10 Years of Xen and beyond ...

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LINUX FOUNDATION
COLLABORATIVE PROJECTS

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FREENODE: lars_kurth
• Teams aka sub-projects
  – Hypervisor
  – XAPI
  – ARM Hypervisor (for Servers as well as Mobile Devices)
  – Mirage OS

• Governance: mixture between Linux Kernel and Apache
  – Consensus decision making
  – Sub-project life-cycle (aka incubator)
  – PMC style structure for team leadership
  – Funded by member companies (Advisory Board)
Xen contributor community is diversifying

- The number of “significant” active vendors is increasing
- New feature development driving new participation
Hypervisor Architecture
Hypervisor Architectures

Type 1: Bare metal Hypervisor
A pure Hypervisor that runs directly on the hardware and hosts Guest OS's.

Provides partition isolation + reliability, higher security
Hypervisor Architectures

Type 1: Bare metal Hypervisor
A pure Hypervisor that runs directly on the hardware and hosts Guest OS’s.

Provides partition isolation + reliability, higher security

Type 2: OS ‘Hosted’
A Hypervisor that runs within a Host OS and hosts Guest OS’s inside of it, using the host OS services to provide the virtual environment.

Low cost, no additional drivers
Ease of use & installation
Type 1: Bare metal Hypervisor

- VM0
- VM1
- VM2

Hypervisor

- Scheduler
- MMU

Device Drivers/Models

Host HW

I/O

Memory

CPUs

Guest OS and Apps

Type 1 with a Twist
Xen: Type 1 with a Twist

Type 1: Bare metal Hypervisor

Xen Architecture
Xen: Type 1 with a Twist

Type 1: Bare metal Hypervisor

Xen Architecture

Control domain (dom0)

Device Models

Drivers

Linux & BSD

Guest OS and Apps

VM$_n$

VM$_1$

VM$_0$

Guest OS and Apps

Drivers

Device Models

VM$_n$

VM$_1$

VM$_0$

Guest OS and Apps

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I/O

Memory

CPUs

Host HW

I/O

Memory

CPUs

Host HW

Scheduler

MMU

Hypervisor

Device Drivers/Models

Scheduler

MMU

Hypervisor

Device Drivers/Models
Xen Project and Linux

- Xen Hypervisor is **not** in the Linux kernel
- **BUT**: everything Xen and Xen Guests need to run is!
- Xen packages are in all Linux distros (except RHEL6)
  - Install Dom0 Linux distro
  - Install Xen package(s) or meta package
  - Reboot
  - Config stuff: set up disks, peripherals, etc.

More info: wiki.xen.org/wiki/Category:Host_Install
Basic Xen Concepts

**Control Domain aka Dom0**
- Dom0 kernel with drivers

**Guest Domains**
- Your apps
Basic Xen Concepts

**Console**
- Interface to the outside world

**Control Domain aka Dom0**
- Dom0 kernel with drivers
- Xen Management Toolstack

**Guest Domains**
- Your apps
**Basic Xen Concepts**

**Console**
- Interface to the outside world

**Control Domain aka Dom0**
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**Guest Domains**
- Your apps

**Driver/Stub/Service Domain(s)**
- A “driver, device model or control service in a box”
- De-privileged and isolated
- Lifetime: start, stop, kill
Xen Variants for Server & Cloud

Hypervisor

Xen Hypervisor
Xen Variants for Server & Cloud

- **Hypervisor**
  - **Toolstack / Console**
  - **Xen Hypervisor**
    - Default / XL (XM)
    - Libvirt / VIRSH
    - XAPI / XE

  - Increased level of functionality and integration with other components

- Single Host
  - Basic Functions
- Single Host
  - Additional Functionality
- Multiple Hosts
  - Additional Functionality
Xen Variants for Server & Cloud

Hypervisor

Toolstack / Console

Xen Hypervisor

Default / XL (XM)

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Increased level of functionality and integration with other components

Single Host Basic Functions

Single Host Additional Functionality

Multiple Hosts Additional Functionality
Xen Variants for Server & Cloud

- **Project**
  - Toolstack / Console
  - Products

- **Xen Hypervisor**
  - Default / XL (XM)
  - Libvirt / VIRSH
  - XAPI / XE

Increased level of functionality and integration with other components

- **Products**
  - Oracle VM
  - Huawei UVP
  - Citrix XenServer
Xen Variants for Server & Cloud

- **Project**
- **Toolstack / Console**
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  - Libvirt / VIRSH
  - XAPI / XE
- **Products**
  - Oracle VM
  - Huawei UVP
  - Citrix XenServer

Increased level of functionality and integration with other components

Used by ...

