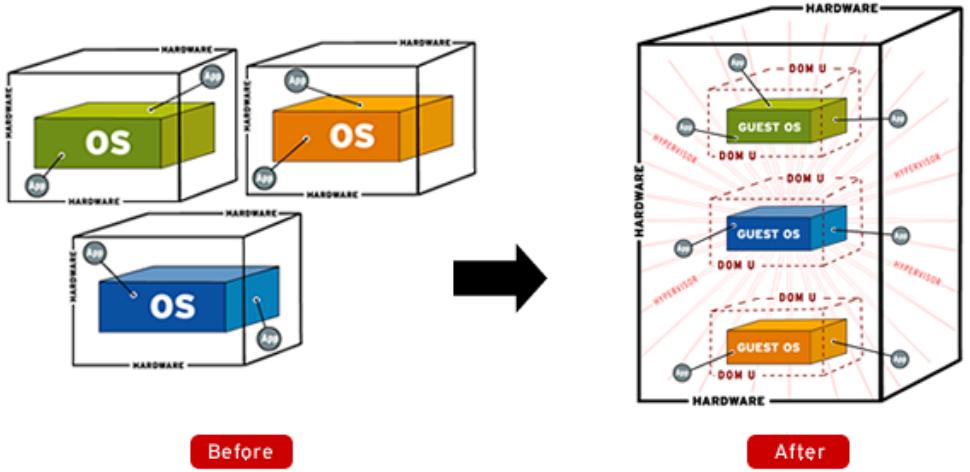
Virtualization and Containerization

So just what is "Virtualization"?

Virtualization – a definition

- In computing, this is the creation of a virtual (rather than actual) version of something, such as a hardware platform, operating system (OS), storage device, or network resources.
- Generally referred to as “server virtualization”, but can mean a few things.



What can we virtualize?

- Hardware (server)
- Desktop (VDI)
- Software
- Memory
- Storage
- Network
- Data

Hypervisor

- A Hypervisor is the kernel or the core of a virtualization platform. The Hypervisor is also referred to as the Virtual Machine Monitor.
- The Hypervisor has access to the physical host hardware.
- Of the total amount of disk space taken for a virtualization platform, the Hypervisor is by far, the smallest part.

Hypervisors – two basic types

Type-1 Hypervisor

- In a Type-1, or Bare Metal Virtualization platform there really isn't a host operating system besides the Hypervisor.
  - VMWare ESX
  - Hyper-V Windows Core
  - XEN

Type-2 Hypervisor

- For a Type-2 Hypervisor, the host operating system is whatever operating system those applications are installed into.
  - VMWare Workstation
  - VMWare Fusion
  - VirtualBox
  - Hyper-V on Windows 10

Host vs. Guest

- A **host** system would be the primary & first installed operating system.
- Your host is what your VMs will run on and will manage them.

- A **guest** system (guest operating system) is a virtual guest or virtual machine (VM) that is installed under the host operating system.
- Guests are the VMs that you run within your virtualization platform.

