Virtualization

Praktisches Linux, SS2008

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Agenda

- What is Virtualization?
- Overview of virtualization categories
- Virtualization of Operating Systems
  - System virtualization using a Virtual Machine Monitor (VMM)
- Virtualization solutions
- Virtualisierung with XEN and KVM
  - Guest creation with KVM

What is virtualization?

- Separation of an operating system from the underlying platform resources
- Virtualization of specific system resources
- Enables the sharing and/or aggregation of physical resources
- “Enable server, storage, and network resources to be deployed and managed as giant pools and seamlessly changed as needs change”

Benefits of virtualization

- **Partitioning**
  - Multiple applications and operating systems can be supported within a single physical system.
  - Servers can be consolidated into virtual machines on either a scale-up or scale-out architecture.
  - Computing resources are treated as a uniform pool to be allocated to virtual machines in a controlled manner.
- **Isolation**
  - Virtual machines are completely isolated from the host machine and other virtual machines. If a virtual machine crashes, all others are unaffected.
  - Data do not leak across virtual machines, and applications can only communicate over configured network connections.
- **Encapsulation**
  - Complete virtual machine environment is saved as a single file; easy to back up, move, and copy.
  - Standardized virtualized hardware is presented to the application, guaranteeing compatibility.

Overview of virtualization categories

- Software virtualization
  - **Virtualization of operation systems**
  - Application virtualization (z.B. Sandboxie, JavaVM)
- Hardware virtualization
  - System virtualization on hardware layer
  - Prozess virtualization
  - Memory virtualization
- Network virtualization (VLAN, VPN)

Virtualization of Operating Systems

- Methods
  - Hardware emulation (different CPU type)
  - Hardware virtualization (same CPU type)
  - Paravirtualization (ported operation system)
- x86 virtualization
  - Hardware-assisted virtualization
  - Instruction set extensions: AMD-V, Intel VT
  - Allows a virtual machine to run without significant emulation performance penalties

Virtualization solutions (I)

- XEN
  - Paravirtualizes hardware for guest systems
  - Very high performance
  - Host-Systems: Linux, BSD, OpenSolaris
  - Guest-Systems: Linux, NetBSD, Windows
    - Support for hardware virtualization techniques since version 3

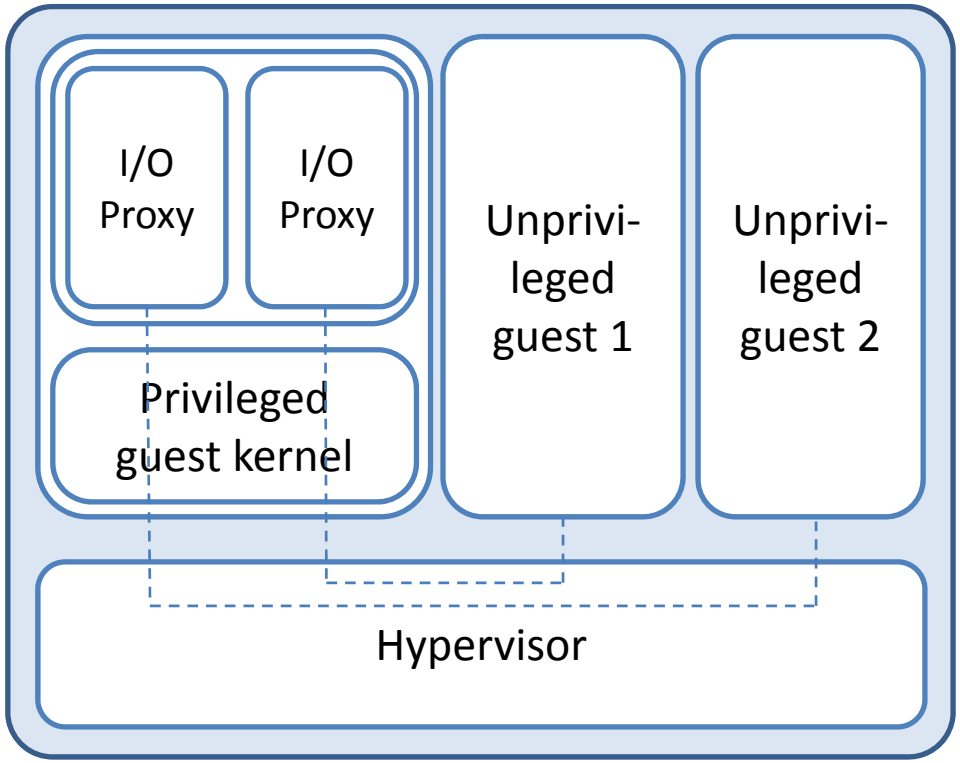
Virtualization solutions (II)

