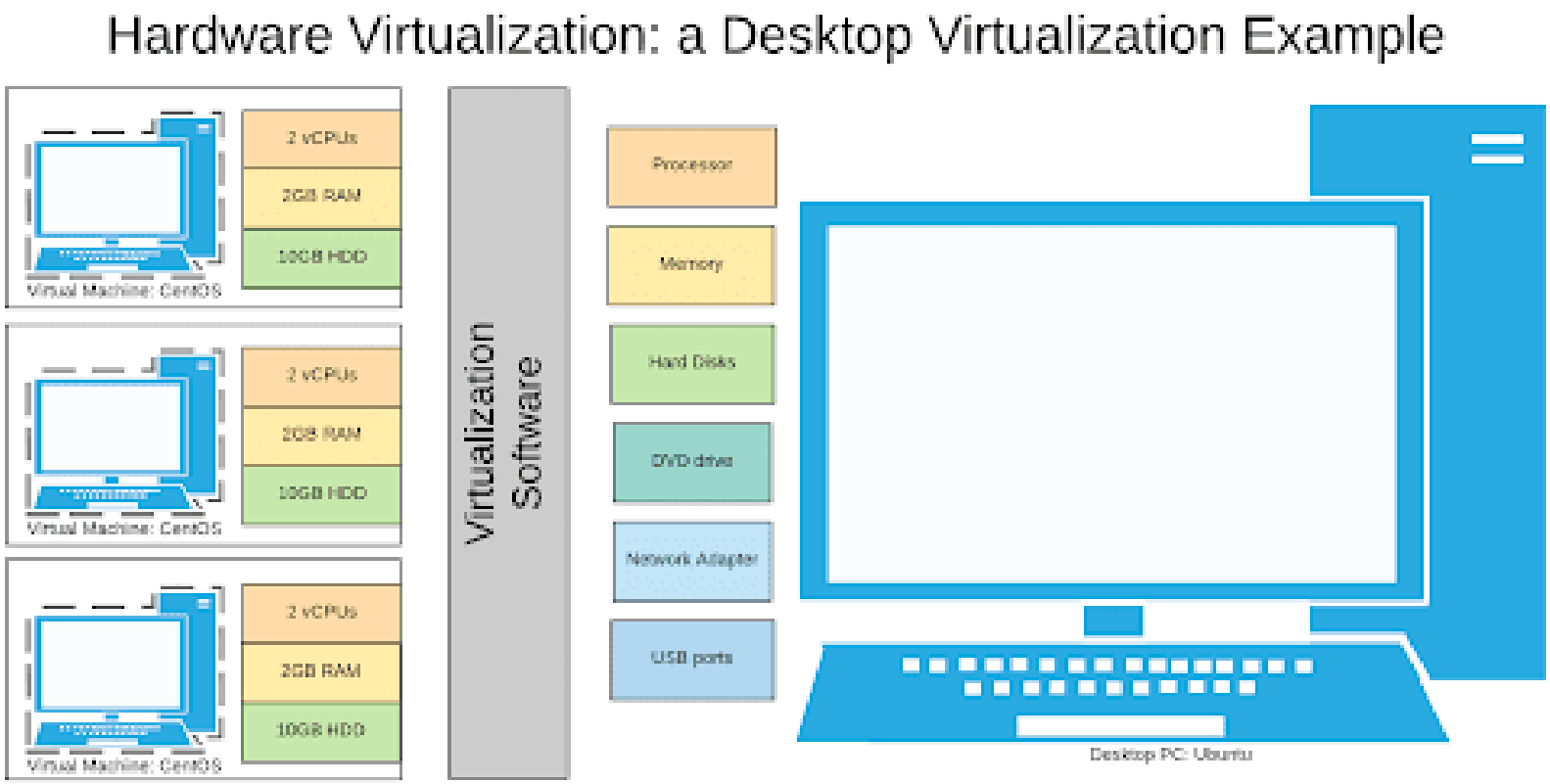
Virtualization

- Virtualization
- Containers/sandboxes
- Cloud

Definition

- **Virtualization** is the act of creating a virtual (instead of actual) version of something, including computer hardware, storage, and networking resources.
  - This is done via software that *virtualizes* or *emulates* the hardware or resources of a physical system