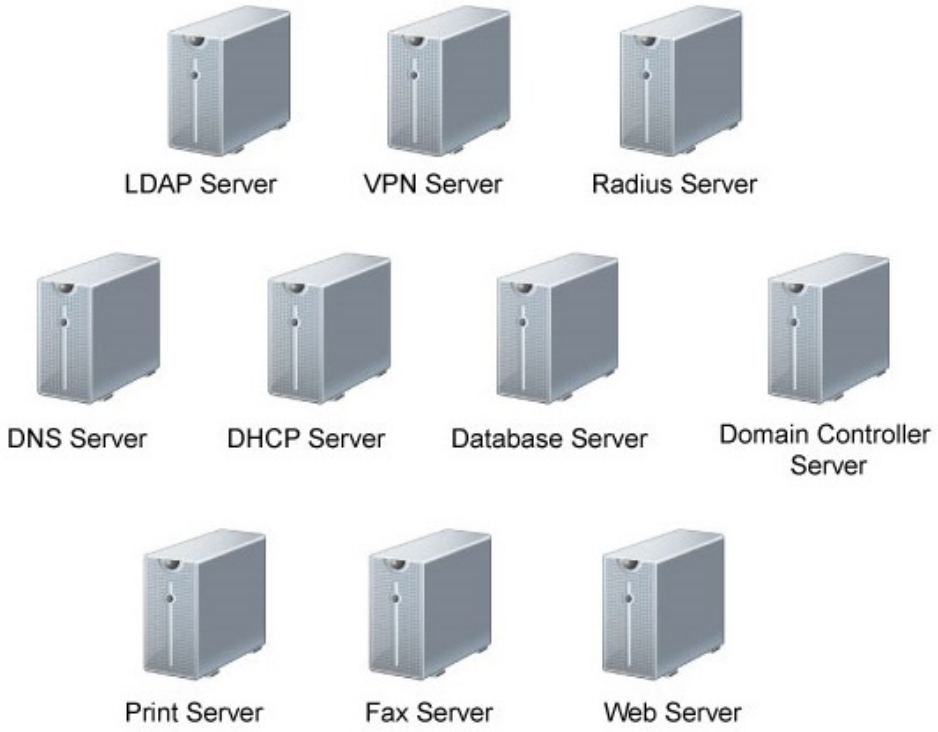
Before Server Virtualization

Multiple servers each on its own hardware

Separate physical servers for each OS/Application

Server sprawl

Inefficient use of resources – most servers sit idle doing their "one job"



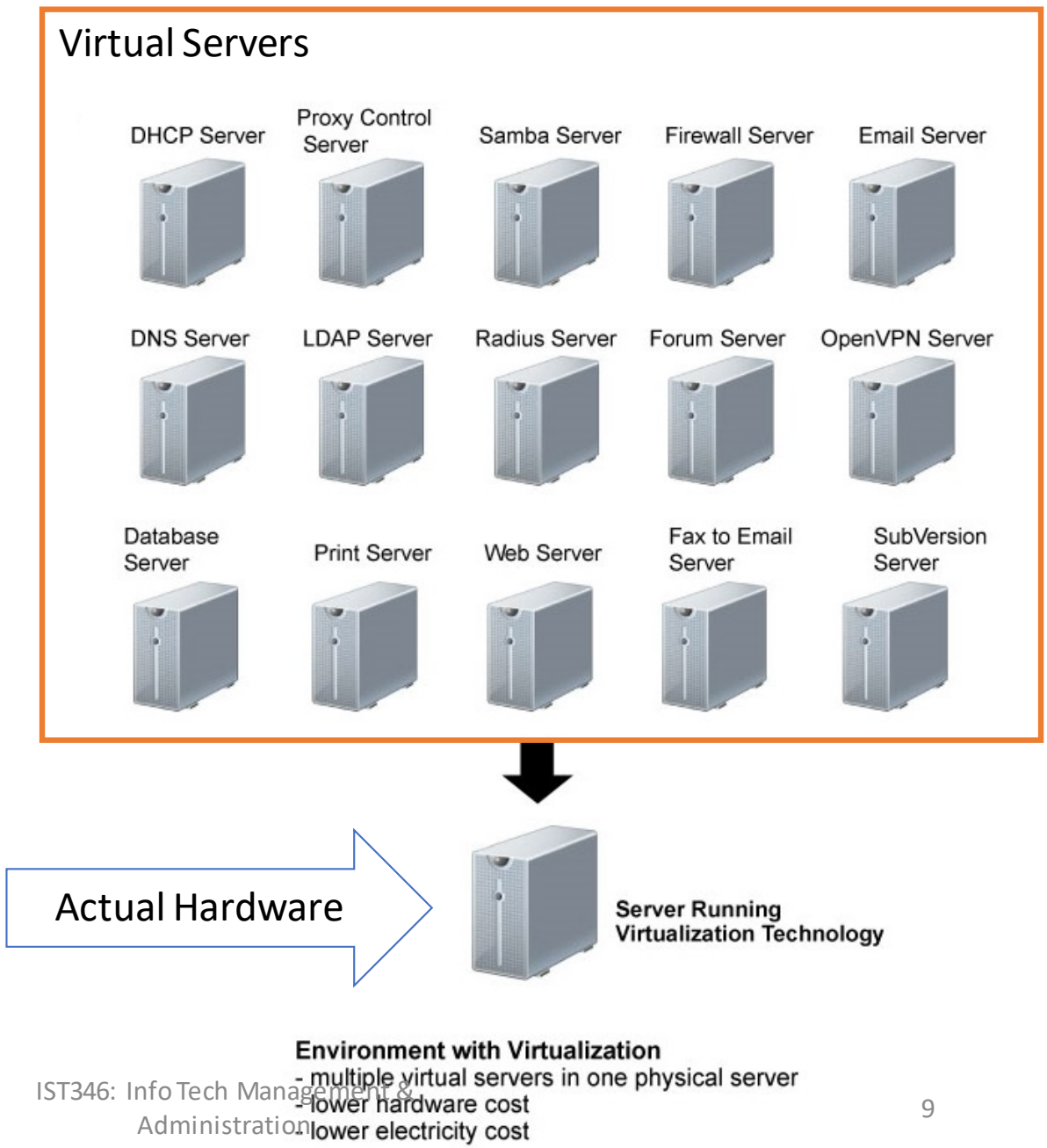
Environment without Virtualization
- multiple physical servers
- higher hardware cost
- higher electricity cost