- QEMU
  - Emulates the complete hardware layer of a PC
  - Not restricted to x86 architecture
  - Host/Guest: Cross-platform (see homepage)
- KVM (Kernel-based virtual machine)
  - Requires a modified QEMU
  - Supports hardware virtualization techniques (Intel VT, AMD-V)
  - Host: Linux (Kernel modules)
  - Guest: Linux, Windows

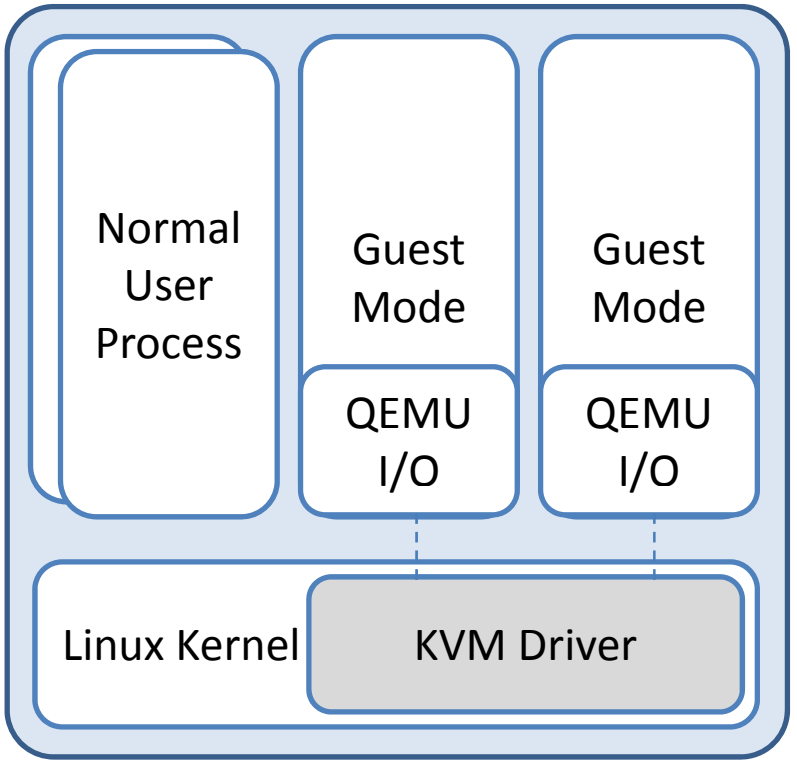
Virtualization solutions (III)

- VirtualBox
  - Runs on Windows, Linux, MaxOSX, Solaris
  - By Sun Microsystems, freely available as Open Source
- VirtualPC
  - Only for Windows hosts
  - By Microsoft ☹, freely available
- Parallels and VMWare
  - Commercial virtualization solutions
  - Large product portfolio for different areas of operation (desktop virtualization, server virtualization, data centers, etc.)

Hypervisor based architecture vs. KVM based architecture



Hypervisor based architecture (e.g. XEN)



KVM based architecture

Virtualization with XEN

- Type-1 hypervisor
  - software systems that run directly on the host's hardware
  - hardware control and guest operating system monitor
- First guest operating system (dom0)
  - Booted automatically
  - Special management privilegs
  - Direct (unlimited) access to physical hardware
  - Modified versions of Linux, NetBSD and Solaris can be used
- Other guest operation systems (domU)
  - Started by administrator from dom0

Virtualization with XEN: Howto

- Install Ubuntu Host System (dom0)
- Install XEN (e.g. from a binary package)
- Create an image with a Debian etch system (see manpage for detailed description of xen-create-image command)
```
xen-create-image –hostname=xen1.example.com –size=2Gb –swap=256Mb –die –ip=192.168.0.101 –netmask=255.255.255.0 –gateway=192.168.0.1 –force –dir=/vserver –memory=32Mb –arch=i386 –kernel=/boot/vmlinuz-2.6.18-xen –debootstrap –dist=etch –mirror=http://ftp2.de.debian.org/debian/
```
- Start the virtual machine
```
xm create /etc/xen/xen1.example.com.cfg
```
- Login to the virtual machine
```
xm console xen1.example.com
```
- Shutdown the virtual machine
```
xm shutdown xen1.example.com
```

