Hot Topics
(CSE 422S)

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Topics

- Chip Multiprocessors
  » Increasing clock speed ➔ Increasing power/heat
  » Want higher speed but at about same power as 1 CPU
  » Multiple CPU/caches and memory attached to interconnect

- OS Virtualization
  » Run multiple commodity OSes on the same hardware instance
    • e.g., XP and Linux on the same x86 processor
  » Want resource isolation and performance guarantees
  » OSes sit on top of a Virtual Machine Monitor

OS Virtualization

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<th>VMs (Guest OSes)</th>
<th>User Software</th>
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<td></td>
<td>Linux</td>
<td>BSD</td>
<td>Win XP</td>
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<th>VMM</th>
<th>virtual x86 CPU</th>
<th>virtual phy mem</th>
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- Virtual Machine Monitor (VMM)
  » Provides the illusion of many virtual machines
  » Enables server consolidation, application mobility, new distributed (Internet) services

Paravirtualization

- Def. Provide a VM abstraction that is similar but not identical to the underlying hardware

- Want
  » No modifications to application binaries
  » Support for full multi-application OSes
  » High performance and strong resource isolation

- Examples
  » Xen, Denali, VMware
Xen x86 Interface (1)

- **Memory Management**
  - Most difficult part of paravirtualization
  - x86 doesn't have software-managed TLB
  - TLB misses serviced by processor walking the page table
  - x86 TLB doesn't have identifier tags
  - Address space switches require complete TLB flush
  - Top 64 MB is reserved for Xen and is not accessible to guest OSes
  - All page table and segment table updates are validated by Xen

Xen x86 Interface (2)

- **CPU**
  - Xen runs in privileged ring 0 (highest)
  - Guest OS runs in privileged ring 1
  - Applications run in privileged ring 3
  - Privileged instructions (e.g., install new page table) are validated and executed by Xen instead of Guest OS
  - Exception handling (e.g., memory faults, system traps)
    - Registered with Xen by each Guest OS
    - System calls handled by fast handler which doesn't go thru Xen
  - Interrupts
    - Replaced by lightweight event system
  - Time
    - Each Guest OS has a timer interface (real and virtual time)

- **Device I/O**
  - Data transferred using asynchronous I/O rings

References

- Whitaker, Shaw and Gribble, “Denali: Lightweight Virtual Machines for Distributed and Networked Applications”