

# Hardware / Virtualization / Architectures

Foundations of the cloud

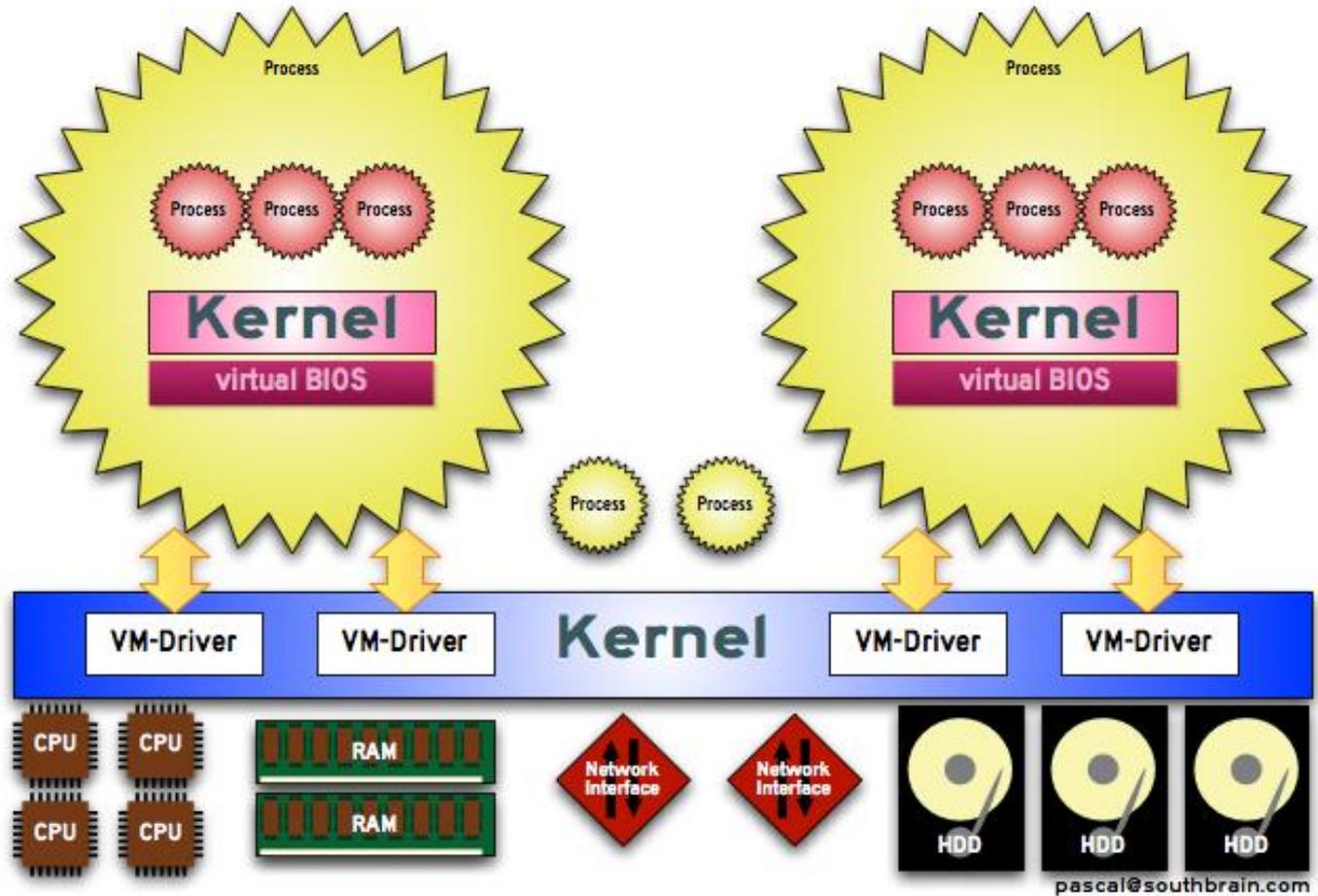
# Implementing Virtualization Technologies

- Cloud Computing relies heavily on the concept of virtualization
  - In fact not possible without it.
  - But they are separate concepts
  - You can have virtualization without doing cloud computing
- Virtualization means to convert physical hosts to logical/virtual ones. This is not really something new. IBM did this from the 60's on with their "VM" operating system ( /370).

