VMware Cloud Initiative
Evolving Virtualized Datacenters to a Cloud Infrastructure

OpenCirrus Summit Oct 2011
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Moore’s law still rules

DRAM
$/GB

$0
$25
$50
$75
$100

2005 2007 2009 2011 2013

SAN Storage
$2 - $10/GB

Local Storage
$0.05/GB

Super-dense power & cooling

Source: Gartner Dataquest, *Forecast: DRAM Market Statistics (1Q11)*
Hyper-density

In 2014, an average server:

• 2-CPU, 16 core per socket, 300 GB RAM, and hold 320 VMs.
• A single rack will hold 20,000 VMs.
• Cost/workload to $100 / year
• You will run a 5,000 employee company on a rack the size of a dorm fridge
New opportunities for the software datacenter

- Powerful enough for any app
- Handle all functions that today require specialized hardware.
- Moving to all-x86, **software-driven** datacenter
- $1 on machines : $6 of labor (today)
- 10,000 VMs : 1 admin (future)
- 10 seconds to provision a new machine
Our customers moving toward private clouds

- 250,000 vSphere customers
- 100% of Fortune 100
- 100% of Fortune Global 100
- 99% of Fortune 1000
- 97% of Fortune Global 500
2,600+ vCloud Service Provider Partners
VMware Products

VMware vShield Security
- Desktops: VMware ThinApp, VMware View
- Existing Applications: App, App, App (VM, VM, VM)
- Future Applications: App, App, App (CloudFoundry, VMware vFabric Cloud Application Platform)

VMware vCloud Director

VMware vCenter Server

VMware vSphere Virtualization Platform

Application Management
- VMware vFabric Hyperic
- VMware vCenter Application Discovery Manager
- VMware vCenter AppSpeed

Virtualization & Cloud Management
- VMware vCenter Operations
- VMware vCenter Site Recovery Manager
- VMware vCenter CapacityIQ
- VMware vCenter Chargeback
- VMware vCenter Configuration Manager
- VMware Service Manager
- VMware vCenter Orchestrator

Private Cloud Resource Pools
- Compute, Storage, Network

Public Cloud Resources
VMware’s cloud initiatives

- vCloud Director – IaaS: built on vSphere
- Cloud Foundry – PaaS: completely open source
- Many other cloudy things:
  - Spring (open source)
    - framework and tools for developer productivity and app portability
  - vFabric (open source)
    - optimized runtime for deployment and management
  - tc server, RabbitMQ, Hyperic, Apache ERS
  - DataAsAService: DataDirector, Gemfire, SQLfire, vFabric Postgres
  - PaaS partnerships
    - VMforce.com (Salesforce.com), Google App Engine
  - SaaS (some open source)
    - Zimbra, SlideRocket, Mozy, ProjectOctopus, Horizon
VMware vCloud

- Essential Cloud Characteristics (defined by NIST)
  - On-demand, self service
  - Broad network access
  - Resource pooling
  - Rapid elasticity
  - Measured service

- Governance
  - Secured multi-tenancy
  - Workflow automation and management
  - Data protection
New abstractions – just a few examples

- Compute: vApps
- Storage hierarchy
- Networking: VXLAN
vApp Templates

- **Container of one or more VMs**
  - Package up multi-tier applications into vApps
  - Operate on VMs as one unit
  - Select boot order of VMs, start delays and stop delays
  - Set runtime and storage leases

- **Can be created from scratch**
  - Use as templates/building blocks

- **Can be imported from outside the cloud**

- **Uses the OVF standard**
  - Captures meta data about the VMs
  - Allows import and export between clouds in standard format
Disruptive changes to storage

Current Challenges

- Cluster size limitations
- Storage silos
- Non-scalable physical network
- Network and Security isolation

Required Architecture Changes

- Elastic compute and storage clusters
- Extensible networking infrastructure
- Policy based security providing isolation b/w entities

Artificial Constraints!
New Storage Infrastructure Emerging to Serve New Apps

Drivers for Change

- New applications are controlling placement, load balancing and lifecycle operations of storage
- Flash/SSD changes DAS/SAN equation

New Storage Hierarchy

- DAS w/ onboard flash
- Scalable storage architecture
  - Global access to data: VM Disks managed under a global namespace
- Gateways to cloud storage
- Secondary data services to the cloud
VXLAN - Enabling Virtualization-aware Networks

