

# Computer Science CSCI 251

## Systems and Networks

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## Software Categories

- Proprietary
- Free-ware
- Free And Open Source (FOSS)
  - developed by "paid" programmers
  - supported by large corporations
  - low risk compared to proprietary software
  - user is granted a licence to the copywrited software

**CSCI 251 will focus on FOSS.**

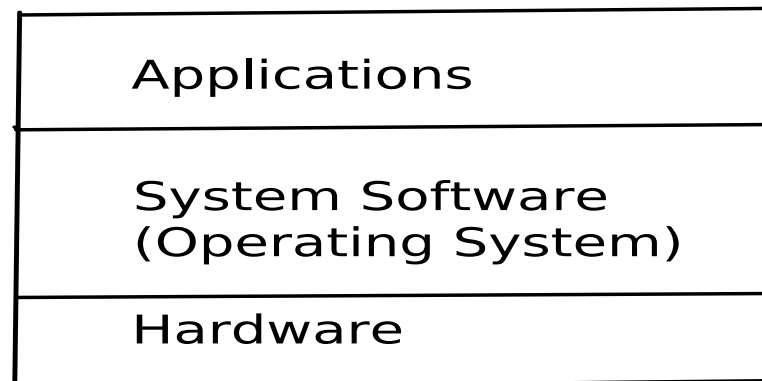
## FOSS Tools

- Compiler Tool Chains
  - gcc
- Scripting Languages
  - Perl, Python
- Graphical Development Environments
  - Eclipse
- Graphical User Interfaces
  - Xwindows
- Graphical Desktop Environment
  - GNOME, xfce
- Source Level Debugging
  - GDB

## FOSS Tools cont.

- Version Control
  - git
- Build Systems
  - make
- Operating Systems
  - Linux, Android, FreeDOS
- Middleware and Applications
  - MySQL, Apache, Icarus Verilog
- Virtualization
  - VirtualBox, Zen, Proxmox

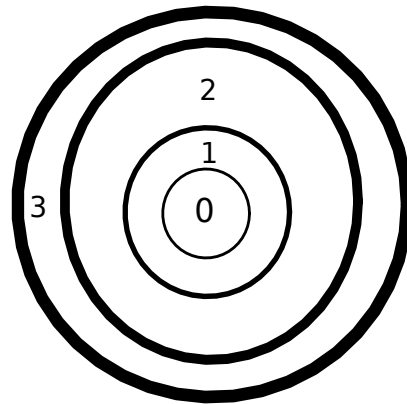
# Stand-alone Computing System



- Performance
  - OS must not add excessive overhead
- Control
  - OS must control access to resources

# Operating System Services

- Control
  - subroutine call offers little control
  - hardware support is needed
- Protection Rings (x86)
  - layers of privilege: certain privileged instructions can only be executed in Ring 0



## x86 in Protected Mode

Ring 0: Kernel  
Ring 1: Device Drivers  
Ring 2: Device Drivers  
Ring 3: Applications

## Linux

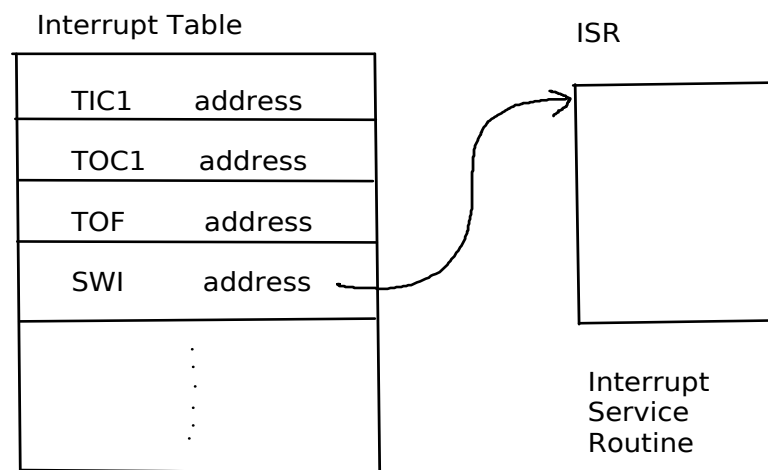
Ring 0: Kernel  
Ring 3: Applications

## Linux Modes

- Kernel (system)
  - executing in Ring 0 (x86)
  - assume trusted software
  - can execute privileged and non-privileged instructions
- User (non-privileged)
  - executing in Ring 3 (x86)
  - assume un-trusted software
  - can execute un-privileged instructions
  - can NOT execute privileged instructions