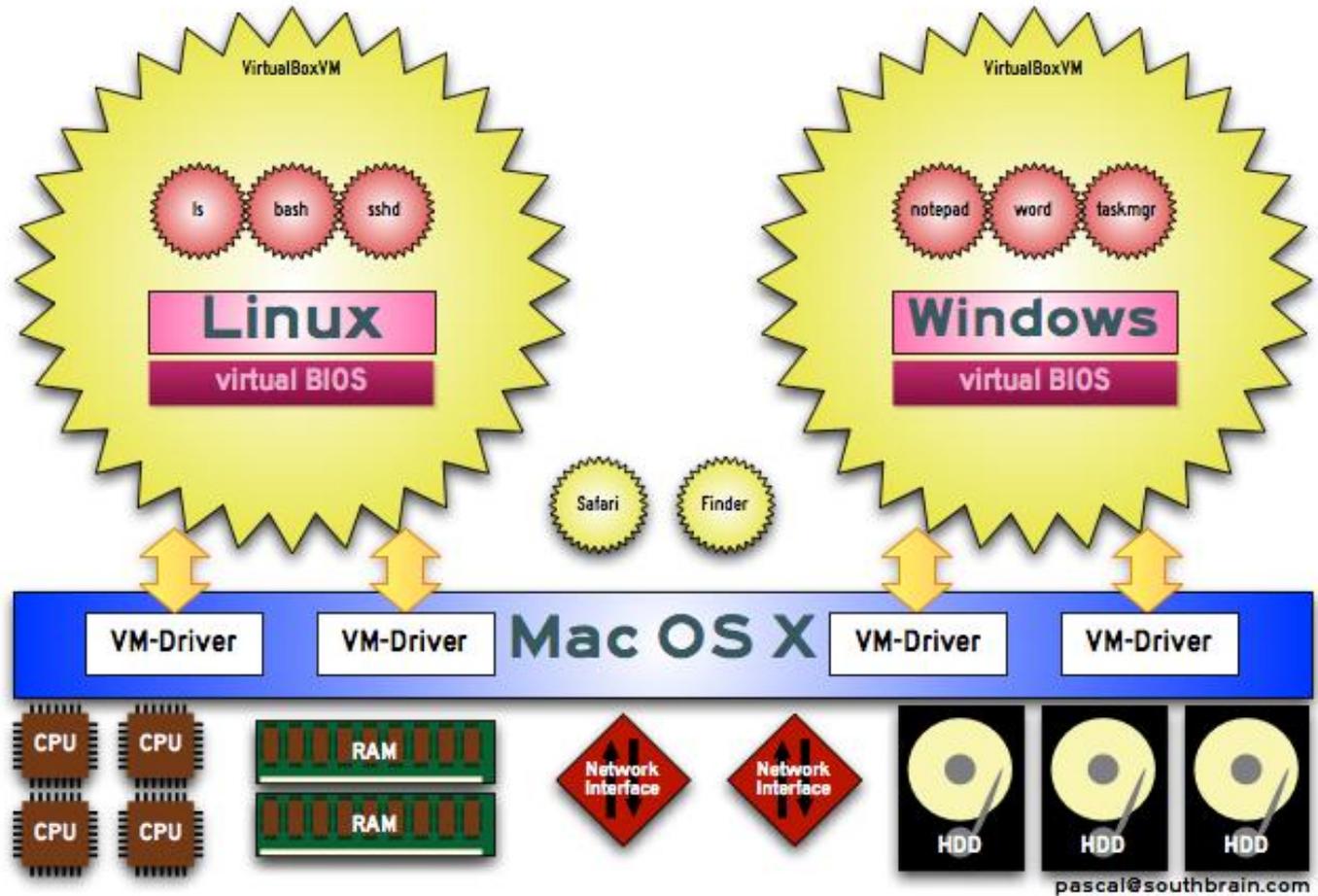
# Cont...