**Telephony**

- Identifier = Location
- 650.555.1212

**Networking**

- Identifier = Location
- 192.168.10.1
- VM
- VXLAN
- VM

**Wireless Telephony**

- 650.555.1212
- 192.168.10.1
- VM
- VXLAN
- VM
How VXLAN Works

Key Properties

- Works with any switching fabric without change across network boundaries even across WAN
- An open standard for ecosystem participation and extension
VMware vCloud

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## VMware vCloud

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<th>Cloud Computing (NIST)</th>
<th>Building Blocks</th>
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<td>On-Demand, Self Service</td>
<td>vCloud API</td>
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<td>Broad Network Access</td>
<td>vCloud Connector</td>
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<td>Resource Pooling</td>
<td>VMware vSphere</td>
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<td>Rapid Elasticity</td>
<td>vCenter Chargeback</td>
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<td>Measured Service</td>
<td>vShield Edge</td>
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<td><strong>Governance</strong></td>
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<tr>
<td>Secured Multi-Tenancy</td>
<td>vCenter Orchesturator</td>
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<tr>
<td>Workflow Automation and Management</td>
<td>vStorage API for Data Protection (VADP)</td>
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<tr>
<td>Data Protection</td>
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</tbody>
</table>
VMware vCloud – Component Integration

Additional components when integrated with vCloud Director/vSphere
vCloud Component: VMware vSphere

- **Objective**
  - Abstract hardware through virtualization
  - Pool resources (DRS is a requirement) to provide cloud foundation

- **Features**
  - Virtualized compute (CPU, memory), network, and storage resources
vCloud Component: VMware vCloud Director

**Objective**
- Abstract, organize and allocate vSphere resources for multi-tenancy
- Provide end users a self-service portal to request and access workloads

**Features**
- **Provider**
  - Resource abstraction, allocation, and separation – virtual datacenters
  - Organizations – security boundaries
  - Resource leases and quotas
  - API for cloud management and interoperability
- **Consumer**
  - Cloud web portal for users
  - Catalogs of vApps (workloads)
  - Access control
  - User clouds for running vApps
  - VMware remote console
VMware vCloud Director

- Abstraction of Resources into Cloud Computing Model
  - Administrators (providers) allocate resources
  - End users (consumers) only see what they need

**Consumers**

- Catalogs
- vApps
- vApp Networks
- Network Connections
- Network Specifications
- Network Services
- Users (Org Admin)

**Providers**

- Provider vDCs
- Organizations
- External Networks
- Private Networking Options (Network Pools)
- Organization Networks
- Organization vDCs
VMware vCloud Director

- Resource Abstraction, Grouping, Allocation, and Separation
  - vSphere resources further abstracted and managed by VMware vCloud Director
VMware vCloud Director

- **Catalogs**
  - vApp Templates
    - Used to deploy workloads to user clouds
    - Set of 1 or more VMs
      - Base OS (templates)
      - Pre-configured applications (vApps)
  - Media
    - ISOs and floppies

- **Catalog Objects**

- **vApp Templates**
  - Web Server vApps
  - Database vApps
  - Windows Template

- **Media**
## VMware vCloud Director Constructs

<table>
<thead>
<tr>
<th>vCloud Director Component</th>
<th>Definition</th>
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</table>
| Organization              | • Logical group of all users (consumers) to which resources will be presented  
                             • Security boundary  
                             • Each organization has its own cloud web portal |
| Provider Virtual Datacenter (vDC) | • Logical group of vSphere compute resources (resource pool + datastores), i.e. “service offering”  
                             • Multiple provider vDCs can separate resources by:  
                               • Tier (i.e. server or storage performance; e.g. gold, silver, bronze)  
                               • Capacity (i.e. quantity of compute resources; e.g. large, medium, small)  
                               • Group (i.e. management, assignment; e.g. vSphere cluster 1, vSphere cluster 2) |
| Organization Virtual Datacenter (vDC) | • Resource allocation for a given organization, created as a subset of a provider vDC  
                             • Assigned a resource allocation model (compute resources, number of VMs limit)  
                             • Multiple organization vDCs for an organization can:  
                               • Map to different provider vDCs to provide different resource tiers, capacities, or groups  
                               • Support different resource allocation models |
| External Network           | • Maps to a vSphere portgroup, dvPortgroup, or Cisco Nexus 1000V port profile to connect to outside |
| Organization Network       | • Network contained within an organization, backed by a network pool  
                             • Remains internal to organization and can connect to an external network |
| vApp Network               | • Network between VMs within a vApp, backed by a network pool  
                             • Can connect to organization network (for cross-vApp communication) or remain isolated |
Network Pools