- amazon web services™
- Cloud Servers
- Custom server instances on demand
Xen: Types of Virtualization
PV Domains

Technology:
- Paravirtualization

Linux PV guests have limitations:
- limited to a subset of set of virtual HW

Advantages
- Fast
- Works on any system (even without virt extensions)
PV Domains & Driver Domains

Technology:
- Paravirtualization

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Advantages
- Fast
- Works on any system (even without virt extensions)

Driver Domains
- Security
- Isolation
- Reliability and Robustness

*) Can be MiniOS
### Technology:
- Shows emulation using QEMU/Device Model (SW Virtualization)
- In other situation HW can be used

### Disadvantages
- Emulation slower than PV (mainly I/O devices)

### Advantages
- No kernel support needed
HVM & Stub Domains

Technology:
- Shows emulation using QEMU/Device Model (SW Virtualization)
- In other situation HW can be used

Disadvantages
- Emulation slower than PV (mainly I/O devices)

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Stub Domains
- Security
- Isolation
- Reliability and Robustness
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**New in Xen 4.4**

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# The Virtualization Spectrum

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- **Optimal performance**
- **Scope for improvement**
- **Poor performance**

- **HVM mode/domain**
- **PV mode/domain**
The Virtualization Spectrum

- **Fully Virtualized (FV)**: Optimal performance
  - VS (VS)
  - VS (VS)
  - VS (VS)
  - VH (VH)

- **FV with PV for disk & network**: Scope for improvement
  - P (P)
  - VS (VS)
  - VS (VS)
  - VH (VH)

- **PVHVM**: Poor performance
  - P (P)
  - P (P)
  - VS (VS)
  - VH (VH)

- **PVH (Xen 4.4)**: Poor performance
  - P (P)
  - P (P)
  - P (P)
  - VH (VH)

- **Fully Paravirtualized (PV)**: Poor performance
  - P (P)
  - P (P)
  - P (P)
  - P (P)

**Important**: Xen automatically picks the best option based on HW & OS capabilities and available drivers.

As a Xen user I chose a HVM or PV domain.
XAPI, XCP and XCP-XAPI: What is it?

**Hypervisor**
- Xen Hypervisor

**Toolstack / Console**
- Default / XL (XM)
- Libvirt / VIRSH
- XAPI / XE

**Single Host**
- Basic Functions

**Single Host**
- Additional Functionality

**Multiple Hosts**
- Additional Functionality

Increased level of functionality and integration with other components.
XAPI : What do I get?

- VM lifecycle: live snapshots, checkpoint, migration
- Storage XenMotion: Migrate VMs between hosts or pools without shared storage (while the VM is running)
- Resource pools: flexible storage and networking
- Event tracking: progress, notification
- Upgrade and patching capabilities
- Real-time performance monitoring and alerting
- Templates for Windows and Linux guests
- Open vSwitch support built-in (default)

More info: wiki.xen.org/wiki/XCP_Release_Features
XAPI: two variants!

- XCP ISO (at v1.6)
  - Xen 4.1.3 + XAPI
  - CentOS 5.3
  - Kernel (v2.6.32.43)
  - OVS 1.4.2

- XCP-XAPI packages
  - Debian Wheezy
  - Ubuntu 12.04 LTS
  - Others in progress...
XAPI: Orchestration and UIs

Apache CloudStack
Open Source Cloud Computing

OpenNebula.org

OpenStack

Xen Hypervisor

XAPI / XE

Multiple Hosts
Additional Functionality

Xen Orchestra

Xen Project
Other XEN Cloud Orchestration

- Single Host
  - Basic Functions
    - XM or XL
  - Xen Hypervisor

- Single Host
  - Additional Functionality
    - Libvirt
  - Xen Hypervisor

Projects:
- OpenNebula.org
- Eucalyptus
- OpenStack
Challenges for FOSS hypervisors
“Security and QoS/Reliability are amongst the top 3 blockers for cloud adoption”

www.colt.net/cio-research
System characteristics cloud users care about: “Robustness, Performance, Scalability & Security”

Results XCP User Survey 2013 – 90% of users quoted these as most important attributes
Disaggregation