- 2 Practical types of virtualization
  - Desktop Level
    - Places virtual machine as a process on top of the existing OS.
    - Great for research or testing of multiple items
    - Base operating system has no idea that there is another operating system.
    - Software abstracts and brokers all the system calls
  - Server Level

# VMware Desktop Virtualization on PC



# Oracle Virtual Box on Mac OSX



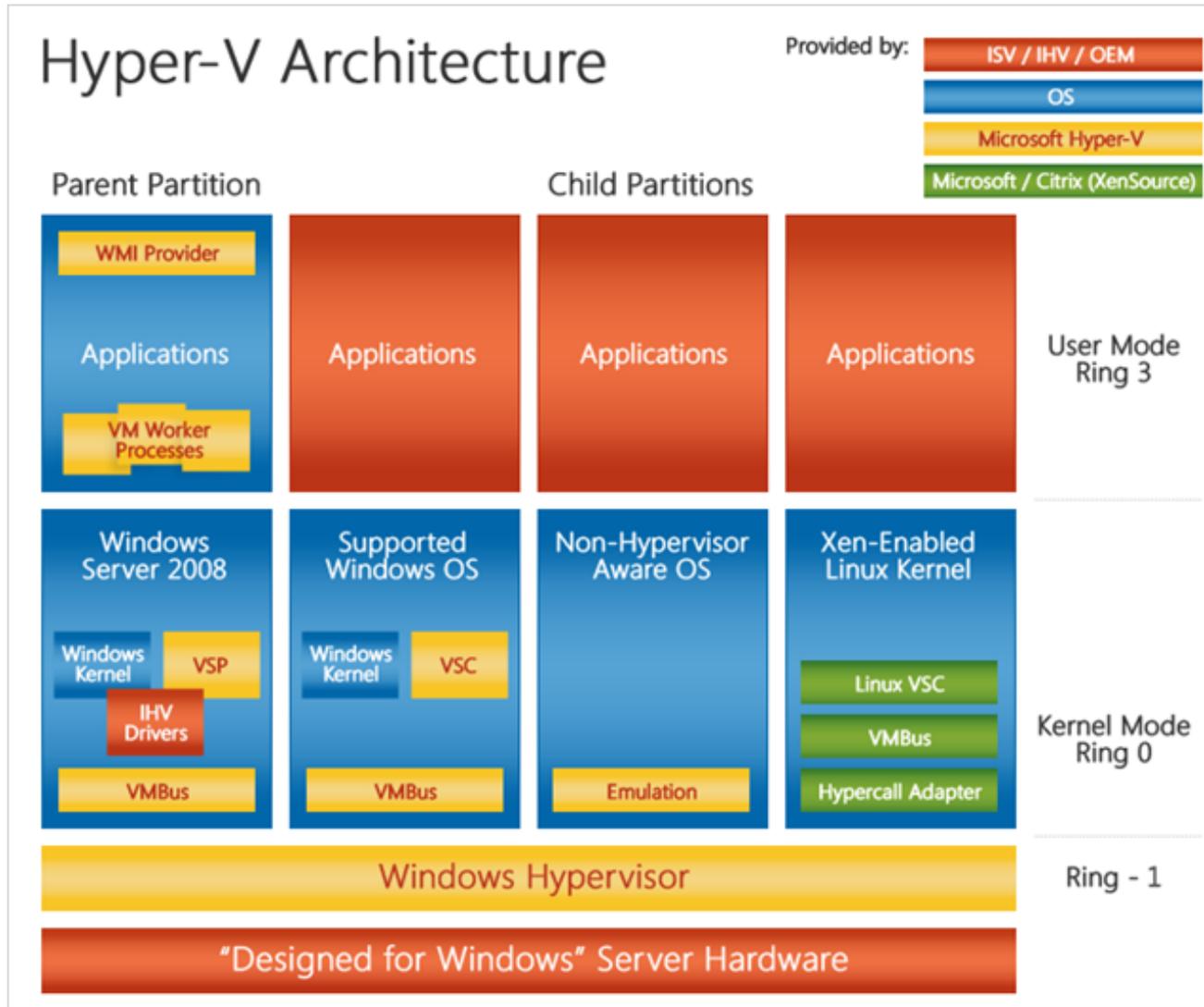
# Server Level Virtualization

- Why call it that?
  - We use the entire system
- “To make things more effective than the user space model (mentioned in part 2) we can use a **Hypervisor**. The Hypervisor is a small piece of software which controls the hardware - it assigns memory, CPU cycles, PCI hardware. This hypervisor replaces the kernel of a traditional, "real" hardware system:”