# Interrupts

- Hardware
  - e.g., internal timers and external devices
- Software
  - e.g., traps (swi)



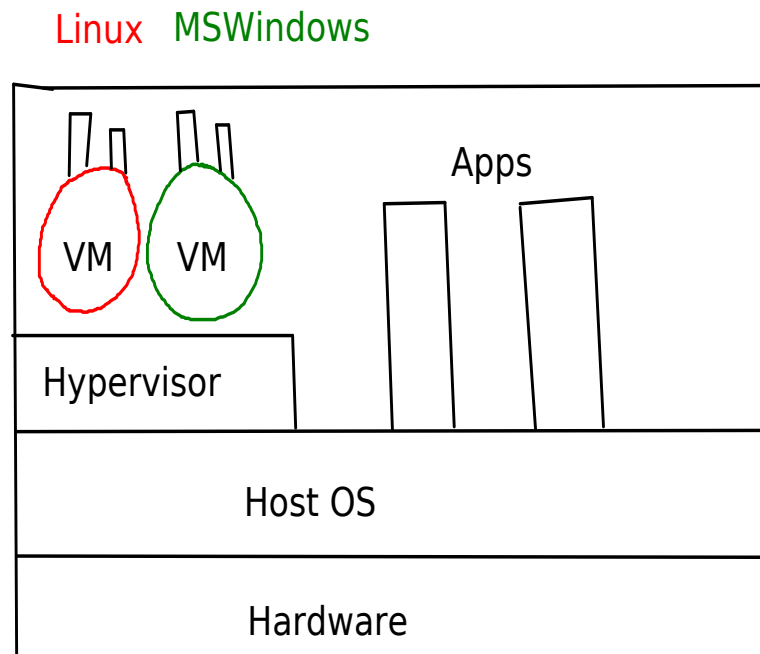


## Linux System Call on x86 Architecture

A "system call" is required when an application needs kernel help to achieve a certain action. This results in a trap (or software interrupt). As a consequence, an ISR runs in Ring 0, which decides if the kernel will allow this action, do the action, and restart the application program in Ring 3.

# Virtual Machines

- Host Virtualization
  - VM uses an un-modified kernel

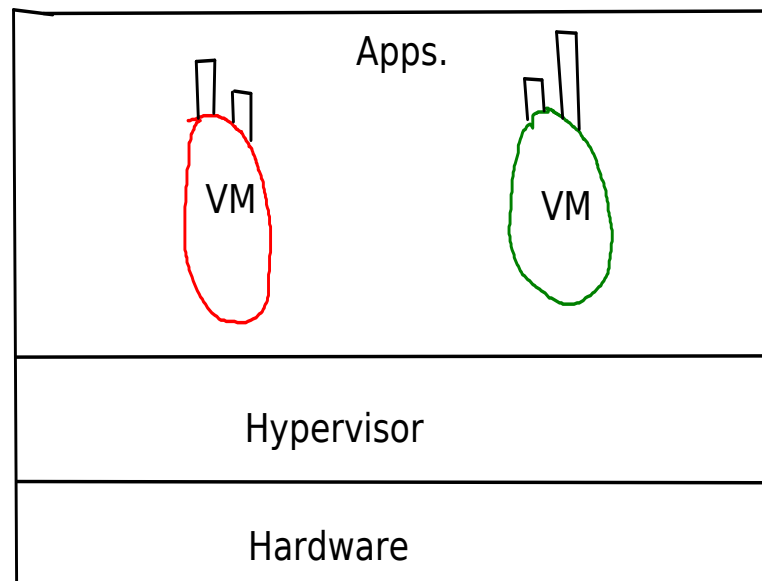


## Virtual Machines cont.

### ○ Server Virtualization

- software assisted (binary translation)
- hardware assisted (new x86 instructions since 2005)
- VM uses an un-modified kernel