After Server Virtualization

Still have multiple servers but, fewer physical hosts

Smaller hardware footprint, uses less energy and data center space.

Maximizes use of hardware /compute resources, Enables IT departments to run more with less.



Advanced Capabilities

More That Virtualization Offers Over Physical Hardware

- Live Migration
- High availability (failover)
- Network isolation without network hardware
- Snapshotting
- Cloning
- Teleportation
- Consolidated backup
- Resource pooling
- P2V conversion

Live Migration

- Allows for the moving of virtual workloads from one physical host to another with no downtime.
- Moving of a running VM to a different physical machine without disconnecting the guest or applications running on it.
- Memory, storage, and network connectivity are transferred from original host to the destination.
- Typically down-time of a VM during a live migration is not noticeable by end-users. This is referred to as a **seamless** live migration.

High availability (failover)

- Utilizing “Clustering” concepts to use more than one physical host configured and managed as a single resource.
- Allows VMs to be run from multiple physical hosts.
- In HA configurations, if the physical host becomes unavailable, a VM can be serviced by another host in the cluster.
- This is typically configured for Real Time failovers (no loss of a VM’s operation), but there are situations where their will be delays (disaster recovery in hot/cold sites).
- Utilizes Live Migration

Network isolation (virtual networking)

- Using software to create “virtual networks” without additional network hardware.
- Allows you to run multiple identical copies of an environment.
- Uses the creation of “virtual networks” to keep computers within from either contacting external networks, or from external devices communicating in.
- Some reasons why we would want to do this:
  - Labs
  - Test environments
  - Development
  - Research
  - Security

Snapshotting

- Dumping the entire machine state to a backup file
- Can include contents of memory (live snapshots)
- Allows for full system state restore in case of failure or changes made
- Can merge the changes from snapshots into the master if needed
- Warning: snapshots increase complexity and disk space, so they need to be monitored and removed when no longer needed.

Cloning

- A clone is a copy of an existing virtual machine
- Changes made to the clone do not affect the parent machine
- Two types of clones, Full (independent) and Linked.
  - **Full** clone is just that, a full and independent copy that shares nothing with the parent VM. This requires more disk space but keeps the VMs completely independent of one another.
  - **Linked** clone is a copy that shares virtual disks with the parent VM in an ongoing manner. This conserves disk space and allows multiple VMs to use the same software configuration.