- **Pools of Isolated Layer 2 Networks**
  - Used by vCloud Director to instantiate org and vApp networks as needed, empowering cloud consumers to self-provision networks

- **Types**
  - **Portgroup-backed**
    - Create isolated portgroups in vSphere manually or with automation for vCD use
  - **VLAN-backed**
    - vCD automatically creates portgroups as needed, using a range of VLANs for isolation
  - **vCloud Director Network Isolation-backed (vCD-NI)**
    - vCD automatically creates portgroups as needed, using VMware-specific network isolation technology (MAC-in-MAC encapsulation)

<table>
<thead>
<tr>
<th>Network Pool</th>
<th>Building Blocks</th>
</tr>
</thead>
<tbody>
<tr>
<td>VLAN-backed</td>
<td>vNetwork Distributed Switch + VLAN tags</td>
</tr>
<tr>
<td>vCD-NI-backed</td>
<td>vNetwork Distributed Switch + one VLAN for transport (optional)</td>
</tr>
<tr>
<td>Portgroup-backed</td>
<td>vNetwork Distributed Switch or vSwitch portgroups</td>
</tr>
</tbody>
</table>
## Resource Allocation Models for Organization vDCs

- Allocated sub-resources of a provider virtual datacenter
- Allocation uses a model, each of which can set limits on number of VMs

<table>
<thead>
<tr>
<th>Allocation Model</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pay As You Go</td>
<td>• No upfront resource allocation in the org vDC</td>
</tr>
<tr>
<td></td>
<td>• Resources are reserved as users create vApps</td>
</tr>
<tr>
<td></td>
<td>• Can set a percentage of resources to be reserved</td>
</tr>
<tr>
<td></td>
<td>• vCPU rating can be adjusted</td>
</tr>
<tr>
<td>Allocation Pool (“Virtual container”)</td>
<td>• Allocated pool of resources with a percentage reserved</td>
</tr>
<tr>
<td></td>
<td>• Cloud admin controls ability to overcommit resources</td>
</tr>
<tr>
<td></td>
<td>• Users cannot modify VM reservations and limits</td>
</tr>
<tr>
<td></td>
<td>• Resources can be shared between org VDCs</td>
</tr>
<tr>
<td>Reservation Pool (“Physical container”)</td>
<td>• Allocated pool of resources with 100% reserved</td>
</tr>
<tr>
<td></td>
<td>• Users can adjust VM reservations and limits</td>
</tr>
<tr>
<td></td>
<td>• No sharing of resources with other org VDCs</td>
</tr>
<tr>
<td></td>
<td>• Similar to allocation pool, with reservation = 100%</td>
</tr>
</tbody>
</table>
vCloud Resource Allocation Models – Example

Pay As You Go (PAYG)

Provider vDC

Org vDC can grow as large as provider vDC
Resources reserved as vApps get created
Reservations applied at VM level

Allocation Pool and Reservation Pool

Provider vDC

Allocation Pool
Org vDC #1
Guarantee

Allocation Pool
Org vDC #2
Shared

Reservation Pool
Org vDC
Guaranteed Resources

Guarantee

Shared

Shared
Service-level Tiers

Cloud Infrastructure

- Gold
- Silver
- Bronze
Intelligent Policy Management Beyond the DC

SLA Definitions

- Availability: 99.99%
- DR RTO: 1 hour
- Back up: daily
- Storage capacity: 1 TB
- Performance: High I/O
- Security: High

Cloud Infrastructure

- Datacenter 1
- Datacenter 2
- Datacenter 3

X-Datacenter and X-Cloud Placement Engine

- Availability:
  - 99.99%
  - 99.9%
  - 99.0%
- DR RTO:
  - 1 hour
  - 3 hour
  - none
- Back up:
  - daily
  - weekly
  - none
- Storage capacity:
  - 10 TB
  - 10 TB
  - 10 TB
- Performance:
  - High I/O
  - Med I/O
  - low I/O
- Security:
  - High
  - Mid
  - low
Security and Isolation

