(Kernel) Isolation – PV, HVM, OS-V technologies in Linux

Introduction and description of the isolation differences between HM, PV and OS-level virt. technologies.

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Paravirtualization

Paravirtualization (a.k.a. PV - Xen)

- Not kernel module, uses a hypervisor(domain 0)
- Guest OS has to be **aware** of the fact it is being paravirtualized(Kernel 3.0+).
- Hypervisor provides ABI to communicate and Guest OS calls it

Paravirtualization (a.k.a. PV)

- “No” Performance losses (direct access to resources)
- Faster boot - Can boot kernel directly (no bootloader)
- Guests uses **own** kernel
- Isolation on the underlying OS – processes could be secured by Apparmor/Selinux

Hardware-assisted virtualization

Hardware-assisted virtualization (a.k.a. HVM)

For example: KVM or Xen

- **Using „hypervisor“ – guests are completely isolated**
  binary translation to trap and virtualize non-virtualized instructions => emulation
- Has own bootloder
- Has own kernel
- **Not** modified OS.

Hardware-assisted virtualization (a.k.a. HVM)

- All resources are handled in-directly through emulation.
- Nowadays **PVHVM** can be used if OS supports it (Kernel 2.6.32+)
- Needs CPU flags (Intel *vmx* | AMD *svm*)

Operating-system-level virtualization

Operating-system-level virt. (a.k.a. containers)

When we talk about containers we can think about a book in a shelf. There are multiple chapters in the book. Every chapter has a different "story" but they belong to the same piece of book.

Operating-system-level virt. (a.k.a. containers)

- Sometimes called as "**jail on steroids**".
- Containers provide an additional layer of the security by isolating resources on a OS level
- Can be used together with apparmor/SELinux to enhance security

Operating-system-level virt. (a.k.a. containers)

- Solves issues with shared libraries(multiple versions) and helps with keeping OS clean
- Easily destroyed
- Sharing the kernel with the host

Differences between virtual machines & containers

Differences between virt. machines & containers

- VMs are "heavier" to setup/start - in general
- OS boot takes up to minutes (PV/HVM difference)
- HW isolation on a hypervisor level(HVM/PV/PVHVM)
- Qemu process represents virtual machine, storage backend involved

Differences between virt. machines & containers

- Lightweight(MiB-"hundreds of MiB")
- Can be application oriented
- Isolation on an OS level - process tree

Containers technologies

Containers technologies

- chroot **1982*
- OpenVZ **2005*
- lxc(lxd) **2008*
- docker **2013*
- systemd-nspawn **2013*

Containers technologies

chroot **1982*

- partial file system isolation
- nested virtualization

Containers technologies

OpenVZ **2005*

- file system isolation
- disk quotas (ZFS)
- IO limiting
- memory limits
- cpu quotas
- network isolation
- partial nested virtualization
- live migration
- root isolation

Containers technologies

lxc(lxd) **2008*

- file system isolation
- partial disk quotas (lvm/btrfs)
- partial IO limiting (btrfs)
- memory limits
- cpu quotas
- network isolation
- partial nested virtualization
- root isolation

Containers technologies

docker **2013*

- file system isolation
- IO limiting (since 1.10)
- memory limits
- cpu quotas
- network isolation
- partial nested virtualization
- root isolation (since 1.10)

Containers technologies

systemd-nspawn **2013*

- file system isolation
- disk quotas
- partial IO limiting (systemd+Cgroups)
- memory limits (systemd+Cgroups)
- cpu quotas (systemd+Cgroups)
- network isolation
- nested virtualization
- root isolation

What are they using to isolate resources?

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- PID namespace - Process identifiers and capabilities
- UTS namespace - Host and domain name
- MNT namespace - File system access and structure

What are they using to isolate resources?

- IPC namespace -Process communication over shared memory
- NET namespace -Network access and structure
- USR namespace -User names and identifiers

What are they using to isolate resources?

- Cgroups

  Resource protection(cpu usage, memory usage, io)

When to choose containers and when vms

When to choose containers

- testing a new application(from source - from the internet)
- fast deployments - "iso" template for the application(or for whole cycle)

When to choose vms

- wider isolation(running in the process, access to resources is filtered/emulated HVM or through api/drivers PV)
- "sendboxes" for customers

Questions?

Sources:

https://en.wikipedia.org/wiki/Hardware-assisted_virtualization
https://en.wikipedia.org/wiki/Operating-system-level_virtualization
http://www.linux-magazine.com/Issues/2016/184/systemd-nspawn

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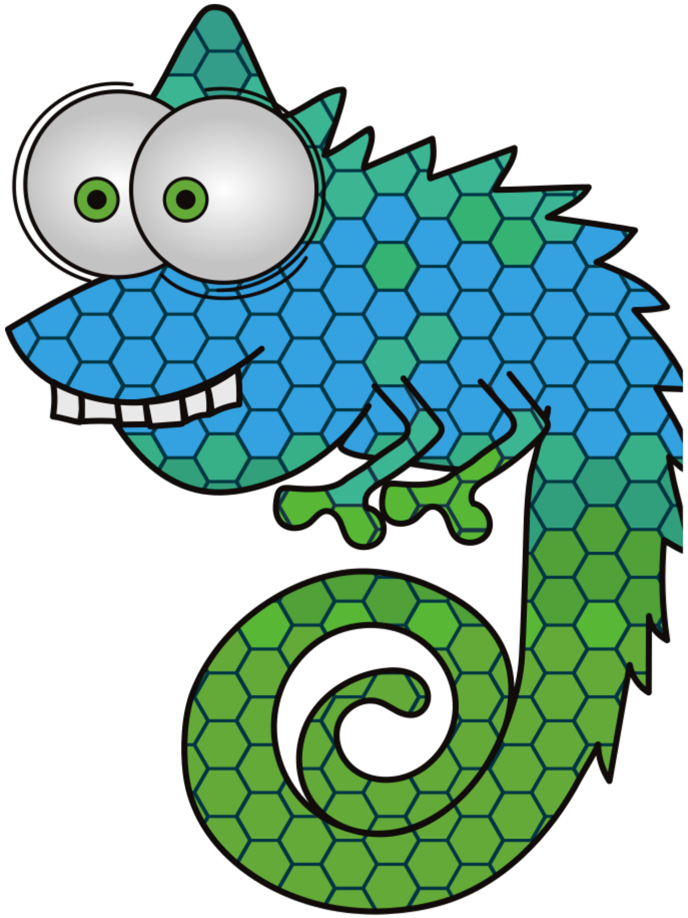
Thank you



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