CLOUD COMPUTING APPLICATIONS

Virtualization: Paravirtualization

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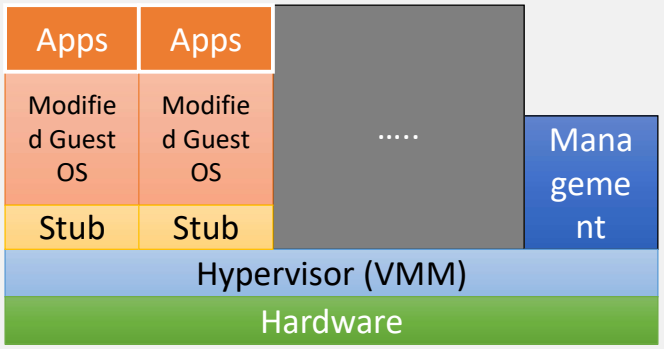
Software-only Virtualization

- Problem: x86 processors were not virtualizable until mid 2000s
- Software-only virtualization is a technique to go around the trap and emulate design of Popek and Goldberg
- Does not need special hardware support, e.g. the Intel "VT-x" or "AMD-V" features

Paravirtualization

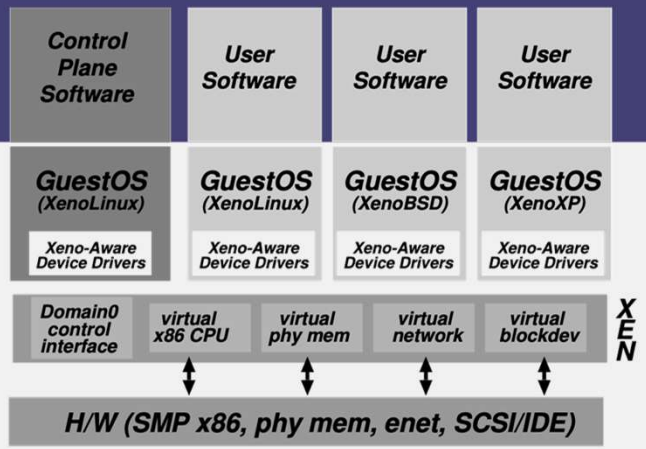
- First approach to software-only virtualization
- The virtual machine does not necessarily simulate hardware, but instead (or in addition), offers a special API that can only be used by **modifying** the "guest" OS
  - Paravirtualization is a technique in which a modified guest operating system kernel communicates to the hypervisor its intent to perform privileged CPU and memory operations
- The guest OS is specifically modified to run on a hypervisor
  - Windows 7 and newer
  - Linux Kernel version 3 and later
- Example:
  - XEN



Xen and the Linux Kernel

- Xen was initially a university research project
- Invasive changes to the kernel to run Linux as a paravirtualized guest
- Maintenance effort required on distributions
  - Support was added in mainstream Linux Kernel 3 (2012)
- Usually very fast → Trap and Emulate has overhead, paravirtualization eliminates traps
- Risk of distributions dropping Xen support

Xen Concepts



- Control Domain 0 a.k.a. Dom0
  - Dom0 kernel with drivers
  - Xen management tool stack
  - Trusted computing base
- Guest Domains
  - Your apps
  - For example, your cloud management stack
- Driver/Stub/Service Domain(s)
  - A "driver, device" model or "control service in a box"
  - De-privileged and isolated
  - Lifetime: start, stop, kill