Consolidated backup

- Provides a single location to backup from, simplifying backup strategies.
- Can reduce or eliminate network traffic by keeping backups local to the Hosts.
- Allows for backup management from a single point.
- Can perform file level or complete VM backups.
- Restores can be of individual files or bare-metal (whole VM)

Resource Pooling

- Ability to “Pool” physical resources together to get more “bang for your buck”
- Manually or Dynamically allocate resources to highest priority servers as needed.
- Pools are typically defined by CPU and memory resources

P2V conversion

- Physical to Virtual conversion
- Refers to the migration of an Operating System (along with its applications and data) from a physical computer's hard disk to a virtual machine.
- Allows the conversion to virtualized machines without having to rebuild computers.
- Without this you had to reinstall the OS, reinstall all applications, copy all data, and reconfigure the applications and services running (tedious process).
- Typically used to accomplish server virtualization.

Benefits of Virtualization

- Reduces hardware footprint (physical servers)
- Reduces operating costs (long term)
  - Server hardware
  - Infrastructure costs
- Servers can be created quickly (and removed)
- Reduce admin overhead (single console)
- Maximizes investment in hardware
- Virtualized servers have the same hardware configuration
- Easier to power virtual machines on and off

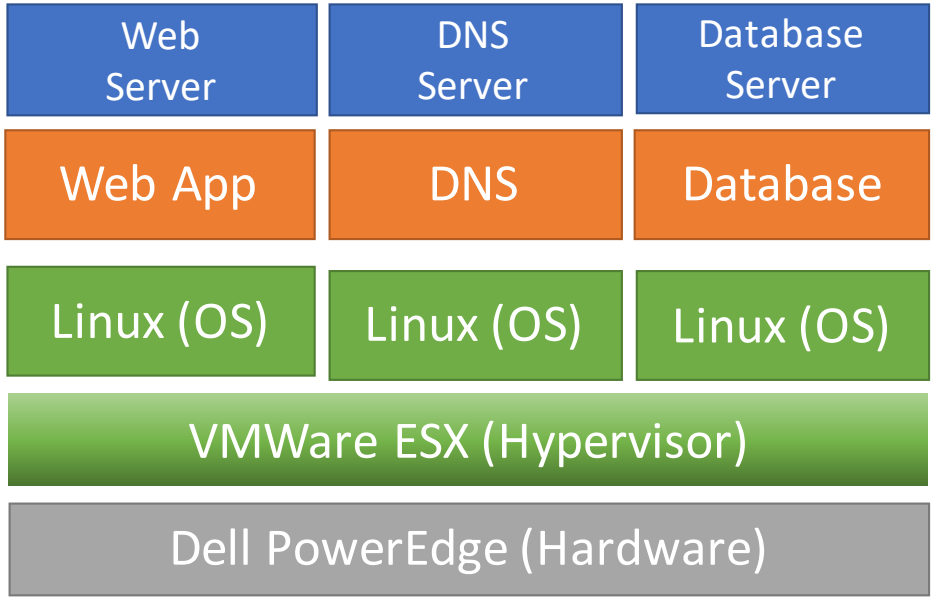
What is Containerization?

Containerization

- Containerization is a form of virtualization at the application level
- Containers run on the host operating system or in a host-based virtual machine
- It was designed to overcome a key limitation of host virtualization

