Containerization & Virtualization

Toward an Agile Infrastructure

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Introduction

History of running a software

- Early on, organizations ran applications on physical servers.
- Install or use an existing operating system.
- Install the tools needed by your software.
- Install dependencies of your software.
- Run your software.
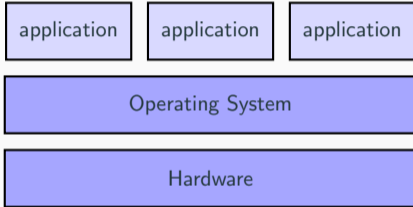
Traditional Deployment

Figure 1: Traditional Deployment

Issues with traditional deployment

- Isolation issue, no way to define resource boundaries for applications in a physical server, and this caused resource allocation issues.
- Scaling issues as resources were underutilized.
- It was expensive for organizations to maintain many physical servers.

Virtualization

Virtual Machines

- Virtualizing hardware produces virtual machines (VMs).

- Virtualization allows you to run multiple VMs on a single physical server. Each VM includes a full copy of an operating system, the application, necessary binaries, and libraries - taking up tens of GBs.

- Virtualization allows more effortless adding and updating of applications that solve the scalability issue.

- Virtualization allows better utilization of resources.

- Virtualization isolates applications between VMs.
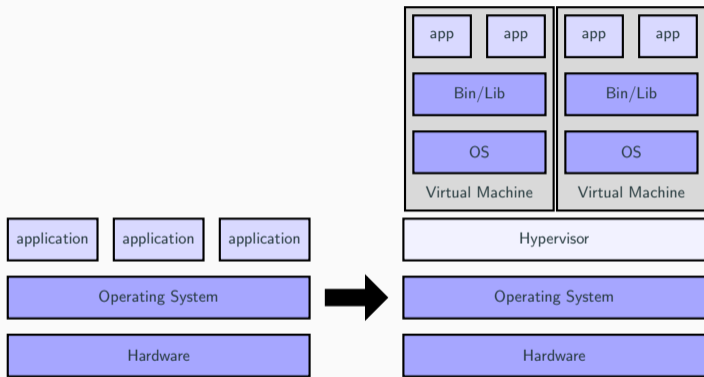
Virtualized Deployment

Figure 2: Virtualization Deployment

Hypervisor

- How is virtualization possible?
    - A hypervisor is computer software, firmware or hardware that creates and runs virtual machines.
    - The hypervisor allows multiple VMs to run on a single machine.
- The hypervisor has 2 types:

Type 1 Hypervisor

Type-1, native, or bare-metal hypervisors.

Examples

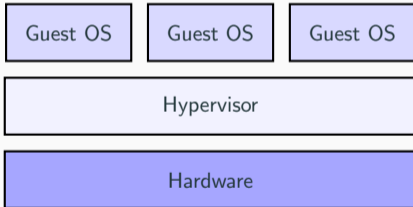- Type-1: VMware ESX and Citrix Xen servers.

Guest OS	Guest OS	Guest OS

Hypervisor

Hardware

Figure 3: Type 1, native, or bare-metal hypervisors

Type 2 Hypervisor

Type-2, or hosted hypervisors.

Examples

- Type-2: VMware player and VirtualBox.

Guest OS	Guest OS	Guest OS

Hypervisor

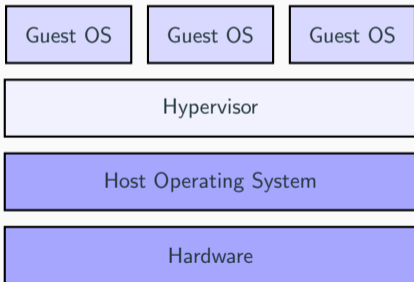| Host Operating System |
| --- |

Hardware

Figure 4: Type 2, or Hosted Hypervisor

Containerization

What is a Container?

- The process of virtualizing the operating system produces containers.
- Container is a virtual operating system.
- A container is an abstraction at the OS layer that packages code and dependencies together as a standardized unit of software.
- Containers take up less space than VMs, boots quickly, and in isolation.
- Containerization eliminates infrastructure wasted resources and utilizes them.
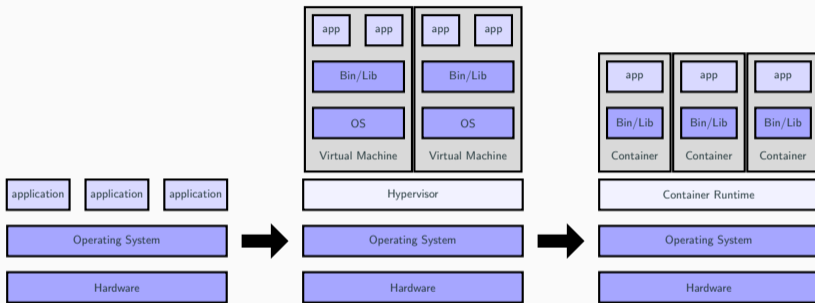
Container Deployment

Figure 5: Containerization Deployment

OS-level virtualization

- How is containerization possible?
  - OS-level virtualization refers to an operating system paradigm in which the operating system allows the existence of multiple isolated user-space instances (containers).
  - OS-level virtualization solutions are the container engines.
  - A container engine is a managed environment for deploying containerized applications.
- User-space instances have different names
  - Containers in **Docker** and Linux containers **LXC**.
  - VPS in **OpenVZ**
  - Virtual Kernel **DragonFly BSD**

Summary and Popular Questions

- The word virtualization applies to hardware and operating system.
- Hardware virtualization produces virtual machines.
- Operating system virtualization produces containers.

Why Containers are more popular?

- Containerization gives us better resource isolation with predictable application performance.
- Containerization gives us better resource utilization with high efficiency and density.
- They are loosely coupled, distributed, elastic, liberated micro-services.
- Environmental consistency across development, testing, and production **"It worked on my machine."**
- Agile application creation and deployment.

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What is hybrid container architecture?

- A hybrid container architecture is an architecture combining virtualization on both hardware and OS levels.
- Example: The container engine and associated containers execute on top of a virtual machine.
- Use of a hybrid container architecture is also known as hybrid containerization.
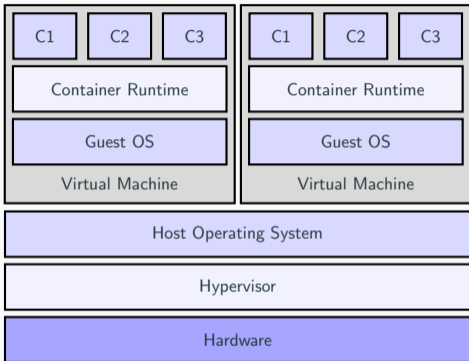
Hybrid container architecture

Figure 6: Hybrid container architecture

Do windows have native containers?

- You can have native windows containers but not Linux native containers yet.
- Microsoft's native hypervisor solution is Hyper-V.
- Using Hyper-V Microsoft supports running VMs natively on Windows, for example, Ubuntu on Windows (WSL).
- Microsoft is working on the OS-level virtualization solution to run Linux native containers.

References

References

- Virtualization via containers
- OS-level virtualization
- Hyper-V
- What is a container?
- What is Kubernetes?
- Prep Windows for containers