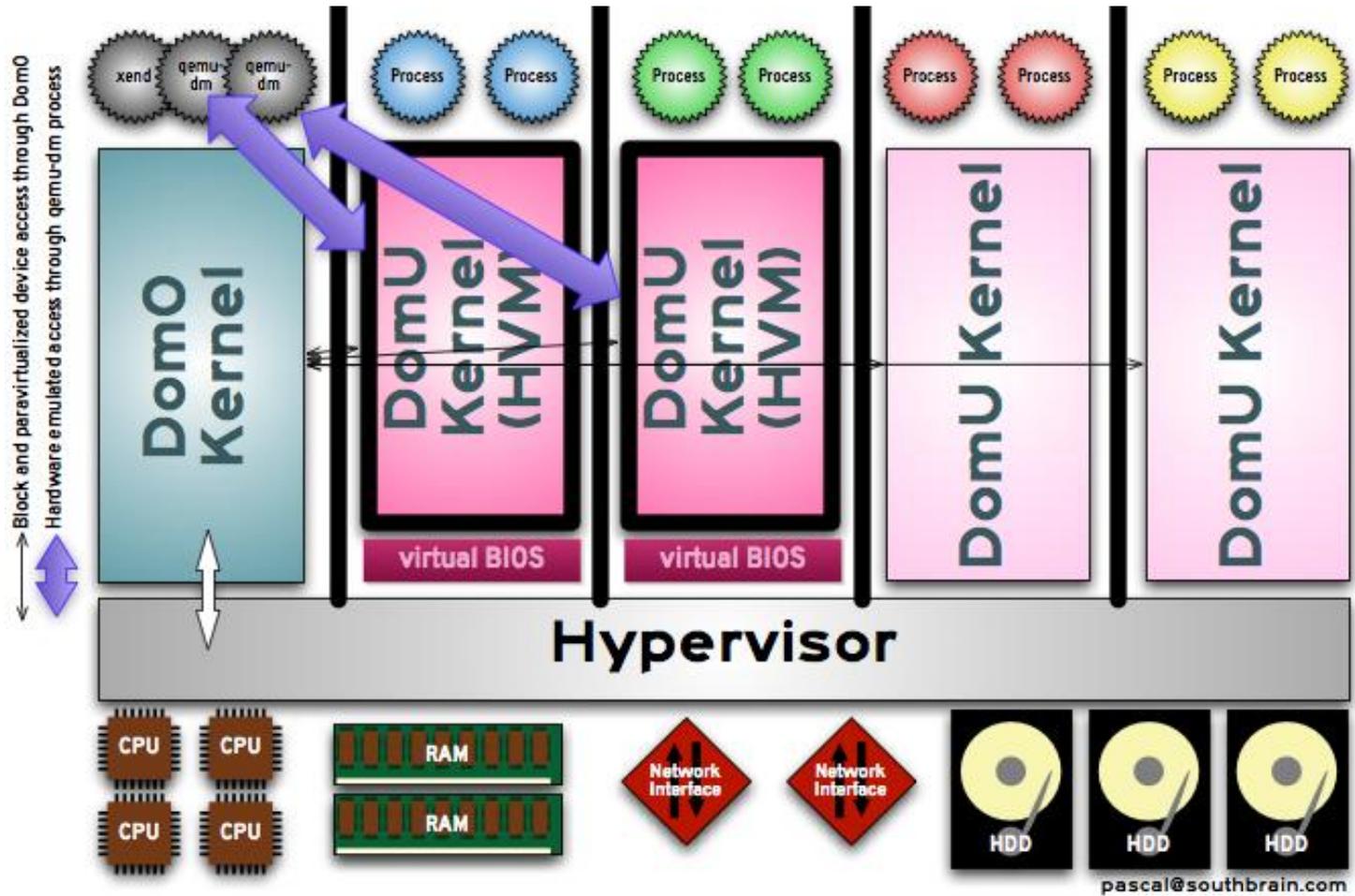
# How Hypervisor works

- X86 architecture
  - Most common and cheapest
  - Ring structure in x 86 architecture
  - User process runs in Ring 3
  - Kernel or heart of OS Runs in Ring 1
  - Hypervisor inserts itself between kernel and hardware
    - Ring -1
    - Separation prevents from Ring 3 causing entire system to crash by making sure system calls pass through proper channels

