Evolution of Virtual Machine Technologies for Portability and Application Capture

Bob Vandette
Java Hotspot VM Engineering
Sept 2004
Topics

- Virtual Machine Evolution
  - Timeline & Products
  - Trends forcing change
  - Technical Challenges

- Java Virtual Machines
  - Successes
  - Todays Challenges
  - Visions of Tomorrow
Virtual Machines Benefits

- Bridging old and new architectures
  - Does anyone remember CP/M?

- Bringing applications to new platforms
  - MS-DOS & Windows Applications to Mac and Unix Workstations

- Providing cross platform portability
  - ANDF, Java
Timeline of Virtual Machine Products

- **1980's**
  - Hardware PC Co-Processors (SunPC)

- **1990's**
  - VP/ix (Virtual x86 mode) (Sun386i)
  - Software PC Co-Processors (RISC - SunPC)
  - Wabi (Windows API Translation)

- **2000**
  - Java Virtual Machines

- **2004**
  - Java 2 Standard Edition 5.0
Hardware PC Co-Processors

- **Description**
  - PC add-on card providing sufficient hardware and supporting logic to provide a virtual MS-DOS environment when coupled with supporting emulation software.

- **Target Host**
  - Unix based Workstation running Unix or some other non PC compatible OS.

- **Benefit**
  - Increased application coverage
  - Excellent compatibility

- **Con**
  - Costly, long design time
Virtual 86 Mode (VP/ix)

● **Description**
  – Intel 80386/80486 Virtual 86 Mode product providing real-mode MS-DOS application compatibility on x86 Unix platforms. (Similar to Microsoft Windows DOS box).

● **Benefit**
  – Provided Multi-Tasking of Unix and MS-DOS apps on a single platform with minimal performance degradation.
  – Best Cost/Performance/Resource usage solution

● **Con**
  – Could not efficiently host protected mode x86 operating systems.
Software PC Co-Processors

- **Description**
  - A complete virtualization of the hardware contained in a PC. Including a JIT to compile x86 binary instructions into the native processors ISA.

- **Benefit**
  - Low cost, easy to upgrade

- **Con**
  - Performance on all but the fastest RISC processors was not equivalent to available PC performance at the time.
  - Considerable overhead for emulating protected mode and high end graphics features of the x86 processor.
Wabi - API Translation

- **Description**
  - Product targeted at running Windows Productivity Applications on Unix workstations (Both RISC and x86 based).
  - Translates Windows APIs to native services in order to achieve native performance levels.
  - Used multi stage JIT to translate application instructions (non x86 platforms)

- **Benefits**
  - Low Cost, High Performance
  - Excellent application integration

- **Cons**
  - Limited Application Compatibility
Technical Challenges

- Device Emulation
  - VGA/XGA emulation
  - Protected Mode Emulation
  - Tradeoff trapping time vs hardware cost

- CPU Simulators/Translators
  - Startup time due to JIT compilation
  - Large memory footprint
Todays Virtual Machines

- Java Virtual Machines
  - Complete Multi-threaded portable language and application platform.
  - Interpreted and native method compilation
- New Features
  - Garbage Collection
  - Multi-Threading Built it
  - Sync primitives part of core language
- Benefits
  - Cross platform portability
  - Security
  - Scalable from low to high end devices
Today's Successes

- Top problems have had much research and successful product deployment
  - Synchronization
  - Garbage Collection
  - Code generation quality

- These continue to be areas of competitive focus but other areas are now gaining attention
Todays Challenges

- Startup
- Observability
- Ergonomics
- Cross Platform Compatibility
- Predictability
- 99.99999999% Reliability
- Resource Utilization
Visions of Tomorrow

- Startup Solutions
- Observability
- Ergonomics II
- VMs as First Class Citizen of OS
Visions Cont..

- Faster startup solutions
  - Deferred initialization
  - Class file tuning
  - Class data sharing
  - Cached compilation decisions
  - Elimination of Interpreter
  - Multi-Tier Compilation
  - Multi-Tasking within VM
Vision cont ...

- **Observability**
  - As the stack of technologies increases, so does the complexity
  - Each element in the stack has its own tool to provide visibility
  - Integrated tools for entire stack are needed for global view and detailed drilling of specific details
Ergonomics II

- Todays Ergonomics is static
  - Doesn’t take into account other processes
  - Only makes decisions based on current snapshot
- Next generation will be more adaptive
  - Monitor health of VM and OS
  - Resources being utilized
  - Scale back or up depending on load
Half-Baked Vision of Tomorrow

- VMs as First Class Citizen of Operating System
  - VM's are not just applications
  - Reduce duplication of technologies
  - Faster start-up
  - Finer grained control
  - More predictable
  - Resources can be managed better
  - Reduces resources due to increased sharing
  - Consistent view and management of Java and native apps
Q & A

Bob Vandette
bob.vandette@sun.com
http://java.sun.com