Virtualization with KVM

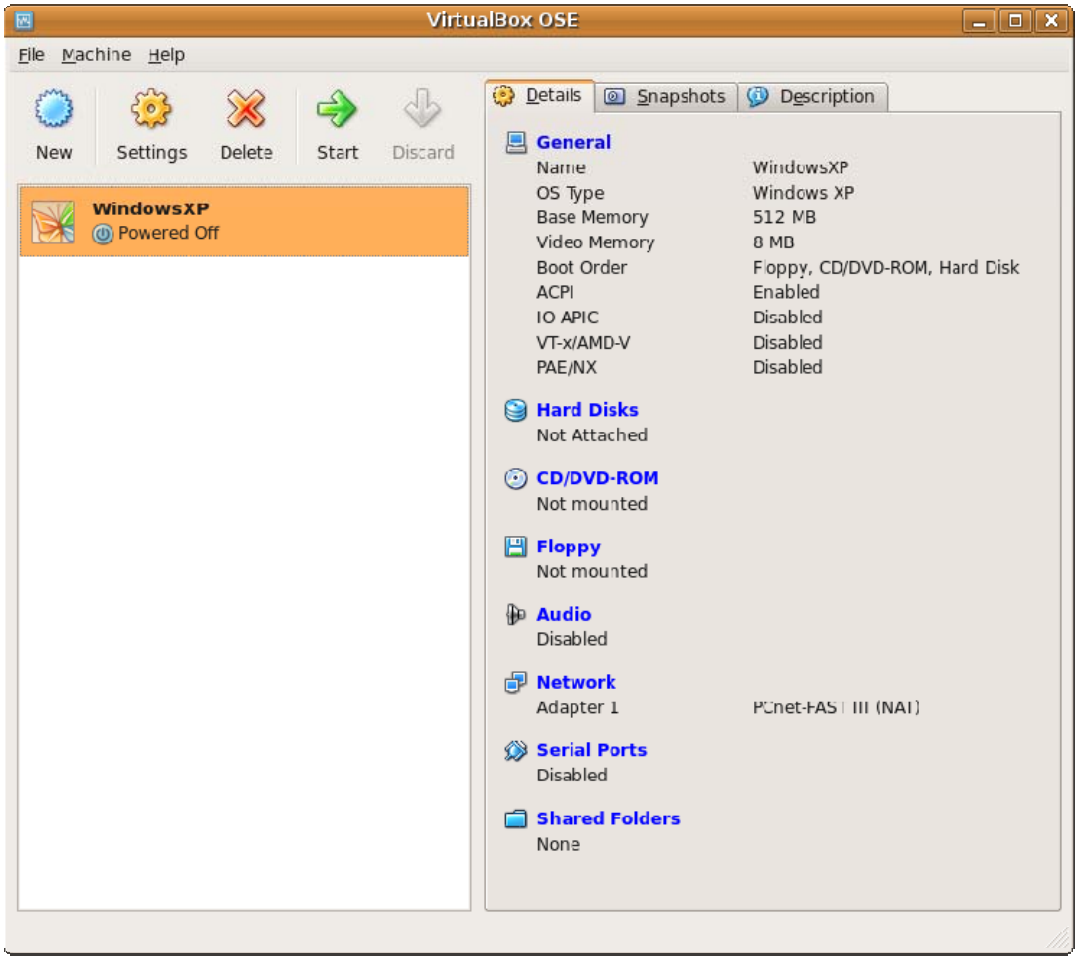
- Adds virtualization capabilities to a standard Linux kernel
- Components
  - device driver for managing the virtualization hardware.
  - user-space component for emulating PC hardware (modified QEMU process)
- Minimal system privilege footprint: only host kernel and kernel mode driver have unlimited hardware access

Virtualization with KVM: Howto

- Install KVM package (e.g. with apt-get)
- Create an image file for the virtual hard disk
  `qemu-img create -f qcow2 disk.img 4G`
- Start the virtual machine
  `kvm -m 512 -hda disk.img –cdrom ubuntu.iso -boot d -smp 2`
  - -m = memory (in MB)
  - -hda = first hard drive (many image file types supported)
  - -cdrom = ISO-Image or CD/DVD drive
  - -boot[a|c|d] = boot from Floppy (a), Hard disk (c) or CD-ROM (d)
  - -smp = number of CPUs

Virtualization with VirtualBox: Howto

- Creation of new virtual machines very simple (GUI)
- Pre-defined configurations for many operating systems
- Mount images files or physical CDROM drives to install OS
- Machines can also be created and run using command line tools (VBoxManage)



References

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- **Hardware-assisted virtualization:** http://en.wikipedia.org/wiki/Hardware-assisted_virtualization
- **Virtualization:** http://en.wikipedia.org/wiki/Virtualization
- **Platform Virtualization:** http://en.wikipedia.org/wiki/Platform_virtualization
- **Kernel-based Virtual Machine**: http://en.wikipedia.org/wiki/Kernel-based_Virtual_Machine
- **QEMU:** http://en.wikipedia.org/wiki/QEMU
- **XEN:** http://en.wikipedia.org/wiki/Xen