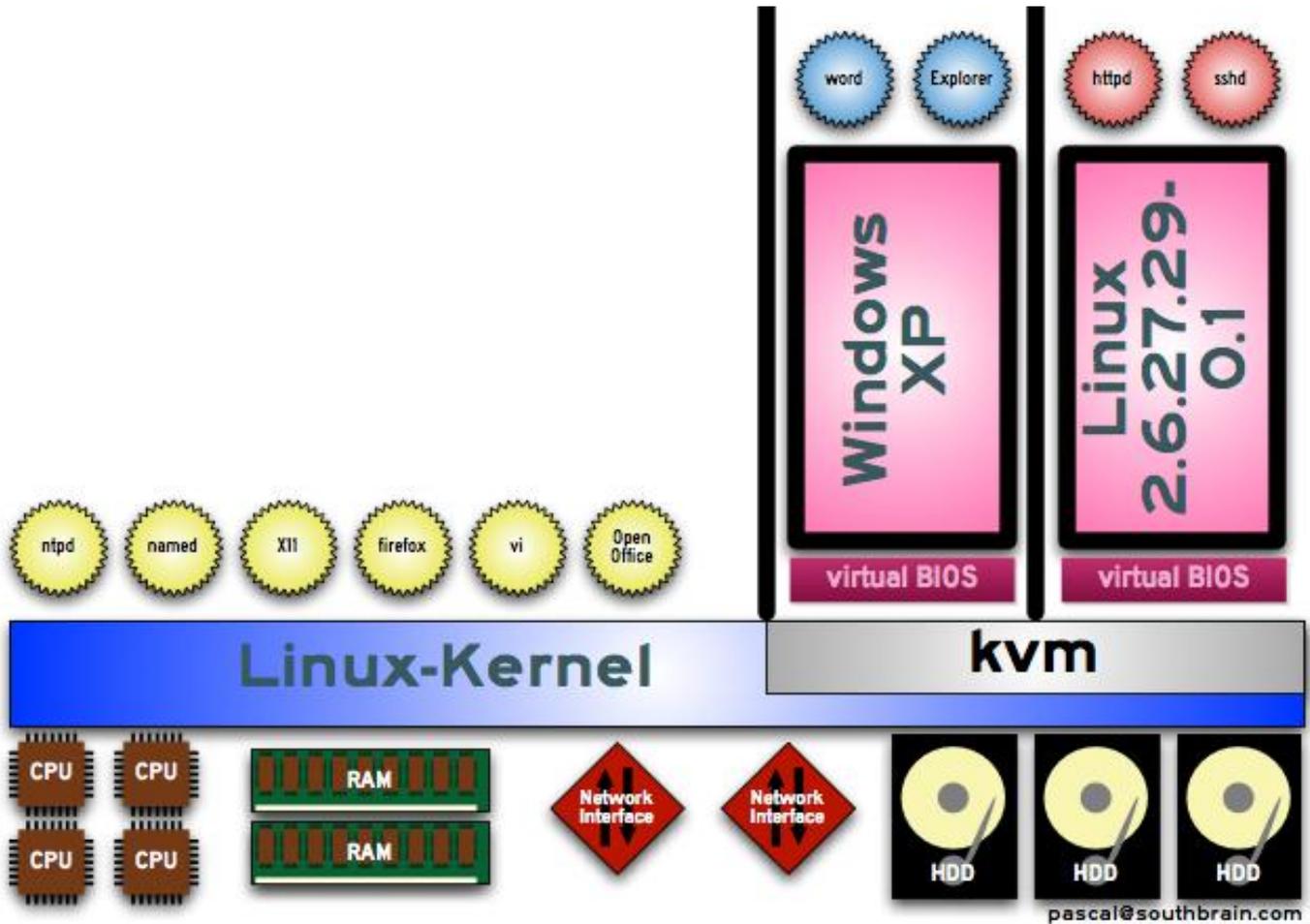
# Hyper-V Microsoft



# XEN – Open source Linux



# KVM – In Linux Kernel



# Hypervisors

- Just one part - need some management technology on top of it to utilize fully
- Three types of virtualization available
  - Paravirtualization
    - No hardware emulation, no need for VT-X and AMD-X CPU extensions
    - But also no Windows on Xen
    - Kernel of operating system that runs XEN needs to be modified
  - Full System Virtualization ← This is the one most used currently
    - Uses HVM (Hardware Virtualization Mode)
    - No need to modify underlying Kernel – CPU does all the translating
  - OS Level virtualization
    - FreeBSD Jail and Solaris Zones (give you access to multiple copies of the same OS per operating system)

# Non x86 Hypervisor

- IBM has their Z/VM operating system and virtualization platform
  - Allows users to run multiple instances of Linux OS complies for the IBM zOS.