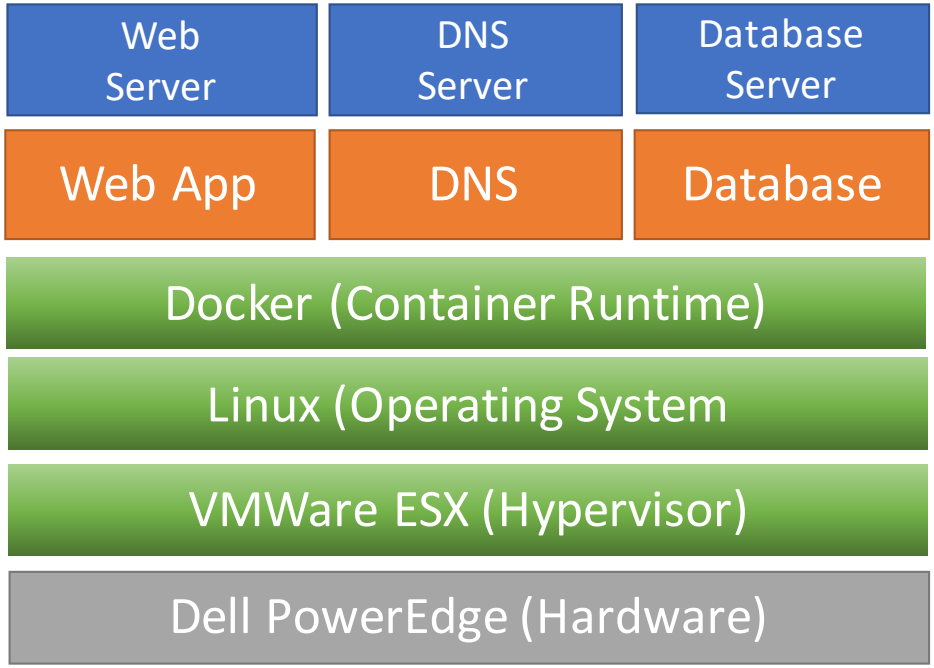
Host Virtualization Is Heavy

- With host virtualization the services share hardware resources only
- The operating system and configuration settings must be maintained on each virtual host
- This creates a maintenance nightmare as it is easy to setup virtualized hosts but difficult and time consuming to maintain them.

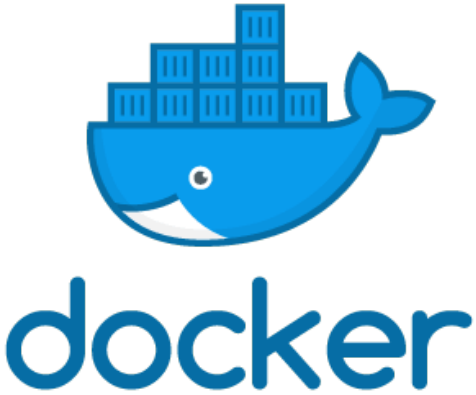


Benefits of Containerization

- Application components run in a container on the operating system
- Operating system and dependencies and configuration of each service are no longer an issue.
- Can easily re-create the environment multiple times for development and testing
- Take up less disk space when compared to host virtualization, since one operating system is used.



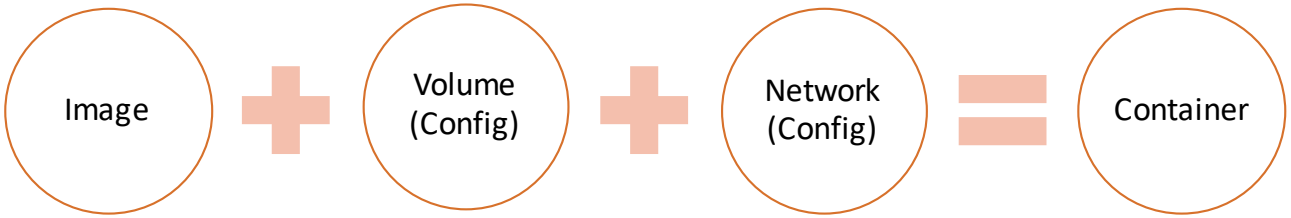
Docker



- Docker is a popular container application. It manages:
- Building of images
- Running of containers and managing their run-time resources like memory, CPU, disk and network.
- Sharing of containers with other people (via registry).

Container Concepts

- **Image** – holds the software, it dependencies and information necessary to run the application
- **Container** – Self-contained unit of software. It is a running image plus the configuration and state. At the time the container runs network and storage information is provided.
- **Volume** – persistent storage mechanism for the container.
- **Network** – containers have virtual network similar to host-based virtualization
- **Registry** – an online source of images.



Docker Compose

- We use docker-compose in the labs.
- Docker-compose is a tool for running multi-container docker applications.
- All aspects of each running container are included in the compose file.
  - Image
  - Network
  - Volumes
- The containers within the compose file are deployed as a single unit.