Software requirements

Virtualization needs either a hypervisor or container engine to run

2 types of Hypervisors (for virtualization)

- Type 1 / Native / Bare metal: hypervisor is the OS
- Type 2 / hosted: hypervisor is software installed on top of the OS

Both perform the same actions

- Control resources available to Virtual Operating systems
- Ensure guest OS cannot disrupt each other (or the Host!)

Containers

A Blending of Type 1 and Type 2 hypervisors

- Emulates systems calls, not hardware
- Allows for OS level virtualization
- Used to isolate applications

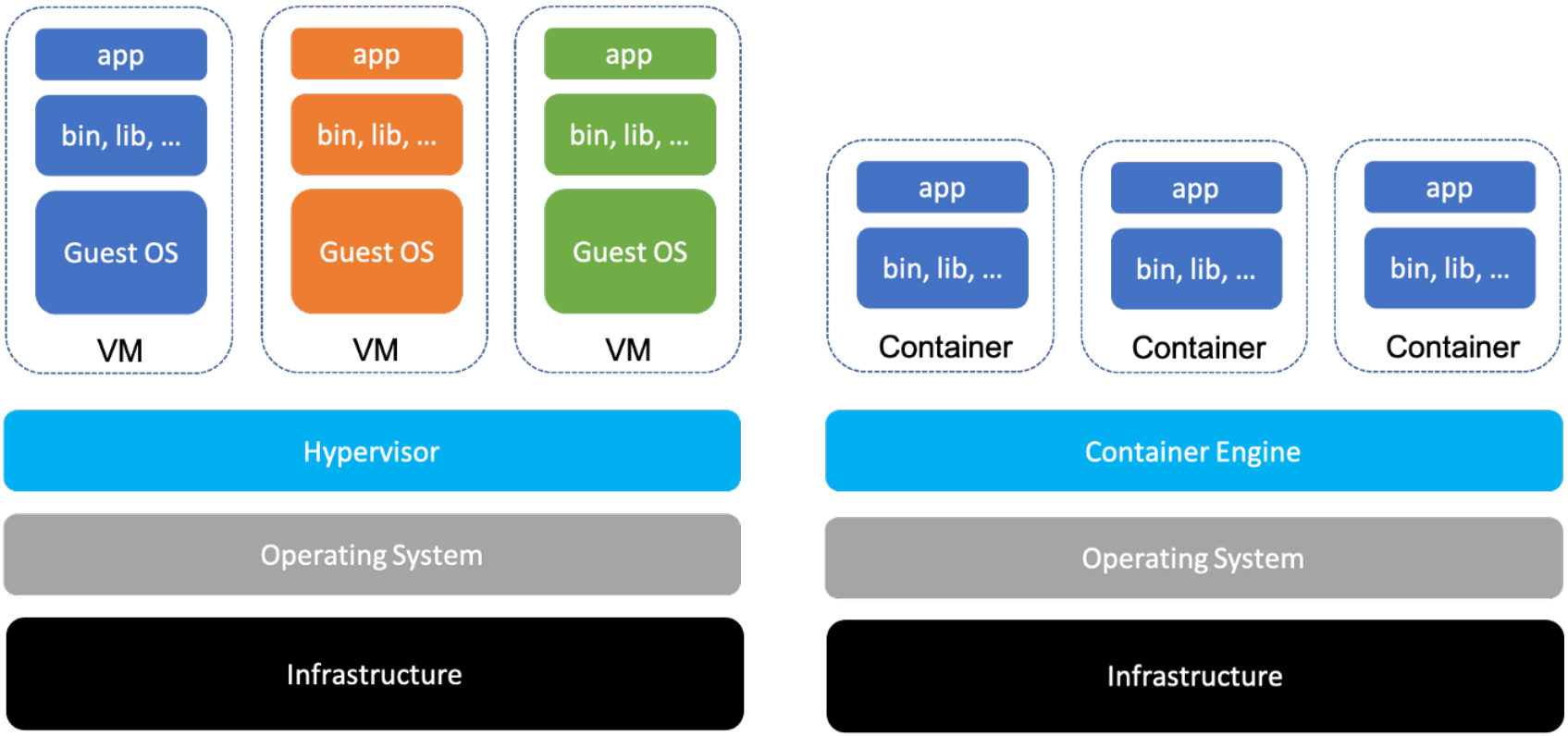


Figure 2: virtualization v. container

Why?

- Contain or limit access of running code (isolation)
- Efficient use of hardware ($$)
- Software Defined ***X***
- Hardware independence
- Portability
- Testing (patches, updates, security controls, etc.)
- Sandboxing (secure isolation)

Helpful hints

- Split hardware virtualization into 3 broad categories
  - Computing (CPU/GPU/RAM requirements)
  - Storage
  - Networking
- Container or VM ?'s
  - Do you care at all abouit the OS?
  - Do you need to SSH into the system often?
  - Is what you are doing dangerous?
- What hypervisor/container engine to use
  - Hypervisor, who cares
  - Container engine: do your research

Virtual Machine Security

- Virtual machine security **is** host system security
  - Patch your (virtual) OS
  - Patch your host OS while you're at it
  - Only difference is the addition of a hypervisor
    - Patch that too...

Virtual Machine security issues

- Hypervisor (updates/vulnerabilities)
- Isolation failure (escape)
- Misconfiguration (Firewall/network/etc.)
- Offline file access (VM not running)
- Malicious VM image
- Complexity

Container Security

- Container security is *mostly* just application security
- Container *engine* security has more complexity
  - Image risks
  - Registry risks
  - Orchestrator risks

Cloud computing

Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction.

Cloud Computing Characteristics

- On-demand self-service
- Broad network access
- Resource pooling (shared tenancy)
- Rapid elasticity
- Measured service

Cloud Service models

- Software as a Service (SaaS)
- Platform as a service (PaaS)
- Infrastructure as a Service (Iaas)
- ***X*** as a Service (***X***aaS)

Cloud Deployment models

- Private cloud (single organization / tenant)
- Community cloud (multiple organizations / tenants that share interest)
- Public cloud (mulitple unrealted orgs/tenants)
- Hybrid cloud (two or more of the above presented to a user as one cloud)

Overall Security issues

- Multi-tenancy
  - Other users and code running on same hardware
- Namespaces (containers)
  - PID namespace
  - User namespace
- Data security
  - Data is accessible when VM/container is not running

What every CS/Cyber/IT student should know

- Install a hypervisor (virtualbox)
- setup a virtual machine (Kali/windows)
- configure a virtual network (malware or testing?)
- choosing a container engine (docker/singularity)
- defining a container
- identify resource requirements of virtualization (do you have enough resources?)
- choosing a cloud provider to meet resource requirements
- Software Defined ***X***

Further Reading

- https://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.800-190.pdf
- https://csrc.nist.gov/publications/detail/sp/800-144/final
- https://nvlpubs.nist.gov/nistpubs/Legacy/SP/nistspecialpublication80145.pdf
- https://spring-gcp.saturnism.me/deployment/docker/container-awareness
- https://en.wikipedia.org/wiki/OS-level_virtualization
- https://netflixtechblog.com/evolving-container-security-with-linux-user-namespaces-afbe3308c082
- https://info.aquasec.com/open-source-trivy?keyword=trivy%20container%20scanner&campaignID=12411515%20Image%20Scanning_US_Wave&utm_medium=cpc&utm_term=939707901794&gclid=Cj0KCQiAkZKNBhDiARIsAPsk0Wh8bozycdBR