# Xen

- Starts as part of the Kernel OS
  - Each virtualized OS has its own domain (called DomU)
  - All succeeding Virtual Machines have to communicate with the hardware through Dom0
  - Dom0 goes through the Hypervisor to the hardware.
  - Dom0 is only thing that has hardware access.

# KVM

- Hypervisor uses AMD-V and Intel VT-x technology to change its architecture.
- KVM lives in the kernel as part of the standard Linux kernel as of 2.6.20 (if packages are enabled)
- Uses QEMU to do all the hardware emulation

# Datacenter Tech

- Starts with your processors
  - Older processors do not have the on chip instruction sets to effectively do Hardware Emulation
    - <http://wiki.xensource.com/xenwiki/HVM-Compatible-Processors>
  - All new processors do (enterprise level for sure)
  - Intel Xeon 5600 Nehalem class
    - Intelligent Power technology
      - Drop processor speed and memory speed to lessen power draw when needed – also can over clock when necessary as well.
    - VT-c – direct access to network for Hypervisor (if supported)
    - VT-d – direct access to storage for Hypervisor (if supported)
  - Intel Xeon 7500 Nehalem class
    - Internal self-diagnostics and self healing
    - Supports 16GB DDR3 dimms and 8 core chips

# Virtualization pieces

- Virtualization is one piece.
- You need some management component on top of that.
- The idea behind cloud:
  - Utilize commodity hardware
  - Utilize lots of it to abstract your computing resources
- Chip based technologies help
  - You now have a large number of smaller systems instead of a few large systems
  - Power and cooling become a financial cost
  - Also Rip and Replace become the option instead of nurse and repair. (Cost vs. Time)

# Datacenter changing with clouds entrance

- Previous data center was wild west of standards
  - Intel working with other groups and companies to produce standard for datacenter
  - <http://www.opendatacenteralliance.org/>
- Currently datacenter built around the application, then OS, and then some hardware was bought to run it
  - Example Airline reservation system.
- Virtualization came in and helped reduce need for physical servers but the design principal is still largely the same.
- The problem: this datacenter design is not meant to handle spikes and sags (to expensive)

# Cloud based datacenter

- Model of computing is changing
  - Datacenter used to serve internal clients or fixed number of outside clients
  - Clients are now more numerous and mobile
    - Data can surge and swell based on popularity
    - Small example: When singer Michael Jackson died Google was crushed under wave of people checking to see if it was true.
  - Cloud based datacenter allows for users to provision the resources they need—instead of begging an admin for some space or requisitioning a system.
  - Cloud based data center is User driven, User provisioned, and responding to mobile clients.

# Networking in the cloud

- Data is abstracted
  - Two new concepts are utilized
  - iSCSI - <http://software.intel.com/file/31966>
    - Hard drive commands over TCP to connect to storage on the network
    - Excellent for attaching NAS, SANS
    - Cheaper than Fibre Channel
    - Requires internal private network – not on public network
  - Jumbo Frames
    - **jumbo frames** are [Ethernet frames](#) with more than 1500 bytes of payload. Conventionally, jumbo frames can carry up to 9000 bytes of payload, but variations exist and some care must be taken when using the term. Many [Gigabit Ethernet](#) switches and Gigabit Ethernet network interface cards support jumbo frames. [http://en.wikipedia.org/wiki/Jumbo\\_frames](http://en.wikipedia.org/wiki/Jumbo_frames)
    - Data –larger frames let you pass more data in less processing time
- Dell, HP, Cisco producing switches that handle Jumbo Frames and have the priority for iSCSI increased – designed for the cloud...