Cloud Infrastructure

Trust Zone

Gold

Silver

“Nosy Neighbor”

Bronze
Secured Multi-Tenancy

- **VMware vCloud Director Organizations**
  - Each organization is a security/visibility boundary between tenants
  - Contains users and virtual datacenter resources
  - Users choose vApps from visible catalogs

- **vShield Edge**
  - Secures network

![Diagram of secured multi-tenancy with organizations A and B, vDC1, vDC2, vDC3, vApp, and Master Catalog.]
vCloud Component: vShield Edge

**Objective**
- Provide network security within organizations for isolated network topologies
  - Organization networks and vApp networks

**Features**
- vShield Edge appliances deployed by VMware vCloud Director on vSphere
- “Routed” networks have security services
  - Firewall services
  - NAT services
  - DHCP
  - Port forwarding
  - IP masquerading
Only VMware Offers Defense in Depth for Cloud Infrastructure

- Virtualizes common network services such as NAT and DHCP
- vShield Endpoint protects the individual VM with offloaded anti-virus
- vShield App protects the applications with multi-VM trust zones
- vShield Edge protects the virtual data centers with port-level stateful firewalls
Security Profiles Remain Intact in the Dynamic Cloud Environment

VDC Gold

VDC Silver
VMware Provides Continuous Compliance Within and Across Clouds

**VDC Gold**

- vCenter Configuration Manager
  - Continuous Compliance
  - Assessment & enforcement

- Policies built from Out-of-the-box compliance templates
  - SOX, HIPAA, FISMA, DISA, GLBA, ISO 27002, NIST, PCI DSS, NERC, CIS, FERC
  - Harden the hypervisor configs for ESX, network, storage, etc.
  - Harden the hypervisor guest
  - Harden the Guest OS

- Build Golden Image / Standards

**VDC Silver**
Interacting with and between Clouds

vCloud API

- Open standard for cloud interaction
- Submitted to DMTF
- RESTful API
- Implemented in vCloud Director

<table>
<thead>
<tr>
<th>HTTP Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>GET</td>
<td>retrieve representation of resource without side effects</td>
</tr>
<tr>
<td>PUT</td>
<td>update representation of resource</td>
</tr>
<tr>
<td>POST</td>
<td>create new resource or execute action on resource</td>
</tr>
<tr>
<td>DELETE</td>
<td>destroy resource</td>
</tr>
</tbody>
</table>
vCloud Component: vCenter Chargeback

- **Objective**
  - Accurately assign, measure, and analyze costs of workloads
  - Allow consumer to understand and be accountable for usage

- **Features**
  - Hierarchical chargeback view of vCenter and vCloud Director objects
  - Usage data collection aligned with resource allocation models
  - Cost assignment
  - Usage data warehouse
  - Reporting
  - Integrate with third-party billing
# vCenter Chargeback

## Assigning Costs to Resource Allocation Models

<table>
<thead>
<tr>
<th>Allocation Model</th>
<th>Cost Considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pay As You Go</td>
<td>• Depends on what is provisioned and/or actual usage</td>
</tr>
<tr>
<td></td>
<td>• Billing options:</td>
</tr>
<tr>
<td></td>
<td>• Flat fee (size/type of vApp)</td>
</tr>
<tr>
<td></td>
<td>• By vApp resource configuration</td>
</tr>
<tr>
<td></td>
<td>• By resources consumed (metered usage)</td>
</tr>
<tr>
<td></td>
<td>• Potentially unpredictable billing if demand unknown</td>
</tr>
<tr>
<td>Allocation Pool (“Virtual container”)</td>
<td>• Bill for actual usage with minimum guarantee</td>
</tr>
<tr>
<td></td>
<td>• Ability to overcommit subject to resource availability</td>
</tr>
<tr>
<td>Reservation Pool (“Physical container”)</td>
<td>• Bill for guaranteed containers, regardless of actual usage</td>
</tr>
<tr>
<td></td>
<td>• Predictable billing – no surprises</td>
</tr>
<tr>
<td></td>
<td>• Predictable level of service – get what you pay for</td>
</tr>
<tr>
<td></td>
<td>• May result in unconsumed but paid-for resources</td>
</tr>
</tbody>
</table>
vCloud Component: VMware Service Manager