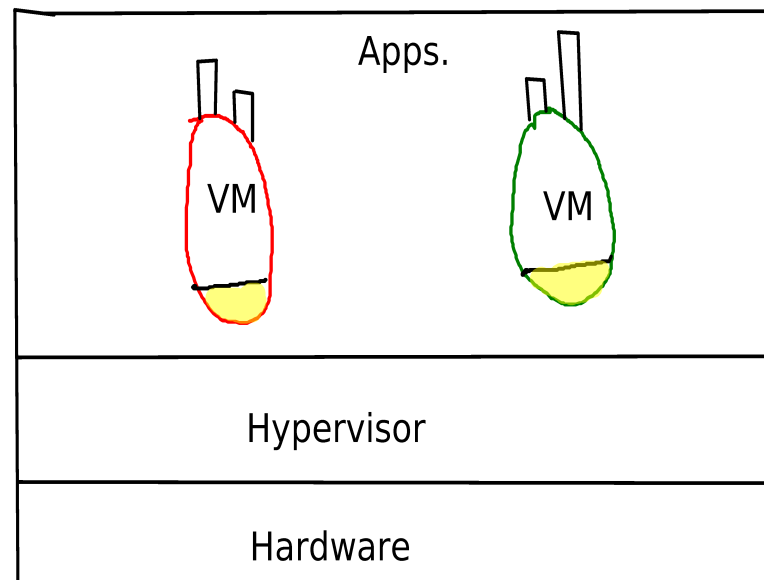
Linux MSWindows



## Virtual Machines cont.

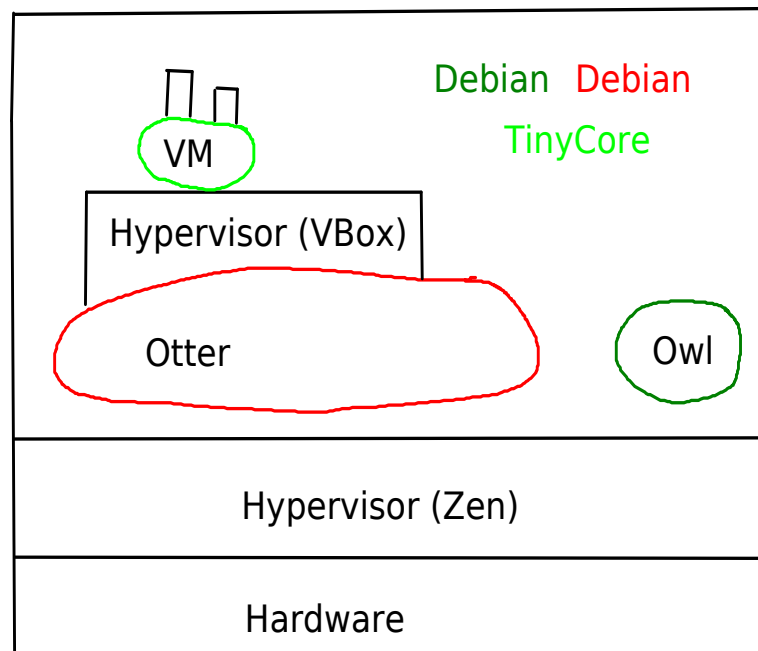
- Para Virtualization
  - VM uses a modified kernel

Linux MSWindows



# Virtual Machines cont.

- Computer Science (VIU)



## Virtual Machines cont.

- Advantages
  - do more with less (improve utilization)
  - consolidation of data
  - flexibility (reduce downtime)
  - OS sand box
- Disadvantages
  - single point of failure
  - resource hungry
- Security?