



Virtual Machines

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Overview

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- What Issue is Addressed
- What are the Challenges Faced
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Why We Chose It


- The term “VM” is frequently used in both the industry, and casually.
- Never really expanded upon.
- Hear about what they do, but not how.
- Have mentioned it subtly in other classes.

- For something that comes up so much, it really is not explained well.



What is a Virtual Machine

- Virtualization/emulation of a computer system environment.
- Has an API that includes everything needed to correctly execute the programs run within it.
- The instruction sets used in the VM may be based off an existing architecture set, or may be entirely original.



Types of Virtual Machines

- System Virtual Machine
 - Complex
- Process Virtual Machine
 - Simpler



System Virtual Machines

- Emulates all hardware facilities needed to run all features inside of an OS.
 - All instructions
 - Memory-mapped I/O
 - Virtual Memory
 - Interrupt facilities
- Functions identically to the actual thing minus some performance.
- Can even run software compatible with that OS inside of it.



System Virtual Machines (contd.)

- In many applications a system VM will be managed by a virtual machine monitor (VMM).
 - Also known as a hypervisor.
- VMMs multiplex a single machine between multiple users with their own hosted VM.
 - This allows circumvention of an OS needing multiple user support.
- This had directly assisted in cloud computing.
- System virtual machines have also aided in development as well.



Process Virtual Machines

- Process virtual machine is much simpler in comparison to system.
- Exclusively provides an environment needed to run a single user-level process.
- The entire VM is terminated upon that process being completed.



Process Virtual Machines (contd.)

- Largest impact on the distribution of software.
- Works as a quick solution to running specific software on architecture types that do not naturally support it.
- Java has a big example with the Java Virtual Machine (JVM).
 - Executed programs run inside of the JVM, they are not compiled.
 - This makes it easier to develop across a wide range of systems and devices.
 - Not a large performance hit as the technology has progressed.



What Issue is Addressed

- Two main issues it addresses.
 - Cloud computing costs (System VM).
 - Software compatibility (Process VM).
- System VMs do provide additional utility to developers when simulating other environments in software development.
 - This is not a perfect impression as performance may be less than expected, it is decent however.



What are the Challenges Faced?

- The most common difficulties that are faced are:
 - VM sprawl
 - Network congestion
 - Hardware limitations
 - Security risks



Challenges - VM Sprawl

- Occurs when there is a lack of required practice to manage VM creation.
- Very easy to create new VMs so it's just as easy to forget to forget about them.
- Lack of management leads to resources getting sucked up.
- Companies may purchase more servers to accommodate for more VMs rather than properly manage their resources.
- Could also lead to issues with backups.



Challenges - Network Congestion

- Occurs when the server's NIC (Network Interface Card) is overloaded.
 - Results in network errors or crashes
- Most servers only have one NIC port so as more VMs are created/used, NIC's capabilities are limited.



Challenges - Hardware Limitations

- Efficiency is lost when the VM takes time to request access to the host machine.
- If the host machine is old, slow, or doesn't have enough computing power, problems arise when running multiple VMs on the same host.
- Issues from the host machine may infect the virtual machine.



Challenges - Security Risks

- Companies can install trojaned VMs that contain malware.
- Possible to run into isolation failures when running multiple VMs on the same host.
- Offline virtual machines are a risk because they don't receive any security updates/patches.



How this was Handled Historically

- No exact timeline of when these issues were fixed.
- Many of the aforementioned issues can simply be fixed with proper resource management of VMs.
 - Many third party management tools exist for organizations to use.
- Network congestion can be avoided by upgrading the amount of NIC ports and/or upgrading their servers and switches.
- Hardware limitations can be solved by upgrading hardware or not pushing the current hardware to extremes.



What Languages Offer this Service

- PL virtualization was first used in 1966 with the introduction of the Basic Combined Programming Language (BCPL).
- This architecture was the precursor of C.
- Other languages that used the BCPL virtualization include:
 - Pascal
 - Smalltalk



What Languages Offer this Service (cont.)

- In 1996, the introduction of the Java platform revived VM programming
- The Java virtual machine architecture was known as JVM.
- Originally meant for Java (of course), over time other languages implemented JVM's capabilities such as:
 - Python
 - Ruby
 - Pascal



What Languages Offer this Service (cont.)

- Support for multiple languages led to the creation of the Common Language Infrastructure (CLI).
- This is included in the .NET framework
- CLI allows multiple high level languages to run on different machines without the need to adjust for different architectures.



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