Containers and Virtual Machines

Everything old is new again (not really)

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BioDec

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Where do they come from ?

- IBM ! IBM invented everything in the 60's.
- Not really, but in a sense . . . it comes from people who wanted to *run away* from IBM.
- Honeywell 200/2000 systems Liberator allowed people to run a virtual machine that emulated the IBM 14xx systems.

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The glorious 60's

- There were dozens (hundreds ?) of different hardware, all of them incompatible which each other.
- IBM wrote OS/360 to *rule them all* but . . .
- . . . people did not want to rewrite all their (working, legacy) software for the new platform.
- So IBM decided to support **virtual machines** to run its own OSs inside the OS/360.

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Hardware level emulation

- To run different computer architectures, with different instruction sets, memory models, etcetera, you need to emulate **the whole hardware**.

- So basically you have **two operating systems** one on top of the other.

- The upper OSs are called "operating system", sometimes **guest OSs**.

- The lower one is called **hypervisor** — but it is an operating system nonetheless.

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Hardware-based virtualization

To overcome the overhead of running an OS inside another OS, the hardware was changed to accommodate for special instruction sets:

- The Intel VT-x and AMD AMD-V are **processor extensions to the x86 architecture** — they were released in years 2005-2006.

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And the Cloud was built

- It is not an overstatement to say that the success of hardware-based virtualization and Linux support for it is demonstrated by the **mere existence of cloud technologies at all**.

- Cloud computing would have been **impossible** without hardware-based virtualization and **free software**.

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chroot (and its user space command) was created for the following reasons:

- ▶ to run untrusted code,
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Jails

In 1999 we added a partitioning facility to FreeBSD called jail(2). It reuses the chroot(2) implementation, but prevents well-documented means to escape chroot confinement. Jail offers semi-permeable partitioning of the file system, process, and networking namespaces, and removes all super-user privileges that would affect objects not entirely inside the jail.

Building Systems to be Shared Securely, Poul-Henning Kamp, ACM Queue July/August 2014.

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FreeBSD Jails

The FreeBSD "Jail" facility provides the ability to partition the operating system environment, while maintaining the simplicity of the UNIX "root" model. In Jail, users with privilege find that the scope of their requests is limited to the jail, allowing system administrators to delegate management capabilities for each virtual machine environment. Creating virtual machines in this manner has many potential uses; the most popular thus far has been for providing virtual machine services in Internet Service Provider environments.

Confining the Omnipotent Root, Poul-Henning Kamp and Robert Watson, Sane 2000.

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Jails *are* for virtual machines

- "(. . .) to delegate management capabilities for each **virtual machine** environment."

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It seems like year 2016 !

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Zones

In year 2005, Sun Microsystems launched **Solaris Zones**:

> *Zones provide a means of virtualizing operating system services, allowing one or more processes to* ***run in isolation*** *from other activity on the system.*
> *This isolation* ***prevents processes*** *running within a given zone* ***from monitoring or affecting processes running in other zones***.

Virtualization and Namespace Isolation in Solaris (PSARC/2002/174), September 7, 2006.

Zones (continued)

>   *A zone is a "sandbox" within which one or more applications can run* **without affecting or interacting with the rest** *of the system.*
>   *It also provides an abstraction layer that* **separates applications from physical attributes** *of the machine on which they are deployed, such as physical device paths and network interface names.*

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Zones had just *one little limitation* . . .

- From the paper:

  > Zones do not present a new API or ABI to
  > which applications must be "ported"; instead, they
  > provide the standard Solaris interfaces and
  > application environment, with some restrictions.

- So, you are basically **running Solaris** — which is good
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- But people wanted to consolidate **Microsoft Windows**.

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Hardware-based virtualization took off, containers stagnated

- Being tied to the same OS of the underlying server meant that by year 2006 the containers adoption hit a wall.
- Some kind of support (*i.e.* Solaris' *branded zone*) allowed cross OS support, but without the simplicity of full machine virtualization.
- The market was dominated by Microsoft Windows machines, and Linux-based hypervisors became the *de facto* standard for running them.

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Over time a set of technologies entered the kernel:

- Control groups (cgroup).
- Namespaces.
- Copy-on-write storage:
  - AUFS, overlay (file level),
  - device mapper thin provisioning (block level),
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Container technologies without containers

From a presentation by Jérôme Petazzoni of Docker's fame:

- Even when you don't run containers . . .
- . . . you are in a container.
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- How do you do the same, in *container land* ?
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At the right time, in the right place

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- They succeeded **quite spectacularly**.
- And renamed the company as **Docker**.

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A solved problem was no more

- Linking *per se* was (is) a solved problem — at least since the 70s' but . . .

- . . . it is the software that has become more complicated: a modern (let's say web) project has *dozens* of different components, all of them talking each other over the network.

- The fault could be in part attributed by *hipster driven development* . . .

- . . . but reality is that there has been a huge driver towards **distributed software components**.

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Enter Docker

Conclusions

Where do we go from there

- ▶ Right now (February 2016) the ecosystem is complex, fragmented and always changing.

- ▶ Death by a thousand frameworks.

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- ▶ Containers are here to stay.

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Questions

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Thanks & see you soon …

Thanks for your attention !

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