Virtual Machines

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Outline

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- Disco
  - Why Disco?
  - What Disco virtualizes
  - Page Replication/Sharing
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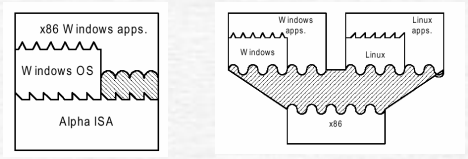
- Co-designed VM
  - Advantages
  - Key aspects
  - Critique
- Questions

Virtual Machines

Interface to conventional software presented by hardware plus translating software – J.E. Smith

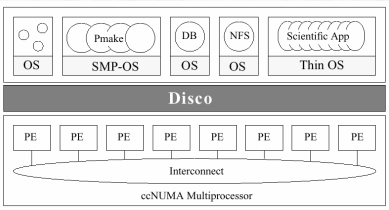
- Virtualization- Adds Level of Indirection
  - Examples: Virtual Memory, Compilers
- Advantages: Flexibility and Portability
- Disadvantages: Additional overhead

Classes of Virtual Machines



ABI VM ISA VM

Disco – Virtual Machine Monitor



Why Disco?

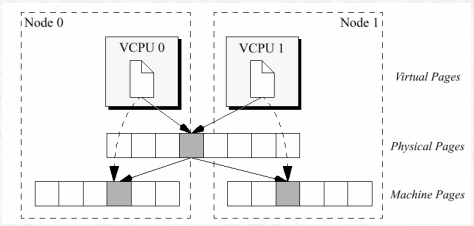
- Highly flexible – different OSes on same hardware
- Minimal changes to existing OS code
- Higher reliability and availability
- Fault containment
- Highly scalable
- Fine grain resource sharing potential of hardware

Virtualization

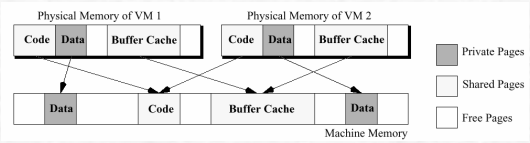
- Disco virtualizes: CPUs, Physical Memory, I/O devices
- Example: TLB Entry

VA	PA	Conventional
VA	MA	Disco

Page Replication



Page Sharing

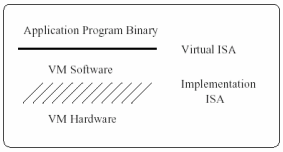


Disco Paper Critique

- Strengths
  - Innovative method of using commodity operating systems on large scale machines.
  - Novel way of hiding NUMA-ness.
  - Detailed breakdown of overheads and performance improvements.
- Weaknesses
  - Don't demonstrate advantage of 8 copies of IRIX on FLASH vs. 8 workstations running IRIX.
  - Only demonstrate scalability for pmake workload

Co-Designed Virtual Machines

- Use a VM to improve performance over existing ISA's.
  - V-ISA is the ISA presented to software
  - I-ISA is the ISA implemented by hardware
- VM mediates between V-ISA and I-ISA and uses specially designed I-ISA features to optimize running code.



Advantages of Co-Design

- Software VM can perform complex analysis and optimization that can't be done in hardware
- VM can modify existing binaries to take advantage of new hardware features as they are developed

Example Optimization

1. VM analyzes running application
2. Determines optimum length of branch predictor global history
3. VM uses special instruction is I-ISA to set global history length for that specific application.

Key aspects of Co-Design

- Hardware provides
  - Performance information
  - Ability to reconfigure aspects of the processor
- Software performs
  - Analysis
  - Optimization
    - Dynamic compilation
    - Rearrange memory to improve locality
  - Re-configuration

Critique of VM Co-Design

- Strengths
  - Suggests that performance enhancement is an important goal for VMs - an interesting direction for further research
- Weaknesses
  - Paper explanation of how to implement suggested optimizations
  - No experimental results.

Questions

- What hooks could hardware provide that would help a VM optimize for CMPs?
- What I-ISA and VM would be best for a java bytecode V-ISA?
- What features of a CMP could be virtualized?
  - For the OS?
  - For the compiler/programmer?
- Is the VM a suitable place to implement dynamic reconfiguration in reconfigurable architectures
  - What could the VM detect?
  - What hardware hooks would be useful?
- Could you do replication/migration between nodes in a CMP? (RAW? Smart Memories? TRIPS?)