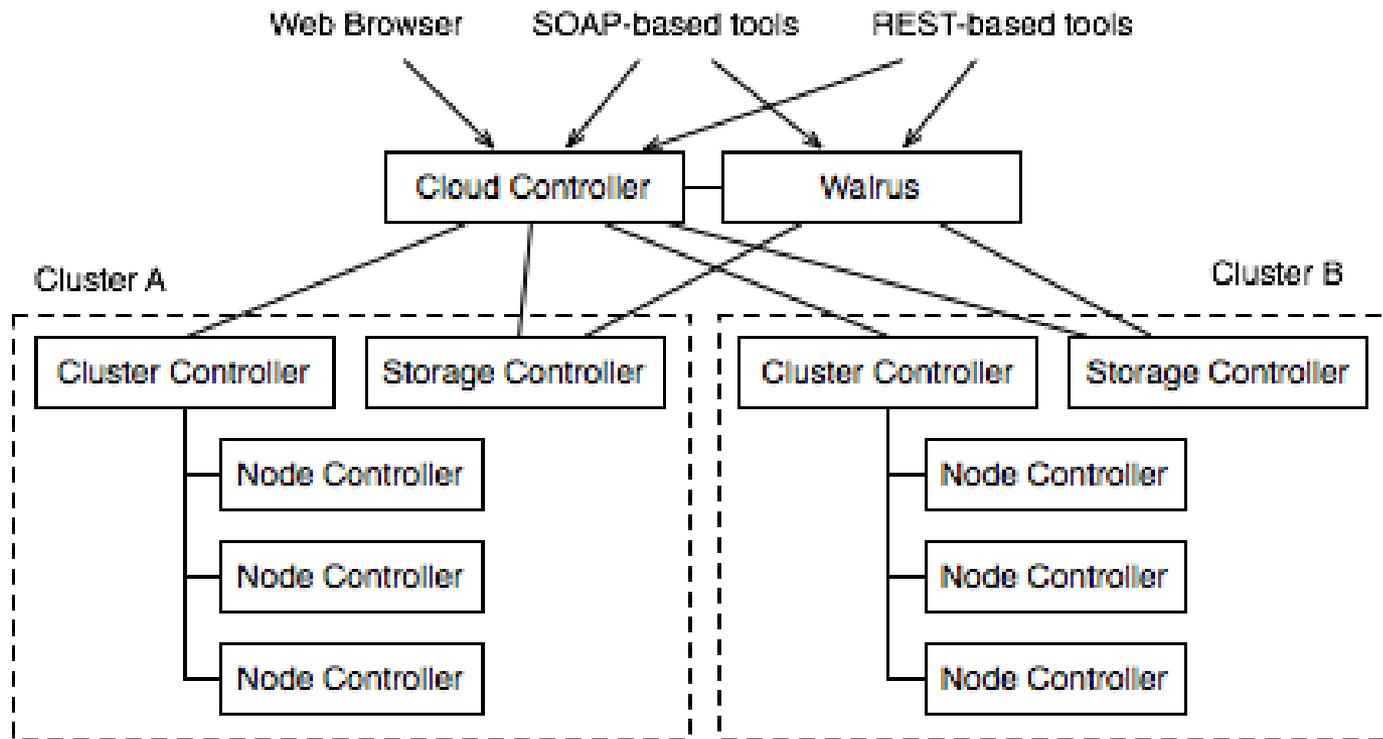
# Ideal datacenter

- Similar to what Microsoft, Google, Amazon, and Rackspace are offering.
  - Two types of Cloud computing
    - Offer just a simple set of API's
      - Amazon has S3 for storage, EBS for permanent storage, and SimpleDB
      - Rackspace has their competing open source version of all Amazon products
      - Google lets you access their Gmail and Picasa API
      - Microsoft gives you program access to their SQL server in their cloud
    - All abstracts the need for separate operating systems.
      - Now you are just offering services not complete operating systems and the user does not need to worry about compatibility.
      - No need to test and build on different hardware – all API based.
  - Really back to the mainframe concept
    - Now IT is focused on Access Control and not so much hardcore IT.

# What really makes the cloud go?

- You need some kind of management software
  - to integrate with all your CPU tech and virtualization platforms
  - Cloud platforms – open source
    - Eucalyptus
    - Ubuntu Enterprise Cloud (built on top of Eucalyptus)
    - OpenStack (Rackspace – Amazon competitor)
    - Nimbus
  - All of these are Amazon service compatible?
    - Why?

# Ubuntu Enterprise Cloud Example



<https://help.ubuntu.com/community/UEC> ← Installation link

# Example Explained

- We need a server to interact with (user) Cloud Controller
  - No need for fast hard drives or new processors (can reuse older hardware)
- There is a Walrus controller
  - Can be accessed via API for someone to attach temporary storage to another project programmatically
  - No need to interact with our Cloud Controller
  - No need VT-x technology here just a lot of hard drive storage for people to use.