Split Control Domain into Driver, Stub and Service Domains

– See: "Breaking up is hard to do" @ Xen Papers
– See: “Domain 0 Disaggregation for XCP and XenServer”

Used today by Qubes OS and Citrix XenClient XT

Prototypes for XAPI

See qubes-os.org

Different windows run in different VMs
Benefits of Disaggregation

More Security

Increased serviceability and flexibility

Better Robustness

Better Performance

Better Scalability

Ability to safely restart parts of the system (e.g. just 275ms outage from failed Ethernet driver)
Next: XAPI Architecture Diagram Before and After Disaggregation
Xen Security Advantages

- Even without Advanced Security Features
  - Well-defined trusted computing base (much smaller than on type-2 HV)
  - Minimal services in hypervisor layer

- Xen Security Modules (or XSM) and FLASK
  - XSM is Xen equivalent of LSM
  - FLASK is Xen equivalent of SELinux
  - Developed, maintained and contributed to Xen by NSA
  - Compatible with SELinux (tools, architecture)
  - XSM object classes maps onto Xen features

More info: http://www.slideshare.net/xen_com_mgr/a-brief-tutorial-on-xens-advanced-security-features
Xen Advanced Security Recipes

• Xen has many Security Features (besides the ones I covered)
• Most are not switched on by default
• Although most are simple to use, some seen complicated

See: http://www.slideshare.net/xen_com mgr/
a-brief-tutorial-on-xens-advanced-security-features

And more are be coming!
ARM Hypervisor
In depth presentation tomorrow …

Xen on ARM

• by Stefano Stabellini – Xen and Xen-ARM Linux maintainer
• New York III from 10:45 to 11:30
• Including a demo

One mode to rule them all
Mirage OS
Library Operating Systems

Application stacks only running on Xen APIs
Works on any Xen based cloud or hosting service

Examples
– ErlangOnXen.org : Erlang
– HalVM : Haskell
– Mirage OS : Ocaml

Benefits:
– Small footprint
– Low startup latency
– Extremely fast migration of VMs
Mirage OS

• Recently added to Xen Project incubator
• In beta stage: first release on its way (July 2013)
• Clean-slate protocols implementations, e.g.
  – TCP/IP, DNS, SSH, Openflow (switch/controller), HTTP, XMPP, ...
  – New applications using next generation XAPI (disaggregated XAPI architecture)

Hot Topics and Projects
Xen 4.3 Release (June 2013)

- Release candidates & Xen Test Days (today, June 5th)
- Xen ARM for Servers
- Extend scope of Xen Security Modules
- Default to QEMU upstream
- Updated and improved libvirt drivers for Xen
- Lots of other stuff:
  - scalability, performance, better NUMA support, ...

“For about a year members of the Xen Project, the CentOS community and large Xen Users have worked on bringing Xen and XAPI to CentOS 6”

Driven by demand from the community:

- Can run Xen on CentOS 6 today, but non-trivial
- We wanted “YUM INSTALL XEN”
- Mostly a packaging problem
- Teams from CentOS, Citrix, Go Daddy & Rackspace
- QA and usability sanity checks
The Xen Community is Changing

“Growth is leading to more structure & more collaboration & more openness!”

- Establishing a shared and open test infrastructure
  - Goal: Increase development velocity
- Improved usability and better distro-integration
  - Xen + XAPI in CentOS 6.4
- More focus on downstreams
  - OpenStack and Xen Orchestra
  - Better libvirt and virt-manager integration
- Changing the XAPI / XCP release model
- Xen on ARM and collaboration with Linaro
Getting Started with Xen Projects

Online: xenproject.org > User & Help menus
- Mailing Lists and IRC
- Q&A System
- Find me and I can get you hooked up!

Events: xenproject.org/about/events.html
- Test Days (IRC at #xentest) ... today, June 5th
- Document Days (IRC at #xendocs) ... the next one is May 28th
- User (Sept 18, New Orleans) and Developer Summits (Oct 24-25, Edinburgh)
- Hackathons - last week search for “[Hackathon Minutes]” on xen-devel
• **News:** blog.xenproject.org
• **Web:** xenproject.org > Help
  – Help for IRC, Lists, ...
  – Stackoverflow like Q&A
• **Wiki:** wiki.xenproject.org
• **Presentations:** slideshare.net/xen_com_mgr
• **Videos:** vimeo.com/channels/xen

Thank You!

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