Objective
- Facilitate workflow and approval process

Features
- Role based approval (requestor, approver)
- Workflow with email notification
  - vApp provisioning
  - Cloud organization creation
- Software license usage tracking
vCloud Component: vCloud Connector

Objective
• Connect local cloud or vSphere to remote cloud

Features
• Transfer vApp (OVF) from local instance to remote cloud or vice versa

See vSphere and vClouds in a single pane of glass from vSphere Client

Copy VMs, vApps, and templates between vSphere and vClouds
vCloud Component: vCenter Orchestrator

Objective

• Orchestrate operations at the vCloud level

Features

• vCO plug-in for vCloud API

![vCenter Orchestrator (vCO) Diagram]
Characteristics of PaaS

The application platform for the cloud era

- Integrated software stack
- Application execution engine
- Self-service application deployment
- Automated application infrastructure provisioning
- Curated, updated and operated as a service

“Contract” between Development and Operation
The risk of an “Incomplete PaaS”

PaaS solutions today are not complete
Introduces significant inhibitors to mainstream/enterprise adoption

- Can’t move between clouds
- Limited to a single provider
- No on-premise solutions
- Limited to a single framework
- Require “special” frameworks
Choice of frameworks
Choice of application services

- vFabric
- Postgres
- MySQL
- RabbitMQ
- Redis
- MongoDB
- Spring (Java)
- Scala
- Node.js

Application Service Interface
Choice of clouds
Significant adoption and a growing ecosystem

- **CloudFoundry.com**
  - Tens of thousands of beta users
  - Thousands of applications deployed

- **Strong community participation**
  - Hundreds of contributions from the OSS community
  - Erlang, install scripts, Neo4J, Rack, JRuby, PHP, Python

- **Multiple distributors, deployers, clouds**
  - Canonical, Dell, enStratus, OpsCode, RightScale

- **Cloud Foundry Community Leads Program**
  - Charter members: PHP by PHPfog, Python by ActiveState
Standards and Cloud Interoperability

• VMware actively contributes to and leads standards work
• VMware is deeply committed to freedom of choice

IaaS: The *most* choices for guest os.
  • MSDOS, Windows 3.1 up through Windows 8
  • 50+ different kinds of Linux:
    - RedHat, CentOS, Suse, Novell, Mandrake, Ubuntu, Debian, SCO, Turbolinux…
  • Solaris, FreeBSD, Novell Netware, Sun JDS

PaaS: The *most* open-source choices:
  • CloudFoundry released as open source: run on public or private cloud
  • Support for Java, Ruby, node.js, PHP, Python
  • Spring partnerships with Salesforce.com, Google App Engine
Problem

• Providing reliable workload transfers between private, public and hybrid clouds
• Packaging of workloads with accompanying dependencies and policies

Solution

• OVF (Open Virtualization Format): packaging of VMs and metadata
• Input from VMware, XenSource, Microsoft, Oracle, IBM, Intel, Sun, HP, Dell, Symantec, NEC, and many others
OVF (Open Virtualization Format)

- Distribution format for software packaged as virtual machines
  - Complete description of single-VM or complex multi-VM software solutions
  - Vendor and platform independent
  - Interoperable across virtualization platforms
  - Extensible

- Standards work summary
  - Technology submission by VMware and Citrix to DMTF September 2007
  - Submission by Dell, HP, IBM, Microsoft, VMware and XenSource to DMTF September 2007
  - DMTF OVF 1.0 standard February 2009
  - DMTF OVF 1.1 standard January 2010
  - ANSI INCITS 469-2010 standard August 2010 (OVF 1.1)
  - ISO/IEC 17203 standard August 2011 (OVF 1.1)
  - DMTF OVF 2.0 work-in-progress released July 2011
Cloud Management API

Problem

• Interoperable programmatic management of clouds

Solution

• **CIMI** (2011): Cloud Infrastructure Management Interface
• DMTF (dmtf.org) working group
• Input from VMware, Fujitsu, HP, Telefonica, Oracle, RedHat, many others.
Thank you