2006

VMM - Virtual Machine Monitors (archived)

The Center for Information Systems Security Studies and Research
RESEARCH: Projects - VMM

Virtual Machine Monitors

This research addresses the problem of implementing secure Virtual Machine Monitors (VMM) on the Intel Pentium architecture. A VMM allows multiple operating systems to run concurrently under virtual machines on a single workstation. High-assurance VMMs could allow complete isolation of, or data sharing between, virtual machines according to a security policy such as a mandatory secrecy policy.

The Intel architecture was mapped to a set of hardware requirements for VMMs. It was found that the Intel architecture was not virtualizable. However, several techniques are presented that allow the Intel architecture to support a "virtual VMM". A Commercial virtual VMM was studied and found to be unable to support secure VMMs. Therefore; a foundation upon which a secure VMM could be built for the Intel Pentium architecture is presented.

A secure VMM for the Intel architecture offers several benefits. First, PC users could run familiar Commercial of the Shelf (COTS) operating systems and applications. Finally, secure VMMs could save the DoD millions of dollars by eliminating the need for separate systems when both high assurance and COTS operating systems and applications are required.

What is a Virtual Machine Monitor?

- A program that creates efficient, isolated duplicates of the real machine
- Mediates these duplicates (virtual machines) and actual computer system resources

Motivation

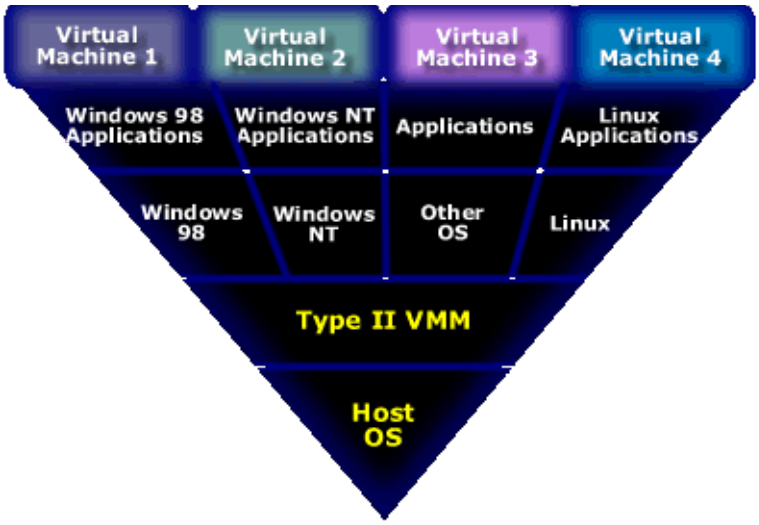
- High assurance VMMs can be used to separate mandatory security classes

Problem

- Can a secure virttual machine monitor be desiged for the Intel architecture?

Types of Virtual Machine Monitors

- Type I: A VMM that runs on a bare machine
- Type II: A VMM that runs as an application on a host operation system



VMM Hardware Requirements

- Rough equivalence of a non-priveleged instruction execution is user and pribeleged mode: applies to a large subset of non-priveleged instructions
- Protection of real system and other VMs from the active VM: examples are a protection system or address translation system
- Method of automatically signaling VMM when a VM attempts to execute a sensitive instruction : VMM must be able to simulate the instruction

Sensitive instructions include those that:

- Attempt to change or reference the mode of the VM or state of the machine
- Reference the storage protefciton system, memory system, or address relocation system
- Look at or change sensitive registers
- Perform I/O

Issues

Claim: "VMware Virtual Platform is both a virtual machine monitor running directly on the hardware and a normal application running on top of the hoset operating system"

- Intel architecture violates rule 3 of the VMM hardware requirements because:
- Actual machine state is accessible in user mode
- Instructions exist that modify the state of x86 CPUs that can not be trapped

Claim: "Even rogue application or operating system is confined to the VMware Virtual Platform sandbox"

VMware Virtual Platform can not handle documented/undefined features of the PC hardware

VMware: A Type II VMM?

- VMware Virtual Platform is "a thin software layer that allows multiple operating system environments to run concurrently using the same hardware resources"

VMware provides:

- Transparent multiplexing of all hardware resources into multiple virtual machines
- Fault isolation and containment
- File and device sharing via multiple VM-unique network addresses
- Encapsulation and movement of VMs amound different physical machines

VMware supports:

- MS-DOS 6
- Windows 3.1
- Windows 95
- Windows NT 4.0
- Linux
- FreeBSD
- Windows 2000
- Solaris 7 Intel Edition

VMM Team

Past Contributers

- 2LT Scott Robin, USAF

Thesis Advisors/Principal Investigators

- Cynthia Irvine, NPS
- Steven Lipner, MitreTek Systems