Graduate Operating Systems

Spring 2023

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Paper “Architecture”

- Interoperability, impregnability, versatility
- Interfaces (ISA) & abstractions (files)
- Virtualization vs. abstraction
- Architecture vs. implementation
- ISA, ABI, API
- Process vs. system

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Paper “Architecture”

- Process VM = execute individual process
- System VM = complete system environment
- Guest, host, run-time, VMM

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Paper “Architecture”

- Process VM
  - Replication: multiprogramming
  - Emulation: different HW, interpretation, dynamic binary translation (+ cache)
  - Optimization: same-ISA optimizers
  - High-level language VM

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Paper “Architecture”

- System VM
  - Multiple, isolated guest OSes
  - Isolation, platform replication
  - Classic system VMs
  - Hosted VMs
  - Whole-system VMs
  - Multiprocessor virtualization
  - Codesigned VMs

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Paper “Xen”

- Goals of Xen; challenges of VMs
- Resource containers
- Accounting issue, QoS crosstalk issue

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Paper “Xen”

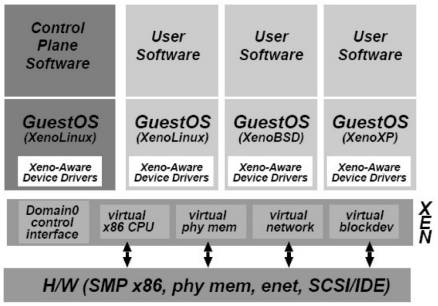

Figure 1: The structure of a machine running the Xen hypervisor, hosting a number of different guest operating systems, including *Domain0* running control software in a XenoLinux environment.

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Paper “Xen”

- Memory management
  - TLB: SW/HW, tagged/flush
  - Push page table responsibility to guest OS
  - Xen avoids TLB flush
    - Give guest OS control over page table management
    - Protect Xen from triggering flushing

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Paper “Xen”

- CPU management
  - Privilege levels
  - Validate privileged calls by Xen
  - System calls handled without Xen involvement
- I/O management
  - Xen does not emulate devices
  - Uses shared-memory buffer-descriptor rings

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Paper “Xen”

- Hypercalls and events
- I/O rings
- BVT scheduling
- Virtual address translation
- Physical memory
- Virtual firewall-router
- Disk

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