# cont

- The cloud controller talks to the Cluster controller
  - The Cloud Controller allows us to provision virtual machines we have created previously (or downloaded)
  - The actual instances are stored on our Node Controllers
  - These use KVM to do the virtualization
    - They need VT-x based CPU's
    - As much memory and CPU cores as they can get
    - KVM virtualization helps utilize every last drop of resources for multiple virtual machines on a single node controller
    - We can continually add more node controllers and expand our "Cloud"
    - -- hence the name cloud computing

# Cont...

- Cluster Controller can also connect to Storage controller
  - Allows for EBS like permanent storage
  - Cloud advantage is that when finished with instance – resources are recycled
  - But what if you want to save some of the data?
  - Attach some EBS permanent storage
- What if I use all of the computers I have available and still need more computing power?
  - All projects currently (UEC, Eucalyptus, OpenStack) are all Amazon compatible and you can add their exhaustive resources to yours or move yours into theirs.
  - Dominos Pizza does this one day of the year every year: which day?

# Optimizations

- As we look at CPU and software virtualization where can we improve
  - Direct Access
  - Letting virtualized systems have direct hardware access to Hard Drives and Networking cuts down on overhead and increases throughput in some cases.

# Not a Single Box

- Planning your cloud applications and what you will need to create to get them going
  - Images which will run your code
  - Storage mechanism to hold data
  - These 2 things are not on the same box. You should not rely on operating system messaging or working with a local filesystem to manage how your software interacts with data.

# Creating Images

- What consists of an image?
  - Operating System?
  - Application Servers (Oracle, Windows, Hadoop) ?
  - Packages (Map reduce / Apache / Tomcat)?
  - What does your application need?
  - “Golden Images”

Remember, storage should be treated separately.

# Amazon EC2 Image Tutorial

- We will log into Amazon Web Services
  - Username: [valscarlata@gmail.com](mailto:valscarlata@gmail.com), password: itmifun
  - Create an AMI (amazon machine image)
  - Launch the AMI
  - Stop the AMI
  - Attach EBS (Elastic Block Storage Device) to the AMI
  - Snapshot the EBS volumes
    - This is how you would backup your data / drives
    - You can also mount these drives in different AMI instances

# How Can We Access the AMI?

- We need to configure / add packages to the instance after we have launched it.
- SSH into it
- Remote desktop into it (windows)
- Use Amazon developer tools to access it.

# Links and sources

- <http://www.opendatacenteralliance.org/>
- [http://www.capgemini.com/ctoblog/2011/01/the\\_new\\_data\\_centre\\_is\\_not\\_you/](http://www.capgemini.com/ctoblog/2011/01/the_new_data_centre_is_not_you/)
- <http://www.capgemini.com/ctoblog/2011/02/generation-data-centre/>
- <http://www.intel.com/itcenter/products/xeon/7500/index.htm>
- <http://www.intel.com/itcenter/products/xeon/5600/index.htm>
- <http://software.intel.com/sites/datacentermanager/faqs.php>
- [http://sites.amd.com/us/business/promo/server/Pages/opteron-6000-series-new-models.aspx?lid=New\\_Models\\_of\\_AMD\\_Opteron&lpos=HP\\_bottom\\_bucket](http://sites.amd.com/us/business/promo/server/Pages/opteron-6000-series-new-models.aspx?lid=New_Models_of_AMD_Opteron&lpos=HP_bottom_bucket)
- [http://www.cio.com/article/638577/Virtualization\\_Meets\\_Its\\_Organizational\\_Limit](http://www.cio.com/article/638577/Virtualization_Meets_Its_Organizational_Limit)
- [http://wiki.xensource.com/xenwiki/HVM\\_Compatible\\_Processors](http://wiki.xensource.com/xenwiki/HVM_Compatible_Processors) <-- list of VT-x AND-V cpu's
- <http://southbrain.com/south/virtualization/3-xen-hypervisor-based-virtual.html>  
(opening slide) // hypervisor pictures

# Links and Sources Continued

- <http://elite-itsolutions.co.uk/images/diag-hyperv-arch.png>  
// Hyper-V picture
- <http://en.wikipedia.org/wiki/Iscsi>
- [http://open.eucalyptus.com/wiki/EucalyptusAdvanced\\_v2.0](http://open.eucalyptus.com/wiki/EucalyptusAdvanced_v2.0)
- <http://www.canonical.com/sites/default/files/active/Whitepaper-UbuntuEnterpriseCloudArchitecture-v1.pdf>
- <https://help.ubuntu.com/community/UEC/PackageInstallSeparate>
- <http://software.intel.com/file/31966>